

# Enhancing the Understanding of the Value Provided to Fisheries by Man-made Aquatic Structures.

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# Foreword

In Western Australia, it is estimated that there are more than 7,400 man-made marine structures. These include structures associated with the oil and gas industry, shipwrecks, artificial reefs, break walls, structures associated with harbours, jetties, marine navigation markers. Around Australia, artificial reefs are being installed to enhance recreational fishing and diving experiences while other installations (e.g. Oyster Reefs) help to improve water quality and restore marine biodiversity. The fate of the many items of oil and gas infrastructure (platforms, wells, pipelines, mattresses, weights, mooring lines etc.) also need to be considered as they come to the end of their life. Around the globe, research suggests that there are substantial ecological communities growing on these structures and you only need to look at YouTube to appreciate they are used and valued by recreational and charter fishers in the Gulf of Mexico.

In the coming years, Western Australia and other states will plan, seek regulatory approval, and build new infrastructure in the marine environment. This may be in the form of new ports, offshore renewable energy, subsea cables and aquaculture facilities. The planning and approvals processes for these projects need to take into consideration the hopes, aspirations, and concerns of all the stakeholders.

In 2018, the state's recreational and commercial fishers (Recfishwest and WAFIC), commissioned a program of research as part of a <u>Fisheries Research Development Corporation project</u> aimed at documenting the social and economic values and benefits of a range of stakeholders towards man-made marine structures.

Using a series of case studies, the research group demonstrated several different sampling and analytical strategies to familiarise end users with what is possible and provided an overview of identified economic and social values as well as issues and opportunities associated with people's values and perceptions. The webinar from this presentation is available at <u>wamsi.org.au/project/webinar-frdc-man-made-structures</u>. A guide was also produced that can be used to determine options for collecting social and economic data.

This report is the result of a collaboration of researchers and subject experts from Curtin University, the University of Western Australia, Australian Institute of Marine Science, and the Western Australian Department of Primary Industries and Regional Development (Fisheries). The science focus was guided by a steering committee with industry representation from Chevron, BHP, Woodside, Santos, National Energy Resources Australia, WA Fisheries Research Advisory Board, Department of Primary Industries and Regional Development and the National Offshore Petroleum Safety and Environmental Management Authority. The outcome from this cross-sectoral collaboration, facilitated by the Western Australian Marine Science Institution, has provided an important science-based benchmark documenting the social, economic and environmental considerations associated with man-made marine structures. It is a vital point of reference for regulators, proponents and other stakeholders when considering the social and economic impact of installing or removing man-made marine structures.

Dr Luke Twomey CEO Western Australian Marine Science Institution

24 August 2021.

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# Abbreviations

AR Artificial reef AUD Australian dollars CS **Consumer surplus** CVM **Contingent Valuation Method** DCE **Discrete Choice Experiment** EEL Extended economic legitimacy EIAR **Exmouth Integrated Artificial Reef** MMS Man-made marine structures NGO Non-governmental organisation 0&G Oil and gas RAC **Research Advisory Committee** RUM Random Utility Model SLO Social license to operate TC Travel cost WA Western Australia WTP Willingness to pay

# Section 1: Executive summary

## Overview

This report outlines the social and economic values and benefits associated with man-made marine structures (MMS) in Western Australia.

The report is the outcome of research undertaken by staff from Curtin University (Professors Euan Harvey and Fran Ackermann, and Ms Georgina Hill), The University of Western Australia (Associate Professors Michael Burton and Julian Partridge, Drs Julian Clifton, Carmen Elrick-Barr, Johanna Zimmerhackel) in collaboration with, and with guidance from staff at the Department of Primary Industries and Regional Development (Dr Stephen Newman, Mr Mark Pagano), the Western Australian Marine Science Institution (Dr Jenny Shaw) and the Australian Institute of Marine Science (Dr Dianne McLean).

During 2019 and 2020 the researchers undertook seven online surveys which focussed on understanding the social and economic benefits and values that recreational and commercial fishers, divers and other users gained from using MMS in Western Australia. This was complemented by eleven focus groups which included representatives from the commercial and recreational fishers, but also the Oil and Gas (O&G) sector, regulators (state and federal), conservation, non-government organisations (NGOs), scientific sectors, and the general community. The researchers used data to develop five case studies representing a range of different structures and end users. These case studies focussed on inshore Thevenard Island subsea O&G infrastructure (incorporating recreational fishing), Woodside's Echo Yodel offshore subsea O&G infrastructure (incorporating commercial fishing), the Exmouth Integrated Artificial Reef (recreational fishing), the Exmouth Navy Pier (diving tourism), and the iconic Busselton Jetty in Southwestern Australia, which is used for tourism, by recreational fishers, divers, swimmers and many other stakeholders. A guidebook was produced outlining the different methods of identifying social and economic values, along with the types of data required, and the approaches to collecting this data. The guidebook also outlines the advantages, disadvantages and resource needs for each method. A database of the MMS in Western Australia was also compiled and made accessible online.

## Background

In 2018, the state's recreational and commercial fishers (represented by the peak bodies Recfishwest and WAFIC) commissioned a program of research as part of a Fisheries Research Development Corporation project aimed at documenting the social and economic values and benefits that stakeholders obtain from MMS in Western Australia. These structures include shipwrecks, artificial reefs, break walls, structures associated with harbours, jetties, marine navigation markers, and O&G infrastructure such as platforms, wells, and pipelines. These structures are used by a wide range of groups in the community for recreation. Some commercial fishers are designing, constructing and installing structures for aquaculture (e.g. abalone and coral for the aquarium trade, floating cages for fish). MMS can also generate direct and indirect income for local communities and businesses with people paying directly to use a resource, but also paying for goods and services locally to support their use. Members of the community, both those who use and those who do not directly use these structures can benefit from the existence of these structures.

Large investments have been made in the construction and installation of purpose-built structures on the seafloor to enhance the experience of recreational fishers (e.g. the Exmouth Integrated Artificial Reef) and divers (e.g. HMAS SWAN) with more structures planned. There will also be significant costs associated with proposed and future ports and offshore wind and wave farms. As a consequence, it is important to understand how to optimise the benefits of these structures for as many stakeholders as is practicable. While new structures are being proposed or installed on the North West Shelf of Australia and elsewhere, O&G infrastructure is generally reaching the end of its productive life and requires decisions on decommissioning strategies. The current legislative requirement and regulatory framework for decommissioning O&G infrastructure in Commonwealth waters (see Sect 572(3) of the Offshore Petroleum and Greenhouse Gas Storage Act 2006) requires the complete removal of structures. The legalisation provides for engagement with persons whose interests, activities and functions may be affected. As a consequence, regulators may support alternative strategies, such as leaving infrastructure in place, or relocation to create artificial reefs, if the risks and impacts are minimised and there are clear environmental, social, and economic benefits.

There is an increasing number of peer-reviewed manuscripts detailing the ecological values and potential benefits of these structures in Western Australia (e.g. McLean et. al. 2018, 2019; Bond et al. 2018a, b, Schramm et al. 2020). However, there is a lack of social and economic data which can inform discussions and decision making, both within Western Australia, nationally across Australia and globally. To inform discussions and decisions there is a need for information on the ecological, economic and social value of MMS to recreational and commercial fishers and other stakeholders, and not just the impacts of MMS on the ecology. For decommissioning in particular, there is a need to understand the opportunities and risks of decommissioning strategies to fishers and other stakeholder groups (e.g. tourism and the wider community) and to document the attitudes of stakeholders, including the broader community. It is also important to recognise that the values of stakeholders may change over time in response to new information about the risks and impacts of MMS. There is a need to ensure our understanding is current.

## Aims/objectives

To contribute information to this discussion this research aimed to:

- 1) Augment and integrate analytical methods to identify and explore the socioeconomic values of MMS in Western Australia.
- 2) Collate a list and description of the MMS in the marine environment in Western Australian and the associated social, economic and biodiversity data.
- 3) Collect and collate data on the social and economic values of MMS in Western Australia, including five case studies.
- 4) Develop a guide for undertaking socioeconomic evaluations of MMS which can be used throughout Australia (and other locations), and direct end users on approaches and strategies depending on their information requirements.

One of the goals of this project was to demonstrate the value of social and economic data, not only to decision makers, but to proponents of projects as a way of understanding the concerns of different stakeholders during the conceptualisation of a project. Proponents can use this information to create opportunities that derive benefits for different stakeholders.

## Methodology

The project was underpinned by a literature review, which set the context for the primary data collection. Primary data collection used seven online surveys to obtain information from different target audiences. The social component of the online surveys collected data on respondents' preferences and attitudes towards manmade marine structures, as well as socio-demographic information. Recruitment was targeted to the audience of interest, which in the case of the social science surveys was primarily users of MMS (e.g. recreational fishers and divers). The online components of economic surveys identified details of previous behaviour (visitation rates etc.) or derived stated preferences about how a user might behave under hypothetical outcomes for the future of MMS. We also used focus groups (both face to face and online) to create a more in-depth engagement with a smaller number of stakeholders.

The social and economic surveys took 15-20 minutes to complete, while the focus group approaches could take up to 3 hours, with these providing a more nuanced perspective of the issues, concerns, benefits, values and opportunities associated with MMS as perceived by different stakeholders, and thus develop a shared understanding.

## **Results/key findings**

The literature review revealed that limited primary social and economic data has been collected on MMS in Australia. While the values and benefits of MMS from other countries can be generalised and transferred to Australia, the usefulness of the information depends on the location specificity (i.e. local fine scale location specific areas of interest) required by proponents or decision makers. The case studies we present generated location specific social and economic values.

As a generalisation, most stakeholders believed that there were social, environmental, and economic values associated with MMS. Stakeholders raised concerns about MMS causing habitat degradation and marine pollution due to chemicals leaching or leaking from structures. Some of these concerns can be resolved by independent, robust, evidence-based case studies with the environmental costs and benefits of different future scenarios clearly communicated.

We also demonstrated that there are significant direct and indirect economic benefits associated with MMS. In coming years there will be an increasing number of proposals to create and deploy new MMS through the creation of ports and jetties, the installation of offshore renewable energy platforms, artificial reefs and other types of infrastructure. We believe there is a need to maximise the environmental, social and economic benefits that can be gained from the installation of these structures. This can be undertaken through eco-engineering which aims to maximise the ecological value of future structures by incorporating knowledge of ecological processes into engineering design principles. By considering the socio-economic values of a range of potential users during planning processes, it may be possible to not only achieve the primary goal of an infrastructure development program, but also maximise the social and economic benefits to potential users and avoid adverse stakeholder responses. Where structures have a temporary lifetime, and particularly where the legislative base-case requires removal, engineers need to ensure that structures are designed and maintained so they can be easily removed from the seafloor. When they cannot, they need to ensure that the structures that are left in place are designed to be environmentally appropriate and meet the social and environmental values and expectations of the community.

## Implications for relevant stakeholders

The information generated by this project provides a strong foundation to facilitate understanding of the values of MMS across diverse user groups into the future. To be trusted by all stakeholders, policy around the installation of new structures, and the removal of existing structures, must be informed by case studies that present robust and independent environmental, social, and economic data. The process also needs to engage and educate stakeholders and the broader community about the issues and opportunities.

The data we generated suggests there is the belief and credence among stakeholders, that there is a need for greater regulatory certainty. This is of particular importance to end users. Any changes to the regulatory framework need to address potential conflict between different users of MMS by providing mechanisms to allocate the use of specific structures to a particular sector, and/or to incorporate property rights.

Public acceptance, and indeed enthusiasm for MMS can be further developed through ongoing and continued extension strategies (communication plans) that highlight their environmental and socioeconomic benefits. These benefits are well established via international and domestic peer reviewed studies and the case studies we present herein. This information provides a means to bridge the otherwise disparate views of some stakeholder groups. These benefits can be realised over short timescales and can be described in accessible, non-technical terms. Building a consensus and positive view on MMS through reference to these attributes will help mitigate any adverse perceptions and values.

In the context of decommissioning O&G infrastructure, public confidence could be strengthened through recognition that the approvals process for decommissioning in Commonwealth waters requires evaluation of all environmental impacts and risks (not just benefits) and a demonstration that these impacts and risks will be of acceptable levels and reduced to as low as reasonably practicable.

It is important to note that the key approval required to install an artificial reef in Australia is the Commonwealth *Environmental Protection (Sea Dumping) Act 1981*, administered by the Department of Agriculture, Water and the Environment (DAWE; Australian Government). This in essence means that protection of the environment is paramount for the installation of any man-made structure.

## Recommendations

- The magnitude and breadth of the socio-economic values and benefits that arise from appropriately designed man-made marine structures (as identified by this report) need to be broadly socialized and communicated (reflecting the breadth of engagement). Understanding these benefits is a key component to guide any future decisions about MMS.
- 2) There is a need to develop greater regulatory clarity around the installation and removal of manmade marine structures (e.g., expanding and building on the Offshore Petroleum and Greenhouse Gas Storage Act 2006; developing guides for the assessment of permit applications for artificial reefs under the *Environmental Protection (Sea Dumping) Act 1981*). There needs to be clear guidelines developed across all levels of Government that reflects the needs of all stakeholder groups. While challenging, the objective would be to develop clear and transparent guidelines (or policy frameworks and regulations) that are consistent across the country. Specific suggested changes to guidelines or regulatory reforms should consider the following:
  - a) policy development that seeks to guide future proposals for the installation of purpose built and integrated (using repurposed subsea infrastructure) reefs in Australia.
  - b) incorporating social and economic data that reflect the values, issues and opportunities raised by stakeholders to maximise benefits is an important consideration for any guidelines. Highlighting benefits is essential for the development of social license for a wide range of projects from decommissioning of O&G infrastructure to the design and installation of artificial reefs, and the development of harbours and ports that are environmentally appropriate.
- 3) In Western Australia, the development and implementation of purpose-built artificial reefs in WA commenced in 2012. Since 2012, seven artificial reefs have been installed without any inter sector conflict. All reefs belong to the wider community. The key has been appropriate constraint mapping and consultation among multiple stakeholder groups prior to reefs being fabricated and deployed. This is a fundamental principle for any ongoing program.
- 4) There is a need to review the legal liability of MMS in general across governments, with the goal being to maximise the social and economic value that may arise from the development of MMS. In addition, consideration needs to be given to the development of explicit frameworks that identify end of life liability, as well as the costs and actions needed for site remediation and/or creation of MMS.

- 5) Importantly, there needs to be a more strategic approach to habitat enhancement structures in all jurisdictions. At present many purpose-built artificial reefs are simply located based on political desires and/or because there is a proposed decommissioning opportunity at the site. A more strategic approach is required from industry to validate and justify where purpose-built reefs are placed with a long-term vision to enhance both fish production and amenity value.
- 6) That further research on key gaps in ecological knowledge is needed to understand the net benefit of MMS for enhancing the condition of the marine environment: e.g., whether MMS provide habitats that increase fish productivity (or just act to attract and aggregate fish stocks); whether MMS are important for the protection of vulnerable species; how MMS will degrade over time and what environmental impacts may result, whether MMS could increase the risk invasive marine species.

## Keywords

Man-made marine structures, socioeconomics, benefits, values, opportunities, recreational fishing, commercial fishing, diving, tourism, artificial reefs, jetties, piers, shipwrecks, platforms, pipelines, decommissioning, planning, resource management, policy development.

# **Section 2: Introduction**

## Background

This project was identified by the WA RAC as a FRDC priority in its November 2017 funding round with this project being funded in July of 2019.

There are in excess 7400 items of MMS in Western Australian coastal and offshore waters (see Appendix 1). The MMS listed in Appendix 1 include shipwrecks, artificial reefs, break walls, structures associated with harbours, jetties, marine navigation markers and O&G infrastructure such as platforms, wells, and pipelines (Perkol-Finkel and Sella, 2015), but do not include aquaculture structures or subsea telecommunication infrastructure.

Different types of MMS are used by stakeholders for different purposes. For example, land based recreational fishers are known to use jetties, groynes, and breakwaters (Smallwood, 2011), while those who have access to boats also fish artificial reefs installed to enhance recreational fishing (Keller et al., 2016; Becker et al., 2020; Florisson et al., 2020). International literature shows that recreational and commercial fishers target offshore O&G infrastructure, including platforms and pipelines (Ditton and Auyong, 1984; Stanley and Wilson, 1989; Rouse et al., 2018) with data from Western Australia demonstrating that some commercial fishing effort (e.g. cage trapping) is periodically focussed along O&G pipelines on the North West Shelf (Bond, 2020). Jetties, shipwrecks, and O&G infrastructure are also utilised by recreational divers with some commercial diving tour operators taking customers to these artificial reefs (Stolk et al., 2005, 2007). In Australia, several ships have been deliberately cleaned, made safe and scuttled specifically to create new diving locations and experiences (Dowling et al., 2001). Internationally, O&G platforms are considered to be essential fish habitats in some countries (Love et al., 2006; Helvey, 2002; Claisse et al., 2019), or to have conservation values in areas where marine life is depleted (Friedlander et al., 2014).

Anecdotal data suggests that stakeholders from different sectors have a range of values driven by the types of MMS they use and their experiences using MMS (if at all) (Shaw et al., 2018). Consequently, different stakeholders have different views and perspectives about the issues and opportunities associated with MMS. This project aims to document those issues and opportunities and list, describe, and where possible quantify the social and economic values of stakeholders.

## Need/definition of problem

The northwest of Western Australia has important commercial and recreational fisheries and extensive offshore O&G infrastructure. These MMS support a range of demersal and pelagic fish species which are targeted by recreational and commercial fishers (Bond et al., 2018a; Schramm et al., 2020). As this O&G infrastructure reaches the end of its productive life, decisions on decommissioning strategies must be made. The current policy for decommissioning requires complete removal. Regulators may support alternative strategies, such as leaving infrastructure in place, or relocating to create artificial reefs if the risks and impacts are minimised, and there are clear environmental, social, and economic benefits. There is an increasing amount of peer-reviewed literature about the ecological values and potential benefits of these structures in Western Australia (Macreadie et al., 2011; Pradella et al., 2014; Fowler et al., 2015; Bond et al., 2018a, 2018b; McLean et al., 2018, 2019; Schramm et al., 2020). However, there is a lack of social and economic data which can inform discussions and decision making (Shaw et al., 2018).

While the discussion about the fate of O&G infrastructure is occurring, there have been large investments in constructing and installing purpose-built MMS on the seafloor to enhance the experience of recreational fishers and divers. There are also ongoing discussions about the ecological, social, and economic values associated with the restoration of terrestrial (Bond and Lake, 2003; Miller and Hobbs, 2007) and marine habitats (Ellison, 2000; Layton et al., 2020). As a fisheries management tool, the concept of habitat enhancement using artificial reefs designed to increase the recruitment, survival and carrying capacity of species targeted by commercial and recreational fishers is increasing in popularity (Stone, 1982; Bortone et al., 2011).

To inform discussions and decisions there is a need for information on:

- 1) the ecological, economic and social value of MMS to recreational and commercial fishers and other stakeholders;
- 2) the attitudes of stakeholders to MMS; and
- 3) the opportunities and risks of decommissioning strategies to fishers and other stakeholder groups (e.g. tourism).

## Why is this important

Social, economic, and ecological data are needed to inform any changes to existing or new policy and legislation regarding the removal of MMS from and/or installation into the sea. We believe that there is a lack of clarity and understanding across the regulatory and management sectors about the application of socioeconomic data to inform decision making on this issue. Similarly, there is a lack of awareness of the methods and techniques that are available for collecting, analysing, and presenting socioeconomic data. There is also a lack of awareness about the types of information that can be generated, the skills required to collect and generate that data, and the time and cost involved. Time and cost will vary depending on the level of detail required. This project has generated social and economic data that is generic to Western Australia, but also case studies that demonstrate the types of data that can be generated at a local scale.

## **Objectives**

The original objectives of this project were:

- 1) To develop conceptual qualitative, semi-quantitative and quantitative models for describing the socioeconomic values and decide what information is needed to give stakeholders an understanding of the value of man-made aquatic structures in the marine environment.
- To collate a list and description of the man-made aquatic structures in the marine environment in Western Australian and the associated social, economic and biodiversity data.
- To collect and collate data on four man-made aquatic structures in the marine environment and develop and compare the costs and benefits of qualitative, semi-quantitative and quantitative models.
- 4) To develop a decision support system or framework for undertaking socio- economic evaluations of man-made aquatic structures which can be used throughout Australia and guide end users on how to develop qualitative, semi- quantitative and quantitative models depending on their information requirements.

These objectives were refined as the project matured. They were also modified to accommodate the limitations forced on us by running a research project based on interviewing and surveying people during the COVID-19 pandemic. Consequently, the objectives of this project were refined:

- 1) To augment and integrate analytical methods to identify and explore the socioeconomic values of MMS in Western Australia.
- 2) To collate a list and description of the MMS in the marine environment in Western Australian and the associated social, economic and biodiversity data.
- 3) To collect and collate data on the social and economic values of MMS in Western Australia, including five case studies.
- 4) To develop a guide for undertaking socioeconomic evaluations of MMS which can be used throughout Australia (and other locations), and direct end users on approaches and strategies depending on their information requirements.

## **Definition of terms**

The terms economic, social and socioeconomic values and benefits have different meanings to different stakeholders. In the context of this research on the values of MMS, we define socioeconomic values as being:

"Values that people hold arising from the direct use (e.g. recreational fishing and diving), indirect use (e.g. flow-on effects to the local communities) and non-use (e.g. the existence of marine life; ecosystem values) with reference to MMS. Values may be material (e.g. employment, tourism, fishing catch), relational (e.g. social interaction/connection), or subjective (e.g. memories, perceived aesthetics, community or individual identity). Socioeconomic values can be either positive or negative and will interact with one another over space and time. Values will therefore evolve in response to the social, economic, political and environmental context."

## How did we collect data?

For the purposes of data collection and reporting we have divided the project into three components (See Figure 1). These comprise a social component which used online surveys to elicit information from individuals about their values and the positive or negative impacts of MMS. This component is referred to herein as the "social value - individual" component. Secondly, an economic component also used online surveys to collect broad-scale and site-specific information about individuals' economic values. This component is referred to hereon as the "economic value" component. Finally, a third component used a "focus group" approach to gain a comprehensive understanding of how the perceived values differed between stakeholders and sector groups and the issues and opportunities that substantiated them. The focus groups identified the interactions of issues and opportunities on one another and the values. Also, the interactions between different stakeholders (e.g. commercial and recreational fishers). This component is referred to herein as the "social value - group" component. More details about the specific approaches are outlined in the methods below. The research was underpinned by a global literature review (See Appendix 2).

The first phase of this project involved a comprehensive literature review to identify existing relevant data at a global, Australian, Western Australian, and regional scale to identify data gaps and assess their consequences. We also proposed to undertake four case studies on different types of MMS to demonstrate what outputs could be developed using different approaches. These structures included the inshore Thevenard Island subsea O&G infrastructure (incorporating recreational fishing), Woodside's Echo Yodel offshore subsea O&G infrastructure (incorporating commercial fishing), The Exmouth Integrated Artificial Reef (recreational fishing) and the Exmouth Navy Pier (diving tourism). At the suggestion of the steering committee, we also included a fifth case study, the Busselton Jetty, an iconic MMS in South Western Australia which is used for tourism, recreational fishers, divers, swimmers and many other stakeholders.

Initially, we planned to undertake four face to face focus group workshops (two in Exmouth and one in each of Karratha and Onslow). Due to COVID-19 the in-depth focus groups had to change the mode of delivery halfway through: from face-to-face to an online forum. An advantage of this in this case was the ability to broaden the geographical scope of the respondents and widen the stakeholder groups involved. We conducted the two face to face workshops in Exmouth and then trialled an online platform for running the workshops virtually. By the completion of the data collection phase, we had conducted 11 workshops in total with the groups from Karratha and Onslow. For the online focus groups, we ensured that stakeholders from the O&G sector, regulators (state and federal), recreational fishers, commercial fishers, conservation, NGO and scientific community all had representation.

Online surveys collected social and economic from a broad range of stakeholders while site specific online surveys collected data from users of the Exmouth Navy Pier, The Busselton Jetty and the broader Ningaloo, Onslow and Geographe Bay regions.

It should be noted that for some of the economic analysis, restrictions on data collection unique to 2020 and caused by Covid-19 restrictions mean that some results should be taken as indicative rather than definitive. For instance, there was an initial plan to conduct a series of boat ramp surveys to collect much of the data on spatial distribution of use, but these could not be completed due to COVID-19 travel restrictions. Instead, the online survey gathered information on location of fishing and diving trips (an essential input into the site choice models). As a consequence, some aspects of the economic analysis were not as detailed as initially intended.



### Figure 1: Data collection strategy.

# **Section 3: Methods**

## Overview

This project adopted mixed methods for evaluating the value of MMS, starting with a comprehensive literature review, followed by a wide-ranging number of primary data collection exercises. The latter were particularly important, as the literature review revealed that there has been relatively little primary data collection focused on MMS in Western Australia.

The primary data collection process reflected the different research approaches across the three components (Economic Value, Social Value - Group, Social Value - Individual) but were integrated together wherever possible. The survey approaches (adopted by the social value-individual and economic projects) relied on collecting data from large samples of the target population. The social surveys identified preferences and attitudes towards the MMS of interest, as well as general sociodemographic information about the respondents. Recruitment was targeted to the population of interest, which in the case of the social science surveys was primarily users of the MMS (e.g. recreational fishers and divers). The economic surveys identified details of previous behaviour (visitation rates etc.) or derived stated preferences about how a user might behave under hypothetical outcomes. Both approaches gave insights into how and why MMS might bring value to respondents but do so in different framings. The target populations were however often the same, and in that case the design attempted to achieve synergies across the two approaches. Thus, those who completed the main "social" survey were then invited to complete the "economic" survey, allowing a sharing of recruitment costs, and basic socio demographic information. Where the economic analysis required a targeted approach to a population using a specific MMS (i.e. the Busselton Jetty) it was possible to pass respondents through to complete the social survey as well so that complementary information could be collected for all groups.

The social values-group took a different approach, in that it required in-depth engagement with a smaller number of stakeholders (the social and economic surveys took 15-20 minutes to complete, while the group approaches could take up to 3 hours). Recruitment processes differed for this approach: key stakeholders were identified and invited into the process. However, this intensive approach was targeted at the same case study sites as the economic approach, and insights from the literature review were used to help frame the group discussions.

All primary data collection approaches in this project were approved from the Curtin University Human Ethics Committee (HRE2019-0465).

## Integration of online surveys

Seven survey questionnaires were developed, each targeting different user groups and/or case sites (Figure 2). The "social value - individual MMS user survey" collected data on the use, perceptions, and social values of multiple users of MMS (e.g., recreational fishers, divers, others) in Western Australia. Within this survey, respondents were asked to assign themselves to one of four stakeholder groups, i.e., recreational fisher, diver, other, or commercial, based on which they thought was the most relevant grouping for them. They were then directed to questions relevant to their selected group. Divers were defined as divers, snorkelers and free divers that do not engage in extractive activities. Recreational fishers were defined as fishers that fish for recreational purposes independent of the fishing technique/gear used. As such, spear fishers were classified recreational fishers. If respondents indicated that they were either recreational fishers or divers, they were forwarded to the "Economic random utility survey" which collected data on the use values of MMS

(relevant to their activity) on multiple sites in Western Australia. The surveys "Busselton Jetty individual travel cost survey" and "Navy Pier zonal travel cost surveys" were designed to collect data on the economic use values for users of these single sites. At the end of these surveys, respondents had the option to participate in the "social - individual MMS user survey" and the "economic random utility survey". Commercial fishers in Western Australia were asked about their use, perceptions, and social values for MMS in the "social - individual commercial fishers survey" and about their business revenues associated with MMS in the "economic commercial fishers survey". The "rigs-to-reefs discrete choice experiment survey" targeted the WA public and elicited economic non-use value associated with potential rigs-to-reefs programs and the publics' social license to operate for O&G companies to implement such programs in WA. The recruitment process for each survey is summarised in Table 1.

# *Figure 2: Distribution, sample and assessed values/information of online surveys from the economic component (green) and the social value - individual component (blue).*



Survey	Distribution	Data collection period	Incentives
Social - Individual MMS user Survey Economic random utility survey	<ul> <li>Recfishwest monthly 'Broadcast' newsletter (Dec 2019 and Jan 2020)</li> <li>Recfishwest Facebook page and Instagram posts (Dec 2019, Jan 2020 and Feb 2020)</li> <li>500 flyers and 100 posters mailed to 40 dive and tackle shops across all four WA fishing regions</li> <li>Forwarded from Busselton Jetty and Navy Pier travel cost surveys</li> </ul>	Nov 2019 - Mar 2020	Prize draw for \$750 AUD (social) Prize draw for \$50 AUD (economic)
Busselton Jetty individual travel cost survey	<ul> <li>Busselton Jetty newsletter and social media posts</li> <li>500 flyers at Busselton Jetty entrance and museum</li> </ul>	May - Sep 2020	Prize draw for \$50 AUD
Navy Pier zonal travel cost survey	<ul> <li>Exmouth dive operator emails to past clients</li> <li>500 flyers at Exmouth dive operator</li> </ul>	May - Sep 2020	Prize draw for \$50 AUD
Social - Individual commercial fishers survey	WAFIC email to commercial fishers     in Western Australia	Feb - Mar 2020	N/A
Economic commercial fishers survey			
Rigs-to-reefs discrete choice experiment survey	Market research company to WA general public	Mar 2020	N/A

Table 1: Recruitment strategy and data collection period for online surveys.

## Method: Systematic literature review

A systematic review of literature exploring the topic of socioeconomic values and MMS was conducted between June and September 2019. For full details on the methodology of the literature review, see "Socioeconomic values associated with man-made aquatic infrastructure academic literature review" in Appendix 2.

Web of Science, Scopus and Google Scholar databases were searched using synonyms for 'economic value', 'social value', 'man-made marine structure', 'structure user' and 'structure objectives'. These terms were based on existing literature and recommendations from technical experts. The review also drew upon a recent National Environmental Science Program (NESP) report that explored the economic value of artificial reefs as a reference source (Blackmore et al, unpublished).

The initial search returned a total of 633 articles, 365 of which focused on social values of MMS and 268 addressing economic values (see Figure 3). All articles' abstracts were then screened to include only those papers published in English from reputable academic, government or professional organisations with a clear focus on social or economic values of MMS, and whose full texts could be accessed via the authors' institutions. This resulted in a set of 117 papers which were then searched for additional references that met the above criteria, yielding a final total of 161 papers. All of these were subject to a full text analysis to identify papers that provided detailed information on specific social or economic values which could be attributed to a user group or MMS type, resulting in a final suite of 67 papers.

#### Figure 3: Literature review process.



The 33 papers detailing social values of MMS were analysed to extract information on the country and year of study; MMS types; stakeholder groups; methods of stakeholder engagement; methods of social value assessment; and findings in relation to social value by stakeholder groups. The concept of social value is diffuse and context-specific, with many different approaches adopted to characterize and measure the values held by stakeholder groups. Thus, research themes covered within the social literature were identified via an inductive approach, listing the social value research question of each paper, and collating into research themes. Three core themes were identified: (i) social values; (ii) perceptions; and (iii) use and behaviour. Social values are those values that people hold arising from the use (e.g. both direct and indirect use) and non-use (e.g. the existence of marine life) of manmade marine structures. Perceptions, reflecting an individual's understanding or interpretation, will shape and be shaped by individual values. Use and behaviour refer to the drivers of MMS usage (eg recreational, commercial) and the basis on which these are used (daily, monthly etc). Sub-themes were also constructed, where relevant, to capture further variation in research focus.

The 34 articles examining economic values of MMS were analysed to identify the country and year of study; MMS type; the measured value type(s); valuation method(s); valuation context or question; and willingness to- pay (WTP) estimate. All value estimates were converted to 2019 USD values using the World Bank Consumer Price Index for the relevant countries (available at https://data.worldbank.org/indicator/FP.CPI.TOTL.ZG) and an online currency converter (www.xe.com).

## Method: Social value - Individual

### Survey design

The social values survey was designed to obtain information on:

- characteristics of the respondent (e.g. age, gender, postcode).
- respondents' use of MMS.
- perceptions of MMS, involving the perceived social, economic and environmental opportunities and issues associated with MMS.
- the social values derived from respondents' use of MMS.

The survey contained both quantitative (closed response, multiple choice, Likert scale) and qualitative (open-ended) questions and was designed to be completed online in no more than 15 minutes.

Four surveys were developed, each targeting different user groups comprising (i) recreational fishers; (ii) recreational divers; (iii) other direct and indirect users; and (iv) commercial fishers. The rationale for four distinct surveys was to ensure that the questions relating to values (relational, subjective, and material) were appropriate with respect to the way the different users interact with MMS. As such, the questions were not in all cases consistent across stakeholder groups. The recruitment strategy for users (i) to (iii) was consistent; while an alternate recruitment strategy was adopted to target commercial fishers (see Table 1 above). The surveys are presented in Appendix 3.

The design of each survey was informed by the literature review, with initial questions covering respondent characteristics (age, gender, postcode), and asking respondents to self-allocate as a recreational fisher, diver or 'neither recreational fisher nor diver' (referred to herein as 'Other') to direct them to the appropriate target survey. While divers were defined as divers, snorkelers and free divers who do not engage in extractive activities, recreational fishers were defined as fishers that fish for recreational purposes independent of the fishing technique/gear used (hence, including spear fishing). Once within the target survey, questions gathered information on the respondent's level of experience with and importance of the chosen activity (e.g., diving or fishing), before asking questions relating to the three aspects of the social well-being framework: material, relational and subjective (refer to Figure 4 and Table 2 for example). The objective was to gather information on: (i) the range of subjective, relational, and material values users derive from MMS, and the importance of the contribution of MMS to social, economic, or environmental outcomes; and (iii) MMS users' views on O&G decommissioning options.

### Figure 4: Survey flow.

General characteristics (age, postcode, gender)				
Recreational fisher Scuba diver Other Commercial fisher			Commercial fisher	
Activity characteristics (e.g. fishing type, level of experience, importance of activity to individual)				
	MMS structure use (in	nclu	ding case sites)	
Site value (most visited MMS site; 1 <sup>st</sup> preference structure type)			Site value (most visited MMS site)	
Issues and Opportunities associated with MMS (open ended)		ed)		
Importance of (values) MMS (closed)				
Anything else important re: MMS (open)		mportant re: MMS (open)		
Perceptions of MMS (closed)				
Decommissioning preferences (closed)				
Other comments (open)				

Five-point Likert scale questions were applied to gather information on respondents' perceptions of MMS (ranging from strongly disagree to strongly agree) and the values they derive from MMS (ranging from not at all important to extremely important). A constraint of close-ended surveys arises when seeking to cover a complex issue through the use of short (i.e. to reduce time constraints), simple (i.e. understood by a diverse audience) and clear (i.e. no ambiguity in terms) questions. To achieve this, the questions relating to social values were designed specific to the target user group and were therefore not consistent in all instances. In addition, respondents had the opportunity to describe via open-ended responses the benefits and limitations (social, economic and environmental) of MMS in Western Australia. In this way, further information on values and perceptions that could extend the closed response questions designed to address aspects of the social well-being framework, were gathered.

Value category	Micro-scale	Macro-scale	Meso-scale
M: Material (income, equipment, assets)	Values: General Independence to choose when or how I access (R/M) Values: MMS Site Specific Value attributed to quantity of fish caught at location X	<b>Perceptions</b> MMS contribute to local tourism MMS provide employment opportunities in the local community <b>Values</b> Contribution of MMS to the local economy (S/M)	
S: Subjective	Values: General Fishing around MMS Diving around MMS Memories or souvenirs collected (S/M) Values: MMS Site Specific Fishing/diving at location X Species at location/visual experience of location X	Perceptions A central point of identify for local communities Values Contribution of MMS to local community identity (S/R)	Perceptions Structures sustain and increase fish populations and other marine life over time Values Contribution of MMS to ecosystem health (mac/mes)
R: Relational (social connections, status, management)	Values: General Talking to friends or family about my fishing/diving experiences Social connections I have made	Perceptions Sites of conflict between different user groups (R/S) Values Unrestricted access (M/R)	<i>Perceptions</i> Existing management controls allow for the sustainable use (R/M)

### Table 2: Example of the alignment between conceptual model of social values and survey questions.

Finally, respondents were asked their views on decommissioning and whether, when O&G facilities come to the end of their operational life, they should be:

- Totally removed and scrapped/recycled.
- Totally or partially removed and made into an artificial reef after being rendered physically stable and environmentally safe.
- Left where they are after having all oil/contaminants removed.

### **Survey analysis**

Analysis of the survey responses was conducted to ascertain the following:

- 1) The level of use of MMS in Western Australia, by MMS structure type (jetties, O&G structures), and for select case study sites.
- 2) The values users derive from MMS in Western Australia and the relative importance of those values.
- 3) Stakeholders' perceptions of MMS.
- 4) Stakeholders' preferred options in relation to decommissioning of O&G infrastructure.
- 5) How values and perceptions differ depending on the types of MMS used by respondents.
- 6) Whether different stakeholder groups hold divergent or convergent values and perceptions of MMS.
- 7) The degree of variance within stakeholder groups regarding the importance they assign to values derived from MMS and their perceptions of MMS.

The intention was to generate an understanding of use, perceptions, and values at the State level, before exploring the drivers of variation within and between stakeholder groups. The first step involved data cleaning (removing duplicates and/or incomplete responses). The survey questions that were compatible across the four surveys were then linked. For example, questions relating to perceptions of MMS were consistent across the four surveys and were 'matched' to enable comparative analysis across stakeholder groups. Similarly, questions relating to the use of different MMS structure types and case sites were largely consistent across the user groups (with different terms applied to capture Thevenard Offshore O&G and some options removed where not applicable to the user group; for example, recreational fishers are not permitted to access the Exmouth Navy Pier). Finally, the questions relating to social values that were comparable across the groups were aligned, where possible. The full survey response dataset is available electronically at https://wamsi.org.au/research/programs/frdc-man-made-structures/.

The survey did not require respondents to name individual MMS that they used, as it was felt this would add considerably to the time required for respondents to complete the survey. Consequently, analysis of responses was undertaken to identify categories of MMS usage in the last 12 months. This generated five categories comprising 1) jetty and/or pier users only; 2) offshore MMS users only; 3) combination of onshore and offshore MMS users; 4) users of all MMS; and 5) non-users. For instance, if a respondent noted that they had visited piers and jetties within the last 12 months, but no other form of structure, they were categorised as 'jetty and/or pier users only'; whilst if they had only used artificial reefs, they were categorised as 'offshore MMS users only'.

To explore the drivers of within and between group variation in perceptions and values, chi-square cross-tabulations and ordinal logistic regression analysis was performed in SPSS. In the first instance, differences in the ratings assigned to each value and perception statement by user group (i.e., recreational fisher, diver, other, commercial fisher) were considered. Pearson chi-square tests with P values <0.05 were defined as a significant level of difference and further analysis of the factors contributing to variation were explored via ordinal logistic regression.

Ordinal logistic regression can operate with categorical and ordinal values. However, respondent age was captured over nine age categories following ABS standard classifications. To facilitate data analysis, three generational age groups were constructed from the base data: 'Generation Y': 15-39 years, born 1980-994; 'Generation X': 40-54 years, born 1964-1985; and 'Baby Boomer': 55+ years, born 1946-1964. In addition, 'unsure' responses were removed. Any 'unsure' responses to values and

perceptions questions were automatically coded 6 (as they were the last option within the multiplechoice question) and therefore had the potential to be processed as of 'highest value' or 'most agreement', respectively within ordinal regression. We chose to remove these rather than reclassify unsure responses as 'neutral', as a neutral option was made available to respondents.

The ordinal logistic regression provided an understanding of the extent to which the independent variables explain the response to the value or perception statement. Positive coefficients imply that higher values of the independent variable will increase the probability of a 'higher' scored response. Significant relationships are evaluated on the basis of the p value for the individual coefficients. The overall significance of the model measures the joint contribution of all independent variables (based on a chi squared test comparing the fitted model with one that only has a constant: reported as Model Fitting Sig.). There are several measures of goodness of fit: we report the Pearson test, which assumes that there is a congruence between the observed answers and those predicted by the model, for the categories of the independent variables. Significance values greater than 0.05 imply a failure to reject the null of a good fit.

Open-ended responses to the questions on the social, economic, and environmental benefits and issues associated with MMS were imported into NVIVO and inductively coded. Also referred to as open coding, inductive coding creates codes based on the qualitative data itself and does not draw on a framework to inform the approach to coding. While the alternative deductive approach was considered, using the social-wellbeing framework as a tool to structure coding of the open-ended responses, it was deemed appropriate to adopt an inductive approach to enable movement beyond the framework that informed data collection through the closed survey responses.

Responses to the Busselton social survey were analysed separately from the State-wide surveys. The focus was on obtaining site-specific information on values and perceptions, as well as use levels. As such, values were confined to micro-scale, site-specific values, focusing on the subjective and relational values relevant to recreational fishing, diving, and other user groups.

## Method: Economic value

### The total economic value

In the context of MMS, one can categorise values into three broad types (Table 3).

Values arising from direct use (i.e. those that require some interaction with the resource of interest, e.g. through fishing, diving, tourism).

Indirect values, which are values that may accrue through the presence of the resource, but which does not involve direct involvement with it (e.g. coastal protection from habitat improvement, and in our case we extend this to include multiplier effects on local economies from expenditure arising from direct use).

Non-use or existence values, which people may hold for the environment, but without the need to directly interact with it (e.g. the value gained from knowing that an ecosystem/species exists and is maintained).

Total Economic Value			
Direct Use Values	Indirect Use Values	Non-Use Values	
Benefits arising from the immediate use of a MMS in the form of outputs that can be consumed or enjoyed directly. <b>Examples:</b> Extractive uses (e.g., commercial, and recreational fishing,	Benefits that a MMS provides to support other economic activities, or positive externalities that affect other users of the marine environment. <b>Examples:</b> Fish production via habitat protection (e.g., seagrass).	Benefits from knowing that a marine asset has been conserved (existence and bequest/altruistic values) or may be available for use later (option value). <b>Examples:</b> Knowledge that reef-based protection has increased marine biodiversity	
offshore aquaculture) Non-extractive uses (e.g., diving and surfing tourism)	Effort diversion from overexploited fisheries or dive sites. Coastal and shoreline protection. Water quality improvement via nutrient removal	Knowledge that a unique habitat is conserved intact for future generations	

### Table 3: Total Economic Value (adapted from Whitmarsh et al. 2008).

Values can be differentiated into 'producer' and 'consumer' surplus. Producer surplus (PS) is synonymous with profit e.g., the profit earned by commercial fishers, or those providing accommodation to recreational users of MMS. Consumer surplus (CS) accrues to those who enjoy the outcomes of the economic activity i.e., those who purchase the fish, (or recreational experience), and is a measure of the value of those goods/activities to the end user.

It is important to distinguish between consumer surplus and expenditures. Expenditures are the costs that users of MMS incur when participating in some activity associated with MMS (e.g., a fisher expends money for bait at local tackle shops, or a consumer purchases fish). Although direct

expenditure is often taken as a measure of the value of an activity, this is strictly not the case. It gives no indication of the level of consumer benefit that may be enjoyed (e.g., some shore based recreational fishing may have high value to the fisher but involve negligible expenditure). It overstates the community benefits (e.g., to those who supply goods/services consumed), as strictly it is the profits that are earned from this expenditure that is the benefit to society. However, the aggregate expenditure or jobs created, are often used instead as a proxy.

However, those who participate in activities gain additional value, over and above the expenditure they have incurred. It is this additional value that is defined as the consumer surplus (or 'welfare' or 'utility'). The consumer surplus can originate from activities directly or indirectly associated with an MMS (CS from the direct or indirect use), or from the existence of MMS (e.g., an improved environment), independent of any activity on MMS (i.e., CS from non-use, also called "existence value"). Although this value can be considered as a 'psychic' phenomenon, there exist methods by which it can be quantified in monetary terms and the use of these values is increasingly accepted in policy evaluation (for example see Bateman and Kling, 2020, for an overview of their use in the UK, EU, and USA).

### **Economic valuation approaches**

There are a variety of economic valuation approaches to estimate particular economic value types, or the total economic value of MMS. These can be broadly categorised into approaches applied in the absence of primary data and with primary data collection taking place. The former is the "benefit transfer approach" that uses previous data and literature to assess the value of MMS. The latter contains numerous valuation techniques. Here we applied approaches that focus on the use values of single sites, the use values of multiple sites as well as on the non-use values associated with MMS.

### Economic values in the absence of primary data: Benefit transfer

In the absence of primary data collection, economic use and non-use values can be quantified using the benefit transfer approach. This was done by estimating a demand curve using information on:

- The size of the population that uses the structure per user group.
- The frequency of trips to the structure in a given time frame (i.e., the last 12 months).
- Economic benefits associated with the structure and/or the activity on the structure.

The identified information needed can be collected from a variety of different sources. Economic data such as the expenditure and consumer surplus measures are regularly available in scientific or grey literature as well as data from governments. For the most reliable results, the numbers used are as closely related to the case study as possible. Factors that can be taken into consideration to check for the applicability of values take into consideration the geographic proximity and the cultural and economic context of the location, the year of data collection, the target species, and the quality of the research or information. In the case that not all the needed data are readily available from existing literature and online sources, the missing information can be gathered through interviews or focus groups with representatives of stakeholder groups.

The benefit transfer approach allows for the estimation of both, use and non-use values, depending on the availability of the information in the literature. Whether a study has assessed non-use values can be identified by checking if they have: (i) used a non-market valuation technique (e.g., discrete choice experiment) and (ii) have sampled the population that does not necessarily use the MMS directly or indirectly (typically the general public). It is important to notice that non-market valuation techniques can measure both use and non-use values. The consumer surplus measure from the literature is then aggregated over the relevant population of the case studies. We developed an assessment framework to estimate the economic value for two case studies:

- O&G infrastructure around Thevenard Island off Onslow which are potential future artificial reefs for a range of different end-users. Values were estimated for two different decommissioning scenarios: i) leave existing O&G structures in place and ii) repurposing parts of the material for new artificial reefs (Appendix 4).
- 2) The Exmouth Integrated Artificial Reef (EIAR) is an existing artificial reef which allowed us to evaluate some pre- and post- data on ecological conditions, and there were relatively good (although still limited) data on recreational fishing activity in the relevant area (Appendix 4).

There is an ongoing discussion about the capability of artificial reefs to produce new biomass vs attracting biomass from surrounding areas (Bull and Love, 2019). The generation of new fish biomass increases the catchability and/or the number of fish to be observed on the artificial structure while maintaining the condition in the surrounding areas equal. Conversely, the attraction of biomass from surrounding areas re-distributes the existing biomass and can increase the catchability on the artificial structure but might decrease the catchability in the surrounding areas (Pickering and Whitmarsh, 1997).

Moreover, there is an uncertainty about whether artificial reef users are new users in the area generating new revenues, or whether they substitute another local site with the artificial reef site. These two factors have consequences for the economic value that an artificial reef can generate. To get an understanding of the range of possible values, we applied two different approaches:

• Approach 1: Upper value

To estimate the upper value of the possible range of the economic impact from an artificial reef, this approach assumed that there is new production of fish biomass available around the reef and that the reef attracts new fishers to the area.

• Approach 2: Lower value

The lower bound of the value range assumed that the biomass on the artificial structure is attracted from the surroundings and that the users have been engaging in activities in the area before the creation of the structure. The creation of a new artificial reef will redistribute efforts in the area and create economic value through lower congestion. This increase in value can attract new users to the area.

Full details of the methods applied can be found in the case study report "The potential economic value associated with the development of artificial reefs in Western Australia" in Appendix 4.

#### Economic use values: Single site-specific

#### Travel cost method

The travel cost method is used to estimate economic use values that are associated with recreational sites. The method is based on the principle that the number of trips people make, and their different travel costs reveal their willingness to pay (WTP) to visit that site (Ward and Loomis, 1986). Therefore, we can estimate not only the expenditures, but also the surplus measure associated with that site. As this method is concerned with single sites, it cannot account for substitutions among different sites. Here, we applied two variations of the travel cost method to two case studies: A zonal travel cost method for tourists diving at the Exmouth Navy Pier and an individual travel cost method for users of the Busselton Jetty.

In both cases, the valuation of economic use values required the estimation of a demand curve which needs the following information that were collected in an online survey:

- the size of the population that uses the structure per user group.
- on land and on water expenditures associated with trips to the MMS.
- the frequency of trips to the structure in a given time frame (i.e., the last 12 months).

Furthermore, the travel cost surveys asked respondents for additional information such as respondents' place of residence, the number of people in their group during the visit, substitution activities if the MMS was not available, and demographic information such as age, gender, and annual household income. In the case of the Busselton Jetty, multiple user groups are visiting the site. Therefore, we also asked them about the way respondents use or engage with the Jetty (see full surveys in Appendix 5).

Economic values were measured as the difference between the status quo and a proposed change in condition. The status quo might be the presence, the absence, or a specific state of an MMS. Consequently, the change in conditions could be that an MMS is being added, removed, or modified. In the two case studies, the MMS is already in place, hence we measured the value under the current level of usage compared to the usage under the proposed condition (e.g., an increase in entrance fees).

### Zonal travel cost method for Exmouth Navy Pier

The zonal travel cost method was used to calculate the number of visits from dive tourists to the Ningaloo Region assuming that travel costs increase with distance. Different travel distances were then combined into six zones (geographic areas) around the site (in the order of increasing distance): Western Australia, other states of Australia, Oceania, Asia, Europe and America. The visitation rate from these zones was obtained based on days spent per million capita of the total population of countries where visitors came from in each zone. We fitted a regression analysis (see formula below) to the data and used the predicted model to estimate how the demand (the number of days spent) in the Ningaloo region would change if travel costs increased. The change in demand under increasing costs revealed the economic benefit (consumer surplus) that the Ningaloo region provides to visitors.

### $\ln(stay) = \alpha + \beta / TC$

where *stay* is the total number of days that people of a certain zone stayed in the Exmouth region, *TC* is the travel cost that is needed to travel from each zone to the Exmouth region and  $\alpha$  and  $\beta$  are model parameters.

### Individual travel cost method for Busselton Jetty

The individual travel cost method relies on estimating a relationship between the trip frequency to a site, and the cost of accessing the site. A Poisson model is commonly used to model the data, as it reflects the count (integer) and non-negative nature of the data. However, there are several issues that have to be addressed. The Poisson model is well known to impose restrictions on the distribution of the data: the assumption is that the conditional mean and variance of the dependent variable is equal, which may not be the case. Extension to the model allows for over dispersion (a negative binomial model). Secondly, if data is collected from intercept sampling, then by definition the number of visits has to be more than one. However, we dealt with this issue by a simple adjustment: by subtracting one from all number of trips (Shaw, 1988).

A further issue arises when data is right censored: if identification of the number of trips includes a "more than x" category. However, there exists a censored negative binomial model, implemented in Stata (Hilbe, 2011).

The estimate of the consumer surplus associated with a trip is identified simply as the negative inverse of the coefficient estimated on cost.

For all details on the methodology, see the full report "The economic value of the Exmouth Navy Pier and Busselton Jetty, Western Australia" in Appendix 5.

#### Economic use values: Choices across multiple sites

#### Random utility model

We used a random utility model (RUM) to analyse to what extent MMS influences the site choice of boat-based recreational fishers and divers in four regions in Western Australia: Geographe Bay, Coral Bay, Exmouth, and Onslow region. The advantage of this approach is that RUMs can not only test how site specific and individual specific factors influence respondents' site choice, but they can also estimate the monetary value of these effects. Moreover, this method allowed us to predict the economic consequences of future scenarios (such as the removal or addition of MMS) for recreational users.

The random utility approach works under the assumption that individuals visit a specific site (out of all possible sites) because they prefer it over the others (they maximize their utility). This site choice is influenced by trade-offs between the quality of the site and the costs to travel to the site. Consequently, the RUM requires information on relevant characteristics and the travel costs for all sites that a visitor could choose.

We used an online survey with recreational fishers and divers that asked about their boat-based trips in the four regions: Geographe Bay, Coral Bay, Exmouth and Onslow in the last 12 months. For each region they visited, they were presented with a map on which they could indicate the exact location that they were fishing or diving at. We also asked them about on-the-water travel distance, travel costs to arrive at the destination, other costs associated with trips, what activity was done at the site, the place of residence, demographic information and factors that determine the quality of the sites (e.g., target fish species). The full survey can be accessed in Appendix 6.

Surveys can also be collected at boat ramps within the study site or via apps that allow respondents to enter detailed information about their visits in a logbook. Due to COVID-19, this approach was not implemented in this case study.

We used a logistic regression (logit) model to test what factors influence the probability of a respondent to choose a certain location in the regions. Each choice option was one cell in a grid of 10 x 10 nautical miles (Figure 5). The limit of the grid was determined by the extent of the map shown to respondents in the survey.

*Figure 5: Study regions with grid, MMS and locations where MMS were hypothetically added.* 

(A) Geographe Bay, (B) Coral Bay, Exmouth, and Onslow region, and (C) close-up of Onslow region.



The variables that we tested for significance were:

- on the water travel cost in AUD.
- number of MMS type per grid cell for shipwrecks, artificial reefs, jetties, and pipelines.
- mean water depth per grid cell in meters.
- distance from the shore in km.
- surface area of the grid cell in square meters.

### Welfare impact of MMS

The model results of the RUM give information about how the above variables influence the probability of visitors to choose the different sites (grid cells) within the study area. Consequently, this approach is able to predict the change in site choices when conditions of a certain site change. We predicted the change in welfare for boat-based recreational fishers and divers associated with various hypothetical scenarios (Table 4) such as the removal of existing MMS as well as the addition of new MMS at certain sites (Figure 5A). We distinguished between different MMS types to measure the effect on recreational fishers and divers because they are being used differently by the user groups:

- shipwrecks in the study area are only open for access to divers.
- artificial reefs are mainly designed for recreational fishing activities but are open to divers.
- Busselton Jetty is open to both recreational fishing and diving, except for a sanctuary zone that is only open to diving.
- Thevenard O&G infrastructure is currently closed to any recreational and commercial activities.

To understand the value associated with potential diving and recreational fishing on Thevenard O&G infrastructure, we changed the structure types into either "shipwrecks" or "artificial reefs" to imitate conditions that are more favourable to divers or recreational fishers. Also, we did not consider the Navy Pier in the scenarios because it is closed to boat-based activities.

Importantly, the RUM measured the change in welfare when visitors substitute among different sites when conditions change. Therefore, the estimated change in welfare took these substitutions in account. It should also be noted that these estimates of welfare changes for the users of the MMS do not account for any costs of constructing them. They therefore represent the benefits of MMS, and could then be combined with estimates of costs within a full cost benefit analysis.

Scenario	Description
Geograp	ne Bay
BJ	Remove Busselton Jetty
sw	Remove Swan Wreck
LW	Remove Lena Wreck
DAR	Remove Dunsborough AR
BAR	Remove Bunbury AR
G25	Add MMS in Geographe Bay (cell 25)*
G28	Add MMS in Geographe Bay (cell 28)*
Coral Bay	/
C36	Add MMS (cell 36)*
Exmouth	region
EAR	Remove EIAR
EW	EIAR diver access only
E37	Add MMS (cell 37)*
Onslow r	egion
AR9	Access O&G infrastructure: 9 "artificial reefs"
W9	Access O&G infrastructure: 9 "wrecks"
AR4W5	Access O&G infrastructure: 4 "artificial reefs" (Roller A, Roller B, Cowle, Saladin A, Saladin C) and 5 "wrecks" (Roller B, Skate, Yammaderry, Saladin B)
AR2	Access O&G infrastructure: 2 "artificial reefs" (Roller B, Roller C)
W2	Access O&G infrastructure: 2 "wrecks" (Roller B, Roller C)

Table 4: Hypothetical scenarios describing the change of MMS at study sites.

\* Added "artificial reefs" for recreational fishers and "wrecks" for divers a) Note that the MMS are assumed to be in the centre of the grid cell

For all details on the methodology, see full report "The use value of man-made marine structures in Western Australia: A random utility model" in Appendix 6.

### **Economic existence values: Community preferences**

### Discrete choice experiment

A discrete choice experiment (DCE) was designed to assess Western Australia community members' preferences towards different policies of MMS. We applied this approach to rigs-to-reefs as an alternative option to complete removal of offshore O&G infrastructure in Western Australia. In this context, we estimated the relative values held by the community members for different attributes of rigs-to-reefs policy. We assessed community members' attitudes towards the O&G sector by measuring their Social License to Operate (SLO) granted to this sector and estimated the extent to which these attitudes could influence their preferences among the two policy alternatives: complete removal vs. rigs-to-reefs.

Like the random utility approach, the DCE approach assumes that people make choices that maximize their utility. It also assumes that the higher the utility of an environmental good the higher their WTP, even when they do not directly or indirectly use this good. Hence, this method is suitable to measure existence (or non-use) values. In the context of MMS, non-use values reflect the value
that people hold for the marine life around the structures and are willing to pay for its preservation, even when they never plan on visiting the area. This WTP depends on the characteristics of the MMS, here called attributes. Each attribute can have different levels (such as specific amounts of biomass). One of the attributes is a monetary measure (also called a payment vehicle), hence we can use the DCE to measure the WTP of people depending on different levels of these attributes. The payment vehicle in this survey was presented as the percentage of the savings that companies would make from not undertaking complete removal and would be paid out to the State budget as additional revenue. All attributes and their levels are described in Table 5.

Attributes	Rig-to-reef levels	Status quo levels
Total fish biomass (tonnes)	0.5, 1, 1.5	Negligible
Fish attracted vs. Fish produced	Attracted, Produced	N/A
Habitat for threatened species	Yes, No	N/A
Who can access the reef	None, Rec. Fishing, Rec. Diving	N/A
Future liability in case of any environmental damage occurring	Company, Government (taxpayer), Shared	N/A
Amount of money paid to the State budget by the company (AUD)	100 million, 130 million, 160 million	0

#### Table 5: Attributes and levels.

The DCE survey presented participants with a number of different rigs-to-reefs scenarios that are reflected in choice options in which the level of each attribute was being alternated. For each choice set, one choice option always remained the status quo level of each attribute (Figure 6). Respondents were then asked to choose their preferred option for each choice set.

#### *Figure 6: Example of choice set.*

	OPTION 1 Rig-to-reef	OPTION 2 Rig-to-reef	OPTION 3 Complete removal
	<u></u>	1	
Total fish biomass (tonnes)	0.5	1.5	Negligible
Fish attracted vs. Fish produced	Produced	Produced	
Habitat for threatened species	Yes	No	
Who can access the reef	Recreational Fishers	Recreational Divers	N/A
Future liability in case of any environmental damage occurring	Government (taxpayer)	Government (taxpayer)	
Amount of money (AU\$) paid to the State budget by the Company	160 million	100 million	0

Additionally, the survey measured the SLO of respondents by asking respondents for their attitudes towards the conservation of the marine environment and the O&G industry. The questions followed the approach by Boutilier and Thomson (2011) which identifies four increasing levels of SLO: economic legitimacy, interactional trust, socio-political legitimacy, and institutionalized trust (Table 6). Finally, respondents were also asked debriefing questions regarding their choices, and demographic information. For the full survey, see Appendix 7.

SLO Level	Description
1. Economic legitimacy	Refers to the perception of economic benefit from the company.
2a. Socio-political	Refers to the perception that the well-being of the region can be
legitimacy	improved by the company.
2h Interactional trust	Refers to the perception that the company is involved in mutual
zb. Interactional trust	dialogue with the community and demonstrates reciprocity.
	The highest level of SLO that can be achieved by a company and
2 Institutionalised trust	refers to the perception that relations between the community and
3. Institutionalised trust	the company are based on the consideration of each other's
	interests.

#### Table 6: Description of levels of SLO (Source: (Boutilier and Thomson, 2011))

The data generated by the DCE were analysed by statistical models that measured the preferences for the different policy scenarios. The analysis provides information about the effect that each level of each attribute has on the preferences and the WTP of respondents.

For all details of the methodology, see the full report "Community acceptance of rigs-to-reefs in Western Australia" in Appendix 7.

# Method: Social value - Group

# **Focus groups**

A series of focus groups were undertaken to complement the survey data elicited from the social value: individual activity. These were designed to allow for participants to surface *deep* (reflecting nuanced, elaborated data capture) and *systemic* (reflecting the presence of interactivity between elements) information. This would allow for a more fine-grained appreciation of the varying values surrounding MMS. In addition, the focus groups were designed to enable participants to gain an *increased awareness and understanding* of the range of issues, opportunities and values surrounding MMS. Other guiding factors taken into account included:

- ensuring capture of contemporaneous data (rather than relying on historical and possibly outdated information).
- attending to context (reflecting the varying impacts/appetites of different geographies).
- addressing a wide range of perspectives i.e., different cohorts of stakeholders (ensuring breadth of view).

The focus group workshops comprised a mix of 'in person, face to face' and 'online' groups, due to COVID-19. Each focus group was targeted to a particular cohort (stakeholder group) including community groups (Exmouth, Busselton, Karratha, Onslow), regulators (federal and state), fishing (commercial and recreational), O&G companies and NGOs. Eleven workshops were run from October 2019 to August 2020, involving a total of 64 participants, with an average of six participants per workshop. The majority of the participants were from Western Australia, however, the Commercial Fishers workshop had one participant from the Northern Territory, the Recreational Fishers' workshop had participants from Victoria, the Northern Territory, Queensland, and New South Wales and the second Regulator 2 workshop had three participants from Canberra. See below Table 7 for details.

## Table 7: Dates and participants of workshops.

Workshop (broader classification of attendees)	Workshop Date	F2F or Online?	Participants
<b>Exmouth 1</b> (Industry, conservation, private sector, local government)	15/10/2019	F2F	7
<b>Exmouth 2</b> (Industry, conservation, private sector)	16/10/2019	F2F	8
<b>Chevron</b> (Industry)	23/04/2020	Online	4
<b>Regulator 1</b> (State and federal government)	18/05/2020	Online	4
<b>Oil &amp; Gas</b> (Industry)	21/05/2020	Online	5
<b>Regulator 2</b> (State and Federal government)	22/05/2020	Online	8*
<b>Recreational Fishers</b> (Private sector, research, industry)	09/06/2020	Online	6*
Karratha & Onslow (Private sector, local government)	24/06/2020	Online	4
<b>Busselton</b> (Private sector, research, conservation, industry)	14/07/2020	Online	4
<b>Commercial Fishers</b> (Industry, private sector, conservation)	21/07/2020	Online	7*
Non-Government Organisation (Industry, conservation)	12/08/2020	Online	7
Total:			64

\*participants joining from places other than Western Australia.

The rationale for conducting stakeholder cohort-oriented focus groups was that it would be possible to identify any cohort idiosyncrasies and subsequently analyse the data to reveal the extent of homogeneity/ heterogeneity of view both between and within cohorts. Thus, it would enable those making decisions to appreciate the diversity (or not) of perspective and be able to design policies and actions accordingly. Attendees were selected based on personal contacts, recommendations, and to ensure diversity of view using a purposive sampling method (Miles and Huberman, 1994).

## The design

The process adopted followed a well-established modelling process which allowed for a structured conversation (Ackermann and Eden, 2011a, 2011b). Each focus group workshop, regardless of mode (face-to-face or online), followed the same design (to ensure comparability) and lasted between 3 to 3.5 hours. The rationale for the selected length of time was to balance busy diaries with being able to capture and explore the emergent material in a comprehensive fashion.

Each focus group workshop began with an introduction to the research objectives, and a review of the agenda, providing participants with a clear outline of how the focus group would unfold. After a brief explanation of mechanics associated with the Group Support System used, all the workshops commenced with participants being requested to surface the issues and opportunities that they felt underpinned MMS. This focus was selected as prior research experience has shown that it is often difficult for individuals to identify the values that drive their behaviour (those 'in action') - instead participants provide values that are 'espoused' (Ackermann and Eden, 2011a). Research has also showed that a less than complete set of values is obtained by simply asking for values. Starting with issues and opportunities enables participants to tease out values 'in action' as issues are only issues if they potentially 'challenge' a desired outcome. Likewise, opportunities provide the basis for eliciting 'aspired for' or valued futures.

In addition, it was believed that by eliciting a wide range of issues and opportunities, decision makers would be better positioned to arrive at *robust* (capitalising on the range of expertise) and *acceptable* (attending to social justice considerations) policies and actions. Identifying both would allow issues to be considered and managed and opportunities capitalised upon when considering any new infrastructure.

To enable as wide a range of views to be captured, in an authentic manner, individuals were able to *enter their issues and opportunities anonymously and directly* via laptops (in the face-to-face workshops these were provided, in the online workshops participants used their own devices). This process ensured that the contributions were captured as the participants viewed them (that is, in their own language) rather than risk being changed through a facilitator paraphrasing them. It also ensured all the views were captured and not lost. Allowing participants to anonymously contribute the issues, opportunities and values directly helps reduce conformity pressures allowing for more wide-ranging views to be captured. It also enables each participant to speak 'simultaneously' enabling an increase in productivity (Ackermann, 2020). In addition, the process enables a breadth of material to be captured, avoiding the constraints imposed by surveys which frequently present a list of options from which to choose. See below Figure 7 for an example of a group using the face-to-face mode and below that see Figure 8 for a screenshot of what on-line participants experienced.

Each participant was able to see their own material and that of others as it was generated. This both enables the prompting of further material (participants can piggyback off one another's contributions) and digestion of others' contributions (avoiding immediate physiological responses and allowing more thoughtful consideration). As such participants were able to immerse themselves in the wide range of views and gain a deeper appreciation of the issues and opportunities surrounding the topic.

During the generation phase, contributions were clustered according to content by the facilitator. This aided the navigation of the material as typically over 50 statements were captured in a very short time and by clustering the material, it is possible to manage the unfolding complexity. Once participants had surfaced all the issues/opportunities that came to mind, a review of the clusters was undertaken. The review enables:

- a check to ensure contributions are in the most appropriate cluster (it is not untypical for contributions to be able to 'fit' in >1 cluster and so determining the most appropriate helps with effective positioning as well as prompting further conversation).
- each contribution to be checked for comprehension by all sometimes resulting in the wording requiring further elaboration to ensure a shared understanding.
- the generation of new material as meaning is discussed promoting further thoughts.
- the ability to determine 'themes'.



Figure 7: Group using Group Explorer at FRDC workshop.

Figure 8: Online view of material being surfaced and structure using Strategy Finder.



Note participants on their laptops were able to see each statement as it was entered (but not who said it), take part in the clustering and linking process, identify themes and values. At the top a number of 'tabs' were created allowing particular chunks (e.g., themes, the value system) to be viewed. Participants could move between them whenever they liked.

The next step was to explore the systemic impacts between the issues and opportunities. This constitutes identifying connections between contributions in the form of causal links (chains of argument) reflecting that issues impact other issues and opportunities. This linking process enables the creation of a network - a directed graph - further assisting with the development of shared understanding, revealing systemic properties, and facilitating analysis. Recognition of the interactivity of issues and opportunities emerges early in the cluster review process as participants provide explanations as to why a statement should be in one cluster or another. The process of linking also reveals that issues and/or opportunities can impact more than one value illustrating multiple ramifications and potentially uncovering potent opportunities (supporting >1 value) or risky issues (having multiple negative consequences).

The process of exploring the impact of contributions on one another:

- facilitates the prompting of further material as participants are exposed to the thinking of one another and how they perceive the world and as such participants respond to differences in opinion by teasing out alternative chains of argument.
- enables the building of a deeper understanding of the topic as issues and opportunities are seen in context.
- assists the group to move from divergence to convergence attending to the objective of increasing awareness.

Below is a small excerpt of material (reflecting the statements and their relationships) from one of the focus groups (Figure 9). The arrows are read as causal links that allow *chains of argument* to be constructed. For example 16 *create new fit for purpose fishing opportunities*, may result in 26 *increase quality abundance* which in turn may enable 12 *provide for new fishing experiences*. The numbers appended to each statement allow the data to be easily identified and managed and have no 'value' associated with them.

As participants were asked to note whether the contribution was an issue (I) or opportunity (O) the general complexion of each cluster could be determined i.e. was it dominated by issues or opportunities or a mix. It was also possible to categorise the material using styles - with blue boxes representing themes and grey boxes representing values. This aids with navigation as participants can easily see the status of each contribution.



#### Figure 9: a small section of a causal map.

Note: The statement at the top of the hierarchy is a 'theme' (blue) and an opportunity (O). Supporting it are three chains of argument plus information noting the fact that there are a number of other statements, not displayed on the map at present (but whose presence is shown through the dotted arrows e.g., 33). The software, a relational database, allows the users to view as much or as little material as is helpful and useful and a range of views displaying user defined maps can be created. The numbers have no 'value' – they are tags to allow each statement to be managed.

For all the workshops aside from the commercial fishers' workshop (due to time pressures) to conclude the issue/opportunity generation phase, participants were asked to prioritise (again using the direct entry anonymous process) the emergent clusters. For the face-to-face groups they were able to allocate preferences reflecting importance and likelihood. For the on-line workshops, each participant was able to rate the themes according to importance. This prioritisation provided an insight into the degrees of convergence of thinking (how much agreement there was within the cohort) and preference (which of the themes received the highest average rating). The results were reviewed with the group and discussed. A brief tea/coffee break was then provided.

The final session of the workshop concentrated on using the clusters of issues and opportunities (themes) to identify emergent values. As noted above, the logic is that participants perceive something to be an issue because it is implicitly adversely affecting something valued (likewise it is an opportunity if it enables the achievement of something desired/valued). This process:

- surfaces a range of interconnected values, issues and opportunities as issues can either negatively affect multiple values and opportunities can likewise positively enable a range of values, and values can impact one another.
- prompts new issues and opportunities as participants discuss the consequences of the issue and opportunity clusters.

As with the issues and opportunities where there are links between the values these were captured. Thus, each workshop generated a 'map' of interconnected issues and opportunities supporting a value *system* articulating not only the social and economic values as viewed by participants, but additionally the issues and opportunities substantiating them. The networks generated in each focus group ranged from around 60 statements to over 100 enabling participants to have a deeper and more systemic understanding of MMS associated values, issues and opportunities and capturing a rich idiosyncratic representation of a particular cohort's perceptions of MMS. In each workshop these 'systems' of goals/values reflected the shared (across all of the workshop participants) values as well as values identified by particular individuals (Bryson et al., 2016).

As a final activity, participants were asked for their views on the workshop process before being thanked for their participation. This feedback provided valuable input in terms of improvements to the design of the focus group workshops as well as insights into the facilitation experience, and benefits of the on-line method. Each participant received a workshop report comprising the material generated (a complete set of the mini reports can be found in Appendix 8).

Concluding the series of focus group workshops the data was integrated allowing for exploration and analysis across the entire body of material (see figure 10).





Note: the activities on the left represent the workshop process, providing categories of data for analysis, and subsequently enabling insights to be gained against each data set.

## Analysing the data

Concluding the 11 workshops, analysis on the data sets was conducted. Analysis of causal maps (comprising subjective data) is well established (Eden and Ackermann, 1998; Bryson et al., 2004) for the management of qualitative data and encompasses a wide range of analyses. These include; examining the networks for those statements that are central to the structure, comprise feedback dynamics, emerge as significant triggers and reveal themselves to be well elaborated values. Leveraging the capabilities of the mapping analyses a number of activities were conducted including:

- Comparing the varying heterogeneity/homogeneity across cohort groups (values, opportunities, and issues) giving rise to a set of generic values/themes and dominant issues and opportunities (see Figure 10 right hand side).
- assessing the interactions (links) between values to construct a decision tree amenable to constructing a multi-criteria model and a value system map.
- exploring how dominant issues and opportunities impacted generic values.

Table 8 outlines the process.

Analysis	Data Used	Program(s) Used	Outputs (see results)
Issues & Opportunities	Issues and opportunities from 11 workshops	Microsoft PowerPoint Microsoft Excel Group Explorer	Generic issues and opportunities
Themes analysis	Workshop themes from 11 workshops	Microsoft Excel Microsoft Word	Meta-themes Meta-themes importance ratings
Values analysis	Workshop values from 11 workshops	Microsoft Excel Microsoft Word Microsoft PowerPoint Group Explorer	Meta-values Meta-values mapped onto literature framework Meta-values map Generic values Generic Values decision tree Generic values spider plot

## Table 8: Summary of group social value analysis method and outputs.

# Methods: Collation of WA MMS

The objective of this component of the project was to collate data from multiple sources to gain an understanding of the types and numbers of MMS located within Western Australia's marine environment.. We did a search of the primary literature using Google Scholar. We also directly approached, or sourced information from the websites of organisations whom we knew had been involved in the deployment of infrastructure and collection of data in Western Australia.

For artificial reefs this included Recfishwest, the Department of Primary Industries and Regional Development, SubCon and Ocean Grown Abalone.

Data on shipwrecks was downloaded from www.data.wa.gov.au while data on maritime facility locations including boat ramps, jetties, slipways, groynes, wharfs, and harbours was provided directly by the Department of Transport.

Data on O&G infrastructure was sourced from the National Offshore Petroleum Titles Administrator (NOPTA) and Geoscience Australia (<u>https://nopims.dmp.wa.gov.au/Nopims/GISMap/Map</u>).

For ease of access, we have summarised data into an Excel spreadsheet under various tabs (see links to the database below).

The spatial component of the database consists of GIS layers (points, lines, and polygons) in ESRI shapefile format. Sources of data were combined, most of them obtained through WFS (Web-feature-service) freely provided by institutes and government organisms (see table below). Layers were processed in QGis software, filtered and reprojected (when necessary) to GDA94 (EPSG:4283), and finally converted to ESRI shapefile format. Other datasets were obtained in CSV format using the latitude and longitude information provided. These datasets were adapted to be transformed into point layers, reprojected, and included in the database as shapefiles.

All layers were analysed together to avoid duplicated data, and had a column added ('SOURCE') to its attribute table stating the original source of the spatial data. When infrastructure objects were repeated, but in different formats (e.g.: As lines and then as polygons), both objects were kept in the database. Area and length calculations were done in projected coordinates: GDA\_1994\_Australia\_Albers (EPSG:3577).

# Table 9: Sources of spatial data.

Dataset	Source	Туре	N objects
Petroleum wells	AIMS database	point	395
Petroleum wells	https://catalogue.data.wa.gov.au	point	2309
Recfish AR	other/various	point	9
National Onshore pipelines	AIMS database	lines	122
O&G platforms	AIMS database	point	59
O&G platforms	https://services.ga.gov.au/	point	38
Navigation aids	https://catalogue.data.wa.gov.au/	point	2684
Tide stations	https://catalogue.data.wa.gov.au/	point	47
Maritime facility locations	https://catalogue.data.wa.gov.au/	point	41
Coastal infrastructure DOT- polygon	https://catalogue.data.wa.gov.au/	polygo n	7726
Coastal infrastructure DOT- points	https://catalogue.data.wa.gov.au/	point	5685
Artificial structures (from SmartLine)	http://www.ga.gov.au/	lines	303
Gas pipelines	https://services.ga.gov.au/	lines	689
Oil pipelines	https://services.ga.gov.au/	lines	73
Shipwrecks	https://catalogue.data.wa.gov.au/ + other	point	305

The spatial database is available through Cloudstore at <a href="https://cloudstor.aarnet.edu.au/plus/s/ZEJ7zkxaJwyNFid">https://cloudstor.aarnet.edu.au/plus/s/ZEJ7zkxaJwyNFid</a>

A visualisation of the data is available at

https://aimsdata.maps.arcgis.com/apps/webappviewer/index.html?id=e534ab2975f64ca68479cc291 dcb3a9f

We are aware that this list will not be all-inclusive, but is meant to aid stakeholders to understand the extent and types of MMS in the marine environment. It is also a starting point if there is a need to scale the social and economic benefits and values of MMS to a broader Western Australian context. We reiterate that this does not include subsea telecommunication cable or aquaculture infrastructure.

# Methods: Integration of components

The three components (social values – individual, social values – group and economic values) were integrated through a number of mechanisms. Firstly, the team met regularly to discuss emerging findings and how they triangulated, secondly representatives from the economic group and social value individual team attended the social group workshops to understand both the process and the data. Finally, at the end of the data collection stage several workshops with the research team were held. In the first workshop, the team collated the values that each component found in their data collection using the Group Support System that was used in the social value group workshops (to allow for breadth and to recognise the impacts of values upon one another). We then identified the most significant values by applying two criteria: (i) values that were identified by multiple components and/or (ii) values that substantially influenced other values. In this process, the links and their causal direction between the different values were also identified. Moreover, we discussed the definition of the values of each component and identified three value categories that encompasses the value definitions of all components: user values, community values and environmental values. We classified each value to one of these overarching value categories recognising that some of the values could relate to more than one category. Kumu software (https://kumu.io/) was used to illustrate the values and their interactions in a map. Finally, we reviewed the map in multiple iterations of the same process described above. The results of the integrated value map are described in the discussion section. We also reviewed the issues and opportunities surfaced by both social value groups to determine their similarities and allow for a more holistic appreciation.

# **Section 4: Results**

# **Results: Systematic literature review**

# Social values

Despite strong advocacy for the inclusion of social values in marine planning for MMS (Shaw et al., 2018), academic and grey literature directly addressing this topic was limited. A total of 126 relevant publications were identified. Within these, our review identified 33 papers addressing an aspect of social value, categorised as: (i) social values associated with MMS (8 papers); (ii) stakeholder perceptions of MMS (23 papers); and (iii) stakeholder use and satisfaction with MMS (11 papers). Within the small number of papers (8) addressing social values, a range of MMS types were covered, including artificial reefs, natural reefs, sea walls, offshore wind turbines and O&G infrastructure. Furthermore, these articles encompassed data from a broad range of stakeholder groups (recreational and commercial fishers, divers, tourism sector representatives, environmental groups, and various government institutions) (refer to Table 8, p22, Literature review report, Appendix 2).

Due to the breadth of structures and stakeholder groups, trends in social values by stakeholder group or structure type could not be derived from the literature review. The literature, did however, indicate stakeholder values are likely contingent on MMS structure type. For example, recreational divers valued the diversity of species associated with artificial reefs (Ramos et al., 2006) whilst recreational fishers' values were affected by the presence or absence of commercial fishers on natural reefs (Barclay et al., 2017). Furthermore, stakeholder groups' values were influenced by less tangible factors than structure type, as demonstrated by Voyer and colleagues in their finding that the presence of a commercial fishing industry was positively associated with tourists' experience of a location (Voyer et al., 2017).

Comparatively, there were a relatively large number of academic and professional publications examining perceptions and perceived benefits of MMS from a variety of locations worldwide (23); however, the majority of these related to either artificial reefs or offshore wind turbines. These studies demonstrate that stakeholder groups can hold markedly different views on the environmental benefits of artificial reefs (e.g. (Ramos et al., 2007) whilst also highlighting the issues surrounding access rights to newly installed offshore infrastructure (Kruse et al., 2015).

Papers exploring the use of, and satisfaction with MMS predominantly focussed on recreational divers' use of artificial reefs, and the characteristics of divers (e.g. dive experience) associated with site preferences (e.g. natural versus artificial reefs or habitat preferences; refer to Table 7, Literature review report, Appendix 2). Information ranged from examining the types of dive activities underway (Ditton et al., 2002a), to preferences for different forms of artificial reef (e.g. Shani et al., 2012) and marine environments (e.g. natural versus artificial; Belhassen et al., 2017) and habitat preferences (Kirkbride-Smith et al., 2013).

The output of the review was a limited understanding of the range of social values derived from MMS and how these differ within or between stakeholder groups and structure types. To address this outstanding gap in knowledge, themes from across the review were collated to develop a conceptual framework of the elements relating to social value of MMS. The themes included (i) multiple stakeholders (direct and indirect); (ii) values, which were distinguished by scale (e.g., personal values/global values) and theme (e.g. measurable/material values, intrinsic/subjective values, relational values); (iii) multiple structure types (e.g. artificial reefs, offshore wind farms); and (iv) the

enactment of values or activities that shape values (including use and behaviours, perceptions/attitudes).

The output was a framework that highlighted the importance of cross-scale and multiple themed values. It is closely aligned to the social well-being framework that has been advocated as an approach to integrate social, economic and environmental aspects in fisheries management (see for example (Weeratunge et al., 2014) and (Johnson et al., 2018)). As per the framework derived from the literature review, the social well-being framework presented in the broader fisheries literature considers values across scales (micro, meso and macro) and across themes (material, relational and subjective). Consequently, the established, peer-reviewed representation of social values, adopting the well-being lens as reported in (Weeratunge et al., 2014) was modified for a MMS context and established as the conceptual model supporting the ongoing research (Figure 11).





#### **Economic values**

The systematic literature research found 34 studies that quantified the economic value that MMS provides to stakeholders such as divers, recreational and commercial fisheries, the general public, and other user groups (see table in Appendix 2). Over the last decades, the number of publications on this topic has steadily increased. The most common structure type investigated are purpose built ARs (18 studies) and shipwrecks (15 studies). We also found six studies on offshore O&G platforms and one on offshore wind turbines. While the literature indicated economic values from MMS all over the world, half of these studies were conducted in the USA. Structures in other regions in the world were far less studied. All 34 articles quantified direct use values (19 extractive use values and 17 non-extractive use values), whereas non-use values were assessed by only two studies. None of the studies estimated indirect use values, even where the context of the studies was relevant for indirect use values (e.g., coastal protection).

#### Direct use values

#### **Business Revenues**

Papers focusing on use values of MMS found that they generate direct use values in terms of business revenues from extractive uses such as commercial fishing (Brock, 1994; Vivekanandan et al., 2006; Islam et al., 2014) and recreational fishing (Buchanan, 1973; Milon, 1989; Brandini, 2014; Morgan et al., 2018). For example, Buchanan (1973) estimated that an artificial reef in South Carolina, USA caused an increase of 10% in the gross economic contribution of marine recreational fishing in the region. In the Gulf of Mexico, a significant part of the commercial harvest of snappers originated from O&G platforms (Bull and Love, 2019). Moreover, Kolian et al. (2018) estimated that in the Gulf of Mexico, a sustainable harvest of aquarium fish could yield approximately USD 1.4 million per O&G platform per year (note that all values are reported in 2019 USD). They also pointed out that there is an unknown value in novel pharmaceutical and/or nutritional products that could be sourced from marine invertebrates that grow on O&G platforms. However, Islam et al. (2014) found that benefits from artificial reefs, including O&G structures- in Malaysia were unequally distributed among artisanal fishers and suggest that sustainable fisheries management within the artificial reef development should ensure economic benefits for the local fishing communities.

Literature also found MMS to provide business revenues through non-extractive uses such as scuba diving (Dowling and Nichol, 2001; Ditton et al., 2002b; Leeworthy et al., 2006). For example, (Dowling and Nichol, 2001) analysed the expenditures from dive tourists that visit the HMAS Swan shipwreck in Western Australia and estimated the annual economic impact to be USD 1.39 million. Johns et al. (2001) estimated that shipwrecks in Southeast Florida provided 26,800 jobs for the tourism industry and were generating USD 2.4 billion of revenues annually. (Hiett and Milon, 2002) found that recreational fishing and diving associated with O&G facilities in the Gulf of Mexico not only generated USD 324.6 million in annual economic revenues, but also provided employment for approximately 5,560 full time equivalents. Both fishing charter and dive tour operators considered the presence of O&G structures to be very important to their businesses.

Two articles compared economic values of commercial fishing opposed to recreational and/or tourism activities on shipwrecks (Brock, 1994; Crabbe and McClanahan, 2006). Both studies found that the revenues generated from recreation and tourism greatly exceeded those from commercial fishing.

#### Non-market direct use values

In addition to business revenues, MMS were found to provide economic benefits in terms of increased satisfaction (consumer surplus) to users. McGurrin and Fedler (1989) found e.g., that the increase in catchability and/or catch rate around O&G platforms in the USA improved satisfaction of recreational fishers which translated into fishers on O&G platforms being WTP more (\$19.38 USD) than non-platform fishers (\$10.00 USD).

Users also were found to value the fact that MMS can deviate user pressure from natural reefs. For example, the construction of a dive and snorkel trail in Dahab, Egypt was meant to prevent tourists from trampling on and therefore damaging natural reefs. (Hannak et al., 2011) used the Contingent Valuation approach and found that especially the less experienced snorkelers (who are more likely to damage reefs) were WTP for the snorkel trail and an educational training to protect natural reefs.

Moreover, literature indicated that the controlled position of artificial reefs can allow for safer conditions than on some natural sites. Christie and Colman (2009) assessed the economic value associated with safer swimming conditions and found that members of a community in Wales held significant values for a multipurpose reef which would provide such conditions. Likewise, Taiwan

residents were WTP about \$13 USD per recreational fishing and diving trip for access to an artificial reef zone that provided safer conditions than surrounding areas (Chen et al., 2013).

#### Comparison of values for MMS and natural marine habitat

Nine studies compared economic values related to MMS with those from non-MMS sites. Out of these, six studies found higher economic values on MMS than on adjacent areas (Johns et al., 2001; Vivekanandan et al., 2006; Oh et al., 2008; Whitmarsh et al., 2008; Kasim et al., 2013; Smith et al., 2016). Kasim et al., (2013) found e.g., that the revenues of commercial fishers in India were over twice as high on artificial reefs compared to non-artificial reef areas. Johns et al., (2003) observed that recreational divers in South-East Florida were WTP over twice as much to protect natural reefs (USD 229.3 million/year) than to protect a shipwreck (USD 85.1 million/year). However, Huth et al., (2015) found that dive tourists in Florida had a higher WTP for a dive trip to a shipwreck (USD 368) than to natural reefs (USD 300) and Islam et al., (2014) found that the monthly fishing income from artisanal fishers on an artificial reef in Malaysia was lower than on adjacent natural reefs.

#### Non-use values

MMS have the ability to enhance marine habitat and therefore improve the biodiversity and/or abundance of marine life on and around them. Hence, people who value these natural benefits can have a WTP for maintaining artificial structures, even when they do not necessarily use them. We found two articles that measured non-use values of artificial reefs. Börger et al., (2015) used a DCE to estimate the WTP of residents in Ireland for an increase in biodiversity on an offshore wind farm off the coast of Ireland. They found that people were WTP GBP 7.25 and GBP 14.83 per person for an increase of ten and 30 species settling on the wind farm, respectively. Hicks et al. 2004 found a positive attitude towards oyster reef restoration programs in the USA and estimated that residents were WTP USD 86.68 per year to fund oyster reef programs although they did not necessarily use such reefs.

For full details on the results of the literature review, see "Socioeconomic values associated with man-made aquatic infrastructure academic literature review" in Appendix 2.

# **Results: Social values - Individual**

In this section we present the results of the Social Values Individual component of the research. We discuss how often stakeholders are interacting with MMS by type, the values they derive from this interaction and their views on MMS in Western Australia. We also present the opportunities and limitations that stakeholders associate with MMS and explore how these views are consistent with or differ by stakeholder groups. We present the outcomes of a case study survey exploring the microvalues generated from Busselton Jetty. Detail on the characteristics of the survey respondents is presented in Appendix 3.

# Use of MMS in Western Australia

The majority of the survey respondents self-classified as recreational fishers (64.2%) followed by divers (16.4%), 'other' (7.5%) (including for example local government, tourism, or research sectors), or a commercial fisher (4.9%). Piers and jetties were the primary MMS structure used by respondents in the last 12 months, followed by artificial reefs and shipwrecks (Figure 12). There was however, overall, low levels of use of MMS across the surveyed population, with the majority of the MMS structure types and sites being used less than once per month, or never in the last 12 months, by survey respondents.



Figure 12: Frequency of use of select MMS structures and types of MMS.

The dominant MMS type used differed across stakeholder groups, with jetties and piers the most frequently used MMS for recreational fishers, divers, and others. For commercial fishers' pipelines were the most frequently used MMS. Divers also more frequently visited shipwrecks compared to the other stakeholder groups.

The case study sites, comprising Busselton Jetty, Exmouth Navy Pier, Onslow Offshore Structures and Thevenard, were rarely used by survey respondents in the last 12 months.

# **Respondents' perceptions of MMS**

Most of the survey respondents strongly agreed that MMS increase and sustain fish populations over time, while there was limited agreement with the statement that MMS are sites of conflict between different user groups (Figure 13).



# *Figure 13: Agreement with statements relating to MMS and its contribution to environment, society and economy.*

Perceptions were, however, not consistent across the stakeholder groups. In particular, commercial fishers and those that did not classify as recreational fishers or divers (i.e., 'others') were less likely to agree that MMS sustain and increase fish populations over time, or that MMS contribute to local tourism in comparison to divers and recreational fishers (Table 10). In contrast, 'others' and commercial fishers more frequently agreed that 'existing management controls allow for sustainable use of MMS', than recreational fishers or divers.

We found that the self-assigned stakeholder group for each respondent, their age and the types of MMS used by the respondent in the last 12 months were all significant factors explaining differences in perceptions. For example, stakeholder group was the explanatory factor for differences in perceptions regarding the contribution of MMS to sustaining and increasing fish populations over time and the contribution of MMS to local tourism, with recreational fishers and divers more frequently expressing higher levels of agreement with these statements than 'others' and commercial fishers. Age was also a defining factor explaining variation in the perceived contribution of MMS to fish populations and tourism, with respondents under 55 years of age generally having lower levels of agreement with this statement. This group was also less likely to view MMS as a point of identity for local communities compared to respondents aged over 55 (see Table 10). The type of MMS structure used by the respondent was also associated with differences in perceptions. Specifically, respondents that only used jetties or piers in the last 12 months were more likely to agree that MMS contribute to local community identity than respondents that had not used MMS in the last 12 months. Further, respondents who had used all forms of MMS in the last 12 months were more likely to agree that MMS sustain and increase fish populations over time than other users.

Perception	Model Fitting Sig	Goodness of Fit	Significant relationships between variables
MMS increase and sustain fish populations over time	0.000	Pearson: 210.73 Sig: 0.986	Independent variable (Divers; Rec Fishers): significantly greater level of agreement with perception than base group (other respondents) Independent variable (Respondents
			using all MMS): significantly greater level of agreement with perception than base group (Respondents with no usage of MMS)
			Independent variable (Gen X; Gen Y): significantly lower level of agreement with perception than base group (respondents over 55 yrs old)
MMS contribute to local tourism	0.004	Pearson: 237.662 Sig: 0.813	Independent variable (Divers; Rec Fishers): significantly greater level of agreement with perception than base group (other respondents)
			Independent variable (Gen X): significantly higher level of agreement with perception than base group (respondents over 55 yrs old)
MMS contribute to local employment opportunities	0.120	Pearson: 248.301 Sig: 0.657	-
MMS are a point of local community identity	0.004	Pearson: 249.559 Sig:0.635	Independent variable (Respondents using jetties only): significantly greater level of agreement with perception than base group (Respondents with no usage of MMS)
			Independent variables (Gen X; Gen Y): significantly lower level of agreement with perception than base group (respondents over 55 yrs old)
MMS are managed sustainably	0.136	Pearson: 246.329 Sig: 0.411	-

# Table 10: Perceptions of MMS: All respondents - ordinal regression outputs

MMS are sites of conflict	0.015	Pearson: 231.467 Sig: 0.738	Independent variable (Male respondents): significantly lower agreement than base group (Female
			respondents)

Note: This table identifies significant differences in prioritisation of perceptions between independent variables (eg experience level, age, gender) within all respondents against a base group. Thus, for example, dive respondents and fisher respondents who had used all types of MMS in the last 12 months were significantly more likely to agree than the base group (in this case, other respondents) that MMS increase and sustain fish populations over time. Where no significant differences were observed, cells are blank.

There were also differences in perceptions within stakeholder groups. However, the number of respondents classifying as a commercial fisher or 'Other' was not large enough to perform statistical analysis within group variation, and therefore this analysis was confined to respondents identifying as recreational fishers or divers.

The statements with the highest degree of within group variation for the **recreational fishing respondents** included:

- MMS are a point of identity for local communities.
- MMS are sustainably managed.
- MMS are sites of conflict.

Respondents with limited recreational fishing experience (i.e. those who self-identified as 'beginners') were less likely to agree that MMS are a point of local community identity than those with greater experience (i.e. those who self-identified as 'experts'). Despite variable responses to the statements 'MMS are sustainably managed' and 'MMS are sites of potential conflict', this variation was not explained by respondent age, experience, fishing type, MMS type used, gender or the importance assigned to recreational fishing as an outdoor activity (Table 11). ). Finally, despite broad agreement with the statement that MMS increase and sustain fish populations over time (which was strongly agreed by a majority of recreational fishing respondents), users of all types of MMS were more likely to agree with this statement than non-users.

Perception	Model Fitting Sig	Goodness of Fit	Significant relationships between variables
MMS increase and sustain fish populations over time	0.181	Pearson: 518.561 Sig: 0.676	Independent variable (Users of all MMS in the last 12 months): greater level of agreement with perception than base group (Users of no MMS in the last 12 months)
MMS contribute to local tourism	0.322	Pearson: 551.308 Sig: 0.293	-
MMS contribute to local employment opportunities	0.227	Pearson: 589.94 Sig: 0.028	-
MMS are a point of local community identity	0.024	Pearson: 505.567 Sig:0.596	Independent variable (Experience level 'beginner'): significantly lower level of agreement with perception than base group (Experience level 'expert')
MMS are managed sustainably	0.224	Pearson: 587.92 Sig: 0.013	-
MMS are sites of conflict	0.880	Pearson: 515.616 Sig: 0.619	-

## Table 11: Perceptions of MMS: Recreational fishing respondents - ordinal regression outputs

Note: This table identifies significant differences in prioritisation of perceptions between independent variables (eg experience level, age, gender) within recreational fishing respondents against a base group. Thus, for example, recreational fishers who had used all types of MMS in the last 12 months were significantly more likely to agree than the base group (in this case, recreational fishers who had not used MMS in the last 12 months) that MMS increase and sustain fish populations over time. Where no significant differences were observed, cells are blank.

Similarly (see Table 12), there was some within group variation in perceptions for **dive respondents**, with jetty users less likely to agree that MMS contribute to local tourism and employment opportunities than non-users of MMS; and more likely to agree that MMS are sites of conflict. Those that more frequently dive were also more likely to agree that MMS are sites of conflict than those that rarely dive. Finally, divers with less experience were more likely to agree that MMS are a point of identity for local communities, and less likely to agree that MMS are sites of conflict.

Thus, the perceptions that MMS are sites of conflict resonated most strongly with experienced and frequent divers that use jetties.

The results indicate that while there appears to be strong agreement that MMS benefit marine ecosystems, perceptions are not consistent within or across stakeholder groups. This highlights the importance of understanding perceptions and drivers to inform communication efforts.

Perception	Model Fitting Sig	Goodness of Fit	Significant relationships between variables
MMS increase and sustain fish populations over time	0.503	Pearson: 121.612 Sig: 1.000	-
MMS contribute to local tourism	0.361	Pearson: 117-494 Sig: 0.140	Independent variable (Users of jetties only): lower level of agreement with perception than base group (Users of no MMS in the last 12 months)
MMS contribute to local employment opportunities	0.754	Pearson: 148.29 Sig: 0.698	Independent variable (Users of jetties only): lower level of agreement with perception than base group (Users of no MMS in the last 12 months)
MMS are a point of local community identity	0.154	Pearson: 213.098 Sig:0.618	Independent variable (Experience level 'beginner'): significantly higher level of agreement with perception than base group (Experience level 'expert')
MMS are managed sustainably	0.669	Pearson: 199.326 Sig: 0.500	-
MMS are sites of conflict	0.022	Pearson: 224.801 Sig: 0.202 Threshold 1 (1.678) – 4 (8.894)	Independent variables (Users of jetties only; users of combination of MMS; users of all MMS): significantly higher level of agreement with perception than base group (Users of no MMS) Independent variable (Experience level 'beginner'): significantly lower level of agreement with perception than base group (Experience level 'expert') Independent variable (Gen Y): significantly higher level of agreement with perception than base group (respondents over 55 yrs old)

# Table 12: Perceptions of MMS: Dive respondents - ordinal regression outputs

Note: This table identifies significant differences in prioritisation of perceptions between independent variables (eg experience level, age, gender) within diver respondents against a base group. Thus, for example, divers who used jetties only were significantly less likely to agree than the base group (in this case, divers who had not used

MMS in the last 12 months) that MMS contribute to local employment possibilities. Where no significant differences were observed, cells are blank.

# Social values derived from MMS

The most important **value** derived from MMS for the surveyed respondents was the contribution of MMS to ecosystem health; followed by (i) independence to choose when or how they access MMS, and (ii) unrestricted access to MMS (Figure 14).





The prioritisation of values was, however, not consistent across the stakeholder groups. There were significant differences in the priorities assigned to the following value statements:

- The importance of fishing MMS
- The importance of diving MMS
- The importance of unrestricted access to MMS,
- The importance of memoirs and souvenirs collected from activities undertaken at MMS (question asked of fishers and divers only)
- The importance of the contribution of MMS to ecosystem health
- The importance of the contribution of MMS to local economy and
- The importance of the contribution of MMS to local community identity

Significant differences in the importance assigned to fishing and diving is self-explanatory, with recreational fishers assigning higher priority to this value than other stakeholder groups, and divers assigning higher priority to the importance of diving compared to other stakeholder groups. Therefore, further analysis of the factors influencing differences in perceived value (and whether stakeholder group was the dominant variable shaping value differences) was focussed on the remaining five value statements.

We found that the factor influencing value prioritisation differed depending on the value statement (Table 13). In some cases, stakeholder group was the dominant factor, whilst in others it was the use of different types of MMS. For example, and as would be expected, there was a clear distinction in

the importance of values such as, 'fishing MMS', 'diving MMS', 'memories from visiting/using MMS', 'unrestricted access to MMS' and social aspects of MMS use (e.g. talking to friends and family about experiences, social connections made), for active MMS users compared to those that had not used MMS in the last 12 months.

Value	Model Sig	Goodness of Fit	Significant relationships between variables
Fishing MMS	0.000	Pearson: 234.886 Sig: 0.885	Independent variable (Rec Fishers): significantly greater level of agreement with perception than base group (other respondents)
			Independent variables (Users of jetties only; users of combination of MMS; users of all MMS): significantly greater level of agreement with perception than base group (Respondents with no usage of MMS)
Diving MMS [fish, dive, neither only]	0.000	Pearson: 211.635 Sig: 0.687	Independent variable (Rec Fishers): significantly greater level of agreement with perception than base group (other respondents)
			Independent variables (Users of jetties only; users of combination of MMS; users of all MMS): significantly greater level of agreement with perception than base group (Respondents with no usage of MMS)
			Independent variable (Gen Y): significantly lower level of agreement with perception than base group (respondents over 55 yrs old)
Memories [only rec fish and divers]	0.003	Pearson: 196.34 Sig: 0.192	Independent variable (Divers): significantly greater level of agreement with perception than base group (rec fishers)
			Independent variables (Users of jetties only; users of combination of MMS; users of all MMS): significantly greater level of agreement with perception than base group (Respondents with no usage of MMS)

# Table 13: Values derived from MMS: All respondents - ordinal regression outputs

Unrestricted access	0.000	Pearson: 245.06 Sig: 0.576	Independent variables (Divers; Rec Fishers): significantly greater level of agreement with perception than base group (other respondents) Independent variable (Respondents using all MMS): significantly greater level of agreement with perception than base group (Respondents with no usage of MMS) Independent variable (Gen X; Gen Y): significantly lower level of agreement with perception than base group (respondents over 55 yrs old)
Independence to choose when to access [only rec fish and divers]	0.252	Pearson: 156.42 Sig: 0.747	Independent variable (Gen Y): significantly lower level of agreement with perception than base group (respondents over 55 yrs old)
Talking to friends and family [only rec fish and divers]	0.180	Pearson: 215.24 Sig: 0.037	Independent variable (Respondents using all MMS): significantly greater level of agreement with perception than base group (Respondents with no usage of MMS)
Social connection made [fish, dive, neither only]	0.066	Pearson: 220.933 Sig:0.527	Independent variable (Respondents using all MMS): significantly greater level of agreement with perception than base group (Respondents with no usage of MMS)
MMS contribution to ecosystem health	0.079	Pearson: 230.56 Sig: 0.920	-
MMS contribution to local economy	0.211	Pearson: 651.429 Sig: 0.000	Independent variable (Rec Fishers): significantly greater level of agreement with perception than base group (other respondents)
MMS contribution to community identity	0.301	Pearson: 242.99 Sig: 0.742	-

Note: This table identifies significant differences in prioritisation of values between independent variables (eg experience level, age, gender) within all respondents against a base group. Thus, for example, recreational fisher respondents were significantly more likely to value the experience of fishing MMS than the base group (in this case, other respondents). Where no significant differences were observed, cells are blank.

We also found that divers placed greater importance on the memories and souvenirs obtained from MMS compared to the 'other' group; and recreational fishers assigned greater importance to the contribution of MMS to the local economy, compared to 'others'. Furthermore, both divers and recreational fishers valued unrestricted access to MMS more highly than 'others'. Unrestricted access

was also more highly valued by baby boomers than Generation Y respondents (across stakeholder groups).

Finally, despite significant differences in the value assigned to the contribution of MMS to ecosystem health, and to the role of MMS in contributing to local community identity, the difference was not explained by respondents age, gender, MMS use or stakeholder group. Perceptions and values are a function of a range of often immeasurable attributes including, for example, past experiences, worldviews, and political orientation (Chuang et al., 2020). If the variation in these values is an important consideration for MMS managers, further research would be required to identify core drivers.

Values expressed by the **recreational fishing** respondents varied based on the structures frequented, level of recreational fishing experience, and the importance assigned to recreational fishing as an outdoor activity (Table 14). For example, diving MMS was more highly valued by active users of MMS, and less valued by those that believed recreational fishing was the most important outdoor activity they undertook. Similarly, the value assigned to the memories derived from activities undertaken at MMS was higher for active users of MMS compared to non-users, but less valued by recreational fishers with 'advanced' experience compared to recreational fishing 'experts.'

The importance of fishing MMS increased with the level of experience of the survey respondent. The value assigned to unregulated access was also higher for: (i) male rather than female recreational fishers; (ii) respondents that believe recreational fishing is the most important outdoor activity they conduct, compared to those that view recreational fishing as just one of many outdoor activities; and (iii) self-assigned 'expert' recreational fishers more so than 'advanced' or 'intermediate' fishers.

For **divers**, the importance of the value statements was a function of how often they go diving. Respondents who dive once a week, or at least once a month, assigning greater importance to the social connections made and the memories obtained from diving MMS and less importance to the contribution of MMS to local economies and to the role of MMS in contributing to ecosystem health (Table 15). Differences in value prioritisation were also a function of divers' age, where talking to friends and family about diving experiences was less important to Gen Y and Gen X dive respondents than to Baby Boomers. Memories and unrestricted access were less important to Gen Y respondents than Baby Boomers.

In contrast to the recreational fishers, level of diving experience was rarely an influencing factor shaping the prioritisation of values for dive respondents. The type of MMS used was also rarely an influencing factor – only in relation to importance of fishing and diving MMS, where we found those that used all forms of MMS assigned greater importance to this value than those that do not use MMS.

Value	Model Sig	Goodness of Fit	Significant relationships between variables
Fishing MMS	0.001	Pearson: 598.27 Sig: 0.036	Independent variables (Experience level 'beginner', 'intermediate' and 'advanced'): significantly lower level of agreement with value than base group (Experience level 'expert')
Unrestricted access to MMS	0.016	Pearson: 508.18 Sig: 0.745	Independent variable (respondents citing fishing as most important outdoor recreational activity): significantly higher level of agreement with value than base group (respondents citing fishing as one of many outdoor recreational activities) Independent variables (Experience level 'intermediate' and 'advanced'): significantly lower level of agreement with value than base group (Experience level 'expert') Independent variable (male): significantly higher level of agreement with value than base
			group (female)
Diving MMS	0.017	Pearson: 550.808 Sig: 0.298	Independent variables (Users of combination of MMS; users of all MMS): significantly greater level of agreement with value than base group (Respondents with no usage of MMS) Independent variable (respondents citing fishing as most important outdoor recreational activity): significantly lower level of agreement with value than base group (respondents citing fishing as one of many outdoor recreational
			activities)
			Independent variable (Gen Y): significantly higher level of agreement with value than base group (respondents over 55 yrs old)
Social Connections	0.033	Pearson: 517.62 Sig: 0.642	-
Independence to choose access	0.274	498.72 0.886	Independent variables (Experience level 'intermediate' and 'advanced'): significantly

# Table 14: Values derived from MMS: Recreational fishing respondents - ordinal regression outputs

			lower level of agreement with value than base group (Experience level 'expert')	
Memories/souvenirs	0.140	Pearson: 556.39 Sig: 0.283	Independent variable (Users of all MMS): significantly greater level of agreement with value than base group (Respondents with no usage of MMS)	
			Independent variable (Experience level 'advanced'): significantly lower level of agreement with value than base group (Experience level 'expert')	

Note: This table identifies significant differences in prioritisation of values between independent variables (eg experience level, age, gender) within recreational fishing respondents against a base group. Thus, for example, recreational fisher respondents with experience levels 'beginner', 'intermediate' and 'advanced' were significantly less likely to value the experience of fishing MMS than the base group (in this case, recreational fisher respondents with experience level 'expert'). Where no significant differences were observed, cells are blank.

## Table 15: Values derived from MMS: Dive respondents - ordinal regression outputs

Value	Model Fitting Sig	Goodness of Fit	Significant relationships between variables
Fishing MMS	0.400	Pearson: 212.112 Sig: 0.562	Independent variable (Users of all MMS): significantly greater level of agreement with value than base group (Respondents with no usage of MMS)
Unrestricted access to MMS	0.000	Pearson: 203.302 Sig: 0.501	Independent variable (respondents who dive at least once a week): significantly greater level of agreement with value than base group (respondents who dive around once per year) Independent variable (Gen Y): significantly lower level of agreement with value than base group (respondents over 55 yrs old)
MMS contribution to ecosystem Health	0.065	70.876 0.964	Independent variables (respondents who dive at least once a week; respondents who dive at least once a month): significantly lower level of agreement with value than base group (respondents who dive around once per year)
MMS contribution to community Identity	0.568	184.033 0.883	-
MMS contribution to local Economy	0.643	185.990 0.021	Independent variables (respondents who dive at least once a week; respondents who dive at least once a month): significantly

			lower level of agreement with value than base group (respondents who dive around once per year)
Diving MMS	0.069	Pearson: 179.698 Sig: 0.114	
Social Connections	0.001	Pearson: 210.643 Sig: 0.513	Independent variable (Male respondents): significantly lower level of agreement with value than base group (Female respondents)
			Independent variables (respondents who dive at least once a week; respondents who dive at least once a month): significantly higher level of agreement with value than base group (respondents who dive around once per year)
Independence to choose access	0.067	231.492 0.091	Independent variable (respondents who dive at least once a week): significantly higher level of agreement with value than base group (respondents who dive around once per year)
Talking to friends and family	0.024	229.149 0.257	Independent variables (Gen X; Gen Y): significantly lower level of agreement with value than base group (respondents over 55 yrs old)
Memories/souvenirs	0.047	Pearson: 187.815 Sig: 0.917	Independent variables (respondents who dive at least once a week; respondents who dive at least once a month; respondents who dive around once every three months): significantly higher level of agreement with value than base group (respondents who dive around once per year)
			Independent variable (respondents citing diving as most important outdoor recreational activity): significantly higher level of agreement with value than base group (respondents citing diving as one of many outdoor recreational activities)

Note: This table identifies significant differences in prioritisation of values between independent variables (eg experience level, age, gender) within diver respondents against a base group. Thus, for example, diver respondents using all types of MMS were significantly more likely to value the experience of fishing MMS than the base group (in this case, diver respondents with no usage of MMS). Where no significant differences were observed, cells are blank.

## Issues and opportunities associated with MMS

In addition to the quantitative questions exploring respondents' perceptions of MMS, survey respondents also had the opportunity to freely describe their views on the **benefits and/or limitations** of MMS from a social, economic, and environmental perspective. A total of 414 respondents, representing 80% of the total sample, identified benefits of MMS, with 399 respondents (77% of the total sample), identifying limitations. Around 80% of recreational fishing, diving and commercial fishing respondents gave open-ended responses, with a lower proportion of responses (58%) from those who did not fall into either of these user categories (hereafter termed 'Other'). Given the dominance of recreational fishers in the total sample (70%), their statements on benefits and limitations will inevitably colour the analysis. However, efforts were made to identify instances where other user groups' responses were characteristic of that group.

With regards to the benefits identified in association with MMS, almost half (45%) of all open-ended responses identified environmental benefits, followed by social (35%) and economic (19%). Very few (<1%) of respondents to this section of the survey failed to identify any benefits. With respect to environmental benefits, increased fish abundance or marine habitat was the most frequently identified, accounting for 22% of all environmental benefits cited, followed by the contribution of MMS to environmental sustainability (18%) and the creation of 'new' habitats in otherwise barren areas (15%).

Considering responses falling into the category of social benefits, the effect of MMS in promoting participation in marine activities, predominantly with reference to recreational fishing, accounted for 51% of responses, followed by accessibility to MMS structures (19%). Three sub-themes were identified with reference to participation, comprising more opportunities to enjoy recreational fishing arising from the increased number of fish in and around MMS; the opportunity for increased social interaction through increased participation; and the effect of MMS in enabling more people to participate in the activity. Sub-themes in the 'accessibility' category of responses included ease of access, equity of access with reference to aged or disabled users and personal safety.

Those respondents who identified economic benefits alluded to these occurring at both local and regional scales. Local economic benefits referenced the supply chain, specifically tackle and bait shops, whilst others mentioned broader benefits associated with increased tourism in general.

Analysis of the benefits identified by each stakeholder group was undertaken to identify any nuances within the respondent sample. The environmental and social benefits noted above were principally associated with recreational fishers, along with the mental health benefits of participation in fishing. Often these were couched in individual terms, i.e., the benefits to the individual of more opportunities to undertake recreational fishing, rather than community or regional benefits. However, it was apparent that divers were more likely to refer to environmental benefits in terms of MMS attracting greater biodiversity, rather than the benefits associated with 'using' biodiversity which were associated with recreational fishers. Respondents in the diver and 'Other' group were more disposed to mention the importance of raising awareness of the marine environment and the enjoyment of nature. These respondents were also more likely to identify tourism-related benefits than either commercial or recreational fishers.

A similar ranking to benefits was observed when analysing limitations identified by respondents in the open-ended section of the survey, 48% of which were categorised as environmental, 21% social and 7% economic. However, 38% of those who responded to the open-ended section of the survey identified no limitations, far greater than the <1% who failed to identify any benefits. However, these opinions were often predicated on the assumption that management arrangements were able to address any negative social or environmental impacts occurring in relation to the presence of MMS.

These included pollution or damage, including littering, pollution associated with MMS structural breakdown or environmental damage arising from poor construction, which were identified by 42% of respondents in the 'environmental' category. Over exploitation of the resource and disturbance to the natural environment were identified by 33% and 22% of respondents in the environmental category, respectively.

In terms of social limitations, a theme of overcrowding accounted for 37% of responses, followed by antisocial behaviour (30%). Overcrowding was commonly described with reference to environmental limitations including pressure on the natural resource. Antisocial behaviour referred to use of the structure for alcohol consumption and/or criminal activities alongside non-compliance with management regulations and disrespect for the natural environment. Within the small number of respondents who identified economic limitations, the dominant issue was the cost of constructing MMS, which accounted for 57% of responses.

There were few instances where an alignment of limitations could be identified with specific user groups, with all groups expressing a similar range of concerns. Divers were more likely to identify disrespect for the natural environment as a social concern, whilst environmental limitations associated with MMS causing a disturbance to the natural environment were raised by a small minority in the 'Other' group.

# **Busselton Jetty**

As noted in the methods section, the aim of the Busselton Jetty survey was to obtain site-specific information on values and perceptions, as well as use levels for a case site. The number of responses (sample size) varied across user groups (recreational fisher n= 50, other n= 35, and diver n= 17) and did not allow between or within group analysis of variance in responses.

## Use of Busselton Jetty

Of all case sites and categories of MMS, Busselton Jetty was the most frequently used MMS by respondents, whether divers, recreational fishers or others. Dive respondents used multiple types of MMS, with respondents from this group using jetties (in addition to Busselton Jetty), artificial reefs and shipwrecks at least once a month. The recreational fishing and other respondents' use of MMS was largely confined to piers and jetties. It should be noted that the smaller sample size of the diving group may contribute to the higher variability in proportionate use of MMS structure types. In accordance with the results of the State-wide survey, piers and jetties were the most frequently used MMS of all Busselton respondents. The case study sites, outside of Busselton Jetty, were again rarely used by respondents.

## Micro-values derived from Busselton Jetty

Questions relating to the values users derive from Busselton Jetty (micro-values) sought to uncover values related to the respondent's core activity (e.g. diving or recreational fishing). The 'other' group included a broad range of users and use types, and therefore a greater number of possible micro-values were explored for this group (Figure 15).

For recreational fishers, the activity of fishing itself is of highest value, while the output derived from fishing (e.g., a diverse target species, and number of fish caught) is of less importance. For divers, the diversity of fish species present is of high importance, as too is the ability to undertake the activity at Busselton Jetty. 'Other' respondents rated almost all of the values as of high importance, although ecological health was the value that most frequently received the 'very important' rating (Figure 15).



Figure 15: Importance of micro-values derived from Busselton Jetty for each stakeholder group.

*Note: values indicate the proportion (%) of respondents within each user group that assigned each level of value to each value statement.* 

#### Perceptions of MMS, Busselton respondents

Respondents recognised the role Busselton Jetty plays in contributing to tourism in the region, with over 70% strongly agreeing that 'MMS contributes to local tourism' - a higher proportion than for the State-wide survey. Approximately half of the respondents strongly agreed that MMS: increase fish populations; provide local employment opportunities; and are a point of identity for local communities. While there was least agreement that MMS are managed sustainably and are sites of conflict. Divers were more likely to strongly agree that MMS are sites of conflict than recreational fishers or 'others'.

There were different perspectives across the user groups on whether MMS are sustainably managed. Recreational fishers strongly agreed with this statement, while divers were most likely to 'somewhat agree' and 'others' more likely to 'somewhat disagree'. The differences in perceptions between the recreational fishing and dive respondents compared to other respondents were also apparent in relation to views on the role of MMS being a point of identity for local communities and the role of MMS in increasing fish populations. Others were more likely to strongly agree with the former and less likely to strongly agree with the latter compared to recreational fishing or dive respondents.

In short, stakeholder groups held divergent perceptions on MMS as sites of conflict, their sustainable management, their ability to provide a point of identity to local communities and their contribution to increasing fish populations. The factors influencing perceptions could not be statistically explored due to the small number of respondents in each user group.

# Summary social values - Individual

The survey respondents did not frequently use offshore MMS, with jetties and piers accounting for the majority of respondents' use of MMS. Despite this, we identified that MMS contribute to multiple values, across the categories of material, relational and subjective, for both direct and indirect users. All user groups prioritised the contribution of MMS to ecosystem health above other potential benefits arising from MMS. However, respondents' perceptions that MMS actually contributed to ecosystem health varied, with recreational fishers and divers more likely to strongly agree that MMS sustain and increase fish populations over time than commercial fishers and 'Other' respondents.

The priority assigned to different values that come from direct and indirect interaction with MMS was not consistent across stakeholder groups, or within stakeholder groups. Nor was there consistency in the factors that influence value prioritisation – demonstrating diversity in both values and their influencing factors.

There was limited variation in perceptions and values within and between the recreational fishing and diving groups; however, where it existed, level of experience and age were the key factors influencing the prioritisation of values for recreational fishers, while for divers the core influencing factors were age and frequency of diving.

There was significant variation in perceptions and values within and between the commercial fishing and other groups, although the sample sizes constrained the ability to explore what factors shaped differences in values and perceptions. The commercial fishing group covered a range of commercial fishing types including some that use MMS and others whose interaction with MMS is limited. The Other group incorporates a range of different users, from tourism operators to researchers, and therefore their interaction with and relationship with MMS is widely different. The different engagement with MMS likely drives variation in the values derived.

Recreational fishers and divers had more positive perceptions of MMS than commercial fishers or other respondents. In particular, they were more likely to strongly agree that: (i) MMS sustain and increase fish populations over time; (ii) MMS contribute to local tourism; (iii) existing management controls allow for sustainable use; and (iv) MMS providing employment opportunities for local communities.

When averaged across stakeholder groups, all MMS values were considered important, by each stakeholder group (Figure 17). Key differences between user groups included the importance of unregulated access (i.e., open access to all) to the recreational fishers and divers versus commercial fishers and 'others'; and the high importance of MMS to the dive respondents. Similarly, perceptions of MMS were generally positive (Figure 17). Recreational fishers and divers agreed that MMS increase fish populations and contribute to local tourism and employment opportunities. There was less agreement that MMS are sites of conflict between user groups. Others and commercial fishers had more neutral perceptions than the former groups, with contribution of MMS to local tourism and employment opportunities receiving the highest average ratings of agreement for these groups. The only disagreement came from commercial fishing respondents with respect to the contribution of MMS to their target species.

To further explore the similarities and differences in values and perceptions within and between stakeholder groups we mapped the relative priority assigned to values and perceptions onto the social well-being framework. Note that for each map, the values and perceptions for the respondent

group could have been generally more or less positive than other groups. However, we explore the *relative* priority or agreement within each group and find (see Table 16 and Figures 3 - 6):

- Micro scale values are prioritised by recreational fishers and divers, and less so by commercial fishers and others; however, the later users assign importance to meso and macro scale values. *Key message: Even though micro (individual/personal) values are less prioritised by those that less frequently directly engage with MMS, this does not preclude the latter from valuing the broader scale benefits that MMS provide.*
- For the 'Other' group, relational values (management and research) were the highest relative priority of the group, along with ecosystem health. This is in contrast to recreational fishers and commercial fishers, where the relational values were relatively less important (excluding for unregulated access for recreational fishers) than material and subjective values. For divers, subjective values were the highest priority relative to other values. *Key message: The manner in which user groups interact with MMS, particularly with regards to extractive and non-extractive use, determines the relative prioritisation of subjective, material and relational values.*
- Across groups, there was most within group agreement with the statement that MMS contribute to local economies, via for example, tourism. *Key message: The material benefits of MMS arising from tourism is an attribute that receives the greatest recognition within and across all user groups.*

Stakeholder Group	Scale	Value	Perception
Recreational fishing	Micro, meso and macro scale values of high importance (particularly ecosystem health and access).	Micro-scale relational values were a lower priority than micro-scale subjective values. At the meso scale, the relational value of unregulated access was a priority value, while at the macro scale, subjective/material value of ecosystem health was of significant importance.	Highest levels of agreement with statements relating to material and subjective benefits delivered by MMS Majority of perceptions are positive, although there is limited agreement that MMS are as sites of conflict.
Diving	Micro and macro scale values of highest relative importance (particularly ecosystem health, for select sites and WA more broadly).	Subjective values receive highest priority, including contribution to ecosystem health, diversity of species, and the activity of diving itself, followed by material value of local tourism contribution to the local economy.	Highest levels of agreement with statements relating to material and subjective benefits of MMS. Least agreement with relational statements. For example, agreement that MMS contribute to local fish populations and tourism, less agreement that they are managed sustainably or sites of conflict.
Other	Micro scale values are less important than meso and macro scale values. Site- specific values receive similar prioritisation to values at State level.	The high priority assigned to ecosystem health increases the relative prioritisation of subjective values. However, beyond ecosystem health, relational/material values including educational and research opportunities and the policy environment were important.	Most agreement with statements relating to the material benefits of MMS (tourism and local employment), less agreement with statements on sustainable management, or social or environmental benefits of MMS.
Commercial fishing	Most highly prioritised values are meso or macro-scale, rather than micro-scale.	Material and subjective values more important than relational.	Most agreement with statements relating to the material benefits of MMS, least agreement that MMS contribute to target species or that they divert pressure from natural sites.

Table 16: Summary of the **relative** importance of, and agreement with, statements of value and perceptions of MMS in Western Australia, per Stakeholder Group.

Note: micro, meso and macro scales are defined in Weeratunge et al (2014).


#### Figure 16: Average importance of values derived from MMS in Western Australia, per user group.

*Figure 17: Average level of agreement to statements regarding MMS in Western Australia, per user group.* 





*Figure 18: Relative importance of, and agreement with, statements of value and perception for MMS in Western Australia, Recreational fishing respondents.* 

Note: Dark blue circles indicate values, light blue circles indicate perceptions. Relative size of circle denotes the average importance of the value and/or level of agreement.





Note: Dark blue circles indicate values, light blue circles indicate perceptions. Relative size of circle denotes the average importance of the value and/or level of agreement.



*Figure 20: Relative importance of, and agreement with, statements of value and perception for MMS in Western Australia, Other respondents.* 

Note: Dark blue circles indicate values, light blue circles indicate perceptions. Relative size of circle denotes the average importance of the value and/or level of agreement.





Note: Dark blue circles indicate values, light blue circles indicate perceptions. Relative size of circle denotes the average importance of the value and/or level of agreement.

# **Results: Economic Values**

This section presents the results of the different economic valuation approaches applied to the different case studies. In particular, we describe the economic use values (both in terms of expenditure and consumer surplus) for the Exmouth Integrated Artificial Reef and Thevenard Island O&G infrastructure, where there are no primary data available, and for simple primary economic data on single sites (Navy Pier, Busselton Jetty). We also present results on the use values of MMS in the context of the recreational use of multiple sites in larger regions (Geographe Bay, and the Exmouth, Coral Bay and Onslow region) where we adjusted values for the substitution of users' activities among sites within these regions. Furthermore, we describe the non-use (existence) values that the WA general public holds for environmental characteristics on O&G infrastructure in WA.

# Economic values in the absence of primary data: Benefit transfer

# Exmouth Integrated Artificial Reef

We estimated that the Exmouth Integrated Artificial Reef (EIAR) will increase the number of fishing trips to the Exmouth region at least by 227 and at the most by 1521 per year, depending on whether the new site primarily leads to substitution among other sites (lower value) or leads to new trips (upper value). The increase in expenditure in the region that arises from this could range from \$160,000 to \$1,051,000 AUD. Figure 22 below shows a graphical representation of the analysis. Panel A shows the representation of the pre-EIAR position, with the estimated demand curve for trips to the region, cost per trip (\$676) and the implied consumer surplus to fishers of \$3.8m. Panel B shows the maximum additional trips estimated, and the implied increase in consume surplus that would arise (note that for clarity these figures are not drawn to scale). Figure 23 employs a different framework, where the provision of the EIAR is assumed to increase the quality of fishing available to all fishers (i.e. the demand curve shifts up) and this causes an increase in consumer surplus and a (small) increase in number of trips. This gives an estimate of the increase in consumer surplus. The increase in the consumer surplus enjoyed by recreational fishers was estimated to vary from \$114,500 to \$267,000 AUD depending on which approach was taken. These are likely to be underestimates of the values generated from the reefs as they only include limited information about any additional benefits to divers, charter boat operators, commercial fisheries and no estimates on the WTP by the general public for enhanced ecological outcomes. Also, activities on artificial structures partly target the same resource and the potential values generated by any stakeholder group will depend on the access/use by others. Hence, this is important when considering the total economic value from the resource to avoid double counting.

Figure 22: Exmouth Integrated Artificial Reef: Value of the artificial reef under (A) the base scenario and (B) when the new site attracts new fishers.



*Figure 23: Exmouth Integrated Artificial Reef: Increase in value due to an improvement in overall fishing quality (movement of lines not to scale).* 



#### Thevenard O&G infrastructure

Again, we use the trip demand function, and estimates of how the provision of MMS might change it, to derive estimates of the change in consumer surplus. Again, making different assumptions leads to alterative estimates of value. Results of the approach that assumed new fishing trips would be generated suggested that the economic value of making Thevenard O&G infrastructure available would increase fishing trips in the area by between 150 to 299. This would result in extra expenditures of \$80,838 to \$161,676 AUD per year and an additional annual consumer surplus between \$26,647 and \$53,293 AUD (Figure 24, which illustrates the effect for the largest change in trips). The second approach that assumed that the availability of the new MMS would increase average catch rates, and hence increase fisher trip satisfaction, and hence consumer surplus. The

extent of that effect will depend on the level of catch rates, which are unknown. Hence, we simulate across a wide range of possible catch rate son the infrastructure, and the proportion of trips that will re-allocate to them as a result (Figure 25). The re-distribution of effort in the area suggested that the Thevenard O&G infrastructure could increase the number of recreational fishing trips to the Onslow and Thevenard Island area by between approximately 24 and 320 extra trips per year. The increase in expenditures due to the new artificial reefs could lie between \$13,137 and \$173,031 AUD per year and the additional consumer surplus between \$10,087 and \$189,872 AUD per year (Figure 25). The range of these values is very high because they depend on the catch rate which can vary highly depending on whether O&G infrastructure is being left at the current place (and therefore preserves the current biomass on it) or whether the infrastructure is being relocated and transformed into an artificial reef elsewhere. However, these values only assumed one artificial reef whereas there are nine O&G structures around Thevenard Island that could be used to create various artificial reefs which would generate higher economic benefits.







*Figure 25: Relationship between catch rate and A) additional trip expenditures and B) additional consumer surplus from recreational fishers that visit Thevenard O&G structures.* 

Note. The colours of the lines indicate the percentage of trips going to the structures: Blue = 15%, red = 20% and green = 30% of total trips in the area.

We have also qualitatively identified economic benefits for recreational diving tourism (including scuba diving, snorkelling and free diving), charter boat operators and commercial fisheries, including aquarium fish harvest. At this stage, the available information did not allow a meaningful estimate of these values. However, we identified clear potential for the O&G structures to enhance the viability of diving tourism, charter boat operators and commercial fishing in the Onslow region.

For detailed results of these case studies, see report "The potential economic value associated with the development of artificial reefs in Western Australia" in Appendix 4.

# Echo Yodel

Echo Yodel is a Woodside energy pipeline located 137 km north-west of Dampier in Western Australia.

Installed in 2001, it transported gas from the Echo Yodel gas and condensate field to the Goodwyn Alpha platform, some 23 km. The gas and condensate wells ceased production in 2012. The current proposal for decommissioning permanently plugs and abandons the two production wells (Yodel-3, Yodel-4 and Capella-1), including removal of associated well infrastructure and involves removal of the 23 km umbilical. At the time of writing the proposed decommissioning of Echo Yodel infrastructure was the subject of the regulatory assessment and approvals process under the Offshore Petroleum and Greenhouse Gas Storage (Environment) Regulations 2009. The Echo Yodel pipeline will be decommissioned in situ.

The Echo Yodel infrastructure has been in place for 18 years. In that time, it has provided habitat and support for a range of marine fauna. Recent studies identified a range of commercially relevant species that have established along the pipeline (Bond et al., 2018). Commercial fishers do fish in the area (Bond, 2020). They are participants in the Pilbara Trap fishery, which harvests a range of demersal species.

The economic value of the infrastructure was evaluated by inferring what the implications are for profits of current fishers if it were removed. This required some assumptions about allocation of effort, catch and economic parameters under the two scenarios, but it is important to note that it is the change in profits that are important, and which may be influenced by changes in catch (both level and quality) and/or changes in costs. The impact of the pipeline therefore comes down to fishing cost on and away from the pipeline and the share of catch that is currently on the pipeline. We estimated that this value may be relatively low (\$9,121 per year).

For detailed results, see Appendix 9 "Economic impact of removing Echo Yodel Pipeline on commercial fishing".

# Economic use values - Single site-specific

## Zonal travel cost model: Exmouth Navy Pier

We collected a total of 153 valid responses through the Exmouth Navy Pier survey. Respondents' characteristics are shown in Table 17. The survey revealed that the average expenditure for one day diving in the Exmouth region is \$205 AUD. With approximately 3000 divers visiting the Navy Pier per year, we estimated an aggregate annual expenditure of \$615,000 AUD.

Respondents' characteristics	Value	Range
Average age (years)	39 (SD 12.17)	22-72
Gender (% female)	45.4	
Zone (%)		
Western Australia	36.8	
Other states of Australia	23.7	
Oceania	0.7	
Asia	2.6	
Europe	25.7	
America	10.5	
Average number of trips (# of trips/year)	1.9 (SD 4.4)	1-50

# Table 17: Respondents' characteristics (n=153).

Average trip duration (# of days/trip)	8.00 (SD 9.90)	2-90
Average expenditure on diving (AUD)	205	
Average total trip expenditure (AUD)	2411 (SD 2086)	150-15000

The travel cost model results (Table 18) show the estimated parameters of the relationship between the costs of getting to the region and the per capita visitation rate. Based on this equation, we extrapolated how aggregate visitation would change for (simulated) increases in price, which is essentially deriving the demand curve for diving in the Exmouth region. We assumed that all respondents have the same 'choke' price of \$978 AUD (being a combination of their current travel costs and the simulated increase in price due to an 'entrance fee') at which demand would fall to zero. We derived this value as approximately double the amount of travel costs from the zone with the highest cost (America) (Cohen et al. 2016). This process led to a segmented aggregate demand curve, as shown in Figure 26, where 'kinks' occur as segments leave the market entirely as the hypothetical 'entrance fee' increases. The area under the aggregate demand curve represents the consumer surplus of our sample that arose from the 1779 trip days that they took (i.e. the benefit that they enjoyed over and above the costs of getting to the location). The estimated consumer surplus for one day diving in the Exmouth region is \$136.39 AUD.

This estimate is derived for dive trips to the Exmouth region as a whole, in any area. We assumed that this value also applied to dives at the Navy Pier. With approximately 3000 divers visiting the Navy Pier per year, this resulted in an aggregate consumer surplus of \$409,170 AUD/year.

Variable	Coefficient	Std. Err.	P-value
1/Travel Cost	262.933	64.517	0.015
Intercept	-1.330	0.796	0.170
R <sup>2</sup>	0.806		
Observations (zones)	6		

# Table 18: Summary regression results of In(stay) on the inverse of travel cost.

*Figure 26: Demand curve for diving in the Exmouth region.* 



#### Individual Travel Cost Model: Busselton Jetty

A total of 211 usable responses from people living in WA gave information on their total number of trips to Busselton Jetty in 2019. 51% were resident in Busselton, and the median number of trips was eight, although a significant proportion (14%) said they went more than 50 times in the year. Using a censored negative binomial model, we found a significant negative relationship between the costs of getting from their place of residence to the Jetty, as reported in Table 19 (i.e. the estimated coefficient of -0.028 implies that number of trips falls as travel costs to the site increases).

Surveys revealed that the median expenditure associated with one visit on the Busselton Jetty per person is \$12 AUD. We estimated the consumer surplus for one visit on the Jetty to be \$36 AUD, which, as noted above, is derived in this form of travel cost model as minus one times the inverse of the coefficient on the travel cost (i.e. -1/(-0.028)). With approximately 535,115 visitors to the Busselton Jetty per year, this resulted in an aggregate annual expenditure of \$6.4 million AUD and a consumer surplus of \$19.26 million AUD per year. Note that in this case the estimates of the surplus value (that attained by the user over and above costs) is substantially greater than the expenditure estimate.

Variable	Coefficient	Std. Err.	P-value
Travel Cost	-0.028	0.007	<0.001
Intercept	2.488	0.088	<0.001
Dispersion	-0.251	0.118	0.034
Observations	195		

Table 19: Summary regression results of number of trips on the estimated travel cost: Busselton Jetty.

Note. For all details on the results, see the full report "The economic value of the Exmouth Navy Pier and Busselton Jetty, Western Australia" in Appendix 5.

# Economic use values - Choices across multiple sites

#### Descriptive statistics

The random utility survey yielded 174 valid responses, out of which 123 were from recreational fishers and 51 from divers. We found that for recreational fishers, the level of use of our case study regions decreased with increasing distance from Perth. The most visited area was Geographe Bay where recreational fishers spent about almost two thirds and divers about 40% of their trips. In the Exmouth region, one third of fishing trips and 57% of dive trips took place, hence Exmouth was the most visited region for divers. Only 4% of fishing and diving trips took place in the Onslow region.

In Geographe Bay, recreational fishers indicated 307 places they visited, out of which 94 (30.6%) were on MMS. Divers used MMS relatively more with 40 out of 61 locations (66.7%) being on MMS (Figure 27: note that the heat maps represent the percentage of total visitation within the sample by location). In the Exmouth Region, use of MMS was overall lower than in Geographe Bay. Recreational fishers added 161 locations, out of which 25 (15.5%) were on MMS and about 12.2% of divers' locations (11 out of 90) were taking place on MMS (Figure 28). This could be explained by the fact that there is only one artificial reef and one jetty in the Exmouth region whereas Geographe Bay has five different MMS available in a smaller area. We had very small numbers of visitors to the Onslow Region (Figure 29) and the heat maps should be interpreted with this in mind. Recreational fishers indicated 21 locations they visited, four being on MMS. Divers added six locations, three being on MMS. Coral Bay has no MMS, so all 83 trips recorded were taking place on natural sites (Figure 30).



Figure 27: Frequency of trips for boat based (A) recreational fishing (n=307) and (B) diving (n=61) in Geographe Bay.



Figure 28: Frequency of trips for boat based (A) recreational fishing (n=161) and (B) diving (n=90) in the Exmouth region.



Figure 29: Frequency of trips for boat based (A) recreational fishing (n=21) and (B) diving (n=6) in the Onslow region.



Figure 30: Frequency of trips for boat based (A) recreational fishing (n=72) and (B) diving (n=11) in Coral Bay.

#### Random utility model

We estimated a random utility model for both recreational fishers and divers (Table 20). This table reports the estimated coefficients of the utility function that underlies the choices made. They can be interpreted as 'scaled marginal utilities' i.e. the change in utility that arises from a unit change in the attribute but they have no directly interpretable units of measure. However, ratios of coefficients are interpretable, as the marginal rate at which a respondent would substitute one attribute for another. As expected from economic theory, the travel cost coefficient had a significant and negative effect in both models. Artificial reefs influenced site choice for recreational fishers strongly and positively, whereas there was a positive but not significant effect for divers. The Busselton Jetty influenced strongly and positively the site choice of divers and fishers. Shipwrecks influenced both recreational fishers' and divers' site choice positively, but this effect was only significant for divers. This is not surprising because both the Lena and the Swan shipwrecks are notake zones. However, recreational fishers might still benefit from spill-over effects from these zones. Another possibility is that respondents combine different activities and go fishing in the surroundings of the wrecks as well as dive on the wrecks during one trip. In general, some recreational fishers indicated to have fished within no-take zones. However, this might be due to an inaccuracy of clicking on the map rather than an illegal activity.

The area of the grid cell and the distance from shore also positively affected site choice for both user groups. Moreover, fishers and divers had a preference for sites more distant from shore. This result might be explained by users trying to avoid overcrowding in areas closer to shore. It might also be an indicator of overfishing in areas closer to shore. Water depth was not significant and is therefore not reported here.

Results of this model also revealed the WTP for MMS types for those who actually visit them and hence did not account for the substitution effect. Given that shipwrecks are closed to fishers it is not surprising that recreational fishers' WTP for artificial reefs was about twice that for shipwrecks. Also, the WTP of divers for jetties was about twice that for shipwrecks.

Variable	Recreational fishers			Recreational divers		
	Coef.	Std. Err.	P- value	Coef.	Std. Err.	P-value
Travel cost	-0.117	0.009	0.000	-0.117	0.012	0.000
Artificial reef	1.126	0.335	0.001	0.428	0.536	0.425
Shipwreck	0.353	0.358	0.325	2.113	0.559	0.000
Jetty	1.391	0.408	0.001	2.729	0.710	0.000
Area	0.007	0.002	0.000	0.008	0.002	0.000
Distance from shore	0.022	0.010	0.027	0.020	0.012	0.105
Number of trips	130			79		
Respondents	70			40		
Log-likelihood	-316.881			-179.942		
WTP artificial reef	-9.620	3.014	0.001			
WTP shipwreck				-18.045	5.282	0.001
WTP jetty	-11.909	3.725	0.001	-23.311	6.786	0.001

*Table 20: Results of the random utility model for recreational fishers' and divers' site choice in Western Australia.* 

# Welfare impact of MMS

It is possible to use this model to simulate what would happen if one introduces or removes MMS from particular cells. Adding an MMS would increase the value of visiting that cell, cause a reallocation of effort and lead to an overall improvement in welfare of fishers/divers. It is possible to quantify (in \$ terms) the overall improvement in welfare of all fishers/divers as a result of the change. We estimated the value associated with existing MMS in the four regions by calculating the change in welfare (in AUD per trip) that occurs when MMS are hypothetically removed (Table 21). The simulation of site choice under the removal scenarios included the redistribution of users across the region, also called the substitution effect. Therefore, the values associated with these structures were lower than the WTP of respondents when not taking substitution into consideration.

For recreational fishers, the removal of the Dunsborough artificial reef (DAR) had the highest welfare impact, followed by removing the Busselton Jetty (BJ). For divers, the removal of the Swan wreck (SW) had the highest welfare impact, followed by the Busselton Jetty (BJ). Overall, the removal of MMS had a higher loss in welfare on divers than on fishers.

As expected, the sum of welfare changed when removing MMS in Geographe Bay separately is lower than when removing all MMS in Geographe Bay at once for divers. This is because the sum of the welfare change of all MMS reflects the welfare change where users still can substitute among

different MMS. Conversely, in the scenario that removes all MMS at once, users can only substitute their sites with non-MMS sites. However, fishers' loss in welfare as the sum of removing all MMS separately was higher than removing them all at once. We suspect that this is because there are two MMS (the Swan wreck and the Dunsborough artificial reef) in the same grid cell. The model suggests that dropping both together was less harmful than the sum of dropping each in turn. However, this likely depends on the number of MMS per cell (having a high number of MMS in single cells probably will cause the substitution effect to overcome the marginal effect of two MMS in one cell). We also simulated the site choice and associated welfare changes under scenarios in which we added MMS to the study regions. We used MMS types that were significant to recreational fishers (artificial reefs) and divers (wrecks) as a proxy. It is noticeable that these two structure types have different characteristics: artificial reefs give access to recreational fishers and divers, however divers rarely use these structures due to the incompatibility of the two activities. Wrecks are only open to divers but have shown to have a positive effect on recreational fishers as well (Table 21). Consistent with the negative travel cost variable, the added value of a MMS to a grid cell closer to boat ramps (G28) was much higher than when adding a MMS further away (G25) for both recreational fishers and divers.

Lastly, we simulated different scenarios of opening access to fishers and/or divers to the Thevenard O&G infrastructures (Table 21). Again, we used the coefficients from "artificial reefs" and "wrecks" as a proxy because we had no estimates for O&G infrastructures. Results indicated a decreasing marginal utility with additional MMS (i.e. additional structures are valued, but at a decreasing rate as more structures are added). For example, divers and recreational fishers had a higher value per structure when opening the access to two structures (AR2 and W2) than when giving access to all nine structures (AR9 and W9). This result was also influenced by the fact that the scenario AR2 and W2 gave access to the two structures closest to shore which reduced travel costs. The scenario that combined O&G infrastructures that are significant to fishers (artificial reefs) with those that are significant to divers (wrecks) (AR4W5) had the most equitable benefits.

Scenario	Description	Change in rec. fishers' welfare (AUD/trip)	Change in divers' welfare (AUD/trip)	Aggregate change in rec fishers' welfare (AUD/year)	Aggregate change in rec divers' welfare (AUD/year)
Geographe E	Bay				
SW	Remove Swan Wreck	-0.27	-0.75		
LW	Remove Lena Wreck	-0.07	-0.36		
DAR	Remove Dunsborough AR	-0.68	-0.21		
BAR	Remove Bunbury AR	-0.20	-0.01		
G25	Add MMS in Geographe Bay (cell 25)*	0.04	0.01		
G28	Add MMS in Geographe Bay (cell 28)*	0.42	0.19		
Sum of removing all MMS separate	-1.67	-1.89			
Remove all MMS at once	-1.59	-1.97			
Coral Bay	•				
EAR	Remove EIAR	-0.20	-0.09	-3,042	
EW	EIAR diver access only	-0.16	0.95	-2,434	
E37	Add MMS (cell 37)*	0.12	0.15	1,825	
Onslow region	on				
AR9	Access O&G infrastructure: 9 "artificial reefs"	1.19	0.10	1,188	
W9	Access O&G infrastructure: 9 "wrecks"	0.21	1.06	210	
AR4W5	Access O&G infrastructure: 4 "artificial reefs" and 5 "wrecks"	0.50	0.60	499	

Table 21: Hypothetical scenarios for MMS in Western Australia and the associated change in welfare for recreational fishers and divers

AR2	Access O&G	0.53	0.05	529	
	infrastructure: 2				
	"artificial reefs"				
W2	Access O&G	0.09	0.54	90	
	infrastructure: 2				
	"wrecks"				

\* "artificial reefs" for recreational fishers and "wrecks" for divers

Our results were consistent with previous studies that have analysed the access value for recreational fishers to sites along the coast of Western Australia. The importance of MMS to recreational fishers in this area was highlighted when comparing the welfare impact of removing all recreational fishing sites in Busselton (\$-3.76 AUD) (from (Raguragavan and Hailu, 2013) to the sum of welfare loss from removing all MMS in the area (\$ -1.40 AUD) (from Table 20 above, for artificial reefs only). In other regions, such as Exmouth, such a comparison suggested that the relative importance of MMS to recreational fishers was lower (\$-6.16 AUD for removing all sites (from (Raguragavan and Hailu, 2013)) compared to \$-0.20 AUD for removing the EIAR). The access value of the Onslow region was relatively low (\$2.95 AUD; (Raguragavan and Hailu, 2013)), hence, opening access to the O&G infrastructures could increase the welfare of users significantly. Conversely, adding an MMS in Coral Bay would not add much to the welfare of users.

For all details on the results, see full report "The use value of man-made marine structures in Western Australia: A random utility model" in Appendix 6.

# **Economic existence values: Community preferences**

# Descriptive statistics

The survey yielded a total of 392 valid responses, drawn from the general Western Australia population. 'Protest' respondents i.e. those who *always* chose the complete removal option (status quo) in all choice sets, were excluded from the analysis of the choice data, although their answers were retained in the descriptive statistics, and should be included when considering the proportion of the sample who would accept a particular reef option over complete removal. This is because they are not revealing any information about the value of the attributes of the reef, as they are making their choice on some other heuristic. Choices of the complete removal that were reported by those making a mixture of choices were included. Overall, respondents in the sample reflected the demographic structure of the Western Australia population (Table 22).

Demographics	Sample (%)	Western Australia population (%)
Gender		
Male	50	50
Female	49	50
Age		
18-30	17	23
31-45	28	28
46-60	27	25
61-75	20	17
Over 76	8	7

# Table 22: Demographic characteristics of survey respondents.

Source: Australian Bureau of Statistics (2016)

#### Social License to Operate

The SLO was measured one a scale from one to five, higher scores indicate a higher SLO. The various questions regarding the different aspects of SLO were combined into two measures of SLO: the "extended economic legitimacy" and the "social legitimacy". The relative distributions of the two measures (Table 23) indicate that respondents tend to agree that the O&G sector contributes to the economy of Western Australia, whereas they neither agree nor disagree on average with the measure of "social legitimacy".

## Table 23: Summary of the "Extended economic legitimacy" and the "Social legitimacy" measures.

	Mean	Standard deviation	Number of observations
Extended economic	3.88	0.734	392
legitimacy			
Social legitimacy	3.15	0.805	392

#### Discrete choice experiment

9.4% of respondents opposed rigs-to-reefs under any scenario presented to them. The remaining proportion revealed preferences for rigs-to-reefs depending on the individual's characteristics and the nature of the reef presented (Table 24). The reported coefficients can be interpreted as the scaled marginal utility associated with an attribute i.e. the change in utility that would arise for a unit change in the attribute. They have no interpretable units *per see*, but ratios of parameters do, as they indicate the trade-offs between two attributes that a respondent is prepared to make. In particular, the ratio of attribute parameter to a cost parameter gives the value of the attribute in monetary terms. Significance of the parameter estimates is determined by conventional measures of statistical significance (p values) or the 95% confidence intervals.

Preferences were higher towards reefs that could provide either habitat for threatened species, increased fish biomass, production of fishes, and access for divers, or increased revenue for the State budget. However, preferences for rigs-to-reefs were reduced if liability lay with the Government, or social licence granted to the O&G sector was low.

Choice	Coef.	Std. Err.	P-value	95% Conf. Interval
Status Quo	0.583	0.433	0.179	-0.267 1.432
Habitat	0.180	0.117	0.124	-0.050 0.409
Biomass	0.087	0.104	0.404	-0.117 0.290
Production	-0.011	0.122	0.925	-0.251 0.228
Access to divers	0.037	0.122	0.764	-0.203 0.277
Access to fishers	-0.329	0.122	0.007	-0.567 -0.090
Liability with government	-0.138	0.084	0.000	-0.301 0.026
Joint liability	-0.815	0.107	0.100	-1.024 -0.606
Attributes interacted with	SLO and a	attitudinal	questions	5
SQ*EEL	-0.429	0.100	0.000	-0.625 -0.232
HAB*ATTHAB	0.619	0.112	0.000	0.399 0.839
BIO*ATTBIO	0.298	0.106	0.005	0.090 0.506
PROD* ATTPROD	0.399	0.147	0.007	0.111 0.687
ACCDIVER*DIV	0.442	0.164	0.007	0.121 0.762
ACCFISHER*FISH	0.490	0.132	0.000	0.230 0.750
REV*ATTREV	0.003	0.001	0.003	0.001 0.005
REV* NOATTREV	0.002	0.001	0.161	-0.000 0.004

#### Table 24: Conditional logit model, full model.

Number of observations = 6,354; LR chi<sup>2</sup> (9) = 906.71; Pseudo R<sup>2</sup> = 0.1948; Log likelihood = -1873.5072

#### Probability of accepting rigs-to-reefs

We estimated the probabilities that a respondent would accept the reef option depending on the attributes of the reef as well as on the level of extended economic legitimacy (EEL) that respondents granted to the O&G sector (Table 25). We show the latter as the range from 1 (does not grant EEL) to 5 (grants the highest EEL).

The probabilities of the 'base reef' were obtained assuming that the reef does not provide habitat for threatened species, has 0.5 tonnes of fish biomass, the fishes are attracted to the rig, there is no access for anyone, the company is liable, it provides \$100 million AUD in revenue to the State budget, and the respondent does not attend to any of the attributes. The results revealed that the probability of choosing a rig-to-reef with these characteristics decreases by 34 percentage points from 0.85 for someone granting an EEL of 5, to 0.51 for someone that does not grant EEL. A higher probability of accepting a reef with a higher EEL was found for all attributes.

All attributes that described an environmental improvement, namely the provision of habitat for endangered species, the increase in biomass and the production of fish (opposed to the attraction of fish) increased the probabilities of respondents accepting a rig-to-reef.

For the access to the reef for divers, the results presented a very small increase (0.01) in the probability of choosing the reef option when the respondent is not a diver, but a high increase in the probabilities for those who are divers. Conversely, the probability of choosing the reef option when the access is allowed for fishers substantially decreases if the respondent is not a fisher, and slightly increases when the respondent is a fisher.

The results regarding the liability attributes revealed that, compared to the base reef, there is a substantial decrease (0.19) in the probability of choosing the reef when the respondent does not

grant EEL and the liability lies with the Government; and a smaller decrease in the probability for someone granting the higher degree of EEL (0.13). In the case of the liability being shared between the Government and the company, the results also showed a decrease in the probabilities, but to a lesser extent.

Finally, the revenue attribute revealed that the probability of choosing the reef option increases when higher amounts of revenue are paid by the company to the State budget (when considering those who attended to revenue).

*Table 25: Probabilities of choosing the rig-to-reef option depending on different levels of attributes and degree of economic legitimacy.* 

	Leve	ls of economic legitimacy
Attributes	1	5
1. Base reef	0.51	0.85
2. Biological		
a. Habitat & attend to habitat	0.70	0.93
b. Fish biomass (tonnes) & attend to biomass		
0.5	0.55	0.87
1.5	0.64	0.91
c. Fish production & attend to fish production	0.61	0.90
3. Access to the reef		
a. For divers, if		
Not a diver	0.52	0.86
Diver	0.63	0.90
b. For fishers, if		
Not a fisher	0.43	0.81
Fisher	0.55	0.87
4. Socioeconomic		
a. Liability		
Government	0.32	0.72
Shared	0.48	0.84
b. Revenue (AUD million) & attend to revenue		
100	0.55	0.87
160	0.60	0.89

For full results, see the full report "Community acceptance of rigs-to-reefs in Western Australia" in Appendix 7.

# **Summary of Economic Values**

We found evidence for the economic value of MMS throughout the different methods used in this study. We estimated both expenditure and consumer surplus measures associated with the MMS of the four case studies. While the expenditure indicated the contribution that an MMS makes to a local economy, the consumer surplus revealed the benefits that people gain from MMS, both from the direct use as well as from the existence of marine life on MMS. The sum of these measures is the total economic value associated with MMS.

We found that within the survey responses recreational fishers used the Geographe Bay region the most, followed by the Exmouth and Onslow region. Conversely, divers made most trips to Exmouth, followed by Geographe Bay and Onslow. Overall, divers used MMS more (34%) than recreational fishers (25%). Divers mainly used jetties and shipwrecks whereas recreational fishers mainly used purpose built artificial reefs.

We used three alternative approaches to estimate the potential value of decommissioned O&G infrastructure off Thevenard Island as well as the EIAR which was constructed using repurposed O&G infrastructure and purpose-built structures. The benefit transfer approach found increased use values (expenditures and consumer surplus) for recreational fishers at these sites. The precise value highly depended on the fish biomass present, and therefore the catchability on these structures. The random utility model indicated that the Thevenard O&G infrastructures could potentially increase the welfare of both recreational fishers and divers significantly, depending on who was granted access to the structures. The EIAR on the other hand had a significantly positive effect on the site choice of recreational fishers, but not divers.

The importance of rigs-to-reefs providing increased fish biomass was also measured by the discrete choice experiment on preferences of the general public in WA. We found that other attributes of an improved environment such as the provision of habitat for threatened species or the production (rather than the attraction) of fishes was preferred. Moreover, the study showed that WA's community preferred reefs with increased revenue for the State budget or access for divers. However, preferences for rigs-to-reefs were reduced if liability lay with the Government, or the social licence to operate granted to the O&G sector was low.

The estimates of the value per day of a diving trip in the Exmouth region was substantially higher than that for a trip to Busselton Jetty, which in turn was higher than estimates for fishing trips to MMS in Geographe Bay. This can largely be explained by the degree to which there are substitute activities for the MMS: not only the presence of MMS but the quality of the experience that they gave. For those using Busselton Jetty, the majority of whom did not fish or dive, there were few experiences that were similar, and even for fishers, who one could argue can access numerous other fishing points, there were few that can give such access without a boat. The MMS in Geographe Bay had a large number of natural substitute sites.

# **Results: Social value - group**

This section presents the results of the Social Values Group component of the research/project. We discuss the synthesis process adopted, before presenting the data. Commencing with the findings relating to values (attending to their systemic impacts, propensity, and convergence with the literature derived framework), the themes (the breadth, their relationship to the values, and associated priorities), opportunities and threats (which are dominant, support for the values etc.) we then present the Busselton case study and the resultant information. Finally, we consider the integration of these different data categories before concluding with a discussion of the integration of the social value group and individual values, opportunities, and issues.

Given the focus on eliciting deep and systemic data, the analysis process focused initially on exploring the three categories: values, emergent themes, and issues/opportunities in terms of their depth (amount of material supporting them), frequency (how often they emerged in the focus groups) and systemic disposition (their position in the network etc.). As such each 'strata' (see Figure 31 below) is analysed (a horizontal assessment) followed by a systemic integrated and vertical assessment. The results are provided below.





An overarching examination (comprising all three categories) was conducted to exploit the systemic nature of the data and gain a set of holistic insights/findings. As such, each value was considered in conjunction with the material supporting it, and each opportunity/issue could be scrutinised to determine which value(s) it impacted. This provides a more nuanced appreciation and potentially better outcomes. For example, based on the combination of analysis and the resultant findings, decision makers will be able to determine how much variance there is between the value systems of different cohorts, where there is agreement and where there is difference between values; which of the values is founded upon a predominance of issues (suggesting it is a value of concern) and which of the values is supported by a predominance of opportunities (implying an aspiration). Consequently, decision makers will be in the position of being well informed regarding what substantiates each of the values (comprising a mix of opportunities and issues), and where there are possible tensions between issues and opportunities and between stakeholder groups. Therefore, the analysis and subsequent findings provide decision makers with a number of models to inform robust decision making (objective 1). Through the generation of a range of models the analysis and findings also provides a framework against which policies and actions can be

considered (objective 4). In addition, an in depth/targeted examination of the Busselton community (objective 3) allows for a micro exploration of the impact of MMS on a particular geographical location.

The 11 focus groups gave rise to 104 values, 86 themes, 246 issues and 214 opportunities (Table 26).

Workshop	Issues	Opportunities	Issues/Opportunities	Themes	Values
Exmouth 1	9	13	0	10	21
Exmouth 2	21	21	0	12	10
Chevron	16	21	1	10	5
Regulator 1	16	21	6	6	8
Oil & Gas	26	15	1	5	12
Regulator 2	29	15	4	6	7
Recreational Fishers	32	38	6	8	15
Karratha & Onslow	13	20	6	6	5
Busselton	23	19	1	8	5
Commercial Fishers	32	14	2	7	5
Non-Government Organisation	29	17	1	8	11

Table 26: Values, themes, issues and opportunities derived from focus groups.

# Values

As noted in the methods, 11 focus group workshops were carried out giving rise to 104 values revealing the <u>breadth of potential values</u>. This ties in with the literature where it is argued that it is important to recognise "the plurality of stakeholders and result in competing strategies and goals" (Smith and Lewis, 2011, p384). In each workshop the values were seen as a system, i.e. values could support values with the values at the top of the chain being very broad and those further down being more detailed. For example, it is worth noting that *protecting/enhancing the marine environment* emerged as an overarching value at the top of the chain. When exploring each workshop's value systems, there was considerable homogeneity in both the values and their relationships. Many of the values were similar in content/meaning and were able to be combined into 21 meta-values - synthesising the value material. From the exploration of the breadth and interconnectivity of the values a number of models were able to be produced.

# Building a decision tree: A key part of multi-criteria model building

The meta-values, along with the relationships between them (retaining the systemic property) were used to produce a decision tree. Decision trees can be used to aid decision makers when considering a range of options as they provide the criteria against which each option can be assessed once weights are allocated to the criteria/values (for example each criteria could be given equal weighting or criteria could be given differential weights depending on the decision maker – either way the weighting would be made explicit).

The tree below (Figure 32) reflects the values and highlights that there are 6 generic values/criteria supporting the 21 meta-values.

- 1) Ensure a healthy marine environment.
- 2) Regional economic benefits.
- 3) Evidence based regulations.
- 4) Ensure social licence to operate.
- 5) Stakeholder collaboration and engagement.
- 6) Effectively designed MMS.

Each of these generic criteria have sub-criteria reflecting the meta-values. For each of the generic values (and associated meta-values) the range of the stakeholder workshops is noted illustrating that in four of the six 'branches' a number of the stakeholder cohorts supported the value (the least supported generic value focusing on design considerations and predominantly supported by O&G).





The decision tree provides decision makers with the basis upon which to construct a multi-criteria decision model. Each of the meta-values would have to be allocated a weighting as would the generic values before the model could be used to assess different options (which are scored against the weights). This could be carried out with particular stakeholder cohorts and informed by the prioritisation process conducted against the themes. In addition, it would be possible to customise the tree, focusing on the generic/meta values that were of particular interest to the stakeholder group/context.

#### Understanding the value systems

As noted earlier, workshop values were not discrete, i.e., some values were supported, or were supported/reinforced by other values. This information is important as it provides a more nuanced appreciation of the social value landscape and provides the opportunity for greater impact.

Complementing the decision tree, and providing an alternative representation, a values map was produced. The map aids with facilitating an *understanding* of both centrality and frequency/ownership of each metavalue (objective 1). For example, *'ensure a healthy marine environment'* (a value owned by all workshops) has a central position in the system as did *'regional economic benefits'* (see Figure 33 below). The metavalues are linked using arrows based on how the workshop values were linked. If the links between metavalues were demonstrated in two workshops the connecting arrow is thicker and where the values supported one another a double headed arrow is presented showing dynamic self-reinforcing behaviour. Three superordinate values are noted (overarching values) and three supporting values (drivers) presented. Attending to the driver values would have a positive impact on the other values. The below Figure (33) shows a high-level view – comprising those values that were elicited from 6 or more of the focus group workshops and so the mostly widely held. The full values system can be found in Appendix 10.





*Note: those values at the bottom of the figure support those at the top – for example regulatory transparency may support ensuring safe accessible fishing environments and may support regional economic benefits.* 

#### Spider (or radar) graphs

Using the generic values and focus group data, it was also possible to construct spider graphs to illustrate the difference emphases between cohorts. Spider graphs (e.g. Figure 34) are one way of visualising data, and are used to plot one or more groups of values over multiple common variables represented on axes starting from the same point. This provides an alternative means of viewing the ownership of the values and a sense of the range of values generated during the focus group workshops.



Figure 34: Generic values spider graph.

Note: The spider graph displays the number of values each individual workshop contributed to generic values. Workshop values were grouped into meta values and these meta values contribute to the generic values that are labelled in the centre of the spider plot. Location of the position (coloured circles) was determined based on how much material each individual workshop contributed to the generic value. Each dash on a line represents the amount of contributing material from 1 - 7.

From the above spider graph, it can be seen that there are differences in support for each of the generic values. For example, the generic value related to *'healthy marine environment'* appears on all of the axes, however it barely registers on some and dominates others gives a sense of appetite/support for the value. The graph therefore presents an easily viewable image of the heterogeneity of each stakeholder group. Individual spider graphs for each generic value can be found in Appendix 8.

## Mapping values to the literature framework

A final activity was to map the meta-values on to the literature framework (Weeratunga et al, 2014). As such it was possible to determine if each of the three dimensions were supported, whether the different levels (i.e. macro, micro and meso) were supported and whether the generic values were situated in specific sectors of the framework. The resultant plot (Figure 35) demonstrates all three literature-based values were supported, and all three levels of analysis were supported. In addition, it revealed that there were distinct clustering's i.e. meta-values relating to regulatory matters were solely situated in the relational arena whereas those related to collaboration and engagement appeared in all three.





Overall, the figure illustrates that material values are dominated by the regional economic benefits and effectively designed MMS, whereas relational values see stakeholder collaboration and engagement, social licence and regulatory considerations. The marine environment predominantly sits in the subjective sector.

In reviewing the values, the analyses illustrate that there exists a wide range of values, that the values can be distilled into six generic values, or if a more fine-grained approach is required, a set of 21 meta values. The meta value level provides more nuanced appreciation necessary for decision making. In addition, different stakeholder groups/cohorts have different appetites for the values. Thus, there are some values that are strongly subscribed to by all, and other values that have only partial (or lukewarm) support. Finally, the analyses reveal the systemic nature of values highlighting the importance of taking a holistic approach when determining policy and action.

# Themes

As noted in the methods section, each workshop gave rise to a series of 'clusters' of material - themes - comprising the issues, opportunities and their interconnections. The 11 workshops yielded 86 themes in total, with each workshop generating between five to 12 themes. The themes were reviewed individually with each workshop cohort to check for comprehension and ensure that the material within them was appropriately situated. As with the values, the themes were reviewed for similarity and able to be distilled into 29 meta-themes (Table 27).

Generic Value	Contributing Meta-Theme
Ensure a healthy marine environment	<ul> <li>Location of MMS</li> <li>Increase habitat productivity</li> <li>Spread pressure across reef systems</li> <li>Increase community awareness of marine environment</li> <li>Competing stakeholder values</li> <li>Pollution from MMS</li> <li>Detrimental impact to the marine environment</li> <li>Research opportunities</li> <li>Ensure sustainable fishing activity</li> <li>Reduce regulation uncertainty</li> <li>Plan for future decommissioning</li> <li>Managing multi-user risk</li> <li>Environmental stewardship</li> <li>Understand MMS structure</li> </ul>
Regional economic benefits (tourism & employment)	<ul> <li>Location of MMS</li> <li>Increase habitat productivity</li> <li>Increase community awareness of marine environment</li> <li>Competing stakeholder values</li> <li>Liability and responsibility of MMS</li> <li>Pollution from MMS</li> <li>Detrimental impact to the marine environment</li> <li>Employment opportunities</li> <li>Impact on local infrastructure</li> <li>Safety hazard from MMS</li> <li>Cumulative impacts of multiple structures</li> <li>Understand and achieve environmental, social and economic outcomes</li> <li>Managing multi-user risk</li> <li>Environmental stewardship</li> <li>Increase stakeholder collaboration</li> <li>Financial assessment and management of MMS</li> <li>Understand MMS structure</li> <li>Increased tourism</li> </ul>
Evidence-based regulations	<ul> <li>Liability and responsibility of MMS</li> <li>Pollution from MMS</li> <li>Detrimental impact to the marine environment</li> <li>Research opportunities</li> <li>Policy unable to keep up with sector</li> </ul>

## Table 27: Listing the generic values and meta-themes that support them.

	<ul> <li>Reduce overall decommissioning cost</li> <li>Understand economic lifecycle cost-benefit analysis</li> <li>Understand and achieve environmental, social and economic outcomes</li> <li>Reduce regulation uncertainty</li> <li>Plan for future decommissioning</li> <li>Managing multi-user risk</li> </ul>
Ensure social licence to operate	<ul> <li>Location of MMS</li> <li>Increase habitat productivity</li> <li>Increase community awareness of marine environment</li> <li>Competing stakeholder values</li> <li>Liability and responsibility of MMS</li> <li>Pollution from MMS</li> <li>Detrimental impact to the marine environment</li> <li>Research opportunities</li> <li>Policy unable to keep up with sector</li> <li>Understand and achieve environmental, social and economic outcomes</li> <li>Managing multi-user risk</li> <li>Environmental stewardship</li> <li>Increase stakeholder collaboration</li> </ul>
Stakeholder collaboration & engagement	<ul> <li>Location of MMS</li> <li>Increase habitat productivity</li> <li>Spread pressure across reef systems</li> <li>Increase community awareness of marine environment</li> <li>Competing stakeholder values</li> <li>Research opportunities</li> <li>Policy unable to keep up with sector</li> <li>Current data gaps</li> <li>Cumulative impacts of multiple structures</li> <li>Balancing risk – leave in vs removal</li> <li>Reduce regulation uncertainty</li> <li>Increase stakeholder collaboration</li> <li>Understand MMS structure</li> </ul>
Effectively designed MMS	<ul> <li>Location of MMS</li> <li>Increase habitat productivity</li> <li>Liability and responsibility of MMS</li> <li>Pollution from MMS</li> <li>Research opportunities</li> </ul>

*Note: Meta-themes can support >1 generic value.* 

Reviewing the meta themes, 14 supported both healthy marine environment, 18 supported regional economic benefits and 11 supported evidence-based regulations, 13 Ensure social licence to operate, 13 Stakeholder collaboration & engagement and 5 Effectively designed MMS. From this it could be concluded that values around ensuring regional economic benefits was first and foremost in participant minds.

Four of the meta themes supported 5 generic values namely, location, marine productivity, pollution, and research, and five supported four generic values namely: community awareness, competing stakeholder values, liability concerns, detrimental risk and multi-user risk. One possible insight from this is that these meta themes were seen as *potent* (providing considerable leverage) in terms of addressing the generic values, and thus exploring the issues and opportunities supporting them would give decision makers useful information when considering policies and action.

As noted in the methods, once the themes had been reviewed, and the opportunities and issues structured using the causal mapping process participants were asked to rate the themes - allowing for some prioritisation to be revealed. The process allows for both the identification of preference (the highest

average) and the degree of consensus (the lower the score the greater the degree of consensus). Table 28 shows the results of the prioritisation process with each meta theme being listed alongside the contributing workshop cohort.

# Table 28: Meta-themes by cohort workshops.

Meta-theme	Contributing	Average Rating of	Degree of
	Workshops (number	Importance (out of 10)	Consensus &
	of attendees)	& Range	Range
Reduce overall decommissioning cost	Chevron (4)	8.3	1.9
Environmental stewardship	Regulator 2 (8)	7.95 (6.5 - 9.4)	1.2 (0.86 - 1.5)
	Recreational Fishers	Regulator (9.4)	Regulator (0.86)
	(6)	Recreational Fishers	Recreational
		(6.5)	Fishers (6.9)
Current data gaps	Oil & Gas (5)	7.6	1.4
Understand MMS structures	<b>Recreational Fishers</b>	7.5 (5.5 - 9.5)	1.6 (0.87 - 2.4)
	(6)	Recreational Fishers	Recreational
	Karratha & Onslow (4)	(9.5)	Fishers (0.87)
	Commercial Fishers	Karratha & Onslow	Karratha &
	(7)	(7.5)	Onslow (1.5)
	NGO (7)	NGO (5.5)	NGO (2.4)
Reduce regulation uncertainty	Regulator 1(4)	7.5 (6.3 - 8.3)	1.7 (0.83 - 2.9)
	Regulator 2 (8)	Regulator 1 (8.3)	Regulator 1
	Recreational Fishers	Regulator 2 (8)	(0.83)
	(0)	(C 2)	Regulator 2 (1.7)
		(0.5)	Fishers (2.9)
Research opportunities	Exmouth 1 (7)	7 3 (6 3 - 8 3)	17(15-18)
Research opportunities	Exmouth 2 (8)	Regulator 1 (8.3)	Regulator $1(1.5)$
	Regulator 1 (4)	Recreational Fishers	Recreational
	Recreational Fishers	(6.3)	Fishers (1.8)
	(6)		
Managing multi-user risk	Regulator 1 (4)	7.25 (6.5 - 8)	2.2 (2.1 - 2.3)
	Karratha & Onslow (4)	Karratha & Onslow (8)	Regulator 1 (2.1)
		Regulator 1 (6.5)	Karratha &
			Onslow (2.3)
Increase stakeholder	Regulator 2 (8)	7.2 (6.4 - 8)	2.2 (1.9 - 2.5)
collaboration	Recreational Fishers	Recreational Fishers (8)	Recreational
	(6)	Regulator 1 (6.4)	Fishers (1.9)
the deveters diese die elsiesse	Descriptor 2 (0)		Regulator 1 (2.5)
Understand and achieve	Regulator 2 (8)	6.75(5-8.6)	2.4 (0.83 - 6.3) Recreational
environmental, social and	(c)	Regulator 2 (0.0)	Fishers (0.83)
economic outcomes	(0) Karratha & Onslow (1)	(7.8)	$\frac{1}{1} \frac{1}{1} \frac{1}$
	Busselton (4)	Karratha & Onslow	Regulator 2 (1.9)
	Commercial Fishers	(5.3)	Karratha &
	(7)	Busselton (5)	Onslow (6.3)
	NGO (7)		
Increased tourism	Exmouth 2 (8)	6.6 (5 - 8.3)	1.44 (10.97 - 1.9)
	Karratha & Onslow (4)	NGO (8.3)	
	NGO (7)	Karratha & Onslow (5)	
Location of MMS	Exmouth 1 (7)	6.5	1.5
	Karratha & Onslow (4)		
	Commercial Fishers (7)		

Understand economic lifecycle cost-benefit of MMS	Chevron (4)	6.5	2.5
Cumulative impacts of multiple structures	Oil & Gas (5)	6.4	3.1
Policy unable to keep up with	Chevron (4)	6.2 (6 - 6.3)	1.7 (1.5 - 1.9)
sector	Busselton (4)	Chevron (6.3)	Chevron (1.5)
	Commercial Fishers (7)	Busselton (6)	Busselton (1.9)
Pollution from MMS	Exmouth 1 (7)	6.2 (5.5 - 6.8)	1.7 (1.6 - 1.8)
	Exmouth 2 (8)	Regulator 1 (6.8)	Regulator 1 (1.6)
	Chevron (4)	Chevron (5.5)	Chevron (1.8)
	Regulator 1 (4)		
Detrimental impact to natural	Exmouth 1 (7)	6.2 (3.3 - 8.7)	2.1 (1.6 - 2.6)
environment	Exmouth 2 (8)	NGO (8.7)	Regulator 1 (1.6)
	Regulator 1 (4)	Regulator 1 (6.8)	Chevron (1.8)
	Busselton (4)	Busselton (6.5)	Busselton (2.5)
	NGO (7)	Chevron (3.3)	NGO (2.6)
	Chevron (4)		,
Liability and responsibility of	Exmouth 1 (7)	5.9 (4.3 - 9)	2 (0.71 - 3.1)
MMS	Exmouth 2 (8)	Chevron (9)	Chevron (0.71)
	Chevron (4)	Karratha & Onslow	NGO (1.1)
	Oil & Gas (5)	(5.8)	Karratha &
	Karratha & Onslow (4)	Busselton (5.8)	Onslow (2.2)
	Busselton (4)	Oil & Gas (4.6)	Busselton (2.9)
	Commercial Fishers (7)	NGO (4.3)	Oil & Gas (3.1)
	NGO (7)		
Increased habitat productivity	Exmouth 1 (7)	5.9 (5.5 - 6.5)	2.25 (1.5 - 2.7)
	Exmouth 2 (8)	Busselton (6.5)	Busselton (1.5)
	Chevron (4)	Chevron (5.8)	Regulator 2 (2.2)
	Oil & Gas (5)	Oil & Gas (5.8)	Chevron (2.5)
	Regulator 2 (8)	Regulator 2 (5.5)	Oil & Gas (2.7)
	Busselton (4)		( )
	Commercial Fishers (7)		
Safety hazards from MMS	Exmouth 2	5.5 (4.3 - 7)	2.5 (2.1 - 2.8)
	Chevron (4)	Busselton (7)	Busselton (2.1)
	Busselton (4)	NGO (5.2)	NGO (2.5)
	NGO (7)	Chevron (4.3)	Chevron (2.8)
Increased community awareness	Exmouth 1 (7)	5.5	2.7
of marine environment	Exmouth 2 (8)		
	Busselton (4)		
Competing stakeholder values	Exmouth 1 (7)	5.4 (3 - 8.8)	2.2 (1.1 - 3.3)
	Chevron (4)	Busselton (8.8)	Busselton (1.1)
	Oil & Gas (5)	Oil & Gas (6.4)	NGO (3)
	Busselton (4)	Chevron (3.5)	Oil & Gas (3.1)
	NGO (7)	NGO (3)	Chevron (3.3)
Financial assessment and	<b>Recreational Fishers</b>	5	3.2
management of MMS	(6)		
Balancing risk - leaving in vs.	Oil & Gas (5)	4.6 (3 - 6.2)	2.5 (2.4 - 2.5)
removal	NGO (7)	NGO (6.2)	Oil & Gas (2.4)
		Oil & Gas (3)	NGO (2.5)
Ensuring sustainable fishing	Chevron (4)	3	0.71
activity			
Spread pressure across reef	Exmouth 1 (7)	N/A	N/A
systems			

Employment opportunities	Exmouth 1 (7)	N/A	N/A
Impact on local infrastructure	Exmouth 2 (8)	N/A	N/A

Note: Workshops themes were collated into meta-themes displayed in column one. Meta-themes are colour coded based on which generic theme they contributed to (Ensure a healthy marine environment, Evidence-based regulations, Regional economic benefits (tourism & employment), Stakeholder collaboration & engagement, Effectively designed MMS, Ensure social license to operate). In column two workshops that contributed to these meta-themes (e.g., had at least one workshop theme that contributed to the meta-theme) were listed. If a meta-theme is contributed to in two or more category of workshop (e.g., community, fishers, regulators, O&G) the names of those workshops are noted in bold font. Average importance ratings and degree of consensus ratings were taken in eight of the 11 workshops. Importance rating and degree of consensus does not include Exmouth workshops (different rating system because of face-to-face workshop) or commercial workshop (rating not used during this workshop). These ratings for workshop themes were averaged together depending on which meta-theme it contributed to. The ranges of these ratings were also reported. In some cases, a meta-theme was only contributed to by one workshop and a range was not possible to report.

When reviewing Table 28, it can be seen that for a number of meta-themes there was a range of views regarding importance.

- The meta-theme with the highest average was *decrease overall decommissioning costs*, however it is worth noting that this only appeared in one workshop.
- Understanding MMS structures (which reflected an interest in more research) appeared in four of the workshops and received the fourth highest overall average. However, there was quite a range as one workshop averaged 5.5 with another averaging 9.5 suggesting a high degree of variability in terms of preference. There was also a degree of difference in terms of the intra-workshop rating with only a medium level degree of consensus.
- The meta-theme relating to *understand and achieve economic, social and environmental outcomes* was rated the most often.
- The meta theme relating to research was identified regularly, was prioritised by four cohorts and was seen as important by many. However, on closer look this apparent homogeneity is reduced as the forms and foci regarding research are quite different.

When exploring the similarity/differences across stakeholder workshops it was interesting to note:

- Meta-themes shared across recreational and commercial fishers' workshops included understand and achieve environmental, social and economic outcomes and understand MMS structures (which had a research connotation).
- The only meta-theme shared across community workshops (Karratha & Onslow, Busselton, and Exmouth 1 & 2) related to *liability and responsibility of MMS*.
- There were no shared meta-themes across all of the regulator, NGO and oil & gas workshops.

Overall, the themes and meta-themes provide insights into the 'bundles' of issues and opportunities surfaced during the workshops. In addition, the range of meta-themes gives insight into the extensiveness of concerns and hopes illustrating the diversity of view. In some workshops the themes giving rise to the meta-themes were well developed comprising 10 or more issues/opportunities, however in other instances they were much sparser only comprising three or four issues/opportunities. When reviewing the prioritisation process in some instances there was high levels of agreement e.g. *'increased habitat productivity* whereas in others the priorities were quite different e.g. *liability and responsibility of MMS'*. This meta-theme had a range of averages from 9/10 (Chevron) to 4.3 (O&G & NGO).

# **Opportunities and issues**

An assessment was carried out on the issues and opportunities. The first analysis centred on the balance of issues to opportunities. This was found to be fairly even with issues comprising around 46% of the material generated, and opportunities making up 42%. In some instances, participants view the contribution as potentially being both (8%) and in a few occasions didn't register whether the statement was an issue or opportunity (4%).

Figure 36: Issues and opportunities.



Note: Issues and opportunities sometimes contributed to more than one workshop theme. An I/O/B was deemed as contributing to a workshop theme if it was linked to the theme via an ingoing arrow. This chart demonstrates how the contribution of issues and opportunities was distributed between the 86 workshop themes.

A further analysis explored the complexion of the meta-themes, i.e. whether they were evenly balanced in terms of issues/opportunities or not (see appendix 11 for 'Issues and opportunities underpinning the meta and generic values'). The analysis also explored the range of issues/opportunities supporting the meta-themes. Table 29 notes each meta-theme, the number of issues/opportunities/both associated with them. Insights from this include:

- those meta-themes that were dominated by a wide range of issues e.g. 'competing stakeholder values', 'liability and responsibility of the MMS', 'detrimental to the natural environment' and 'reduce regulatory uncertainty'. There were also meta-themes that were predominantly issue oriented but without such depth of material.
- those meta-themes that were dominated by a wide range of opportunities e.g. 'increased habitat productivity', and 'understand and achieve environmental, social and economic outcomes'. As with the issue dominated meta-themes, there were a few that were broadly opportunities but did not have a substantial amount of material supporting them.
- those meta-themes that were extensively supported.

Table 29: Issues and opportunities contributing to meta-themes.

Dominant Issue	Contributing Stakeholder Cohorts
Balance access across stakeholders	Community, Oil & Gas, Fishers
Risk of fish stock depletion	<b>Community,</b> Oil & Gas, Regulator, Fishers, NGO
Creation of user/navigational hazards	<b>Community,</b> Oil & Gas, <b>Regulator,</b> Fishers, NGO
Disintegration of structure	Community, Oil & Gas, Regulator
Spread of invasive species	Community, Oil & Gas, Regulator, NGO
Lack of clarity around ownership/liability	Community, <b>Oil &amp; Gas, Regulator,</b> Fishers, NGO
Perception of 'dumping'	Community, <b>Oil &amp; Gas, Regulator,</b> Fishers, NGO
Changes to natural aesthetic	Community, Oil & Gas, NGO
Impact on natural environment	Community, Oil & Gas, Regulator, NGO
Dominant Opportunity	Contributing Workshops
Increased fish habitat	Community, Oil & Gas, Fishers, NGO
Recycling material	Community, Oil & Gas, Regulator
Increase tourism	Community, Oil & Gas, Regulator, NGO
Provides recreational uses	Community, Oil & Gas, Regulator NGO
Ensuring economic gains	Community, Oil & Gas, Fishers, NGO
Job creation	Community, Oil & Gas, Regulator, Fishers
Dominant Issues/Opportunity	Contributing Workshops
Undertaking (further) research	Community, Regulator, NGO

Note: Dominant issues (I) and opportunities (O) were determined after compiling lists of Is, Os, and both issues and opportunities (B) for each of the 11 workshops. Each I, O and B list was examined for common words/themes/meanings to create a dominant set. Workshop themes were excluded from this process as they are a summary of the current data being examined. I, O, and Bs are considered dominant if they are addressed by at least 3/4/5 workshops.

Overall, when considering the balance between issues and opportunities there is a fairly even spread. However, a deeper scrutiny reveals that some of the meta themes were dominated by issues or opportunities. For example, the meta-themes below are dominated by issues,

- Liability and responsibility (47).
- Detrimental impact to the natural environment (58).
- safety hazard (26).

Whereas only one theme was dominated by opportunities

• increased community awareness of marine environment (29).

Returning to the issue of balance, 4 meta-themes received high volumes of both issues and outcomes,
- competing stakeholder values (53) (29).
- reduce regulatory uncertainty (44) (35).
- increased habitat productivity (36) (54).
- understand and achieve environmental, social and economic outcomes (34) (71).

The meta-themes can be clustered together, e.g. liability and responsibility and reduce regulatory uncertainty making up one cluster, detrimental impact to the natural environment and increased habitat productivity making up another.

### **Busselton case study**

The Busselton focus group took place on the 14<sup>th</sup> July 2020 and involved 4 participants from a range of different organisations and disciplines. It followed the same design as all of the other focus groups and was conducted on-line. Despite the small number of participants, the group was able to construct a model comprising 76 statements (issues, opportunities, values). Analysis of the resultant model gave rise to the following observations.

When reviewing the themes, the theme titled 'manage the type and use of MMS was prioritised most frequently, receiving a score of 8.8/10 with a high degree of consensus. The theme reflected the recurring theme relating to potential competing demands amongst stakeholders and was a mix of both issues and opportunities. As in other workshops, another important theme for the group was habitat rehabilitation, closely linked to a theme comprising 'threaten the natural marine and coastal environment (particularly instigated by concerns regarding the theme of user safety). To a lesser extent there were concerns regarding liability and cost and an appreciation of the economic benefits for the area. A final theme, that was relatively distinct to the group centred on understanding of the natural environment.

Busselton contributed to 4/6 generic values (Ensure a healthy marine environment, Regional economic benefits, Evidence based regulations and Social licence to operate. In terms of the themes Busselton contributed to eight of the 29 generic themes and 4/9 of the dominant issues 2/6 opportunities. Thus demonstrating a high degree of similarity and shared many commonalities with the other community oriented workshops.

Along with having similarities with much of the material elicited, the group raised a relatively unique value -'Australian Way of Life' and added a particular nuance to the social licence to operate through the value of 'inspire a younger generation about the marine environment.

### Table 30: Statistics from Busselton workshop.

Participants	Values	Themes	Issues	Opportunities	Total
4	5	8	23	19	76

### Summary: Holistic integrative analysis and participant engagement

In reviewing the focus group material together (rather than through the lens of particular data sets, e.g. values) four key content oriented aspects straddling all of the focus group workshops emerged. Each of these is discussed below. This is followed by process-oriented material reflecting the satisfaction/engagement with the process as noted by participants.

### Regulatory environment

Legislation and regulation emerged consistently throughout the focus groups as an area of concern i.e., an issue. They comprised two connected values namely:

- ensure evidence-based regulations.
- ensure regulatory transparency and liability.

When reviewing these values alongside the issues and opportunities it is apparent that the two metavalues were dominated by issues. In the below figure (Figure 37), the two meta-values are positioned centrally (black text with borders). Linking into them are the dominant issues (red background). Each issue has listed the stakeholder groups that raised the issue (illustrating high degrees of homogeneity). Where there were multiple routes (links connecting an issue to a value, potentially through themes) these are noted at the arrowhead (for example, the issue relating to *'ownership and liability'* is linked six times to the value relating to *regulatory transparency*.

There appears to be two 'clusters' of 'dominant issues' namely marine and liability. These clusters reflect that a number of the issues are closely related. This key aspect is the only one that is extensively dominated by issues/concerns and therefore was one of great concern. In addition, many of the focus groups raised the need for 'additional research'. This is categorised as 'both' (yellow background) and constituted an opportunity (as it would facilitate action) and issue (there was insufficient data for effective decision making).



Figure 37: Regulatory aspect (meta-values) with associated dominant issues clustered.

### Impact of stakeholder conflict versus collaboration and engagement

Effective engagement, collaboration, and the avoidance of conflict between stakeholders was another key aspect for many if not all of the workshop cohorts. As with regulatory considerations, two meta-values were central, namely *manage stakeholder conflict* and *stakeholder collaboration and engagement* (potentially reflecting two sides of the stakeholder coin) (Figure 38). It could be argued that these are the same in meaning if not in words, however it is worth considering whether the different terminology relates to the perceptions of the cohort members with some seeing conflict as a likely outcome (and thus taking a negative view) and others seeing real value in engaging stakeholders and as such potentially requiring different approaches. Interestingly, as with regulatory matters, the topic was supported by dominant issues with only one dominant opportunity. The two clusters of concern appear to relate to 'uses' and to 'liability' (linking it with the regulatory area) (Figure 38).

### Figure 38: Stakeholder Aspect with associated clusters of issues and opportunities.



### Retention/regeneration of a health marine environment

This aspect was not surprising - and comprised two meta-values namely *ensure a healthy marine environment* and *protect the marine environment* (Figure 39). Again, whilst these could be seen as synonyms the wording suggests different nuances - one focusing on protecting what is there currently, and the other potentially focusing on improvement. This separation is also reflected in the clusters of dominant issues and opportunities. For example, there is an issue dominated 'marine' theme, and a balanced 'use' theme (touching on the stakeholder aspect) relating to '*ensure a healthy marine environment*' as well as 'additional research'. *Desire to protect the marine environment* shares one of the dominant issues as well as being influenced by issues relating to liability (connecting it with the regulatory topic) (Figure 39).



### Figure 39: Marine environment aspect with associated clusters of issues and opportunities.

### **Regional benefits**

The final aspect relates to regional and economic benefits and this topic sees a number of dominant opportunities supporting it (job creation, recycling and recreational uses) (Figure 40). However, there are still 5 dominant issues and the area of additional research. Use, materials and Marine emerge as the clusters of issues/opportunities.





### **Participant feedback**

Alongside the data-oriented findings, there were also those relating to the processes adopted to elicit data reflecting participant involvement. Due to the impact of COVID-19, an alternative to face-to-face focus group workshops was required. One option was using a newly developed software package whereby participants could join the focus group from wherever they were using a standard web browser. The package allowed the issues, opportunities and values along with their impacts on one another to be modelled in the same manner as the face-to-face groups. However, given the newness of the approach feedback on the system, meeting process and facilitation of the group was sought to ensure the approach met the objectives.

The feedback was extremely positive across the nine sessions. Universally, participants noted how easy it was to use the system, that the process worked well, and that the facilitation was appropriate. Comments such as

"Using the strategy finder (the software) I think was really, really good because if I had just spent this much time of my day giving feedback without seeing it, how it all linked together and fed into another and helped inform my own mental map in live time. I may have thought it might be something I'm not too keen to do again but seeing it unfold in front of me and really understanding how it's been used is really, really helpful. And it feels like it was a good use of time. So, I want to thank you for engaging in that way" – Recreational Fishers

"I think this really focuses people because they are looking at their screen and nothing else. And if anything I think it [online workshops] might be better in terms of focus." – Chevron.

"Software was great. Actually worked better than a whiteboard/post-it note session in the office", "I really liked doing this digitally over the web, in my opinion it was more focused than in face. More time to think" – O&G

"Very good facilitation. Good at capturing thoughts accurately and keeping the group focused." – Chevron

"Worked very well in terms of having everyone 'at the table' and being able to see the facilitator 'link' up suggestions in real time!" – NGO

### Social value individual and group comparison

A comparison of the results from the social value individual and social value group data was also undertaken. Overall, there appeared to be high levels of similarity between the findings providing corroborating evidence for the values, issues and opportunities. The social value data elicited from the group process, unsurprisingly, provided more nuance and a sense of relative importance (through prioritisation activities) and inter-connectivity (allowing a systemic perspective to be taken), whereas the survey provided a wider participation rate and thus adds robustness to the findings.

When comparing the values, the structure of the survey prompted respondents to consider ten values (elicited from the literature) allowing for comparison across demographics to be undertaken. The group focus workshops allowed the values to 'emerge naturally' (rather than being pre-selected). Despite these different approaches, on examination of the data, both research approaches identified healthy marine environments as being the most significant value as well as use (e.g. access, independence, wellbeing). The focus groups saw support for the ten survey values being surfaced and raised evidence based regulatory transparency and liability as additional important values (nine of the 11 workshops). Another area of value from the focus group workshops was that of effectively designing MMS, which was also raised by survey respondents in the open-ended responses, where a majority noted that MMS did not deliver negative social, economic or environmental consequences, "if done correctly".

Comparing the issues and opportunities, there was considerable homogeneity between the two data sets. However, there were differences in terms of coverage (the group workshops highlighting a number of dominant issues/opportunities that did not emerge from the survey) and in designation (in the survey some items were classified as opportunities whereas they were classified as issues by the group workshops). For example, the focus groups raised opportunities in terms of recycling materials and undertaking further research which the survey did not uncover. When considering different designations, the survey listed accessibility (ease of access) as an opportunity, whereas this was considered an issue by the group workshops. Similarly, environmental sustainability was seen as being a key benefit for the survey respondents, whereas the group workshops noted the issue of fish stock depletion (potentially the reverse of sustainability). However, for survey respondents how they viewed issues and opportunities depended on the question being asked. In the case of sustainability, overfishing was noted, but not as extensively as the opportunity for growing fish stocks. Illustrating the nuanced difference further. In terms of sustainability, the focus groups designated food sustainability as a value suggesting that not only were concepts differently designated between issue and opportunity, but also between issues/opportunities and value. These differences could be explained by the composition of the focus groups as compared with survey respondents as many of the focus group participants were decision makers, whereas the survey targeted users.

# **Section 4: Discussion**

This section focuses on integrating the information obtained from the three data sets to provide a holistic perspective on these social and economic values and their inter-relationships. The discussion therefore synthesizes the views and perspectives of a range of stakeholders from different sectors, including recreational and commercial fishers, tourists and tourist operators, local council and chamber of commerce staff, people representing state government, conservation and fisheries agencies, regulators from state and commonwealth agencies, staff from NGOs representing commercial and recreational fishing, and conservation groups.

It is important to note at this point that there are sectors and stakeholders that are not represented. Attempts were made to collect and analyse indigenous views and perspectives on the values of MMS, but these were not successful. It should also be noted that the artisanal fishing sector, usually defined as small scale subsistence and commercial fishing activity utilising specific fishing gear, is not active in this case study area.

Eliciting and reflecting on socioeconomic values relating to MMS is important from both a procedural justice (Kim and Mauborgne 1995) and procedural fairness (Moffat and Zhang 2013) perspective as well as the more commonly considered rationality (Simon 1976) angle. Attending to justice or fairness closely relates to social license (raised as one of the values) to operate, which in itself goes beyond initial development and operation into decommissioning of O&G infrastructure (Genter 2019). Whilst decommissioning of O&G structures is often first to mind when considering MMS, paying attention to the social licence to operate relates to all projects. This is because stakeholder engagement is critical to retain social license (Eskerod and Lund 2013). Trust is a key element and effective engagement through meaningful conversations, rather than superficial consultation, has been found to be paramount (Genter 2019; Moffat and Zhang, 2013). Consequently, understanding the broad spectrum of stakeholders affected by MMS is important and thus engaging stakeholders to understand the breadth of values an important activity. This project sought the views of a range of different stakeholder groups seeking to ensure a comprehensive coverage of stakeholder groups (although recognising that there are some important omissions e.g. indigenous communities). It is also important to recognise the formal and informal links between stakeholders (Genter 2019, Ackermann and Eden 2011c). Considering stakeholders in isolation risks losing valuable support and increasing the chances of hostile coalitions.

In order to provide a visual summary of the social and economic values and their inter-relationships, three categories were identified and defined which collectively represent almost all values identified through the research. These are:

- Use values. These are defined as the values that arise from the direct use of MMS and can be interpreted as economic direct use values and social values held by the individual reflecting their interaction with MMS.
- 2) Community values. These relate to a broader scale and can be interpreted as economic indirect use values and social values reflecting attributes gained by users arising from the presence of MMS.
- 3) Environmental values. These are associated with the quality of the marine environment, as this pertains to the presence of MMS. In economic terms, those values are existence or non-use values held by the general public, whilst social values reflect the significance of these environmental qualities to an individual.

Figure 41 depicts these value categories as three circles. Within each value category, there is an overarching value represented by a larger node which are hereafter referred to as 'end state values'. Thus, 'community benefits' is the end state value in the 'community values' category, 'user wellbeing' is the end state value in the 'use value in the 'use values' category and 'condition of marine environment' is the end state value in the 'environmental values' category. Each end state value is influenced by other factors/values, which are represented by links to nodes, both within and across the three categories. It is worth noting that the

terminology used across components varies. For example, while in social science the node "safety" would be defined as a value, in economics safety is interpreted as a factor that contributes to the wellbeing of the user (end state value). As such, a hierarchy can be deduced.

The coloured segments around each node denote where each value was detected through the research activities. Thus, for example, 'job creation' is a community value which was identified through collection of data relating to economic values, individual social values and group social values. 'Pollution and water quality' is an environmental value which was identified through collection of data relating to individual and group social values, but it was not highlighted through collection of data relating to economic values. Hence, this figure does not indicate whether a certain node definitely has economic or social values attached to it, but rather reflects the outcomes of this research project (for example, it is possible to measure the influence that invasive species on MMS have on economic existence values, but this has not been measured here). Where all three coloured segments appear, it can be reasonably assumed that there is triangulation across data sources, and thus an increased weighting to the significance of that value.

Several values lie outside of the main categorisation outlined above. 'Social license to operate' and 'regulations' were grouped into a sub-category called 'rules and norms', whilst 'design of MMS' is a standalone value.

It should be borne in mind that this categorisation process may obscure differing stakeholders' interpretations and understandings of values (reflecting idiosyncratic perceptions). For example, 'safety' is a highly subjective value, reflecting an individual's perception of what constitutes personal or collective safety (e.g. proximity of MMS to shore, visibility of MMS, behaviour of individuals in and around MMS and so on). Thus, each value should be understood as including potentially different emphases or characteristics, whilst the importance attached to each value will vary within and between stakeholder groups. With that caveat in mind, the discussion will now examine each of the three main categories in turn.

## Use values

User wellbeing is the end state value in this category. This is influenced by individual use (including experiences of using MMS) and the benefits of interacting with other users. These in turn are conditioned mainly by access, which is a complex value composed of elements including the physical location of MMS, travel costs, personal safety considerations and any regulations defining rights of access for specific user groups. Use is also related to values in other categories, including job creation and business revenues and the condition of the marine environment. Accessibility was particularly important to recreational fishers and divers, who valued the enhanced opportunities for greater involvement and engagement with the marine environment. Economic survey data demonstrated a strong preference for MMS sites close to boat ramps due to the decrease in travel costs. Further depth to the notion of user wellbeing was provided by focus group work, which noted the cultural importance of MMS through fulfilling traditional lifestyle habits such as 'catching a snapper for dinner' and the aesthetics of the MMS.

However, it is important to consider how cumulative policy decisions may impact on these professed values. The economic data indicated an increase in consumer surplus value to both recreational fishers and divers as more sites are available, rising from \$9.6 AUD per trip to an existing jetty to \$11.9 AUD per trip to additional jetties for fishers and from \$18 AUD to an existing shipwreck dive to \$26 AUD for additional shipwrecks for divers. These results did not predict how the values per additional MMS change when creating numerous MMS in a region. It is likely that there is a saturation at some point and indeed, the social focus groups revealed that there was concern that whilst one or two MMS might be acceptable, a cumulative build-up of MMS could be perceived as losing the 'authenticity' associated with fishing and diving over natural sites. Results from the social survey also highlighted issues of overcrowding and inappropriate behaviour by some users impacting the enjoyment and well-being of others. Hence, MMS are also perceived as potential sites of conflict between different users. As an example, divers believe the

values of diving at MMS decrease in the presence of recreational fishers due to the prevalence of lost fishing equipment and rubbish on the seafloor and the behaviour of fishers. Similarly, the value that recreational fishers place on MMS decreases if commercial fishers have access. Commercial fishers want certainty over access to MMS, particularly if they were to invest in them, and stressed the need to recognise and reconcile different priorities within the sector (e.g. aquaculture versus line fishing). This result was supported by findings from the economic RUM survey which showed that recreational fishers have no significant value for shipwrecks which they have no access to. Accordingly, the discrete choice experiment found that the value of a rig-to-reef with access for fishers decreases significantly if the respondent is not a fisher, and slightly increases when the respondent is a fisher, indicating a noncompatibility of these activities. Conflict also emerged as a theme from the group social value data with conflict possibly occurring in the allocation/designation of MMS.





# **Community values**

Community benefits are the end state value in this category, with job creation being the only related value highlighted by all three research streams. Job creation evidently has many economic and social facets which would be desired by stakeholders, including direct and indirect employment opportunities, community stability and local identity. Business revenues and taxation are also important values generating community benefits alongside environmental awareness and education. Community benefits are directly

related to values outside of this category including social license to operate, whilst job creation is influenced by MMS usage as represented in the use values category.

Business revenues and the creation of jobs are flow-on effects of the direct use of MMS. For example, we estimated that people diving the Exmouth Navy Pier spend about \$205 AUD for one day's diving (\$615,000 AUD annually). We also found that the expenditures related to the Exmouth Navy Pier made up a substantial part of business revenues and employment for the operating dive company. For Busselton Jetty, the expenditure was estimated at \$12 AUD per person per visit or annual expenditure of \$6.4 AUD million. The case study on the Exmouth Integrated Artificial Reef showed it could generate between \$155,000 and \$1.05 AUD million for the local economy.

The economic importance of MMS was also particularly evident in the information generated by some of the regional focus groups and case studies where MMS were seen as a mechanism for creating local jobs and generating business revenues, and ultimately taxes which could be used to support regional infrastructure development and community programs. However, focus groups found that whilst it was appreciated that an increase in MMS could result in increased tourism for the area, there was concern that the increased tourist numbers would not only overwhelm the services used by members of the community but also potentially change the experience – touching on the 'well-being' value in a negative fashion. As such another balance, relating access to over access and thus ensuring sustainability was identified. This concern by the community was also found by the social online survey which noted the impact of increased usage - with a recognition that whilst tourism would benefit, there was in addition the potential for tension over resources such as food or fuel.

Commercial fishers can also benefit economically from MMS. Commercial trap fishers have been documented fishing near offshore O&G structures periodically (Bond, 2020). Another example of commercial fishing/aquaculture benefitting from MMS is the design and deployment of purpose-built artificial reefs to allow in water sea ranching business for abalone (see <a href="https://www.oceangrown.com.au/">https://www.oceangrown.com.au/</a>). Some commercial fishers believed that the construction and deployment of purpose-built artificial reefs were one mechanism available to them for increasing their profitability. Challenges to pursuing this option for enhancing fishing and profits were the current legislation for deployment and installation of artificial reefs and obtaining exclusive access rights – touching again on the regulation transparency value. Also, the social - individual survey found that commercial fishers and other stakeholders were less inclined to agree that MMS deliver environmental benefits although the social group workshops did see environmental values being subscribed to, but with less weight than economic. This underlies a need to demonstrate the environmental benefits of MMS if seeking to gain widespread community support.

One challenge that was found by all components was the question of who assumed the long-term liability for MMS. The focus groups revealed that there is a perception by some stakeholders that O&G companies wanted to 'dump' their rubbish on the seafloor under the guise of a 'rigs-to-reefs' program and transfer liability to the government. This perception led to one of the most frequent concerns raised which was who was responsible for the maintenance of MMS and the liability and costs of removal at the end of its life, or for the costs of clean up if an unforeseen event occurred. This was particularly relevant to discussions around decommissioning offshore O&G infrastructure and was part of the discussion around the need to reduce regulatory uncertainty by having clear and consistently applied guidelines both for decommissioning and the installation of new structures. Similarly, the economic discrete choice experiment showed that the WA general public preferred decommissioning scenarios where the future liability lies either solely with the O&G companies, or jointly between the O&G companies and the Australian government.

The results from some of the focus groups revealed that it was a complex arena to navigate. For example, the uncertainty around the regulatory framework, and the short and long-term environmental impacts when compared against the potential social, economic and environmental benefits, has an effect on the social licence to operate and therefore needs to be taken into account by any proponent wanting to install or relocate MMS. Accordingly, the social online survey found that the enhancement of community benefits is seen to contribute towards a social licence to operate, thereby creating a feedback loop between individual perceptions of community benefits and the broader policy environment. Then again, the

economic discrete choice experiment suggests that members of the WA general public that grant a higher degree of a social license to operate to the O&G sector are more likely to prefer decommissioning options that convert O&G infrastructure into artificial reefs.

There was a belief among focus group participants that if the process of designing, constructing, deploying, and monitoring MMS was undertaken with meaningful and collaborative stakeholder engagement that an outcome could be increased community awareness of the marine environment promoting environmental stewardship. The opportunity for increased environmental awareness associated with MMS was also found by the social online survey as an additional component of community benefits.

## **Environmental values**

Condition of the marine environment is the end state value in this category and was highlighted by all three research streams as the most central and important value. The workshops highlight the centrality of ensuring a healthy marine environment with all 11 workshops raising this as a value and the vast majority prioritising the themes supporting it. This value is influenced by pollution, water quality and the presence of invasive species and in turn influences whether MMS act as sites of attraction or production for marine species. Habitat creation is related to the latter, and also influences the presence of invasive marine species. The condition of the marine environment is also affected by values in other categories, principally those associated with use and catchability, but also interacts with values associated with environmental awareness and education. Rules and norms and MMS design do not directly influence this end state value but do interact with pollution and water quality.

MMS often have unique assemblages of marine organisms, and in the case of some artificial reefs, jetties and piers, O&G platforms and pipelines the biomass of fish exceeds nearby marine habitats (Bond et al., 2018a, b; Schramm et al., 2020). In part, this is because some of these structures are not fished (platforms), but also because the sometimes vertical and complex engineering of the structures create a number of different habitats and ecological niches for organisms to occupy (McLean et al. 2019). Habitat creation was frequently cited as an important value and driver in the online survey of social values, whilst focus group work revealed a broad range of environmental benefits associated with MMS including increasing or improving local fish stocks, biodiversity and overall ecosystem health.

There was also a belief that MMS benefited the marine environment by diverting recreational fishing and other pressures away from natural habitats – although care had to be taken as the provision of well sited MMS could result in overfishing (both at the site of the MMS and from surrounds as fish moved from one location to another). Economic valuation surveys highlighted the presence of non-use values, whereby individuals valued the environmental contribution from MMS regardless of whether they personally benefited from it. These non-use values (expressed as consumer surplus) were higher where O&G infrastructure generated a higher fish biomass and/or habitat for endangered species. The study also found that production of new fish biomass was preferred over attraction of biomass from the surroundings. Whilst the social and economic benefits arising from the impact of MMS on the marine environment were noted across all stakeholders, there were clear differences in nuance. For some focus group respondents, the emphasis was on protecting the environment, whilst for others it centred on rebuilding the environment (restoration), which may reflect whether respondents had a pristine or damaged marine environment in mind and the activity they participated in.

In addition, in the social values online survey and workshops, stakeholders raised issues and concerns about the installation of MMS including potential pollution (whether that be from the gradual disintegration of the structure or the aesthetics - visual pollution) and a degradation of the marine environment due to MMS. It was also noted that they could become stepping-stones for the spread of invasive marine species suggesting careful management and design would be needed. Focus group participants were also concerned that an overuse can lead to detrimental environmental impacts such as pollution and a reduction in the quality of the marine environment due to over-consumption. There was a concern from focus group participants that current policy and legislation was unable to reflect what stakeholders wanted and needed. This was particularly the case for decommissioning of O&G infrastructure where decommissioning options were supported on the premise that decommissioning was evidence based, addressed community and regulator concerns about pollution, habitat degradation, and invasive marine species and benefitted a broad range of stakeholders, including diving and conservation.

# **Rules and norms**

When looking at the synthesis and integration of the information generated by the research (Figure 41), it is evident that regulations and MMS design are key drivers of values within the use values category. It was therefore necessary to include a small subcategory entitled 'Rules and Norms' to reflect the importance attached to regulations and a social license to operate. These values are closely related and underline the importance of regulations that were seen as transparent, consistent and evidence based. A failure to adhere to these values would negatively impact all three end state values in the other categories. Regulations exert an influence on this flow of use values through determining how and when users can access MMS, whilst MMS design determines location, type of construction and the capacity of the MMS to support multiple user groups. This raises the issue of resource allocation and sharing and implies that the purpose of the installation of an MMS needs to be well defined in advance, which may lead to specific types of MMS being allocated to specific stakeholders/user groups at some locations. To some extent, this already occurs with recreational fishing on shipwrecks such as the HMAS Swan and Perth banned so that these wrecks are for the enjoyment of recreational divers only. Resource allocation can result in better outcomes for all users which will ultimately lead to greater user wellbeing being derived from MMS. It was noted in the group value workshops that more research into the justification for MMS in terms of designated users was an important activity. The focus group work also revealed that such a failure could manifest through a lack of clarity in policy, incidents associated with MMS acting as hazards to individual or commercial activities, or evidence of contamination arising from MMS degradation or disintegration.

# **Section 5: Conclusion**

This research had four objectives:

- 1) To augment and integrate analytical methods to identify and explore the socioeconomic values of MMS structures in Western Australia.
- 2) To collate a list and description of the MMS in the marine environment in Western Australian and the associated social, economic and biodiversity data.
- 3) To collect and collate data on the social and economic values of MMS in Western Australia including five case studies.
- 4) To develop a guide for undertaking socioeconomic evaluations of MMS which can be used throughout Australia (and other locations) and direct end users on approaches and strategies depending on their information requirements.

These objectives have been fulfilled, and the information generated by this project provides a strong foundation to inform decisions and facilitate acceptance of MMS across diverse user groups into the future.

As a generalisation, most stakeholders believed that there were social, environmental, and economic values associated with MMS. However, concerns were raised about issues such as habitat degradation and marine pollution due to chemicals leaching or leaking from structures.

In order to address these concerns policy must be informed by case studies that present robust and independent environmental, social and economic data and engage the stakeholder community.

There was also a consistent call for greater regulatory certainty. Moreover, a part of that regulatory framework needs to address potential conflict between different users of MMS by providing mechanisms to allocate the use of specific structures to a particular sector and/or to incorporate property rights.

# The opportunity

In coming years, there will be increasing numbers of proposals to create and deploy MMS. Whether this is through the creation of new ports and jetties, the installation of offshore renewable energy, artificial reefs, or other types of infrastructure, there is a need to maximise the environmental, social and economic benefits that can be gained from the installation of these structures. This can be done through eco-engineering which aims to maximise the ecological value of future structures by incorporating knowledge of ecological processes into engineering design principles (Chapman and Underwood, 2011; Dafforn et al., 2015; Todd et al., 2019).

By also considering the socioeconomic values of all potential stakeholders (as illustrated by this report) during planning processes, it will be possible to maximise the social and economic benefits to potential users (Lacroix and Pioch, 2011) and avoid adverse stakeholder responses (and attendant costs). Where structures have a temporary lifetime, engineers need to ensure that structures can be easily removed from the seafloor, and when they cannot, they need to ensure that the structures that are left in place are designed to be environmentally friendly and meet the social and environmental values and expectations of the community thus addressing the regulatory considerations raised in this report.

# Implications

The work of this report has established the benefits of MMS via international and domestic peer reviewed research and the case studies we present. This information provides a means to bridge otherwise disparate stakeholder groups' views. These benefits can be realised over short timescales and can be described in

accessible, non-technical terms. Building a consensus and positive view on MMS through reference to these attributes will help mitigate any adverse perceptions and values.

# **Section 6: Recommendations**

- 1) The Environmental Protection (Sea Dumping) Act 1981 is the key approval required for an artificial reef permit for any purpose-built or integrated reefs. While the assessment for this permit considers impacts on stakeholders the key underlying principle for the decision making is environmental, not socioeconomic values or benefits. The socio-economic values and benefits is what drives the funding and support (upfront and ongoing) for proposals in the first instance. Socioeconomic values and benefits are important considerations for future MMS implementation. Consequently, it is important that the outcomes of this research are broadly socialized and communicated for example via webinars (<u>https://wamsi.org.au/news/webinar-the-value-provided-to-fisheries-by-man-made-aquatic-structures/</u>), academic and non-academic papers and presentations. The proponents of the research will need to plan how to achieve this effectively.
- 2) Understanding socio-economic values and benefits is a key component to guide any future decisions about MMS.
- 3) There is a need to demonstrate the environmental benefits of MMS if seeking to gain widespread community support.
- 4) There is a need to develop greater regulatory clarity around the installation and removal of manmade marine structures (e.g., expanding and building on the Offshore Petroleum and Greenhouse Gas Storage Act 2006; developing guides for the assessment of permit applications for artificial reefs under the *Environmental Protection (Sea Dumping) Act 1981*). There needs to be clear guidelines developed across all levels of Government that reflects the needs of all stakeholder groups. While challenging, the objective would be to develop clear and transparent guidelines (or policy frameworks and regulations) that are consistent across the country. Specific suggested changes to guidelines or regulatory reforms should consider the following:
  - a. policy development that seeks to guide future proposals for the installation of purpose built and integrated (using repurposed subsea infrastructure) reefs in Australia.
  - b. incorporating social and economic data that reflect the values, issues and opportunities raised by stakeholders to maximise benefits is an important consideration for any guidelines. Highlighting benefits is essential for the development of social license for a wide range of projects from decommissioning of O&G infrastructure to the design and installation of artificial reefs, and the development of harbours and ports that are environmentally appropriate.
- 5) In Western Australia, the development and implementation of purpose-built artificial reefs in WA commenced in 2012. Since 2012, seven artificial reefs have been installed without any inter sector conflict. All reefs belong to the wider community. The key has been appropriate constraint mapping and consultation among multiple stakeholder groups prior to reefs being fabricated and deployed. This is a fundamental principle for any ongoing program.
- 6) There is a need to review the legal liability of MMS in general across governments, with the goal being to maximise the social and economic value that may arise from the development of MMS. In addition, consideration needs to be given to the development of explicit frameworks that identify end of life liability, as well as the costs and actions needed for site remediation and/or creation of MMS.
- 7) Importantly, there needs to be a more strategic approach to habitat enhancement structures in all jurisdictions. At present many purpose-built artificial reefs are simply located based on political desires and/or because there is a proposed decommissioning opportunity at the site. A more strategic approach is required from industry to validate and justify where purpose-built reefs are placed with a long-term vision to enhance both fish production and amenity value.

8) That further research on key gaps in ecological knowledge is needed to understand the net benefit of MMS for enhancing the condition of the marine environment: e.g., whether MMS provide habitats that increase fish productivity (or just act to attract and aggregate fish stocks); whether MMS are important for the protection of vulnerable species; how MMS will degrade over time and what environmental impacts may result, whether MMS could increase the risk invasive marine species.

### **Further development**

Although the objectives of the project have been fulfilled, there are a number of limitations to the research, and a number of additional research outcomes emerged that should be pursued

#### Limitations:

- We acknowledge that this research does not incorporate the values of indigenous stakeholders and that their input and values will be important in the development of any future management plans. The timeframe, resourcing and expertise of the research team precluded this. The values of indigenous people from across Western Australia and Australia should be explored and taken into consideration.
- 2) This research provides a snapshot of stakeholders' values and the economic and social outcomes (both positive and negative) of interactions with MMS in Western Australia. To be more comprehensive we recommend that this research is scaled to incorporate the views of stakeholders from other states (more broadly than was possible in this study).
- 3) The evaluation of MMS was framed by the current provision, or only marginal changes in it. However, over the next 30 years there will be substantial, non-marginal changes in MMS (e.g. from decommissioning or major infrastructure developments.

Further research recommendations:

- There were a number of re-occurring arenas for potential conflict relating to MMS illustrated through different uses not being compatible thus raising the issue of resource allocation. From an economic perspective, the ability to quantify the relative values of a structure to different users may assist with allocation decisions. With comprehensive regional data on people's values and wants, combined with ecological data it is possible to develop a spatial allocation model to optimise the outcomes of deploying different types of MMS in different locations for different users.
- Proposals for the installation of MMS needs to be cognisant of the different stakeholder values and benefits and tailor each to fit the local context (as context is important) and ensure equity and sustainability. As such, developing a process to facilitate each proposal – attending to inclusivity and systemicity – and capture learnings would provide an important resource for decision makers.
- 3. Due to the cumulative impacts of human activities, there is a loss of both condition and area in terrestrial, estuarine and marine habitats. There are significant attempts globally to restore critical habitats (Miller and Hobbs, 2007; van Katwijk et al., 2016) and it has been suggested that artificial reefs may be used as a tool to enhance the productivity of essential fish habitats and generate economic return to commercial fishers (Kasim et al., 2013; Yu and Zhang, 2020). We believe there is the need to consult with commercial fishers to determine whether there is the need or want to develop a broad scale trial which investigates the economic benefits to commercial fishers of deploying structures which are purpose built to drive production, growth and catchability.
- 4. Invasive marine species occupying MMS and using them as a mechanism for spreading was a consistent concern/issue raised. Research does need to be undertaken exploring whether this is a reality or a belief as well as the means for managing IMS should they occur.

# **Section 7: Extension and Adoption**

The project outcomes were communicated to industry, Recfishwest, WAFIC and state government through steering committee meetings. A webinar was hosted on the 17th of December 2020 as a COVID-19 safe way of communicating the outcomes to a broader audience.

Where opportunities present themselves, we will continue to promote the outcomes of this research.

## **Project coverage**

The project was promoted in the Fisheries Research & development Corporation News (FISH, Volume 28(2) pg 16-17.

FRDC also did a media release on the 5th of October 2020 <u>https://www.frdc.com.au/media-publications/news-and-media-releases/Oil-and-gas-infrastructures-become-fish-havens</u> which resulted in an interview with the ABC Pilbara on the 6th of October. GWN also did an article to air on the 6th of October 2020 <u>https://www.gwn7.com.au/news/30335-fish-havens</u>.

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# **Section 9: Appendices**

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- Appendix 2 Socioeconomic values associated with man-made aquatic infrastructure academic literature review
- Appendix 3 Social and commercial surveys
- Appendix 4 The potential economic value associated with the development of artificial reefs in Western Australia
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- Appendix 7 Community acceptance of rigs-to-reefs in Western Australia
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- Appendix 11 Issues and opportunities underpinning the meta and generic values
- Appendix 12 Assessing the social and economic value of man-made marine infrastructure: A guidebook



## Appendix 1 Man-made marine structures in Western Australian coastal and offshore waters Euan Harvey<sup>1</sup> Dianne McLean<sup>2</sup>, Ben Radford<sup>2</sup>, Ariel Neri<sup>2</sup>, Laura Fullwood<sup>1</sup> <sup>1</sup> Curtin University <sup>2</sup> AIMS

This appendix is part of the final report for:

# Enhancing the Understanding of the Value Provided to Fisheries by Man-made Aquatic Structures.

Euan S. Harvey, Fran Ackermann, Michael Burton, Julian Clifton, Carmen Elrick-Barr, Johanna Zimmerhackel, Georgina Hill, Stephen J Newman, Jenny Shaw, Mark Pagano, Paul McLeod, Dianne McLean, Julian Partridge

24 August 2021

FRDC Project No 2018-053

The data on MMS in Western Australian coastal and offshore waters is available online through various routes:

Here is the link to the web app:

https://aimsdata.maps.arcgis.com/apps/webappviewer/index.html?id=e534ab2975f64ca68479cc291dcb 3a9f

The web app is primarily for viewing and interrogating data, although one can download data from it one dataset at a time.

As well as the web app link, you can download the data from the link below, or access it directly in ArcGIS, ArcPro or QGIS GIS systems:

https://aimsdata.maps.arcgis.com/home/item.html?id=afeddcca05a44789a946623d01a32376

ESRI requires a sign-in to access the data. It can be either by using an institution ESRI account, generating a free ESRI account or via an existing google, apple, facebook or github account.

If accessing the data through the web app, the following figure gives some information on functionality.

## How to use the FRDC mapping tool functions/widgets cheatsheet





# Appendix 2 Socioeconomic values associated with man-made aquatic infrastructure academic literature review

Dr Julian Clifton, Dr Carmen Elrick-Barr, Dr Johanna Zimmerhackel & Ms Georgie Hill

This appendix is part of the final report for:

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24 August 2021

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# Enhancing the Understanding of the Value Provided to Fisheries by Man-Made Aquatic Structures

Draft Final Report: Socioeconomic Values Associated with Man-made Aquatic Infrastructure Academic Literature Review





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### Introduction

This Report details the outcomes of a literature review pertaining to the social and economic values and perceptions of man-made aquatic structures in the marine environment which was conducted as part of the FRDC Project entitled 'Enhancing the Understanding of the Value Provided to Fisheries by Man-Made Aquatic Structures' (FRDC 2018-053). A summary of this Report was presented to the Project Steering Committee on 21 November 2019.

The objectives of the literature review are as follows:

- Understand the scope of academic and professional literature addressing socioeconomic values of man-made aquatic structures in the marine environment
- Understand best-practice approaches to inform research methods
- Understand the values of man-made aquatic structures in the marine environment, by stakeholder group and/or structure type to enable future comparative analysis with case-study areas

### Structure of the report

This Report begins by defining the terminology relating to social and economic values and perceptions through reference to key principles and literature. The processes through which relevant publications pertaining to these topics in the academic and professional literature are identified. These are then reviewed to ascertain the state of knowledge regarding social and economic values and perceptions. The final discussion section identifies key gaps in this knowledge with reference to the case study sites for this project and the next stages of the research.

## Definitions

### Economic value

This is defined as the total economic value (TEV) of direct use values, indirect use values and non-use values.

### Direct use value

These represent the benefits arising from the immediate use of a marine man-made structure in the form of outputs that can be consumed or enjoyed directly (for example, extractive uses such as fishing or aquaculture; non-extractive uses such as diving).

### Indirect use value

These represent the benefits that a marine man-made structure provides to support other economic activities, or positive externalities that affect other users of the marine environment (for example enhanced fish biomass through habitat protection, diversion of effort from other fishing or diving sites)

### Non-use value

These represent the benefits arising from knowing that a marine asset has been conserved (termed existence and bequest/altruistic values) or may be available for use at a later date (termed option value).

### Man-made aquatic structures in the marine environment

Any artificial structure in the marine environment, including artificial reefs, jetties, oil and gas infrastructure (including pipelines), piers and shipwrecks. These are collectively referred to as MMI (man-made infrastructure) for ease of reference in this report.

### Model

A representation that describes and simulates reality, relationships, decision making and/or behaviour. Different models produce, and require, different types of information (shared) and take into account different perspectives and stakeholder needs

### Secondary data

Existing data sources and literature.

### Social value

A desirable goal based on what a person or group perceives as valuable and important that influences actions, behaviours, attitudes, and norms (O'Connell et al., 2018).

### Methods

The systematic literature reviews were conducted separately by the social and economic research teams. As such, the methods are presented separately for each theme. However, the research teams collectively defined search criteria and approach (e.g. databases) to ensure consistency. In addition, literature was shared between the teams. For example, papers addressing social values identified in the economic value systematic review were shared with the social values research team, and vice versa.

### Social Value Methods

### Academic Literature Review

A systematic literature review of academic literature exploring the topic of social values and manmade marine structures was conducted across the Scopus, Web of Science and Google Scholar databases (see Figure 1). Database queries were conducted using synonyms for 'social values',' 'man-made aquatic structures', 'uses' of structures, and 'objectives' of structures (see Appendix 1 for search terms). This initial search produced 327 articles. Abstracts of these articles were evaluated based on inclusion/exclusion criteria<sup>1</sup> and reduced to 75 articles. These 75 articles consisted of peer reviewed journal articles written after 1989 in English with an explicit focus on the social value of man-made marine structures. During the review process, 38 additional articles that appeared relevant to the review, but were not captured via the systematic review protocol were included and reviewed. For all articles meeting the secondary criteria (N = 113) full text review was undertaken.

Each article was ranked according to its focus on social values and man-made marine structures (MMI). A three star rating system was applied. Three star papers addressed social values and/or perceptions in relation to MMI, while two star papers addressed one of these topics with minor reference to the other. One star papers did not provide the level of detail required to interrogate social values and MMI, but may have contained an element/aspect that could be useful for later stages of the project. Papers that did not address any of the review topics were removed. All articles that received a 2- or 3-star rating (N = 26) were examined to explore the: geographic focus; stakeholder groups involved; social values examined/addressed; methods of stakeholder engagement; methods of social value assessment; findings in relation to social values by stakeholder group.

### Professional Literature Review

The review of professional literature (grey literature) covered reports and other publications produced by, or stored by, marine-based professional industries and organisations. The professional literature review focussed on the case location (i.e. Australia) and countries with similar resource and management conditions (i.e. United Kingdom and the United States of America)<sup>2</sup>. Two approaches were applied to profile the literature: (i) a search of industry organisation's websites using synonyms for 'social values',' 'man-made marine structures', 'uses' of structures, and 'objectives' of structures; and (ii) recommendations from technical experts. The initial search produced 38 publications. Executive summaries were reviewed based on inclusion/exclusion criteria<sup>3</sup> and reduced to 13 publications. Full review was completed for each of the 13 remaining publications and each was assigned a rating using the 3-star system (as per the academic literature

<sup>&</sup>lt;sup>1</sup> Refer to Appendix 1

<sup>&</sup>lt;sup>2</sup> Refer to Appendix 1 for further detail.

<sup>&</sup>lt;sup>3</sup> Refer to Appendix 1 for further detail.

review). The 2 and 3 star publications (7 in total) were interrogated to find trends in geographic focus, stakeholder group(s), social values explored, research methods and key findings by stakeholder group.



Figure 1. Social Value in Man-Made Aquatic Structures Academic Literature Review Process.



Figure 2: Social Value in Man-Made Aquatic Structures Professional Literature Review Process.

## Economic Value Methods

### Conceptual framework of economic valuation of marine man-made structures

Economic values associated with the natural environment are usually described in various value types which together add up to the total economic value (TEV). This TEV framework has been widely applied to measure the change in values when interventions impact on the natural environment, such as the development of artificial reefs in the marine environment. Table 1 shows the benefits of artificial reefs within the TEV framework. Direct use values include consumptive and nonconsumptive use values, with consumptive use values covering the values that result from extractive uses such as commercial and recreational fishing around artificial reefs. Non-consumptive use values are derived from usages that do not diminish the amount of the resource. For example, artificial reefs provide non-consumptive use values through recreational activities such as diving, surfing and. Indirect use values are benefits that artificial reefs generate in the marine environment which affect other economic activities. These benefits include various reefing effects such as habitat enhancement, increased fish production and coastal protection. Different from the direct and indirect use values which are commercial in nature, non-use values result from the satisfaction that people derive from goods or services, without them necessarily having to interact directly with the resource. This can be for example peoples' value for knowing that a natural resource has been conserved or improved without necessarily using it. In the context of marine artificial structures, non-use values include, the knowledge that artificial reefs have increased species diversity (existence values) or conserved a species for future generations or other people (bequest/altruistic values).

Total economic value						
Direct use values	Indirect use values	Non-use values				
Benefits arising from the immediate use of a marine man- made structure in the form of outputs that can be consumed or enjoyed directly.	Benefits that a marine man-made structure provides to support other economic activities, or positive externalities that affect other users of the marine environment.	Benefits from knowing that a marine asset has been conserved (existence and bequest/altruistic values) or may be available for use at a later date (option value).				
Examples: - Extractive uses (e.g. commercial and recreational fishing, offshore aquaculture) - Non-extractive uses (e.g. diving and surfing tourism)	<ul> <li>Examples:</li> <li>Fish production via habitat protection (e.g. seagrass).</li> <li>Effort diversion from overexploited fisheries or dive sites.</li> <li>Coastal and shoreline protection.</li> <li>Water quality improvement via nutrient removal</li> </ul>	<ul> <li>Examples:</li> <li>Knowledge that reefbased protection has increased marine biodiversity</li> <li>Knowledge that a unique habitat is conserved intact for future generations</li> </ul>				

Table 1: Values attributed to marine man-made structures (adapted from Whitmarsh et al. 2008)

There are various methodologies to quantify the economic value of a good or service, which can be separated into market and non-market valuation techniques. Market valuations quantify values from the market prices for the good or service being valued and the quantities purchased. This technique is therefore limited to goods and services that are traded in markets (such as products related to

tourism and recreation, or fish). Conversely, non-market valuation methods allow goods and services to be valued which are not traded in markets. Non-market valuation methods can be further divided into stated preference and revealed preference techniques: Stated preference techniques (such as contingent valuation, contingent behaviour, and discrete choice experiments) use surveys with questions that typically present respondents with a hypothetical change in an environmental condition to determine how much they are willing to pay for this environmental good or service. Revealed preference techniques (such as the travel cost method and hedonic pricing), in contrast, can be applied where the value of goods and services affect markets without being directly traded within them (Hanley et al. 2019).

Conceptually, the economic value derived from the acquisition of any good, service, or experience, whether purchased in a market or acquired by non-market means, is measured in monetary terms by the willingness to pay (WTP) for that good, service, or experience. Therefore, the economic value of each recreational fishing or diving trip is the maximum amount of money that a given person (e.g. a recreational fisher or diver) would be willing to pay for the trip. The demand to go fishing or diving can be represented by a conventional demand curve (Figure 1) where the chosen number of trips per year is a function of the WTP for the trip. The total value derived from a given number of trips is the area under the demand curve (equivalent to the area ABCO) and is called the gross WTP. Recreational fishers and divers choose to expend resources because the value derived from fishing or diving is greater than or equal to the value of these resources expended in some other way, so the value of expenditures is a minimum or lower bound estimate of the value of recreational fishing or diving (shown as the area EBCO). The excess of the WTP over and above resource costs incurred is the consumer surplus (or net WTP) from the recreational fishing or diving experience (shown as the area ABE). Hence to estimate the gross WTP, an estimate of the consumer surplus is added to the estimated expenditure.



Figure 3: Expenditure and consumer surplus of recreational activities

### Literature Review

We conducted a systematic review of the national and international literature on economic values of marine man-made structures. The steps of the search protocol are illustrated in Figure 2. A recent report from the National Environmental Science Program (NESP) conducted a literature review on the economic value of artificial reefs which we used as a base (Blackmore et al. n.d.). This literature review included 26 studies meeting the following eligibility criteria: (i) written in English language, (ii) has a reference to either market or non-market valuation of artificial reefs in title, keywords or abstract, (iii) is primarily a valuation study on artificial reefs, (iv) quantitatively estimates values of artificial reefs and (v) was published by scientifically-reputable sources e.g. peer-reviewed journals, book reports, project reports, academic theses or government agencies. The approach was appropriate because the report used a broad definition of artificial reefs as any man-made structure in the ocean which fitted the scope of this project.

Additionally, we ran a literature research using the Web of Science database, Google Scholar, and a snowball technique by analysing the reference lists of relevant studies. We ran a search string in Web of Science and Google scholar to find literature on marine man-made structures for each of the structure types relevant to this report, namely: artificial reefs, oil and gas platforms, pipelines, and piers and jetties. This yielded a total of 268 studies that met the phase I inclusion/exclusion criteria: (i) written in English language, (ii) has a reference to the economic value of one of the four structure types in title, keywords or abstract and (iii) was published by scientifically-reputable sources e.g. peer-reviewed journals, book reports, project reports, academic theses or government agencies. The studies were then analysed in more detail by screening of their abstracts (and where necessary their full-text). Studies were regarded as eligible when they fulfilled the following Phase II inclusion/exclusion criteria: (i) is primarily a valuation study for the specific structure type and (ii) quantitatively estimates values of this structure type. The articles found together with the NESP articles yielded in 29 studies. An additional six articles were found through the snowball technique by screening the reference lists of eligible studies.

For each of the 35 identified valuation studies, we extracted information about the purpose of the structure, the measured value type(s); data collection year; valuation method(s); country in which the study was conducted; valuation context or question; and willingness-to-pay estimate. Moreover, we converted all of the value estimates from the relevant studies to 2019 USD to present consistent and up-to-date values. We did so using online sources for the Consumer Price Index for the relevant countries (*World Bank Open Data | Data* n.d.) and a currencies converter (*XE - The World's Trusted Currency Authority: Money Transfers & Free Exchange Rate Tools* n.d.).

Where we found less than five economic valuation studies for a particular structure type, we searched the initial 268 articles that met Phase I criteria for studies that mentioned the economic importance of these structures without quantifying them. This was the case for piers and jetties as well as for pipelines and yielded zero and nine articles, respectively. We extracted relevant quotes referring to the economic value of these structures.

Overall, this process resulted in 44 relevant studies: Artificial reefs (29), oil and gas platforms (6), piers and jetties (0), pipelines (11). Please note that two studies fit into the artificial reef and the oil and gas platforms categories which is why the sum of these articles does not add up to 44.


*Figure 4: Literature review process and number of eligible studies per type of marine man-made structure.* 

# Findings

# Social Value Findings

In this section, the results of the systematic review of the social value literature are presented. The discussion of findings is limited to the literature classified as 2 or 3 stars. We commence with an overview of the geographic scope of the papers, the coverage of structure types and stakeholder groups. We then focus in more detail on the types of social values examined and finish with presentation of the conceptual model developed.

# Scope of the papers.

Artificial reefs were the dominant man-made marine structure (MMI) addressed in the reviewed literature (see Figure 2). Structures not classified as MMI, such as natural reefs or marine protected areas, were the second most common structures. Papers on social values beyond MMI were included in the review when identified via the search criteria and containing a strong focus on social values useful during later stages of this project. The third most common structure was oil and gas platforms.

The three most common geographic regions discussed in literature were Australia, the US and the UK. It should be noted that the literature from Australia came predominantly from the Eastern States (see Figure 3). A majority of papers addressed either a single stakeholder group (e.g. divers), or multiple stakeholder groups. Commercial and recreational fishers were the two groups discussed most in reviewed papers (see Figure 4).



Figure 5. Breakdown of structure types discussed in social value literature review.



*Figure 6*. Breakdown of geographic regions discussed in social value literature review.



Figure 7. Breakdown of stakeholder groups discussed in social value literature review.

#### Social values assessment

The social values assessment of the literature review sought to identify patterns in the literature in relation to the social values reported across structure type and stakeholder group. The concept of 'social value' is diffuse and highly context-specific, with many different approaches being taken to characterize and measure the values held by stakeholder groups. As a result, the literature identified in the review covered a range of different research areas, from stakeholder perceptions of MMI, to patterns of use, and links to social well-being. To gain an understanding of the priority research

areas covered within the review, an inductive approach was adopted to identify the social research focus of the review papers. This involved analyzing the research focus of each of the papers classified as 2 or 3 stars, and slowly constructing dominant categories of research focus across the papers. Three overarching themes capturing the core research topics were identified, two containing subthemes (Figure 8):

- Social values
- Perceptions
- Use and satisfaction

In the next section, we summarise how social values were addressed in the literature, by structure type and stakeholder group, under each research theme.



Figure 8: Research themes in the Social Values reviewed literature

#### Social Values

Nine papers identified in the review examined social values, as defined as 'a desirable goal based on what a person or group perceives as valuable and important that influences actions, behaviours, attitudes, and norms' (O'Connell et al., 2018). The nine papers were categorised into three subtopics on the basis of their focus on social value: (i) social well-being; (ii) interests and alignment to personal or MMI goals; (iii) and social value of the MMI resource/asset (Table 2). Each is described in turn.

## Social Values: Well-being

The concept of well-being seeks to represent the elements that contribute to individual or community health, happiness and prosperity. A three-dimensional approach is adopted to explore values across three categories: material well-being (encompasses practical welfare and standards of living, such as income, wealth, assets, environmental quality, physical health), relational well-being

(includes relations of love and care, networks of support and obligation, social, political and cultural identifies) and subjective well-being (spans notions of self, individual and shared hopes, fears and aspirations, expressed levels of satisfaction or dissatisfaction, trust, and confidence) (Weeratunge et al. 2014). The papers categorised under this sub-topic addressed different elements of well-being (e.g. material, relational or subjective). Only one paper addressed all three elements in unison (Barclay et al 2017); however, it did not incorporate MMI. It did however provide the most detailed assessment of social values of all papers captured in the systematic literature review. Note: The papers by Barclay et al (2017) and Voyer et al (2017) are based on the same research project, each reporting on different elements of the one project.

## Social Values: Interests and alignment to personal or MMI goals

Under this theme, the focus of the research papers was on understanding the interests of different stakeholder groups and how these interests support or hinder the implementation of offshore MMI, to inform decision-making. In each case, the values of the stakeholder groups were not explicitly defined, rather the focus was on their interests, which were used to categorise stakeholders in different ways. For example, stakeholders were categorised based on their use of the MMI (e.g. primary/secondary users); or their interest in the MMI (e.g. community members, resource accessibility).

## Social Values: Social value of the resource/asset

Under this topic, papers focused not on the social values of the stakeholder groups themselves, but rather on the social values derived from the 'resource' more broadly. For example, Pike et al (2010) obtained stakeholder perceptions of the social values of a Marine Protected Area, and therefore was not MMI focussed. Despite this, it provided an example of research seeking to understand the broader social values delivered by a resource and how these values are conceptualised across management groups. Evans et al (2017) addressed MMI, with the primary focus on obtaining stakeholder perceptions of the values (considerations and benefits) that determine whether MMI will be adopted. Pike et al (2010) can also be classed as addressing subjective well-being (i.e. what is perceived to be important), however the paper was separated here given the focus on the resource asset (what is important about the asset) rather than what was important to stakeholders.

Paper	Citation					
ID						
Well-be	Well-being					
#1	Barclay K., Voyer M., Mazur N., Payne A.M., Mauli S., Kinch J., Fabinyi M., Smith G. (2017) The					
	importance of qualitative social research for effective fisheries management, Fisheries Research,					
	186: 426- 438					
#24	Voyer, M., Barclay, K., McIlgorm, A., & Mazur, N. (2017) Connections or conflict? A social and					
	economic analysis of the interconnections between the professional fishing industry, recreational					
	fishing and marine tourism in coastal communities in NSW, Australia. Marine Policy, 76, 114-121					
#23	R.L. Morris, G. Deavin, S.H. Donald, R.A. Coleman (2016) Eco-engineering in urbanised coastal					
	systems: consideration of social values, Ecol. Manag. Restor. 17 (1) (2016) 33-39.					
#17	Ramos, J; Santos, MN; Whitmarsh, D; Monteiro, CC (2006) The usefulness of the analytic hierarch					
	process for understanding reef diving choices: A case study, <i>Tourism Geographies</i> , 14(3): 361-382					
Interest	erests and alignment to personal or MMI goals					
#7	Ramos, J., Santos, M., Whitmarsh, D., & Monteiro, C. (2011b) Stakeholder analysis in the					
	Portuguese artificial reef context: winners and losers, Braz. J. Oceanogr, 59: 133-143					
#9	Schroeder D.M., Love M.S. (2004) Ecological and political issues surrounding decommissioning of					
	offshore oil facilities in the Southern California Bight, Ocean and Coastal Management, 47: 21-48					

Table 2: Literature addressing Social Values

P#13	Bates (2016) Key Challenges Of Offshore Wind Power: Three Essays Addressing Public Acceptance,				
	Stakeholder Conflict, And Wildlife Impacts, PhD Thesis, Available online from:				
	http://udspace.udel.edu/handle/19716/19780				
Social v	alue of the asset/structure				
#16	Pike, K., Johnson, D., Fletcher, S., Wright, P., & Lee, B (2010), Social Value of Marine and Coastal				
	Protected Areas in England and Wales, Coastal Management, 38(4): 412 - 432				
#21	A.J. Evans, B. Garrod, L.B. Firth, S.J. Hawkins, E.S. Morris-Webb, H. Goudge, P.J. Moore (2017)				
	Stakeholder priorities for multi-functional coastal defence developments and steps to effective				
	implementation, Mar. Pol. 75: 143–155.				

## Social Values: Type of structure and stakeholder groups

Despite the small number of papers dealing directly with social values, a range of types of MMI were covered in these publications, including artificial reefs, natural reefs, sea walls, offshore wind turbines and oil and gas infrastructure (Table 3). Furthermore, these articles encompassed data from a broad range of stakeholder groups (recreational and commercial fishers, divers, tourism sector representatives, environmental groups and various government institutions). These papers indicated that particular types of structures may be associated with values specific to stakeholder group, with divers valuing the diversity of species found in association with artificial reefs whilst recreational fishers' values were affected by the presence or absence of commercial fishers on natural reefs. Furthermore, the inter-dependence of stakeholder groups' values was influenced by less tangible factors such as the presence of a commercial fishing industry being positively associated with tourists' experience of a location.

Sub-topic	MMI type (PL)*	Stakeholders**	Examples
Well-being	Artificial Reef: 1	Artificial Reef: Divers	Material: Despite a widespread
(material,	Seawall: 1	Seawall: Not stated	perception among recreational
relational and	Natural Reef: 1	Natural Reef: Commercial	fishers in NSW that recreational
subjective)	None: 1	fishermen, Recreational	fishing catches are better if
		fishermen, Tourism sector	professional fishing is excluded, the
		None: Commercial and	data clearly showed that if
		recreational fishing, tourism	professional fishing were to
			disappear from areas of the coast,
			the utility of recreational fishers
			would be negatively impacted (#1:
			Barclay et al. 2017)
			Subjective: Divers attach value to
			ecological diversity and
			conservation more than the chance
			to improve their diving skills (#17:
			Ramos et al. 2006).
			Relational: Tourists are drawn to
			communities because of seafood
			and activity brought in by
			commercial fishers (#24: Voyer et
			al. 2017).

Table 3 Coverage of MMI types and stakeholder groups for the Social Values literature

Interests /values that align to the goals of the MMI or personal goals	Artificial Reef: 1 Oil and Gas: 1 Offshore Wind: 1 (1)	Artificial Reef: Commercial fishermen, recreational fishermen, tourism sector, government, scientists, ports, navy Oil and gas: None (lit review) Offshore Wind: Residents	Social/values concerns of stakeholders categorized into three groups: community membership, resource accessibility, environmental issues (#9: Schrouder and Love, 2004)
Social value of asset (e.g. global values associated with MMI)	Coastal defense structures: 1 None (Marine Protected Area): 1	Coastal defense structures: Infra specialists, government, environmental groups None (MPA): MPA experts/managers;	Industry managers perceive the ecological value of the environment as more important more than spirituality and organisational interest (#16: Pike et al. 2010)

\* Brackets indicated the number of professional reports in total value

\*\* Brackets indicate the number of papers/reports incorporating the stakeholder group

#### Perceptions

The subjective values held by individuals will shape their expressions of opinion or 'perceptions' in relation to external objects. Perceptions in relation to MMI are thus informed by individual values but may be easier to identify and quantify than values, and consequently recur far more frequently in the literature review. We classified research into perceptions of MMI into three subcategories, namely (i) stakeholder perceptions in general (social and environmental benefits, awareness levels, perceptions of conflict); (ii) resource access (to the area and the items within the area, i.e. fish); (iii) priority issues/threats associated with MMI.

## **Perceptions: General perceptions**

Whilst there were a relatively large number of academic and professional publications examining the overall perceptions and perceived benefits of MMI from a variety of study locations worldwide, the majority of these pertained to either artificial reefs or offshore wind turbines. The latter have been the focus of research in the past 2-3 years, reflecting the growth of the offshore wind energy sector particularly in the United Kingdom.

## **Perceptions: Resource access**

The literature regarding perceptions of resource access to MMI is more restricted, but does encompass research particularly focusing on repurposing of offshore oil and gas infrastructure in Australia and the USA.

## Perceptions: Priority issues/threats

The literature on priority issues and threats predominantly incorporates professional rather than academic literature. The reports seek to understand stakeholders' views on the priority concerns in relation to repurposing of offshore oil and gas facilities or the installation of artificial reefs.

Paper	Citation
ID	
Percep	tions in general (social and environmental benefits, awareness levels, perceptions of conflict)
#5	Murray, J. D., & Betz, C. J. (1994) User views of artificial reef management in the southeastern US,
	Bulletin of Marine Science, 55: 970 - 981

Table 4: Literat	ure addressing	Perceptions
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#6	Ramos, Jorge; Santos, Miguel N.; Whitmarsh, David; Monteiro, Carlos C. (2007) Stakeholder
	perceptions regarding the environmental and socio-economic impacts of the Algarve artificial reefs,
	Hydrobiologia, 580: 181 - 191
#8	ten Brink T.S., Dalton T. (2018) Perceptions of commercial and recreational fishers on the potential
	ecological impacts of the Block Island Wind Farm (US), Frontiers in Marine Science, 5: 439
#11	Andriesse E. (2018) Persistent fishing amidst depletion, environmental and socio-economic
	vulnerability in Iloilo Province, the Philippines, Ocean and Coastal Management, 157: 130- 137
#12	Hooper T., Ashley M., Austen M. (2015) Perceptions of fishers and developers on the co-location of
	offshore wind farms and decapod fisheries in the UK, Marine Policy, 61: 16- 22
#13	Hooper T., Hattam C., Austen M. (2017) Recreational use of offshore wind farms: Experiences and
	opinions of sea anglers in the UK, Marine Policy, 78: 55-60
#14	Kienker, S. E., Coleman, R. A., Morris, R. L., Steinberg, P., Bollard, B., Jarvis, R., Strain, E. M. A.
	(2018), Bringing harbours alive: Assessing the importance of eco-engineered coastal infrastructure
	for different stakeholders and cities, Marine Policy, 94: 238 - 246
#15	Lima J.S., Zappes C.A., Di Beneditto A.P.M., Zalmon I.R. (2018), Artisanal fisheries and artificial reefs
	on the southeast coast of Brazil: Contributions to research and management, Ocean and Coastal
	Management,163: 372-382
#18	Shani A., Polak O., Shashar N. (2012) Artificial Reefs and Mass Marine Ecotourism, <i>Tourism</i>
	Geographies, 14 (3): 361-382
#20	Tessier A., Francour P., Charbonnel E., Dalias N., Bodilis P., Seaman W., Lenfant P. (2015),
	Assessment of French artificial reefs: due to limitations of research, trends may be misleading,
	Hydrobiologia, 753 (1)
#22	Ditton, R.B., Osburn, H.R., Baker, T.L. and Thailing, C.E. (2002) Demographics, attitudes, and reef
	management practices of sport divers in offshore Texas waters. ICES Journal of Marine Science 59,
	186–191.
P#13	Bates (2016) Key Challenges Of Offshore Wind Power: Three Essays Addressing Public Acceptance,
	Stakeholder Conflict, And Wildlife Impacts, PhD Thesis, Available online from:
	http://udspace.udel.edu/handle/19716/19780
P#3	CRC Research Centre (1999) Understanding public perceptions of the Great Barrier Reef and its
P#3	CRC Research Centre (1999) Understanding public perceptions of the Great Barrier Reef and its management, Available online from: http://rrrc.org.au/wp-content/uploads/2014/03/Technical-
P#3	CRC Research Centre (1999) Understanding public perceptions of the Great Barrier Reef and its management, Available online from: http://rrrc.org.au/wp-content/uploads/2014/03/Technical-Report-29.pdf
P#3 P#11	CRC Research Centre (1999) Understanding public perceptions of the Great Barrier Reef and its management, Available online from: http://rrrc.org.au/wp-content/uploads/2014/03/Technical- Report-29.pdf Leeworthy, Wiley and Hospital (2004) Importance-Satisfaction Ratings Five-year Comparison, SPA &
P#3 P#11	CRC Research Centre (1999) Understanding public perceptions of the Great Barrier Reef and its management, Available online from: http://rrrc.org.au/wp-content/uploads/2014/03/Technical- Report-29.pdf Leeworthy, Wiley and Hospital (2004) Importance-Satisfaction Ratings Five-year Comparison, SPA & ER Use, and Socioeconomic and Ecological Monitoring Comparison of Results 1995-96 to 2000-01,
P#3 P#11	CRC Research Centre (1999) Understanding public perceptions of the Great Barrier Reef and its management, Available online from: http://rrrc.org.au/wp-content/uploads/2014/03/Technical- Report-29.pdf Leeworthy, Wiley and Hospital (2004) Importance-Satisfaction Ratings Five-year Comparison, SPA & ER Use, and Socioeconomic and Ecological Monitoring Comparison of Results 1995-96 to 2000-01, Available online from: https://nmssanctuaries.blob.core.windows.net/sanctuaries-
P#3 P#11	CRC Research Centre (1999) Understanding public perceptions of the Great Barrier Reef and its management, Available online from: http://rrrc.org.au/wp-content/uploads/2014/03/Technical- Report-29.pdf Leeworthy, Wiley and Hospital (2004) Importance-Satisfaction Ratings Five-year Comparison, SPA & ER Use, and Socioeconomic and Ecological Monitoring Comparison of Results 1995-96 to 2000-01, Available online from: https://nmssanctuaries.blob.core.windows.net/sanctuaries- prod/media/archive/science/socioeconomic/floridakeys/pdfs/impsat.pdf
P#3 P#11 Resour	CRC Research Centre (1999) Understanding public perceptions of the Great Barrier Reef and its management, Available online from: http://rrrc.org.au/wp-content/uploads/2014/03/Technical- Report-29.pdf Leeworthy, Wiley and Hospital (2004) Importance-Satisfaction Ratings Five-year Comparison, SPA & ER Use, and Socioeconomic and Ecological Monitoring Comparison of Results 1995-96 to 2000-01, Available online from: https://nmssanctuaries.blob.core.windows.net/sanctuaries- prod/media/archive/science/socioeconomic/floridakeys/pdfs/impsat.pdf ce Access
P#3 P#11 Resour #4	CRC Research Centre (1999) Understanding public perceptions of the Great Barrier Reef and its management, Available online from: http://rrrc.org.au/wp-content/uploads/2014/03/Technical- Report-29.pdf Leeworthy, Wiley and Hospital (2004) Importance-Satisfaction Ratings Five-year Comparison, SPA & ER Use, and Socioeconomic and Ecological Monitoring Comparison of Results 1995-96 to 2000-01, Available online from: https://nmssanctuaries.blob.core.windows.net/sanctuaries- prod/media/archive/science/socioeconomic/floridakeys/pdfs/impsat.pdf ce Access Kruse S.A., Bernstein B., Scholz A.J. (2015) Considerations in evaluating potential socioeconomic
P#3 P#11 Resour #4	CRC Research Centre (1999) Understanding public perceptions of the Great Barrier Reef and its management, Available online from: http://rrrc.org.au/wp-content/uploads/2014/03/Technical- Report-29.pdf Leeworthy, Wiley and Hospital (2004) Importance-Satisfaction Ratings Five-year Comparison, SPA & ER Use, and Socioeconomic and Ecological Monitoring Comparison of Results 1995-96 to 2000-01, Available online from: https://nmssanctuaries.blob.core.windows.net/sanctuaries- prod/media/archive/science/socioeconomic/floridakeys/pdfs/impsat.pdf ce Access Kruse S.A., Bernstein B., Scholz A.J. (2015) Considerations in evaluating potential socioeconomic impacts of offshore platform decommissioning in California, <i>Integrated Environmental Assessment</i>
P#3 P#11 Resour #4	CRC Research Centre (1999) Understanding public perceptions of the Great Barrier Reef and its management, Available online from: http://rrrc.org.au/wp-content/uploads/2014/03/Technical- Report-29.pdf Leeworthy, Wiley and Hospital (2004) Importance-Satisfaction Ratings Five-year Comparison, SPA & ER Use, and Socioeconomic and Ecological Monitoring Comparison of Results 1995-96 to 2000-01, Available online from: https://nmssanctuaries.blob.core.windows.net/sanctuaries- prod/media/archive/science/socioeconomic/floridakeys/pdfs/impsat.pdf ce Access Kruse S.A., Bernstein B., Scholz A.J. (2015) Considerations in evaluating potential socioeconomic impacts of offshore platform decommissioning in California, <i>Integrated Environmental Assessment and Management</i> , 11 (4): 572-583
P#3 P#11 Resour #4 #10	CRC Research Centre (1999) Understanding public perceptions of the Great Barrier Reef and its management, Available online from: http://rrrc.org.au/wp-content/uploads/2014/03/Technical- Report-29.pdf Leeworthy, Wiley and Hospital (2004) Importance-Satisfaction Ratings Five-year Comparison, SPA & ER Use, and Socioeconomic and Ecological Monitoring Comparison of Results 1995-96 to 2000-01, Available online from: https://nmssanctuaries.blob.core.windows.net/sanctuaries- prod/media/archive/science/socioeconomic/floridakeys/pdfs/impsat.pdf ce Access Kruse S.A., Bernstein B., Scholz A.J. (2015) Considerations in evaluating potential socioeconomic impacts of offshore platform decommissioning in California, <i>Integrated Environmental Assessment and Management</i> , 11 (4): 572-583 Ammar, M. S. A. (2009) Coral Reef Restoration and Artificial Reef Management, Future and
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P#3 P#11 Resour #4 #10 #12 #19 P#1 P#2	CRC Research Centre (1999) Understanding public perceptions of the Great Barrier Reef and its management, Available online from: http://rrrc.org.au/wp-content/uploads/2014/03/Technical- Report-29.pdf Leeworthy, Wiley and Hospital (2004) Importance-Satisfaction Ratings Five-year Comparison, SPA & ER Use, and Socioeconomic and Ecological Monitoring Comparison of Results 1995-96 to 2000-01, Available online from: https://nmssanctuaries.blob.core.windows.net/sanctuaries- prod/media/archive/science/socioeconomic/floridakeys/pdfs/impsat.pdf ce Access Kruse S.A., Bernstein B., Scholz A.J. (2015) Considerations in evaluating potential socioeconomic impacts of offshore platform decommissioning in California, <i>Integrated Environmental Assessment and Management</i> , 11 (4): 572-583 Ammar, M. S. A. (2009) Coral Reef Restoration and Artificial Reef Management, Future and Economic, <i>Open Environmental Engineering Journal</i> , 2 (1): 37-49 Hooper T., Ashley M., Austen M. (2015) Perceptions of fishers and developers on the co-location of offshore wind farms and decapod fisheries in the UK, <i>Marine Policy</i> , 61: 16- 22 Sutton S.G., Bushnell S.L. (2007) Socio-economic aspects of artificial reefs: Considerations for the Great Barrier Reef Marine Park, <i>Ocean and Coastal Management</i> , 50(10): 829-846 Shaw J.L., Seares P., Newman S.J. (2018) Decommissioning offshore infrastructure: a review of stakeholder views and science priorities, Available online from: http://www.marinescienceblueprint.org.au/
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P#3 P#11 Resour #4 #10 #12 #19 P#1 P#1 P#2 Priority #26	CRC Research Centre (1999) Understanding public perceptions of the Great Barrier Reef and its management, Available online from: http://rrrc.org.au/wp-content/uploads/2014/03/Technical- Report-29.pdf Leeworthy, Wiley and Hospital (2004) Importance-Satisfaction Ratings Five-year Comparison, SPA & ER Use, and Socioeconomic and Ecological Monitoring Comparison of Results 1995-96 to 2000-01, Available online from: https://nmssanctuaries.blob.core.windows.net/sanctuaries- prod/media/archive/science/socioeconomic/floridakeys/pdfs/impsat.pdf ce Access Kruse S.A., Bernstein B., Scholz A.J. (2015) Considerations in evaluating potential socioeconomic impacts of offshore platform decommissioning in California, <i>Integrated Environmental Assessment and Management</i> , 11 (4): 572-583 Ammar, M. S. A. (2009) Coral Reef Restoration and Artificial Reef Management, Future and Economic, <i>Open Environmental Engineering Journal</i> , 2 (1): 37-49 Hooper T., Ashley M., Austen M. (2015) Perceptions of fishers and developers on the co-location of offshore wind farms and decapod fisheries in the UK, <i>Marine Policy</i> , 61: 16- 22 Sutton S.G., Bushnell S.L. (2007) Socio-economic aspects of artificial reefs: Considerations for the Great Barrier Reef Marine Park, <i>Ocean and Coastal Management</i> , 50(10): 829-846 Shaw J.L., Seares P., Newman S.J. (2018) Decommissioning offshore infrastructure: a review of stakeholder views and science priorities, Available online from: http://www.marinescienceblueprint.org.au/ WAFIC (2017) Thevenard Offshore Platform Retirement Commercial Fishing Sector Stakeholder Consultation – WAFIC Report. Available from: https://www.wafic.org.au/offshore-stakeholder- consultation-environment-plans-nopsema-update-commercial-fishers/ / Issues/threats associated with MMI Cripps SJ and Aable JP (2002), Environmental and socio-economic impact assessment of Ekoreef, a mutbiel alterem is the staft of and heurent in the staft of Marine O in the staft of and heurent of and socio-economic impact assessment of Ekoreef, a
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P#3 P#11 Resour #4 #10 #12 #19 P#1 P#2 Priority #26 P#1	CRC Research Centre (1999) Understanding public perceptions of the Great Barrier Reef and its management, Available online from: http://rrrc.org.au/wp-content/uploads/2014/03/Technical- Report-29.pdf Leeworthy, Wiley and Hospital (2004) Importance-Satisfaction Ratings Five-year Comparison, SPA & ER Use, and Socioeconomic and Ecological Monitoring Comparison of Results 1995-96 to 2000-01, Available online from: https://nmssanctuaries.blob.core.windows.net/sanctuaries- prod/media/archive/science/socioeconomic/floridakeys/pdfs/impsat.pdf ce Access Kruse S.A., Bernstein B., Scholz A.J. (2015) Considerations in evaluating potential socioeconomic impacts of offshore platform decommissioning in California, <i>Integrated Environmental Assessment and Management</i> , 11 (4): 572-583 Ammar, M. S. A. (2009) Coral Reef Restoration and Artificial Reef Management, Future and Economic, <i>Open Environmental Engineering Journal</i> , 2 (1): 37-49 Hooper T., Ashley M., Austen M. (2015) Perceptions of fishers and developers on the co-location of offshore wind farms and decapod fisheries in the UK, <i>Marine Policy</i> , 61: 16- 22 Sutton S.G., Bushnell S.L. (2007) Socio-economic aspects of artificial reefs: Considerations for the Great Barrier Reef Marine Park, <i>Ocean and Coastal Management</i> , 50(10): 829-846 Shaw J.L., Seares P., Newman S.J. (2018) Decommissioning offshore infrastructure: a review of stakeholder views and science priorities, Available online from: http://www.marinescienceblueprint.org.au/ WAFIC (2017) Thevenard Offshore Platform Retirement Commercial Fishing Sector Stakeholder- consultation – WAFIC Report. Available from: https://www.wafic.org.au/offshore-stakeholder- consultation-environment-plans-nopsema-update-commercial-fishers/ visues/threats associated with MMI Cripps SJ and Aable JP (2002), Environmental and socio-economic impact assessment of Ekoreef, a multiple platform rigs-to-reef development, <i>Journal of Marine Science</i> , 59: 300-308. As above

P#11	Leeworthy, Wiley and Hospital (2004) Importance-Satisfaction Ratings Five-year Comparison, SPA &
	ER Use, and Socioeconomic and Ecological Monitoring Comparison of Results 1995-96 to 2000-01

#### Perceptions: Type of structure and stakeholder groups

Artificial reefs have been the principal focus of research into perceptions of MMI, with studies demonstrating that stakeholder groups can hold markedly different views on the environmental benefits of artificial reefs whilst also highlighting the issues surrounding access rights to newly installed offshore infrastructure. However, both studies used as examples in Table 5 are somewhat dated now and may not reflect contemporary perspectives given the increased availability of scientific data relating to biomass around artificial reefs and greater management experience.

Sub-topic	MMI type (PL)*	Stakeholders**	Examples
Perceptions in general (social and environmental benefits, awareness levels, perceptions of conflict)	Artificial Reef: 8 (1); Offshore Wind: 3 (1) Seawall: 1 Natural Reef: 1 (1);	Artificial Reef: Commercial fishing (5), Recreational Fishing (3), Divers (5), Recreational boaters (1), Environmentalists (2), Local government (1), Research (1), Tourists (1), Residents (1) Offshore wind: Residents (1), Commercial fishing (2), Recreational fishing (2) Seawall: Harbour workers, local businesses, tourists/recreationalists (1) Natural reef: None (1)	Scientists have more optimistic perceptions of the impact of artificial reefs on the environment whereas fishers reported more sceptical views (#6: Ramos et al. 2007)
Resource access (to the area and the items within the area, i.e. fish)	Artificial Reef: 2 Oil and Gas: 3 (2) Wind: 1	Artificial Reef: Commercial fishing (1), Recreational fishing (1), Divers(1), Management authorities (1), Research (1), Industry (1), Community (1), Local Business (1), None (lit review) (1) Oil and Gas: Commercial fishing (3), Recreational fishing (2), Divers(2), Recreational boating (1), Commercial shipping (1), Management authorities (1), Research (1), Private industry (aquatic) (1), Community groups (1) Offshore Wind: Commercial fishermen (1), Private business(1)	Placing an artificial reef in an area where commercial fishers operate can exclude them from an area that was formally open access and their perceived 'right' to use (#19: Sutton & Bushnell, 2007)
Priority issues/threats associated with MMI	Artificial Reef = 1 (1) Oil and gas = 3 (2)	AR: Recreational and commercial fishing, diving, fisheries agencies, researchers, the aquatic industry, community groups O&G: Commercial fishers (1); Rec boaters, tourists, residents (1); None (1)	Destruction and or disruption of the benthic environment is a major concern, as too is the potential impact of structures left below on vessels (#P2: WAFIC, 2017)

Table 5 Coverage of MMI types and stakeholder groups for the Perceptions literature

\* Brackets indicated the number of professional reports in total value

\*\* Brackets indicate the number of papers/reports incorporating the stakeholder group

#### Use and Satisfaction

The final category incorporated papers exploring the use of, and satisfaction with, MMI (Table 6). The predominant focus was on recreational divers' use of artificial reefs, and the characteristics of divers (e.g. dive experience) associated with site preferences (e.g. natural versus artificial reefs or

habitat preferences) (Table 7). Information ranged from examining the types of dive activities underway (Ditton et al 2002), to preferences for different forms of artificial reef (e.g. Sahni et al 2012) and marine environments (e.g. natural versus artificial, Belhassen et al 2017; habitat preferences, Kirkbride-Smith et al 2013). Kirkbride-Smith et al 2013 found that shipwrecks were the most preferred form of artificial reef (76%), followed by sunken vessels (15%) and piers, jetties or platforms (3%).

7	Table	6:	Literature	addressina	Use	and	Satis	faction
'	ubic	υ.	LILLIULUIC	uuurcssnig	USC	unu	Julis	juction

Paper	Citation
ID	
#2	Belhassen, Y., Rousseau, M., Tynyakov, J., & Shashar, N (2017) Evaluating the attractiveness and
	effectiveness of artificial coral reefs as a recreational ecosystem service, Journal of Environmental
	Management, 203 (1): 448 - 456
#3	Kirkbride-Smith A.E., Wheeler P.M., Johnson M.L. (2013) The Relationship between Diver
	Experience Levels and Perceptions of Attractiveness of Artificial Reefs - Examination of a Potential
	Management Tool, PLoS ONE, 8(7)
#5	Murray, J. D., & Betz, C. J. (1994) User views of artificial reef management in the southeastern US,
	Bulletin of Marine Science, 55: 970 - 981
#8	ten Brink T.S., Dalton T. (2018) Perceptions of commercial and recreational fishers on the potential
	ecological impacts of the Block Island Wind Farm (US), Frontiers in Marine Science, 5: 439
#18	Shani A., Polak O., Shashar N. (2012) Artificial Reefs and Mass Marine Ecotourism, Tourism
	Geographies, 14 (3): 361-382
#20	Tessier A., Francour P., Charbonnel E., Dalias N., Bodilis P., Seaman W., Lenfant P. (2015),
	Assessment of French artificial reefs: due to limitations of research, trends may be misleading,
	Hydrobiologia, 753 (1)
#22	Ditton, R.B., Osburn, H.R., Baker, T.L. and Thailing, C.E. (2002) Demographics, attitudes, and reef
	management practices of sport divers in offshore Texas waters. ICES Journal of Marine Science 59,
	186–191.
#25	Stolk P., Markwell K., Jenkins J.M. (2007) Artificial reefs as recreational scuba diving resources: A
	critical review of research, Journal of Sustainable Tourism, 15(4): 331-350
P#3	CRC Research Centre (1999) Understanding public perceptions of the Great Barrier Reef and its
	management, Available online from: http://rrrc.org.au/wp-content/uploads/2014/03/Technical-
	Report-29.pdf
P#4	CRC Reef Research Centre (1998), Visitor experiences and perceived conditions on day trips to the
	Great Barrier Reef, Available from: http://rrrc.org.au/wp-content/uploads/2014/03/Technical-
	Report-21.pdf
P#12	Montes, N., Sidman, C., Lorenzen, K., Tamura, M. and Ishida, M., (2019) Influence of fish
	aggregating devices on the livelihood assets of artisanal fishers in the Caribbean, Ocean & Coastal
	Management, 179: 104823.

## Use and Satisfaction: Type of structure and stakeholder groups

As per the Perceptions literature, artificial reefs were again the principle MMI type of focus for research on stakeholder use and satisfaction. Seven of the eight papers assigned to this theme engaged recreational divers, and in four of these papers, divers were the only stakeholder group engaged. The outlying paper examined the past and current uses of offshore wind turbines by commercial and recreational fishermen (ten Brink and Dalton 2018), comparing past and current uses and perceptions of change before and after wind turbines were constructed and operational (e.g. ecological and behavioural impacts).

Table 7 Coverage of MMI types and stakeholder groups for the Use and Satisfaction literature

Sub-topic	MMI Type (PL)*	Stakeholders**	Examples
	Artificial Deafs 7	Autificial Deefs Divers (7)	
Use levels, preferred resources/environment for activity (e.g. natural versus artificial reefs), satisfaction level with asset	Artificial Reef: 7 Offshore Wind: 1 Moored FAD: 1 (1) Natural Reef: 2 (2)	Artificial Reef: Divers (7), Commercial fishing (2), Recreational fishing (2), Environmentalists (1) Offshore Wind: Commercial fishing, Recreational fishing Moored FAD: Artisanal fishers Natural Reef: Tourists (1), None (1)	Divers use a mixture of natural and artificial reefs. Though they feel more relaxed when diving in a natural environment the artificial sites were reported as more popular (#2: Belhassen et al. 2017)

I
 \* Brackets indicated the number of professional reports in total value
 \*\* Brackets indicate the number of papers/reports incorporating the stakeholder group

	Stakeholder Group	Com	mercia	al fishir	ng		Recr	eation	al Fishi	ing		Divii	ng				Othe	er*				Non	None/Not stated					
	MMI Type	AR	0&G	Wind	Other*	None	AR	o&G	Wind	Other	None	AR	0&G	Wind	Other	None	AR	0&G	Wind	Other	None	AR	O&G	Wind	Other	None	TI**	TD***
Social	Personal				1	1				1	1	1							1	1		1	2				10	6
Values	Global	1					1										1			2							5	3
Perceptions	Benefits /awareness	4		2			3		1			5					3		1	1					1		21	13
	Priority issues/threats		2				1	1				1	1				2	1					1				10	4
	Resource access	1	3	1			1	2				1	2				1	2	1			1					16	6
Use types a	nd satisfaction	3		1			3		1			5					1			1					1		16	11
	Total Instances	9	5	4	1	1	9	3	2	1	1	13	3	0	0	0	8	3	3	5	0	2	2	0	2	0		

#### Table 8: Literature coverage of social research themes, by stakeholder group and MMI type

\* 'Other' includes all other stakeholder groups, for example, residents, local government, researchers; and 'Other' MMI types, for example, seawalls, coastal defence and eco-engineering

\*\*Total number of instances that the stakeholder group or MMI type was covered across the reviewed literature

\*\*\* Total number of reports/documents from the reviewed literature addressing the selected subcategory.

## Summary

At the completion of the social values literature review, it was clear that while there is significant advocacy for research examining social values to support effective decision-making in marine environments, the available research addressing this topic for MMI is limited. Artificial reefs and the diving sector dominate the literature (Table 8). Stakeholder perceptions of the benefits and awareness of MMI is also the primary research focus, followed by the use types, satisfaction with, and access to MMI. Social values are rarely explored and when done so, only for select elements of social value (e.g. relational aspects or subjective aspects in isolation).

Despite this, the studies identified in the systematic review cover select structure types, stakeholder groups, and aspects of social value. Therefore, by bringing together the information from across the review, a model of social values for MMI could be constructed (Figure 9). The elements within the constructed model (i.e. material, subjective and relational values across multiple scales) closely align to the social well-being framing, which has been advocated as an approach to integrate social, economic and environmental aspects in fisheries management (see for example Weetatunge et al. 2014). Consequently, the established, peer-reviewed representation of social values, adopting the well-being lens as reported in Weeratunge et al (2014) was modified for an MMI context and established as the conceptual model supporting the ongoing research (Figure 10).



Figure 9: Preliminary conceptual model of social values for MMI

#### Micro-scale

#### Material

- Income associated with activity
- · Catch quantity associated with activity
- Rights of access to location of activity Subjective
- Independence to conduct activity
- · Wellbeing associated with conduct of activity
- Experience of activity
- · Satisfaction with catch arising from activity
- Importance of memories/souvenirs from activity Relational
- Outcomes of interactions via social networks (family, friends, community, fellow users) as a result of activity

## Meso-scale

Material

- · Outcomes for tourism sector in community
- Diversification of employment opportunities in community Subjective
- Ecological connectivity between aquatic manmade infrastructure
- Inter-generational consequences of presence of aquatic manmade infrastructure

Relational

- · Conflict or co-operation between sectors of community
- Cultural significance of aquatic manmade infrastructure

#### Macro-scale

#### Subjective/Material

 Ecosystem health in relation to presence of aquatic manmade infrastructure



Figure 10: Conceptual model of the social values of man-made marine structures, following Weeratunge et al (2014)

# **Economic Value Findings**

The systematic literature research found 34 studies that quantified the economic value that MMI provide to stakeholders such as divers (20), recreational fishers (10), commercial fisheries (7), the general public (3) and other user groups (7). Since the first study on the economic value of a marine artificial structure was published in 1973 by Buchanan, the number of publications on this topic has steadily increased and the issue has started to gain considerably more attention in the last 2 decades (Figure 11). One study was published in the 1970s, three in the 1980s, three in the 1990s, 14 in the 2000s, and 14 in the 2010s (please note that this number is still subject to changes until the end of 2019). While the literature indicated economic values from artificial reefs all over the world, nearly half of these studies (17) were conducted in the USA and much less in other parts of the world. There are six European studies (2 in Portugal, 3 in the UK, 1 in France); five Asian studies (2 in India, 1 in Malaysia, 1 in Taiwan); two Middle-Eastern studies (Israel); two Central/South American studies (Brazil and Barbados), one African study (Kenya); and one Oceanian study (Australia).

All articles quantified direct use values, whereas non-use values were assessed by only two studies. To our knowledge, no study has estimated indirect use values, even where studies had a context that could be relevant (e.g. coastal protection). The reason for this is probably that different value types can overlap. For example, if one wants to measure the total economic value of an artificial reef and estimates the direct use value provided by an increased catch rate of fish due to habitat enhancement it would be double counting to measure the value of habitat enhancement that causes the increased catch rate (unless there are other economic benefits associated with the habitat enhancement that are not included in the direct use value of the catch). Due to the lack of indirect use values in the literature, this value type is not further discussed in the following sections.

The following sections review the economic values for each of the MMI types as well as the potential applicability to the case studies following the TEV framework.



Figure 11: Cumulative number of economic valuation studies on marine man-made structures.

## Artificial reefs

## Direct-use values

Artificial reefs have been found to generate direct use values in terms of business revenues from extractive uses such as commercial fishing (Vivekanandan et al., 2006, Brock, 1994, Islam et al., 2014) and recreational fishing (Buchanan 1973; Milon 1989; Morgan et al. 2018). For example, Buchanan (1973) estimated that an artificial reef in South Carolina, USA caused an increase of 10% in the gross economic contribution of marine recreational fishing in the region. Moreover, 16% of recreational fishers stated that they would not return to the area if the artificial reef was not there. They argue that therefore the revenues of these fishers would be lost without that reef. In Brazil, an artificial reef was deployed to protect the habitat from trawling activities which positively influenced recreational fishing and dive tourism in the area (Brandini 2014).

In addition to revenues from extractive activities, artificial reefs also have been found to provide economic benefits to non-extractive uses such as scuba diving (Chen et al. 2013; Ditton et al. 2001; Dowling & Nichol 2001; Leeworthy et al. 2006; Westerberg et al. 2013; Wilhelmsson et al. 1998), snorkelling, surfing, and boat tours (Pendleton 2005; V Westerberg et al. 2013). For example, Dowling and Nichol 2001 analysed the expenditures from dive tourists that visit the HMAS Swan shipwreck in Western Australia and estimated the annual economic impact to be USD 1.39 million. Similarly, Ditton et al. (2001) estimated the expenditures from scuba divers on artificial reefs in Texas to be between USD 320,324 and 960,712 per year and a shipwreck in Florida, USA increased total recreational expenditures from snorkelers, divers and boating by USD 2.7 million (Leeworthy et al. 2006).

Artificial reefs not only directly enhance habitat but also deviate user pressure from natural reefs. For example, the construction of a dive and snorkel trail in Dahab, Egypt was meant to prevent tourists from trampling on and therefore harm natural reefs. Hannak et al. (2011) did a contingent valuation study and found that especially the less experienced snorkelers (who are more likely to damage reefs) were willing to pay for the snorkel trail and an educational training to protect natural reefs.

Some valuation studies on marine artificial structures include economic impact assessments (Bell et al. 1998, Johns et al. 2001). Economic impact assessments quantify the increased economic activity that e.g. the deployment of an artificial reef brings to a region. This is typically measured as the number of jobs and the income the artificial reef is generating. For example, Johns et al. (2001) estimated that artificial reefs in Southeast Florida provide 26,800 jobs and are generating USD 2.4 billion of revenues annually. A similar study from Bell et al. (1998) used the contingent valuation method and showed that artificial reefs in Northwest Florida have an annual impact of USD 415 million annually and provide 8,100 jobs.

Two articles compare economic values of commercial fishing opposed to recreational and/or tourism activities on artificial reefs in Hawaii (Brock 1994), and Kenya (Crabbe and McClanahan, 2006). Both studies found that the revenues generated from recreation and tourism exceed those from commercial fishing by far.

Finally, the controlled position of artificial reefs allow for safer conditions than on some natural sites. Christie (2009) assessed the economic value associated with (among other attributes) safer swimming conditions and found that all members of a community in Wales held significant values for a multipurpose reef which would provide such conditions. Likewise, Taiwan residents were willing to pay about USD 13 per recreational fishing and diving trip for access to an artificial reef zone that provides safer conditions than surrounding areas (Chen et al. 2013).

#### Non-use values

Non-use values result from peoples' satisfaction which a natural resource provides that is not traded in a market. This satisfaction can have various sources. For example, as described above, artificial structures in the ocean have the ability to enhance marine habitat and therefore improve the biodiversity and/or abundance of marine life on and around them. Although there is no process by which these values can be captured by any party, techniques exist that quantify them in monetary form. Hence, people who value these natural benefits can have a "willingness to pay" for maintaining artificial structures. We have found two articles that measured non-use values of artificial reefs. Börger et al. (n.d.) used a discrete choice experiment to estimate the willingness to pay of residents in Ireland for an increase in biodiversity on an offshore windfarm off the coast of Ireland. They found that people were willing to pay GBP 7.25 and GBP 14.83 per person for an increase of ten and 30 species settling on the windfarm, respectively. Hicks et al. 2004 conducted a contingent valuation study to measure the public's willingness to pay for artificial oyster reef programs. Their results show that the general public have a positive attitude towards oyster reef restoration programs, and are willing to pay a median of USD 86.68 per year in income taxes to fund oyster reef programs although they not necessarily use such reefs.

#### Artificial reefs versus natural reefs

A total of nine studies have compared economic values related to artificial reefs with those from non-artificial reef sites. Three studies have found that revenues from commercial fishing were significantly higher on artificial reefs than on adjacent areas. Kasim et al (2013) found that the revenues of commercial fishers in India were over twice as high on artificial reefs compared to nonartificial reef areas and Vivekanandan et al. (2006) estimated the income from hook and line fishing on artificial reefs to be 36% higher than on non-artificial reef sites. Similarly, results from (Whitmarsh et al. 2008) show that the revenues from an artisanal fishery on an artificial reef off the Algarve in Portugal to be substantially higher than on control sites. However, the literature also indicates that this is not always the case. For example, the monthly fishing income from artisanal fishers on an artificial reef in Malaysia was lower than on adjacent natural reefs (Islam et al. 2014) and Crabbe and McClanahan (2006) observed that not all commercial fisheries benefited from deployed shipwrecks in Kenya resulting in potential stakeholder conflicts.

Another set of four articles estimated the willingness to pay for recreational activities on artificial reefs and natural reefs (or other adjacent natural sites). Overall, the majority of these studies (three out of four) indicate that people have a higher willingness to pay for natural reefs than for artificial reefs. In Southeast Florida, Johns et al. (2003) observed that recreational reef users (including recreational fishers, reef divers, reef snorkelers, and visitors viewing the reefs on glass-bottomed boats) were willing to pay an extra \$12.74 per person per day in trip costs to maintain artificial reefs in their existing condition. The comparative value for natural reefs was significantly higher, at \$18.81 per person per day. When these values were aggregated over the population, their results showed a willingness to pay to protect natural reefs (USD 229.3 million/year) over double as high as to protect artificial reefs (USD 85.1 million/year) (Johns et al., 2003). Similarly, (Oh et al. 2008) estimated that values over the annual trip expenditures from divers in Texas were \$159.97 per person for artificial reefs and \$270.83 per person for natural reefs. Also, (although not statistically significant) marine park users in Barbados were willing to pay an additional \$19.18 per day in trip costs to recreate at artificial reefs, compared to \$20.00 per day for natural reefs (Kirkbride-Smith et al. 2013). On the other hand, Huth et al. (2015) conducted a contingent behaviour study and found that dive tourists in Florida had higher willingness to pay for a dive trip to a shipwreck (USD 368) than to natural reefs (USD 300). All literature on the economic value of artificial reefs is shown in Table 9.

## Exmouth Integrated Artificial Reef

The Exmouth Integrated Artificial Reef (EIAR or also called the King reef) was deployed in July 2018 with the purpose to enhance habitat to benefit the environment as well as to provide a new, accessible and safe recreational fishing site in Exmouth, Western Australia. We have identified the following economic values that can be associated with the deployment of the EIAR if these objectives are met.

## **Direct-use values**

Expenditures: The EIAR can provide extractive direct use-values through recreational fishing activities. The direct economic impact associated with the development of the reef includes direct expenditure from recreational fishers (e.g. on boat fuel and fishing gear) in pursuing activities on the EIAR. Moreover, a boat ramp survey from Recfishwest has shown that the EIAR is also visited by divers and snorkelers. Therefore, expenditures from divers that visit the EIAR account for non-extractive direct use-values.

The EIAR is well accessible, about 6.5 km distance from the Exmouth marina and 9.6 km from the Bundegi boat ramp. Hence, visitors to the region might be able to benefit from the EIAR by reducing the resources that are necessary to invest (e.g. in fuel costs and time) to reach the EIAR compared to substitute sites with a similar experiential quality.

- *Multiplier effects:* In addition to this direct economic impact, there are multiplier effects which arise when local businesses that supply goods and services to recreational fishers and divers in turn demand goods and services from their suppliers. Consequently, these shops spend money for e.g. on rent, electricity, fuel and materials. This generates output, incomes and employment in those industries supplying the local businesses and shows how the wider economy might benefit from the EIAR.
- Consumer surplus: In addition to the expenditures, recreational fishers and divers will derive a value that is over and above the cost incurred to participate in the EIAR related activity. This consumer surplus can be increased if the EIAR can provide a more enjoyable experience. An improved fishing experience could result from an increased fish abundance and diversity which in turn could enhance the catchability and catch rate on the EIAR. Accordingly, divers might have an improved experience when they observe a more diverse and abundant habitat. Moreover, recreational fishing on the nearby natural Ningaloo reef is limited due to rough weather conditions. Hence, the EIAR was positioned inside the Exmouth Gulf where weather conditions are more stable. This can increase visitors' consumer surplus through safer conditions on the water.

## Indirect use-values

In addition to the direct use-values, the EIAR can potentially provide indirect use values due to spillover effects. Spill-over effects occur when fish and other fauna are over-produced in one area and move into nearby areas. Where commercially important species spill-over into fishing grounds, the EIAR might indirectly increase the profitability of commercial fisheries.

## Non-use values

An ecological monitoring program has shown increased fish abundance and diversity on the EIAR in comparison to the same area before the deployment as well as compared to adjacent habitats (Harvey et al., unpublished data). It is reasonable to expect that residents of Western Australia

would have some positive willingness to improve fish abundance and biodiversity in the Exmouth Gulf. Conversely, it is possible that other members of the general public value habitats that are undisturbed from human intervention. In that case, the EIAR would have reduced the value this area provides for them.

Generally, it is important to notice that there is a debate about the level that artificial reefs are able to produce marine fauna as opposed to attracting it from adjacent areas. Therefore, it remains unclear whether (or to what extent) the EIAR can provide the economic benefits that depend on increased productivity. Also, while the preliminary ecological surveys have shown increased fish abundance and diversity, the EIAR is still in its early stages and will not have reached an equilibrium, which may be a higher level of productivity than currently seen. However, countering that, the fishing pressure will also not yet be at equilibrium, and one would expect that will provide a counterweight that will reduce fish populations. Therefore, economic surveys with stakeholder groups and long-term ecological monitoring of the EIAR would be necessary to understand the economic values associated with the EIAR.

## Table 9: Economic valuation studies on artificial reefs (n=29).

Study	AR <sup>1</sup> Type(s)	Value Type(s)	Data Collection Year	Valuation Method(s)	Country	Valuation Context/Description	WTP (study units)	WTP (2019 USD)
Bell et al. 1998	Shipwreck	Use – Direct		Market	USA	Revenues from user expenditures	\$414 million/study period	652 million/study period
		(Recreation/Tourism)	1997-1998	Non-market (CVM <sup>2</sup> )		Consumer surplus for residents and tourists	\$3.62-\$4.4/\$6.51- \$7.96 per day and resident/vicitor	\$5.7-\$6.93/\$10.25- \$12.54 per day and
Börger et al.	Wind Turbines	Non-use	2013	Non-Market	UK	Hypothetical windfarm in the Irish Sea between Anglesey and the Isle of	£7.25-£12.91 per	\$10.79-\$19.21 per
(2015)		(Existence)		(DCE <sup>3</sup> )		Man	(10 species) £14.83-£15.84 per	(10 species) \$22.06-\$23.56 per
		Use – Direct				Attributes/levels:	household per year (30 species)	household per year (30 species)
		(Visual Amenity)				0, 10, 30 additional species to settle in and around the new offshore wind farm	No impact of wind turbine height/visibility on	No impact of wind turbine height/visibility on
						180m, 240m, 300m high turbines	WTP	WTP
						No impact (cabling buried at 1m) Impact on marine mammals (cabling buried at 2m) <u>Payment vehicle</u> : additional tax to be paid annually by every household to	£26.49 per household per year to prevent impact of cables on marine mammals	\$30.11 per household per year to prevent impact of cables on marine mammals
Brandini et al. 2014	Concrete structures	Use – Direct (Recreation/Tourism)	1998-2003	Market	Brazil	fund alternative windfarm design Revenues from recreational fishing and dive tourism	\$266,000/\$69,400 revenues from recreational fishing/dive tourism in study period	\$288,498/\$75,270 revenues from recreational fishing/dive tourism in study period
Brock et al. 1994	Various sunken objects	Use – Direct (Recreation/Tourism,	1990	Market	USA	Revenue associated with submarine/dive tourism and commercial fishing on Hawaiian ARs	\$69.63/\$63.02 pp per submarine tour/dive	\$135.43/\$122.57 pp per submarine tour/dive
	(snip, concrete modules, aircraft)	commercial Fishing)					\$58,840 per year for commercial fishing (4% of net profit of dive tourism alone)	\$114,440 per year for commercial fishing
Buchanan 1973	Car tyres and sunken ships	Use- Direct	1972	Market	USA	Total expenditure associated with AR	\$36,000 per 4 months season	\$221,132 per 4 months season

Study	AR <sup>1</sup> Type(s)	Value Type(s)	Data Collection Year	Valuation Method(s)	Country	Valuation Context/Description	WTP (study units)	WTP (2019 USD)
Chen et al. 2013	Various sunken objects (ships, utility poles, steel and concrete structures)	Use – Direct (Recreation/Tourism)	2008	Non-Market (TCM⁴ and CVM)	Taiwan	Travel costs associated with diving/recreational fishing trips in Penghu <u>Survey question</u> : "How much did you actually pay (travel and other costs) to participate in scuba diving or recreational boat fishing?" WTP for a ticket to visit an AR diving/recreational fishing zone in Penghu <u>Survey question</u> : "If the government planned an AR scuba diving zone (or boat fishing zone) to improve the safety and facilities and to provide ocean weather conditions and other recreation information, how much would you be willing to pay for a ticket to participate in these	\$348.50/\$281.91 per tourist per trip for diving/recreational fishing (TCM) \$12.70/\$13.00 per ticket for diving/recreational fishing (CVM)	\$\$411.46/\$332.83 per tourist per trip for diving/recreational fishing (TCM) \$14.99/\$15.35 per ticket for diving/recreational fishing (CVM)
Christie et al. 2009	Sunken Sandbags (TerraFix mega geotextile)	Use – Direct (Visual Amenity, Recreation/Tourism)	(not stated)	Non-Market (DCE)	UK	activities?" Coastal defence options for Borth in West Wales <u>Attribute levels:</u> no change (timber groynes), rock groynes, offshore reef <u>Payment vehicle</u> : annual increases in local tax over a five-year period	£98 per household per year (offshore reef excl. improved surf conditions) £171 per household per year (offshore reef incl. improved surf conditions)	<ul> <li>\$171 per household per year</li> <li>(offshore reef excl. improved surf conditions)</li> <li>\$298 per household per year</li> <li>(offshore reef incl. improved surf conditions)</li> </ul>
Crabbe & McClanahan 2006	Sunken Ships	Use – Direct (Recreation/Tourism, Commercial Fishing)	2004	Market	Kenya	Revenue associated with commercial fishing and dive tourism	\$9.00 increase per fisher per day at landing site for commercial fishing \$75,000-\$174000 per wreck per year in dive tourism	\$12.00 increase per fisher per day at one landing site for commercial fishing \$100,927-\$234.151 per wreck per year in dive tourism

Study	AR¹ Type(s)	Value Type(s)	Data Collection Year	Valuation Method(s)	Country	Valuation Context/Description	WTP (study units)	WTP (2019 USD)
Ditton et al. (2001)	Various sunken objects	Use – Direct (Recreation/Tourism)	1997	Market	USA	Revenue associated with commercial dive tourism	\$162 pp per diving trip day for Texas residents	\$256.58 pp per diving trip day for Texas residents
	(man-made materials, shipwrecks, oil and gas platforms)						\$170 pp per diving trip day for Texas non-residents	\$270.67 pp per diving trip day for Texas residents
Dowling and Nichol (2001)	Sunken Ships	Use – Direct	1999	Market	Australia	Revenue associated with commercial diver tourism and recreational fishing	\$22.20 pp per day for private permit divers	\$33.87 pp per day for private permit divers
		(Necreation) rounsin)					\$35.35 pp per day for domestic group charter divers	\$53.94 pp per day for domestic group charter divers
							\$41.10 pp per day for international group charter divers	\$62.71 pp per day for international group charter divers
Hannak et al. 2011	Snorkel trail	Use – Direct (Recreation/Tourism)	2007-2008	Non-Market	Egypt	WTP for guided tour and guide book hire for an artificial snorkel trail to protect natural reefs from trampling	€13.42 per person per day for guided snorkel trip	\$17.24 per person per day for guided snorkel trip
Hicks at al. 2004	Oustor roof	Liso direct		Markot	115.4	Total WTP of recreational fishers for	€14.38 per person per day for guide book hire fee \$638.259 per year	\$18.56 per person day for guide book hire fee \$1.005.391 per year
There et al. 2004	Oyster reer	Use-unect		Warket	USA	oyster reef restoration	9030,235 per year	\$1,005,551 per year
		(Recreation/Tourism)		Non-market (TCM & CVM)		General public's WTP for oyster reef restoration	\$86.68 per household per year	\$136.54 per household per year
		Non-use				Payment vehicle: Increase in annual		
Huth et al. (2015)	Shipwreck	Use-direct (Recreation/Tourism)	2013	Non-market (TCM & CBM⁵)	USA	WTP of divers diving on all reef types and natural reefs with and without a new shipwreck	\$6,531 /\$6,163 per year on all reef types with/without new shipwreck	\$7,198 /\$6,793 per year on all reef types with/without new shipwreck
							\$3,802/\$3,685 per	\$4,190/\$4,062 per

year on natural reefs year on natural reefs

Study	AR¹ Type(s)	Value Type(s)	Data Collection Year	Valuation Method(s)	Country	Valuation Context/Description	WTP (study units)	WTP (2019 USD)
Islam et al. (2014)	Various sunken	Use – Direct	2011	Market	Malaysia	Revenue associated with commercial	with/without new shipwreck \$164 per fisher per	with/without new shipwreck \$185.34 per fisher
	objects					fishing (small-scale/artisanal)	month	per month
		(Artisanal fishing)						
	(ships, tyres,							
	objects/structures							
	oil and gas platforms)							
Johns et al. (2001)	Unspecified	Use – Direct	2000	Market and Non-Market	USA	WTP an extra amount in trip costs to maintain the AR in its existing	\$8.63 extra pp per day to maintain AR	\$12.74 extra pp per day to maintain AR
		(Recreation/Tourism)		(CVM)		condition	\$75 pp per year for a	\$110.12 pp per year
						WTP in annual boat	program that	for a program that
						registration/higher charter fees for an artificial reef program	maintains existing ARs	maintains existing ARs
							\$24 pp per year to	\$35.43 pp per year to
							create new ARs	create new ARs
Kasim et al. 2003	Concrete Structures	Use – Direct	2007	Market	India	Net income from commercial fishing	INR1252 per unit	\$42.75 per unit
		(Commercial fishing)					for gillnet fisheries	for gillnet fisheries
		(8/					IND4650 por upit	6159 77 par upit
							operation per vear	operation per vear
							for hooks and line	for hooks and line
							fisheries	fisheries
Kirkbride-Smith et	Sunken	Use – Direct	2013	Non-Market	Barbados	WTP an extra amount in trip costs for	\$17.58 extra pp per	\$19.18 extra pp per
al. (2016)	Ships			(CVM)		recreation in the Folkestone Marine	day	day
1	Contract	(Recreation/Tourism)	1007	N. de alla et	110.4	Reserve	ća Casillian in total	ć4.12 million in total
Leeworthy et al.	Sunken	Use – Direct	1997	warket	USA	fishing and diving/snorkelling tourism	s2.6 million in total recreational	s4.12 million in total
2000	Ships	(Recreation/Tourism)					expenditure	expenditure
Milon (1988)	Sunken	Use – Direct	1985	Non-Market	USA	Benefits of a new centrally-located	\$1.80 pp per year	\$4.28 pp per year
	Ships			(TCM &		artificial reef site for private boat		
		(Recreation/Tourism)		NMNL)		sport anglers		

Study	AR¹ Type(s)	Value Type(s)	Data Collection Year	Valuation Method(s)	Country	Valuation Context/Description	WTP (study units)	WTP (2019 USD)
Morgan et al.	Sunken	Use – Direct	2006	Non-Market	USA	Travel costs for divers to visit the USS	\$480-\$750 pp per	\$605.24-\$945.69 pp
(2009)	Ships	(Descention /Termines)		(TCM & CVM)		Oriskany	trip to the Oriskany	per trip to the Oriskany
		(Recreation/Tourism)				Divers' WTP for an additional sunken	\$220-\$1160 pp per	
						ship	year for an additional	\$277.40-1462.67 pp
							snip	per year for an additional ship
Morgan et al.	Sunken	Use – Direct	2014	Non-Market	USA	WTP an increased saltwater fishing	\$32.71 pp per year in	\$35.12 pp per year in
(2018)	Ships			(CVM)		license fee	additional license fee	additional license fee
Ob. at. al. (2000)	l lucius e efficiend	(Recreation/Tourism)	1007			W/TD additional diving trip pacts	¢101 outro po por	¢150.07 outro pp por
On et al. (2008)	Unspecified	Use – Direct	1997	Non-Market (CVM)	USA	wip additional diving trip costs	year	year
		(Recreation/Tourism)						
Pendleton (2005)	Sunken	Use – Direct	2002	Market and	USA	Revenue associated with dive tourism	\$4.5 million in	\$6.36 million in
	Ships			Non-Market		Travel costs for divers to dive the	market contribution	market contribution
		(Recreation/Tourism)		(TCIVI)		Yukon artificial reef	\$12 million in non-	\$1.70 million in non-
							market contribution	market contribution
Dolak and Shachar	Concroto Structuros	Lico Direct	2010	Non Market	Icraol	W/TP to roctoro APs (biological	(\$110 pp per day)	(\$156.62 pp per day)
(2013)	concrete structures	Use – Direct	2010	(CVM)	ISIdei	attributes coral size, coral diversity,	(low effort)	year (low effort)
()		(Recreation/Tourism)		(0,1,1,1)		fish abundance, coral abundance, a		
						combination of numbers of fish and	NIS15-50 pp per year	\$4.57-\$15.24 pp per
						using varying degrees of effort	(medium enort)	year (medium enort)
						6,66	NIS25-70 pp per year	\$7.62-\$21.34 pp per
			2002				(high effort)	year (high effort)
Ramos et al.	Concrete Structures	Use – Direct	2002	Market	Portugal	commercial fishing	€7858-€18896 per fisherman per vear.	€11652.94-€28021.64 per fisherman per
(2000)		(Commercial fishing)					depending on boat	year, depending on
		(00111101010111011118)					type	boat type
Vivekanandan et	Various sunken	Use – Direct	2003	Market	India	Income associated with artisanal fishing	RS71.3 per hour of	\$2.93 per hour of
al. (2009)	objects	(Artisanal fishing))				1311116	operation	operation
	(concrete, and high-							
	density							
	polyethylene							
	objects)							
Westerberg et al.	Wind Turbines	Use – Direct	2010	Non-Market	France	Additional cost of accommodation to have access to reef and wind farm	€39.60 pp per week (no wind farm)	\$50.04 pp per week (no wind farm)
(2013)				(DCE)		associated recreational activities	(	(

Study	AR <sup>1</sup> Type(s)	Value Type(s)	Data Collection Year	Valuation Method(s)	Country	Valuation Context/Description	WTP (study units)	WTP (2019 USD)
		(Recreation/Tourism					-€76.1 pp per week	-\$96.17 pp per week
		Visual Amenity)				farm 5km offshore, wind farm 8km	(Skm offshore)	(Skm offshore)
						offshore, wind farm 12km offshore	€13.3 pp per week (8km offshore)	\$16.80 pp per week (8km offshore)
						Payment vehicle: change in weekly		
						accommodation price	€43.9 pp per week (12km offshore)	\$55.48 pp per week (12km offshore)
Whitmarsh et al. (2008)	Concrete Structures	Use – Direct	1990-2005	Market	Portugal	Value per unit effort associated with artisanal fishing	€13 extra per unit effort on AR sites	\$18.47 extra per unit effort on AR sites
(2000)		(Artisanal fishing)					compared to (non- reef?) control sites	compared to non- reef control sites
							€0.18 increase per	\$0.26 increase per
							unit effort per month	unit effort per month
Wilhelmsson et al. (1998)	Various Sunken Objects	Use – Direct	1996	Market	Israel	Revenue associated with dive tourism excluding course dives and non-	\$23 pp per dive	\$37.26 pp per dive
	•	(Recreation/Tourism)				guided tours	\$368,000 per year	\$596,216.29 per year
	(ships, dead coral heads)							

<sup>1</sup>AR= Artificial reef; <sup>2</sup>DCE=Discrete Choice Experiment; <sup>3</sup>TCM=Travel Cost Method; <sup>4</sup>CVM=Contingent Valuation Method; CBM = Contingent Behaviour Method

## **Pipelines**

## Direct-use values

There are two studies that have estimated the in-situ value of fish stocks that are associated with pipelines. An additional nine studies have mentioned economic values of pipelines. The findings of these articles are briefly discussed below and shown in Table 10.

Bond et al 2018a found that the Echo Yodel pipeline on the Northwest shelf of Western Australia was characterised by large, commercially important species such as snappers (Lutjanidae) and grouper (Epinephelidae). They estimated that the biomass of commercial fish was approximately 7.5 times higher than in adjacent natural habitats. General species richness on the pipeline was about 25% greater than off the pipeline and relative abundance of fish was nearly double on the pipeline than in adjacent natural habitats. The association of commercially important species on the pipeline could be explained by their association with complex epibenthic habitat which was observed on the pipeline. As this habitat was previously degraded by trawling (Bond et al 2018c), the pipeline might provide important fish stocks on the pipelines (AUD 65.11  $\pm$  AUD 11.14 SE) was about 8.6 times higher than on natural sites (AUD 7.57  $\pm$  \$2.41 SE).

Another pipeline (Griffin) on the Northwest shelf of Western Australia was also characterized by higher biomass and abundances of commercially important species such as goldband snapper (*Pristipomoides multidens*), saddletail snapper (*Lutjanus malabaricus*) and Moses' snapper (*Lutjanus russellii*) among others. Therefore, the pipeline possessed an in-situ value two to three times higher (AUD 32.87 ± AUD 8.21 SE) than off-pipeline (AUD 15.62 ± AUD 2.97) (Bond et al 2018b).

A number of other studies have also found higher abundance of commercial fish species around three obsolete wellheads (Wanea, Goodwyn and Echo) on the Northwest shelf of Western Australia (Pradella et al 2014) as well as along pipelines off Santa Barbara in the USA (Love and York 2005).

Due to the lack of valuation studies it remains unclear whether or to what extent a higher in-situ value of fish stocks along the pipelines translates into direct extractive use values for fishers. However, commercial and recreational fishers that operate on the Northwest shelf in Western Australia have anecdotally reported that their catch is higher along pipelines (McLean et al 2017).

Rouse et al 2018a found further evidence that fishers aggregate around pipelines in the UK. They estimated that over a five year period about a third (36.1%) of fishing trips happened within 200 m of pipelines. Also, the actual percentage of fishing effort was higher close to pipelines (2.52%) than on the same substrate off-pipelines (1.33%). They conclude that pipeline decommissioning can have negative impacts on fisheries through displacement of aggregated fishing effort. However, they also identify positive effects that pipeline decommissioning can have on fisheries through decreased interaction between fishing gear and pipelines. The possible threats from pipelines to fishers include the loss of access to fishing sites where pipelines are left on the seafloor as well as snagging hazards from pipelines (including loss or damage of gear, lost fishing time and risk of injuries to crew members). These risks can increase with time because more interactions between fishing gear and either the pipeline or its protective material can modify their structure (Rouse et al. 2018a). However, as noted before, the associated economic costs and benefits have not been evaluated. We also have found no studies that have measured the non-extractive direct use-value or indirect use-values associated with pipelines.

#### Non-use values

To the best of our knowledge, there is no valuation study that has investigated non-use values of pipelines. However, Rouse et al (2019) identified established epibenthic species on a pipeline in the UK, some of which have conservation value. Therefore, it could be inferred that there are non-use-values related to these species.

## Echo Yodel

The Echo Yodel pipeline is located in approximately 140m water depth in the Dampier Sub Basin in Commonwealth waters. The production of two wells (Yodel 3 and 4) together with the pipeline was ceased in 2012. Therefore, the removal of these structures is currently being discussed. Below, we discuss what economic impact the removal of the Echo Yodel pipeline could have on relevant stakeholder groups.

## **Direct use values**

The Northwest shelf maintains four fisheries (Open West Coast Fishery, the Pilbara Trawl Fishery, the Pilbara Trap Fishery and the North Coast Shark Fishery). However, only the trawl fishery has any noteworthy catch in water deeper than 50 m. The Yodel wells and pipeline lie in Zone 1 of Pilbara Trap Managed Fishery and adjacent to the Pilbara Trawl Fishery (Zone 2). As noted above, the Echo Yodel pipeline is characterised by large, commercially important species and it was estimated that their biomass is 7.5 times higher than in adjacent off-pipeline areas. Also, species diversity and relative fish abundance was higher on the pipeline than in close by natural habitats. Moreover, there is anecdotal evidence that commercial fishers target the pipeline because they are aware of higher catch rates on it. Therefore, the removal of the pipeline would most likely result in some loss in profit for these commercial fishers. On the other hand, there might be a potential increase in profit for trawl fisheries as the removal of the pipeline makes this area available to them.

Most recreational activities such as recreational fishing and diving are located within inshore waters. Therefore, economic values from recreational activities are not relevant to the removal of the pipeline.

## Indirect use-values

We could not identify any indirect use values associated with the removal of the pipeline.

## Non-use values

It is sensible to expect that residents of Western Australia would have some positive willingness to pay to maintain the higher fish biomass, abundance and biodiversity on the Northwest shelf. Therefore, these non-use values might be reduced or lost if the pipeline was removed. Conversely, it is possible that other members of the general public value habitats that are undisturbed from human intervention. In that case, the removal of the Echo Yodel pipeline would increase the value this area provides for them.

#### Table 10: Studies on the economic value of pipelines.

Reference	Study site	Value type	Valuation Context	WTP/Value	Unit	Data	Quote
Quantitative	e studies						
Bond et al 2018a	Echo Yodel, WA, Australia	In-situ value of commercial fish species	In-situ value of potential catch on and off pipeline as well as along a depth gradient	On pipeline: 65.11 ± 11.14, off pipeline: 7.57 ± 2.41	AUD/ deployment ± SE	2017	
Bond et al 2018b	Griffin, WA, Australia	In-situ value of commercial fish species	In-situ value of potential catch on and off pipeline as well as along a depth gradient	On pipeline: 32.87 ± 8.21, off pipeline: 15.62 ± 2.97	AUD/deploy ment ± SE	2017	
Qualitative	studies						
Bond et al 2018c	Echo Yodel, WA, Australia	In-situ value of commercial fish species	N/A	N/A	N/A	2013	"The pipeline was characterised by a high abundance of commercially important snapper (Lutjanidae) and grouper (Epinephelidae) species. () Structurally complex mesophotic epibenthic habitat forming invertebrates were observed on the pipeline () These complex epibenthic habitats were considered to be important to commercial target species and the modification or loss of these habitats is thought to have negatively impacted the valuable commercial fisheries in the region. This study suggests pipelines can offer a significant epibenthic habitat and refuge for fish, potentially comparable to the historical habitats lost to trawling."
Love and York 2005	Santa Barbara, CA, USA	Not specified	N/A	N/A	N/A	2001 and 2002	"Compared to the seafloor habitats, overall fish numbers and densities were highest at the two pipeline habitats. Fish densities along the shallow portion of the pipeline were about seven times higher than on the adjacent seafloor and densities along the deep pipeline portion were nearly six times that of the deeper seafloor. () Similarly, species richness (defined as the number of species/ area surveyed) was greater in the pipeline habitat (W = 13, n = 23, P = 0.001) than on the seafloor."
McLean et al 2017	Echo Yodel and 2TL, WA, Australia	Direct-use (extractive)	N/A	N/A	N/A	2007, 2008, 2013 and 2014	"Both pipelines were characterised by a high abundance of commercially important fishes including: snappers (Lutjanidae) and groupers (Epinephelidae). The presence of thousands of unidentifiable larval fish, in addition to juveniles, sub-adults and adults suggests that the pipelines may be enhancing, rather than simply attracting, fish stocks."
							"Anecdotally, however, local commercial and recreational fishers report increased fish- take close to pipelines (D. Gibson pers. com.)."
							"Commercially important fish species were ubiquitous and abundant on both the EY and 2TL pipelines. The surveyed section of the EY pipeline is within the boundaries of the Pilbara Trap Managed Fishery and the Pilbara Line Fishery () However, fish species comprising the majority of commercial catches in the Pilbara differed from the most abundant and ubiquitous target species observed on the pipelines."

Reference	Study site	Value type	Valuation Context	WTP/Value	Unit	Data	Quote
Pioch et al. 2011	Mayotte Island, France	Not specified	Fish abundance on new pipeline with "eco-weights" compared to old pipeline without	N/A	N/A		"Fish abundance on the old pipeline, still in use and located 5 m away from the new construction, was insignificant. In contrast, schools of >15 fishes from 3 to 5 different families were seen on the new pipeline (L. Bigot, personal communication). Monitoring of the biota on the new construction will continue for 3 years. The first video was shown to the stakeholders (artisanal fishermen, scuba divers) and policy makers. They were pleased to see that the project did return technical and ecological services with socio-economic benefits."
Pradella et al 2014	WA, Australia	Direct-use (extractive)	N/A	N/A	N/A		"Fishes from 14 families and 31 species were observed associating with the structures. () Ten of the species observed are commercially fished in the region, although only three () are major target species.
Rouse et al. 2017	UK, North Sea	Direct-use (extractive)	Decommissioning effects on commercial fisheries				"The societal impacts that must be considered in the comparative assessment include the consequences of decommissioning to commercial fishers. These include potential snagging hazards from in situ decommissioned pipelines, and loss of access either during the decommissioning process and/or as a result of disused pipelines left on the seabed (de Groot, 1982; Jiexin et al., 2013). Snagging can potentially result in damage to gear, loss of fishing time and/or risk of injuries to crew. Additionally, physical contact between fishing gear and decommissioned pipelines can be a risk to pipeline integrity and, over time, increase the snagging hazard posed by the pipeline (Ellinas et al., 1995; Det Norske Veritas (DNV), 2006). Repeated trawling activity may also disturb any protective material (such as rock placement) which has been added to in situ decommissioned pipelines to mitigate snagging risks."
Rouse 2018	UK, North Sea	Direct-use (extractive)	Comparison of effects from decommissioning options on seabed recovery and interactions with commercial fisheries	N/A	N/A		"Decommissioning all pipelines in situ had the smallest spatial foot print of the in situ scenarios, but offers no mitigation for fisheries risks. Rock dumping pipelines occupies a smaller area of seabed than establishing fisheries exclusion zones around pipelines, but the effects of rock dump on the ecosystem are unknown and may constitute a significant change to the seabed (Lindeboom et al., 2011). These changes will include loss of underlying soft-sediment habitats and an increase in the surface area available for colonisation by epibenthic organisms, with the potential for delivery of ecosystem services associated with natural hard substrates (Miller et al., 2013)."
Rouse 2018	UK, North Sea	Direct-use (extractive)	Decommissioning effects on commercial fisheries	N/A	N/A	2009- 2013	"Approximately one-third (36.1%) of trips fished within 200 m of a pipeline over a 5- year period, suggesting that pipelines are subjected to regular interaction with fishing gear. The fishing effort (in hours) associated with pipelines was 2.52% of the total effort, compared to 1.33% in an equivalent area of seabed 1 km away, implying modest aggregation of fishing around pipelines. Only a small percentage (0.93%) of fishing trips actively targeted pipelines as fishing grounds. () The results suggest that pipeline decommissioning may have both negative (displacement of aggregated effort) and positive (reduced snagging potential) outcomes for commercial fisheries."

Reference	Study site	Value type	Valuation Context	WTP/Value	Unit	Data	Quote
Rouse 2019	UK, North Sea	"Conservation value"	Decommissioning effects on associated species	N/A	N/A	2013- 2016	"Pipelines have traditionally been excluded from North Sea connectivity/larval dispersal models (Hyder et al., 2017), but our results, documenting the presence of marine fauna on pipelines, suggest that pipelines will, to some extent, contribute to the connected network of some taxa. The extended linear presence of pipelines over the seabed, connecting larger areas of artificial hard substrate (i.e., platforms), could mean that pipelines facilitate dispersal of epifauna.() The results suggest that removal of pipelines will remove established colonies of epibenthic species, some of which have conservation value."

## Oil and gas platforms

## Direct-use values

Oil and gas platforms have been found to generate direct use values in terms of business revenues from both extractive uses (such as commercial fishing, recreational fishing) and non-extractive uses (such as scuba diving).

Hiett and Milon (2002) found that recreational fishing and diving associated with oil and gas facilities in the Gulf of Mexico not only generated USD 324.6 million in annual economic revenues, but also provided employment for approximately 5,560 full time equivalents. Both fishing charter and dive tour operators considered the presence of oil and gas structures to be very important to their businesses. In Texas, USA, the annual business revenues associated with diving on a variety of artificial reefs - including decommissioned oil and gas platforms – were estimated as USD 261,439 to USD 784,106 (Ditton et al. 2001). However, results are not divided by artificial structure types, and so the fraction that can be attributed to oil and gas structures is unknown.

Oil and gas structures have been also found to increase the satisfaction of recreational fishers through the increase the catchability and/or the catch rate during their fishing trips. McGurrin and Fedler (1989) used the contingent valuation method to compare the perception of fishers that fish on and off an oil and gas platform and found that platform users felt that both the size and types of fish that could be caught were better than off the structure. Consequently, fishers that fished on oil and gas platforms were willing to pay more (USD 19.38) for another artificial reef site than non-platform fishers (USD 10.00).

Roberts et al 1985 used a contingent valuation method to estimate the economic value that oil and gas structures provide for recreational divers in Louisiana, USA. Their results show that the average diver derived a consumer surplus of \$163 annually from this activity.

Three studies have looked at the economic benefits that oil and gas platforms can generate for commercial fisheries. One example are the oil and gas platforms in the Gulf of Mexico which provide habitat for snapper populations. As a result, a significant part of the commercial harvest of snappers originates from petroleum platforms (Bull and Love, 2019). However, Islam et al. 2004 found that benefits from artificial reefs –including oil and gas structures- in Malaysia were unequally distributed among artisanal fishers and suggest that sustainable fisheries management within the artificial reef development should ensure economic benefits for the local fishing communities.

Another potential source of economic value from offshore oil and gas structures is the harvest of ornamental fish. Kolian et al. (2018) estimated that in the Gulf of Mexico, a sustainable harvest of aquarium fish could yield approximately USD 1.4 million per platform per year. Moreover, they point out that there is an unknown value in novel pharmaceutical and/or nutritional products that could be sourced from marine invertebrates that grow on oil and gas platforms.

## Non-use values

Non-use values result from peoples' satisfaction with natural resources that are not traded in a market. To our knowledge, there is no literature on the non-use values that oil and gas platforms provide.

All economic valuation studies on oil and gas platforms are shown in Table 11.

## Thevenard

As outlined above, literature has shown that oil and gas platforms can create substantial economic values for various user groups. In Thevenard, production from the offshore fields ceased in January 2014 and therefore a decision has to be made about the decommissioning of the oil and gas structures. These structures are in particular three platforms, six monopods and one pipeline. As different decommissioning options would create different values, this section provides an indication of the values that may be lost or generated if the existing Thevenard oil and gas infrastructure were to be either completely removed (Figure 12, option a) or used to generate artificial reefs through partial removal (option b) or toppling (option c). The exact form and location of a potential artificial reef is yet to be decided. As the latter two options would have a similar effect on economic values, we are treating them as one scenario.



Figure 12: Decommissioning options for oil and gas platforms (adapted from Bull and Love 2019).

## **Complete removal**

To this very moment, there is a 500 m exclusion zone around the platforms and monopods in the Thevenard Island region. However, there are indications that de facto these structures are being used from recreational fishers and divers. Therefore, the direct use-values (both extractive and non-extractive) associated with the recreational use of the structures would be lost if they were completely removed. There is no information about the use of the pipeline in the area, but if there are any values associated with it, those would be lost by the removal.

Under the status quo, indirect use values might be present for recreational fishers, divers and commercial fishers through spill-over effects. Therefore, the complete removal of the oil and gas structures would also remove these values.

Moreover, the full removal scenario would permanently remove all sessile marine life that is currently living on the structures. It is not clear to what extent this scenario would impact the marine fauna that is able to relocate itself but depends on the structure for feeding, protection from predation and/or reproduction. This impact is most likely different for each species (and/or life stage of each species). In any case, the existence values that people hold for the marine life associated with these structures would be largely reduced or even lost with the full removal. Conversely, existence values for natural marine habitats without marine man-made structures would be gained under the full removal scenario.

## Partial removal and toppling

Under a scenario where the oil and gas structures are partially removed or toppled to create one or various new artificial reefs, the economic values that would arise will depend, from both an ecological and economic perspective, on the objectives, characteristics and locations chosen for new artificial reef(s). It is worth noting, that the manipulation of the structures to create artificial reefs involves the use of explosives or mechanical cutting and can partially or completely remove the marine life currently living on it. Depending on the new application of these structures, this is likely a temporary removal as life might either return to the structures or new life would settle on it again. In theory, all of the economic value types that are discussed in sections 3.1 and 3.2 could potentially be influenced:

- Direct use values
  - o Extractive use values through commercial and recreational fishing activities
  - Non-extractive use values through scuba diving, snorkelling, surfing or other recreational activities
- Indirect use values
  - Coastal protection
  - Spill-over effects
- Non-use values
  - o Existence values for species associated with artificial reefs
  - o Loss of existence values for habitats without man-made structures

## Table 11: Economic valuation studies on oil and gas platforms.

Study	AR Type(s)	Value Type(s)	Data Collection Year	Valuation Method(s)	Country	Valuation Context/Description	WTP (study units)	WTP (2019 USD)
Ditton et al. (2001)	Various sunken objects	Use – Direct	1997	Market	USA	Revenue associated with commercial dive tourism	\$162 pp per diving trip day for Texas	\$256.58 pp per diving trip day for Texas
	(man-made materials, shipwrecks, oil and gas	(Recreation/Tourism)					residents	residents
	platforms)						\$170 pp per diving trip day for Texas non-residents	\$270.67 pp per diving trip day for Texas residents
Hiett and Milon (2002)	Oil and gas platforms	Use – Direct	1999	Market	USA	Revenue associated with commercial dive tourism and recreational fishing	\$4691 per angler per year	\$7157.63 per angler per year
		(Recreation/Tourism)					(\$13 per angler per day)	(\$20 per angler per day)
Islam et al. (2014)	Various sunken objects	Use – Direct	2011	Market	Malaysia	Revenue associated with commercial fishing (small-scale/artisanal)	\$164 per fisher per month	\$185.34 per fisher per month
	(ships, tyres, concrete objects/structures, oil and gas platforms)	(Artisanal fishing)						
Kolian et al. (2018)	Oil and gas platforms	Use- Direct	N/A	Market	USA	Potential harvest: Market price of \$20/invertebrate and \$10/fish and a	\$14 million per platform per year	14.3 million per platform per year
		(Pharmaceutical products)				sustainable yield of 10% of the population (50000 invertebrates and 4000 fish/year) per platform		
McGurrin and Fedler (1989)	Oil and gas platforms	Use – Direct	1989	Non- Market	USA	Willingness to pay for an additional AR	\$14.36 pp one-off payment	\$29.44 pp one-off payment
Roberts et al. (1985)	Oil and gas platforms	(Recreation/Tourism)	1982	(CVM) Non-	1150	Willingness to pay for annual pass to	\$163 pp per year	\$429.38 pp per year
		USC Direct	1902	Market	034	dive under offshore oil and gas rigs	4100 pp pc. Joan	¢ 125.00 pp pc. (cu.
		(Recreation/Tourism)		(CVM)				

<sup>1</sup>DCE=Discrete Choice Experiments; <sup>2</sup>TCM=Travel Cost Method; <sup>3</sup>CVM=Contingent Valuation Method

## Piers and jetties

To our knowledge, there are no economic valuation studies on piers and jetties. However, the Australian Department of Planning, Transport and Infrastructure has recognised the importance of piers and jetties for residents and is conducting research on the usage and the economic benefits of jetties in South Australia (https://yoursay.sa.gov.au/decisions/yoursay-engagements-sa-jetties-strategic-plan/about).

## Exmouth Navy Pier

The Point Murat Navy Pier (from here on only Navy Pier) is located at the mouth of Exmouth Gulf and is adjacent to Bundegi Reef in the Ningaloo Marine Park. It was constructed in 1964 to service the US Naval Communication Station and is nowadays mainly used to supply the base with fuel. The general public has no access to the base. The waters 400 m around the Navy Pier structure is protected under Commonwealth Defence since 1964. In 2005 an additional area was included in the Ningaloo Marine Park as the Point Murat Sanctuary Zone. Therefore, the Navy Pier offers no extractive direct use-values. However, one local dive company has the permission to conduct scuba diving tours underneath the pier which generates non-extractive direct-use values through dive tourist expenditures, multiplier effects and the consumer surplus from dive tourists.

Ecological surveys on the Navy Pier have confirmed a high biodiversity, including over 160 species of finfish from 50 families (Whisson & Hoschke 2013). Given the long history of protection at this site, it is likely that some fish spill over into surrounding areas. Therefore, it is likely that the Navy Pier generates indirect use-values in form of improved fishing experience for recreational fishers in the region.

Moreover, the Navy Pier was identified as an aggregation site for the grey nurse shark (*Carcharias taurus*) which is completely protected within Australian waters since 1997 (Hoschke & Whisson 2016). Therefore, it is very likely that the general public holds existence values for the biodiversity including protected species that are associated with the Navy Pier.

## Attraction vs. production

It becomes evident from the literature that the economic values associated with MMI largely depend on their capacity to enhance the marine environment. While it is widely acknowledged that the presence of artificial structures have increased fish populations around them, there is a continuing discussion about whether these structures merely attract and aggregate fish or also increase the production of existing fish stocks (Bull & Love, 2019). Researchers that found an aggregation effect on artificial reefs are concerned that artificial reefs increase the vulnerability of fish populations to fishing and therefore contribute to overfishing (Pickering & Whitmarsh 1997). However, some researchers have found that various species use artificial structures as nursery grounds and therefore increase the production of these species (Claisse et al., 2014). While the degree of attraction and production effects in each artificial reef varies, this most likely has effects on the behaviour of reef users and consequently the economic benefits that these structures provide.

It is worth noting that the impacts of aggregation versus production are likely to have different impacts on the different values, and that aggregation, although not causing an increment in the underlying ecology, and hence have no impact on non-use values, may still create benefits for use values, if it reduces costs. Fisheries management such as harvest restrictions, temporal closures or the designation of some AR as no-take areas could ensure that artificial reefs meet their targets and maintain ecologically and economically sustainable fisheries.

## Discussion

An overall summary of the social and economic literature identified in the review process with reference to the study sites which represent the focus of primary data collection in this research is summarised in Table 12. These are categorised into instances of either hard evidence which relates directly to a study site, or inferred evidence which identifies cases where data can be extrapolated from another location and applied to one of the case study sites. Cases where there is no hard or inferred evidence are left blank. This may be due to the fact that a stakeholder group has no relationship with a specific structure – e.g. fishing is not permitted around the Navy Pier, hence the cells are blank – or that there exists no data which can be inferred for the relationship between a stakeholder group and a particular type of MMI structure.

The first point to note from Table 12 is that there is only one instance where hard evidence relating to social or economic values and perceptions can be utilised. This relates to the evaluation of direct use benefits to commercial fishers arising from fish biomass around Echo Yodel conducted by Bond et al (2018). The second point to note is that the literature enables most inferences to be drawn in relation to artificial reefs, as these are consistently the most 'popular' form of MMI in the literature. Similarly, recreational divers and (to a slightly lesser extent) non-governmental organisations are the stakeholder groups for whom economic and social evidence can be inferred most frequently. This does come with a distinct caveat, however, as there is only one publication which discussed the social values of recreational fishers associated with an artificial reef and dates from 1994. Consequently, the ability to 'infer' data in relation to the case study sites for the current research must be understood in relation to the quantity and range of evidence in the literature.

There are several broader issues arising from the literature review which merit comment. The first of these is that no publications either in the academic or professional literature attempt to consider both social and economic values and perceptions of stakeholder groups with reference to MMI. This is of significance as the theoretical literature consistently points to inter-dependencies between social and economic values and perceptions, with one being informed or influenced by the other. Secondly, the literature does not reflect or recognise the heterogeneity within stakeholder groups, which clearly does not reflect the reality of diverse characteristics of individuals within stakeholder groups and their divergent values and perceptions of both social and economic benefits of MMI. Finally, the literature considers examples of values and perceptions of MMI on an individual basis, with no consideration of inherent systemicity whereby individual or collective values and perceptions will be coloured by the degree of knowledge or experience of other MMI sites.

These broader issues, together with the gaps in knowledge identified in Table 12, will be addressed in the next stages of this research through a combination of online surveys and workshops. The outcomes of these will be discussed at the appropriate time with the Steering Committee and will be reported in detail in the next Report.
	Exmouth Artificial Reef	Navy Pier	Thevenard Island	Echo Yodel Pipeline	Busselton Jetty
Commercial Fishers	S: Inferred		S: Inferred		
			E: Inferred	Economic: Hard Evidence	
Recreational Fishers	S: Inferred		S: Inferred		
	E: Inferred		E: Inferred		E: Inferred
Recreational Divers	S: Inferred	S: inferred	S: Inferred		
	E: Inferred	E: Inferred	E: Inferred		E: Inferred
Non-Government	S: Inferred				
Organisations	E: Inferred	E: Inferred	E: Inferred	E: Inferred	E: Inferred
Government (Local	S: Inferred				
	E: Inferred	E: inferred	E: inferred	E: inferred	E: Inferred

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## Appendices

### Appendix 1: Social Values Literature Review Criteria

Table 13: Search terms applied in academic literature review

	Level 1: Structures AND	Level 2: Values AND	Level 3 Uses OR	Level 4 Objectives
	Artificial reef	Well*being	Recreational fishing	Marine restoration
	Oil pipeline	Social value	Commercial fishing	Decommissioning
	Gas pipeline	Perception	Fishing	
	Pier	Value*	Ecotourism	
	Jetty	socioeconomic	Touris*	
Synonyms	Oil platform	Soci* ecological	Recreational diving	
	Gas platform		Diving	
	Oil and gas platform			
	Offshore structures			
	Aquatic infrastructure			

Table 14: Inclusion and exclusion criteria applied in academic literature review

Inclusion	Exclusion
Initial	
Written in English	Written in other languages
1989 - 2019	Pre 1989
Peer-reviewed journal article or review	Book chapters, non peer-reviewed, conference proceedings
All hits using Web of Science & Scopus	
First 100 hits using Google Scholar	Hits greater than 100
Secondary	
Explicit focus on the social value of man-made	Social values incidental to focus
marine structures	
Full text available through university access rights	Full text unavailable through university access rights
Type of study (empirical data, review, theory) ~	
all types.	

Table 15: Professional literature search terms

	Structures	Environment		Values		Users	Objectives
٠	Man-made	Marine	•	Social value	٠	Fisheries	Marine date
	structures	Environment	•	Human well-	٠	Stakeholders	acquisition
•	Marine	<ul> <li>Ecosystem</li> </ul>		being	•	Community	Decommissioning
	Infrastructure		•	Perceptions	٠	Public	Marine
•	Subsea						Management
	pipelines						Consultation
•	Offshore						Maximising socio-
	installations						economic benefits
•	Oil and gas						Policy change
	pipelines						
•	Artificial						
	structures						
•	Offshore						
	windfarm						
•	Offshore oil						
	and gas						
•	Artificial reef						

### Table 16: Professional literature organisations

Organisation Name
AUSTRALIA
WAFIC
Department of Biodiversity, Conservation and Attractions
Department of Primary Industries and Regional Development -> fisheries
Chevron
National Energy Resources Australia
Recfish West
National Offshore Petroleum Safety and Environmental Management Authority
APPEA
Department of industry, innovation and science
Subcon
NOGA
Shell Australia
ARPANSA
ВНР
ConocoPhillips
Woodside
UNITED KINGDOM
INfluence of man-made Structures In The Ecosystem (INSITE)
Department for Environment Food & Rural Affairs (UK Gov)
Marine Management Organisation (UK Gov)
Department for Business, Energy & Industrial Strategy (UK Gov)
Centre for Environment Fisheries and Aquaculture Science (UK Gov)
Oil and Gas Authority (UK Gov)
The Oil and Pipelines Agency (UK Gov)
Marine & Fisheries (Scottish Gov)
Marine and fisheries (Welsh Gov)
Department of Agriculture, Food and Marine (Irish Gov)
Oil and Gas UK
UNITED STATES
Environmental Protection Authority
Florida Fish and Wildlife Conservation Commission

NOAA National Sea Grant Library

NOAA Fisheries

NOAA National Marine Sanctuaries, Florida Keys Socioeconomic Monitoring Program

National Ocean Economics Program

### Appendix 2: Social Value Literature 2 or 3 Stars

#### Table 17: Academic literature review articles rated 2 or 3 stars

Rating*	Theme	Reference	ID
3	Social: Well-	Barclay K., Voyer M., Mazur N., Payne A.M., Mauli S., Kinch J., Fabinyi M.,	1
	being	Smith G. (2017) The importance of qualitative social research for effective	
		fisheries management, Fisheries Research, 186: 426- 438	
3	Use &	Belhassen, Y., Rousseau, M., Tynyakov, J., & Shashar, N (2017) Evaluating	2
	Satisfaction	the attractiveness and effectiveness of artificial coral reefs as a	
		recreational ecosystem service, Journal of Environmental Management,	
		203 (1): 448 - 456	
3	Use &	Kirkbride-Smith A.E., Wheeler P.M., Johnson M.L. (2013) The Relationship	3
	Satisfaction	between Diver Experience Levels and Perceptions of Attractiveness of	
		Artificial Reefs - Examination of a Potential Management Tool, PLoS ONE,	
		8(7)	
3	Perceptions:	Kruse S.A., Bernstein B., Scholz A.J. (2015) Considerations in evaluating	4
	RA	potential socioeconomic impacts of offshore platform decommissioning in	
		California, Integrated Environmental Assessment and Management, 11	
		(4): 572-583	
3	Perceptions: G	Murray, J. D., & Betz, C. J. (1994) User views of artificial reef management	5
		in the southeastern US, Bulletin of Marine Science, 55: 970 - 981	
3	Perceptions: G	Ramos, Jorge; Santos, Miguel N.; Whitmarsh, David; Monteiro, Carlos C.	6
		(2007) Stakeholder perceptions regarding the environmental and socio-	
		economic impacts of the Algarve artificial reefs, Hydrobiologia, 580: 181 -	
2			_
3	Social:	Ramos, J., Santos, M., Whitmarsh, D., & Monteiro, C. (2011b) Stakeholder	/
	interests	analysis in the Portuguese artificial reef context: winners and losers, Braz.	
2	Dercentions: C	J. Oceanogr, 59: 133-143	0
5	Perceptions: G	ten Brink T.S., Daiton T. (2018) Perceptions of commercial and	ð
		Wind Farm (US) Frontiors in Marine Science, 5: 420	
2	Social	Schrooder D.M., Love M.S. (2004) Ecological and political issues	0
5	Jutorosts	surrounding decommissioning of offshore oil facilities in the Southern	9
	IIILEIESIS	California Bight Ocean and Coastal Management 47: 21-48	
2	Porcontions:	Ammar M S A (2000) Coral Roof Postoration and Artificial Roof	10
2	Perceptions.	Management Euture and Economic Open Environmental Engineering	10
		Journal 2 (1): 37-49	
2	Perceptions: G	Andriesse F (2018) Persistent fishing amidst depletion environmental and	11
-		socio-economic vulnerability in Iloilo Province, the Philippines. Ocean and	
		Coastal Management, 157: 130- 137	
2	Perceptions: G	Hooper T., Ashley M., Austen M. (2015) Perceptions of fishers and	12
	& RA	developers on the co-location of offshore wind farms and decapod	
		fisheries in the UK, Marine Policy, 61: 16- 22	
2	Perceptions: G	Hooper T., Hattam C., Austen M. (2017) Recreational use of offshore wind	13
		farms: Experiences and opinions of sea anglers in the UK, Marine Policy.	_
		78: 55-60	
2	Perceptions: G	Kienker, S. E., Coleman, R. A., Morris, R. L., Steinberg, P., Bollard, B., Jarvis,	14
		R., Strain, E. M. A. (2018), Bringing harbours alive: Assessing the	

		importance of eco-engineered coastal infrastructure for different	
		stakeholders and cities, Marine Policy, 94: 238 - 246	
2	Perceptions: G	Lima J.S., Zappes C.A., Di Beneditto A.P.M., Zalmon I.R. (2018), Artisanal fisheries and artificial reefs on the southeast coast of Brazil: Contributions to research and management, Ocean and Coastal Management,163: 372-382	15
2	Social: Asset	Pike, K., Johnson, D., Fletcher, S., Wright, P., & Lee, B (2010), Social Value of Marine and Coastal Protected Areas in England and Wales, Coastal Management, 38(4): 412 - 432	16
2	Social: Well- being	Ramos, J; Santos, MN; Whitmarsh, D; Monteiro, CC (2006) The usefulness of the analytic hierarchy process for understanding reef diving choices: A case study, Tourism Geographies, 14(3): 361-382	17
2	Perceptions: G	Shani A., Polak O., Shashar N. (2012) Artificial Reefs and Mass Marine Ecotourism, Tourism Geographies, 14 (3): 361-382	18
2	Perceptions: RA	Sutton S.G., Bushnell S.L. (2007) Socio-economic aspects of artificial reefs: Considerations for the Great Barrier Reef Marine Park, Ocean and Coastal Management, 50(10): 829-846	19
2	Perceptions: G	Tessier A., Francour P., Charbonnel E., Dalias N., Bodilis P., Seaman W., Lenfant P. (2015), Assessment of French artificial reefs: due to limitations of research, trends may be misleading, Hydrobiologia, 753 (1)	20
2 SB	Social: Asset	A.J. Evans, B. Garrod, L.B. Firth, S.J. Hawkins, E.S. Morris-Webb, H. Goudge, P.J. Moore (2017) Stakeholder priorities for multi-functional coastal defence developments and steps to effective implementation, Mar. Pol. 75: 143–155.	21
2 SB	Perceptions: G	Ditton, R.B., Osburn, H.R., Baker, T.L. and Thailing, C.E. (2002) Demographics, attitudes, and reef management practices of sport divers in offshore Texas waters. ICES Journal of Marine Science 59, 186–191.	22
2 SB	Social: Well- being	R.L. Morris, G. Deavin, S.H. Donald, R.A. Coleman (2016) Eco-engineering in urbanised coastal systems: consideration of social values, Ecol. Manag. Restor. 17 (1) (2016) 33–39.	23
2	Social: Well- being	Voyer, M., Barclay, K., McIlgorm, A., & Mazur, N. (2017) Connections or conflict? A social and economic analysis of the interconnections between the professional fishing industry, recreational fishing and marine tourism in coastal communities in NSW, Australia. Marine Policy, 76, 114-121	24
2	Use & Satisfaction	Stolk P., Markwell K., Jenkins J.M. (2007) Artificial reefs as recreational scuba diving resources: A critical review of research, Journal of Sustainable Tourism, 15(4): 331-350	25
2	Perceptions:TI	Cripps SJ and Aable JP (2002), Environmental and socio-economic impact assessment of Ekoreef, a multiple platform rigs-to-reef development, Journal of Marine Science, 59: 300-308.	26

\*(SB) indicates a paper identified through snowballing.

#### Table 18: Professional literature review documents rated 2 or 3 stars

Rating*	Theme	Reference	ID
3	Perceptions: RA & TI	Shaw J.L., Seares P., Newman S.J. (2018) Decommissioning offshore infrastructure: a review of stakeholder views and science priorities, Available online from:	P1
2	Perceptions: RA & TI	WAFIC (2017) Thevenard Offshore Platform Retirement Commercial Fishing Sector Stakeholder Consultation – WAFIC Report. Available from: https://www.wafic.org.au/offshore-stakeholder-consultation-environment-plans- nopsema-update-commercial-fishers/	P2
2	Perceptions: G	CRC Research Centre (1999) Understanding public perceptions of the Great Barrier Reef and its management, Available online from: http://rrrc.org.au/wp- content/uploads/2014/03/Technical-Report-29.pdf	Р3

2	Use &	CRC Reef Research Centre (1998), Visitor experiences and perceived conditions on day	P4
	Satisfaction	trips to the Great Barrier Reef, Available from: http://rrrc.org.au/wp-	
		content/uploads/2014/03/Technical-Report-21.pdf	
2	Perceptions:	Leeworthy, Wiley and Hospital (2004) Importance-Satisfaction Ratings Five-year	P11
	G & TI	Comparison, SPA & ER Use, and Socioeconomic and Ecological Monitoring Comparison	
		of Results 1995-96 to 2000-01, Available online from:	
		https://nmssanctuaries.blob.core.windows.net/sanctuaries-	
		prod/media/archive/science/socioeconomic/floridakeys/pdfs/impsat.pdf	
2	Use &	Montes, N., Sidman, C., Lorenzen, K., Tamura, M. and Ishida, M., (2019) Influence of	P12
	Satisfaction	fish aggregating devices on the livelihood assets of artisanal fishers in the Caribbean,	
		Ocean & Coastal Management, 179: 104823.	
3	Social:	Bates (2016) Key Challenges Of Offshore Wind Power: Three Essays Addressing Public	P13
	Interests &	Acceptance, Stakeholder Conflict, And Wildlife Impacts, PhD Thesis, Available online	
	Perceptions:	from: http://udspace.udel.edu/handle/19716/19780	
	G		

# Appendix 3: Social Value Review Templates

### Social Value Academic Literature Review

	Al-Horani and Khalaf 2013
Document type	Research based peer reviewed article
Title	Developing artificial reefs for the mitigation of man-made coral reef damages in the Gulf of Aqaba, Red Sea: coral recruitment after 3.5 years of deployment
Summary	Article examines rates of coal colonisation on a deployed artificial reef 3.5 yrs after deployment to test their conservation outcomes
Geographic region	Gulf of Aqaba, Red Sea
Structure Type	Artificial reef with high structural complexity
Stakeholders / sectors	None
Social values explored	None
Methods:	What approach was adopted to engage stakeholders
	NA – no stakeholders engaged
	What approach was adopted to identify and evaluate social values
	NA – no social values evaluated
Findings	Social values [interrelationships, variability across stakeholder groups, potential impacts on or opportunities for]
	NA
Other findings	Issues
	<b>Structures:</b> Special concern should be given to the structural design of the AR and the materials used for its construction. Those two factors are of prime importance for the success of the AR in achieving its set goals, especially if habitat restoration is required.
Other findings	Opportunities
	The AR offers additional ecological benefits through its ability to trap sediments and seawater filtration through its filter feeders. Therefore, it is recommended to use ARs for restoration purposes in areas that have denuded reefs. They may represent attractive recreational diving sites in areas of intensive dive use, and therefore have the potential to protect the natural reefs (p. 756).
Thoughts/reflections	1: No focus on social values, the last sentence of the paper makes minor reference to the potential for ARs to be dive sites.

Ref ID# 10	Ammar et al 2009
Document type	Review, peer reviewed article
Title	Coral Reef Restoration and Artificial Reef Management, Future and Economic
Summary	This paper reviews conditions driving the need for restoration, and the questions that must be considered to identify the type of restoration necessary or possible. Artificial reefs around the world, their uses, social and economic impacts, liability, the use of novel technology approaches in artificial reefs and future applications were also reviewed
Geographic region	Global literature review
Structure Type	Artificial reefs
Stakeholders / sectors	NA
Social values explored	Does not explore values, but identifies 4 different 'uses' for artificial reefs: (i) tourism (scuba diving, recreational fishing, surfing and beach enhancement); (ii) fisheries; (iii) nature conservation (protecting what exists, mitigate unavoidable damage cause by infrastructure, restore damaged habitat to provide new community habitat); (iv) Science (audit the performance of reef, commercial species survey, epifaunal monitoring)
Methods:	What approach was adopted to engage stakeholders
	NA – no stakeholder engagement
	What approach was adopted to identify and evaluate social values
	NA
	Does however recommend an approach to ensure socio-economic objectives of ARs are realized: (1) assess the demand for artificial reefs (2) consult relevant stakeholders; (3) conduct a cost/benefit analysis; (4) decide whether to permit artificial reefs in the marine park; (5) involve stakeholders in the planning and management process; (6) set clear socio-economic goals and objectives; (7) consider social and economic issues in an appropriate management plan; (8) monitor and evaluate social and economic issues. (p 46)
Findings	Social values [interrelationships, variability across stakeholder groups, potential impacts on or opportunities for]
	Contested objectives: Because of incompatibilities between gear and structure, placing an artificial reef on a seabed where commercial fishers operate can automatically exclude this group from the area that was formally open access and their 'right' to use (p. 45). Liability: Speculative questions regarding who is liable if accidents occur on AR or for property damage. In Australia, private citizens and interest groups can apply for artificial reef permits, and may be required to provide liability insurance for deployed structures p. 45
Other findings	Issues
	<ul> <li>Stock increases: To date, artificial reefs have not proven to be an efficient restoration tool, neither when used for transplantation measures nor when left for natural recruitment (p. 41)</li> <li>Have the potential to lead to overfishing if they increase the aggregation/ attraction of existing stocks without increasing overall stock size (p. 45)</li> </ul>
Other findings	Opportunities
	<b>Structures:</b> Artificial reefs can create or enhance recreational experiences: (i) add to the variety of fishing and/or diving experiences that exist within an area by providing different types of structure and attracting different kinds of marine life; (ii) provide more accessible fishing and diving opportunities when placed close to access points, thereby enabling people who are limited by experience, boat size/horsepower, time, or money to enjoy recreational fishing or diving; (iii) can enhance the recreational experience or success rate by attracting or producing more marine life and increasing the probability of observing and/or catching fish; (iv) can help redistribute use throughout a given area thereby reducing user congestion and crowding.

Thoughts/reflections	2: Identifies the social and economic uses of reefs, along with some of the potential conflicts
	that could arise. Good basis, but no stakeholder engagement, literature review only

Ref ID# 11	Andriesse 2018
Document type	Empirical research, peer-reviewed article
Title	Persistent fishing amidst depletion, environmental and socio-economic vulnerability in Iloilo Province, the Philippines
Summary	Article is concerned with the impact of environmental pressures on coastal livelihoods in the municipality of Ajuy, Iloilo Province, central Philippines. One of the three focuses of the research is on artificial reefs submerged to increase fish stocks. Specifically asked: Are the artificial reefs, submerged by the Red Cross in Ajuy Municipality in 2016 to increase fish stocks, likely to contribute to more sustainable fishing practices?
Geographic region	Iloilo Province, the Philippines
Structure Type	Artificial Reef
Stakeholders / sectors	Local fisher folk Key informants (unspecified)
Social values explored	Livelihood security and status, fishery productivity, perceptions of artificial reefs
Methods:	What approach was adopted to engage stakeholders
	Survey among 111 fisher folk households – the supposed future beneficiaries of the artificial reefs – and 19 semi-structured interviews with key informants Respondents for the survey were selected through snowball sampling as the survey was not meant for households that are not engaged in fishing. Questions pertained to their basic household structure, impact of the 2013 Typhoon Yolanda and the 2015–2016El Niño related drought, fishing practices (experience, selling or consuming, fisher folk associations activities), other livelihood options (land availability, employment of household members, remittances), their knowledge of and opinion on the newly installed artificial reefs, their opinion on relocation efforts by the government, standard of living before and after Typhoon Yolanda, as well as the major challenges in their community. The semi-structured interviews generated information on the institutional and political aspects of the artificial reef programme, the trade-off between fishing and non-fishing activities, local political tensions, and outlook on relocation efforts. The interviews also provided the opportunity to triangulate the answers with the survey data; to distil any inconsistencies and differences of opinions
	Surveys and interviews
Findings	Social values [interrelationships, variability across stakeholder groups, potential impacts on or opportunities for] Submerging artificial reefs created a positive perception of the future. There was now an
	expectation that fish stocks would improve in the medium term. But this expectation was not supported by evidence (see Issues below).
Other findings	Issues
	Perceptions/expectations: 'Not all presidents of fisher folk associations were informed about the reefs and only 31% of the respondents participated in seminars. This implies that 69% of the fisher folk do not have a precise idea of the functioning of the artificial reefs' (p. 134). In other words, potentially misplaced positive expectations on reef performance. Stakeholder expectations that the Municipality would enact an ordinance stipulating protection of reefs did not occur. Submerging prior to such an ordinance 'has created a serious issues' (p. 134)

	<b>Responsibility:</b> Lack of clear responsibility for monitoring and enforcing fishing rules on submerged reef, means illegal fishing difficult to stop without confirmed mandate.
Other findings	Opportunities
	Not stated
Thoughts/reflections	<ul> <li>2: covers aspects of social value but not interrogated in detail.</li> <li>Focus not entirely on MMI, but is one component of the study.</li> <li>Specifically explores stakeholder's perceptions of submerged reefs.</li> <li>Issues of management in already difficult/unmanaged fisheries raised.</li> </ul>

Ref ID #1	Barclay et al 2017
Document type	Case-study research, peer-reviewed article.
Title	The importance of qualitative social research for effective fisheries management
Summary	Uses three case study research projects to demonstrate the value of social qualitative research in understanding and managing fisheries resources.
Geographic region	Case 1: Eastern Australia
	Case 2: Solomon Islands
	Case 3: Papua New Guinea
Structure Type	None – general fisheries assessments
Stakeholders / sectors	Case 1: Fishers and non-fishers such as members of local councils and community groups.
	Case 2: People selling fish and other marine products in markets; people from fishing villages; people from government and from non-government organizations (NGO) working on gender, conservation and fisheries management; employees and managers from tuna companies; community representatives, and people from villages.
	Case 3: fishers and customary resource owners, exporters in PNG, importers, wholesalers and retailers in China, key informant BDM researchers and staff of relevant government agencies in PNG (NFA, Customs, Provincial Fisheries Officers and other Provincial Government officials, and Local Level Government representatives)
Social values explored	Focus on Case 1: Well-being
	In the 3D wellbeing approach, the factors to consider are divided into material, relational, and subjective (or cognitive). Material wellbeing = income, assets, educational and health status. Relational wellbeing = social relationships people have that enable them to pursue their livelihoods or through psychological questionnaires about satisfaction with important relationships. Subjective wellbeing = quality of life people perceive themselves as achieving, including the meanings they give to the goals they achieve and the processes in which they engage. It has been measured by tools such as the Global Person Generated Index (GPGI).
Methods:	What approach was adopted to engage stakeholders
	Case 1: Not stated Case 2: Snowballing Case 3: Contacting relevant stakeholder groups
	What approach was adopted to identify and evaluate social values
	Focus is on Case 1 – as this is closest to our type of study. Case 1: Well-being approach: aim was to go beyond the Gross Value of Production (GVP) and uncover broader community perceptions of and values around commercial fishing. <i>Overall approach</i> : 1) qualitative interviews and document reviews; 2) questionnaires measuring the values of various stakeholder groups regarding the contributions of professional fishing to communities; and 3) a quantitative regional economic analysis.

	<ul> <li>open-ended interviews, asking fishers and non-fishers, such as members of local councils and community groups, what kinds of social benefits they saw arising from the fishing industry in their communities.</li> <li>Compared interview data with literature on assessing well-being and quality of life and identified areas of community well-being significant to case study area.</li> <li>Used outputs to structure remaining interviews. Then analyzed all interviews together established these indicators of contribution to well-being, mapped the interview data on the material/relational/subjective aspects of these indicators, existing government and industry data, and the economic part of the project, and designed questionnaires to measure some elements.</li> <li>Case 2: Gendered approach: to uncover the roles of women in fisheries value chains, and the opportunities and constraints they face. See paper for further details.</li> <li>Case 3: Governance analysis: to illuminate market and social factors affecting governance of</li> </ul>
	the fishery, as well as assess the fit of management instruments to those market and social factors. Since the first major publication on interactive governance, Fish For Life (Kooiman et al., 2005), it has been applied as an analytical tool to many different fisheries internationally. The study was thus based on interviews and a desktop review. See paper for further details.
Findings	Social values [interrelationships, variability across stakeholder groups, potential impacts on or opportunities for]
	Case 1: Key finding was that despite a widespread perception among recreational fishers in NSW that recreational fishing catches are better if professional fishing is excluded, the data clearly showed that if professional fishing were to disappear from areas of the coast, the utility of recreational fishers would be negatively impacted.
Other findings	Issues
	Not stated
Other findings	Opportunities
	Not stated
Thoughts/reflections	3: Good background, references to support statements on the importance of social research and its growth in marine resource management and conservation in the Introduction of the article. Several articles identified for further review – see snowballing tab in excel literature file. Provides a good basis to support selected approach to assessing social values from aquatic infrastructure.

	Chen et al 2013
Document type	Empirical research, peer reviewed article
Title	Recreational Benefits of Ecosystem Services on and around Artificial Reefs: A Case Study in Penghu, Taiwan
Summary	Article examines economic value of ecosystem services – ie Two non-market methods, the Travel Cost Method (TCM) and the Contingent Valuation Method (CVM), were used to estimate the recreational value of ARs in Penghu, Taiwan.
Thoughts/reflections	0: Marked for removal from review due to economic focus only

	Do Carmo et al 2011
Document type	Empirical research, peer-reviewed article
Title	Enhancing submerged coastal constructions by incorporating multifunctional purposes
Summary	An appropriate reef design in terms of 'surfability', i.e. the possibility to surf a wave, for the Leirosa beach, located to the south of Figueira da Foz, midway along Portugal's West Atlantic coast, has been investigated.

Thoughts/reflections	0: Marked for removal from review as looks only at the design parameters of the structure,
	no social value assessment component.

Ref ID# 19	Sutton and Bushnell 2007
Document type	Review article, peer reviewed publication
Title	Enhancing submerged coastal constructions by incorporating multifunctional purposes
Summary	Reviews the available socio-economic literature regarding the deployment, use, and management of artificial reefs, and aims to identify and understand potential socio-economic issues and information gaps surrounding deployment of artificial reefs in the GBRMP.
Geographic region	GBMP Eastern Australia
Structure Type	Artificial reef
Stakeholders / sectors	Multiple stakeholder groups with diverse and often conflicting values and opinions surrounding use of the park: artificial reef proponents (e.g. recreational and commercial fishing groups, diving groups, fisheries agencies, researchers, the aquatic industry, community groups, private businesses (eg dive operators)
Social values (or issues)	Enhanced recreational opportunities
explored	Potential for increased fish catch and overfishing
	Change in property and resource rights
	Potential for conflict between user groups.
	Liability
Methods:	What approach was adopted to engage stakeholders
	NA – literature review only
	What approach was adopted to identify and evaluate social values
	NA – literature review only
Findings	Social values [interrelationships, variability across stakeholder groups, potential impacts on or opportunities for]
	Enhanced recreational opportunities
	Potential for increased fish catch and overfishing - has direct social and economic impacts including reduced fishing opportunities, lower quality recreational fishing experiences, negative economic impacts on the communities and businesses that support the commercial and recreational fishing industries, and diminished natural values of the GBRMP.
	Change in property and resource rights: placing an artificial reef on a seabed where commercial fishers operate can automatically exclude this group from the area that was formally open access and their 'right' to use.
	Potential for conflict between user groups: resulting from pressure on the newly developed AR site; or stock redistribution.
	Liability: Content 'word for word' as per Ammar 2009. No current issues so potential social impacts are speculative at present. Concerns on who is responsible for potential accidents and the release of AR permits.
Other findings	Issues
	<b>Economic</b> : significant financial costs associated with deploying and managing artificial reefs.
Other findings	Opportunities
	<b>Economic:</b> Impacts on local economies due to artificial reef use can be significant, i.e. indirect job creation and spending in the community.
	<b>Planning and Management of AR:</b> should include the following steps: (1) assess the demand for artificial reefs in the GBRMP; (2) consult relevant stakeholders; (3) conduct a cost/benefit analysis; (4) decide whether to permit artificial reefs in the marine park; (5) involve stakeholders in the planning and management process; (6) set clear socio-economic goals

	and objectives; (7) consider social and economic issues in an appropriate management plan; (8) monitor and evaluate social and economic issues.
Thoughts/reflections	2: Ammar 2009 article looks like a very close rip-off of this article published in 2007. Same content for both.
	Useful in identifying different stakeholder groups and their potential issues, but no specific assessment of the 'values' of these groups and how interrelate or clash.

	Lima et al 2019
Document type	Review, peer-reviewed literature
Title	Overview and trends of ecological and socioeconomic research on artificial reefs
Summary	Systematic literature review of artificial reef research, including 620 studies throughout the world from 1962 to 2018. The primary focus of this study was to examine long-term trends in research, focusing on ecological and socioeconomic questions, and to develop new research directions for this field.
Geographic region	Global review
Structure Type	"artificial reef," "artificial structure," "artificial habitat," "artificial sea-mount," "surf reef," "fish aggregating device" and "fish attracting device".
Stakeholders / sectors	NA
Social values explored	Review examined all elements of AR research. Here we focus on the outcomes of their 'social-economic' component of the review.
	Systematic literature review under 6 papers addressing 'social aspects'
Methods:	What approach was adopted to engage stakeholders
	Review found the following methods were adopted: Interviews, questionnaire, boat monitoring, databases, and photographic record.
	The articles with the focus on 'social benefits' and 'environmental perception' applied interview methods and likert scale. These papers were either captured in our systematic literature review or have been added to the snowballing list (i.e. 1 article by Fitzsimmons 2008)
	What approach was adopted to identify and evaluate social values
	NA
Findings	Social values [interrelationships, variability across stakeholder groups, potential impacts on or opportunities for]
	NA
Other findings	Issues
	A potentially useful quote: 'the socioenvironmental aspects of conflicts arising from installing artificial reefs have been neglected, due to the difficulty of developing interdisciplinary studies that involve communities directly affected by these structures' (p. 90).
Other findings	Opportunities
	The progress of artificial reef sciencedepends on a better understanding of settlement and production mechanisms of artificial structures base on the effects of anthropogenic activities. In addition, it is important to consider several legislative requirements for artificial reef implantation at local, national and international scale (p. 90)
Thoughts/reflections	1: Review article demonstrating significantly low volume of peer-reviewed literature looking at the social aspects of Artificial Reefs. Useful as supporting evidence for importance of social and transdiscplinary research in this area, but no direct examples of social values or their assessment .

Ref ID #3	Kirkbride-Smith et al 2013
Document type	Empirical research, Peer-reviewed article
Title	The relationship between diver experience levels and perceptions of attractiveness of artificial reefs – examination of a potential management tool
Summary	Explores how AR should be designed to maximize appeal to scuba divers. Used questionnaire survey to explore divers perceptions of artificial reefs in Barbados and examined reef substitution behavior among divers.
Geographic region	Barbados, West Indies
Structure Type	Artificial reef forms: sunken vessels and Reef Balls
Stakeholders / sectors	Recreational divers
Social values explored	Reef use, satisfaction and habitat preferences
Methods:	What approach was adopted to engage stakeholders
	36 question self-administered questionnaire exploring artificial reef use, awareness, satisfaction of AR diving and their habitat preferences. Likhert scales and checklists and 8 open ended responses. Distinction between the experience levels of divers was incorporated (i.e. < or >100 logged dives)
	Sampling conducted with assistance of diving companies.
	What approach was adopted to identify and evaluate social values
	What approach was adopted to identify and evaluate social values Quantitative surveys
Findings	What approach was adopted to identify and evaluate social values Quantitative surveys Social values [interrelationships, variability across stakeholder groups, potential impacts on or opportunities for]
Findings	What approach was adopted to identify and evaluate social values         Quantitative surveys         Social values [interrelationships, variability across stakeholder groups, potential impacts on or opportunities for]         With increasing experience of divers, satisfaction level with AR declined.
Findings	What approach was adopted to identify and evaluate social values         Quantitative surveys         Social values [interrelationships, variability across stakeholder groups, potential impacts on or opportunities for]         With increasing experience of divers, satisfaction level with AR declined.         Fish abundance rated as the most important attribute of an artificial reef, followed by sea visibility, safety and coral cover.
Findings	What approach was adopted to identify and evaluate social values         Quantitative surveys         Social values [interrelationships, variability across stakeholder groups, potential impacts on or opportunities for]         With increasing experience of divers, satisfaction level with AR declined.         Fish abundance rated as the most important attribute of an artificial reef, followed by sea visibility, safety and coral cover.         Shipwrecks were the most preferred AR (76%), followed by sunken vessels (15%) and piers, jetties or platforms (3%).
Findings	What approach was adopted to identify and evaluate social values         Quantitative surveys         Social values [interrelationships, variability across stakeholder groups, potential impacts on or opportunities for]         With increasing experience of divers, satisfaction level with AR declined.         Fish abundance rated as the most important attribute of an artificial reef, followed by sea visibility, safety and coral cover.         Shipwrecks were the most preferred AR (76%), followed by sunken vessels (15%) and piers, jetties or platforms (3%).         Motives for diving were dominant by the reliability of the diving experience and associated biodiversity viewing and photographic opportunities.
Findings Other findings	<ul> <li>What approach was adopted to identify and evaluate social values</li> <li>Quantitative surveys</li> <li>Social values [interrelationships, variability across stakeholder groups, potential impacts on or opportunities for]</li> <li>With increasing experience of divers, satisfaction level with AR declined.</li> <li>Fish abundance rated as the most important attribute of an artificial reef, followed by sea visibility, safety and coral cover.</li> <li>Shipwrecks were the most preferred AR (76%), followed by sunken vessels (15%) and piers, jetties or platforms (3%).</li> <li>Motives for diving were dominant by the reliability of the diving experience and associated biodiversity viewing and photographic opportunities.</li> <li>Issues</li> </ul>
Findings Other findings	What approach was adopted to identify and evaluate social values         Quantitative surveys         Social values [interrelationships, variability across stakeholder groups, potential impacts on or opportunities for]         With increasing experience of divers, satisfaction level with AR declined.         Fish abundance rated as the most important attribute of an artificial reef, followed by sea visibility, safety and coral cover.         Shipwrecks were the most preferred AR (76%), followed by sunken vessels (15%) and piers, jetties or platforms (3%).         Motives for diving were dominant by the reliability of the diving experience and associated biodiversity viewing and photographic opportunities.         Issues         Not stated
Findings Other findings Other findings	What approach was adopted to identify and evaluate social valuesQuantitative surveysSocial values [interrelationships, variability across stakeholder groups, potential impacts on or opportunities for]With increasing experience of divers, satisfaction level with AR declined.Fish abundance rated as the most important attribute of an artificial reef, followed by sea visibility, safety and coral cover.Shipwrecks were the most preferred AR (76%), followed by sunken vessels (15%) and piers, jetties or platforms (3%).Motives for diving were dominant by the reliability of the diving experience and associated biodiversity viewing and photographic opportunities.IssuesNot statedOpportunities
Findings Other findings Other findings	What approach was adopted to identify and evaluate social valuesQuantitative surveysSocial values [interrelationships, variability across stakeholder groups, potential impacts on or opportunities for]With increasing experience of divers, satisfaction level with AR declined.Fish abundance rated as the most important attribute of an artificial reef, followed by sea visibility, safety and coral cover.Shipwrecks were the most preferred AR (76%), followed by sunken vessels (15%) and piers, jetties or platforms (3%).Motives for diving were dominant by the reliability of the diving experience and associated biodiversity viewing and photographic opportunities.IssuesNot statedOpportunitiesNot stated

Ref ID# 20	Tessier et al 2015
Document type	Empirical research, peer-reviewed literature
Title	Expectations of professional and recreational users of artificial reefs in the Gulf of Lion, France
Summary	In this work, the perceptions of AR professional and recreational users (direct users only) were studied by focusing on three AR sites located along the Gulf of Lion coastline (northwestern Mediterranean Sea, France) to determine whether they were becoming multi-use sites or were negatively perceived.
Geographic region	Three sites on the Gulf of Lion coastline (northwestern Mediterranean Sea, France): Agde, Valras and Leucate-Barcares
Structure Type	Artificial reefs, constructed from pipes and deployed on sandy-mud bottoms 1-2km from the coast

Stakeholders / sectors	Only incorporated direct users of the sites.
	Artisanal fishermen,
	Recreational fishermen,
	Recreational spear fishermen and
	SCUBA divers
Social values explored	Expectations of ARs, satisfaction with ARs, use levels, knowledge
Methods:	What approach was adopted to engage stakeholders
	Exhaustive sampling for users of small populations (artisanal fishermen and speak fishermen) and quota sampling for large populations (recreational fishermen, club and non- club members, and SCUBA divers).
	What approach was adopted to identify and evaluate social values
	Interviews were semi-directed (closed and open ended questions). Interviews designed for each target group, but with similar elements across the groups. Qualitative data was coded and analyzed as quantitative data.
Findings	Social values [interrelationships, variability across stakeholder groups, potential impacts on or opportunities for]
	The results of this study indicate that AR users have either neutral or positive perceptions regarding ARs.
	User groups were predominantly male.
	All users highlighted the goal of AR to increase fish populations and rated this goal as desirable. Different species recruitment priorities for commercial vs recreational fishermen. Using ARs to prevent illegal trawling was a desired goal for artisanal fishermen. Different satisfaction levels with the enhancement of fish around ARs, but valued their ability to support target species (ie spear fishermen and recreational fishermen. SCUBA divers were dissatisfied with AR design. Local recreational fishermen the most common users of the ARs
Other findings	Issues
	Not stated
Other findings	Opportunities
	Not stated
Thoughts/reflections	2/3: Intro section provides good summary of lack of research into socioeconomic features of ARs. Highlights differences in perceptions based for different user groups. Main finding is that while designed as mono-use (ie one stakeholder group) structures in France, they are being adopted by multiple user groups and therefore require greater management attention.

Ref ID #2	Belhassen, Y., Rousseau, M., Tynyakov, J., & Shashar, N. 2017
Document type	Peer reviewed Journal Article
Title	Evaluating the attractiveness and effectiveness of artificial coral reefs as a recreational ecosystem service
Summary	This paper evaluates the recreational benefits of artificial coral reefs for recreational divers. Artificial reefs are perceived as recreational ecosystem services. Artificial reef use is compared to natural reef use.
Geographic region	Eliat, Israel
Structure Type	Artificial reef e.g. shipwreck
Stakeholders / sectors	Recreational divers
Social values explored	Popularity of types of marine environments (natural and artificial)
	Recreational benefits of artificial reefs
	Self-perceived behaviour and attitudes towards types of marine environments

Methods:	What approach was adopted to engage stakeholders
	Qualitative and quantitative survey's distributed through recreational diving clubs and direct observation of recreational divers on artificial reefs
	what approach was adopted to identify and evaluate social values
	Study 1: Mixed method survey distributed through recreational diving Facebook group about skill level and diving sites frequented
	Study 2: direct observation of diving behaviour at natural and artificial marine sites
	Study 3: mixed methods questionnaires distributed at diving sites and online to examine recreational divers self-perceived behaviour and attitudes towards types of marine environments
Findings	Social values [interrelationships, variability across stakeholder groups, potential impacts on or opportunities for]
	Large majority of divers use a mixture of natural and artificial reefs
	Though there are more natural reefs available an artificial structure was the most popular site
	Recreational divers are more likely to disturb (touch) an artificial reef than a natural reef
	Both new and independent divers caused damage to the artificial reefs
	Recreational divers feel more relaxed around natural marine environments
	Large majority of divers did not feel it was appropriate to touch either types of reefs
	Small percentage felt that it was appropriate to touch artificial reefs
Other findings	Issues
	Ensuring artificial reef structures remain popular for recreational use
	The functionality of artificial coral reefs is related to their ability to serve as a training site for introductory divers
Other findings	Opportunities
	Artificial reefs can be used as a distraction from natural marine environments ensuring ecological or sustainable functioning of natural reefs
	Introduction of pre-diving instructional videos for ALL recreational divers to minimise damage on artificial and natural reefs
Thoughts/reflections	3: specifically examines value of artificial marine infrastructure from multiple directions (frequency, self-report, and direct observation) within a identified group of interest for the FRDC study. Snowballing references found within article.

	Fabi & Spagnolo 2011
Document type	Edited Chapter Book
Title	Artificial reefs in the management of Mediterranean Sea fisheries
Summary	This book provides an assessment and synthesis of the role of artificial reefs in fisheries management. It also places emphasis on artificial reefs increasing impact on the environment and ecology. Individual papers within a book, collation of literature with a management and ecology focus.
Thoughts/reflections	0: removed from review. No in depth social value component rather focuses on management of artificial structures and the impact on the ecological environment.

	Feary, Burt, & Bartholomew, 2011
Document type	Peer Reviewed Journal Article
Title	Artificial marine habitats in the Arabian Gulf: Review of current use, benefits and management implications.

Summary	Article discusses the types of artificial reef structures that exist within the Arabian Gulf and explores challenges (from an ecological, economic, tourism and fishing activity perspective) and opportunities regarding future management of these reefs.
Thoughts/reflections	0: though it gives good background and could be useful in a broader sense is has no social component. Removed from review.
	Fernandez 2005
Document type	Peer Reviewed Journal Article
Title	A diversified portfolio: joint management of non-renewable and renewable resources offshore
Summary	This paper gives provides a stochastic control model grounded in ecological and economic theories for renewable and non-renewable infrastructure in relation to the oil and gas and fishing industries. It is said that this could help highlight decommissioning decisions relating to full removal or leaving the structures in place.
Thoughts/reflections	0: no social value, heavily focused on oil and gas industry economics and decommissioning decisions, removed from review

	Florisson, Tweedley, Walker, & Chaplin 2018
Document type	Peer Reviewed Journal Article
Title	Reef vision: A citizen science program for monitoring the fish faunas of artificial reefs
Summary	This study engages recreational fishers in a community to monitor fish populations at artificial reef structures using video technology placed under the boat. The study had two objectives the first to prove the effectiveness of citizen scientist programs and the second to use Baited Remote Underwater Video Systems (BRUVs) to monitor fish at two artificial reef locations.
Geographic region	Dunsborough and Bunbury, Western Australia
Structure Type	Artificial Reefs
Stakeholders / sectors	Recreational Fishers
Social values explored	Sense of stewardship/ownership of community on artificial structures
Methods:	What approach was adopted to engage stakeholders
	Participants were recruited via a science program called "Reef Vision" run by Recfish West
	What approach was adopted to identify and evaluate social values
	Not explicitly stated: effectiveness of the citizen science program and engagement in associated closed Facebook group
Findings	Social values [interrelationships, variability across stakeholder groups, potential impacts on or opportunities for]
	Participant contributions were viewed as a way to give back to the community
	Creating a sense of satisfaction, contentment, achievement, fulfilment, pride and happiness
	This may increase ownership and stewardship over the artificial reefs
Other findings	Issues
	Large pool of volunteers may have been more effective for data collection
Other findings	Opportunities
	Study demonstrated that citizen science can be effective in studies exploring aspects of artificial reefs – could be applied in future studies
Thoughts/reflections	1: does not explicitly state that it is exploring social values or how inferences were made but mentions social values of stewardship and ownership

Haddock-Fraser & Hampton 2012

Document type	Peer Reviewed Journal Article
Title	Multistakeholder values on the sustainability of dive tourism: case studies of Sipadan and Perhentian Islands, Malaysia
Summary	Paper explores the sustainability of dive tourism from the lens of interrelated pillars of sustainable development (economic, social and environmental) within two case studies on islands in Malaysia
Geographic region	Sipadan and Perhentian Islands, Malaysia
Structure Type	N/A (natural reefs)
Stakeholders / sectors	Dive instructors, dive businesses, non-dive businesses and tourists
Social values explored	Community development issues: cultural challenges at the site; impact of tourism on language; impact of large business investors; role of government
Methods:	What approach was adopted to engage stakeholders
	Semi-structured interviews exploring infrastructure development, tourist impacts, environmental impacts and community development within two case studies/locations
	What approach was adopted to identify and evaluate social values
	Transcripts put into NVivo and analysed for emergent stakeholder issues
Findings	Social values [interrelationships, variability across stakeholder groups, potential impacts on or opportunities for]
	Perhentian:
	Non-dive business expressed negative feelings towards tourism development based societal changes
	Interviewees feel powerless to influence proposed development changes suggested by government e.g. proposal for expansions on resort hotels
	Sipadan:
	Non-dive business' were positive on community aspects that would relate to the economy
	Non-dive businesses, divers and locals expressed concerns over cultural differences e.g. attitudes towards modesty, religion and drinking
Other findings	Issues
	Concerns over government control of development not considering the wider community opinion
Other findings	Opportunities
	Social value related to economic value: engaging in community activities for the economic benefit
Thoughts/reflections	1: though it does not specifically explore MMI it mentions provides insight into social values due to develops associated with activities similar to those found on existing MMI. Also refers to the development of two jetties that destroyed diving sites in one case study.

Ref ID# 12	Hooper Ashley & Austen 2015
Document type	Peer Reviewed Journal Article
Title	Perceptions of fishers and developers on the co-location of offshore wind farms and decapod fisheries in the UK
Summary	Discussion surrounding co-location of offshore windfarms and fisheries. Perceptions of potential barriers and opportunities are given by fishers and developers and compared to current practices.
Geographic region	The UK
Structure Type	Offshore windfarms, decapod fisheries and artificial reefs
Stakeholders / sectors	Fishers and representatives of companies developing offshore windfarms

Social values explored	Access and licensing
	Artificial reefs as structural enhancers
	Previous experiences of fishing activities relating to artificial infrastructure
	Perceived harm of artificial infrastructure
Methods:	What approach was adopted to engage stakeholders
	Face-to-face semi-structure interviews using a questionnaire
	What approach was adopted to identify and evaluate social values
	Transcripts were evaluated for emergent themes themes
Findings	Social values [interrelationships, variability across stakeholder groups, potential impacts on or opportunities for]
	Fishers either agreed or did not know if offshore windfarms would cause benefit or harm to fishing activities
	Main perceived effect of building offshore windfarms was loss of ground for fishermen
	Another perceived effect was loss or damage of gear
	Fishermen expected to receive financial compensation for disruption to fishing activity
	Co-location of infrastructure seems logical if managed properly
	Fishers and developers agree that artificial reefs would support fishing activity
	Developers have a clear preferences for licensing around infrastructure but fishers oppose to this practice
Other findings	Issues
	Concerns of gear getting snagged by infrastructure that would result in costs for fishermen and developers alike
	Fishermen have concerns about effects of noise of structures to marine like and
	displacement of fishing grounds
Other findings	Opportunities
	Developers seeking to build a relationship based on mutual understanding
	Fishermen expect to receive financial compensation for disruption to activities
Thoughts/reflections	2: article discusses some social values related to man-made marine infrastructure but is more focused on the impact of co-location of these structures with fisheries

Ref ID# 13	Hooper, Hattam & Austen, M 2017
Document type	Peer Reviewed Journal Article
Title	Recreational use of offshore wind farms: Experiences and opinions of sea anglers in the UK
Summary	This paper discusses and compares the impacts that offshore windfarms have or may have on the fishing activity of recreational anglers in the UK. The primary aim of this paper was to address the gaps in previous research addressing the same topic. Differences arise between perceptions of offshore windfarms and actual experiences with the structures.
Geographic region	The UK
Structure Type	Offshore windfarms
Stakeholders / sectors	Recreational anglers in the UK
Social values explored	Experiences angling within offshore windfarms
	Environmental/energy impacts of offshore windfarms
Methods:	What approach was adopted to engage stakeholders
	An closed and open ended online questionnaire exploring demographic information, fishing activity, experience with offshore windfarms and, environmental/energy impacts. Questionnaires were distributed by angling clubs and representatives of the Inshore

	Fisheries and Conservation Authorities.
	What approach was adopted to identify and evaluate social values
	Responses were analysed for agreeance or disagreement on a Likert scale while open ended question responses were analysed for emergent themes
Findings	Social values [interrelationships, variability across stakeholder groups, potential impacts on or opportunities for]
	No consensus on whether fishing activities would be impacted by offshore windfarms
	A small proportion felt that offshore windfarms would harm wildlife and the environment including impacts on: the view, noise disturbances, navigation and safety issues
	Perceptions from recreational anglers was generally positive however actual experience was a mix of positive and negative
Other findings	Issues
	Infrastructure would decrease the aesthetics of the environment
Other findings	Opportunities
	Infrastructure would provide a safe haven for fish from commercial fishers
	Infrastructure would help negate the impacts of climate change
Thoughts/reflections	2: paper explores opinions of one singular group and doesn't go in depth as to why this group have the opinions or values that they do but rather just state what their opinions/concerns/opportunities are

	Kantavichai et al 2019
Document type	Peer Reviewed Journal Article
Title	Small-scale fishery income impact from artificial reefs in Lang Suan District, Chumphon Province, Thailand
Summary	This paper studies the economic impacts of artificial reefs in Thailand providing estimates of how the artificial reefs have impacted the fishing communities incomes. Researchers also explore perceptions of fishers of whether they think that the reefs have positively or negatively impacted their incomes.
Thoughts/reflections	0: no social value, economic focus, removed from review

	Karm, 2008
Document type	Peer Reviewed Journal Article
Title	Environment and energy: The Baltic Sea gas pipeline
Thoughts/reflections	0: though the article has a sections for the 'Assessment of Political, Socioeconomic and Energy Implications' it is heavily focused of the politics and history of interactions between oil and gas companies and economic impacts of a potential pipeline. No stakeholder consultation was engaged in rather is article is an academic opinion piece. Removed from review.

Ref ID# 14	Kienker et al 2018
Document type	Peer Reviewed Journal Article
Title	Bringing harbours alive: Assessing the importance of eco-engineered coastal infrastructure for different stakeholders and cities
Summary	The aim of this study was to assess the attitudes and perceptions of people towards ecological engineering in four urban harbours, in which seawalls are the dominant artificial coastal structure. Findings differed based on stakeholder education levels and socioeconomic status.

Geographic region	Australia: Sydney and Hobart
	New Zealand: Auckland and Tauranga
Structure Type	Seawalls in coastal harbours
Stakeholders / sectors	Stakeholders were divided into: property and businesses, transport or work unrelated to the harbour, leisure and recreation, work directly associated with the harbour and work tied directly to managing or understanding the harbour.
Social values explored	Overall support for ecological engineering
	Concern for harbour environment
	Impact of prior knowledge on social values e.g. environmental concerns
Methods:	What approach was adopted to engage stakeholders
	Quantitative survey that was distributed using convenience sampling via through advertisements on community boards, business cards, emails, social media, newsletters, mailing lists, and in-person using face-face surveys in four suburbs along each harbor foreshore
	What approach was adopted to identify and evaluate social values
	Data was analysed using a generalised linear models with a binomial distribution
Findings	Social values [interrelationships, variability across stakeholder groups, potential impacts on or opportunities for]
	Stakeholders whose work is associated with the harbour are more supportive of ecological engineering
	As income and education levels rise so does concern for the harbour
	Prior knowledge of the harbour did not impact attitudes towards ecological engineering
	People with prior knowledge of the harbour were more likely to respond positively to the idea of paying taxes associated with ecological engineering
Other findings	Issues
	Socioeconomic status can impact how artificial infrastructure is perceived
Other findings	Opportunities
	Increasing knowledge of artificial infrastructure may increase community monetary support of the structures via taxes
Thoughts/reflections	2: explores perceptions of ecological engineering but does not go in depth as to why. Not within an oil and gas setting. Snowballing articles found from paper.

	Kirkbride-Smith Wheeler & Johnson 2016
Document type	Peer Reviewed Journal Article
Title	Artificial reefs and marine protected areas: a study in willingness to pay to access Folkestone Marine Reserve, Barbados, West Indies.
Summary	This paper explores the economic value of artificial reefs and marine protected areas by measuring individuals willingness to pay for access to the two types of marine environments. Individuals are more willing to pay more for use of a natural marine environment over a artificial one.
Geographic region	Marine Reserve, Barbados, West Indies.
Structure Type	Artificial reefs
Stakeholders / sectors	Recreational snorkellers and divers
Social values explored	Visitors' perceptions of artificial reefs
	Reef material preferences
	Reef conservation awareness
Methods:	What approach was adopted to engage stakeholders

	Quantitative survey exploring demographics, diver history, snorkeling satisfaction, and a description of a hypothetical marine environment with payment options, questions about the type of organisation respondents would prefer the reef to be managed by, and questions about environmental awareness and general concern for the reef Informal focus group for recreational snorkelers and divers
	What approach was adopted to identify and evaluate social values
	SPSS used to analyse quantitative values
Findings	Social values [interrelationships, variability across stakeholder groups, potential impacts on or opportunities for]
	Artificial reef awareness was higher than marine reserve awareness
	Majority of participants had 'good' or 'very good' experiences with artificial reefs
	Majority of participants were open to the development of a new artificial reef within the Folkestone Marine Reserve
	The most preferred artificial reef type was a shipwreck
Other findings	Issues
	N/A
Other findings	Opportunities
	Participants are willing to pay for access to artificial reefs
	Openness to future artificial reef development
Thoughts/reflections	1: focus on economic value rather than social value associated with willingness to pay. Some social value therefore left in review.

Ref	Kotowicz, Richmond & Hospital 2017
Document type	Peer Reviewed Journal Article
Title	Exploring Public Knowledge, Attitudes, and Perceptions of the Marianas Trench Marine National Monument.
Summary	This paper explores public social values regarding knowledge and awareness, benefits and impacts; management and governance, and variation in perceptions regarding the Marianas Trench Marine National Monument. This was achieved by using a telephone survey.
Thoughts/reflections	0: though the review discusses social value the national monument does not contain any man-man aquatic infrastructure. Removed from the review.

Ref ID #4	Kruse, Bernstein & Scholz 2015
Document type	Peer Reviewed Journal Article
Title	Considerations in evaluating potential socioeconomic impacts of offshore platform decommissioning in California.
Summary	This review explorers the socioeconomic impact of decommissioning options (complete or partial removal) on commercial and recreational fishers and recreational divers within the domains of access, marine resources, and preferred options of stakeholders. The paper suggests that socioeconomic impacts are influenced by a combination of ecosystem, commercial fishery, recreational fishery and scuba/dive values.
Geographic region	Southern California
Structure Type	Oil and Gas Platforms
Stakeholders / sectors	Commercial fishers, recreational fishers, recreational divers
Social values explored	Access
	Marine resources
	Preferred decommissioning options

Methods:	What approach was adopted to engage stakeholders
	Existing data sets were used therefore no stakeholder engagement was performed
	What approach was adopted to identify and evaluate social values
	PLATFORM decision support model's conceptual modelling tools
Findings	Social values [interrelationships, variability across stakeholder groups, potential impacts on or opportunities for]
	Partial Removal
	Access:
	Take zone: marginally increase area for all users. No risk of collision for commercial fishers, commercial fishers who were concerned about snagging will still avoid areas, recreational fishermen and divers may now access the areas
	No-take zone: recreational fishermen and divers will have increased access but commercial fishermen will not
	Marine Resources
	No-take zones: increased access for commercial and recreational fishermen may contribute to regional maintenance of populations once targets by other types of fishing, unclear impact for recreational divers
	Complete Removal
	Access: fishermen and boaters will see marginal increase in accessible area, boats over 100ft will see larger increase due to elimination of safety zones, trawl and longline fisheries will see greatest increase as no risk of snagging equipment, recreational divers and fishermen see no benefit as they do not tend to use these areas, commercial fishers see no benefit as they use designated shipping lanes
	<i>Marine resources:</i> removal of habitat may negatively impact commercial fisheries production potential, minimal impact on recreational fishers, recreational divers lose opportunity to view wildlife
	Overall decommissioning preference:
	Commercial fishing:
	Trawlers, purse seiners, longliners: complete removal Fixed gear: partial
	Recreational fishing: partial
	Recreational diving: Partial
	Recreational boating: none
	Commercial shipping: none
Other findings	Issues
	Stakeholder groups have different preferences for decommissioning options for different reasons which can make decision making regarding removal of oil and keeping multiple communities happy
Other findings	Opportunities
	Collaboration opportunity
Thoughts/reflections	3: explores social values within a causal model framework involving multiple stakeholder groups. Potentially provides a way of looking at existing data.

Ref ID# 15	Lima et al 2018
Document type	Peer Reviewed Journal Article
Title	Artisanal fisheries and artificial reefs on the southeast coast of Brazil: Contributions to research and management.

Summary	This study explored the populations of fish found on a artificial reef if Brazil as reported by local commercial fishermen. Perceptions of the role the reef has on the fish ecology is also explored.
Geographic region	Guaxindiba, Brazil
Structure Type	Artificial Reefs
Stakeholders / sectors	Artisanal Fisheries (commercial fishermen)
Social values explored	Perception of artificial reefs: their roles, uses, and influence
	Particularly in relation to the fish populations themselves
Methods:	What approach was adopted to engage stakeholders
	Semi-structured mixed methods interviews using snowball sampling
	What approach was adopted to identify and evaluate social values
	Interview responses organised into quantitative categories
	Fishermen perception was analysed through the triangulation method: crossing information collected through field diary, participant observation, and interview-questionnaire
Findings	Social values [interrelationships, variability across stakeholder groups, potential impacts on or opportunities for]
	Most fishermen were aware of the artificial reef and its location
	Majority of fishermen use the AR to fish
	Fishermen associated 24 fish species with the AR (15 of which not previously found in that area)
	Fishermen stated that Ars were useful for fish feeding, breeding and shelter
Other findings	Issues
	N/A: fishermen reported that the AR structure did not create any conflicts
Other findings	Opportunities
	Ars are seen as having a positive impact on local fishing
	Increase in catch abundance and species richness
Thoughts/reflections	2: though some social values are discussed the studies primary focus is the populations

	Mangano, & Sarà, 2017
Document type	
Title	Collating science-based evidence to inform public opinion on the environmental effects of marine drilling platforms in the Mediterranean Sea.
Summary	This study completed a systematic literature review to create a evidence map to be used to inform public opinion informing the question 'what effects do offshore extraction platforms have on the Mediterranean marine ecosystem components?' This map was to be used at the beginning of public consultations.
Thoughts/reflections	0: no social value except for a line at the end that states that this form of research can be used to 'drive decision- makers, stakeholders and public opinion in taking evidence- based decisions.' Removed from review.

	Munsch, Cordell, & Toft, 2017
Document type	Peer Reviewed Journal Article
Title	Effects of shoreline armouring and overwater structures on coastal and estuarine fish: opportunities for habitat improvement.
Summary	This article examined literature exploring the impacts of costal structures on estuarine fish. It was determined that there are differences in fish population and behaviour when

	comparing armoured and unarmoured shorelines and structures. It is suggested that further research and management into these structures within human-use constraints may be beneficial.
Thoughts/reflections	0: ecological focus , no social value researched, limited mention of 'human use constraints'
	but is not the locus of the study removed nonlifeview

Ref ID #5	Murray & Betz 1994
Document type	Peer Reviewed Journal Article
Title	User views of artificial reef management in the southeastern US.
Summary	This article explores the views of recreational fishers and divers, environmentalist and commercial fishers on artificial from the perspectives of general use and knowledge, administration, sitting/construction, funding, information, evaluation, and conflict resolution. Researchers find both differences and similarities across user groups and locations depending on topic being discussed.
Geographic region	North Carolina, Florida, and Texas USA
Structure Type	Artificial Reefs
Stakeholders / sectors	Recreational divers and fishers (sportsdivers and sportsfishermen), environmentalists, commercial fishers
Social values explored	general use and knowledge, administration, sitting/construction, funding, information, evaluation, and conflict resolution
Methods:	What approach was adopted to engage stakeholders
	A quantitative questionnaire that included 8 sections:
	<ol> <li>general knowledge and use, 2) administration, 3) funding, 4) siting/construction, 5) information, 6) evaluation, 7) conflict resolution and 8) a user profile.</li> </ol>
	The questionnaire was distributed via the mail and stakeholder communities were accessed via respective clubs they were involved in
	What approach was adopted to identify and evaluate social values
	Quantitative methods were used to assess % of responses on the Likert scale or rankings of perceived views
Findings	Social values [interrelationships, variability across stakeholder groups, potential impacts on or opportunities for]
	General use and knowledge
	Majority of respondents were very or somewhat familiar with their local artificial reef
	Environmentalists had the lowest familiarity
	Top ranked perceived benefit of an AR was to increase the number of fishing locations, second was provides fishing/diver closer to home – importance of access
	Respondents perceived Ars as important for removing fishing pressure from natural reefs and increasing fish productivity
	Commercial fishing was seen as the least relevant benefit
	Overcrowding was viewed as an issue found at ARs
	Administration
	User community is satisfied with how the AR is run
	No significant difference in satisfaction across user groups other than commercial fishermen who were more likely to be dissatisfied
	Funding
	User groups favoured the use of a stamp to fish/dive program on artificial reefs
	Majority of user groups were willing to pay \$5 or \$10 to use ARs

	Sitting/construction
	Offshore reefs (12 miles offshore) ae the most preferred ARs
	Most popular ARs are made from ships or barges while the second most popular are obsolete oil rigs
	Information
	All user groups except commercial fishermen reported newsletters as their primary source of AR information
	Club meetings, newspapers and magazines were also ranked as important
	Evaluation
	Users willing to serve on an advisory committee outnumbered those who would not
	50.6% of participants indicated that they would assist in data collection about fishing and diving activity – recreational divers and fishers more so than commercial fishers or environmentalists
	Conflict resolution
	Majority of users had no experiences conflict
	Most reported conflict was as a result of overcrowding
Other findings	Issues
	Overcrowding or overuse at AR locations leading to conflict
	Environmentalists concerned about negative impacts on biological community as a result of overfishing and pollution
	Agencies that maintain/manage ARs do not do a good job informing the public about artificial reef activities
Other findings	Opportunities
	Artificial reefs provide additional fishing locations
	Issue relating to ARs were agreed to less or seen as less of an issue than the benefits Stakeholders willing to donate their time and energy in assisting reef management and maintenance
Thoughts/reflections	3: explores multiple social value of multiple user groups. Fits well with scope of current research. Snowballing papers found from paper.

	Ng et al 2013
Document type	Peer Reviewed Journal Article
Title	Seeking harmony in coastal development for small islands: Exploring multifunctional artificial reefs for São Miguel Island, the Azores
Summary	This paper determines "optimal" MFAR multifunctional design criteria based on current progress and assessment of nine international MFARs installed to-date. It subsequently explores MFAR feasibility in São Miguel Island, the biggest and most populated Azorean Island with the largest surfing population. An assessment of surf breaks was undertaken, including coastal processes and retreat rates, and MFAR site selection, criteria and rationale are discussed
Geographic region	The Azores is a remote archipelago rich in the middle of the North Atlantic Ocean
Structure Type	Multifunctional artificial reefs (MFARs)
Stakeholders / sectors	None
Social values explored	None
Methods:	What approach was adopted to engage stakeholders
	None
	What approach was adopted to identify and evaluate social values
	None

Findings	Social values [interrelationships, variability across stakeholder groups, potential impacts on or opportunities for]
	No social values explored, although notes some 'values' artificial reefs provide: i.e. reduced coastal erosion, surfing tourism, amenity value via beach widening.
Other findings	Issues
	Poor construction, imprecise location, can cause negative outcomes, i.e. reduced surfing quality
Other findings	Opportunities
Other findings	Opportunities One quote that provides more support for the need for social assessments: "More emphasis needs to be given to social perceptions of the reef (e.g. locals, tourists, surfers, beach-goers, divers, fishermen) and socio-economic studies to consider regional economic return (e.g. local businesses, tourists, lodgings, property value).: p. 106

	Ocke 2016
Document type	Review, Peer Reviewed Journal Article
Title	Management recommendations of artificial reefs for practice of surfing
Summary	This study aims to present a set of recommendations that may contribute to public and private managers who plan to include the deployment of artificial reefs focusing on surfing conditions improvement in many localities. Therefore, this exploratory qualitative research runs from a brief literature review on the subject and a multiple case study - Australia, USA, New Zealand, India and England - to support the reasoning.
Geographic region	Multiple case study - Australia, USA, New Zealand, India and England
Structure Type	Artificial reef
Stakeholders / sectors	Surfing
Social values explored	Not explored
Thoughts/reflections	0: Exclude as not in English (Spanish I think??)
	Conclusion from abstract suggests its coverage of social values would have been limited anyway. "The results included the innovative nature of this type of structure, requiring a steady improvement in the construction and management methods, long-term monitoring programs to assess effectiveness, challenges in integrating users, public participation in different stages along the process, appropriate expectations management of the shareholders."

Ref	Oh, Ditton and Stoli 2008
Document type	Empirical research , Peer Reviewed Journal Article
Title	The Economic Value of Scuba-Diving Use of Natural and Artificial Reef Habitats
Summary	This article addresses the question of whether artificial reefs are functionally acceptable to scuba divers. Research objectives were (1) to identify the nonmarket value of recreational scuba diving in offshore marine waters and (2) to ascertain whether the willingness to pay for scuba diving varied between users of natural and artificial reef habitats.
Geographic region	Texas offshore waters, US
Structure Type	Artificial reefs
Stakeholders / sectors	Divers
Social values explored	Differentiating use values of natural and artificial reefs in the same area.
Methods:	What approach was adopted to engage stakeholders

	Survey, respondents approach via dive charter operators records
	What approach was adopted to identify and evaluate social values
	Economic valuation only
Findings	Social values [interrelationships, variability across stakeholder groups, potential impacts on or opportunities for]
	Satisfaction levels: Explored satisfaction levels of reef divers versus artificial reef divers. Found reef divers more satisfied.
Other findings	Issues
Other findings	Opportunities
Other Infalligs	Opportunities
	MPAs in the future may need to include artificial reef habitats to help redistribute scuba diving use and give heavily used areas time to recover.
	MPAs in the future may need to include artificial reef habitats to help redistribute scuba diving use and give heavily used areas time to recover. Apparently, artificial reefs are not the "junkyards of the ocean" as some have suggested previously, but rather, they have value to their users and offer an opportunity to reduce pressure on natural reefs through wise management while producing additional human benefits perhaps not otherwise possible.

	Oliveira et al 2015
Document type	Empirical Research, Peer Reviewed Journal Article
Title	An approach to the economic value of diving sites: artificial versus natural reefs off Sal Island, Cape Verde
Summary	In the present paper there was a twofold hypothesis, i.e. that the deployment of artificial reefs adds value to natural features by diversifying diving sites and thus be a certain propensity concerning the type of added value (either of non-extractive direct or indirect use). The objective was to ascertain to what extent artificial reefs deployed off Sal Island (Cape Verde) contribute to the local economic value by specifically providing alternative sites for recreational divers.
Research Type	Empirical research
Geographic region	Sal Island (Cape Verde)
Structure Type	Artificial reef – sunken vessels
Stakeholders / sectors	Divers,
Social values explored	Indirect values – species colonisation, creation of new dive sites, reduced pressure on natural reefs
Methods:	What approach was adopted to engage stakeholders
	None – stakeholders not engaged
	What approach was adopted to identify and evaluate social values
	None – economic value assessed only.
Findings	Social values [interrelationships, variability across stakeholder groups, potential impacts on or opportunities for]
	Not stated
Other findings	Issues
	On the demand side, artificial reefs are not as appealing to divers
Other findings	Opportunities
	Not stated in relation to social values

Thoughts/reflections	0: Focus is on economic valuation – suitable reference for Johanna.
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	Ounanian et al 2012
Document type	Empirical research Peer Reviewed Journal Article
Title	On unequal footing: Stakeholder perspectives on the marine strategy framework directive as a mechanism of the ecosystem-based approach to marine management
Summary	This article concentrates on five marine sectors active in the marine environment (fisheries, offshore renewable energy, offshore oil and gas, navigation, and coastal tourism) and on non-industry stakeholders represented by environmental Non-Governmental Organizations (eNGOs) and how they have engaged in the Marine Strategy Framework Directive (MSFD) stakeholder consultation process and what they foresee as potential challenges for implementation.
Geographic region	EU
Structure Type	None, exploring stakeholder perspectives on a EU marine policy
Thoughts/reflections	0: Not in scope, does not address offshore marine infrastructure or related social values.

Ref ID# 16	Pike et al 2010
Document type	Empirical research, Peer Reviewed Journal Article
Title	Social Value of Marine and Coastal Protected Areas in England and Wales
Summary	This article argues the need for a clearer, shared understanding of the social value of protected areas in creating new designations and managing existing ones. Social value reflects the complex, individual responses that people experience in a given place. Many reasons determine why one area is valued above another, and this research investigates the social value of MCPAs from a practitioner's perspective through a series of interviews.
Geographic region	England and Wales
Structure Type	None – focus on MPAs, but included given the explicit focus on social values.
Stakeholders / sectors	Managers and others with role in MPAs
Social values explored	Stakeholder definition of social value and the attributes that they believe contribute to the social value of MPAs. Categorised under 9 groups: Management, natural environment, spirituality, activities, community involvement, research etc, built infrastructure, access, marketing & promotion.
Methods:	What approach was adopted to engage stakeholders
	Selected representative MCPAs from international, European, national, regional, and local levels that were either statutory or non-statutory and marine with coastal boundaries or terrestrial with coastal boundaries. Interviewee selection was determined partly by the designation and partly by geographical location within England and Wales.
	Interviewees were also selected for their specific working experience within protected areas. There are many hundreds of people working within MCPA designations in England and Wales. In consideration of this, the main agencies responsible for MCPAs, including Natural England (NE), Countryside Council for Wales (CCW), as well as the Joint Nature Conservation Committee (JNCC) were phoned in the first instance and then contacts suggested by them were followed up until appropriate candidates were established.
	What approach was adopted to identify and evaluate social values
	Twenty-four semi-structured, telephone interviews with MCPA practitioners were conducted for the study and sought to identify what practitioners understand by social value within their MCPA and activities that encouraged or discouraged it. The interviews were analyzed using techniques consistent with grounded theory. These
	included memos and diagrams that helped with data organization and conceptualization, and coding that helped to sort, relate, and to continue to develop data categories in terms

	of their various properties, with final integration of key concepts. Data themes were
	assigned during analysis of the interview transcripts where direct comments were made. As
	analysis became more detailed sub-themes were applied and inferences were noted and
	also assigned a category. Interconnections in the data were noted and pertinent quotes
Findings	Social values [interrelationships, variability across stakeholder groups, potential impacts on or opportunities for]
	Key themes of social value in MCPAs
	Management: The organization's reason for interest in environmental qualities and features: ecological interest scored highest with a significant decrease to spirituality, placing far less organizational interest in this area
	The natural environment: natural environment provides a strong and inextricable link to the social value of a MCPA and interviewees cited the natural environment as the main reason they understood for people visiting these areas. The dynamic nature of the coastal environment causes change in people's use patterns and the value of the area.
	<b>Spirituality:</b> can be considered on one level as a sense of place that can be experienced collectively or individually and is essentially an emotional connection that develops between people and their environment. Although spirituality was assigned a low score according to how interviewees felt their designating body viewed it, the interviewees themselves throughout the research made associations to the importance of spirituality in connection with social value. This disparity reinforces the need for a shared understanding of all social values effecting MCPAs if a full and effective contribution to MCPA development is to be made.
	Activities: ability to engage in recreational and educational activities directly contributed to social value. But increasing or adding activities within a MCPA did not necessarily increase its social value. Nearly half the interviewees felt their site had no capacity to do this anyway. Rather than increasing activities, interviewees discussed various ways of improving existing ones by better and more sustainable management and by widening the target group to include under represented members of the public
	<b>Community involvement</b> : Voluntary approaches to community work and inclusion of under- represented groups of people from the community were specifically mentioned.
	Research, education, and interpretation
	Built infrastructure
	Access
	Marketing and promotion
Other findings	Issues
-	Not addressed
Other findings	Opportunities
	Generated a 'statement of best practice' which provides examples of the aspects that contribute to social value of MCPAs. For example:
	Management: Experienced, innovative staff; Reliable annual budget; Sustainable goals; Management plan; Enforceable regulations/Codes of conduct Health and safety; Site wardens; Study and analysis of management pressures; Collaboration with other managers in the area; Forecasting impacts of coastal dynamics and implications to recreational use of the coast
	Nature: Diversity of habitats and environmental features; Rare species, birds and wildlife; Good view points of land or seascapes; Coastal; Natural beauty
	For remainder of list see pg 427 in paper.
	Also developed a conceptual model to represent the key criteria contributing to social value. Very basic, natural environment and management in the middle, with the other elements (ie activities, spirituality etc) contributing to social value.

Thoughts/reflections	2: While focus is on MPAs (not offshore marine infrastructure), the introduction/rationale component of the paper would be useful when emphasising the value of social research in our context.
	The highlighted text provides example of what workshops could focus on, as opposed to 'issues and opportunities' as per the first workshop. The methods may be useful in considering how social values have been collated and represented.

	Polnac et al 2006
Document type	Peer Reviewed Journal Article
Title	Toward a model for fisheries social impact assessment
Summary	The Office of Science and Technology of NOAA's National Marine Fisheries Sevice invited a group of marine fisheries social scientists with expertise in social science modeling, quantitative methods, and marine fisheries impact assessment to create a conceptual model for predicting the social impacts of fishery management action alternatives using a limited set of quantitative and qualitative indicators. This paper presents the results of the first phase of this group's work. Well-being was selected as the dependent measure for marine fisheries social impact assessment in this model. While this model is not the only possible approach to social impact assessment, it does open a door to a room that is closer to those currently occupied by marine fisheries economists and their biologist counterparts.
Geographic region	United States
Structure Type	None
Stakeholders / sectors	None – framework involving engagement is presented
Social values explored	The SIA model for marine resource management is designed to predict changes in well- being (ie individual or group characterized as being healthy (sound and functional), happy, and prosperous).
Methods:	What approach was adopted to engage stakeholders
	Expert input for model development
	What approach was adopted to identify and evaluate social values
	Initial assessment identifies the critical populations that have a significant stake in the management action and the issues of concern to these populations that may increase or decrease their well-being. Next step following the scoping process is to operationalize the relevant variables by defining the variables in a way that facilitates measurement More important than simply identifying variables, however, is discerning the relationships among them
Findings	Social values [interrelationships, variability across stakeholder groups, potential impacts on or opportunities for]
	The model proposes aspects affecting well-being and potential interrelationships between them (ie external forces, management, activity attributes, activity satisfaction, social problems, individual attributes, social and community attributes). But does not provide applied examples, only theoretical examples for commercial fishers, recreational fishers, & subsistence fishermen.
Other findings	Issues
	Not applied, and refers to the need for extensive data to populate the model which does not currently exist and would require significant investment from managing authorities.
Other findings	Opportunities
	Suggest that the model provides a comparable assessment framework as per economic assessment, but does not demonstrate how this is achieved.

Thoughts/reflections	1: Not very useful, a general model from which potential attributes influencing well-being
	could be drawn, but does not explicitly consider stakeholders values in relation to offshore
	marine infrastructure.

Ref	Ramos et al 2019
Document type	Empirical Research Peer Reviewed Journal Article
Title	Local fishermen's perceptions of the usefulness of artificial reef ecosystem services in Portugal
Summary	Proponents of artificial reef (AR) deployment are often motivated by the usefulness of such structures. The usefulness of ARs is related to their capability of providing ecosystem services/additional functions. We present two distinct Portuguese AR case studies: (1) The Nazaré reef off the central coast of Portugal and (2) the Oura reef off the Algarve coast. Semi-structured interviews were conducted with local fishermen in the fishing towns of Nazaré and Quarteira pre-and post-AR deployment. The main focus of the interviews was to understand fishermen's perception of AR usefulness (or lack thereof) in terms of nine ecosystem services/additional functions potentially provided by the ARs.
Geographic region	Portugal
Structure Type	Artificial reefs
Stakeholders / sectors	Fishermen
Social values explored	Main focus of the interviews was to understand fishermen's perception of AR usefulness (or lack thereof) in terms of nine ecosystem services/ functions potentially provided by the AR (food production, recreation, biological control, nutrient cycling, disturbance regulation, reuse of obsolete structures, habitat and refuge, diversion effect, biodiversity preservation).
Methods:	What approach was adopted to engage stakeholders
	Not stated, only states that 'the potential survey population for this questionnaire included all fishermen who participate in fisheries that are generally prosecuted adjacent to the ARs.'
	What approach was adopted to identify and evaluate social values
	Survey questionnaires were conducted with local fishermen in the fishing towns of Nazaré and Quarteira pre-and post-AR deployment.
Findings	Social values [interrelationships, variability across stakeholder groups, potential impacts on or opportunities for]
	No specific social values or interrelationships explored. Focus was on examining perceptions of the utility of AR pre and post deployment, with the intention of highlighting the importance of understanding perceptions, and community expectations of AR outcomes, to ensure alignment between expectations and possible benefits to stakeholders.
Other findings	Issues
Other findings	Opportunities
	Methodological issue but overall benefit of AR: there is a possibility that some of the respondents were queried both before and after deployment. However, since the interviews conducted for this study were anonymous, we cannot confirm which respondents were queried twice. Although this limits further statistical analysis, interviews with the same respondent pool in both the pre- and post-deployment data collections were not possible given the 14 years between studies. Despite this limitation, this study shows that, generally, fishermen across both case studies had a range of expectations of the ecosystem services and benefits that ARs will provide. Likewise, they reported having benefited to some extent from a range of ecosystem services post-deployment.
Thoughts/reflections	1: While ecosystem services can align to social values, this paper does not go into detail regarding the values of the stakeholders in relation to the ARs – rather it examines

stakeholders perceptions of the ability of AR to deliver specific ecosystem services, without
asking if these ecosystem services are important or valued by the stakeholders.

	Ramos et al 2011
Document type	Empirical Research, Peer Reviewed Journal Article
Title	Stakeholder perceptions of decision-making process on marine biodiversity conservation on sal island (Cape Verde)
Summary	In order to allocate demand for diving and fishing purposes, we have developed a socio- economic research approach addressing the theme of biodiversity and reefs (both natural and artificial) and collected expectations from AR users by means of an inquiry method. Scrutinized stakeholders' perception on the best practice for marine biodiversity conservation in the Sal Island.
Geographic region	Cape Verde (Islands off the African coast)
Structure Type	Artificial reef
Stakeholders / sectors	1) Biologists, 2) Diving operators (DOs), 3) Non-governmental organizations (NGOs), 4) Managers, and 5) Recreational divers (RDs).
Social values explored	Stakeholder values were not explicitly explored, rather, their management preferences were evaluated (i.e. sinking artificial structures, restocking living organisms, raising community awareness or limiting threatening activities).
Methods:	What approach was adopted to engage stakeholders
	Targeted specific stakeholder groups directly, (ie approaching management authorities and local NGOs).
	What approach was adopted to identify and evaluate social values
	Questionnaire using the Analytic hierarchy process that asked to give their opinions, by means of a simple AHP methodology, about a future project aiming at marine biodiversity conservation on Sal Island and their preference regarding the allocation of money for each type of diving site, in the light of four different management options. Respondents were then asked to rank their preferred management measures. AHP = Individual experts' experiences are utilized to estimate the relative magnitudes of factors through pair-wise comparisons. Each of the respondents has to compare the relative importance between the two items under special designed questionnaire (from Wiki –
	clearer definition than available in paper).
Findings	Social values [interrelationships, variability across stakeholder groups, potential impacts on or opportunities for]
	No specific social values explored, however, the method adopted provides information on the variability or consistency in management option preferences across stakeholder groups which can be useful in understanding the potential support for management actions.
Other findings	Issues
	Not applicable
Other findings	Opportunities
	Not applicable
Thoughts/reflections	1: As stated, explores the management preferences of different stakeholder groups, and the AHP process presented might be useful in our context, but otherwise the paper provides limited contribution to understanding the range of social values or their assessment in relation to offshore marine infrastructure.

Ref ID #7	Ramos et al 2011b
Document type	Peer Reviewed Journal Article

Title	STAKEHOLDER ANALYSIS IN THE PORTUGUESE ARTIFICIAL REEF CONTEXT: WINNERS AND LOSERS
Summary	Presents the results of a stakeholder analysis in relation to an artificial reef program in Algarve. Stakeholders' interactions with the ARs were studied, along with their likely attitudes and behaviour towards the man-made structures. All stakeholder clusters were classified according to their expected degree of involvement throughout the different AR stages. The purpose of this stakeholder analysis was to find out winners and losers connected with the reef deployment.
Geographic region	Algarve (Southern Portugal mainland
Structure Type	Artificial reef
Stakeholders / sectors	Local fleet users, non-users, coastal fleet users, non-users, fishermen associations, fishermen producers org, charter boat anglers, offshore anglers, anglers clubs and associations, dive operators, spear-fishermen, offshore-aquaculture, fisheries research institute, directorate for fisheries, directorate for the environment, ports authority, financial institutions, navy, university, city councils. environmental agencies.
Social values explored	Policy goals explored, including: PRIMARY GOALS
	(1) to protect juvenile fish, especially those ones having higher commercial value
	(2) to promote biodiversity and allow the diversification of catches,
	(3) to contribute to the recovery of coastal fish resources,
	4) to create fishing areas and promote a controlled exploitation of coastal fishing resources,
	5) to develop a sustainable exploitation
	(6) to reduce fishing costs, and strategy,
	7) to promote alternative fishing management measures.
	SECONDARY GOALS
	(1) to promote off-shore aquaculture,
	(2) to carry out fish enhancement/restocking actions,
	(3) to develop reef-related eco-tourism activities,
	(4) to develop integrated studies of coastal ecosystems functioning.
Methods:	What approach was adopted to engage stakeholders
	Several methods. In the first instance semi-structured questionnaire-based interviews were conducted to discover potential AR users, and (2) seminars were given in three fishing communities to promote structures among fishermen and obtain feedback from those that expressed interest in the ARs. A second instrument used was a questionnaire survey, intending to widen the range of stakeholder types, including not only primary stakeholders (i.e. AR users or potential users), but also secondary and external stakeholders (i.e. AR non-users). Additional instruments based on secondary data were also used including documentary sources such as research archives (e.g. electronic files from the Fisheries Directorate - DGPA) and content analysis (e.g. newspapers and internet pages).
	A stakeholder analysis on a regular basis is necessary because stakeholders' influence is not static.
	What approach was adopted to identify and evaluate social values
	The first phase the most important goals and purposes of the AR program were identified - goals that were perceived to have direct usefulness to people. IPIMAR developed seven primary and four secondary goals for the AR program, most of them focusing on biological (benthos and ichthyology) and oceanographic functions.
	In the second phase a list of all the different parties that revealed any interest in the developments was drawn up, i.e. stakeholders (i.e. primary, secondary and external).
	The third phase consisted of determining the interests of the different stakeholders. The stakeholders identified were questioned about their interests concerning the different policy objectives of the program. The data sources were: initial interviews with commercial
	fishermen and recreational users (anglers and divers), a questionnaire survey (RAMOS et al., 2007), and informal meetings. The fourth phase considered the impact of the project on each stakeholder, and also the influence or power each stakeholder wielded on the program according to their own interests and influence on the project outcomes [but how this was undertaken is not specifically stated].
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Findings	Social values [interrelationships, variability across stakeholder groups, potential impacts on or opportunities for]
	<b>Experience shapes values – Primary winners and losers:</b> Primary stakeholders' interest was triggered by the experiences they encountered when using the reefs. If they enjoyed good outcomes when they used the reefs, they will repeat the experience. Losers were the ones that due to reef deployment were expelled from the reef area or suffered operational limitations (e.g. some purse seine owners). For instance, secondary stakeholders such as IPIMAR achieved a higher reputation among stakeholders by delivering the program along its stages.
	<b>Secondary benefits:</b> External stakeholders such as local City Councils were winners because they gained in terms of job creation both during the construction of the ARs and as a consequence of primary stakeholder gains. In their turn, losers were all those who lacked
	believed that some habitat was destroyed or lost for a certain number of species (e.g. flatfish).
Other findings	believed that some habitat was destroyed or lost for a certain number of species (e.g. flatfish).
Other findings	confidence in the stability of the materials used in the construction of the ARs and/or         believed that some habitat was destroyed or lost for a certain number of species (e.g.         flatfish). <b>Issues</b> Empirically stakeholders judged ARs in their own interests and evaluated them according to         their needs. In this stakeholder analysis it seems that those stakeholders to whom AR         deployment has impacted negatively do not pose a threat to the success of the AR program.
Other findings Other findings	confidence in the stability of the materials used in the construction of the ARs and/or         believed that some habitat was destroyed or lost for a certain number of species (e.g.         flatfish).         Issues         Empirically stakeholders judged ARs in their own interests and evaluated them according to         their needs. In this stakeholder analysis it seems that those stakeholders to whom AR         deployment has impacted negatively do not pose a threat to the success of the AR program.         Opportunities
Other findings Other findings	confidence in the stability of the materials used in the construction of the ARs and/or         believed that some habitat was destroyed or lost for a certain number of species (e.g. flatfish).         Issues         Empirically stakeholders judged ARs in their own interests and evaluated them according to their needs. In this stakeholder analysis it seems that those stakeholders to whom AR deployment has impacted negatively do not pose a threat to the success of the AR program.         Opportunities         Overall, the aggregated results show that most stakeholders are optimistic concerning the main objectives of AR policy and find them a useful way to invest in the marine environment, principally as a way of mitigating fishing problems and amplifying the economic value of the coastal area.

Ref ID# 17	Ramos et al 2006
Document type	Empirical research, Peer Reviewed Journal Article
Title	The usefulness of the analytic hierarchy process for understanding reef diving choices: a case study
Summary	The main objective of this paper was to test the usefulness analytic hierarchy process AHP in identifying the conditions influencing divers' choice of dive sites. Decision makers need to know what role artificial reef modules play within the diving choice spectrum in order to decide their potential management interests, and AHP results can be used in that decision.
Geographic region	Algarve region of Portugal
Structure Type	Artificial reefs
Stakeholders / sectors	Diving
Social values explored	Examined how diving preferences determine the use of different dive sites, e.g. seeing unusual aquatic organisms, the benefits of updating diving skills.

	Biological diversity, geographic characteristics (depth, topography), dive atmosphere (water clarity etc), economic aspects (cost), dive motivations (diverse sites, updating skills, explore known site).
Methods:	What approach was adopted to engage stakeholders
	Not stated
	What approach was adopted to identify and evaluate social values
	Survey designed based on information obtained from a diving school to set questions exploring: (1) the beneficiaries (SCUBA divers); (2) the goal (choosing the best diving spot); (3) the criteria (relative factors to consider during the choice process); and (4) the alternatives (the different types of reef sites, which are prioritized). The value tree divided into A) the upper part of the tree, which aimed to establish the criteria taken into account by divers to go diving, and the relative importance of these criteria in order; and (B) the lower part of the tree, which identifies the choice options amongst five different diving site alternatives.
Findings	Social values [interrelationships, variability across stakeholder groups, potential impacts on or opportunities for]
	Ecological diversity: divers' preferences indicate that divers attach the highest importance to the biological criterion, particularly the possibility of seeing an unusual fish or other less common aquatic organism. Conservation value of the dive spot also highly ranked in divers' choices. Personal development: The incentive to update diving skills or progress in scientific knowledge through diving discoveries was considered to be the second best sub-criteria that encourages people to dive.
	<b>Facilities</b> : Facilities provided by the hired service were also highly ranked in divers' choices.
	Site physical characteristics: geographic (0.070) and atmospheric (0.082) criteria seemed to be not as important for divers, and their respective sub-criteria always had a low elicited weight (always < 5% of the value in each of the choices). Surprisingly, species biodiversity (0.042) and visibility (0.044) were the least important as sub-criteria.
	ranked far below, with the artificial reef concrete modules being the least preferred choice.
Other findings	Issues
	While concrete artificial reef modules can be beneficial for local and recreation- al fishing, this exploratory study suggests that there are still questions over their importance for diving purposes. p 217
Other findings	Opportunities
	Given that the attributes of diving sites that attract divers are not unique to natural reefs, there may be scope in the future to divert diving choices towards artificial habitats, whether these be accidental (e.g., shipwrecks) or intentional structures (e.g., sunk vessels), in order to avoid mechanical damage to natural reefs from increased demand for diving. p. 217
Thoughts/reflections	2: Provides information on the attributes that affect choice of dive site, but the limit of the study to divers as the stakeholder group reduces its utility for our purposes

Ref ID# 6	Ramos et al 2007
Document type	Empirical research, Peer Reviewed Journal Article
Title	Stakeholder perceptions regarding the environmental and socio-economic impacts of the Algarve artificial reefs
Summary	To evaluate the overall perception of the effects of deployment of artificial reefs, a survey of stakeholders' opinions was undertaken based on a set of questions addressing various dimensions (environmental, social, and economic). The results obtained reflect the most important issues be impacted and the possibility of using them as indicators of relative

	success or failure – on the basis tht managers want to know which impacts are acceptable and which are not.
Geographic region	Algarve, Portugal
Structure Type	Artificial reef
Stakeholders / sectors	Commercial fishermen associations, anglers associations and clubs, diving schools and clubs, fisheries and environ- mental administrators, natural and social scientists, and local council representatives in the fisheries and environmental sectors
Social values explored	Perceptions of impact across social, economic and environmental elements of the AR - not social values
Methods:	What approach was adopted to engage stakeholders
	The questionnaires were sent directly to each representative by hand or via post mail, and were addressed to the highest representative of each body/institution, or to the person used to work with fisheries or environmental issues
	What approach was adopted to identify and evaluate social values
	Survey covered 44 key-stakeholder representatives distributed in six groups outlined above. The opinions of stakeholders were measured using summated rating scales. First, three dimensions expected to be impacted by reef deployment were selected:
	environmental (Deployment use area, ecological impact and bio-diversity, pollution, fishery and management), social (Demography and employment, Enforcement and communication, Opinion; Conflicts), and economic (production, costs to society, changes in local economic, safety at sea). For each dimension, an item-pool was constructed which included all the perceived predefined impacts (shown in brackets). The item-pool consisted of 54 ambiguous-free relevant items to be included in the survey of respondents' opinions. Key-stakeholders used 5-point Likert scales to state their positions about impacts. Used AMOEBA plots to view results.
Findings	Social values [interrelationships, variability across stakeholder groups, potential impacts on or opportunities for]
	In general different stakeholder-types take somewhat different positions and attitudes towards AR impacts: usually scientists are the most optimistic, whereas fishermen take the most sceptic view.
	<b>Note</b> : info below is 'perceptions' of impact not social values
	Despite the differences found between those stakeholders who knew the reefs from first- hand experience and those that had only heard about them, the entire panel thought that the most important positive impacts belonged to the environmental dimension.
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	<b>Structures:</b> scientific evidence shows that there has been an increase in abundance of economically-important fish species on the pilot ARs surveyed since their deployment in the early 1990s
	On the positive side, the overall perception is that: ARs promote a specific habitat enriched with several different species, promoting bio-diversity; being also able to aggregate marine fauna, and the structures are more likely to attract local fishermen than other users. The use of local fishing vessels at the reef area was considered an environmental positive impact once it is recognised as a more sustainable way of fishing, when compared with larger vessels.
Thoughts/reflections	3. While useful in that the paper covers and compares a range of stakeholders, the focus is on perceptions of impact, not the 'values' of the stakeholders. Although these can in part be inferred based on the perceptions given.

Ref [1]	Saengsupavanich 2019
Document type	Empirical research, Peer-reviewed journal articles
Title	Willingness to restore jetty-created erosion at a famous tourism beach
Summary	This research revealed the intangible benefit of preserving the downdrift eroded shoreline at Cha-Am beach, Thailand. It integrated coastal engineering and environmental economics to urge for the beach restoration. Although providing some benefits, the jetty at Cha-am beach has also created severe downdrift coastal erosion. Future coastline change was predicted. The updrift part of the beach would be widened by approximately 8 m/yr, while the downdrift side of the jetty would experience severe coastal erosion by as much as 13 m/yr. A valuation of the downdrift eroded shore was consequently undertaken using a willingness-to-pay (WTP) study. Four hundred sets of questionnaires were surveyed using 10 different bid amounts. The huge non-market value of the downdrift beach might urge decision makers to initiate certain continuous beach restoration measures.
Geographic region	Cha-am beach, Thailand
Structure Type	Jetty
Stakeholders	Interviewed respondents were tourists on the beach, business operators of resorts and restaurants, and their employees at the updrift side. The people at the updrift area gained benefits from the sediment deposition so they had a sense of paying to restore the downdrift beach. Moreover, there were very few people along the downdrift area since the downdrift beach was very narrow, thus no tourism activity existed
Thoughts/reflections	0: Removed, only explores willingness to pay – no exploration of other social values. Relevant for Johanna.

	Sayer and Wilding 2002
Document type	Report on Activities, Peer reviewed journal article
Title	Planning, licensing, and stakeholder consultation in an artificial reef development: the Loch Linnhe reef, a case study
Summary	Discusses the licencing process for the Loch Linnhe Artificial Reef, which was one of the first applications successful under new guidelines under the auspices of the Oslo Paris Commission. Argues that the process was assisted by open dialogue with a range of user groups and local bodies.
Geographic region	European Union
Structure Type	Artificial Reef
Stakeholders / sectors	Licensing/regulatory bodies and fishermen, sport diving and fishing charter boat operators, recreational sailing groups, academia, and other identified experts, the media, and a wide range of governmental and non-governmental bodies such as local,

	community and regional councils, maritime heritage groups, and nature conservation
	bodies.
Social values explored	No specific values, focus was on the potential issues/concerns of different stakeholder
	groups so that these could be addressed in the application for AR development.
Methods:	What approach was adopted to engage stakeholders
	Interviews with fishermen, public meetings for general public. Local media channels were
	used constructively to assure a balanced representation of facts. In this case, a series of
	press statements was issued to local newspapers and radio stations. To share
	involvement with stakeholder groups, the establishment of the management committees
	turned out to be advantageous. Because the various groups may not share a common
	approach, they chose to have their meetings coordinated by independent facilitators
	What approach was adopted to identify and evaluate social values
	None, focus on priority issues rather than values. Outcomes of initial discussions with
	fishermen captured below.
Findings	Social values [interrelationships, variability across stakeholder groups, potential impacts on
	or opportunities for]
	Responses to reef development differed based on the type of fishing gear employed.
	Static-gear fishermen expressed the concern that any new reef-based fishery would
	attract additional fishing effort into the area and that some of this effort would be
	directed at the existing wild stocks. The towed-gear sector expressed concerns regarding
	the concept of artificial reefs being used to protect areas of seabed through effort
	exclusion and, in particular, was concerned that the chosen site would not interfere with
	their existing fishing grounds
	The main concern raised during public meetings for the Loch Linnhe reef was that of the
	potential for ash- derived trace metals to leach from the blocks into the environment.
Other findings	Issues
Other findings	Opportunities
	Artificial reefs facilitate the restoration, manipulation, or protection of habitat availability
	and potentially assist in sustaining or restoring inshore fishery resources
Thoughts/reflections	1: Has some information relating to stakeholder engagement and the importance of
	involving stakeholders in the planning process. But does not explicitly try to understand
	stakeholder values, or how these vary across groups.

	Schaffer and Lawley 2011
Document type	Empirical research, Peer reviewed journal article
Title	An analysis of the networks evolving from an artificial reef development
Summary	Understanding the flow and development of knowledge within tourism networks is important to the success and value of the network, especially networks based on a single resource such as an artificial reef. Using the ex-HMAS Brisbane Conservation Park as the context, a network analysis was conducted with stakeholders to address the question: 'How can network analysis be used to measure the social value of an artificial reef?' The results of this study identified information flows over time, who was involved and not involved at different stages of development, as well as opportunities for further collaborative relationships.
Geographic region	Sunshine Coast, Australia
Structure Type	Artificial reef
Stakeholders / sectors	Tourism sector; business groups, community groups and government departments.
Social values explored	None
Methods:	What approach was adopted to engage stakeholders

	Interviews and snowballing for additional participants. To assess information flow, data collection focused on those individuals and organizations with a direct connection to the Conservation Park. Purposive sampling, using secondary sources, identified seven stakeholders from two groups: authorized dive operators and government departments. Stakeholders were interviewed using a semi-structured survey which requested respondents to identify additional stakeholders.
	What approach was adopted to identify and evaluate social values
	None – social values were not examined
Findings	Social values [interrelationships, variability across stakeholder groups, potential impacts on or opportunities for]
	The values of stakeholders were not explored
Other findings	Issues
	<b>Network structure:</b> A key management challenge when developing artificial reefs is stakeholder collaboration to generate knowledge and innovation for improved project outcomes. The whole network consisted of 492 ties (the connections that link stakeholders) of which 117 were transfer (one-way) ties and 375 exchange (two-way) ties. The greater number of exchange ties is critical for opening pathways for creating knowledge, innovation and sustainability Despite the main goal for the artificial reef being the enhancement of regional dive tourism (SQDERM, 2011), the Conservation Park network was weak in the areas of regional tourism organisations and hospitality support services. Respondents said contact with these stakeholders was limited and they were considered unimportant in the network. To address this gap, key stakeholders could broke ties with these groups to expand their involvement in the network
Other findings	Opportunities
	In summary, information was extensively sourced and knowledge was created at all stages of the project. This research can be used to facilitate consultation with stakeholders to investigate ways to collaborate, introduce new stakeholders and to work towards re-assessing goals and objectives as the tourism resource (Conservation Park) matures.
Thoughts/reflections	1: Paper only examines network linkages relating to the Conservation Park, does not examine the values or priorities of the different stakeholders within the network.

Ref ID #9	Schrouder and Love 2004
Document type	Review, Peer-reviewed journal article
Title	Ecological and political issues surrounding decommissioning of offshore oil facilities in the Southern California Bight
Summary	This paper summarizes and clarifies some of the issues and options that the federal government and the state of California face in decommissioning offshore oil and gas production platforms, particularly as these relate to platform ecology. Compared to the relatively supportive political climate in the Gulf of Mexico for "rigs-to-reefs" programs, conflicting social values among stakeholders in Southern California increases the need for understanding ecological impacts of various decommissioning alternatives (which range from total removal to allowing some or all of platform structure to remain in the ocean).
Geographic region	California, USA
Structure Type	Offshore oil facilities
Stakeholders / sectors	Not stated
Social values explored	None – although states 'Defining the social and ecological goals of decommissioned platforms as artificial reefs will be critical in evaluating the efficacy of any potential rigs-to-reefs program and the current and future performance of any artificial reef', p. 29

Methods:	What approach was adopted to engage stakeholders
	None
	What approach was adopted to identify and evaluate social values
	Literature review
Findings	Social values [interrelationships, variability across stakeholder groups, potential impacts on or opportunities for]
	The authors sort the multitude of stakeholder viewpoints regarding a rigs-to-reefs program into three groups, each of which is primarily defined by one social concern:
	1. Community membership, consists of stakeholders who are concerned about community membership, and either oppose or support local presence of the oil industry.
	2. Resource accessibility, stakeholders are primarily concerned with resource accessibility. A heterogeneous group, these citizens will either favour or oppose decommissioning alternatives depending on how these alternatives aid or inhibit their ability to access a particular resource (e.g. fishermen)
	3. Environmental (marine life) issues: members of this group make decisions regarding decommissioning based on their perception of how certain marine populations or environmental ideals fare under the various decommissioning alternatives
	Of course, an individual may be influenced by more than one social value, and others may use arguments from multiple categories to promote a desired decommissioning outcome.
	The authors argue that stakeholders preferences for 'data' input into the decision making process is a function of their inherent support or lack of for the decommissioning process. They provide examples of how different stakeholders may value different scientific information based on how it contributes to their underlying values/ priorities. (see p 32 for example)
Other findings	Issues
	When there is greater scientific uncertainty, social values and political or economic factors often become more important in the decision-making process. Determination and ranking of ecological goals necessarily reflects cultural values. Thus, even if large amounts of ecological data regarding decommissioning consequences were available, controversies surrounding platform decommissioning will still arise because there is no formal ranking of which species or habitats have management priority. Further, there is no agreement on the space and time scales in which ecological impacts should be measured.
	Therefore, managers should explicitly state whether reefing alternatives will be designated as marine protected areas
Other findings	Opportunities
	Economic incentives interact and overlap with social values. Additional financial resources may be used to develop or enhance projects important to stakeholders, and may be a sufficient incentive to alter the preferred decommissioning option for some groups. Finally, social values will also be important in directing how potential cost savings will be used. The overarching conclusion from both ecological and political perspectives is that
	decommissioning decisions should be made on a case-by-case basis.
Thoughts/reflections	3: One of the few articles that highlights stakeholder perceptions/values and how they relate to their support or not of decommissioning. However, results are only based on literature review, it is not an empirical research article.
	Has a nice figure showing the different alternatives for decommissioning oil and gas production platforms (p. 25)

	Schuett et al 2016
Document type	Empirical research. Peer-reviewed journal article
Title	Examining the Behavior, Management Preferences, and Sociodemographics of Artificial Reef Users in the Gulf of Mexico Offshore from Texas
Summary	This study used a mixed-mode approach (mail and online) to survey licensed private boat owners (26 ft [8 m] and larger) from Texas on the use, choice and management of artificial reefs in the Gulf of Mexico (GOM) offshore from Texas.
Geographic region	Gulf of Mexico, Texas
Structure Type	Artificial reef
Stakeholders / sectors	Boat owners (8m or larger)
Social values explored	None, focus on factors driving visitation to ARs
Methods:	What approach was adopted to engage stakeholders
	A total of 7,000 names and addresses were randomly selected from the population of registered boaters in the Texas Parks and Wildlife Department's database. Survey questionnaire sent to boat owners.
	What approach was adopted to identify and evaluate social values
	The questionnaire included behavioral queries, e.g., number of trips to the GOM, type of reefs visited, preferred distance to reef sites, and socio-demographics. Subjects were asked to rate the importance of various factors they take into account when selecting artificial reef structures for recreation. Also investigated participants' opinions regarding artificial reef management. 1,671 returned surveys.
Findings	Social values [interrelationships, variability across stakeholder groups, potential impacts on or opportunities for]
	Factors defining which AR structure will be used for recreation: presence of fish (extremely important for over half of the respondents), followed by distance from port, depth of water, and diversity of marine life.
	For those with more trip experience, the importance of depth of water and presence of desired fish species increased. As the experience of boat owners increased, the location of artificial reefs in deeper water and the ability to see desired fish species became more important to boaters
	Thus, respondents with more experience wanted more artificial reefs in the GOM that are designed for specific uses and marked or identified, and believe they should be allowed to place them offshore as long as they are in safe locations.
Other findings	Issues
	Makes some reference to potential for overuse of sites if not managed effectively.
Other findings	Opportunities
	The main purpose of their trips to the GOM was to go fishing (83%), followed by boating (10%) and snorkelling or diving (6%).
	The most frequented structures visited were standing rigs and oil production structures, followed by toppled submerged rigs and oil production structures, and Liberty ships (U.S. cargo ships from World War II) and other submerged vessels
Thoughts/reflections	1: Only covers boat owners and explores reasons for visitation of AR.

	Seaman et al 2011
Document type	Book chapter, included as also identified via snowballing
Title	Artificial reefs as unifying and energizing factors in future research and management of fisheries and ecosystems

Summary	Uses case studies to explore the contribution of artificial reefs to meeting different biodiversity management goals.
Geographic region	Multiple cases
Structure Type	Artificial reef
Stakeholders / sectors	Focus on fishing sector across each case study
Social values explored	None, biological focus only
Thoughts/reflections	0: Remove from review, book chapter that focuses on biodiversity outcomes with no incorporation of stakeholder values.

Ref ID# 18	Sahni et al 2011
Document type	Empirical Research, Peer-reviewed journal article
Title	Artificial Reefs and Mass Marine Ecotourism
Summary	Deploying artificial reefs on the seabed has become popular in diving management. This practice has been advocated as a means towards meeting both ecological concerns and recreational divers' demands for diversification and themed experiences. Nevertheless, the perceptions of the user community itself – the scuba divers – regarding the establishment of artificial reefs have received only limited attention in the literature. Their views on critical issues concerning artificial reefs remain, as a result, fairly vague and speculative. The aim of the current paper is to bridge this gap in the literature by presenting the results of a study exploring divers' attitudes and preferences with regards to the plan for a new artificial reef along the northern shore of the Red Sea in Eilat, Israel.
Geographic region	Red Sea in Eilat, Israel
Structure Type	Artificial reef
Stakeholders / sectors	Diving
Social values explored	Preferences for different AR forms, views on ecological benefits of ARs, diving motivations.
Methods:	What approach was adopted to engage stakeholders
	Six trained research assistants recruited the participants in nine different diving clubs
	What approach was adopted to identify and evaluate social values
	Survey. First, a list of prominent diving sites in Eilat was presented to the participants, who were asked to indicate the degree to which they prefer to dive at each site. The list includes both NRs (e.g. Japanese Gardens, Dekel Beach and Aqua Sport), and ARs (e.g. Satil, Yatush and Tamar Reef). The second part of the questionnaire measured preferences for potential forms/structures of the future AR to be positioned along the northern shore. Respondents were asked other relevant questions for planning and deploying ARs, such as their favoured depth and location for placing the AR, and what would be the implications of such a new AR on the frequency of their diving in this area. Participants also expressed their views with regards to the environmental impacts of an AR, its contribution to the diving experience and their general level of support for placing a new AR along the northern shore of the Israeli coast. The last section of the survey included references to the participants' socio- demographics and diving-related characteristics, including motivations for diving.
Findings	Social values [interrelationships, variability across stakeholder groups, potential impacts on or opportunities for]
	Most favoured AR structures by far were large naval ships and airplanes, followed by culverts. Other popular structures were small boats and barges, and replicas of coral reefs. The least favoured structures include tyres, concrete blocks, pipes, walls and cars or car parts.

	Slightly more than three-quarters (78.6%) of the respondents expressed the belief that a new AR would contribute to the natural marine environment. A higher percentage (more than 90%) stated that the AR would contribute to the diving experience, yet less than the tet (70.3%) indicated that the tet would be divine more foreworkly.
	There is a clear tendency towards preferring large objects as ARs, rather than small objects. One of the most popular diving sites was the Satil, which is a 45 m long missile boat, while smaller AR's (Yatush and Tamar Reef) received quite neutral scores.
	The respondents appear to favour structures that have a clear theme, rather than abstract forms.
	Experienced, highly trained divers were significantly more in favour of the deployment of ARs than less trained divers.
	Participants' declared motivations to dive include, 'relaxation' and 'special underwater feature', followed by 'expanding knowledge'
Other findings	Issues
Other findings	Opportunities
	To alleviate the pressure from the coral reefs and to increase the carrying capacity of the sites, ARs are being deployed world-wide to serve as underwater attractions (or theme parks) that can divert the lion share of divers from the more sensitive areas.
Thoughts/reflections	2: Provides some insight into diving sectors preferences in relation to AR.

	Simard et al 2016
Document type	Empirical Research, Peer reviewed journal article.
Title	Quantification of Boat Visitation Rates at
	Artificial and Natural Reefs in the Eastern
	Gulf of Mexico Using Acoustic Recorders
Summary	Artificial reefs are commonly used as a management tool, in part to provide ecosystem ser- vices, including opportunities for recreational fishing and diving. Quantifying the use of artifi- cial reefs by recreational boaters is essential for determining their value as ecosystem services. In this study, four artificial–natural reef pairs in the eastern Gulf of Mexico (off western Florida) were investigated for boat visitation rates using autonomous acoustic recorders. Digital SpectroGram (DSG) recorders were used to collect sound files from April 2013 to March 2015.
Geographic region	Gulf of Mexico
Structure Type	Artificial Reef
Stakeholders / sectors	NA
Other Findings	In every artificial–natural reef pair studied, significantly more boats visited the artificial reef site than the natural reef site.
	At the inshore locations, visitation rates at the artificial reef sites were approximately ten times higher than those at natural reefs. Differences in visitation rates were approximately eight times higher at the offshore artificial reef Pinellas II than the natural reef Caves
	The high rates of boat visitation at artificial reefs in comparison to natural reefs in this study are likely due to increased recreational value perceived by sport fishers.
	Recreational fishermen often report high success rates on artificial reefs [23,27], and the opinion that artificial reefs increase the amount of desirable species is shared by most users in Florida [24].
Social values explored	None – explores boat visitation rates only

Thoughts/reflections	0: No assessment of social values, externally (via digital records) examines boat visitation
	rates. Makes statements regarding the drivers of visitation to ARs, but these are not
	empirically tested (see 'other findings' above for example).

	Stolk et al 2005
Document type	Empirical research, Peer-reviewed journal article.
Title	Perceptions of Artificial Reefs as Scuba Diving Resources: A Study of Australian Recreational Scuba Divers
Summary	Marine-based recreation and tourism activities have experienced substantial growth over the past few decades and concerns about the ecological sustainability of many of these activities have been recognised by researchers, policy-makers and the recreation and tourism industries. One strategy to deal with diver-induced impacts is the creation of new or artificial reefs which, when established, can become substitute dive sites for more naturally occurring reefs. However, there have been very few studies into the acceptability of these substitute reef environments to divers and the social aspects of diving on artificial reefs. This paper explores the perceptions of diving on artificial reefs through a questionnaire survey of a sample of 337 Australian scuba divers.
Geographic region	Australia
Structure Type	Artificial reef
Stakeholders / sectors	Divers
Social values explored	None
Methods:	What approach was adopted to engage stakeholders
	Using a questionnaire, a sample of Australian recreational scuba divers was surveyed during the period August 2004 to June 2005. Participants were recruited by actively publicising information about the study, via print, radio and television, dive club newsletters and noticeboards, electronic mail bulletins from community organisations, internet chat rooms, news stories on websites and word of mouth communication
	What approach was adopted to identify and evaluate social values
	None reported
Findings	Social values [interrelationships, variability across stakeholder groups, potential impacts on or opportunities for]
	None reported
Other findings	Issues
	Not stated
Other findings	Opportunities
	Research Needs: Understanding scuba divers' attitudes, perceptions and satisfaction levels with regard to artificial reef environments is important in order to adequately plan for future sustainable tourism and recreation. If properly planned, designed and managed, artificial reefs may augment the supply of marine resources available to diving enthusiasts without compromising their preferred type of experience.
Thoughts/reflections	<ol> <li>Very strange paper, very detailed upfront (ie lit rationale and methods), then combines results and discussion and only discusses diver demographics and participation frequency, with not other results presented or discussed and no conclusion. Therefore, provide no contribution to our study.</li> <li>Has a small section on Busselton jetty, which might be useful if this becomes a case study</li> </ol>
	(see p. 158)

Ref ID# 24

Voyer et al 2017

Document type	Empirical Research, Peer-reviewed journal article
Title	Connections or conflict? A social and economic analysis of the interconnections between the professional fishing industry, recreational fishing and marine tourism in coastal communities in NSW, Australia
Summary	Resource conflict is a common feature of coastal management. This research examined the relationships between the three sectors (professional fishing, recreational fishing and broader coastal tourism) using economic valuations, qualitative interviews and a large- scale representative questionnaire of the general public. The results revealed highly interconnected and mutually supportive relationships, with professional fishing providing a range of services that benefit both tourism and recreational fishing. These results suggest that spatial management exercises that seek to segregate or remove one sector from an area, may be counter- productive to the interests of all these groups.
Geographic region	Australia, NSW
Structure Type	None – focus is on the fishing industry in general
Stakeholders / sectors	Professional fishing, recreational fishing and broader coastal tourism.
Social values explored	Relational dimensions of wellbeing – i.e. the interactions and relationships that help determine whether citizens are able to achieve what they value in life
Methods:	What approach was adopted to engage stakeholders
	Interviews with fishermen: Initial contact with interview participants was made in a variety of ways, including purposive sampling of industry bodies, cooperatives and community groups, opportunistic sampling (e.g. via advertising 'drop in sessions' through local media or industry channels) and 'snowball' sampling whereby people interviewed recommended additional people to contact. General public: A total of 1423 interviews were completed via computer assisted telephone interview (CATI). Survey focused on coastal residents Fish merchants and cooperatives: 77 interviews were completed via CATI. The sample was obtained partly from pre- existing contacts, especially the fishing cooperatives, and partly from a random selection from public phone records Tourism and hospitality providers: An online questionnaire of the tourism and hospitality industry. The survey was distributed through a range of channels including regional and local tourism bodies and industry groups in coastal NSW.
	What approach was adopted to identify and evaluate social values
	Focus: Detailed examination of how professional fishing interacts with recreational fishing and tourism sectors in coastal communities. The fieldwork commenced with a series of qualitative interviews (160) which identified features of these relationships that warranted closer examination. Further quantitative data was collected based on these key themes using economic and social questionnaires. Interviews were audio recorded and transcribed in full. All the transcripts and interview notes were entered into NVivo 10 and coded to identify key themes
Findings	Social values [interrelationships, variability across stakeholder groups, potential impacts on or opportunities for]
	Social and economic interactions between the different user groups were examined, ie between professional and recreational fishing; followed by between professional fishing and tourism sectors. Found that social and economic interactions were generally positive, and uses the fidnings as a basis for rejecting management approaches that focus on segregation or removal of certain groups. Some of the interrelationships identified include: (i) professional and recreational fishing: recreational and professional fishing sectors supported each other economically and socially through the bait industry. 35% of respondents identified as recreational fishers. Of them, 78% agreed or strongly agreeing that they preferred local bait, even if it is more expensive. This support is primarily driven by a desire to support the local community (90% agree); (ii) professional fishing and

	tourism: contribution of the industry to tourism through the provision of sought-after seafood meals for visiting tourists and via the provision of an experience for visitors wishing to witness fishing practices or a working harbour.
Other findings	Issues
	Conventional valuation approaches to fisheries were conducted as part of this project and they found that a direct comparison of the economic values of professional fishing with the other two competing sectors would likely result in a decision to favour the prioritisation of recreational fishing and tourism. Comparisons of this nature have been used in the past to justify calls to restrict professional fishing in Australia. The broader analysis, however, highlights the dangers inherent in such a narrow assessment of the value of a particular industry.
Other findings	Opportunities
	Value of Social Assessment: Relying on economic valuations of each sector as if they stand alone is insufficient to adequately understand their roles in local communities. Resource allocation decisions should be based on evaluations that consider the interconnections between sectors, and consider whether negotiated sharing of resources may provide greater community benefits than excluding certain groups of users.
Thoughts/reflections	2. Good paper with a specific focus on social interactions and benefits of three sectors, but no focus on offshore marine infrastructure. Argues that looking beyond purely economic measures to consider contributions in context with a range of other factors – specifically how the industry supports and interacts with other important sectors in regional economies, and the extent to which local communities value those contributions, is a very valuable process that provides a greater understanding of the management issues/goals.

	Klaoudatos et al 2012
Document type	Journal Article – Discussion paper
Title	The greek experience of artificial reef construction and management.
Summary	This paper discusses the importance of having clear management protocol for artificial reefs and how this can benefit the environment as well as social and economic factors.
Geographic region	Greece
Structure Type	Artificial Reefs
Stakeholders / sectors	N/A
Social values explored	Acceptance of artificial reefs from stakeholders
Methods:	What approach was adopted to engage stakeholders
	N/A
	What approach was adopted to identify and evaluate social values
	N/A
Findings	Social values [interrelationships, variability across stakeholder groups, potential impacts on or opportunities for]
	No findings as no research process appears to be engaged in
Other findings	Issues
	If the community opposes the development of an artificial reef they will not engage in research and preliminary development
Other findings	Opportunities
	Artificial reefs can increase employment and further expand infrastructure – theme park, tourist shops, hotels, restaurants
	Success of artificial reef is dependent on the support of the community – willingness to help with research and preliminary development

Thoughts/reflections	1: though it does mention some social impacts that artificial reefs can have a lot of them
	are not backed up with references. Launches straight from aims to a discussion.
	References that would be available for snowballing are only in Greek. No stakeholder
	consultation and heavy management focus.

Ref ID# 25	Stolk, Markwell, & Jenkins, 2007
Document type	Peer Review Journal Article
Title	Artificial reefs as recreational scuba diving resources: A critical review of research.
Summary	This paper systematically reviews literature relating to scuba divers recreational use of artificial reefs, examines papers for salient themes and presents a conceptual model of artificial reef dive experience. Key salient themes found in literature were: social dimensions, socioeconomic impact and environmental engineering. The proposed conceptual model described diver experience from the domains of influential factors, significant outcomes and the relationship. Article also provides a definition of artificial reefs.
Geographic region	No specific region – literature review of ARs around the worlds: USA, Japan, Europe, Taiwan, Australia, South Africa and New Zealand
Structure Type	Artificial Reefs
Stakeholders / sectors	Recreational scuba divers
Social values explored	Artificial reefs as marine tourism and recreational resources
	Recreational divers structure preferences
	Recreational divers user type preferences
Methods:	What approach was adopted to engage stakeholders
	No stakeholder engagement – literature review
	What approach was adopted to identify and evaluate social values
	Review 6 papers found that specifically explore scuba divers recreational use of artificial reefs from the lens of social dimensions, socioeconomic impact and environmental engineering
Findings	Social values [interrelationships, variability across stakeholder groups, potential impacts on or opportunities for]
	Social dimensions Recreational divers have preferences for artificial reefs based on factors, including: the reef's structure, size, location, depth, resident species and surrounding sea conditions Exclusion of recreational user groups from artificial reefs may improve recreational scuba diver experience Socioeconomic dimensions Consumptive and non-consumptive recreational divers cannot operate on the same
	protection for artificial reef sustainability
	Environmental engineering dimensions
	Creation of specifically engineered recreational diving areas of differing complexity is seen as a way of maximise diver enjoyment
Other findings	Issues
	Divers attitudes must be understood to plan for sustainable tourism
Other findings	Opportunities
	promoting ecotourism-related activity around these artificial reefs may: Redistribute tourist activity away from at-risk locations Increase tourist access to environmental areas easier access for most potential visitors than ecotourism in pristine natural areas;

	Provide the opportunity for more socioeconomic research
Thoughts/reflections	2: provide definition of artificial reefs which may be useful in future. No direct
	stakeholder engagement but explores social values found in other studies. Good for
	snowballing. As only 6 articles were reviewed would probably be better of reading those
	articles to see if they are relevant.

	Strickland-Munro et al 2015
Document type	Technical Report
Title	Values and aspirations for coastal waters of the Kimberley: social values and participatory mapping using interviews
Summary	This report aimed to explore social values and aspirations towards coastline and marine environment of stakeholders in the Kimberly (Perth and Darwin) over a 3 year period. This was achieved by conducting mapping exercise and semi-structured interviews. Man- made aquatic infrastructure is not specifically explored however, social values are explored in-depth. Paper discusses major themes found within 4 key use areas direct use, consumptive, direct use non-consumptive, indirect use and non-use values.
Geographic region	Kimberly Region, Western Australia
Structure Type	N/A broad coastal and marine region
Stakeholders / sectors	Aboriginal traditional owners
	Aboriginal and non-Aboriginal residents
	Tourists and the tourism industry
	Commercial and recreational fishing
	Aquaculture
	Federal, state and local government
	Mining, oil, gas and tidal energy interests
	Marine transport and aviation
	Environmental and non- government organisations
Social values explored	Direct use, non-consumptive values
	Physical landscape
	Aboriginal culture
	Therapeutic
	Recreation-other
	Social interaction and memories
	Experiential
	Learning and research
	Historical
	Spiritual
	Direct use, consumptive values
	Recreation-camping
	Recreation-fishing
	Subsistence
	Economic-tourism
	Economic–commercial fishing, pearling and aquaculture
	Indirect use values
	Biodiversity
	Non-use values
	Bequest

	Existence
Methods:	What approach was adopted to engage stakeholders
	Data collection relied on face-to-face, semi-structured interviews consisting of 8-10 open- ended questions
	Questions were based on literature exploration and had a focus on eliciting values related to the Kimberly area
	Participants were also asked to mark areas on a map of the Kimberly region of areas the saw value in
	What approach was adopted to identify and evaluate social values
	Interviews: analysed using grounded theory an inductive technique generating themes
	from constant comparison of patterns and emerging concepts. Emergent concepts were then organised according to the values typology: (1) direct use, non-consumptive values; (2) direct use, consumptive values; (3) indirect use values; and (4) non-use values
	Maps: spatial analysis was conducted to see commonalities in areas of value and place numerical values on these areas
Findings	Social values [interrelationships, variability across stakeholder groups, potential impacts on or opportunities for]
	Below the key themes are listed along as categorised by the types of use and % of how often they were discussed in interviews
	Direct use, non-consumptive values
	Physical landscape (77%): aesthetics, tidal phenomenon, coastal geology, unique nature experiences, the Kimberley's 'pristine untouched environment'
	Aboriginal culture (63%): cultural sites, connection to country, evidence of historical use, and transmission of cultural knowledge
	Therapeutic (62%): make people feel mentally better, calm, or recharged. Major elements: escapism, relaxation, remoteness, and personal recharge
	Recreation–other (62%): exploration of environment
	Social interaction and memories (56%): social experience and home/ childhood memories
	Experiential (51%): adventure, iconic destination, blown away experience, private experience
	Learning and research (34%): Typically expressed in terms of scientific research, but also monitoring, exploration, discovery and more generally the ability to learn about the environment
	Historical (19%): European and missionary history
	Spiritual (11%): nature as a spiritual landscape
	Direct use, consumptive values
	Recreation–camping (58%): places that offer recreational activities centred on overnight or longer stays in transient and/or fixed accommodation in coastal areas
	Recreation–fishing (54%): places that offer recreational activities relating to the catching of fish species as well as gathering of other marine life
	Subsistence: subsistence food collection and fresh water provision
	Economic–tourism (44%): Generic tourism values, or more specifically refers to eco or nature based tourism, or Aboriginal cultural tourism.
	Economic–commercial fishing, pearling and aquaculture (24%): Values derived from commercial fishing, aquaculture and pearling activities
	Indirect use values
	Biodiversity (80%): marine fauna, reef biodiversity, migratory shorebirds and mangroves Non-use values

	Bequest (7%): places that offer future generations the ability to know and experience places, landscapes and habitats as they are no
	Existence (4%): knowing that a particular place, environmental resource and/or organism exists, regardless of having physically been to or directly used an are
Other findings	Issues
Other findings	Opportunities
	Implications for future management as the area is highly valued by both aboriginal and non-aboriginal stakeholders – they should be involved in the decision making process
	Must consider social impacts always when planning for development
Thoughts/reflections	1: though man-made aquatic infrastructure is not explored specifically the study focuses heavily on social values within the Kimberly region. As such, that report may be useful for providing baseline insights into how stakeholder groups feel about the environment. Also gives insights into types of research that have already been conducted around this area. May be useful for comparison with future data that is collected. Flag for use for causal model.

Ref	Taylor et al 2017
Document type	Peer Reviewed Journal Article
Title	Fisheries enhancement and restoration in a changing world.
Summary	This paper discusses the importance of maintaining fisheries and how they can provide an environment where things like aquaculture technology, quantitative modelling, social science, physiology and ecology can interact. These interactions can be used to estimate enhancement potential, improve enhancement strategies, assess enhancement outcomes, and support adaptive management.
Thoughts/reflections	0: upon reading there were 2 papers discussed within this paper that seemed within scope. One paper was already found using databases and the other was added to snowballing. Beyond that this paper does not seem like it would add value as there is no in depth stakeholder engagement or social value focus. Removed from review.

	Tessier, et al 2015
Document type	Peer Reviewed Journal Article
Title	Assessment of French artificial reefs: due to limitations of research, trends may be misleading
Summary	This report explored research trends relating to artificial reefs in France from the 90s onwards. Areas explored included fish populations, reef design, ecology richness, and stakeholder perceptions towards artificial reefs. Overall findings suggest that more long term research should be conducted within the areas of trophic dynamics, ecological connectivity of habitats, and socioeconomics.
Geographic region	France
Structure Type	Artificial reefs
Stakeholders / sectors	Not specifically stated: Commercial/recreational fishermen Recreational divers Recreational fishermen
Social values explored	Effectiveness to maintain artisanal fishing How social value is explored on ARs Management implications
ivietnoas:	what approach was adopted to engage stakeholders

	N/A Literature review of 45 articles relating to France and artificial reefs from the 90s onwards
	What approach was adopted to identify and evaluate social values
	N/A review of the literature
Findings	Social values [interrelationships, variability across stakeholder groups, potential impacts on or opportunities for]
	no socioeconomic research concerning impact, cost- benefit and cost-effectiveness analyses has been conducted for ARs in France
	Fishermen concern with AR deployment is if they will catch more after deployment
	Experimental fishing is the most common sampling technique used to test if fishing yield increased after AR deployment
	Majority of fishers new that the ARs existed but not know the exact location
	Currently, user views of ARs are becoming broader.
	ARs are perceived as multiuse
	Perceptions of ARs have implications on future management
Other findings	Issues
	Socioeconomic research in combination has not been conducted yet
	Few studies researching non-professional use of ARs and social value
Other findings	Opportunities
	Funding for artificial reefs in France has increased
	All potential stakeholders should be considered in social value of AR research
Thoughts/reflections	1: study mentions social values but has very limited discussion on social value – this may reflect the limited availability of social value research on artificial reefs in France. Relevant papers have been pulled out for snowballing purposes however some were only in French.

	Ten Voorde et al 2009
Document type	Peer reviewed journal article
Title	Designing a preliminary multifunctional artificial reef to protect the Portuguese coast
Summary	Article focuses on optimising design of artificial reefs so that it can be used for multiple purposes. Tests of geometry of proposed reef are performed to assess suitability.
Thoughts/reflections	0: no social value focus. Design of artificial reef focus for multiple functions like surfing.

Ref ID #8	Ten Brink & Dalton 2018
Document type	Peer Reviewed Journal Article
Title	Des Perceptions of commercial and recreational fishers on the potential ecological impacts of the Block Island Wind Farm (US)
Summary	Researchers interview commercial and recreational fisher to understand their perceptions of how offshore windfarms has affected fishing behaviour and fish ecology before during and after construction. Themes are organised by behavioural and ecological impacts.
Geographic region	Rhode Island, USA
Structure Type	Block Island Wind Farms (BIWF)
Stakeholders / sectors	Recreational or Commercial Fishers

Social values explored	Past and current uses and perceptions of change before and after wind turbines were constructed and operational (ecological and behavioural impacts)
Methods:	What approach was adopted to engage stakeholders
	Purposive sampling to invite participants to engage in a semi-structured interview. tried to recruit fishers from across a diversity of commercial and recreational gear types and different home ports.
	Interviews focus on interviewees:
	<ul> <li>Fishing experience and use of the study area before the construction of the BIWF</li> <li>Use of the area and any ecological changes in the area during construction of the BIWF</li> <li>Perceptions of any changes in the area and uses of the area after the BIWF was constructed</li> <li>How individual behaviors in the area changed as a result of the BIWF</li> </ul>
	behavioural or ecological
Findings	Social values [interrelationships, variability across stakeholder groups, potential impacts on or opportunities for]
	Increased recreational fishing in the area since the turbines were constructed – wind turbines may function as a landmark
	Wind turbines may provide ability to catch targeted species of fish
	Turbines viewed as an eyesore but others enjoyed the visual aesthetics
	Concerns over having to navigate around the infrastructure
	Recreational and commercial fishers not compensated for loss of access during construction
	Perceived loss of productive fishing ground
	Influx of recreational fishers causes loss of ground for commercial fishers (feelings of displacement)
	More commercial rod and reel fishers in the areas since building
	Positive reception for energy production of BIWF
	Concern about how or if the BIWF would be decommissioned in the future
	BIWF create new structure for fish – artificial reef though many felt that it had had no
	difference on the amount/species of fish
	Construction scared away fish
Other findings	Issues
	Intrastructure as an eyesore
Oth an fin dia an	Loss – gear, fishing ground, money, fish available during construction
Other findings	Desite in the second se
	Building mirastructure has meant increased fishing activity in the area
The	Provide nabitat for fish
i nougnts/retiections	3: In depth examination of perceptions of two stakeholder groups before and after the construction of man-made aquatic infrastructure. Concept of asking for perceptions before AND after is interesting

	Kevin Leleu et al 2012 (From Tessier, et al 2015)
Document type	Peer Reviewed Journal Article
Title	Fishers' perceptions as indicators of the performance of Marine Protected Areas (MPAs)

Summary	This paper studies fishers perceptions of marine protected areas, in particular two no- take zones that exist within this area. No take-zones in this area ban fishing and harvesting, scuba diving and anchoring. Artificial reefs exist near but not in these areas to prevent trawling.
Geographic region	North Western Mediterranean, Parc Marin de la Coste Bleue, France
Structure Type	Marine protected area no-take zone with artificial reefs
Stakeholders / sectors	Isn't clear if recreational or commercial fishers
Social values explored	How NTZs affect artisanal fishery in general
	The balance between loss of fishing grounds and NTZ benefits
	Fishing interest near the NTZs
	The seniority of fishers (number of years they have been fishing within the MPA)
Methods:	What approach was adopted to engage stakeholders
	Fishing activity: estimate for the year and The choice of gear, the species targeted and the fishing grounds, asked to plot where they fish on maps
	Semi-structured interviews: to appraise their perception of the effects of the NTZs on their own activity, on the artisanal fishery in general and on the marine ecosystem, perceptions of loss of fishing ground and if they would use the ground if the no-take zone did not exist, and the most important factors guiding their fishing spot choice.
	What approach was adopted to identify and evaluate social values
	Qualitative answers were assessed quantitatively using frequency of answer
Findings	Social values [interrelationships, variability across stakeholder groups, potential impacts on or opportunities for]
	No negative perception of the effects of NTZs, with the exception of a slight impression that losses exceed
	Positive opinions towards no-take zones were most predominate
	Fishers had more negative or neutral perceptions about the no-take zones when evaluating how it impacted their own activity when compared to ow they evaluated broader activity other than their own such as the ecosystem or overall effects
	positive perceptions are inversely linked to seniority. Fishers with less seniority seem to be more attracted by the zone adjacent to the NTZs than those with more seniority – seniority in the number of years they have been fishing
	Minimal fishers expressed an interest in fishing more frequently near the NTZs, even when they regarded the NTZs as being beneficial
	The most important factors involved in the choice of a fishing location were fish abundance (44%), presence of suitable habitats (38%), harbor proximity (31%) and weather (13%)
Other findings	Issues
	Fishers are concerned with how NTZ impact their own activity more than the broader impacts it may have
Other findings	Opportunities
	High degrees of social acceptance of MPA and NTZs may be explained by good management and research that engages and informs the community
Thoughts/reflections	1: does not specifically assess man-made marine infrastructure. HOWEVER, explores social values and no-take zones which is something that may relate to infrastructure e.g. oil and gas platforms are no take zones, when developing artificial reefs a temporary no-take zone may have to be put in place.

	Garlock and Lorenzen 2017 (From Taylor et al 2017)
Document type	Peer Reviewed Journal Article
Title	Marine angler characteristics and attitudes toward stock
	enhancement in Florida
Summary	This study explores fishers perceptions towards ways of managing of managing fish populations. Attitudes explored focus on fishing using a quantitative survey that asks questions like "When I go fishing, I'm not satisfied unless I catch at least something'. Management tools include restricting size limits, stocking hatchery-reared fish, restoring habitats or providing artificial habitats.
Geographic region	Florida
Structure Type	Artificial structures/habitats
Stakeholders / sectors	Recreational Angler Fishers
Social values explored	Perceptions of methods for managing fish populations
Methods:	What approach was adopted to engage stakeholders
	Internet-based survey was used to collect information from anglers on their fishing behavior and experience, fishing preferences, motivations, demographics and attitudes toward fisheries management options including stock enhancement
	What approach was adopted to identify and evaluate social values
	Quantitative analysis of the Likert scale answers
Findings	Social values [interrelationships, variability across stakeholder groups, potential impacts on or opportunities for]
	60% of inshore anglers supported stock enhancement whereas support for providing artificial habitat and for protecting or restoring degraded habitat was considerably greater, 76% and 85% respectively
Other findings	Issues
Other findings	Opportunities
	Majority of responders agreed that some form of management for fish populations should be put in place
Thoughts/reflections	1: study has more of a focus on increasing fish populations and providing ways of doing that. Small focus on artificial reefs as an option of population numbers which is the only reason this paper should not be removed.

	Brock, 1994 (From Stolk, Markwell, & Jenkins, 2007)
Document type	Peer Reviewed Journal Article
Title	Beyond fisheries enhancement: Artificial reefs and ecotourism
Summary	This study explores how artificial reefs can be used to improve and increase fish populations and tourism in communities. Researchers evaluate these two areas using an economic lens. No social value.
Thoughts/reflections	0; no social value, observation more than stakeholder engagement. Removed from review.

Ref ID# 22	Ditton et al 2002 (From Stolk, Markwell, & Jenkins, 2007)
Document type	Peer Reviewed Journal Article
Title	Demographics, attitudes, and reef management practices of sport divers in offshore Texas waters

Summary       This study aimed to characterise the recreational diver activity in reaso ffshory reefs. Researchers wanted to examine and understand this stakeholder groups demographic characteristics, participation patterns, level of involvement in spo diving motivations, attitudes, and management preferences.         Geographic region       Texas, USA         Structure Type       Artificial Reefs         Stakeholders / sectors       Recreational divers         Social values explored       Artificial reef structure preference         Importance values of artificial reefs       Attitude values towards artificial reefs         Methods:       What approach was adopted to engage stakeholders         Stepwise approach:       1.         1.       Inventory of dive charter boat operators was completed in 1997         2.       Dive boat operators to survey of their customers to select a random sam their clientele         3.       Data collected of recreational divers using a mail questionnaire: Question assessed overall sport diving activity and experience, saltwater scuba div activity in Texas and elsewhere, reefs, water depth preferences in the G Mexico, and motivations for the "last diving trip" to the Texas coast, and demographic information of the divers.         Vehat approach was adopted to identify and evaluet social values       Quantitative analysis of survey         Findings       Social values [interrelationships, variability across stakeholder groups, potential i or opportunities for]         Individuals who divied on ARs reported	ertificial diving,
Geographic region         Texas, USA           Structure Type         Artificial Reefs           Stakeholders / sectors         Recreational divers           Social values explored         Artificial reef structure preference Importance values of artificial reefs           Methods:         What approach was adopted to engage stakeholders           Stepwise approach         1. Inventory of dive charter boat operators was completed in 1997           2.         Dive boat operators to survey of their customers to select a random sam their clientele           3.         Data collected of recreational divers using a mail questionnaire: Question assessed overall sport diving activity and experience, saltwater scuba div activity in Texas and elsewhere, reefs, water depth preferences in the GL Mexico, and motivations for the "last diving trip" to the Texas coast, and demographic information of the divers.           What approach was adopted to identify and evaluate social values         Quantitative analysis of survey           Gocial values [interrelationships, variability across stakeholder groups, potential i or opportunities for]         Individuals who dived on ARs reported diving in both fresh and saltwater           R divers reported they participated in night-diving (81%), underwater photogr (53%), wreck diving (52%), and marine identification (52%), and spear fishing (2 The most preferred AR material was large naval ships (68.4%) with oil productio structures as second (17.7%)           Importance statements         More than 50% of the divers rated 12 out of 15 experience motivations for divi as very or as ext	le of
Structure Type         Artificial Reefs           Stakeholders / sectors         Recreational divers           Social values explored         Artificial reef structure preference Importance values of artificial reefs           Methods:         What approach was adopted to engage stakeholders           Stepwise approach:         1.           1.         Inventory of dive charter boat operators was completed in 1997           2.         Dive boat operators to survey of their customers to select a random sam their clientele           3.         Data collected of recreational divers using a mail questionnaire: Question assessed overall sport diving activity and experience, saltwater scuba div activity in Texas and elsewhere, reefs, water depth preferences in the G Mexico, and motivations for the "last diving trip" to the Texas coast, and demographic information of the divers.           What approach was adopted to identify and evaluate social values         Quantitative analysis of survey           Findings         Social values [interrelationships, variability across stakeholder groups, potential i or opportunities for]           Individuals who dived on ARs reported diving in both fresh and saltwater AR divers reported they participated in night-diving (81%), underwater photogr (53%), wreck diving (52%), and marine identification (52%), and spear fishing (2 The most preferred AR material was large naval ships (68.4%) with oil productic structures as second (17.7%)           Importance statements         More than 50% of the divers rated 12 out of 15 experience motivations for divi as very or as extremely important	le of
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<ul> <li>Experience adventure</li> <li>Get away from demands Experience tranquillity</li> </ul>	
Get away from demands Experience tranquillity	
I o be with friends	
For the exercise	
Develop skills and abilities	
<ul> <li>Get away from routine</li> <li>New and different things Spearing fish to eat</li> </ul>	
Attitude statements	
Most AR divers agreed with five of the nine attitude statements asked:	
<ul> <li>Mooring buoys should be provided at all artificial reef sites 80%</li> <li>Certain artificial reefs should exclude spear-gun fishing' 73%</li> <li>more funds should be used to deploy large naval ships as reefs' 72%</li> <li>Certain reefs should be designated for specific uses such as for diving only recreational fishing only 71%</li> <li>All sub- merged artificial reefs should be identified with marking buoys 695</li> <li>82% disagreed that there were currently too many AB</li> </ul>	

Other findings	Issues
	Limited stakeholder engagement outside of "sports divers"
Other findings	Opportunities
	Future opportunity for more engagement with other stakeholder groups
Thoughts/reflections	2: good study for exploring a particular stakeholder group. Does not go in depth as to WHY they have these values/attitudes etc.

	Milon, 1989 (From Stolk, Markwell, & Jenkins, 2007)
Document type	Peer Reviewed Journal Article
Title	Artificial marine habitat characteristics and participation behavior by sport anglers and divers
Summary	Researchers used a mail survey to assess the use of reefs habitats available on Florida by recreational anglers and divers. Socioeconomic and demographic values are assessed using the survey. Different use values are placed on artificial reefs by the two stakeholder groups.
Geographic region	Florida
Structure Type	Artificial Reefs
Stakeholders / sectors	Recreational Anglers and Divers
Social values explored	Objective for using artificial reef
Methods:	What approach was adopted to engage stakeholders
	Mail surveys were sent out to private registered boat owners and assessed:
	Participation in fishing and diving activities for the prior 6 months.
	General descriptive information about boats and socioeconomic characteristics.
	Report specific details about most recent trip and type of environment visited: natural or artificial, time spent at specific sites, the size of the party, and the number and weight offish harvested
	Rate reasons for using artificial reefs
	What approach was adopted to identify and evaluate social values
	Binomial logit analysis and multinomial logit analysis
Findings	Social values [interrelationships, variability across stakeholder groups, potential impacts on or opportunities for]
	Objective for use in order form highest rated to lowest:
	Anglers
	Better chance of harvesting fish
	Previous success at reef sites
	Easy to locate
	Proximity to shore
	Proximity to other boats
	Recommendations from others
	Divers
	Easy to locate
	Previous success at reef sites
	Proximity to shore
	Recommendations from others
	Better chance of harvesting fish

	Proximity to other boats
Other findings	Issues
	Users prefer sites that are in close proximity to their launch area
Other findings	Opportunities
	reef users were likely to be more avid anglers or divers who were better informed and better equipped to locate the reef sites – importance of prior knowledge
Thoughts/reflections	1: explores social values of two specific stakeholder groups but does not go in depth as to why and has limited responses by giving set reasons for use.

	Tompkins, Few, Brown, 2008 (From Kienker et al 2018)
Document type	Peer Reviewed Journal Article
Title	Scenario-based stakeholder engagement: incorporating stakeholders preferences into coastal planning for climate change
Summary	
Thoughts/reflections	0: looking at climate change and social value/stakeholder opinions rather than a focus on man-made aquatic infrastructure. Must be noted that they are using a decision support system and that this paper could be useful later on when justifying workshop techniques.

Ref ID #21	Evans et al 2017 (From Kienker et al 2018)
Document type	Peer Reviewed Journal Article
Title	Stakeholder priorities for multi-functional coastal defense developments and steps to effective implementation
Summary	This study employed a Delphi technique to extract informaiton from experts regarding planning priorities for coastal defence developments, potential second-hand benefits from costal defence development and their priorities, overall support for coastal defence development that have multiple functions, consensus of perceptions across stakeholder groups and steps/implementation moving forward. Costal defense developments can include sea walls, reinforcing already existing seasides/beachers, artificial reefs, concrete blocks etc. Once stakeholder perceptions were determined they were asked to rank them in order of perceived importance and preferred importance
Geographic region	England and Wales
Structure Type	Misc. multipurpose costal defense structures
Stakeholders / sectors	Academic non-specialist
	Academic Specialist
	Conservation
	Ecological Consultant
	Engineering Consultant
	Local Authority
	Statutory Bodies
Social values explored	Importance considerations values
	Potential secondary benefit values
	Reasons for multifunctionality
	Barriers to effective implementation
Methods:	What approach was adopted to engage stakeholders
	Initial survey: indicate level of support for traditional and then multi-functional coastal

	defense structures on a Likert scale. This was used to inform the Delphi survey
	Delphi survey: questions are asked over a number of rounds, and between each round, responses are analysed and fed back to the panel in an iterative process. 3 rounds 1
	scoping and 2 convergence.
	<ul> <li>What are the most important considerations when planning coastal defense works (i.e. construction or maintenance of engineered coastal defense structures)?</li> <li>What are the potential secondary benefits of engineered coastal defense structures (i.e. beyond their primary function of providing protection against flooding and erosion)?</li> <li>Would you be more supportive of the construction of additional coastal defenses around the UK if they were multi-functional structures (i.e. ones that deliver</li> </ul>
	secondary ecological and/or socio-economic benefits)? Why?
	What approach was adopted to identify and evaluate social values
	Quantitative analysis for preliminary survey (ANOVA)
	Qualitative analysis for Delphi approach with 3 rounds (1 scoping 2 convergence) then analysis of data for themes (Nvivo) after the scoping round. Convergence rounds individual ranks participants ranked themes that came out of initial round by importance. Box and whisker plots of median scores, interquartile ranges and outliers were plotted to visually assess the level of consensus among the panel.
Findings	Social values [interrelationships, variability across stakeholder groups, potential impacts on or opportunities for]
	Perceived priority rankings (in order from most important to least)
	Essential criteria
	Cost
	Net socio-economic impacts on local communities and businesses
	Net ecological impacts
	Net landscape impacts
	Level of community support
	Net culture and heritage impacts
	Carbon footprint
	Opportunities for research and development
	Opportunities for education and outreach
	Preferred Priority ranking
	Essential criteria
	Net ecological impacts
	Cost
	Net landscape impacts
	Carbon footprint
	Opportunities for research and development
	Level of community support
	Net culture and heritage impacts
	Opportunities for education and outreach
	High consensus of ranking across stakeholder groups however views on cost varied greatly
	All agreed that essential criteria is the most important
	Education and opportunities for outreach was consistently the least important

	Secondary values (in order highest value to lowest)
	Habitat for natural rocky shore communities
	Habitat for species of conservation interest
	Refuge for exploited species
	Habitat heterogeneity in structure design
	Enhanced commercial fisheries
	Safeguarded biosecurity
	Enhanced amenity/recreation
	House other technologies
	Mariculture opportunities
	Reduced carbon footprint
	Opportunities for research and development – investigating marine/coastal ecology
	Enhanced landscape value
	Opportunities for education and outreach
	Enhanced culture and heritage value
	Potential for reasons for building-in secondary benefits (in order from highest to lowest)
	Positive ecological impacts
	Divert pressure from natural systems
	Positive socio-economic impacts on local communities and businesses
	Increase likelihood of scheme progression
	Reduce maintenance requirements
	Research and development
	Enhance/safeguard landscape
	Education and outreach
	Education and outreach Culture and heritage
Other findings	Education and outreach Culture and heritage Issues
Other findings	Education and outreach Culture and heritage Issues Barriers to implementation (in order from most common to least)
Other findings	Education and outreach Culture and heritage Barriers to implementation (in order from most common to least) Developments driven by cost and funding priorities
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	Develop 'products' that can be incorporated into scheme designs
	Develop new technologies to improve potential of multi-functional structures
	Expand beneficiary pays principal to include secondary benefits
	Collaborate with EU/international partners (knowledge exchange)
Thoughts/reflections	2: good stakeholder engagement and clear ranking of what stakeholders see as
	important for costal defense. In terms of current research is simultaneously too specific
	and to broad. Specific for coastal defense systems but within that there is some mention
	of artificial reefs etc but also unclear as to which values relate to which types of costal
	defense structures. However, structures in current research are often multifunctional
	meaning that this paper can be useful.

Ref ID# 23	Morris et al 2016 (From Kienker et al 2018)
Document type	Peer Reviewed Journal Article
Title	Eco-engineering in urbanised coastal systems: consideration of social values
Summary	Researchers engaged with local community to gain insights into perceptions surrounding modifications to costal seawalls that may result in loss of habitat and marine destruction. The study focuses on costal habitat destruction/environmental issues, the value of the overall marine environment and attitudes towards eco-engineering research.
Geographic region	Sydney, Australia
Structure Type	Flowerpot enhancements to Seawalls
Stakeholders / sectors	Community surrounding the seawall – no specific groupings
Social values explored	The value of Sydney harbour
	Attitudes towards eco-engineering research
	Views on coastal habitat destruction/environmental issues
Methods:	What approach was adopted to engage stakeholders
	Survey 1: sent out online during the initial phases of the flowerpots via local community groups and community events. Contained quantitative Likert based closed questions and two open ended questions that asked List three threats to the health of the natural environment in your local area'; 'In a word or short sentence what comes to mind when you think about the harbor coastline'. Survey 2: sent out during later phases of the flowerpot construction and contained only quantitative Likert based closed questions. Online survey was distributed via local newspapers, council websites, community events Both Surveys: which covered three themes: coastal habitat destruction as an environmental issue; the value of Sydney Harbor marine environment; and (attitudes towards eco-engineering research, in addition to some initial demographic questions
	What approach was adopted to identify and evaluate social values
	Quantitative analysis was conducted on closed question responses. Word clouds were used to assess open ended answers
Findings	Social values [interrelationships, variability across stakeholder groups, potential impacts on or opportunities for]
	All respondents view the Sydney Harbour as valuable
	Marine environment is perceived as valuable
	In survey 1 one half stated that aesthetics was the most important reason for harbour value
	In survey 2 wildlife was cited as the most important reason for value by just under half of the participants

	community participation is seen as important for maintaining a healthy harbor
	environment
	Disclosing the cost of the flowerpot project had no effect on the views and perceptions
	of participants
Other findings	Issues
	N/A overall a positive views/perceptions.
Other findings	Opportunities
	Desire for community to be involved in marine research, eco-engineering and
	interventions
	Participants willing to compromise aesthetics of structures if it benefited the marine
	environment
Thoughts/reflections	2: good study that assess a type of man-made marine infrastructure. Only downfall is
	that stakeholders are not categorised which limits application of findings to broader
	sense.

	Shafer and Inglis 2000 (From Belhassen et al 2017)
Document type	Peer Reviewed Journal article
Title	Influence of Social, Biophysical, and Managerial Conditions on Tourism Experiences Within the Great Barrier Reef World Heritage Area
Summary	Researchers explored the variation between tourism groups visting the great barrier reef (size, duration etc) and if/to what extent social, biophysical and managerial aspects impacted these variations (being close to nature, spending time with family).
Thoughts/reflections	O: a lot of focus on social values relating to tourism and tourism of natural marine environments. No mention of artificial marine environments. Though social value is discussed it seems out of scope – other MPA articles kept in refer to artificial environments in some way or it is not specifically stated that it is ONLY natural environment. A lot of the engagement influencing factors are also heavily dependent on the environment e.g. weather, types of fish, coral, being close to nature OR things that are not only relatable to tourism and reefs (being close to family). Removed from review.

	Jentoft 2000 (From Barclay et al 2017)
Document type	Peer Reviewed Journal Article
Title	Beyond fisheries management: The Phronetic dimension
Summary	Researcher explores how the changes in development of fisheries and how they are managed. Paper explores if political and social aspects of managing fisheries are as important as technical and scientific aspects and what implications this may have on research and responsibility for managing these fisheries.
Thoughts/reflections	O: seems out of scope – arguing the importance of social science/politics for fisheries and management of fisheries. No stakeholder engagement or measurement of social values relating to man-made aquatic infrastructure. Removed form review.

Ref	Bradshaw, Wood, & Williamson, 2001 (From Barclay et al 2017)
Document type	Peer Reviewed Journal Article
Title	Applying qualitative and quantitative research: a social impact assessment of a fishery.
Summary	Study aimed to demonstrate the efficacy of using qualitative and quantitative methods of a social impact assessment to explore a Tasmanian Rock Lobster fishery a social economic profile of a Tasmania Rock Lobster Fishery. Researchers aimed to provide a baseline socioeconomic profile of the Tasmanian rock lobster industry in late 1997 and

	also examine the implication that changes to catch quotas would have on for costal communities.
Thoughts/reflections	0: socioeconomic focus seems to lean more towards economic side than social when building baseline. No man made aquatic infrastructure. Social value that is explore more how changes to catch quota management would impact the community – seems out of scope. Removed from review.

	Barclay 2012
Document type	Literature review, Peer Reviewed Journal Article
Title	The Social in Assessing for Sustainability: Fisheries in Australia
Summary	This paper surveys the literature about sustainability in fisheries, focusing on Australia, and focusing on the way social aspects have been treated. The paper finds that the problems that have been identified for assessing the social in sustainability in general are certainly manifest in fisheries. Management of Australian fisheries has arguably made great improvements to biological sustainability over the last decade, but much remains to be done to generate similar improvements in social sustainability for fishing communities.
Geographic region	Australia
Structure Type	None – general review of fisheries
Stakeholders / sectors	NA
Social values explored	NA
Methods:	What approach was adopted to engage stakeholders
	None – review only
	What approach was adopted to identify and evaluate social values
	None – review only
Findings	Social values [interrelationships, variability across stakeholder groups, potential impacts on or opportunities for]
	Not stated
Other findings	Issues
	A significant challenge for improving sustainability in Australian fisheries lies in improving data collection on social factors, and in bridging disciplinary divides to better integrate social with economic and biological assessments of sustainability.
	The public and private sector measures remain hampered by the dual problem of insufficient data appropriate for measuring social factors, and misunderstandings of how the social may be integrated with economic and biological assessments of sustainability.
Other findings	Opportunities
	Not stated.
Thoughts/reflections	0: Emphasises the importance of social research, presents outcomes of a review exploring the incorporation of social research into fisheries management. Identifies some relevant resources (e.g. an FRDC report on the value of social research in fisheries management, 2011), but not specific to MMI and does not undertake an empirical assessment of social values.

	Johns et al 2001
Document type	Research Report
Title	Socio- economic study of reefs in Southeast Florida-final report. Report prepared for Broward County, Palm Beach County, Miami-Dade County, Monroe County, Florida

Summary	Investment in and maintenance of public resources is a prime function of government. Artificial and natural reefs are public resources that provide recreational benefits to reef users and income to local economies. This study determined, in a comprehensive manner, the net economic value of southeast Florida's natural and artificial reef resources to the local economies and the reef users. Southeast Florida is defined as the counties of Palm Beach, Broward, Miami-Dade and Monroe. This study area includes, from north to south, the cities of West Palm Beach, Fort Lauderdale, and Miami, and the Florida Keys.
Geographic region	Florida, USA
Structure Type	Artificial Reefs & Natural Reefs
Stakeholders / sectors	Boaters (recreational fishers (commercial fishers were not included), reef divers, reef snorkelers and/or visitors viewing the reefs on glass-bottom boats)
Social values explored	None – focus on socio-economic characteristics, use levels and economic contribution and willingness to pay for management or to invest. The opinions of resident reef-using boat owners regarding the existence or establishment of "no-take" zones as a tool to protect existing artificial and natural reefs were also gathered.
Methods:	What approach was adopted to engage stakeholders
	Conducted four surveys as follows: ß Resident boaters – mail survey conducted in the Fall of 2000 ß General visitors – intercept survey conducted in the Summer of 2000 and the Winter of 2001 ß Visitor boaters – intercept survey conducted in the Summer of 2000 and the Winter of 2001 ß Charter / Party boats – mail survey conducted in the Spring of 2001
	What approach was adopted to identify and evaluate social values
	Quantitative analysis of survey questionnaire
Findings	Social values [interrelationships, variability across stakeholder groups, potential impacts on or opportunities for]
	Majority of resident reef-users endorse the idea of "no-take" zones in their county and in the other southeast Florida counties. A majority of residents would support "no take" zones on 20 to 25 per cent of the existing natural reefs. About 75 precent of respondents in all counties supported the existing "no take" zones in the Florida Keys. About 60 precent of respondents supported "no take" zones in their own counties and about the same percentage supported "no take" zones on some of the reefs in Palm Beach, Broward and Miami-Dade counties.
Other findings	Issues
	N/A
Other findings	Opportunities
	N/A
Thoughts/reflections	0/1 – Economic dominant – obtains perceptions of one management strategy but does not link these to values or differentiate by stakeholder group/respondent type

	Blythe 2015
Document type	Empirical Research, Peer Reviewed Journal Article
Title	Resilience and social thresholds in small-scale fishing communities
Summary	This paper explores resilience and social thresholds in two coastal communities in Mozambique by having fishers define their system identity, identify potential system thresholds, and explain how they would respond to crossing a threshold. A 90 % decline

	in current catch rates would represent a threshold for both communities. Fishers with
	strong attachment to occupation would respond by migrating permanently to new
	changing their professions while remaining in their community. The paper concludes with
	a discussion of the implications of social threshold data for fisheries governance.
Geographic region	Mozambique
Structure Type	None – general fisheries assessment
Stakeholders / sectors	Local fishermen
Social values explored	Defined system identity, identified potential system thresholds, and explained how they would respond to crossing a threshold.
Methods:	What approach was adopted to engage stakeholders
	Qualitative, semi-structured interviews
	What approach was adopted to identify and evaluate social values
	Interview questions were grouped into three categories. First, fishers were asked to describe the most critical components of their community. The second group of questions focused on system drivers and thresholds. In a scoping trip, fishers identified declining catch rates, the most critical driver of change within the system. Fishers were, therefore, asked to explain how they would respond to sustained 30, 50 and 90 % declines in their current daily catch, based on a methodology developed by Cinner et al. (2011). Fishers were also asked to describe any other stressors or shocks they were experiencing. Finally, fishers were asked to reflect on several possible future scenarios and to describe their preferred state for their community.
	Interviews were coded based on emergent themes
Findings	Social values [interrelationships, variability across stakeholder groups, potential impacts on or opportunities for]
Findings	Social values [interrelationships, variability across stakeholder groups, potential impacts on or opportunities for] Values of fishery explored across elements argued to contribute to system identify. Including components (e.g. family, fish, fishermen, machambas, fishing materials), relationships (e.g. informal social relationships, formal social relationships and socio- ecological relationships), innovation (e.g. ability to target a diversity of species, livelihood diversification, knowledge) and continuity (generations of fishers, closed season). By getting people from within the system of interest define which components are most important to them (e.g., fish and fishers in this case study), identify the drivers of change that pose the greatest threat to those components (e.g., declining catch rates), and describe how they would respond to change in those drivers (e.g., continuing to fish or exiting the fishery) the framework allows researchers to address the dynamic, subjective dimensions of social responses to change.
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	Triantafillos et al 2014
Document type	Research Report

Title	Developing and testing social objectives for fisheries management
Summary	Little is known about the social dimensions of sustainable fisheries management. In particular, there is little guidance available for fisheries managers to assist them in identifying the social objectives they are managing for, or in collecting information that helps them more successfully manage for these objectives. To address this, this project developed a two-part guide, titled 'Managing the Social Dimensions of Fishing' ('the Guide'). This Guide takes fisheries managers and other key stakeholders through the steps of implementing social objectives, in an ESD context, by helping them identify, document and manage social objectives relevant to their fishery. The Guide also helps fisheries managers identify what aspects of the social dimensions of fisheries they can influence and what factors remain outside their direct influence. This will help fisheries managers better target the identification and management of social objectives to those issues that they can address.
Geographic region	Australia, South Australia
Structure Type	None – not MMI focussed
Stakeholders / sectors	Fisheries
Social values explored	Explores the social objectives relevant to managing fisheries and indicators of relevance for assessing performance against objectives/ Objectives are defined for three 'groups': fishermen, broader community, indigenous persons.
Methods:	What approach was adopted to engage stakeholders
	Multiple: Interviews, surveys, meetings
	What approach was adopted to identify and evaluate social values
	None – social values not specifically targeted, although the social objectives obviously link to the different values of the groups.
Findings	Social values [interrelationships, variability across stakeholder groups, potential impacts on or opportunities for]
	NA
Other findings	Issues
	N/A
Other findings	Opportunities
	The outcome of the project was a set of recommended social objectives and associated indicators, as well as recommended processes for selecting, measuring, and analysing them in different contexts. The guide provides a tool for those seeking to measure progress towards ecologically sustainable development of fisheries resources.
Thoughts/reflections	1: Not very relevant, does not directly address social values or aquatic infrastructure. But it does provide an overarching framework regarding the social objectives of FRDC (in terms of achieving ESD fisheries management).

	Bohnsack (1989)
Document type	Journal Article
Title	High densities of fishes at artificial reefs the result of habitat limitation or behavioural preference?
Thoughts/reflections	0: removed ecological focus only

	Grossman, Jones & Seaman (1997)
Document type	Journal Article
Title	Do artificial reefs increase regional fish production? A review of existing data.
Thoughts/reflections	0: removed ecological focus only

Ref ID# 26	Cripps & Aabel (2002)
Document type	Journal Article
Title	Environmental and socio-economic impact assessment of Ekoreef, a multiple platform rigs- to-reefs development
Summary	This paper provides an impact assessment looking at a rigs-to-reef program in Norway. The paper looks at potential short and long term impacts from environmental, ecological, and socio-economic perspectives
Geographic region	Norway
Structure Type	Artificial Reef
Stakeholders / sectors	Not engaged but mentioned: oil and gas companies, fishers (commercial and recreational)
Social values explored	Company reputation, gear, safety, access, licensing
Methods:	What approach was adopted to engage stakeholders
	N/A – impact assessment conducted: look at legislation, impact identification and evaluation, site-specific data -> environmental and socioeconomic impacts -> construction-phase impacts short-term impacts, long term impacts -> design specific impacts (reef design) -> comparison between reefs -> ranking of reef scenarios
	What approach was adopted to identify and evaluate social values
	Semi-quantitative impact severity scale: 0 no effect likely, +1 limited benefits - +3 large and almost immediate benefits, -1 limited effect3 serious and long term regional or ecosystem damage
Findings	Social values [interrelationships, variability across stakeholder groups, potential impacts on or opportunities for]
	Socio-economic impacts:
	<i>Operating company reputation:</i> reef creation handled well company may derive benefits. However, if it's handled badly there may be future costs of disposal that exceed creation/restoration costs. (short term impact)
	<i>Increased catch:</i> If fishing effort remains constant, reefs might result in larger catches. However, given current quota regulations, local increases in catch rates should be compensated by lower total effort. (long term impact)
	<i>Improved catch security:</i> Theoretically, reefs may lead to less uncertainty about prospected catch rates. This could result in a more stable income for fishers provided that overfishing is not further exacerbated. (long term impact)
	<i>Changes in gear requirements</i> : To exploit reef resources, alternative gear may be required (e.g. long lines instead of bottom trawls). Depending on the type of gear chosen, this might be a benefit for the environment if the use of more damaging methods becomes restricted. There may be a cost for fishers though. (short term impact)
	<i>Gear damage:</i> fishing close to a artificial reef structure may cause gear damage (long term impact)
	<i>Safety:</i> Entanglement of nets presents a danger to the crew and may lead to the loss of boats. (long term impact)
	<i>Limited access:</i> Reef management for optimizing catches or protecting stocks may require local effort restrictions (long term impact)
	<i>Licensing:</i> The responsibility for control, management and safeguarding of a reef might be delegated to specific fishers co-operatives so that their members would have an interest in sustainable fishing, subject to the full benefits of their actions being internalized rather than being dissipated amongst the wider fishing community. However, exclusion of others could easily lead to conflict and again a legal basis does not presently exist. (long term impact)

Other findings	Issues
	Best options for rigs-to-reefs depending on what perspective you are looking at it form (environmental, ecological, socio-economic)
Other findings	Opportunities
Thoughts/reflections	2 discusses social values from impact assessment standpoint -> stakeholder engagement or if it has it is not gone into detail has not occurred but literature and legislation has been consulted.

	Ajemian et al (2015)
Document type	Journal Article
Title	An Analysis of Artificial Reef Fish Community Structure along the Northwestern Gulf of Mexico Shelf: Potential Impacts of "Rigs-to- Reefs" Programs
Summary	This paper discusses the impact that artificial structures have had on fish populations in the Gulf of Mexico. This was achieved by using ROV dad to study fish assemblages on various artificial oil and gas structures.
Thoughts/reflections	0: ecology fish population as a result of rigs to reefs focus -> one line that says that the study could have potential economic and social values but nothing else

	Edwards (2012)
Document type	Journal Article
Title	Partial vs. Complete Removal: The Debate Surrounding California's Implementation of the Rigs-to-Reef Project
Summary	Paper discusses the two main concerns related to partial or complete removal of oil and gas platforms in California. The first is the environmental impact partial decommissioning will have on the marine environment. The second is the economic benefit that is provided to oil companies and the liability cost that the states who engage in the rigs-to-reef-program. Paper goes into detail around the debate surrounding the rigs-to-reef project form a legal, policy and environmental perspective. Paper also lists group interested in the debate as oil companies, environmental groups, recreational fishermen, and commercial fishermen.
Geographic region	California USA
Structure Type	Oil and Gas Rig, Artificial Reef
Stakeholders / sectors	oil companies, environmental groups, recreational fishermen, and commercial fishermen
Social values explored	Concerns for the environment, concerns over cost
Methods:	What approach was adopted to engage stakeholders
	N/A – overview of development of, implantation of and debate surrounding the rigs-to- reef program
	What approach was adopted to identify and evaluate social values
	Reads like a literature review
Findings	Social values [interrelationships, variability across stakeholder groups, potential impacts on or opportunities for]
	Removal of oil platforms completely is expensive for companies and less so for partial removal Partial removal is also more flexible for oil companies
	Parties argue that providing oil companies with lower costs after drilling is inequitable

	Environmentalists concerned for impact complete removal has on marine life
	Generally recreational fishermen are in support of partial removal -> increase in recreational fishing area
	Trawl fishermen are generally opposed to rigs-to-reef -> loss of area
	Environmentalists and commercial fishermen concerned with overfishing
Other findings	Issues
Other findings	Opportunities
Thoughts/reflections	1: though not specifically examined, stakeholder groups and their views towards rigs-to- reefs are mentioned – these values are mostly regarding the environment

	Castello et al 2019
Document type	Journal Article
Title	Sunken Worlds: The Past and Future of Human-Made Reefs in Marine Conservation
Summary	This paper provides history of reef like structures placed in the ocean by humans. It highlights the importance of defining what is meant by a human-made reef. It also highlights the controversy around the cost vs benefit of these structures and the importance of assessing them from social, ecological and structural lenses. Furthermore, the paper argues that these structures should be examined in relation to the role they have on the marine environment rather than just being compared to natural reefs. The paper provides a key on how to identify a diverse initial pool of HMRs at a local or global level, conduct data collection, and carry out systematic assessment of conservation intention and benefits to identify conservation opportunities.
Geographic region	Global
Structure Type	Human-made reefs
Stakeholders / sectors	N/A
Social values explored	N/A
Methods:	What approach was adopted to engage stakeholders
	N/A
	What approach was adopted to identify and evaluate social values
	N/A
Findings	Social values [interrelationships, variability across stakeholder groups, potential impacts on or opportunities for]
	Step 1. Classify as a HMR
	Based on yes to: is the structure submerged or semi-submerged in the marine environment?
	Is there evidence that the structure was created by humans, either purposefully or accidentally?
	Does the structure contain, hard persistent materials
	(Artworks, prefabricated modules, sunken artefacts, infrastructure, traditional structures)
	Step 2. Collect and collate data
	Social data: who created this structure, when and why? How is it used by humans?
	Structural data: what properties does he structure have? Where is it?
	Ecological data: how is this structure used by marine life? (general metrics, targeted metrics)
	Step 3. Systematically assess conservation intention and benefits

	Is there any evidence of intention to create benefits for marine life, indicating available
	of resource conservation (yes: conservation intention, no: no conservation intention)
	- Conservation intention +, Conservation benefit - HMRs negating or failing to generate
	intended conservation benefits
	- Conservation Intention -, conservation benefit – HMRs with no conservation intention which are negating or not generating conservation benefits
	<ul> <li>Conservation intention -, Conservation benefit +, HMRs achieving intended social and ecological benefits for conservation</li> </ul>
	<ul> <li>Conservation intention -, conservation benefit + HMRs providing social and ecological benefits for conservation despite lack of stated conservation intention</li> </ul>
	Do the social, ecological and structural characteristics of this structure align with general or targeted conservation goals? (no: harmful or neutral outcome, yes: beneficial outcomes)
	Step 4 Identify and act on conversation opportunities
Other findings	Issues
	Many arguments relating to HMRs are based on comparisons to natural reefs
	Conceptualising HMRs as imitations of natural reefs may limit our ability to perceive the
	unique costs, benefits, and opportunities they present
Other findings	Opportunities
	HMRs can be used to create opportunity for economic growth
Thoughts/reflections	1: Good for definitions and uses of structures. Provides way of classifying HMRs. Gives

## **Professional Literature Review Templates**

Ref	INsite (2018)
Document type	Industry Report
Title	The Influence of Man-made Structures in the North Sea
	(INSITE) Synthesis and Assessment of Phase 1
Summary	This paper discusses the first phase of a project that aims explore the scientific evidencebase needed to better understand the influence of man-made structures on the ecosystem of the North
	Sea. Specifically, the project wanted to investigate the effects of the structures may have on the spatial and temporal variability of the sea ecosystem and if they are connected in any way. The paper also describes the governance of the committee organising the project.
Thoughts/reflections	0: this paper does not explore stakeholder engagement or social values in MMAI in any way. Removed from review

Ref	Marine Management Organisation (2016a)
Document type	Industry report
Title	Managing commercial fisheries in marine protected areas (MPA) Call for evidence
Summary	Report details assessments carried out on whether certain fishing activities are posing a risk to achieving the conservation objectives for marine protected areas (MPAs) in English inshore waters. These assessments were conducted to inform whether additional management action should be taken to help safeguard the environment and ecosystem in these areas.
Geographic region	UK
Structure Type	Marine Protected Areas
Stakeholders / sectors	Not specified – potentially fishing communities
------------------------	--
Social values explored	Ecological/environmental sustainability
Methods:	What approach was adopted to engage stakeholders
	Awareness of the consultation was raised through various methods including: news stories, government websites, an online questionnaire, flyers, information in fishing magazines, Facebook and other social media, fishing agencies, direct emails
	The consultation asked for feedback via an online questionnaire that asked which management option is deemed most appropriate:
	Option 1: Introduce a monitoring and control plan within the site to monitor current and potential fishing activities
	Option 2: Reduce or limit levels of fishing activities within the site
	Option 3: Prohibit fishing activities on features within the site
	What approach was adopted to identify and evaluate social values
	Information/feedback received summarized and responded to
Findings	Social values [interrelationships, variability across stakeholder groups, potential impacts on or opportunities for]
	Certain types of fishing gear use should be limited to protect the ecosystem and biodiversity
	Concerns over unclear sources that map sea floor composition and fish composition in certain areas
	MPA management should be concerned with maintaining physical habitats
	Reducing or limiting fishing in certain sites
Thoughts/reflections	1: stakeholder consultation exploring ecology/environmental impacts of fishing. Social value in the form of concern for the environment can potentially be inferred but is limited.

Ref	Marine Management Organisation (2016b)
Document type	Industry report
Title	Stakeholder engagement to assess the economic impact of the South marine plans
Summary	Report details the assessment of the economic impact on industry of the three South Inshore and South Offshore marine plan options in the UK. Stakeholder and industry bodies were interviewed to gain insight into this impact – economic value is considered in terms of impact on businesses, employees, gross added value to the marine sector and administrative impact. Findings were categorised into administrative impacts, economic impacts and environmental impacts. All 3 proposed plans amounted in economic benefit.
Thoughts/reflections	0: economic focus only no social value. Plans for change but no MMAI removed from review

Ref	Marine Management Organisation (2011)
Document type	Industry report
Title	Maximising the socio-economic benefits of marine planning for English coastal communities
Summary	This report was made in order to help marine planners adhere to marine policy. This is achieved by exploring the socio-economic processes that are present within coastal communities. Additionally the report provides an understanding of the socio-economic impacts of marine activities in coastal communities and suggestions about how these can be positively maximised. The report made a point to state they are not looking at the social impact from the areas of: broad environmental impact, local culture/community, wellbeing, or health. Report also states that economic value will be at the forefront while social impacts will be used to explain economic value.

Thoughts/reflections	0: though paper claims to explore social impact it is very lacking in terms of our definition of
	social impact. Primarily an economic focus and no mention of MMAI

Ref	Marine Management Organisation (2019)
Document type	Industry Report
Title	You said, we did: Summary of stakeholder led Iteration 3 policy changes
Summary	Summary of workshops held exploring stakeholder perceptions and desired improvements to marine policy and marine development. 3 iterations of stakeholder engagement were conducted.
Thoughts/reflections	0: focus on marine policy not MMAI. Perceptions of policy changes rather than of social value. Removed from review.

Ref	Oil and Gas Authority (2011)
Document type	Industry Report
Title	Decommissioning Delivery Program
Summary	This paper describes a program that was put in place to deliver the decommissioning strategy in the UK. The report also describes in how and when near-term priority areas in decommissioning will be delivered. The program described in the report takes into account the various obligations and commitments from industry bodies in the oil and gas sector. The paper describes the importance of consultation during decommissioning and related objectives.
Thoughts/reflections	0: no social value, MMAI or stakeholder consultation

Ref	Marine Scotland (2011)
Document type	Industry Report
Title	A STRATEGY FOR MARINE NATURE CONSERVATION IN SCOTLAND'S SEAS
Summary	This report aims to describe current objectives for protecting the environment and biodiversity of Scotland's marine life in accordance with government policy. This focuses on 3 pillars that include: species conservation, site protection, wider seas police and measures.
Thoughts/reflections	0: no social value, MMAI or stakeholder consultation

Ref	Marine Scotland (2019)
Document type	Industry report
Title	Future of fisheries management in Scotland: national discussion paper
Summary	This report explores the future of fisheries in Scotland in terms of fishing opportunities, access to fish, inshore fisheries, funding, labour, innovation, science and technology. A particular focus is put on Brexit and how this will impact the Scottish commercial fishing industry. Paper begins by describing themes that emerged from initial stakeholder consultation and then asks individual readers to comment on the rest of the paper throughout.
Geographic region	UK
Structure Type	Fisheries
Stakeholders / sectors	Environmental groups, fishers, local authorities, industry professionals
Social values explored	Broad environmental and industry values can be inferred but are not explored specifically
Methods:	What approach was adopted to engage stakeholders
	Initial dialogue with stakeholders to set the scene and highlight key themes and concerns with stakeholders

	What approach was adopted to identify and evaluate social values
	Potentially some sort of low level thematic analysis
Findings	Social values [interrelationships, variability across stakeholder groups, potential impacts on or opportunities for]
	Fishing in a responsible and sustainable way
	Robust evidence needed to establish fishing opportunities
	Removal of barriers to prevent fishing sector from growing and diversifying
Thoughts/reflections	1: stakeholder consultation exploring perceptions of impacts of commercial fisheries and how best to move the industry forward. Social value in the form of concern for the environment /sustainability and industry can potentially be inferred but is limited.

Ref	Marine Scotland (2018)
Document type	Industry Report
Title	Report of The Scottish Coastal Forum's National Marine Plan Review Workshop held on behalf of Marine Scotland on 29 September 2017
Summary	Description of a workshop held to explore the Scottish governments' National Marine plan in terms of: Implementation and effectiveness of the Plan; Emerging and new marine activities; Changing policy landscape; and Use of information and data sources.
Thoughts/reflections	0: social value of MMAI not explored. Note that more research is needed into the social value of marine planning and policy.

Ref	Marine Scotland (2011a)
Document type	Industry Report
Title	A review of marine social and economic data
Summary	This report lists and describes the availability of marine economic and social data so that it may be used to facilitate decision making for marine planning and licensing. Gaps and weaknesses within the data set are identified. Social value data is defined as: "Data relating to the characteristics of coastal and linked marine communities: employment, demographics, business base, health and wellbeing data including access to recreational and leisure facilities, wealth / deprivation indices, quality of life indicators" (p. 4).
Geographic region	UK
Structure Type	Marine Planning
Stakeholders / sectors	N/A
Social values explored	employment, demographics, business base, health and wellbeing data including access to recreational and leisure facilities, wealth / deprivation indices, quality of life indicators
Methods:	What approach was adopted to engage stakeholders
	Literature review of available data sets
	What approach was adopted to identify and evaluate social values
	Prepare and review a catalogue of marine social and economic data:
	1. Development of catalogue attributes
	2. Initial preparation of catalogue from key datasets
	3. Prioritisation of data sources
	4. Consultation with the marine community

	5. Review and assessment of data
Findings	Social values [interrelationships, variability across stakeholder groups, potential impacts on or opportunities for]
	Social value data sets were found in the following data categories: costal defence, education, fisheries, marine time transport, 'social' Social value in oil and gas, renewable energy, research, and leisure/recreation is missing
Thoughts/reflections	1: could be useful for justifying a lack of data

Ref	Marine Scotland (2011b)	
Document type		
Title	Marine social and economic data: A critical review of tools and methods to apply marine social and economic data to decision making	
Summary	Review of socioeconomic data bases that were found in study discussed about and evaluation of how they can be used as tools for decision making in marine planning in terms of: understanding the problem that needs management, data mapping and visualisation, development of policy or development options, selection of sites to meet policy or development objectives, assessment of the economic and social impacts of policy and development options, monitoring and evaluation of policy objectives, targets and licensing conditions.	
Thoughts/reflections	0: marine planning and policy focus and application of data from decision making. No MMAI focus.	

Ref	CRC Reef Research Centre (2002)	
Document type	Technical Report	
Title	Marine tourism impacts and their management on the Great Barrier Reef	
Summary	Paper is a literature review of social, economic and cultural impacts that tourism has on the great barrier reef.	
Geographic region	GBR, Queensland	
Structure Type	Natural Reef	
Stakeholders / sectors	N/A reads like a literature review	
Social values explored	coastal tourism development (population pressures, construction activities);	
	island-based tourism infrastructure (marinas, sewage discharge, construction);	
	marine-based tourism infrastructure (pontoons, moorings, fish feeding);	
	boat-induced damage (anchoring, ship grounding, litter, waste discharge);	
	water based activities (diving, snorkelling, reef walking, fishing);	
	wildlife interactions (seabirds, turtle-watching, whale-watching).	
Methods:	What approach was adopted to engage stakeholders	
	N/A	
	What approach was adopted to identify and evaluate social values	
	Literature review	
Findings	Social values [interrelationships, variability across stakeholder groups, potential impacts on or opportunities for]	
	mismatch between public perceptions of tourism as a threat to the GBR, relative to other broad scale impacts.	
	"there have been relatively few studies of social and cultural impacts relative to the studies of ecological impacts" (p. 20)	

Thoughts/reflections	1: reads more like a literature review rather than completing research of their own.
	Snowballing articles found from it for academic review however they all focus on non-
	artificial marine infrastructure.

Ref	CRC Reef Research Centre (2005)
Document type	Technical Report
Title	POTENTIAL EFFECTS OF ARTIFICIAL REEFS ON THE GREAT BARRIER REEF: BACKGROUND PAPER
Summary	This paper discusses key gaps, issues and potential problems in literature surrounding the effects that artificial reefs may have on the great barrier reef and gives recommendations as to how these can be addressed. Paper also provides a definition of artificial reef and applications of artificial reefs.
Geographic region	GBR, Queensland
Structure Type	Natural Reef and Artificial reefs
Stakeholders / sectors	N/A
Social values explored	The values and motivations underlying the potential social and/or economic benefits of artificial reefs (e.g. enhanced fishing experiences); The likelihood of artificial reefs effectively addressing those values
Methods:	What approach was adopted to engage stakeholders
	N/A
	What approach was adopted to identify and evaluate social values
	N/A
Findings	Social values [interrelationships, variability across stakeholder groups, potential impacts on or opportunities for]
	Key information should be sought as a basis for any developments. In particular:
	Clear documentation of stakeholder needs: Who wants what, why, and what is the best way to satisfy them
	Artificial reefs may potentially enhance diving/tourism opportunities in several ways by providing: a focus and guaranteed experience for recreational divers; convenient, all weather access to dive sites; and new marketing/economic opportunities for local communities
Thoughts/reflections	1: paper focuses mostly on potential ecological/environmental issues of AR near the GBR. Social values are addressed mostly in terms of a cost-benefit analysis. As no experiment was conducted a lot of what they say is speculation – further research needs to be conducted to asses gaps they have highlighted. Useful definition and application of artificial reefs

Ref	WAFIC (2017)
Document type	Industry Report
Title	Thevenard Offshore Platform Retirement Commercial Fishing Sector
	Stakeholder Consultation – WAFIC Report
Summary	This paper details a stakeholder consultation plan created to involve the commercial fishing sector in the next phases of the Chevron Thevenard Offshore Platform Retirement project. This consultation aimed determine commercial fisher views on full removal of, or partial retention of infrastructure.
Geographic region	WA
Structure Type	Oil and Gas Platform
Stakeholders / sectors	Commercial Fishers

Social values explored	Values associated with removal of oil and gas infrastructure
Methods:	What approach was adopted to engage stakeholders
	Identified relevant commercial fishing stakeholders specific to the scope of
	the Thevenard Offshore Platform Retirement project
	On behalf of Chevron, distributed relevant information provided by Chevron about the scope and impact of the Thevenard Offshore Platform Retirement project to identified relevant stakeholders
	Provided to Chevron all feedback, responses and statements of claim to
	enable Chevron to address commercial fishing sector concerns
	What approach was adopted to identify and evaluate social values
	Not specifically stated – key/salient points from stakeholder feedback are summarized
Eindings	Social values linterrelationships, variability across stakeholder groups, potential impacts on er
Findings	opportunities for]
	Destruction and or disruption of the benthic environment is a major concern: complete removal will impact fishing activities,
	impact fishing for the duration of the removal activities
	Contamination concerns: no toxic materials should be left to avoid environmental risk
	Vessel: will the structures left below impact their vessels? How can they be avoided? Safety risks, loss of gear
	Positive attributes of leaving structures behind will: will be beneficial for some fisheries, potentially benefit future fishing activities, beneficial for recreational fishing, open up new fishing sites, breeding sites
	Safety concerns: damage to vessels causing fatalities
	Artificial reefs: improve overall marine environment, wont necessarily benefit fisheries , damage gear
	Exclusion Zones: always an issue for commercial fishers
Thoughts/reflections	2. explores stakeholder views on MMAI but no in-depth analysis of what the social values are – could be inferred but more detail is needed

Ref	WAMSI
Document type	Industry Report
Title	Decommissioning offshore infrastructure: a review of stakeholder views and science priorities
Summary	This report details the concerns, opportunities and issues that stakeholders towards decommissioning options. This consultation is being conducted within the context of the blueprint for marine science.
Geographic region	WA and Canberra
Structure Type	Oil and Gas Platforms
Stakeholders / sectors	Commercial fishers, recreational fishers, tourism, community, conservation, indigenous, government regulators, state government agencies, commonwealth government agencies, science
Social values explored	Environmental, safety, maintenance, resources, community, connectivity
Methods:	What approach was adopted to engage stakeholders
	Semi-structured interviews and workshops with more than 120 stakeholders and association representatives from multiple sectors and the community from Perth, Exmouth, Karratha, Dampier, Port Sampson and Canberra

	Prompts for discussion: Environment, Shipping & navigation, Fishing, Tourism, Depth, location & weight, Waste, Safety & technical feasibility, Disposal / recycling / reuse, Research & education	
	What approach was adopted to identify and evaluate social values	
	Discussions were assessed by themes then divided by sectors	
	The prioritisation was completed in workshops that included experts from the regulation, industry,	
	management and research sectors involved in different aspects of decommissioning. The people	
	involved well placed to identify how the different stakeholder identified questions, once addressed, would improve regulatory and operational processes and therefore their relevant priority.	
	Prioritisation was completed by considering the questions derived from stakeholder engagement against a framework of value provided by answering those questions. The framework considers the value in the context of drivers drawn from the Blueprint Implementation Strategy of:	
	<ul> <li>efficient and effective policy and regulation</li> </ul>	
	• cost efficiency for industry	
	<ul> <li>social license to operate for both industry and government</li> </ul>	
	<ul> <li>multi-sector benefits from improved approaches</li> </ul>	
Findings	Social values [interrelationships, variability across stakeholder groups, potential impacts on or opportunities for]	
	Main issues:	
	Environmental issues – productivity, impacts, invasive species	
	Safety and risk issues - navigation hazards, issues relating to hook-ups, visibility	
	Maintenance issues - corrosion/contamination, stability, pollution, end of line responsibility, liability for ongoing maintenance	
	Resource sharing issues –competing sectors, exclusion zones, information transparency, flow on benefits from cost savings	
	Opportunities for future uses, reefing, tourism development, accommodation	
	Economic issues - opportunities (business), liability	
	Aesthetics and accessibility	
	Case by case considerations	
	Recycling	
	Connectivity and interrelationships - environmental, social, cultural & economic - all options of decommissioning	
	Community acceptance of decommissioning approach	
	Prioritisation (High, medium, low)	
	Environmental effect	
	<ol> <li>What are the direct impacts on important fish species including from contamination, noise, habitat removal and resulting cumulative ecological effects? (H)</li> </ol>	
	<ol> <li>What is the timeframe and breakdown (corrosion rates) of the various components of oil and gas infrastructure? (H)</li> </ol>	
	<ol> <li>What are the main contaminants following decommissioning, will they be released into the environment, and what are the toxicity issues? (H)</li> </ol>	

	4.	Can the contaminants resulting from decommissioning be completely removed e.g. from sludges, scale, sands and drill cuttings? (H)
	Benefits	to be realised
	1.	Does oil and gas infrastructure (pipelines and jackets) increase productivity of key fish species and biodiversity generally? (H)
	2.	What are the economic benefits to local and regional communities for all options of decommissioning? (H)
	3.	What types of infrastructure maximises benefits for fishing and other recreational activities? (M)
	4.	Can existing infrastructure be enhanced to optimise fishing and other recreational activities? (L) $% \left( L\right) =\left( L\right) \left( $
	5.	Are there alternative opportunities for decommissioned infrastructure (e.g. tourism, recycling, reefing elsewhere)? (L)
	Risks	
	1.	What are the navigation issues with regards to options other than 'full removal'? (H)
	2.	Is there connectivity between structures and does this provide 'stepping stones' for introduced marine pests? (H)
	3.	Do introduced marine pests colonise oil and gas infrastructure more readily than natural structures? (M)
	4.	Does oil and gas infrastructure act as refugia (fish, mammals, birds) and what are the risks to these species on removal? (L)
	5.	Over time, what are the risks of 'toppled' or 'reefed' structures becoming unstable or moving and creating hazards for trawlers, other vessels and recreational interests? (H)
	6.	What are the human health and safety issues associated with decommissioning? (L)
	Manager	ment
	1.	What is an agreed approach to quantifying the benefits of decommissioning options? (H)
	2.	Is it possible to measure the cumulative regional impacts of decommissioning options? (H)
	3.	Are there efficient and effective monitoring processes to gauge effects of decommissioning options over time? (M)
	4.	If there are cost savings for decommissioning options (e.g. reefing), will there be flow-on benefits for the community? (M)
	5.	Are there management processes in place to deal with resource sharing issues with various decommissioning options? (L)
	6.	Will the future design of offshore infrastructure be informed by a range of decommissioning options? (L)
	The key decomm	non-scientific issues that may need to be addressed to support orderly issioning activities include:
	•	Liability, including future environmental and navigation issues
	•	Resource sharing between commercial fishers, recreational fishers and conservation
	•	Opportunities of enhanced fisheries and or habitats created
	•	Consideration that any science program should improve the fundamental knowledge of decommissioning effects and underpin an improvement across all assessments
	•	Concern that when resource companies are on-sold, the capacity and resources for complete removal or other costly decommissioning options may not be available.
Thoughts/reflections	3: explor	es stakeholder values in relation to decommissioning. Furthers exploration by
	completi	ing prioritisation.

Ref	Chevron (2017)
Document type	Industry Report
Title	Gorgon Gas Development Marine Environmental Quality Management Plan
Summary	The purpose of this document is to gather information about the environmental and ecological impacts of developing the gas reserves of the Greater Gorgon Area. While the document focuses mostly on the spatial and ecological aspects of the development some stakeholder engagement and social values are discussed.
Geographic region	Onslow West Australia
Structure Type	Oil and Gas Platform
Stakeholders / sectors	Industry bodies
Social values explored	Fishing and Aquaculture, recreation, cultural, industry and tenure, marine protected areas
Methods:	What approach was adopted to engage stakeholders
	Chevron Australia informed OEPA and Parks and Wildlife of its intention of development of this Plan. Return correspondence received from OEPA
	Chevron Australia briefed OEPA and Parks and Wildlife on 23 October 2014 regarding the proposed implementation
	The presentation material was provided electronically to OEPA and Parks and Wildlife after the briefing.
	What approach was adopted to identify and evaluate social values
	Unclear
Findings	Social values [interrelationships, variability across stakeholder groups, potential impacts on or opportunities for]
	There are no aquaculture activities in the waters surrounding Barrow Island – minimal impact to aquaculture
	Tourism around this area is low but increasing
	Aboriginal land significance incorporated into development plan
	No residential areas around the island that could be impacted
	May be within a marine protected area
Thoughts/reflections	1: very technical report. Some mention of social values but no clear engagement with groups they are speaking for – not clear where social value information has come from. More so talking about how they MAY be impacted. Main focus is not social value related to MMAI

Ref	CRC Reef Research Centre (1999)
Document type	Technical report
Title	Understanding public perceptions of the Great Barrier Reef and its management
Summary	This paper describes a research process conducted to determine participants experience with the Great Barrier reef. Perceptions of the current and future state of the reef, threats to and attitudes towards reef protection were examined. The aim of the study was to assist/contribute to development of reef interpretive activities and produce data that could be used by management agencies and operators associated with the Great Barrier Reef.
Geographic region	Australia – Melbourne, Sydney, Brisbane and Canberra
Structure Type	Natural Reef – GBR
Stakeholders / sectors	Not specified
Social values explored	Perceptions of the current and future state of the reef, threats to the reef and attitudes towards reef protection

Methods:	What approach was adopted to engage stakeholders	
	Mixed-methods telephone survey from a random sample	
	Topics examined in the survey included:	
	Understanding of the World Heritage status of the GBR,	
	Knowledge of what was allowed within the Great Barrier Reef Marine Park,	
	Perceptions of threats to the GBR, in particular knowledge and perceptions of negative	
	impacts,	
	Perceptions of the GBR, including images of the GBR, reasons for its protection, and it's current and likely future status, and	
	Major channels used for information about the GBR.	
	What approach was adopted to identify and evaluate social values	
	Mixed methods analysis of the responses	
Findings	Social values [interrelationships, variability across stakeholder groups, potential impacts on or opportunities for]	
	40% of the respondents had never visited the reef site – of those participants 40% of them	
	had no intention to visit the site	
	Snorkelling, swimming, fishing, Scuba diving, general sightseeing, glass bottom boat, coral/fish viewing, reef walking, sailing, visit islands (most preferred activities from highest to lowest)	
	Most popular words to describe the reef were beautiful, splendid and unique	
	53% of particpants felt the reef was currently in good condition	
	%1% felt that in 10 years it would be in worse condition than it is now	
	Pessimism in relation to the GBR is high	
	Threats to the GBR were perceived to be pollution/rubbish (55%), general human impact (38%), tourism/tourists (36%) and the Crown-of-Thorns (34%)	
	69% of respondents believe it is the governments' responsibility for managing the reef	
	77% believe the reef should be protected as it is a unique natural environment	
	Major sources of information about the GBR include: television, friends/relatives, personal experience, and magazines	
Thoughts/reflections	2: explores perceptions/social values in relation to a natural reef rather than MMAI but is within an Australian context. Details activity preferences for reefs. Idea of pessimism in relation to the GBR – does this carry over to other marine structures?	

Ref	CRC Reef Research Centre (1998)
Document type	Technical Report
Title	Visitor experiences and perceived conditions on day trips to the Great Barrier Reef
Summary	This report details the experiences had by day-trip visitors to the Great Barrier Reef and the conditions that they were influenced by. This purpose of this was to determine the qualities/benefits that visitors want from a trip to the reef. Additionally, researchers wished to determine the attainment of these benefits is changed by natural and social environments experienced on the trip.
Geographic region	Australia – GBR
Structure Type	Natural Reef – GBR
Stakeholders / sectors	Not specified – respondents tourists from Australia, Japan, Britain and the US
Social values explored	Benefits/experiences of visiting natural reefs

	Influence of biological and social conditions on experiences				
	Social carrying capacity: as a level of use beyond which a person's experience in an environment was negatively affected by other users				
	Carrying capacity for tourism: carrying capacity has been used to describe relationships between use and environmental change at two different scales				
Methods:	What approach was adopted to engage stakeholders				
	Self-administered mixed methods questionnaire completed by day-trip visitors to the GBR				
	Participants asked to rate how much the trip provided them with different benefits as a part of their experiences (e.g., get some exercise, meet people, learn about a coral reef) and the influence that different physical, biological and social conditions had on their enjoyment of the trip.				
	The first section asked visitors to respond to open ended questions regarding things that "added to" or "detracted from" their reef experience				
	The second section of the survey asked visitors to provide information about past visitation/experience on the GBR and/or at other reef sites				
	The third and fourth sections of the questionnaire queried visitor perceptions about the reef site and the nature of the experience they had enjoyed.				
	What approach was adopted to identify and evaluate social values				
	Mixed methods analysis of the responses – factor analysis. LAC process				
Findings	Social values [interrelationships, variability across stakeholder groups, potential impacts on or opportunities for]				
	Four main classes of benefits: experiencing nature, relaxing and escaping from normal routines, excitement with family and friends, and being physically active				
	Five general types of reef visitors based on benefit classes: people who predominantly escaped from their normal routine and experienced nature, visitors who shared their experience of the natural environment with friends and family, those who experienced nature without taking part in physical activities (e.g. snorkelling), people who were very enthusiastic about all aspects of the trip, and people who were generally not enthusiastic about any particular part of the trip				
	Natural conditions at the visited sites were the most important influences on enjoyment of the trip				
	notable differences between large and small operations in the benefits visitors received from travelling to the reef and in their perceptions of a quality experience – mostly related to social conditions present during the trip				
	Activities completed on the tours: underwater observatory, semi-submersible ride, snorkelling, scuba diving				
	Perceptions of 9 potential uses of values (highest to lowest value): conservation opportunities, natural processes, educational opportunities, scientific research, cultural heritage, historical meaning, economical opportunities, spiritual meaning				
	Visitors' perceptions of how much their trip to the GBRMP provided 16 possible benefits (from highest to lowest): Experience the beauty of nature, Be in a natural place, Experience something new and different, Experience an undeveloped environment, Learn about a coral reef, Learn more about nature, Escape the normal routine, Have some excitement, Rest and relax, Be physically active, Be close to friends or family, Be with others who enjoy things that I enjoy, Get some exercise, Meet new people, Develop skills and Experience some solitude Visitor perceptions of the influence of 24 conditions on their experience (from highest to lowest): Helpfulness of the staff, Types of fish I saw, Size of the coral I saw, Total amount of coral I saw, Number of different kinds of coral, Information provided by the staff, Colour of the fish I saw. Clarity (visibility) of the ocean water.				

	the staff, Total number of fish I saw, Behaviour of the fish, Size of the fish I saw,
	Temperature of the air, Depth of the water, Temperature of the water, Number of animals
	other than coral or fish that I saw, Sea conditions during the trip from/to shore, Number of people on the main boat, Number of people snorkelling, Currents in the water around the reef, Number of people on the pontoon, Amount of wind, Number of human-made objects in the water
Thoughts/reflections	2: in depth analysis of factors that can influence experience and benefits associated with visiting a reef site. No mention of MMAI

Ref [1]	Leeworthy, Wiley and Hospital 2004		
Document type	Report		
Title	Visitor Importance-Satisfaction Ratings: A Five-year Comparison		
Summary	Presents summarised results of a Recreation and Tourism survey undertaken as part of the Socioeconomic Research and Monitoring Program for the Florida Keys National Marine Sanctuary. Compared findings of survey initially undertaken in 1995-96 with results of current survey (2000-2001)		
Geographic region	Florida USA		
Structure Type	Artificial and Natural reefs		
Stakeholders / sectors	Users, defined as 'boating' and 'experienced' >5yrs , 'unexperienced' <5yrs, visitor, resident		
Social values explored	Perceptions of importance and satisfaction with natural resources (inc. artificial reefs)		
Methods:	What approach was adopted to engage stakeholders		
	Survey		
	What approach was adopted to identify and evaluate social values		
	Quantitative survey analysis		
Findings	Social values [interrelationships, variability across stakeholder groups, potential impacts on		
	or opportunities for]		
	Increase in the attributes identified as important		
	Experience visitors have higher importance scores and less satisfaction than less experienced visitors		
	Decline in boating satisfaction in 2001 compared to 1996		
	Key areas of concern identified across the themes of natural resources (amount of cora diversity in species, large wildlife viewing, beach quality), natural resource facilities (shoreline access, parks and protected areas), other facilities (directional signs, cleanliness of streets and sidewalks, uncrowded conditions) and services (e.g. value for price).		
Other findings	Issues		
	There were additional issues of concern in 2000/1 compared to 1996, despite measureable improvements in environmental condition. Suggest communication needed to raise awareness of positive env conditions/ outcomes.		
	Talks about the value of understanding change in perceptions over time with respect to making management changes to improve perceptions prior to 'value loss'.		
Thoughts/reflections	Contains a model linking the economy and environment, drawn from report by Leeworthy and Bowker 1997 (a copy is in the professional literature folder), which might be useful when integrating the economic and social value components of our work.		





Ref [1]	Montes et al 2019		
Document type	Empirical assessment, Peer-reviewed literature		
Title	Influence of fish aggregating devices on the livelihood assets of artisanal T fishers in the Caribbean		
Summary	Use of moored FADs has been actively promoted in artisanal fisheries, including those of many island nations, in order to increase food security, improve livelihoods and safety-at-sea for fishers. Using structured face-to-face interviews of 316 artisanal coastal fishers across five Eastern Caribbean island nations, we studied perceived and self-reported livelihood assets (natural, financial, physical, social and human) of non-users, long-term users and recent adopters of moored FAD fishing.		

Geographic region	Caribbean: Antigua & Barbuda, Dominica, St. Lucia, St. Vincent & the Grenadines, and Grenada			
Structure Type	Moored FADs = manmade structures that attract pelagic fish, thereby aggregating the thinly distributed resource in a known location where it can be effectively targeted.			
Stakeholders / sectors	Non-users, long-term users and recent adopters of moored FAD fishing. The fishery sector is artisanal or small- scale commercial in nature.			
Social values explored	Self-reported livelihood assets (natural, financial, physical, social and human)			
Methods:	What approach was adopted to engage stakeholders			
	Structured face-to-face interviews of 316 artisanal coastal fishers. The survey sample was determined from estimates of the number of moored FADs, general fishermen population, and moored FAD fishers based on reports from the CRFM (2015), FAO (2016), and personal communication with local Fisheries Officers.			
	What approach was adopted to identify and evaluate social values			
	The questionnaire, which guided the interviews, captured fishers' general perceptions about attributes of wellbeing that characterized various livelihood assets. Survey questions were designed to allow for an appraisal of current (during the past year) and past (from one to five years ago) wellbeing using a common set of assets outlined in the sustainable livelihoods framework. The selection of survey questions was facilitated by borrowing and adapting items from similar studies, which were found to contribute significantly towards measuring changes in the status of wellbeing			
Findings	Social values [interrelationships, variability across stakeholder groups, potential impacts on or opportunities for]			
	Physical and social assets showed a perceived increase over the five-year timeframe, and natural and the financial assets were considered to have decreased over the five-year timeframe			
	the natural and financial assets than fishers using moored FADs during the past year gave lower scores for			
Other findings	Issues / Opportunities			
	Used findings to provide recommendations to increase livelihood assets across the categories of social, human, natural and financial/physical assets			
Thoughts/reflections	Not specific to the held values we are exploring, but addresses multiple elements contributing to well-being and compares across stakeholder/user type. This is a journal article, but was sourced from location of professional literature and published post our academic literature review (1 Sept 2019) and was therefore included.			

Ref [1]	Bates 2016			
Document type	PhD Thesis			
Title	Key Challenges of Offshore Wind Power: Three Essays Addressing Public Acceptance, Stakeholder Conflict, and Wildlife Impacts			
Summary	This dissertation addresses social and regulatory issues surrounding offshore wind development through three stand-alone essays, which, in combination, address a decision-making framework of where to locate offshore wind turbines, by minimizing effects on people and wildlife. The challenges to offshore wind that are addressed by this dissertation include (1) understanding underlying factors that drive support for or opposition to offshore wind energy; (2) conflict with existing ocean uses and users; and (3) public concern and regulatory processes related to wildlife impacts.			
Geographic region	USA - Atlantic City, New Jersey and coastal Delaware			
Structure Type	Offshore Wind Farms			
Stakeholders / sectors	Community residents			

Social values explored	Support and opposition towards wind farms, factors influencing support or opposition					
Methods:	What approach was adopted to engage stakeholders					
	Used a random probability sample and obtained addresses from the sampling firm Survey Sampling International.					
	What approach was adopted to identify and evaluate social values					
	Survey of 699 residents in greater Atlantic City, New Jersey and coastal Delaware, United States, where near-shore wind demonstration projects had been proposed.					
Findings	Social values [interrelationships, variability across stakeholder groups, potential impacts on or opportunities for]					
	<ul> <li>Strong majority of the public supports near-shore demonstration wind projects in both states. Primary reasons for support include benefits to wildlife, cost of electricity, and job creation, while the primary reasons for opposition include wildlife impacts, aesthetics, tourism, and user conflicts. These factors differ between coastal Delaware and greater Atlantic City and highlight the importance of local, community engagement in the early stages of development.</li> <li>In Atlantic City, demonstration projects may be seen as further industrialization of the ocean and conflicting with the traditional uses of the ocean, and therefore inconsistent with their notion of the ocean. Conversely, in Delaware, residents with a strong ocean identity likely see the demonstration project symbolizing clean energy, consistent with</li> </ul>					
Other findings	Issues / Opportunities					
	While it is evident that coastal communities are generally supportive of offshore wind development, those opinions are nuanced and a number of factors are likely to be relevant as to whether communities comes together in support of a local project, or reject such a proposal. These nuanced findings signify that coastal communities are not uniform and care should be taken to understand these nuances early in the planning process of offshore wind energy.					
Thoughts/reflections	Content above focuses on the first essay in the thesis, as the second two were not closely related to our topic. The second essay looking at conflicts, a spatial assessment, comparing areas valuable to wind power generation with those areas valuable to commercial fishing.					



#### Appendix 3 Social and commercial surveys

Carmen Elrick-Barr & Julian Clifton

This appendix is part of the final report for:

Enhancing the Understanding of the Value Provided to Fisheries by Man-made Aquatic Structures.

Euan S. Harvey, Fran Ackermann, Michael Burton, Julian Clifton, Carmen Elrick-Barr, Johanna Zimmerhackel, Georgina Hill, Stephen J Newman, Jenny Shaw, Mark Pagano, Paul McLeod, Dianne McLean, Julian Partridge

24<sup>th</sup> August 2021

FRDC Project No 2018-053

This appendix reports some summary statistics from the online Social Survey, and a record of the full Social and Commercial Fishers surveys.

## Survey respondent profile

	All Responses		Completed Surveys	
	Number	%	Number	%
Recreational fishermen	353	64.2	309	70.1
Diver	90	16.4	81	18.3
Other	41	7.5	28	6.3
Commercial fishermen	27	4.9	23	5.2
Not stated	39	7.1	0	0
Total	550	100.0	441	100

#### Table 1 Stakeholder groups represented in the social value surveys

Note: For the purpose of analysis, incomplete survey responses were removed.

#### Table 2 Profile of 'Other' respondents

		Total	%
	Local	3	6.8
	government		
	State	2	4.5
	government		
	Private sector	3	6.8
	NGO	4	9.1
	Research	8	18.2
	Tourism	17	38.6
	Other*	7	15.9
Total		44	100

\* Others include: Local community/resident (4); Environmental; Commercial fishing; Local tourism

	Stakeholder Group				Total	
Age	Not stated	Comm Fish	Dive	Rec fish	Other	
15-19	0	0	1	8	3	12
20-24	2	0	10	18	9	39
25-29	1	0	14	22	2	39
30-34	3	4	14	41	9	71
35-39	2	0	13	40	9	64
40-44	1	1	3	39	2	46
45-49	2	0	6	42	0	50
50-54	3	7	13	42	5	70
55-59	1	2	9	36	1	49
60-64	1	4	2	31	0	38
65-69	1	4	2	15	1	23
70-74	0	2	0	9	0	11
75 and over	1	2	0	7	0	10
Total	18	26	87	350	41	522

## Table 3 Age distribution by stakeholder group

## Table 4 Respondent gender by stakeholder group

	Male	Female	Total
Not stated	9	7	16
Commercial	24	3	27
fisher			
Diver	58	29	87
Recreational	303	39	342
fisher			
Other	17	24	41
Total	411	102	513

## Recreational fishing respondent profile

	Frequency	Percent	Valid	Cumulative
			Percent	Percent
Collection by hand	3	0.5	.9	.9
Line fishing from a boat	221	40.2	62.8	63.6
Line fishing from the	114	20.7	32.4	96.0
shore				
Net fishing	2	0.4	.6	96.6
Pot fishing	8	1.5	2.3	98.9
Spear fishing	4	0.7	1.1	100.0
Total	352	64.0	100.0	
Missing	198	36.0		
Total	550	100.0		

#### Table 5 Forms of recreational fishing most frequently undertaken.



Figure 1 The forms of recreational fishing most frequently undertaken by recreational fishing survey respondents.



Figure 2 The importance of recreational fishing compared to other outdoor recreational activities.



Figure 3 Level of recreational fishing experience

## Dive respondent profile



Figure 4 Importance of diving compared to other outdoor recreational activities







Figure 6 Frequency respondent dives in Western Australian waters

## Commercial fishing respondent profile



#### Table 6 Commercial fishing sector and number of years working in sector

		North	Gascoyne	West	South	Total
		Coast	Coast	Coast	Coast	
		(114°50'E	(27°S to	(115°30'E	(115°30'E	
		to NT	114°50'E)	to 27°S)	to SA	
		border)			border)	
Ν	Valid	4	5	19	10	27
	%	10.5	13.1	50.0	26.3	100
	Missing	546	545	531	540	

#### Has the respondent fished MMS in the last 12 months?

Yes: 13 (48.1%) No: 14 (51.8%) Table 7 For those that had not fished an MMS in the last 12 months: Have you ever fished a man-made marine structure?

	Frequency	Percent %
Yes	2	15.4
No	11	84.6

Table 8 Why did you choose not to fish any man-made marine structures in the last financial year

	Frequency	Percent
Man-made marine structures do not attract my target	1	100.0
species		

# Final MMI survey

#### **Start of Block: consent**

## Q39 Win one of three \$750 Visa Cards by participating in this man-made structure rec fishing and diving survey!

Thank you for your interest in this survey which examines social and economic values associated with man-made aquatic structures.

Structures such as artificial reefs are playing an increasing role in shaping the recreational fishing and diving landscape. In order to plot the future direction and potential development of these structures, a better understanding is needed of the social and economic value these structures provide the community. Your participation in this survey will help develop a clearer understanding of how recreational fishers and divers are using these structures and their importance as assets for metro and regional communities.

Full details of the research are available at http://www.frdc.com.au/project/2018-053

#### Confidentiality and completing the survey

Taking part in a research project is voluntary. Should you change your mind at any point in the survey before submitting it, you can withdraw from the project. Any information we collect will be treated as confidential and all data collected is anonymous. The results of this research may be presented at conferences or published in professional journals. You will not be identified or be identifiable in any results that are published or presented. The survey should take no more than ten minutes to complete. Curtin University Human Research Ethics Committee (HREC) has approved this study (HREC number CTR-10729). Should you wish to discuss the study with someone not directly involved, in particular, any matters concerning the conduct of the study or your rights as a participant, or you wish to make a confidential complaint, you may contact the Ethics Officer on (08) 9266 9223 or the Manager, Research Integrity on (08) 9266 7093 or email hrec@curtin.edu.au By continuing with the survey, you agree with the following statement: "I have received information regarding this research and have had an opportunity to ask questions. I believe I understand the purpose, extent and possible risks of my involvement in this project and I voluntarily consent to take part."

**The prize-draw** Upon completion of the survey, you will be invited to take part in a prize draw with the chance to win one of three \$750 Visa gift cards which can be used at any outlet accepting Visa payments.

1) Winners will be chosen by selecting three random entrants. This selection will be undertaken by the Chair of the Research Project Steering Committee who will not be permitted to enter the survey. This selection will be witnessed by two other members of the Steering Committee, who will also not be permitted to enter the survey.

2) Prize winners will be contacted by the researchers via email and/or phone within 48 hours of the prize draw. Verbal confirmation of age will be requested to ensure that the recipient is aged 15 or over as required by the online survey. Recipients will not be identified or identifiable publically. Only the postcode of the three winners will be published on the FRDC website.

3) Should any prize winner not be able to be contacted within one week of the draw, the above procedure will be repeated until all three prizes are claimed.

## O I agree

**Start of Block: Block 1 Personal** 

Q1.1	Please	indicate	vour	ade
			J =	~ 9 ~

- 0 15-19
- 0 20-24
- 0 25-29
- 0 30-34
- 0 35-39
- 0 40-44
- 0 45-49
- 0 50-54
- 0 55-59
- 0 60-64
- 0 65-69
- 0 70-74
- 75 and over

## Q1.2 Please indicate your gender

O Male

O Female

Other / prefer not to say

Q1.3 Please type the postcode of your place of usual residence

Start of	Block:	Block 2	<b>Fisher</b>	or diver
----------	--------	---------	---------------	----------

Q2.2 We would like to know about your recreational fishing and/or diving activities in Western Australian marine waters.

Approximately how frequently do you engage in recreational fishing in the marine waters off Western Australia? We define recreational fishing as fishing for pleasure or competition, including line, trolling, pots and spearfishing.

O At least once a week
O At least once a month
O Around once every three months
O Around once a year
O Never

Q2.3 Approximately how frequently do you engage in diving in the marine waters off Western Australia? We define diving as a leisure and enjoyment activity that only involves looking at the marine environment. This includes snorkeling.

O At least once a week
O At least once a month
O Around once every three months
O Around once a year
○ Never

### Q2.1

Would you describe yourself predominantly as a recreational fisher, a diver or neither?

Recreational fisher
 Diver

O Neither

Start of Block: Block 3 Diving practices and values

Q143 How would you compare diving to any other outdoor recreational activities you pursue?

- O Most important outdoor recreational activity
- O Second most important outdoor recreational activity
- O Third most important outdoor recreational activity
- One of many outdoor recreational activities

Q144 Which of the following best describes you as a diver?

O Beginner

O Intermediate

O Advanced

O Expert

Skip To: End of Block If Which of the following best describes you as a diver? , Beginner Is Displayed

Q145 We would now like to know about your diving experiences around man-made marine structures. Man-made marine structures are structures in marine and coastal environments that serve a diversity of purposes, including recreation, coastal protection, transport and resource extraction. Jetties, piers, artificial reefs, shipwrecks, pipelines, and oil and gas infrastructure are all man-made marine structures.

In the past 12 months, have you undertaken any diving around the following man-made marine structures?

	Frequency					
	At least once a month	Less than once a month	Never			
Busselton Jetty	0	0	0			
Exmouth Navy Jetty	0	0	$\bigcirc$			
Other piers, jetties or sea walls	0	0	0			
Exmouth Artificial Reef	0	0	0			
Other artificial reefs	0	0	$\bigcirc$			
Onslow offshore structures	0	0	0			
Pipelines	0	0	0			
Shipwrecks	0	0	0			

Q91 Please name the man-made marine structure you most frequently visit.

Q148 When thinking about the man-made marine structure you most frequently visit, how important are the following to you?

	Importance							
	Not at all important	Not particularly important	Neutral	Somewhat important	Very important	Unsure		
Diving at this location	0	0	$\bigcirc$	0	0	$\bigcirc$		
The diversity of marine species at this location	$\bigcirc$	0	0	0	0	0		
The aesthetics or visual experience of this location	0	0	0	0	0	0		
Having not many other people dive at this location	0	0	0	0	0	0		

Q149 Which of the following categories of marine resource is your first preference when diving?

Natural reef
Artificial reef
Shipwreck
Jetty/Pier
Pipelines
Platforms or structures

Start of Block: Block 4 Rec fishing practices and values

Q93 What form of recreational fishing do you most frequently undertake?

Collection by hand
Line fishing from a boat
Line fishing from the shore
Net fishing
Pot fishing
Spear fishing

Q2.4 How would you compare recreational fishing to any other outdoor recreational activities you pursue?



O Beginner

Intermediate

Advanced

O Expert

Skip To: End of Block If Which of the following terms best describes yourself as a recreational fisher? , Beginner Is Displayed Q2.6 We would now like to know about your recreational fishing experiences around man-made marine structures. Man-made marine structures are structures in marine and coastal environments that serve a diversity of purposes, including recreation, coastal protection, transport and resource extraction. Jetties, piers, artificial reefs, shipwrecks, pipelines, and oil and gas infrastructure are all man-made marine structures.

In the past 12 months, have you undertaken any recreational fishing around the following manmade marine structures?

	Frequency					
	At least once a month	Less than once a month	Never			
Busselton Jetty	0	0	$\bigcirc$			
Other piers, jetties or sea walls	0	0	$\bigcirc$			
Exmouth Artificial Reef	0	0	0			
Other artificial reefs	0	0	0			
Onslow offshore structures	0	0	0			
Pipelines	$\bigcirc$	$\bigcirc$	0			
Shipwrecks	0	$\bigcirc$	$\bigcirc$			

Q92 Please name the man-made marine structure you most frequently visit.

Q2.8 When thinking about the pleasure derived from visiting the man-made marine structure you most frequently visit, how important are the following to you?

			Impo	ortance		Importance						
	Not at all important	Not particularly important	Neutral	Somewhat important	Very important	Unsure						
Fishing at this location	0	0	0	$\bigcirc$	0	0						
The amount of fish I catch at this location	0	0	0	0	0	0						
The fish species I catch at this location	0	0	0	0	0	0						
Having not many other people fish at this location	0	0	0	0	0	0						

Q42 Which of the following categories of marine resource is your first preference when fishing recreationally?

Artificial reefs
Natural reefs
Jetties/piers
Pipelines
Shipwrecks
Platforms or structures
Other Shore-based fishing

#### **Start of Block: Block 5 Neither**

Q78 Which of the following best describes your interest in the marine environment?

Local government	
State government	
Private sector (e.g. local business, retail or industry)	
Non-government organisation (including community groups)	
Research	
Tourism	
Other (please specify)	

Q73 Man-made marine structures are structures in marine and coastal environments that serve a diversity of purposes, including recreation, coastal protection, transport and resource extraction. Jetties, piers, artificial reefs, shipwrecks, pipelines, and oil and gas infrastructure are all man-made marine structures.

Q79 How frequently do you visit or interact with the following man-made marine structures?				
	At least once a month	Less than once a month	Never	
Exmouth Navy Jetty				
	0	$\bigcirc$	$\bigcirc$	
Other piers or jetties				
	0	0	$\bigcirc$	
Exmouth Artificial Reef				
	0	0	$\bigcirc$	
Other artificial reefs				
	0	0	0	
Thevenard structures				
	0	0	$\bigcirc$	
Pipelines				
	0	$\bigcirc$	$\bigcirc$	
Shipwrecks	0	$\bigcirc$	$\bigcirc$	
If How frequently do you visit or interact with the following man-made marine structures? [Never] (Count) < 7

Q80 Please name the man-made marine structure you most frequently visit or interact with

If How frequently do you visit or interact with the following man-made marine structures? [ Never] (Count) < 7

Q81 Thinking about this structure, how important are the following to you?

	Not at all important	Not particularly important	Neutral	Somewhat important	Very important	Unsure
The diversity of marine species at this location	0	0	0	0	0	0
The aesthetic or visual experience of this location	0	0	0	0	0	0
Opportunities for public visitation or engagement at this location	$\bigcirc$	0	0	0	0	0
Equal access for all user groups to the site	0	0	0	0	0	0
The ecological health of this location	0	0	0	0	0	0
Your personal connection to the site	0	0	0	0	0	0
The heritage value of the site	0	0	0	$\bigcirc$	$\bigcirc$	0

Q82 What do you think are the social, economic or environmental benefits of man-made marine structures?

Q85 What do you think are the negative social, economic or environmental consequences of man-made marine structures?

Q72 Listed below are some uses and attributes of man-made marine structures. Please click the box that best reflects the importance of these to you.

			Impo	rtance		
	Not at all important	Not particularly important	Neutral	Somewhat important	Very important	Unsure
Fishing around man- made marine structures	$\bigcirc$	0	0	0	0	0
Diving around man-made marine structures	$\bigcirc$	0	0	0	0	$\bigcirc$
Visiting man- made marine structures	0	0	0	$\bigcirc$	0	0
Social interactions when visiting man-made marine structures	0	0	0	0	0	0
The contribution of man-made marine structures to local community identity	0	0	0	0	0	0

The contribution of man-made marine structures to ecosystem health	0	$\bigcirc$	$\bigcirc$	$\bigcirc$	0	0
Unrestricted access to man-made marine structures	0	0	0	0	0	0
The educational opportunities afforded by man-made marine structures	0	0	0	0	0	0
The research opportunities afforded by man-made marine structures	0	0	0	0	0	0
The ability of man-made marine structures to divert pressure from natural systems	0	0	0	0	0	0
The contribution of man-made marine structures to local employment	0	0	0	0	0	0
The contribution of man-made marine structures to tourism	0	0	0	0	0	0



Q86 Is there anything else that makes man-made marine structures important to you?

**Start of Block: Block 6 All** 

Display This Question:

If Would you describe yourself predominantly as a recreational fisher, a diver or neither? = Recreational fisher

Or Would you describe yourself predominantly as a recreational fisher, a diver or neither? = Diver

Q89 What do you think are the social, economic or environmental benefits of man-made marine structures?

If Would you describe yourself predominantly as a recreational fisher, a diver or neither? = Recreational fisher

Or Would you describe yourself predominantly as a recreational fisher, a diver or neither? = Diver

Q90 What do you think are the negative social, economic or environmental consequences of man-made marine structures?

Q167 Below are some statements regarding man-made marine structures. Please rate your level of agreement with each statement.

	Strongly disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Strongly agree	Unsure
Man-made marine structures sustain and increase fish populations and other marine life over time	0	0	0	0	0	0
Man-made marine structures contribute to local tourism	0	0	0	0	0	$\bigcirc$
Man-made marine structures provide employment opportunities in the local community	0	$\bigcirc$	0	$\bigcirc$	0	0
Man-made marine structures are a central point of identity for local communities	0	0	0	0	0	0
Existing management controls allow for the sustainable use of man- made marine structures	0	0	0	0	0	0
Man-made marine structures are sites of conflict between different user groups	0	0	0	0	0	0

If Would you describe yourself predominantly as a recreational fisher, a diver or neither? = Recreational fisher

Or Would you describe yourself predominantly as a recreational fisher, a diver or neither? = Diver

Q168 Listed below are some uses and attributes of man-made marine structures. Please click the box that best reflects the importance of these to you.

			Impo	rtance		
	Not at all important	Not particularly important	Neutral	Somewhat important	Very important	Unsure
Fishing around man- made marine structures	0	0	0	0	0	0
Diving around man-made marine structures	0	0	0	0	0	$\bigcirc$
The memories or souvenirs (e.g. photos) collected while fishing/diving	0	0	0	0	0	0
Unrestricted access to man-made marine structures	0	0	0	0	0	0

Independence to choose when or how I access man- made marine structures	0	0	0	0	0	0
Talking to friends or family about my fishing/diving experiences at man-made marine structures	0	0	0	0	0	0
The social connections I have made through fishing/diving at man-made marine structures	0	$\bigcirc$	0	$\bigcirc$	$\bigcirc$	$\bigcirc$
The contribution of man-made marine structures to ecosystem health	0	0	0	0	0	0
The contribution of man-made marine structures to the local economy	0	0	0	0	0	0
The contribution of man-made marine structures to local community identity	0	0	0	0	0	0

Start of Block: Block 7 Decommissioning

Q3.1 We have been asking about your experiences with man-made marine structures. Oil and gas facilities such as rigs and pipelines are one type of man-made marine structure. When these facilities come to the end of their operational life, do you believe they should be:

O Totally removed and scrapped

O Totally or partially removed and made into an artificial reef after being rendered physically stable and environmentally safe

O Left where they are after having all oil/contaminants removed

Q3.2 Do you have any other comments you would like to make?

If Would you describe yourself predominantly as a recreational fisher, a diver or neither? = Neither

Q88 Thank you!

If you would like to be entered into the prize draw for one of three \$750 Visa gift cards, please enter your email address and mobile number below. Multiple survey entries from the same individual or from respondents outside of Australia will not be eligible for the prize draw. We will only use this information to contact you if you are selected in the prize draw.

Email address:

Display This Question:

If Would you describe yourself predominantly as a recreational fisher, a diver or neither? = Neither

Q40 Phone number:

# **Commercial Fishers Survey**

### **Participant Information Form**

Thank you for your interest in this survey which examines social and economic values associated with man-made marine structures. Structures such as artificial reefs are playing an increasing role in shaping the marine landscape. In order to plot the future direction and potential development of these structures, a better understanding is needed of the social and economic value these structures provide. Your participation in this survey will help develop a clearer understanding of how commercial fishermen are using these structures and the importance of these assets. Full details of the research are available at http://www.frdc.com.au/project/2018-053

### Confidentiality and completing the survey

Taking part in a research project is voluntary. Should you change your mind at any point in the survey before submitting it, you can withdraw from the project. Any information we collect will be treated as confidential and all data collected is anonymous. The results of this research may be presented at conferences or published in professional journals. To maintain confidentially, no data will be reported where the number of respondents is less than 5 i.e. data will be aggregated by geographical location/fishery etc to ensure that there are at least 5 respondents per group when reporting financial and all other data. The survey should take no more than fifteen minutes to complete.

Curtin University Human Research Ethics Committee (HREC) has approved this study (HRE2019-0465). Should you wish to discuss the study with someone not directly involved, in particular, any matters concerning the conduct of the study or your rights as a participant, or you wish to make a confidential complaint, you may contact the Ethics Officer on (08) 9266 9223 or the Manager, Research Integrity on (08) 9266 7093 or email hrec@curtin.edu.au

By continuing with the survey, you agree with the following statement: "I have received information regarding this research and have had an opportunity to ask questions. I believe I understand the purpose, extent and possible risks of my involvement in this project and I voluntarily consent to take part."

Block: Demographics

**Q1** Please indicate your age

▼ 15-19 ... 75 and over

### **Q2** Please indicate your gender

▼ Male ... Other / prefer not to say

**Q3** Please type the postcode of your place of usual residence

### **Block: Fisheries**

**Q4** Please indicate which of the following WA fisheries you currently work in and the duration of your involvement in each fishery. Select only those that apply.

	Less than 1 year	1-5 years	5-10 years	More than 10 years
Abalone				
Aquaculture				
Aquarium				
Blue swimmer crab				
Deep sea crab				
Fin fish				
Octopus				
Pearling				
Prawn				
Scallop				
Sea cucumber				
Shark				
Southern rock lobster				
Specimen shell				
Western rock lobster				
Other (please specify)				

Q5 What is your current work situation in regards to commercial fishing?

- o Full time
- o Part time
- o Casual

**Q6** What is your current role?

- o Licence holder
- o Licence lessee
- Licence holder and active fisher
- o Licence lessee and active fisher
- o Skipper (on behalf of licence holder or licence lessee)
- o Crew / deckhand

**Q7** What proportion of your total personal income was derived from commercial fishing activities in the last financial year (July 1 2018 - 30 June 2019)?

- o More than 80%
- o **61-80%**
- o **41-60%**
- o **21-40%**
- o Less than 20%

**Q8** In which regions do you fish?

- □ North Coast (114°50′E to NT border)
- □ Gascoyne Coast (27°S to 114°50′E)
- □ West Coast (115°30′E to 27°S)
- South Coast (115°30'E to SA border)

### **Block: Fishing Experience**

**Q9** We would now like to know about your fishing experiences around man-made marine structures and purpose built FADs (fish aggregation devices). Man-made marine structures are structures in marine and coastal environments that serve a diversity of purposes, including recreation, coastal protection, transport and resource extraction. Jetties, piers, artificial reefs, shipwrecks, pipelines, and oil and gas infrastructure are all man-made marine structures. In the last financial year (July 2018-June 2019), did you fish near any of the following man-made structures?

	At least once a week	At least once a month	Less than once a month	Never
Onslow offshore oil and gas structures Other offshore	0	0	0	0
oil and gas structures (please specify which)	0	0	0	0
Echo Yodel pipelines	0	$\bigcirc$	$\bigcirc$	0
Other pipelines (please specify which)	0	$\bigcirc$	$\bigcirc$	0
Swan or Lena shipwreck (Busselton) Other	0	0	0	0
shipwrecks (please specify which)	0	$\bigcirc$	$\bigcirc$	0
Exmouth artificial reef	0	0	0	0
reefs (please specify which)	0	$\bigcirc$	$\bigcirc$	0
Purpose built FADs	0	$\bigcirc$	$\bigcirc$	0
Jetties (please specify which)	0	$\bigcirc$	$\bigcirc$	0

If We would now like to know about your fishing experiences around man-made marine structures and pu... [At least once a week] (Count) >= 1

Or We would now like to know about your fishing experiences around man-made marine structures and pu... [At least once a month] (Count) >= 1

Or We would now like to know about your fishing experiences around man-made marine structures and pu... [Less than once a month] (Count) >= 1

**Q10** Please name the man-made marine structure you most frequently fished during the 2018-19 financial year.

Display This Question:

If We would now like to know about your fishing experiences around man-made marine structures and pu... [At least once a week] (Count) >= 1

Or We would now like to know about your fishing experiences around man-made marine structures and pu... [At least once a month] (Count) >= 1

Or We would now like to know about your fishing experiences around man-made marine structures and pu... [Less than once a month] (Count) >= 1

			Impo	rtance		
	Not at all important	Not particularly important	Neutral	Somewhat important	Very important	Unsure
Unregulated access to the site (e.g. open access for all)	$\bigcirc$	0	0	0	0	0
Ease of access (eg en route to other fishing sites)	0	0	0	0	0	0
The quantity of target species present	0	0	0	0	0	0
Limited / no conflict with other users	0	0	$\bigcirc$	$\bigcirc$	0	$\bigcirc$
Limited competition for access to site	0	0	$\bigcirc$	0	0	0
Your familiarity with fishing this site	$\bigcirc$	0	$\bigcirc$	$\bigcirc$	0	0

**Q11** When thinking about the man-made marine structure you most frequently fish, how important are the following to you?

### Display This Question:

If We would now like to know about your fishing experiences around man-made marine structures and pu... [At least once a week] (Count) >= 1

Or We would now like to know about your fishing experiences around man-made marine structures and pu... [At least once a month] (Count) >= 1

Or We would now like to know about your fishing experiences around man-made marine structures and pu... [Less than once a month] (Count) >= 1

Q12 Is there anything else that makes this man-made marine structure important to you?

### Block: Use of MMS

### Display This Question:

If We would now like to know about your fishing experiences around man-made marine structures and pu... != At least once a week

And We would now like to know about your fishing experiences around man-made marine structures and pu... != At least once a month

And We would now like to know about your fishing experiences around man-made marine structures and pu... != Less than once a month

### Q13 Have you ever fished a man-made marine structure?

- o Yes
- o **No**

### Display This Question:

If Have you ever fished a man-made marine structure? = Yes

**Q14** What type of man-made marine structure did you most recently fish and how long ago?

	Between 12-18 months ago	Between 18-24 months ago	Between 2-3 years ago	More than 3 years ago
Offshore oil and gas structures	0	0	0	0
Oil and gas pipelines	0	0	0	0
Shipwrecks	$\bigcirc$	0	0	0
Artificial reefs	0	0	0	0
Purpose built FADs	0	0	0	0
Jetties	$\bigcirc$	0	0	0

If Have you ever fished a man-made marine structure? = Yes

**Q15** Why did you choose not to fish any man-made marine structures in the last financial year (2018/19)? Please tick all that apply.

- Man-made marine structures do not attract my target species
- My target species is not available in sufficient volumes around man-made marine structures
- o Man-made marine structures are further away than natural sites
- Natural fishing sites meet my needs
- o I am not familiar with fishing around man-made marine structures
- o I want to avoid conflict with the recreational sector

### Display This Question:

*If Have you ever fished a man-made marine structure? = No* 

**Q16** Why have you never fished man-made marine structures? Please tick all that apply.

- o Man-made marine structures do not attract my target species
- My target species is not available in sufficient volumes around man-made marine structures
- Man-made marine structures are further away than natural sites
- Natural fishing sites meet my needs
- o I am not familiar with fishing around man-made marine structures
- o I want to avoid conflict with the recreational sector
- Other (please specify) \_\_\_\_\_\_

#### Display This Question:

*If Have you ever fished a man-made marine structure?* = Yes

Or Have you ever fished a man-made marine structure? = No

# **Q17** Will you fish man-made marine structures in the future? Please give a reason for your answer.

Display This Question:

If Have you ever fished a man-made marine structure? = Yes

Or Have you ever fished a man-made marine structure? = No

**Q18** What would make man-made marine structures a more viable location for your fishing activities?

### **Block: Perspectives**

Display This Question: If Have you ever fished a man-made marine structure? = Yes Or Have you ever fished a man-made marine structure? = No

**Q19** While you have not, or did not, in the last financial year (2018/19), fish man-made marine structures, we would like your perspectives on their use and value in Western Australia in general.

### Display This Question:

If We would now like to know about your fishing experiences around man-made marine structures and pu... [At least once a week] (Count) > 1

Or We would now like to know about your fishing experiences around man-made marine structures and pu... [At least once a month] (Count) >= 1

Or We would now like to know about your fishing experiences around man-made marine structures and pu... [Less than once a month] (Count) >= 1

**Q20** We would now like to ask you some questions about man-made marine structures in Western Australia in general.

Q21 What do you think are the benefits of man-made marine structures in Western Australia?

**Q22** What do you think are the negative consequences of man-made marine structures in Western Australia?

**Q23** Thinking about man-made marine structures in Western Australia, please rate your level of agreement with the following statements.

	Strongly disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Strongly agree	Unsure
Man-made marine structures contribute to the productivity of my target species	0	0	0	0	0	0
Man-made marine structures improve sustainability of fish resources	0	0	0	0	0	0
Man-made marine structures provide opportunities to learn more about the marine environment	0	0	0	0	0	0
Man-made marine structures provide employment opportunities in the local community	0	0	0	0	0	0
Man-made marine structures are a central point of identity for local communities	0	0	0	0	0	0
Man-made marine structures contribute to local tourism	0	0	$\bigcirc$	0	0	0
Man-made marine structures divert pressure from current natural commercial fishing sites	0	0	0	0	0	0

Existing management controls (ie open access for all) allow for the sustainable use of man-made marine structures	0	0	0	0	0	0
Man-made marine structures are sites of conflict between different user groups (such as recreational fishermen, commercial fishermen and/or recreational divers)	0	0	0	0	0	0
Man-made marine structures negatively affect my commercial fishing activities (e.g. by limiting access to fishing locations, damage to gear etc)	0	0	0	0	0	0

### **Block: Decommissioning**

**Q24** We have been asking about your experiences with man-made marine structures. Oil and gas facilities such as rigs and pipelines are one type of man-made marine structure. When these facilities come to the end of their operational life, do you believe they should be:

- o Totally removed and scrapped
- Totally or partially removed and made into an artificial reef after being rendered physically stable and environmentally safe
- o Left where they are after having all oil/contaminants removed

### **Block: Economic Value**

Display This Question: If What is your current role? = Licence holder and active fisher Or What is your current role? = Licence holder

**Q25** We would now like to ask a final few questions about the economic value of your catch.

Please note: To maintain confidentially, no data will be reported where the number of respondents is less than 5 i.e. data will be aggregated by geographical location/fishery to ensure that there are at least 5 respondents per group when reporting financial and all other data.

**Q26** What is the total value of your catch in the last financial year (July 2018 - June 2019), in thousands of dollars?

Display This Question:

*If What is your current role? = Licence lessee and active fisher* 

Or What is your current role? = Skipper (on behalf of licence holder or licence lessee)

Or What is your current role? = Licence lessee

We would now like to ask a final few questions about the economic value of your catch.

Please note: To maintain confidentially, no data will be reported where the number of respondents is less than 5 i.e. data will be aggregated by geographical location/fishery to ensure that there are at least 5 respondents per group when reporting financial and all other data.

**Q27** What is the total value of the catch from the commercial fishing licence(s) you owned /leased or skippered in the last financial year (July 2018-June 2019), in thousands of dollars?

**Q28** Can you estimate what proportion of that has come from fishing man-made marine structures and/or FADs?

- o zero
- o **1-25%**
- o **26-50%**
- o **51-75%**
- o **76-100%**

Display This Question: If Can you estimate what proportion of that has come from fishing man-made marine structures and/or... != zero

**Q29** If those man-made marine structures or FADs were not available for some reason, and you had to re-allocate effort, what would be the percentage reduction in the total value of catch? 0 10 20 30 40 50 60 70 80 90 100

Reduction in value of catch without marine	
man-made structures	

### **Block: Comments**

Q30 Do you have any other comments you would like to make?



# Appendix 4 The potential economic value associated with the development of artificial reefs in Western Australia

Dr Paul McLeod, Dr Johanna Zimmerhackel & Dr Michael Burton

This appendix is part of the final report for:

Enhancing the Understanding of the Value Provided to Fisheries by Man-made Aquatic Structures.

Euan S. Harvey, Fran Ackermann, Michael Burton, Julian Clifton, Carmen Elrick-Barr, Johanna Zimmerhackel, Georgina Hill, Stephen J Newman, Jenny Shaw, Mark Pagano, Paul McLeod, Dianne McLean, Julian Partridge

24<sup>th</sup> August 2021

# The Potential Economic Value Associated with the Development of Artificial Reefs in Western Australia

Prepared for the FRDC Project: Enhancing the Understanding of the Value Provided to Fisheries by Man-Made Aquatic Structures



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### 1 Executive summary

This report provides a framework for estimating the benefits that may arise as a result of developing artificial reefs. Those values can be broadly categorised as direct economic values that arise from expenditures by users of the reefs, the 'surplus' value that arises from the enjoyment of the activities by those engaged in the activities, and the potential 'existence' values that may be generated for those who do not use the reef, but who value the improved ecological outcomes never the less.

We developed an assessment framework to estimate the economic value for two case studies:

- Oil and gas infrastructure around Thevenard Island off Onslow which are potential future artificial reefs for a range of different end-users. Values are estimated for two different decommissioning scenarios: i) leave existing oil and gas structures in place and ii) repurposing parts of the material for new artificial reefs.
- The Exmouth Integrated Artificial Reef (EIAR) is an existing artificial reef which allows us to evaluate some pre- and post- data on ecological conditions, and there is relatively good (although still limited) data on recreational fishing activity in the relevant area.

Due to the lack of primary data that would allow a more bespoke evaluation, we generate estimates of the values using a 'benefit transfer' approach. This involves taking values from the literature and applying them to this context. Moreover, at this stage we consider only the values that arise from recreational fishing (and for the Thevenard structures recreational diving).

Results of this report suggest that the Thevenard oil and gas infrastructure off Onslow could increase the number of recreational fishing trips to the Onslow and Thevenard Island area by between approximately 24 and 320 extra trips per year. The increase in expenditures due to the new artificial reefs could lie between \$13,137 and \$173,031 per year and the additional consumer surplus between \$10,087 and \$189,872 per year. However, these values only assume one artificial reef whereas the oil and gas structures around Thevenard could be used to create various artificial reefs which would generate higher economic benefits.

We have also qualitatively identified economic benefits for recreational dive tourism, charter boat operators and commercial fisheries, including aquarium fish harvest. At this stage, the available information does not allow a meaningful estimate of these values. However, there is clear potential for the oil and gas structures to enhance the viability of dive tourism, charter boat operators and commercial fishing in the Onslow region.

We estimate that the EIAR will increase the number of fishing trips to the Exmouth area at least by 227 and at the most by 1521, depending on whether the new site primarily leads to substitution among other sites or leads to new trips. The increase in expenditure in the region that arises from this could range from \$160,000 to \$1,051,000. The associated increase in the consumer surplus enjoyed by recreational fishers varies from \$114,500 to \$267,000. These are likely to be underestimates of the values generated from the reefs as they only include limited information about any additional benefits to divers, charter boat operators, commercial fisheries and no estimates on the willingness to pay by the general public for enhanced ecological outcomes.

However, activities on artificial structures partly target the same resource and the potential values generated by any stakeholder group will depend on the access/use by others. Hence, this is important when considering the total economic value from the resource to avoid double counting.

This also highlights the importance to recognise that all activities have to be managed within an appropriate management plan.

## 2 Introduction

The value of reefs for recreational fishing, diving and tourism is well documented. However, the role of natural reefs in generating recreational value is limited by their capacity and location. Capacity limits are typically based on the requirements to manage the reef environment for long term sustainability of the fish populations and the broader ecology. In some cases, even before ecological capacity is reached congestion will diminish the value of accessing a location and limit demand. We note that 'congestion' may occur in an economic sense independent of any physical constraint on access e.g. if congestion is denoted as a loss in value due to the presence of others then in some contexts 'congestion' may be present at very low densities of use (i.e. for those who are seeking a wilderness experience), or a desire to engage with the resource without the visual presence of any (or few) others. Congestion can arise for both diving and fishing for those sectors that are unregulated. For commercial dive tourism, charter and commercial fishing, activities are subject to various licence and management arrangements that affect the number of participants. For recreational boating activity (fishing, diving, pleasure boating) the number of participants is generally not regulated, although catch would be regulated by bag limits.

Artificial reefs and related structures aim to emulate the role and value of natural reefs by creating similar environments. These structures are well established as a mechanism to improve the marine environment through (i) the attraction of species from an existing stock in the surrounding areas, (ii) an increase in the number and density of species due to enhanced habitat and/or protection from predators, and (iii) the increase of diversity by developing new species in certain areas. As a result, artificial reefs improve the ecology, supplementing natural reef systems. They also improve the recreational value of the marine environment in the area in which the structure is located. This is achieved by improving the quality of the recreational experience for those who currently access the region and by encouraging increased participation in the area by those who currently do not access the area for fishing, diving and other related marine activities.

By adding to the stock of reef environments in an area, these structures allow for increased participation in reef-based tourism, fishing and diving while at the same time relieving pressure on other (natural) reef environments. As well as reducing pressure on the natural environment, this expanded capacity reduces the congestion costs associated with accessing natural reefs in high demand locations. Moreover, because they can be positioned in preferred locations, this enhancement of fishing, diving and tourism outcomes can potentially be delivered at lower cost and with greater safety for users.

The increased stock of reef environments also offer potential benefits for commercial fishing, including aquarium fish. In particular, enhanced value for commercial fishers is possible because species already well established commercially have been identified around existing structures. As documented in the main body of the report several of the species identified are commercially as valuable as the iconic Pink Snapper. The biomass in the area is currently not fished. This value will depend on how the area and biomass are factored into future harvest strategies. If this biomass is deemed to be part of the wider currently fished biomass such that an increase in catch may not be permitted, the expanded area may still result in improved fishing efficiency due to higher accessibility and catchability. If this biomass is deemed to be independent of the biomass currently fished outside of the area, it represents a potential expansion of the commercial catch. If the oil and
gas infrastructure cause spill-over into other areas open to commercial fisheries, the full removal of the structures might cause loss of value to these fisheries.

# 2.1 Aim of the report

Firstly, this report describes the total economic value framework and applies it to identify the economic values of artificial reefs through a review of the scientific literature. Secondly, this report presents an approach of evaluating the economic value of artificial structures in the marine environment. Thirdly, this report aims is provide indications of the potential economic value that artificial reef(s) made from oil and gas infrastructure in the Onslow area could generate and the economic value that the EIAR provides for recreational fishing and other recreation activities.

The EIAR has only recently been established, so data on its economic impact and value is limited. At the moment, there is no structure in the Onslow area and the exact location and form of any future structure is yet to be decided. However, by using these examples as the basis for the analysis, we ground our empirical analysis in particular case studies, while illustrating the general principles that need to be applied for the evaluation of any such structure.

# 3 The economic value of artificial reefs

Economic values associated with the natural environment are usually described in various value types which together add up to the total economic value (TEV). This TEV framework has been widely applied to measure the change in values when interventions impact on the natural environment, such as the development of artificial reefs in the marine environment. Table 1 shows the benefits of artificial reefs within the TEV framework. Direct use values include consumptive and nonconsumptive use values, with consumptive use values covering the values that result from extractive uses such as commercial and recreational fishing around artificial reefs. Non-consumptive use values are derived from usages that do not diminish the amount of the resource. For example, artificial reefs provide non-consumptive use values through recreational activities such as diving and surfing. Indirect use values are benefits that artificial reefs generate in the marine environment which affect other economic activities. These benefits include various reefing effects such as habitat enhancement, increased fish production and coastal protection. Different from the direct and indirect use values which are commercial in nature, non-use values result from the satisfaction that people derive from goods or services, without them necessarily having to interact directly with the resource. This can be for example peoples' value for knowing that a natural resource has been conserved or improved without necessarily using it. In the context of marine artificial structures, non-use values include, the knowledge that artificial reefs have increased species diversity (existence values) or conserved a species for future generations or other people (bequest/altruistic values).

Total economic value				
Direct use values	Indirect use values	Non-use values		
Benefits arising from the immediate use of an artificial structure in the form of outputs that can be consumed or enjoyed directly.	Benefits that an artificial structure provides to support other economic activities, or positive externalities that affect other users of the marine environment.	Benefits from knowing that a marine asset has been conserved (existence and bequest/altruistic values) or may be available for use at a later date (option value).		
<ul> <li>Examples:</li> <li>Extractive uses (e.g. commercial and recreational fishing, offshore aquaculture)</li> <li>Non-extractive uses (e.g. diving and surfing tourism)</li> </ul>	<ul> <li>Examples:</li> <li>Fish production via habitat protection (e.g. seagrass).</li> <li>Effort diversion from overexploited fisheries or dive sites.</li> <li>Coastal and shoreline protection.</li> <li>Water quality improvement via nutrient removal</li> <li>Vicarious consumption</li> </ul>	<ul> <li>Examples:</li> <li>Knowledge that reefbased protection has increased marine biodiversity</li> <li>Knowledge that a unique habitat is conserved intact for future generations</li> </ul>		

## Table 1: Values attributed to artificial reef development\*

\* Adapted from Whitmarsh et al. 2008

# 3.1 Literature review: The economic value of marine infrastructure

Studies on the economic value of marine infrastructure in Australia is scarce. Therefore, this report presents evidence of the economic value of these structures using examples from international literature. A systematic literature research found 33 studies that quantified the economic value that marine man-made structures provide to stakeholders such as divers (19), recreational fishers (12), commercial fisheries (8), the general public (3) and other user groups (6). Since the first study on the economic value of a marine artificial structure was published in 1973 by Buchanan, the number of publications on this topic has steadily increased and the issue has started to gain considerably more attention in the last 2 decades (Figure 1). While the literature indicated economic values from artificial reefs all over the world, nearly half of these studies (15) were conducted in the USA and much less in other parts of the world. Various structures were valuated with shipwrecks being the most common (16), followed by concrete structures (8) and oil and gas platforms (5). A total of 28 studies quantified direct use values and 17 non-use values and to our knowledge no study has estimated indirect use values. All economic valuation studies are summarized in Appendix A.



Figure 1: Cumulative number of economic valuation studies of artificial reefs.

#### 3.1.1 Direct use values

Artificial reefs have been found to generate direct use values in terms of business revenues from commercial fishing (Vivekanandan et al., 2006, Brock, 1994, Islam et al., 2014), recreational fishing (Buchanan, 1973, Kolian et al., 2018, Milon, 1989), scuba diving (Westerberg et al., 2013, Chen et al., 2013, Leeworthy et al., 2006) and of other recreational and tourism activities including snorkelling, surfing, and boat tours (Pendleton, 2005, Westerberg et al., 2013). For example, Buchanan (1973) estimated that an artificial reef in South Carolina, USA caused an increase of 10% in the gross economic contribution of marine recreational fishing in the region. Moreover, 16% of recreational fishers in the area stated that they would not return to the area if the artificial reef was not there. Hence, the revenues of these fishers would be lost without that reef. Also, a shipwreck in Florida, USA increased total recreational expenditures from snorkelers, divers and boating by USD2.7 million (Leeworthy et al., 2006).

Many valuation studies on marine artificial structures include economic impact assessment. Economic impact assessments quantify the increased economic activity that e.g. the deployment of an artificial reef brings to the region. This is typically measured as the number of jobs and the income the artificial reef is generating. For example, Hiett and Milon (2002) found the recreational activity (such as fishing and diving) associated with oil and gas facilities in the Gulf of Mexico not only generated USD324.6 million in annual economic revenues, but also provided employment for approximately 5,560 full time equivalents. Both fishing charter and dive tour operators considered the presence of oil and gas structures to be very important to their businesses. Similarly, Johns et al. (2001) estimated that Florida's artificial reef programs provide 34,900 jobs and are generating USD2.8 billion of income annually.

In addition to revenues from recreational activities, artificial reefs also have been found to provide economic benefits to commercial fisheries. Examples of this are the oil and gas platforms in the Gulf of Mexico which provide habitat for snapper populations and today, a significant part of the commercial harvest originates from petroleum platforms (Bull and Love, 2019). Most economic studies of artificial reefs have compared the revenues of commercial fisheries on artificial and natural reefs. Kasim et al (2013) found that the revenues of commercial fishers in India were over twice as high on artificial reefs compared to adjacent natural reefs and Vivenkandan et al. (2006)

estimated the income from hook and line fishing on artificial reefs to be 36% higher than on nonartificial reef sites. Similarly, Whitmarsh et al. (2008) found the revenues from an artisanal fishery on an artificial reef off the Algarve in Portugal to be substantially higher than on control sites. However, the monthly fishing income from artisanal fishers on an artificial reef in Malaysia was lower than on adjacent natural reefs (Islam et al., 2014). Also, Crabbe and McClanahan (2006) observed that not all commercial fisheries benefited from shipwrecks in Kenya.

Another potential source of economic value from offshore oil and gas structures is the harvest of ornamental fish. Kolian et al. (2018) estimated that in the Gulf of Mexico, a sustainable harvest of aquarium fish could yield approximately USD1.4 million per platform per year. Moreover, they point out that there is an unknown value in novel pharmaceutical and/or nutritional products that could be sourced from marine invertebrates that grow on oil and gas platforms.

Recreational fishers can increase their satisfaction through the increase the catchability and/or the catch rate during their fishing trips. McGurrin and Fedler (1989) compared the perception of fishers that fish on and off an oil and gas platform and found that platform user felt that both the size and types of fish that could be caught were better than off the structure. Consequently, fishers that fished on oil and gas platforms were willing to pay more (USD19.38) for another artificial reef site than non-platform fishers (USD10.00).

Artificial reefs not only directly enhance habitat but also deviate user pressure from natural reefs. For example, the construction of a dive and snorkel trail in Dahab, Egypt was meant to prevent tourists from trampling on and therefore harm natural reefs. Hannak et al. (2011) did a willingness to pay study and found that especially the less experienced snorkelers (who are more likely to damage the reefs) were willing to pay for the snorkel trail, education about reef ecology, threats to the reef and skill training to protect natural reefs.

Finally, the controlled position of artificial reefs allow for safer conditions than on some natural sites. Christie (2009) found that all members of a community in Wales held significant values for a multipurpose reef which would provide (among other attributes) safer swimming opportunities. Likewise, Taiwan residents were willing to pay WTP of about USD13 per recreational fishing and diving trip for access to an artificial reef zone that provides safer conditions than surrounding areas (Chen et al. 2013).

#### 3.1.2 Indirect use values

While the described reefing effects (see Table 1) are widely acknowledged in the literature, to our knowledge no studies have sought to quantify the economic indirect use values associated with marine artificial structures. The reason for this is probably that different value types can overlap and the complexity involved in such valuations. Firstly indirect values, almost by definition, involve potentially complex environmental linkages and economic linkages and typically occur outside of the direct area of interest. For example, effort diversion could occur from a range of substitute sites which could conceivably be some way from the area of interest. Effort diversion could also be time related in that an activity that is a direct use activity of the reef of interest this period may simply defer use of the alternative location to another year.

Secondly, potentially significant indirect benefits have the characteristic of a public good. For example a diver or fisher photographs their experience on the reef. Their experience is a direct use that can meaningfully be valued. If they post a video of their experience on YouTube, many users can derive value from watching without visiting the area (vicarious consumption) and they do not compete with each other to watch.

If indirect values are pursued, a question of double counting also arises. As an example, consider habitat enhancement, leading to improved stock and catch rate. This will be measured by the direct use value of the associated catch and fishing experience. Similarly, the direct use value for diving reflects the habitat enhancement. This can be added to the fishing value to get an aggregate value for the direct uses.

However, if a separate estimate was made for the habitat enhancement per se, without reference to the fishing and diving values, it would be double counting. Only a residual value for the habitat that is not accounted for by the direct use values could legitimately be included.

Similarly, if a stated preference study is conducted to derive estimates of non-use values from a general population sample, it is important to recognise that those who gain *use values* from the resource will include these values in their stated value. Thus aggregating both total revealed and stated preference values will result in an overstatement of value.

These issues are not insurmountable, but require careful accounting frameworks that identify which values are being captured by which techniques, and to ensure that overlaps are adjusted for. For example, if a stated preference study is undertaken for general population existence values, but a travel cost recreational fisher survey is employed for fisher use values (because of its greater sensitivity to spatial distributions) then potentially one is double counting. But if in the stated preference study preferences by demographics are disaggregated by stakeholder, then it would be possible to infer fishers' existence values from the general population, and their use values from the travel cost method.

#### 3.1.3 Non-use values

Non-use values result from peoples' satisfaction which a natural resource provides that is not traded in a market. This satisfaction can have various sources. For example, as described above, artificial structures in the ocean have the ability to enhance marine habitat and therefore improve the biodiversity and/or abundance of marine life on and around them. Although there is no process by which these values can be captured by any party techniques exist that quantify them in monetary form. Hence, people who value these natural benefits can have a "willingness to pay" for maintaining artificial structures. For example, Börger et al. (2015) estimated the willingness to pay of residents in Ireland for an increase in biodiversity on an offshore windfarm off the coast of Ireland. They found that people were willing to pay GBP7.25 and GBP14.83 per person for an increase of ten and 30 species settling on the windfarm, respectively. It is reasonable to expect that residents of Western Australia would have some positive willingness to improve biodiversity on the North West shelf, although this would need to be tested with appropriate surveys.

The willingness to pay to protect artificial reefs and natural reefs can vary. In southeast Florida, visitors and residents are willing to pay more than double (USD229.3 million/year) as much to protect natural reefs than artificial reefs (USD85.1 million/year) (Johns et al., 2003). On the other hand, Huth et al. (2015) found that dive tourists in Florida had higher willingness to pay for a dive trip to a shipwreck (USD368) than to natural reefs (USD300).

#### 3.1.4 Attraction vs. production

It becomes evident from the literature that the economic values associated with artificial structures largely depend on their capacity to enhance the marine environment. While it is widely acknowledged that the presence of artificial structures have increased fish populations associated with them, there is a continuing discussion about whether these structures merely attract and

aggregate fish or also increase the production of existing fish stocks (Bull and Love, 2019). Researchers that found an aggregation effect on artificial reefs are concerned that artificial reefs increase the vulnerability of fish populations to fishing and therefore contribute to overfishing (Pickering and Whitmarsh, 1997). However, various species have been found to use artificial structures as nursery grounds and therefore increase the production of these species (Claisse et al., 2014). This can not only increase fish stocks on the structures but also supply recruits to other areas via spill-over effects. Also, there is evidence that fish are recruiting to artificial structures as juveniles, suggesting that the structures are not only attracting adults from surrounding habitat (Fowler and Booth 2012). The degree of attraction and production effects in each artificial reef varies depending on a variety of factors including the proximity to other reefs (Bohnsack 1989, Strelcheck et al. 2005). This most likely has effects on the behaviour of reef users and consequently the economic benefits that these structures provide.

It is worth noting that the impacts of aggregation v production are likely to have different impacts on the different values. For example, aggregation does not cause an increment in the underlying ecology, and hence has no impact on non-use values. (However, it may still create benefits for use values if it reduces fishing trip related expenditures. Fisheries management such as harvest restrictions, temporal closures or the designation of some AR as no-take areas could ensure that artificial reefs meet their targets and maintain ecologically and economically sustainable fisheries.

# 3.2 Literature review: The value of recreational fishing in Australia

A primary focus of the discussion relating to artificial structures in the North West has been their value for fishing. It is therefore useful to begin with a short review of studies relating to the value of recreational fishing in Australia and in Western Australia in particular.

#### 3.2.1 Expenditure studies of recreational fishing in Australia and Western Australia

Most value studies have focused on the economic impact of recreational fishing expenditures. The most recent detailed expenditure survey for recreational fishing is one for Victoria in 2008/09 (Ernst & Young 2009a). This was updated in 2013/14 (Ernst & Young 2015). The 2008/09 study reported the following key findings.

- An estimated 721,000 Victorians participated in recreational fishing. Victoria's population in June 2009 was 5.44 million. Recreational fishers were 13 percent of this population and 19 percent of the adult population.
- The number of fishing trips taken in Victoria is estimated at an average of 12 per year per fisher, making total fishing trips 8.7 million;
- Average expenditure per trip per fisher is estimated to be \$250 inclusive of variable costs (such as accommodation, bait, fuel etc) and fixed costs (such as equipment and capital);
- Aggregate direct expenditure was valued at \$2.3 billion in 2008-09.
- Aggregate direct expenditure is estimated to increase to \$2.9 billion in 2028-29.

The later study (Ernst & Young 2015) reported the following.

- Lower average trips per fisher of 7.3 although the participation rate has stayed about the same at 18 percent of the adult population.
- Average per trip expenditure by fishers of \$326 excluding boat purchase.
- Aggregate direct expenditure was valued at \$2.6 billion in 2008-09.
- Aggregate direct expenditure is estimated to increase to \$3.3 billion in 2028-29;

A 2012/13 survey of recreational fishers in Tasmania (Lyle et al. 2014) found the following.

- 98,000 Tasmanian residents aged 5 years or older fished at least once in Tasmania, representing an overall participation rate of 22%.
- Recreational fishers accounted for about 507,000 person days of effort, with an average of 5.5 days per fisher.
- Direct expenditure is estimated to \$93 million on goods and services relevant to fishing, \$1008 per fisher or \$183 per day.

In 2012 a NSW survey of recreational fishers (Mcllgorm & Pepperell 2014) found the following.

- 905,048 anglers fished in NSW with 773,000 adults over 18 years of age. The NSW population in June 2012 was 7.29 million. Recreational fishers were 12.4 percent of this population and 14 percent of the adult population
- Average trips per year were 10.7 combined saltwater and freshwater. Average days fished per year were 14.6.
- Average expenditure per angler of \$225.24 per trip. \$154.05 on fishing trip related items plus \$71.20 was spent on tackle and boat fuel per trip.
- Annual fishing related boat expenditure averaged \$768.15 per angler.
- Aggregate expenditure was estimated at \$1.626bn per year, \$1.439bn from NSW residents alone.

An early study economic impact study of recreational fishing in Western Australia was completed in 1991 by Lindner and McLeod. Two surveys, one by telephone interviews of 401 recreational fishers, and another via a self-enumeration questionnaire of a non-random self-selecting sample were conducted to determine how much recreational fishers spend during a year on goods and services on activities related to fishing. Total annual expenditure associated with recreational fishing was estimated to lie within the range from \$200 million to \$415 million.

The original Lindner and McLeod study was updated in 2018 and estimated aggregate expenditures to be:

- \$1,859,607,819 for trip related expenditure (incl. land travel to site of fishing platform and accommodation on overnight trips)
- \$159,890,879 for gear related expenditure
   \$389,029,065 for boat related expenditure (incl. boat hire and charter fees)
   Aggregate expenditure was \$2.41 billion, or \$1.80 billion if costs for Food & Refreshments are excluded.

For more details on this report, see Appendix B.

#### 3.2.2 Willingness to pay studies of the value of recreational fishing

Studies directly relevant to Western Australia are limited. Use of revealed preference techniques (van Bueren 1999; Raguragavan et al. 2013) has allowed imputation of economic value for catch and site, but sites are defined at a very large geographical level. Van Bueren estimated values for share based fishing for five categories of fish (namely prize fish, reef fish, key sports fish, butter fish and table fish) and for 13 recreational fishing sites on the southwest coast. He found that angler benefits range from A\$13.00 to \$39.00 per day of fishing. Raguragavan et al. used essentially the same methodology, but with an expanded, albeit dated data set drawn from the 2000/2001 National Survey of Recreational Fishing. Their published economic welfare estimates for a 100 per cent catch

rate increase (\$/trip) for the five categories of fish ranged from \$14.88 for table fish to \$31.41 for prize fish. They also estimated the access value for forty-eight West Australian fishing sites, defined as the welfare loss suffered by an angler if a site became unavailable. Averaged across all sites, welfare losses from a site closure amount to \$3.81 per trip per angler.

# 4 Methodology

## 4.1 Study sites

#### 4.1.1 Thevenard Island oil and gas infrastructure

Thevenard Island is part of the Mackerel Islands group off Onslow in the North Coast bioregion, approximately 25 km northwest of Onslow and 70 km southwest of Barrow Island. Offshore oil and gas infrastructure around Thevenard Island includes three platforms in the depth of 12-18 m and six monopods in 9-16 m of water (Figure 2) as well as pipelines and other infrastructure. Production from the offshore fields ceased in January 2014 and structures are due to be decommissioned imminently. These structures could be available for artificial reef projects.

The exact form, location and quantity of potential artificial reef(s) is yet to be decided. The total area of the nine platforms is 815 m<sup>2</sup> (Harvey et al. 2020b). There is also an exclusion zone of 500 m around the structures to which the public currently has no access. Therefore, as of now, there are no activities such as commercial and recreational fishing nor other tourism tours associated with the platforms.

The Mackerel Islands are a group of ten islands that are a popular destination for recreational fishers and other water-related activities such as snorkelling and scuba diving. There are accommodation options on two of the islands (Mackerel Island Resort on Thevenard Island and the Direction Island Beach Shack on Direction Island).



*Figure 2: Location and characteristics of Thevenard oil and gas infrastructure. Source: Harvey et al. 2020b.* 

#### 4.1.2 The Exmouth Integrated Artificial Reef

The EIAR was deployed in July 2018 with the purpose to enhance habitat to benefit the environment as well as to provide an accessible and safe recreational fishing site in Exmouth, Western Australia. The Exmouth location is within the Geraldton Coast bioregion.

In Exmouth, recreational fishing on the Ningaloo reef is limited due to rough weather conditions. Hence, the EIAR was positioned well accessible and inside the Exmouth Gulf where weather conditions are more stable. The EIAR comprises 49 concrete modules (1 to 10 m) and six steel tanks (Fish Towers) which make up 27,000 cubic meters of habitat on two acres of ocean floor in 17 m depth (Figure 3).

The funding for the reef was \$1 million through the Recreational Fishing Industry Fund (RFIF), BHP and NERA. Other groups involved with the project across funding and research include Subcon, Curtin University, BHP, and Recfishwest.

There is a monitoring BRUVS citizen science project (Reef Vision) in place which has collected data for analysis at Curtin University. The monitoring project is dealing with the early stages of reef development but has to date recorded 40 species on and around the reef. Six months after deployment the variety of species recorded include a range of species valued by recreational fishers including:

- Pelagic species: golden trevally, school mackerel, tuna, trevally, potentially sailfish
- Demersal species: red emperor spangles emperor, rankin cod, coral trout, bluebone



Figure 3: Location of the EIAR and the position and material used to develop the reef. Source: Harvey et al. 2020a

# 4.2 Economic valuation of artificial reefs

At the current time there is only a limited amount of primary data relevant to estimating the value of artificial reef structures in the North West. The approach adopted in this study therefore is to estimate the value of the reefs using a benefit/value transfer approach. This has two broad elements:

- The economic impact associated with the development of artificial structures
- The value (consumer surplus) that users derive from artificial structures

These elements can be described and quantified by a demand curve which is underpinned by a model of peoples' behaviour.

#### 4.2.1 Direct economic impact

The direct economic impact associated with the development of artificial reefs encompasses the direct expenditure made by recreational fishers and divers in pursuing reef based activities. The direct expenditure can act as a lower bound on the value of the associated fishing (see below). There will also be indirect impacts following on from these direct expenditures (e.g. a fisher expends money for bait, ice, hooks at local tackle shops which has a direct impact on output). The indirect impacts arise when the industries supplying these goods and services to fishers/divers/tourists in turn demand goods and services from their suppliers. In turn these shops spend money on rent, electricity, fuel, materials etc. which generates output, incomes and employment in those industries supplying the local tackle shop sector. This is relevant for understanding how the wider economy might benefit from the activities of recreational fishers and divers and tourists. At this stage the information is too limited to account for tourists.

There is little information on participant numbers on recreational activities around artificial reefs in Western Australia. Therefore, we estimate the expenditure value of the reefs using expenditure estimates of recreational fishing, diving and tourism studies undertaken elsewhere suitably adjusted to allow for location and time.

#### 4.2.2 Value derived from users

It needs to be recognized that participants in reef-related marine activities will derive a value or surplus that is over and above the expenditure or cost incurred to participate. In order to gain an understanding of the value of the recreational experiences associated with the proposed reef, we apply estimates of the willingness to pay for artificial reef activities, focussing on recreational fishing, derived from studies of compatible situations elsewhere.

Central to this approach is the extent to which an artificial structure is perceived differently and therefore has an intrinsically different value to a natural reef. If yes, then only studies directly dealing with artificial structures are relevant. However, it can be argued that once an artificial reef is developed and settled into the marine environment, recreational fishers will value the fishing experience in the same way that they value fishing at any other location. Species, catch, catch rates, accessibility, congestion and safety will drive the value of the fishing experience. Hence the value of recreational fishing can reasonably be based on relevant studies from comparable cases, whether based on artificial or natural reefs.

To understand how value is derived from recreational fishing, it is useful to begin with a model of recreational fisher behaviour. Such models have been an accepted part of the economics literature for many years, and assist in the analysis of value because they help to:

- Clarify how value is derived from the choices that recreational fishers make
- Allows inferences to be made about expenditures and value
- Help to put intelligible bounds on value

Assuming that fishers go fishing to maximize the value they derive from fishing a simple model implies that:

- The resource cost of going fishing is expenditure (money outlays plus opportunity cost of time)
- Fishers choose to expend these resources because the value derived from fishing is greater than or equal to the value of these resources expended in some other way, so

• The value of resources expended (money plus time) is a minimum or lower bound estimate of the value of recreational fishing

This principal components of the higher value that justifies incurring these resource costs are:

- Experiential value related to the wider trip experience irrespective of whether any fish are caught and kept or released
- Sport value related to the excitement of catching sporting species of fish irrespective of whether kept or released
- Food value directly connected to kept catch of edible species

Looking at the value of recreational fishing imputed from the choices that fishers make enables analysis of policies such as bag limits and closures that impact the quantity and quality of options available to fishers, and so have the potential to directly enhance or diminish the value of recreational fishing, even if the resource cost is little impacted. It applies to artificial reefs in that the development of a successful reef will improve all aspects of the fishing experience without necessarily increasing the cost of undertaking the fishing activity.

The following diagram is a simple representation of this concept.

Assume a recreational fisher makes several trips per year to go fishing. The "price paid" for each trip is composed of money costs (trip, gear, and boat) and time cost as reflected in the opportunity lost by committing the time to fishing.

The financial cost includes:

- Direct per trip costs such as boat fuel, food, launch fees, bait and ice, plus the financial cost of land transport to get to the location of the fishing platform. The annual cost is the sum of the individual trip costs, or the average trip cost multiplied by the annual number of trips chosen
- Annual gear cost for items such as rods and reels, clothing, and other annual costs that are independent of fishing effort levels
- Annual boat costs which can be apportioned based on the percent of times the boat is used for recreational fishing

The time cost includes total trip time which is composed of:

- Travel time from residence to launch site or shore location
- Time spent fishing and
- Time spent on the water or at the shore location when not fishing
- The opportunity cost value of time which might be different for the different types of time

To the recreational fisher, the economic value of each trip is the maximum sum of money the fisher would be *willing to pay* for that trip. In the literature, the demand for a non-market good or service, such as recreational fishing, is expressed as the maximum willingness to pay (WTP) for that experience, and the demand to go fishing can be represented by a conventional demand curve making chosen trips per year a function of WTP for the trip. This is illustrated in Figure 4.

The total value derived from OC trips is the area under the demand curve or ABCO. Of this gross value, the shaded area EBCO is the cost of going fishing for OC trips. Assuming OC trips at average cost E is the optimal solution for the fisher, EBCO also is the lower bound on the value that can be ascribed to recreational fishing activity; because for all but the marginal trip at OC, the WTP for the

trip exceeds the price paid as measured by the resource cost of going fishing. The excess of WTP over and above resource costs incurred is depicted by the triangle ABE, and is referred to in the literature as the consumer surplus from the recreational fishing experience

Hence, a more complete valuation is based on area ABCO which encompasses the experiential, the sport, and the food value of fishing.



Figure 4: Expenditure and consumer surplus for recreational fishing

From the above diagram, value can be assessed as follows:

- At a minimum it is the expenditure the recreational fisher, diver or tourist incurs to access the site and pursue fishing, diving and other marine tourism activities.
- Over and above the expenditure there is the consumer surplus value.
- Combined, these are the gross value.

The addition of an artificial structure that supplements the natural structures, increases choice and improves the related ecology has the potential to enhance value as illustrated in the diagram below.

The improvement in the attractiveness of the area can be represented by a shift in the demand curve for fishing, diving and marine tourism in the area. There are two consequences of this.

First the experience of existing users is enhanced. This can be represented as an increase in the value of activities in the area equal to AFGB. This enhanced value is based on the current volume of activity (e.g. fishing trips/days, dives/dive days etc.) as reflected in OC. The underlying level of expenditure is still OEBC.

Second, the improved amenity of the area will increase activity levels (e.g. fishing trips/days, dives/dive days etc.). This increase in volume will in part be from existing users increasing their

activity in the area and in part from new participants attracted to the area because of the improved fishing/diving/tourism opportunities afforded with the new structure in operation. The additional activity is CI. This causes an increase in expenditure on activities equal to CIHB and generates additional consumer surplus of BHG.



*Figure 5: Expenditure and consumer surplus for recreational fishing following an improvement in fishing quality* 

In assessing the value of an artificial structure, we need estimates of:

- The current activity level OC and the potential increase in activity Cl. This might be determined by studies of participation on the actual structure or, where data is not available, by applying response rates determined in comparable structures.
- The expenditure made on the estimated incremental activities. There is no reason to expect expenditures per unit (e.g. fishing trip or day) to be different between base and incremental activity. Hence current estimates of expenditure per day can be applied to estimated activity increase.
- The surplus on existing activity of ABGF and the consumer surplus on the incremental activity. This might be implied using benefit transfer whereby the estimated net willingness to pay for access to artificial reefs in other established locations or estimates of the increased value per trip that may arise because of improved catch.

In applying this to an artificial reef, we start with the expenditure.

The expenditures made by the recreational fisher/diver/tourist to access and participate in reef related activities cause direct and indirect economic impacts in the local and State economies. The direct impact derives from the expenditure incurred and is associated with additional output,

incomes and employment associated with this expenditure on the goods and services required for their activities.

Estimating the consumer surplus that accrues over and above these direct expenditures is essential to understanding how the availability and use of an artificial reef contributes to overall fisher, diver and tourist welfare.

## 4.2.3 Valuation approaches

As described in the literature review above, there is an ongoing discussion about the capability of artificial reefs to produce new biomass vs attracting biomass from surrounding areas. The generation of new fish biomass increases the catchability and/or the number of fish to be observed on the artificial structure while maintaining the condition in the surrounding areas equal. Conversely, the attraction of biomass from surrounding areas re-distributes the existing biomass and can increase the catchability on the artificial structure, but might decrease the catchability in the surrounding areas.

Moreover, there is an uncertainty about whether artificial reef users are new users in the area generating new revenues or whether they substitute another local site with the artificial reef site. These two factors have consequences for the economic value that an artificial reef can generate. To get an understanding of the range of possible values, we apply two different approaches in this report:

• Approach 1: Upper value

To estimate the upper value of the possible range of the economic impact from an artificial reef, this approach assumes that there is new production of fish biomass available around the reef and that the reef attracts new fishers to the area.

• Approach 2: Lower value

The lower bound of the value range assumes that the biomass on the artificial structure is attracted from the surroundings and that the users have been engaging in activities in the area before the creation of the structure. The creation of a new artificial reef will redistribute efforts in the area and create economic value through lower congestion. This increase in value can attract new users to the area.

# 5 The potential value of artificial reefs made from decommissioned oil and gas infrastructure off Onslow

The following analyses of available data and information from the literature are used to make an indicative assessment of the potential economic impact of artificial reef development made from decommissioned oil and gas infrastructure around Thevenard Island off Onslow in Western Australia. We follow two approaches, one which assumes new production of fish and new created trips to the area and one that assumes a sharing of created benefits among all users in the region. We also distinguish between two scenarios: i) leaving existing oil and gas structures in place and ii) repurposing parts of the material for new artificial reefs.

## 5.1 Framework to estimate values

The base load for fishing expenditure is area OCBE in Figure 4. The potential future artificial reefs are offshore so fishing at that location requires a boat. Therefore, the relevant base is activity and expenditure by those fishing from a boat. The horizontal volume could be measured as boat days, fishing events or catch. Measured as boat days the vertical axis would be expenditure ("price") per day. Additional value generated by the structures would be measured as an increase in boat days and a willingness to pay for additional boat days. Additional boat days could be a combination of existing fishers staying longer and new fishers participating in the structure based activities. The value of these additional boat days would reflect both the catch and the boating experience sans catch.

Measured as catch, the vertical axis would be expenditure per unit of catch. Additional value is measured as the increase in catch due to fishing on the structures and the willingness to pay for additional catch. Using catch is the less attractive option because fishing experience can encompass, catch and keep, catch and release and non-catch value associated with fishing (e.g. spending time with family and friends). However, studies of willingness to pay have concentrated on catch so the bulk of the data relevant to the benefit transfer analysis is based on catch. It will be necessary to infer this value based on catch values. Focusing on boat days Table 2 shows the estimated boat days used for recreational fishing in Western Austral in 2015/16.

Region fished	Boat days	Events	Hours fished
North Coast	31,375	33,046	122,192
Gascoyne Coast	43,237	44,407	169,312
West Coast	271,311	285,157	740,815
South Coast	24,444	25,097	80,260
State-wide Total	370,368	387,707	1,112,579

Table 2: Annual fishing effort, expressed as boat days and fishing events, for boat-based recreational fishing in Western Australia during 2015/16.

Source: Ryan KL, Hall NG, Lai EK, Smallwood CB, Taylor SM, Wise BS 2017. State-wide survey of boatbased recreational fishing in Western Australia 2015/16. Fisheries Research Report No. 287, Department of Primary Industries and Regional Development, Western Australia. 205pp

The State-wide estimates are based on a survey of RFBL holders with 2,931 fishers 320,661 individual fish caught (kept or released), 39,416 boat days, 42,152 fishing events and 123,378 fishing hours. These data can act as a reference point to assist estimating a base load for analysis of Thevenard Island.

# 5.2 Private recreational fishing effort

Private recreational fishing effort includes boat launch events for boat ramps in the North Coast as the indicator of relevant effort (Table 3). The boat launch events are around 7.5% of State activity. Launch activity from Onslow and Thevenard Island ramps is about 3.2% of North Coast activity.

Table 3: Launch activi	y from North	Coast boat	ramps 2015/1	6 survey.
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North Coast	% of North coast launchings	% State launchings
BROOME ENTRANCE POINT (1) BR	7.81%	0.59%
BROOME ENTRANCE POINT (2) BR	12.88%	0.97%
BROOME GANTHEUME POINT BR	4.05%	0.31%
BROOME PORT SMITH BR	1.16%	0.09%
BROOME TOWN BR	12.88%	0.97%
CAPE KERAUDREN BR	0.43%	0.03%
CLEAVERVILLE BR	0.43%	0.03%
COSSACK BR	0.58%	0.04%
DAMPIER BOAT HARBOUR BR	7.53%	0.57%
DAMPIER BR	1.45%	0.11%
DAMPIER TOWN BR	11.87%	0.90%
DERBY BR	1.30%	0.10%
DERBY TOWN BR	3.18%	0.24%
FORTESCUE RIVER BR	4.78%	0.36%
FORTY MILE BEACH BR	0.14%	0.01%
KARRATHA BACK BEACH BR	1.59%	0.12%
KARRATHA BOAT HARBOUR BR	0.72%	0.05%
KARRATHA BR	0.58%	0.04%
KARRATHA BR	0.14%	0.01%
KARRATHA BR	0.58%	0.04%
KARRATHA BURRUP BR	0.87%	0.07%
LAKE ARGYLE BR	0.14%	0.01%
LAKE KUNUNURRA BR	0.14%	0.01%
LAKE KUNUNURRA BR	1.30%	0.10%
ONSLOW BR	1.45%	0.11%
ONSLOW BR	1.74%	0.13%
PORT HEDLAND BOAT HARBOUR BR	4.63%	0.35%
PORT HEDLAND FINUCANE ISLAND BR	6.51%	0.49%
WYNDHAM ANTHON LANDING BR	2.89%	0.22%
WYNDHAM TOWN BR	6.22%	0.47%
Total North Coast	100.00%	7.55%
Total Western Australia		100.00%

*Source: Estimated by author using data supplied by Department of Primary Industry and Regional Development for the analysis in McLeod and Linder (2018)* 

Applying this percent to the North Coast effort gives 998 as the North Coast boat days departing from Onslow and Thevenard ramps, pre-reef.

Questions were added to the WASHF survey to collect data on trip expenditures as part of the surveys undertaken for McLeod and Lindner (2018). Questions dealt with average expenditure per trip for food and drinks, bait and ice, boat fuel, parking and launch fees and other trip costs. These are the variable costs that are expected to change with the number of trips measured as boat days. Gear costs and boat costs were also collected as part of the survey. These were collected on a 12 months basis as they do not change with the number of trips at the margin within a year.

Additional trips arise either because current fishers increase trips per year or new fishers participating will incur trip costs. The per night and aggregate trip costs on food and drinks, bait and

ice, boat fuel, parking and launch fees and other trip costs (based on the WASHF survey 2018) based on Onslow and Thevenard Island boat ramps are shown in Table 4.

Food and drink	Fuel for boat	Parking and launch fees	Bait and ice	Other trip costs	% Trips with nights away	Accommodation cost
Per day/night	t costs					
\$169.16	\$147.15	\$4.53	\$45.04	\$53.43	56.72%	\$121.45
Aggregate Co	sts					
\$167,300.92	\$145,532.14	\$4,483.07	\$44,542.69	\$52,847.17	56.72%	\$120,112.27
Aggregate Ex	penditure					
Expenditure	Cost per day					
\$534,818.26	\$540.77					

Table 4: Aggregate trip expenditure for effort from Onslow and Thevenard boat ramps

The expenditure of \$534,818 is the annual expenditure made by fishers operating from Onslow boat ramps, equivalent to \$541 per boat day. Translating this to the diagram of demand and expenditure this is the rectangle of current expenditure as shown by OCBE in Figure 4.

Assuming the demand curve through B is linear we can solve for the intercept A in two ways. Using an estimate of consumer surplus per day we can estimate aggregate consumer surplus for the 998 boat days and derive an estimate for the maximum price. Alternatively using an estimate of the price elasticity at the point B, we could calculate the maximum price. No specific data on these values exists for Onslow, nor Western Australia. Moreover, the literature is thin on meaningful estimates of these concepts.

In the recent McLeod and Linder (2018) the Recreation Use Values Database (RUVD) for North America was used as a basis for inferring an estimate of consumer surplus. The RUVD reviews and indexes estimates of consumer surplus from economic valuation studies of the use value derived from a wide range of recreational activities in the U.S. and Canada from 1958 to 2015 (Rosenberger, 2016).

The 2016 update contained 421 documents of studies that yielded 3,192 estimates of consumer surplus from twenty-one primary activity types in per standardised person per activity day units. The primary activity type relevant to the current study is "saltwater fishing", for which the database studies contained 134 documents, almost all of which contained multiple estimates of consumer surplus. Some of these multiple estimates reflect plausible differences in values of consumer surplus from the fish species targeted by recreational fishers, but much of the variability reflected alternative estimation techniques. After filtering out documents classed as PhD Dissertation; Working Paper; or Proceedings Paper, 121 documents remained comprising published journal articles; government agency or university report; or consulting report; that yielded some 15,285 estimates of consumer surplus from saltwater fishing.

For consistency these estimates were adjusted for time and currency differences. After standardising these 15,285 consumer surplus estimates to 2016 USD values, the overall average was USD 126.32 per person per fishing day. However, the span was very wide, ranging from less than USD 1 per day per person to nearly USD 700 per day per person. The judgment was made to exclude outliers that were either less than USD 10 or greater than USD 500, which left 100 estimates of consumer surplus with an average value of USD 133.75 per person per fishing day. Converted to AUD at the prevailing

exchange rate of AUD1.33 per USD yields an estimate of consumer surplus from recreational fishing of \$178 per person per fishing day.

Some of the higher estimated values were for prized sport fish such as Blue Fin Tuna with an upper bound of USD339.59 and an average of USD268.94, and an average of USD336.98 per person per fishing day for unspecified species of Tuna. The estimated consumer surplus from recreational fishing for other most other fish species, including many keenly sought species such as snapper and grouper was substantially less. For instance, the average of 15 estimates of consumer surplus for associated fish species, including snapper, sea trout, grouper, catfish, and red snapper, was USD79.10. Converted to AUD at the prevailing exchange rate of AUD1.33 per USD yields an estimate of consumer surplus from recreational fishing of \$105 per person per fishing day. Applying the \$178 dollar figure yields a consumer surplus estimate of \$2.71 million dollars which implies an intercept price of \$1032 and a price elasticity of -1.90. As the consumer surplus estimate increases the implied intercept price goes up and the implied price elasticity deceases in absolute value (is more inelastic). This is shown in Table 5 for a range of consumer surplus and elasticity estimates, ranging from \$105 through to \$300. Using the model as outlined in Figure 4 we can infer the elasticity of demand using the consumer surplus estimate, or infer consumer surplus by assuming a price elasticity and hence inferring the slope of the demand curve. Estimates of the price elasticity of demand for recreational fishing are few and relatively poorly documented so we adopt the former approach: taking an estimate of consumer surplus from the literature and inferring the elasticity of demand and demand curve. We are using for our indicative calculations a lower end CS with a "reasonable" implied price elasticity. However, it needs to be recognized that the experiences being created are unique and until original survey data is collected, a refined estimate is not possible.

	Consumer surplus per	Consumer	Intercept	Implied price elasticity at
Trips	trip (\$)	surplus	price	current trips
998	105	104790	750	-2.57
998	178	177644	896	-1.52
998	200	199600	940	-1.35
998	250	249500	1040	-1.08
998	300	299400	1140	-0.90

Table 5: Implied price elasticity at different consumer surplus per trip value

Using the \$178 per day figure and assuming the demand curve through B is linear, we estimate the aggregate consumer surplus for the 998 days to be \$177,644 and derive an estimate for the maximum price of \$896 (Figure 6).

#### 5.2.1 Approach 1: Upper value

To estimate the economic impact from an artificial reef made out of oil and gas structure around Thevenard Island, we start with the approach that assumes that the additional fish available around the reef are new production and will attract new fishers to the area (Figure 6). This assumption is supported by available information of reef activity (Recfishwest, unpublished data) and information gathered in a focus group with 5 Recfishwest representatives who expect that there will be an increase in private boat activity for both fishing and diving once the location around the existing structures is open for fishing and diving activities. However, depending on the final location of the new artificial reef, this might not be accurate. The Onslow boat ramp locations are isolated. This is reflected in the much smaller number of boat launches from these locations compared to the Exmouth launch number documented previously. In part this appears to be due to the greater distance from Perth and in part it is due to the significant ocean distance that needs to be travelled to reach attractive fishing areas. The facilities available in Onslow and the boat ramp facilities have also been suggested as a limitation

Making the area around the Thevenard structures available is a quantum change. It offers potentially rich fishing and diving opportunities much closer to shore and within a safer area close to Thevenard Island. The low current base and the absence of any reliable data on intentions from fishers mean that estimating the likely additional number of participants that go to Onslow and Thevenard Island as a result of any artificial reefing is difficult.

Rather than nominate an exact number we illustrate what might be the result with increases of 15%, 20% and 30% in total fishing trips from the current base load. The results are shown in Table 6. Assuming that they have the same expenditure patterns as current fishers, with a 15% increase in activity which is 150 extra boat days, aggregate expenditure increases by around \$80,840 per year. Using the same analysis as for the base case with a surplus per day of \$178, aggregate consumer surplus is around \$26,650. If the increase in activity is 30%, aggregate expenditure increases by \$161,670 per year and the associated consumer surplus is around \$53,300.



*Figure 6: Economic value of the status quo fishing on existing sites (A) and the value of the new artificial reef(s) if the site attracts new fishers (B).* 

It is important to note that the area around the current structures is currently not available to private fishing boats, private diving boats or charter fishing boats. Therefore, while the above increments illustrate what a transformation of the base load might imply, any increase is unlikely to be instantaneous. It may take time for fishers to become aware of the artificial reef and begin investigations. Once open, the opportunities will need to be appropriately promoted and managed. Nevertheless, based on feedback from charter operators, who are currently in the best position to estimate what opportunities the area offers, for private fishers and divers, a significant increase in private boating activity is expected.

	Expenditure	CS per	%	# Trips	Additional	
Base trips	per trip	trip	increase	increase	expenditure	CS
998	\$540	\$178	15%	150	\$80,838	\$26,647
998	\$540	\$178	20%	200	\$107,784	\$35,529
998	\$540	\$178	30%	299	\$161,676	\$53 <i>,</i> 293

Table 6: Incremental consumer surplus (CS) from additional fishing activity at Onslow boat ramps

#### 5.2.2 Approach 2: Lower value

An alternative approach is to estimate how the presence of the new site will cause the demand to fish in the area to shift. This will induce an increase in the value (on average) to existing fishers, plus an increase in visitors. The lift in demand is due to the whole area being perceived as more attractive because of the development of the reefs. As already discussed, this can arise because the "portfolio" of opportunities is increased and depending on the responsiveness of demand, the fishing and diving conditions should improve at all locations on average as consumers spread around the locations to pursue activities inclusive of the new reef.

The starting point for this analysis are the status quo values from section 7.1 above. These numbers are assumed to apply for the catch rate for reef fish of 4.2 per trip (Department of Primary Industry and Regional Development, unpublished data). We use the WTP per fish caught of \$9.47 (Raguragavan et al. 2013) and calculate the additional consumer surplus which increases with the increase in the catch rate. Given our uncertainty about the future use of the newly available structures, we apply the additional consumer surplus on 15%, 20% and 30% of visitors visiting the new reef. The distribution of catch rates and the associated consumer surplus is shown in Figure 7.

#### Scenario 1: Leave in place

Current estimates from ecological data indicate that there are 98 fish species associated with the nine Thevenard oil and gas structures out of which 40 are routinely retained by recreational and commercial fishers (Harvey, unpublished data). The biomass on the Thevenard structures is approximately 250 and 356 times higher than on adjacent natural reefs and soft sediment, respectively (Harvey, unpublished data). If the structures were left in place and made available to recreational fishing with all biomass preserved, this would potentially result in a strong increase in catch rate. However, the new catch rate might not be proportional to the difference in biomass because of bag limits for recreational fishing activities (Table 7). It also has to be recognised that the current estimates of ecological data reflect the status of the oil and gas infrastructure when it has been protected from fishing, and the equilibrium level of biomass, if fishing were to proceed, would be lower.

Category	Bag limit
Demersal finfish	5
Large pelagic finfish	3
Nearshore/estuarine finfish	16
All other species of finfish	30
Total	54

Table 7: Bag limits in the North Coast bioregion that apply to different finfish categories that are present around Thevenard oil and gas infrastructure.

Source: Department of Primary Industries and Regional Development 2019: Recreational fishing guide 2020.

Based on the bag limits, the maximum number of fish one fisher is allowed to catch on artificial structures offshore from Onslow is 54 fish per day. For example, if we used this as that maximum legal catch rate and 15% of trips would go to the reef, the increase in demand would generate an additional 181 trips to the area, and produce an additional consumer surplus of \$92,153 and an additional expenditure of \$97,790. If 20% of trips were going to the new reef, the site could produce 231 extra trips, \$124,954 of extra revenues and an additional consumer surplus of \$124,749. With 30% of total trips in the area visiting the new reef, these benefits could rise to an extra 320 trips, additional revenues of \$173,013 and \$189,872 of additional consumer surplus (Figure 7).

## Scenario 2: Re-purpose parts of the oil and gas infrastructure to create new artificial reefs

In the scenario where oil and gas structures around Thevenard Island are transported to a designated reefing location, it is possible that the fish communities currently associated with structures will disperse or be lost. Under this scenario, the biomass on the new artificial reef will have to start growing on an initially uninhabited artificial structure. Given the proximity of the site to Exmouth, we can expect a development of marine life and therefore a catch rate similar to the one of the EIAR. After about one year of the deployment of the EIAR, biomass was measured to be about three times higher than on adjacent natural habitat and the catch rate was estimated to be 10.89 fish per day (see section 8.2.2). Applying this catch rate to artificial reefs made out of Thevenard oil and gas infrastructure, it would generate between 24 and 43 new trips, \$13,137 and \$23,242 in extra revenues and an additional consumer surplus between \$10,087 and \$18,330 depending on the percentage of trips to the new artificial reef.

However, as previously discussed, there is an uncertainty about the size, location and condition of a future artificial reef. Moreover, the ecology on the structures may change over time depending on environmental factors and fishing pressure. Therefore, a catch rate and the resulting additional revenues and consumer surplus it is generating could lie somewhere between the values above.



Figure 7: Relationship between catch rate and A) additional trip expenditures and B) additional consumer surplus from recreational fishers that visit Thevenard oil and gas structures. The colours of the lines indicate the percentage of trips going to the structures: Blue = 15%, red = 20% and green = 30% of total trips in the area.

In summary these two approaches (new production and shift in demand) give us an idea about the potential economic benefits that the artificial reef(s) made out of Thevenard oil and gas infrastructure could bring to recreational fishers in the area. Approach one indicates that the development of an artificial reef off Onslow could increase the number of trips to the Onslow and Thevenard Island area by between approximately 150 and 299 per year. The results of the second approach suggest a range of 24 to 320 extra trips to the new reefs per year. Under the given assumptions and depending on the approaches and scenarios, the increase in annual expenditures due to the new artificial reefs could lie between \$13,137 and \$173,031 and the additional consumer surplus between \$10,087 and \$189,872 per year. It is important to notice that these benefits are annual values and would accumulate to larger benefits over the years. At times it is of interest to compare the value of the benefit stream to e.g. the initial costs of provision. However, future values have to be discounted and expressed in net present values. Table 8 shows the net present value for the benefits over the next ten years for a low, medium and high discount rate. It is important to note that these calculations assume that the estimated benefit stream will be sustained over the whole time period, although ecological and economic uncertainties may lead to greater uncertainty about the evolution of values.

Table 8: Net present value of economic benefits (\$'000) from Thevenard artificial reefs over 10 years with low medium and high discount rates. Benefits are given for lower and upper bound estimates of the total annual economic value of artificial reefs (expenditures and consumer surplus).

Total annual benefit	Low (4%)	Medium (7%)	High (10%)
Lower bound: \$23	188	163	143
Upper bound:\$363	2,943	2,548	2,228

# 5.3 Charter boat operators

The analysis above has been based on data for private recreational fishers. However, given the location and potential quality of the fishing experience offered, the site may provide significant attractions for charter boat operators. At the moment, there are ten charter boats with an average capacity of ten passengers each operating in the area of Thevenard Island. These are based in Exmouth, Onslow and on Thevenard Island and mostly visit the Mackerel Islands and Montebello Islands. The most common activity is recreational fishing but free diving, snorkelling and scuba diving activities are also done occasionally. Operations occur during the dry season between April and November and follow a roster of one week trips. The trip costs range between \$3000 and \$4000 per person. Based on these figures, revenues from charter boat operations under the status quo are estimated to be approximately \$8.75 million per season. Given that the oil and gas facilities around Thevenard Island are closed, at this moment none of these revenues can be attributed to them.

#### 5.3.1 Potential economic value from Thevenard oil and gas infrastructure

A focus group with the charter boat sector (conducted in March 2020) that operates in the region revealed that the availability of Thevenard oil and gas infrastructure could cause the following changes to the charter boat and tourism industry in the region:

- 1) Establishment of a new market for companies offering one day trips to the artificial reef(s) because they are only about two hours away from Onslow.
- 2) Live-aboard trips have to be occasionally cancelled due to rough weather conditions. The area around Thevenard Islands is closer to launching locations than the final destination of these trips and is fairly protected from rough weather conditions. Therefore, the newly available structures could be used as a substitute site when it is too rough to go to e.g. the Montebello Islands and increase the number of trips the operator can do. This also saves operation costs.
- 3) Increased customer satisfaction because charter boat operators could start high quality recreational activities much sooner within the trip (within two hours from Onslow, rather than 6 hours of navigation to the Montebello Islands).
- 4) Attraction of more tourists to Onslow with flow-on effects such as an increased variety of other small businesses like restaurants and souvenir shops.

At this stage it is not possible to quantify the economic value of these benefits.

#### 5.4 Commercial fishing operators, including aquarium fish

There are a total of seven different commercial fisheries with that operate in the area that would be relevant to the decommissioning of Thevenard oil and gas infrastructure. Fisheries target beche de mer, mackerels, prawns, oysters, a range of scale fish using lines, crabs, and shells. These fisheries encompass 70 commercial fisheries licenses (Shea, 2017). At this moment, the area around the

current structures is off limits for commercial fishing. However, once the new structures are in place the area could be made available to commercial fishing alongside recreational fishing and dive tourism.

The initial investigations of the ecology on the structures have identified a total of 40 species of commercial relevance and with established presence in the commercial market place (Harvey et al., unpublished data). Of those identified, the following species have a high market price: Rankin Cod, Rosy Snapper, Grass Emperor, Duskytail Grouper, Golden Snapper and Pearl Perch, Spangled Emperor, Mangrove Jack and Pearl Perch and Pink Snapper. Species identified that have slightly lower commercial values include Spangled Emperor, Mangrove Jack, Saddletail Snapper, Crimson Snapper, a range of Wrasses and Golden Trevally.

Enhanced value for commercial fishers is possible because:

- 1) Species that are commercially well established have been identified.
- 2) The biomass in the area is currently not fished commercially and represents a potential new opportunity for commercial fishers.
- 3) If this biomass is deemed to be independent of biomass currently fished outside of the area, it represents a potential expansion of the commercial catch.
- 4) If the biomass within the currently restricted area is deemed to be part of the currently fished biomass such that an increase in catch may not be permitted, the expanded area can still result in improved fishing efficiency.
- 5) If the structures cause spill-over effects into surrounding fishing areas, commercial fisheries might already benefit from the structures. These benefits could be reduced or lost if (some of the) structures were completely removed.

At this stage it is not possible to quantify the economic value of these benefits because the commercial catch that would be available for each of these species is not determined. This would be subject to further stock assessment within and outside of the area preparatory to establishing a management plan including consultation with stakeholders.

Harvesting aquarium is a specialised activity with 12 commercial licences in WA. There is a harvest strategy covering aquarium fish (DPIRD, 2018). A total of 20 aquarium species have been identified around the structures that are deemed to be commercially valuable and are incorporated in the current harvest strategy (Harvey et al, unpublished data). These include Clark's Anemonefish, Yellowtail Fusilier, Scribbled and Yellowtail Angelfish, Orangebanded Coralfish, Three-spot Humbug, Red Lionfish and Moon Wrasse. The availability of area around the new structures for fishing may offer an opportunity to recalibrate the harvest strategy for aquarium fish based on the species identified and a final assessment of the stock impact.

#### 5.5 Diving activities

Diving activities are here defined as free diving, snorkelling and scuba diving for non-extractive purposes. As mentioned above, dive activities are offered by charter boat operators in the region around Thevenard Island.

If some of the Thevenard infrastructure were made available for dive tourism, this could diversify the economy in the region and make it more resilient. Under the assumption that this would provide a high quality dive destination there could be:

- 1) An establishment of a new market for one day trips because Thevenard is only about 2h away from Onslow,
- 2) More demand for dive tourism on live-aboard charter boat operators,
- 3) An increase in demand from private boat owners going diving on the structures, and
- 4) An attraction of more tourism to Onslow which could increase a variety of other small businesses (restaurants, souvenir shops, etc).

Currently, oil and gas structures are in depth of maximal 18 m and reach the surface which is accessible to all these activities. However, depending on the decommissioning option and a new location of the structures, free diving and snorkelling activities might not be feasible.

#### 5.5.1 Potential consumer surplus from diving/snorkelling

There is very little evidence to allow an estimate of the potential expenditure and consumer surplus associated with diving/snorkelling at the location of the structures off Thevenard Island. This is essentially because in the absence of rigorous surveys of diving and snorkelling participation by destination for Western Australia, there is no meaningful base load estimate to start the calculation with as there was for fishing.

However, an indicative estimate is possible using a range of third-party sources. Surf Life Saving Australia (SLSA) produces a National Coastal Safety Report that estimates participation in diving and snorkelling by State. The estimates for Western Australia from the 2019 report are given in Table 9.

	_		% to	
	Participants	Frequent/dedicated	Thevenard	Thevenard trips
Snorkelling				
Australia	1,700,000	400,000		
Western				
Australia	170,000	40,000	5%	2,000
Scuba				
Australia	600,000	200,000		
Western				
Australia	24,000	8,000	5%	400
Total				2,400
Average spend per c	live trip			\$618.28
Total expenditure				\$1,483,879.97

#### Table 9: Participation in diving and snorkelling and potential expenditure

SLSA report an estimated 170,000 snorkelling participants and 24,000 diving participants in Western Australia. Of these, 40,000 snorkelers and 8,000 divers are estimated to be frequent/dedicated participants. We take this as the number of participants likely to consider the Thevenard Island location, at least in the first instance. If we assume that 5% of these could be enticed to experience the waters around the decommissioned structures, then around 2,400 person would make trips to the area per annum.

In their study of shark diving in Western Australia, Huveneers et al (2017) estimated trip expenditures for 2013/14 of \$524. In 2018 values this is around \$628 per trip. In the absence of an equivalent estimate for snorkelling, we apply this estimate to both snorkelling and diving. This is

equivalent to \$1.48 million for 2,400 participants. This can be translated into a consumer surplus measure by assuming a straight line demand curve and an associated price elasticity (Table 10).

Table 10: Consumer sur	olus from diving
------------------------	------------------

	Value
Trips	2,400
Expenditure/trip	\$618.00
Expenditure	\$1,483,200.00
Price elasticity of demand	-0.85
Slope	-3.30
Intercept price	\$1,345.06
Consumer surplus	\$872,470.59
Consumer surplus /trip	\$363.53
USD reference	\$272.65

Using a price elasticity of -0.85 at a price -quantity combination of (\$618,240) implies a consumer surplus of around \$872,400 which is \$363 per trip. Converted to USD at the long run exchange rate of USD/AUD0.75 this is equivalent to USD272. By way of comparison, in their study of the WTP for diving day trips, Ditton et al estimated a WTP between USD256.58 and 270.67. However, the ultimate numbers will depend on the final form of the structures available, the quality of the diving/snorkelling opportunities, the quality of the onshore facilities as well as promotional activity.

# 6 The potential value of the Exmouth Integrated Artificial Reef

This section analyses the available data and information from the literature to make an indicative assessment of the potential impact of the EIAR in Western Australia. This serves as an example of the benefits that can arise from artificial reefs partly made out of oil and gas structures in the region. The EIAR is offshore so activities at that location requires a boat. The impact from the artificial reef on activities in the area will ultimately depend on the development of the reef environment over time and how existing and new users will change their behaviour in response. Therefore, the following sections follow a similar rationale as Section 7.

# 6.1 Share of fishing effort attributable to Exmouth

Exmouth sits within the Gascoyne Coast bio region. Taking boat activity as the indicator of relevant effort, we look at launch events for boat ramps in the Gascoyne Coast (Table 11). The boat launch events are around 10.7% of State activity. Launch activity from Exmouth ramps is about 35.2% of Gascoyne Coast Activity. Applying this percent to the Gascoyne Coast effort gives 15,210 as the Gascoyne Boat days departing from Exmouth ramps, pre-reef.

	% Boats launched	% Boats launched	
Boat ramp location	WA	Australia	
CARNARVON BLOW HOLES BR	0.21%	0.02%	
CARNARVON BOAT HARBOUR BR	5.64%	0.60%	
CARNARVON PELICAN POINT BR	9.13%	0.97%	
CORAL BAY GNARALOO BR	7.59%	0.81%	
CORAL BAY MONKS HEAD BR	9.64%	1.03%	
CORAL BAY WAROORA STATION BR	1.54%	0.16%	
DENHAM BR	0.82%	0.09%	
DENHAM BR	18.26%	1.95%	
DENMARK BR	0.92%	0.10%	
DENMARK BR	0.82%	0.09%	
EXMOUTH BOAT HARBOUR BR	9.54%	1.02%	
EXMOUTH BUNDEGI BR	6.36%	0.68%	
EXMOUTH TANTABIDDI BR	19.28%	2.06%	
MONKEY MIA BR	6.15%	0.66%	
NANGA BR	4.10%	0.44%	
Total	100.00%	10.66%	
Total WA		100.00%	

## Table 11: Launch activity from Gascoyne Coast boat ramps 2015/16 survey.

Source: Estimated by author using data supplied by Department of Primary Industry and Regional Development for the analysis in McLeod and Linder (2018)

Additional trips arise either because current fishers increase trips per year or new fishers participating will incur trip costs. The per night and aggregate trip costs on food and drinks, bait and ice, boat fuel, parking and launch fees and other trip costs (based on the WASHF survey 2018) based on Exmouth boat ramps are shown in Table 12.

#### Table 12: Aggregate trip expenditure for effort from Exmouth boat ramps

Food and drink	Fuel for boat	Parking and launch fees	Bait and ice	Other trip costs	% Trips with nights away	Average accommodation cost per night	
Per day/night cos	sts						
\$232.25	\$290.64	\$4.62	\$69.22	\$9.52	\$0.51	\$137.09	
Aggregate costs							
\$3,532,658.97	\$4,420,847.38	\$70 <i>,</i> 306.85	\$1,052,852.10	\$144,733.92		\$1,072,823.54	
Aggregate expenditure							
Expenditure	Cost per day						
\$10,294,222.76	\$676.78						

The expenditure of \$10.294 million is the annual expenditure made by fishers operating from Exmouth boat ramps, equivalent to \$676 per boat day. Translating this to the diagram of demand and expenditure this is the rectangle of current expenditure as shown by OCBE in Figure 4. As in section 7 above, we use the consumer surplus value of \$178 per day which was identified as the most appropriate value (depending on target species and the realism of the implied elasticity), giving an estimate of consumer surplus of \$3.8m (Figure 8)



Figure 8: Consumer surplus for fishing from Exmouth boat ramps

# 6.2 Economic value of the Exmouth Integrated Artificial Reef

Given the early age of the EIAR, detailed surveys have yet to be undertaken to assess how fishers might respond and the final likely impact on the marine ecology and its impact on fishing have yet to be determined. That being the case we develop indicative estimates of potential values based on a range of assumptions.

#### 6.2.1 Approach 1: Upper value

Approach 1 assumes that the additional fish available around the reef are new production and will attract new fishers to the area. Existing fishing opportunities will be unaffected. This is represented in Figure 9.



*Figure 9: Value of the artificial reef when new site attracts new fishers.* 

Based on the available information of reef activity (Recfishest, unpublished data), we estimate that the likely additional number of participants that go to the EIAR is 10% of total fishing trips which is 1,500. Assuming that they have the same expenditure patterns as current fishers, aggregate expenditure increases by \$1.051 million per year. Using the same analysis as for the base case with a surplus per day of \$178, aggregate consumer surplus is \$0.267 million. Although this is based on values consistent with the estimates in the literature, the actual demand for the reef may be different from the demand for existing sites. More accurate assessment would require detailed surveys of potential users. The model above treats the new location as a separate entity added to the system, with no impact on the rest of the system.

#### 6.2.2 Approach 2: Lower value

Under approach 2, we consider the increase in the value (on average) to existing fishers, plus an increase in visitors due to the shift in demand to fish in the area. The starting point for this analysis is the base set of values with 15210 trips and a price of \$676/trip and \$10.3 million expenditure. Using the base assumption of \$178 per trip (day) consumer surplus provides the base estimate or initial consumer surplus \$3.8 million.

These numbers are assumed to apply for the catch rate for reef fish of 4.2 per trip (Department of Primary Industry and Regional Development, unpublished data). Current estimates from ecological data are that the artificial reef has approximately three times more fish than on adjacent natural reefs (Harvey, unpublished data). We use parameter from Raguragavan et al. (2013) to estimate how this increase in fish abundance translates into a higher catch rate. Using an elasticity of 0.53, the catch rate at the artificial reef increases by 6.68 fish/trip in comparison with adjacent natural reefs. Added to the current catch rate this gives a new total catch rate for fishers on the artificial reef of 10.89.

This increase in the catch rate generates increased consumer surplus for the fishers that visit the reef. We assume that this is 10% of all current trips (Recfishwest, unpublished data). The extra WTP per trip for the 10% of trips with the increased catch rate is estimated by multiplying the increase in catch rate (6.68) by the willingness to pay per reef fish. Until detailed surveys are completed, we are transferring estimates from previous studies to this catch. Raguragavan et al. (2013) estimate the willingness to pay at \$9.47 per fish. This gives an extra value per trip of \$63.354 or \$74.753/trip in 2018 dollars for fishers that visit the reef.

This increased value is effectively spread across the whole population. At \$74.75 for 1521 trips to the reef (10% of trips), the consumer surplus is \$113,699. Across the whole population of trips this is equal to \$7.475 per trip. On average for the existing population the availability of higher catch rates on the new reef adds \$7.475 in consumer surplus per trip. This is appropriately represented as an increase in demand (shift in the demand curve) of \$7.475 per trip.

The shift in the demand curve will also increases the number of trips that people make to the area. If we accept the base starting conditions as outlined above, the slope of the new demand curve is the same as the base curve. A shift equal to \$7.475 increases trips by 227.4. The consumer surplus from these new trips is \$848 which can be added to the overall surplus. Total consumer surplus is \$114.55. This is illustrated in Figure 10.

In summary, these two approaches give us a range. On the current available evidence, the artificial reef has increased the number of trips to the Exmouth area at least by 227 and at the most by 1521 and that depending on these approaches the increase in consumer surplus varies from \$114,500 to \$267,000.



*Figure 10: Increase in value due to an improvement in overall fishing quality (movement of lines not to scale).* 

# 6.3 Expenditure Impact

The current expenditure by fishers and the incremental expenditure that follows from the reef generate positive economic impacts for Exmouth. These are given in Table 13 based on the Exmouth IO table available from AURIN. These are indicative. A potential more accurate assessment could be made once the numbers are refined by using the REMPLAN model or the .ID impact module of the .ID demographic system depending on which one the Exmouth Shire has a subscription for.

The base expenditure has economic impacts equal to around 100 FTE. The estimated increment is equivalent to around 10 FTE, although as is noted elsewhere there are additional impacts that cannot be quantified at this time, for example the potential impact on general tourism or on charter boat activities that will grow after the full impact of the reef structure can be marketed.

Base	Expenditure (\$mill)	Output multiplier T2	Employment multiplier T2	Output impact	Employment FTE/\$mill	Direct FTE's	Total FTEs'
Recreational services	\$9.22	2.26	1.76	\$20.84	5.37	49.52	87.16
Accommodation	\$1.07	2.02	1.49	\$2.17	8.2	8.79	13.10
Total	\$10.29			\$23.01		58.31	100.26
Increment							
Recreational services	\$0.94	2.26	1.76	\$2.13	5.37	5.05	8.89
Accommodation	\$0.11	2.02	1.49	\$0.22	8.2	0.90	1.34
Total	\$1.05			\$2.35			10.23

#### Table 13: Output and employment impact of fishing related expenditures

# 7 Discussion

In this report we have predicted the economic value generated from man-made marine structures based in the waters off Onslow and Exmouth, Western Australia using available data and literature. The study provides an indication of the values that may be generated if the existing Thevenard oil and gas infrastructure were to be used to generate artificial reefs, including two reefing scenarios: i) leaving existing oil and gas structures in place or ii) removing structures and re-purposing parts of the material for new artificial reefs. It also has used the Exmouth Integrated Artificial Reef (EIAR), which was established in 2018, as an exemplar to evaluate the possible benefits that may arise from an artificial reef, constructed in part from oil and gas infrastructure. For both case studies, we applied two approaches: Approach 1 assumes new production of fish and new trips. Approach 2 assumes that all extra benefits are shared among the current population of users which increases trip demand. A limitation is the issue of needing to predict the future use of these new infrastructures, and the possible evolution of their ecological status under different levels of use.

For the Thevenard oil and gas infrastructure, we identified an overall annual economic benefit of \$189,943 to \$362,885 for approach 2 scenario 1 (leave in place) and \$23,224 to \$41,572 for approach 2 scenario 2 (use part of structures for developing an artificial reef) in the first year. The benefits included expenditures and consumer surplus measures for private recreational fishers. We also identified benefits for divers and charter boat operators. These results indicate that in the short term leaving Thevenard oil and gas infrastructure in place may result in higher economic benefits than repurposing parts of the structure as artificial reefs. This is mainly explained by the fact that the demand and the consumer surplus of recreational fishers depend on the catch rate and leaving the structures in place would preserve the marine life on the structure while a new artificial reef had to grow new fish populations. How exactly these values will evolve will depend on the growth on the new artificial reef and the fishing pressure on the structures. For example, a new artificial reef that is placed closer to shore can expect more recreational fishing activity than when structures are left in place. This might increase economic value in the short term but can also cause that the equilibrium is reached later. However, it is likely that the values presented may represent the bounds for potential values, and that the economic values associated with the two scenarios become more similar when fish communities reach an equilibrium in the long-term.

The analysis of potential economic benefits that the Thevenard oil and gas infrastructure could provide to commercial fisheries indicates that out of the 98 species that were documented around the existing structures, 40 have commercial and commercial/recreational value while 20 have aquarium fish value. Several of the species identified, most notably snappers and emperors are already well established species in the commercial market place. Just as with private recreational fishing and charter fishing there is clear potential to enhance the viability of commercial fishing. However, benefits ultimately depend on the impact that opening up the area has on the estimates of sustainable and allowed catch of each species. Hence, values will depend on the assessment of stocks in the area by species and estimation of the consequent impact on the sustainable harvests and allowable catch. Any recalibration of these measures will need to be built into future harvest strategies.

For the EIAR, the overall economic benefit expected from installation of the structures is \$269,882 under approach 1 (shift in demand) and \$1,318,000 under approach 2 (new production). These benefits included both expenditures and consumer surplus from recreational fishers.

In both case studies, the estimated increased value per fishing trip are relatively high compared to other studies, which arises from the relatively high level of fish stock identified on the structures compared to other natural reefs nearby (Harvey, unpublished data), the assumed relationship between increased biomass and catch rates, and the relatively high value placed on this fish species by fishers.

However, results from this report are likely underestimated for various reasons. Firstly, values are derived from only one element of the fishing experience, and exclude other values such as increased safety, that may arise from the location of the potential reef off Onslow and of the EIAR in the Exmouth Gulf than currently used fishing grounds.

Secondly, the study has included only limited information about values that may be associated with other user groups such as charter boat operators, recreational diving (i.e. non-extractive use) and commercial fisheries. Including economic benefits that artificial structures provide to these user groups would most probably increase total benefit estimates.

Moreover, due to a lack of information, land travel costs to arrive at boat ramps were not included in the calculations. Especially when visitors come from Perth, other Australian states or overseas, these costs might add significantly to the overall expenditures associated with the artificial structures.

The total economic value framework includes non-use values such as existence values which have not been estimated in this study. In the context of this work, existence values are values for marine man-made structures, or the assets associated with them without the person that holds these values actually using them. Therefore, these values can be held by anyone of the general public. A more complete assessment would therefore include surveys with the general public to identify what they would be WTP to achieve the improved ecological and economic outcomes associated with a new artificial reef.

Lastly, in the case of Thevenard infrastructure, current estimates assume one new artificial reef. However, it is not clear how many artificial reefs would be created. Given that there are nine oil and gas structures available, it is likely that more than one structure would be made available to users, therefore increasing the generated economic benefits. This is especially relevant when different structures are opened for different user groups such as recreational fishers, recreational divers and commercial fishers as this would create diverse economic benefits to a larger portion of the population.

However, the question of when there are diminishing returns to additional artificial reefs in the area needs to be considered if there is a large scale program put in place, at least from the perspective of use values. It is possible that existence values may be less affected by this. Moreover, some of these activities target the same resource and will compete with each other. This can mean that the level of use from the different user groups might be more restricted than estimated in this work. Also, overcrowding of a particular user group can diminish the value derived from these structures. This is especially important for extractive activities as they can decrease the fish biomass and therefore the economic returns on these structures. Hence, it is important that the role of the areas after the new structures are in place would have to be incorporated into adjusted harvest strategy documents where all activities would have to be managed within an appropriate management plan.

The applicability of predicted economic values will depend, from both an ecological and economic perspective, on the locations chosen for new reefs, as that will influence both the ecological "aggregation/production" and economic "additional/substitution" outcomes. From an ecological

perspective, variability in reef fish abundance and biomass can be explained by the proximity to other artificial reefs, artificial reef design, and annual seasons (StreIcheck et al. 2005). Although these factors will have implications for economic values of the structures, to our knowledge there is no literature on the effects of the proximity to other artificial reefs on their economic values.

However, this is an area where the use of more complex models, that explicitly consider site choice by fishers in terms of expected catch and costs of undertaking trips (e.g. Random Utility Models of recreational fisher site choices) would provide additional insight, as they explicitly consider issues of site substitution and diminishing marginal utilities from additional sites, which will depend on spatial location. Economic data for the artificial reefs made out of Thevenard infrastructure as well as future studies from other locations are important to improve our understanding of these effects. This information would be very helpful to improve future decision making regarding the creation of new artificial reefs.

Given the lack of primary data that is specifically related to recreational site choice in this region, at an appropriate spatial scale, the approach has relied on benefit transfer i.e. taking values from the literature and applying them to this specific location, with assumptions about use derive from the limited available data. This introduces some uncertainty about the values that are attributed to the addition of the reefs. Specifically, the question of whether the reefs will generate new trips, or reallocate existing trips, or the balance between the two, is important for evaluating aggregate value. Having region specific values for the value of improved recreational experience is also important, given the very wide range of values that are present in the data.

The study has included only limited information about values that may be associated with diving (i.e. non-extractive use). There are even fewer studies that can be used to identify values, and less data on use and expenditure in the region, but in principle the same analysis that is applied here to recreational fishing trips could be applied to diving. The issue of substitution v additional trips is also key here, as well as the possibility that the values associated with diving on artificial v natural reefs may differ, even if the species viewed are the same, adding an extra layer of complexity in the benefit transfer approach.

In the case of the EIAR, the improved catch from the reef was based on the preliminary surveys. Ecologically the reef had not yet reached an equilibrium state at the time of the surveys. Therefore, a higher level of productivity may be possible in the future than is currently seen. However, countering that, the fishing pressure will also not yet be at equilibrium, and one would expect that will provide a counterweight that will reduce fish populations.

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# Appendix A

## Table A.1: Artificial Reef Valuation Study Results

Study	AR Type(s)	Value Type(s)	Data Collection Year	Valuation Method(s)	Country	Valuation Context/Description	WTP (study units)	WTP (2019 USD)
				Market				
Bell et al. (1998)	Shipwreck	Use - Direct		Non- Market	USA			
Börger et al. (2015)	Wind Turbines	Non-use	2013	Non-	UK	Hypothetical windfarm in the	£7.25-£12.91 per	\$10.79-\$19.21 per
				Market		Irish Sea between Anglesey and	household per year	household per year
		(Existence)		(DCE <sup>1</sup> )		the Isle of Man	(10 species)	(10 species)
		Use – Direct				Attributes/levels:	household per year (30 species)	\$22.06-\$23.56 per household per year (30 species)
						0, 10, 30 additional species to	,	,
		(Visual Amenity)				settle in and around the new offshore wind farm	No impact of wind turbine	No impact of wind turbine
						180m (visible from Anglesey and the Isle of Man), 240m (visible	WTP	WTP
						from Anglesey, the Isle of Man	£26.49 per	\$30.11 per
						and Cumbria), 300m (visible from	household per year	household per year
						Anglesey, the Isle of Man,	to prevent impact	to prevent impact of
						turbines	mammals	mammals
						Impact (cabling buried at 1m) No		
						impact (cabling buried at 2m) of		
						cables on marine mammals		
						Payment vehicle: additional tax		
						to be paid annually by every		
						windfarm design		
Brandini et al. 2014	Concrete				Brazil			
	structures							
Brock et al. 1994	Various Sunken	Use – Direct	1990	Market	USA	Revenue associated with	\$69.63/\$63.02 pp	\$135.43/\$122.57 pp
	Objects					submarine/dive tourism and	per submarine	per submarine
		(Recreation/Tourism,				commercial fishing on Hawaiian	tour/dive	tour/dive
		Commercial Fishing)				AKS		

Study	AR Type(s)	Value Type(s)	Data Collection Year	Valuation Method(s)	Country	Valuation Context/Description	WTP (study units)	WTP (2019 USD)
	(ship, concrete modules, aircraft)						\$58,840 per year for commercial fishing (4% of net profit of dive tourism alone)	\$114,439.52 per year for commercial fishing
Buchanan 1973		Use- Direct			USA			
Chen et al. 2013	Various Sunken Objects (ships, utility poles, steel and concrete structures)	Use – Direct (Recreation/Tourism)	2008	Non- Market (TCM <sup>2</sup> and CVM <sup>3</sup> )	Taiwan	Travel costs associated with diving/recreational fishing trips in Penghu <u>Survey question</u> : "How much did you actually pay (travel and other costs) to participate in scuba diving or recreational boat fishing?" Willingness to pay for a ticket to visit an AR diving/recreational fishing zone in Penghu <u>Survey question</u> : "If the government planned an AR scuba diving zone (or boat fishing zone) to improve the safety and facilities and to provide ocean weather conditions and other recreation information, how much would you be willing to pay for a ticket to participate in these	\$348.50/\$281.91 per tourist per trip for diving/recreational fishing (TCM) \$12.70/\$13.00 per ticket for diving/recreational fishing (CVM)	\$\$411.46/\$332.83 per tourist per trip for diving/recreational fishing (TCM) \$14.99/\$15.35 per ticket for diving/recreational fishing (CVM)
Christie et al. 2009	Sunken Sandbags (TerraFix mega geotextile)	Use – Direct (Visual Amenity, Recreation/Tourism)	Assume 2009 (not stated)	Non- Market (DCE)	UK	activities?" Coastal defence options for Borth in West Wales <u>Attribute levels:</u> no change (timber groynes), rock groynes, offshore reef <u>Payment vehicle</u> : annual increases in local tax over a five- year period	£98 per household per year (offshore reef excl. improved surf conditions) £171 per household per year (offshore reef incl. improved surf	<ul> <li>\$171 per household per year</li> <li>(offshore reef excl. improved surf conditions)</li> <li>\$298 per household per year</li> <li>(offshore reef incl. improved surf</li> </ul>

Study	AR Type(s)	Value Type(s)	Data Collection Year	Valuation Method(s)	Country	Valuation Context/Description	WTP (study units)	WTP (2019 USD)
Crabbe & McClanahan 2006	Sunken Ships	Use – Direct (Recreation/Tourism, Commercial Fishing)	2004	Market	Kenya	Revenue associated with commercial fishing and dive tourism	\$9.00 increase per fisher per day at landing site for commercial fishing	\$12.00 increase per fisher per day at one landing site for commercial fishing
							\$75,000-\$174000 per wreck per year in dive tourism	\$100,927-\$234.151 per wreck per year in dive tourism
Ditton et al. (2001)	Various Sunken Objects	Use – Direct (Recreation/Tourism)	1997	Market	USA	Revenue associated with commercial dive tourism	\$162 pp per diving trip day for Texas residents	\$256.58 pp per diving trip day for Texas residents
	materials, shipwrecks, oil and gas platforms)						\$170 pp per diving trip day for Texas non-residents	\$270.67 pp per diving trip day for Texas residents
Dowling and Nichol (2001)	Sunken Ships	Use – Direction (Recreation/Tourism)	1999	Market	Australia	Revenue associated with commercial diver tourism and recreational fishing	\$22.20 pp per day for private permit divers	\$33.87 pp per day for private permit divers
							\$35.35 pp per day for domestic group charter divers	\$53.94 pp per day for domestic group charter divers
							\$41.10 pp per day for international group charter divers	\$62.71 pp per day for international group charter divers
Hannak et al. 2011	Snorkel trail	Non-use		Non- Market	Egypt			
Hicks et al. 2004	Oyster reef	Use-direct Non-use		Market Non- market	USA			
Hiett and Milon (2002)	Oil and Gas Platforms	Use – Direct (Recreation/Tourism)	1999	Market	USA	Revenue associated with commercial dive tourism and recreational fishing	\$4691 per angler per year (\$13 per angler per	\$7157.63 per angler per year (\$20 per angler per
							day)	day)
Huth et al. (2015)	Shipwreck	Use-direct			USA			

Study	AR Type(s)	Value Type(s)	Data Collection Year	Valuation Method(s)	Country	Valuation Context/Description	WTP (study units)	WTP (2019 USD)
Islam et al. (2014)	Various Sunken Objects	Use – Direct	2011	Market	Malaysia	Revenue associated with commercial fishing (small-	\$164 per fisher per month	\$185.34 per fisher per month
		(Artisanal fishing)				Scale/ aftisalial)		ррр
	(ships, tyres,							
	concrete							
	objects/structures,							
	oli allu gas							
Johns et al. (2001)	Unspecified	Use – Direct	2000	Market and	USA	Willingness to pay an extra	\$8.63 extra pp per	\$12.74 extra pp per
		(Recreation/Tourism)	2000	Non- Market		amount in trip costs to maintain the AR in its existing condition	day to maintain AR	day to maintain AR
		(neereation, rounshi)		(CVM)			\$75 pp per year for	\$110.12 pp per year
				(2000)		Willingness to pay in annual boat	a program that	for a program that
						for an artificial reef program	ARs	ARs
							\$24 pp per year to	\$35.43 pp per year
							create new ARs	to create new ARs
Kasim et al. 2003	Concrete	Use – Direct	2007	Market	India	Net income from commercial	INR1252 per unit	\$42.75 per unit
	Structures					fishing	operation per year	operation per year
		(Commercial fishing)					for gillnet fisheries	for gillnet fisheries
							INR4650 per unit	\$158.77 per unit
							operation per year	operation per year
							for hooks and line	for hooks and line
							fisheries	fisheries
Kirkbride-Smith et al.	Sunken	Use – Direct	2013	Non-	Barbados	Willingness to pay an extra	\$17.58 extra pp per	\$19.18 extra pp per
(2016)	Ships			Market		amount in trip costs for	day	day
		(Recreation/Tourism)		(CVM)		recreation in the Folkestone Marine Reserve		РРР
Leeworthy et al. 2006	Sunken	Use – Direct	1997	Market	USA	Revenue associated with	\$2.6 million in total	\$4.12 million in total
	Ships					recreational fishing and	recreational	recreational
		(Recreation/Tourism)					experioriture	experialitate
McGurrin and Fedler	Oil and Gas	Use – Direct	1989	Non-	USA	Willingness to pay for an	\$14.36 pp one-off	\$29.44 pp one-off
(1989)	Platforms	(D ti / <b>T</b>		Market			payment	payment
Milen (1000)	Curlier	(Recreation/Tourism)	1005			Popofite of a now controlly	¢1.90 pp por voor	\$4.29 pp por voor
IVIIIOII (1988)	Sunken	Use – Direct	1982	Non-	USA	located artificial reef site for	31.00 hh hei Aeal	34.20 hh hei degl
	Suihz	(Pocroation/Tourism)		IVIAI KE(		private boat sport anglers		
		(necreation/ rounsin)						

Study	AR Type(s)	Value Type(s)	Data Collection Year	Valuation Method(s)	Country	Valuation Context/Description	WTP (study units)	WTP (2019 USD)
				(TCM & NMNL)				
Morgan et al. (2009)	Sunken Ships	Use – Direct (Recreation/Tourism)	2006	Non- Market (TCM &	USA	Travel costs for divers to visit the USS Oriskany	\$480-\$750 pp per trip to the Oriskany	\$605.24-\$945.69 pp per trip to the Oriskany
				CVM)		Divers' willingness to pay for an additional sunken ship	\$220-\$1160 pp per year for an additional ship	\$277.40-1462.67 pp per year for an additional ship
Morgan et al. (2018)	Sunken Ships	Use – Direct (Recreation/Tourism)	2014	Non- Market (CVM)	USA	Willingness to pay an increased saltwater fishing license fee	\$32.71 pp per year in additional license fee	\$35.12 pp per year in additional license fee
Oh et al. (2008)	Unspecified	Use – Direct (Recreation/Tourism)	1997	Non- Market (CVM)	USA	Willingness to pay additional diving trip costs	\$101 extra pp per year	\$159.97 extra pp per year
Pendleton (2005)	Sunken Ships	Use – Direct (Recreation/Tourism)	2002	Market and Non- Market (TCM)	USA	Revenue associated with dive tourism Travel costs for divers to dive the Yukon artificial reef	\$4.5 million in market contribution \$12 million in non- market contribution (\$110 pp per day)	\$6.36 million in market contribution \$1.70 million in non-market contribution (\$156.62 pp per day)
Polak and Shashar (2013)	Concrete Structures	Use – Direct (Recreation/Tourism)	2010	Non- Market (CVM)	Israel	Willingness to pay to restore ARs (biological attributes coral size, coral diversity, fish abundance, coral abundance, a combination of numbers of fish and corals, and fish and coral biodiversity) using varying degrees of effort	NIS10-35 pp per year (low effort) NIS15-50 pp per year (medium effort)	\$3.05-\$10.67 pp per year (low effort) \$4.57-\$15.24 pp per year (medium effort)
							NIS25-70 pp per year (high effort)	\$7.62-\$21.34 pp per year (high effort) PPP
Ramos et al. (2006)	Concrete Structures	Use – Direct (Commercial fishing)	2002	Market	Portugal	Net income associated with commercial fishing	€7858-€18896 per fisherman per year, depending on boat type	€11652.94- €28021.64 per fisherman per year, depending on boat type PPP

Study	AR Type(s)	Value Type(s)	Data Collection Year	Valuation Method(s)	Country	Valuation Context/Description	WTP (study units)	WTP (2019 USD)
Roberts et al. (1985)	Oil and Gas Platforms	Use - Direct (Recreation/Tourism)	1982	Non- Market (CVM)	USA	Willingness to pay for annual pass to dive under offshore oil and gas rigs	\$163 pp per year	\$429.38 pp per year
Sun et al. 2017	Concrete structure, rocks, shipwrecks	Direct-use			China			
Vivekanandan et al. (2009)	Various (concrete, and high-density polyethylene objects)	Use – Direct (Artisanal fishing))	2003	Market	India	Income associated with artisanal fishing	RS71.3 per hour of operation	\$2.93 per hour of operation PPP
Westerberg et al. (2013)	Wind Turbines	Use – Direct (Recreation/Tourism Visual Amenity)	2010	Non- Market (DCE)	France	Additional cost of accommodation to have access to reef and wind farm associated recreational activities <u>Attribute levels</u> : no wind farm, wind farm 5km offshore, wind farm 8km offshore, wind farm 12km offshore <u>Payment vehicle</u> : change in weekly accommodation price	<ul> <li>€39.60 pp per week (no wind farm)</li> <li>-€76.1 pp per week (5km offshore)</li> <li>€13.3 pp per week (8km offshore)</li> <li>€43.9 pp per week (12km offshore)</li> </ul>	<ul> <li>\$50.04 pp per week (no wind farm)</li> <li>-\$96.17 pp per week (5km offshore)</li> <li>\$16.80 pp per week (8km offshore)</li> <li>\$55.48 pp per week (12km offshore)</li> </ul>
Whitmarsh et al. (2008)	Concrete Structures	Use – Direct (Artisanal fishing)	1990- 2005	Market	Portugal	Value per unit effort associated with artisanal fishing	€13 extra per unit effort on AR sites compared to (non- reef?) control sites €0.18 increase per unit effort per month	\$18.47 extra per unit effort on AR sites compared to (non-reef?) control sites \$0.26 increase per unit effort per month
Wilhelmsson et al. (1998)	Various Sunken Objects (ships, dead coral heads)	Use – Direct (Recreation/Tourism)	1996	Market	Israel	Revenue associated with dive tourism excluding course dives and non-guided tours	\$23 pp per dive \$368,000 per year	\$37.26 pp per dive \$596,216.29 per year

<sup>1</sup>DCE=Discrete Choice Experiments; <sup>2</sup>TCM=Travel Cost Method; <sup>3</sup>CVM=Contingent Valuation Method

Study	Key Findings	WTP (study units)	WTP (2019 USD)	
Islam et al. (2014)	Income from artisanal fishing in Malaysia was significantly lower in AR areas, compared to "non-AR"	\$164 per fisher per month in AR area	\$185.34 per fisher per month in AR area	
	areas	\$817 per fisher per month in non-AR area	\$923.39 per fisher per month in non-AR area	
Johns et al. (2001)	Recreational value of NRs in South-East Florida was higher than ARs	\$8.63 per person per day on ARs	\$12.74 per person per day on ARs	
		\$12.74 per person per day on NRs	\$18.81 per person per day on NRs	
Kasim et al. (2013)	Income from commercial fishing in India was higher in AR areas, compared to "non-AR" areas	INR1252 per unit operation per year for gillnet fisheries on ARs	\$42.75 per unit operation per year for gillnet fisheries on ARs	
		INR449 per unit operation per year for gillnet fisheries on NARs	\$15.33 per unit operation per year for gillnet fisheries on NARs	
		INR4650 per unit operation per year for hooks and line fisheries on ARs	\$158.77 per unit operation per year for hooks and line fisheries on ARs	
		INR1919 per unit operation per year for hooks and line fisheries on NARs	\$65.52 per unit operation per year for hooks and line fisheries on NARs PPP	
Kirkbride-Smith et al. (2016)	Recreational value of NRs was higher than ARs in Barbados, but not significantly so	\$17.58 extra per person per day for ARs	\$19.18 extra per person per day for ARs	
		\$18.33 extra per person per day for NRs	\$20.00 extra per person per day for NRs PPP	
Oh et al. (2008)	Recreational value of NRs was higher than ARs in Texas	\$101 extra per person per year for ARs	\$159.97 extra per person per year for ARs	
		\$171 extra per person per year for NRs	\$270.83 extra per person per year for NRs	
Vivekanandan et al. (2009)	Income from commercial fishing in India was higher in AR areas, compared to "non-AR" areas	RS71.3 per hour of operation in AR areas	\$2.93 per hour of operation in AR areas	
		RS52.5 per hour of operation in non-AR areas	\$2.19 per hour of operation in non-AR areas PPP	

# Table A.2: Studies that compare artificial reefs with natural reefs/non-artificial reef areas

# Appendix B

The 2018 McLeod and Lindner study used a combination of surveys – a boat based study where the survey frame was fishers holding a valid recreational fishing boat license (RFBL) and a phone interview survey of anyone in a household in WA who could be contacted by any type of phone was initiated in 2016 to provide the necessary benchmark data. The comprehensive sampling frame for this survey was the Electronic White Pages (EWP) and allowed for the expenditure patterns of boat-and shore-based fishers in Western Australia to be assessed with and without an RFBL.

Information was collected on fishing activity, fishing location by bioregion, fishing platform, household composition and fishing expenditure across by major expenditure category. Effort was measured by days spent fishing for each household member. Mean shore fishing days per household was estimated to be 12.6 days, while mean boat fishing days was 10.77, so mean total fishing days per household was equal to 23.40. Of the 459 fishing households, around 26 percent fished only from a boat, 38 percent fished only from the shore and 36 percent fished from both shore and boat. Mean shore days per fisher was 6.76, mean boat days was 5.77, and mean total days per fisher was 12.53.

Only 27% of these 789 recreational fishers were what might be termed more avid fishers (i.e. fishers who fished 15 or more days per year), while a higher proportion (57%) were less avid fishers (i.e. fishers who fished less than 10 days per year). For WA, 357 (45%) recreational fishers fished only from a shore-based platform, while 189 (24%) fished only from boat-based platform, and 243 (31%) fished from both platforms during the year. Avidity varies across the fishing platforms. While some 57% of all WA recreational fishers were less avid, a much higher proportion (78%) of shore only recreational fishers were less avid. Conversely, less than half (47%) of boat only fishers were less avid, and only 37% of shore and boat fishers were less avid. Then again, the proportion of more avid fishers was highest among shore and boat fishers at 46%, followed by boat only fishers at 31%, while only 15% of shore only fishers were more avid.

Estimation of household expenditure by recreational fishers was subdivided into three main categories as follows:

- Trip related expenditures incurred per trip by each fisher (e.g. fuel, bait, ice, food) plus resources spent to travel from place of residence to the boat launch site for boat-based fishing trips, or to the site on the shore for shore-based fishing trips. Trip related expenditures also includes accommodation costs for trips involving one or more overnight stays.
- Gear related expenditures incurred annually by each fisher (e.g. rods, reels)
- Boat related expenditure incurred annually for own boat use for recreational fishing (e.g. repairs, insurance, etc.) plus boat and charter hire.

The sample aggregate expenditure attributable to fishing households among the whole 1810 EWP sample households is representative of the fishing expenditure that would occur in all WA households. Hence aggregate expenditure by households in the sample can be scaled up to the estimated population of WA. A detailed breakdown of aggregate expenditure into component parts is provided in Table B.1 below.

Expenditure item (\$/year)	Avg\$/HH <sup>a</sup>	Avg\$/fisher	Avg\$/trip	Population \$
Expenditure on overnight accommodation	\$171	\$92	\$7	\$37,394,182
Expenditure on food, drink, refreshments	\$2,775	\$1,495	\$120	\$605,675,342
Expenditure on fuel for boat	\$1,918	\$1,033	\$83	\$418,546,256
Expenditure on parking and launching fees	\$160	\$86	\$7	\$34,968,170
Expenditure on bait and ice	\$1,120	\$604	\$49	\$244,539,414
Expenditure on other fishing trip costs	\$189	\$102	\$8	\$41,315,141
Expenditure on land travel	\$2,186	\$1,178	\$95	\$477,169,314
Aggregate trip expenditure				\$1,859,607,819
Expenditure on rods, reels, pots, etc.	\$561	\$307	\$24	\$122,464,856
Expenditure on clothing (e.g. shoes, hats)	\$63	\$34	\$3	\$13,658,904
Expenditure on diving gear (incl. hire)	\$87	\$47	\$4	\$19,032,183
Expenditure on fishing club membership	\$16	\$9	\$1	\$3,574,312
Other gear related costs	\$5	\$3	\$0	\$1,160,624
Aggregate gear expenditure				\$159,890,879
Expenditure on new boats	\$537	\$289	\$23	\$117,258,994
Expenditure on 2nd Hand Boats	\$534	\$288	\$23	\$116,531,293
Expenditure on Equipment (incl. hire)	\$84	\$45	\$4	\$18,307,306
Expenditure on repairs, maintenance	\$332	\$179	\$14	\$72,418,586
Expenditure on insurance	\$115	\$62	\$5	\$25,117,962
Expenditure on boat trailer licences	\$53	\$29	\$2	\$11,597,717
Expenditure on pen and club fees	\$39	\$21	\$2	\$8,404,255
Other boat related costs	\$2	\$1	\$0	\$448,073
Boat hire and charter fees	\$87	\$47	\$4	\$18,944,879
Aggregate boat expenditure				\$389,029,065
Aggregate annual expenditure				\$2,408,527,764
<sup>a</sup> HH = household				

# Table B.1: Expenditure by category for recreational fishing in Western Australia Expenditure item (\$/year)

Expenditures are likely to vary by region of residence and region fished. Using data from the McLeod and Lindner (2018) study, Table B.2 below estimates per trip costs by bioregion fished. Exmouth is in the Geraldton Coast area and has the highest cost structure.

## Table B.2: Per trip expenditures by bioregion

	Food and		Parking and		Other trip
Region fished	drink	Fuel for boat	launch fees	Bait and ice	costs
North Coast	\$169.16	\$147.15	\$4.53	\$45.04	\$53.43
Geraldton Coast	\$232.25	\$290.64	\$4.62	\$69.22	\$9.52
West Coast	\$97.84	\$110.16	\$6.78	\$36.61	\$6.12
South Coast	\$107.53	\$96.34	\$1.41	\$45.72	\$6.45
Total	\$122.47	\$134.44	\$5.69	\$42.48	\$11.21

Gear costs are incurred per year rather than per trip. The Table B.3 estimates the annual gear costs for recreational fishers by region fished.

	Rods,	Special		Fishing club	Other gear
<b>Region Fished</b>	reels, pots	clothing	Diving gear	membership	costs
North Coast	\$870.91	\$157.79	\$117.17	\$49.80	\$6.35
Geraldton Coast	\$756.24	\$78.98	\$94.01	\$24.68	\$10.38
West Coast	\$513.93	\$51.65	\$67.37	\$25.51	\$3.90
South Coast	\$408.01	\$45.11	\$52.29	\$11.82	\$2.60
Total	\$566.70	\$64.67	\$73.81	\$26.23	\$4.79

#### Table B.3: Annual gear costs by bioregion

Annual boat related costs are shown below by region fished (Table B.4).

#### Table B.4: Annual boat costs by bioregion

Region fished	New boat	Second hand boat	Equipment other than boat	Repairs and maintenance	Insurances	Boat and trailer licence fees	Boat club membership	Other boat costs
North								
Coast	\$2,663.31	\$440.84	\$627.76	\$806.88	\$352.68	\$202.31	\$23.89	\$30.84
Geraldton								
Coast	\$2,093.41	\$1,185.41	\$660.05	\$1,110.78	\$385.09	\$162.87	\$62.07	\$29.28
West								
Coast	\$1,772.39	\$779.78	\$550.72	\$1,491.21	\$388.01	\$142.50	\$160.12	\$81.35
South								
Coast	\$338.98	\$855.93	\$309.68	\$1,229.78	\$201.11	\$177.38	\$16.08	\$1.63
Total	\$1,756.49	\$804.09	\$547.59	\$1,346.76	\$364.86	\$154.74	\$119.11	\$61.47

In order to access fishing opportunities in the Geraldton and North Coast regions, many fishers will incur accommodation costs. The nights away on a fishing trip and the average cost per night for accommodation are shown below (Table B.5) by fishing region.

Fishers in the Geraldton region incur cost of \$137 for accommodation.

#### Table B.5: Accommodation costs by bioregion

		Average accommodation
Region fished	Nights away	cost per night
North Coast	6.93	\$121.45
Geraldton Coast	12.30	\$137.09
West Coast	6.46	\$177.55
South Coast	9.25	\$84.02
Total	7.92	\$149.61



# Appendix 5 The economic value of the Exmouth Navy Pier and Busselton Jetty, Western Australia

Johanna Zimmerhackel, Michael Burton

This appendix is part of the final report for:

# Enhancing the Understanding of the Value Provided to Fisheries by Man-made Aquatic Structures.

Euan S. Harvey, Fran Ackermann, Michael Burton, Julian Clifton, Carmen Elrick-Barr, Johanna Zimmerhackel, Georgina Hill, Stephen J Newman, Jenny Shaw, Mark Pagano, Paul McLeod, Dianne McLean, Julian Partridge

24<sup>th</sup> August 2021

# The Economic Value of the Exmouth Navy Pier and Busselton Jetty, Western Australia

# Abstract

Piers and jetties are commonly used by recreational fishers and divers due to the marine life that aggregates around their pillars. We used an online travel cost survey to estimate the economic value in terms of expenditures and consumer surplus measures of two piers/jetties in Western Australia: The Exmouth Navy Pier and the Busselton Jetty. The Navy Pier was the second most important dive attraction in Exmouth for survey respondents and we estimate that it generates about \$615,000 AUD in business revenues and \$409,170 AUD in consumer surplus per year. We also found that the Busselton Jetty attracts approximately 535,115 visitors per year generating an annual expenditure of \$6.4 million AUD and a consumer surplus of \$19.26 million AUD per year. Results of this work highlight that piers and jetties have a high value for users in Western Australia and that more research is needed to better understand these values. Results also can be used in decision making processes regarding the management, maintenance, building and/or removal of piers and jetties in Western Australia.

# 1 Introduction

Piers and jetties are commonly used by recreational fishers as fishing platforms as well as by scuba divers due to the marine life that aggregates around the pillars of the structures. In Western Australia, there are about 1000 wharfs, piers and jetties along the coastline (See Appendix 1 of Harvey et al 2021). Also, recreational fishing and diving are popular activities and recreational fishing alone is estimated to generate an economic value of \$2.4 billion AUD in Western Australia per year (McLeod & Lindner 2018). Consequently, it is likely that piers and jetties have a major social and economic value. However, to this date there is no study worldwide on the social or economic value of piers and jetties (there is ongoing work in South Australia on the social economic and historical significance of piers and jetties, but the report has not been released at this point: see https://yoursay.sa.gov.au/decisions/yoursay-engagements-sa-jetties-strategic-plan/background). Therefore, the aim of this work is to estimate the economic value associated with two piers and jetties in Western Australia: The Exmouth Navy Pier and the Busselton Jetty.

The Navy Pier is an active pier managed by the Australian Navy, located in a naval base 14 km away from Exmouth town, Western Australia. Although the pier is not open for public use, one local dive operator has the permission to use the pier for dive operations. The pier reaches 300 m into the Exmouth Gulf. The Navy Pier is rated as one of the best shore dives in Australia and the world. The rich marine life underneath the pier can be mainly explained by the well enforced no take area around the pier and very restricted access.

The Busselton Jetty is a 1.8 km long Jetty in Geographe Bay, Western Australia which is operated by a non-profit community organisation (Busselton Jetty Inc.). The Jetty runs a train, underwater observatory, interpretive centre and museum, underwater restaurant and undersea walk and scuba diving activities. The Jetty moreover can be used by recreational fishers and has a scuba diving platform about 1.7 km from the shore. Furthermore, the Busselton Jetty has a marine monitoring and research program and engages in marine education with local schools. The Busselton Jetty lies within the 'General Use Zone' of the Ngari Capes Marine Park. However, at the end of the Busselton Jetty, there is a sanctuary zone where fishing is not allowed.

We use two versions of the travel cost method to estimate both the expenditures that people incur to visit these sites as well as the users' personal welfare (measured as the consumer surplus) associated with a visit to the Navy Pier and Busselton Jetty. Results of this work give important information on the importance of piers and jetties that can be used in the decision making processes regarding the management, maintenance, building and/or removal of piers and jetties in Western Australia.

# 2 Methods

# 2.1 Survey Design and Distribution

# 2.1.1 Exmouth Navy Pier dive tourist survey

An online dive tourist survey was designed to understand the level of use as well as the expenditures associated with the Navy Pier. As there is only one diving company allowed to operate on the Navy Pier, the survey was distributed through the email system of this operator from May to September 2020. Additionally, in August and September 2020 flyers with the link to the online survey were distributed to dive tourists by the operator. Respondents were eligible for the survey if they were over 18 years old and had done diving activities in Exmouth in 2019 and/or 2020.

Section one of the survey asked respondents about demographic characteristics such as age, gender, location of residence and the number of dives (anywhere) done in 2019 and 2020 as well as in total. Diving was defined as "scuba diving, snorkelling and free diving for recreation (opposed to extractive activities)". Section two asked participants about their diving activities in Exmouth in 2019 and 2020. In particular, they were asked about the frequency and duration of visits to the Exmouth region (a visit being defined as "a period of one or more days spent in the Exmouth region (i.e. for holidays, visit friends or family, or for work"), as well as where they stayed and what their total expenditure for these visits were. Section three of the survey asked respondents to fill out a logbook where they indicated the dates, diving activities and diving related expenditures of each visit. Diving activities were given as a dropdown menu that included all of the main dive attractions (natural sites and marine infrastructure sites) in the region. The final section asked how many times people have visited the Navy Pier in their lives and what substitute activities they would do if the Navy Pier was not available for diving. For the full survey, see Appendix A.

# 2.1.2 Exmouth Navy Pier dive operator interview

The dive operator interview was done face to face via online conference and asked about visitor numbers to all attractions as well as specifically to the Navy Pier in 2019. It also asked questions regarding the contribution to the local economy in terms of operating, fixed and capital costs and well as expenditure on salaries and government fees.

## 2.1.3 Busselton Jetty survey

We designed an online survey for visitors of the Busselton Jetty to understand their frequency of visits as well as their expenditures associated with these visits. The survey was accessible between

May and August 2020 and was distributed from the Busselton Jetty staff through their social media channels and email newsletters. Due to the COVID-19 restrictions, this was the main distribution channel. However, in June 2020 visitors slowly started returning to the Busselton Jetty and we also distributed a link to the online survey via flyers that were given out at the entrance and in the museum of the Busselton Jetty. With the completion of the survey, respondents could opt in to participate in a prize draw to win \$50 AUD.

The survey asked respondents about their demographic information such as age, gender and place of residence (via postcode). They then were asked about their frequency of visitation to the Jetty and people who stated zero were excluded from the following questions. We furthermore asked people about the purpose/intended activity for their current visit and how much they had spent for travelling to the Jetty as well as any other costs associated with that trip. Participants were asked what they would have done as an alternative if the Busselton Jetty was not closed. Lastly, they had the option to give comments on the content or quality of the survey. The full survey can be accessed in Appendix B.

# 2.2 Analysis

## 2.2.1 Travel Cost Method

The travel cost method is a revealed-preference method that is commonly used to measure the economic use value associated with a single recreational site (Ward et al. 1986). The method is based on the notion that visitors bear different travel costs to stay at a recreation site and that the number of trips made to this site depends on these costs. The relationship between the number of trips and the travel costs describes the demand curve which in turn reveals the consumer surplus (a monetary measure of the benefits to users) of that recreation site (Ward et al. 1986).

# 2.2.2 Navy Pier: Zonal Travel Cost Model

The zonal travel cost method is typically used to estimate the value for recreational services of a single site. It is used to calculate the number of visits to the site assuming that travel costs to the site increase with distance. Respondents are combined into a number of zones (geographic areas) with increasing distance around the site. In this study, we calculated the total number of days spent in the Ningaloo region from dive tourists coming from six zones (in the order of increasing distance): Western Australia, other states of Australia, Oceania, Asia, Europe and America. The visitation rate was obtained based on days spent in the Exmouth region per million capita of the total population of countries where visitors came from in each zone.

The travel costs were estimated as the product of the global average of airflight costs per 100 km (ref) and the travel distance. For travellers coming from outside Australia, it was assumed that they departed from the capital city of their country of origin and travelled through Perth to get to Exmouth, Western Australia. Similarly, for travellers from Australia, we used the distance from the capital city of the Australian state to Perth and added the distance from Perth to Exmouth. For travellers from Western Australia, we only used the distance from Perth to Exmouth. We fitted the following regression analysis to the data:

$$\ln(stay) = a + \frac{1}{TC} * b \tag{1}$$

Where *stay* is the total number of days that people of a certain zone stayed in the Exmouth region, *TC* is the travel cost that is needed to travel from each zone to the Exmouth region and *a* and *b* are model parameters.

We then used the predicted model to estimate how the demand (the number of days spent) for the Ningaloo region would change if travel costs increased in order to estimate the economic benefit (consumer surplus) that the Ningaloo region provides to visitors. The increase in travel costs was based on a hypothetical entrance fee that visitors had to pay per day to enter the Exmouth region.

# 2.2.3 Busselton Jetty: Individual Travel Cost Method

The individual travel cost method relies on estimating a relationship between the trip frequency to a site, and the cost of accessing the site. A Poisson model is commonly used to model the data, as it reflects the count (integer) and non-negative nature of the data. However, there are a number of issues that have to be addressed. The Poisson model is well known to impose restrictions on the distribution of the data. This model holds the assumption that the conditional mean and variance of the dependent variable is equal (also called equidispersion), which may not be the case. An extension to the model in form of a negative binomial model allows for over dispersion. Secondly, if data is collected from intercept sampling, then by definition the number of visits has to be more than one. However, it is possible to deal with this issue by a simple adjustment: by subtracting one from all number of trips (Shaw 1988).

A further issue arises when data is right censored: if identification of the number of trips includes a "more than x" category. However, there exists a censored negative binomial model, implemented in Stata (Hilbe 2011). The estimate of the consumer surplus associated with a trip is identified simply as the negative inverse of  $\alpha$ , the estimated cost coefficient (-1/ $\alpha$ ).

The other issue is the definition of cost of travel to the site. The sample has limited information on travel cost, other than that which can be derived from information about the postcode from which they live. We start by calculating the direct travel cost from the centroid of the postcode they give as their home, to the centroid of the 6280 postcode area. For those who lived outside of 6280, an additional 10 km was added to reflect the distance from the centroid to the jetty. For those who lived within 6280 this was reduced to 0.5 km, on the assumption that the majority of respondent lived in the city, not the surrounding area. Then an adjustment was made for the cost per person, based on the number of people in the group.

# 3 Results and Discussion

# 3.1 Exmouth Navy Pier

# 3.1.1 Descriptive statistics

The online survey resulted in a total of 153 valid responses. Respondent characteristics are shown in Table 1. Over one third of visitors come from Western Australia, followed by Europeans and other states of Australia from where each about one quarter of respondents come from. The average number of visits to the region per year is relatively high (1.95), which can be explained by a high visitation rate from Western Australians. The dive operator interview revealed that approximately 3000 divers visit the Navy Pier per year. With an average expenditure for one day diving in the Exmouth region of AUD 205, this gives an aggregate annual expenditure of AUD 615,000.

Table 1: Respondents'	characteristics	(n=153).
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Respondents' characteristics	Value	Range
Average age (years)	39 (SD 12.17)	22-72
Gender (% female)	45.39	
Origin (%)		
Western Australia	36.84	
Other states of Australia	23.68	
Oceania	0.66	
Asia	2.63	
Europe	25.66	
America	10.53	
Avidity scuba diving		
Average number of dives in last 12 months	24.71	5-250
Average number of dives in life	123.05	5-500
Avidity snorkelling		
Average number of snorkelling in last 12 months	21.08	5-250
Average number of snorkelling in life	138.93	5-500
Average number of trips (# of trips/year)	1.95 (SD 4.37)	1-50
Average trip duration (# of days/trip)	8.00 (SD 9.90)	2-90
Average number of days spent diving or snorkelling		
Average total trip expenditure (AUD)	2410.66 (SD 2085.59)	150-15000
Average expenditure on diving (AUD/day)	205	

When respondents were asked what they would do if the Navy Pier was not available for diving, 62.22% said that they would dive at another dive site in Exmouth instead. Doing non-diving activities in Exmouth or diving at a dive site outside Exmouth was selected by 13.3% each. 6.67% stated they would do non-diving activities somewhere else and 4.44% said that they would stay at home if the Navy Pier was not available. Hence, it can be argued that the Exmouth region could lose up to a quarter of their dive tourists if the Navy Pier was not open to diving. Moreover, for 27% of the sample the Navy Pier was the second most visited dive attraction in the Exmouth region (Figure 1).



Figure 1: Percentage that respondents visited different dive attractions in the Exmouth region.

# 3.1.2 Zonal Travel Cost Model

The travel cost model results (Table 2) show the relationship between the costs of getting to the region and the per capita visitation rate. Based on this equation, we extrapolate how aggregate visitation would change for (simulated) increases in price, which is essentially deriving the demand curve for diving in the Exmouth region. We assume that all respondents have the same 'choke' price of \$978 AUD (being a combination of their current travel costs and the simulated increase in price) at which demand would fall to zero. This is approximately double the amount of travel costs from the zone with the highest cost (America) (Cohen et al. 2016). This approach leads to a segmented aggregate demand curve, as shown in Figure 2, where 'kinks' occur as segments leave the market entirely. The area under the demand curve represents the consumer surplus of our sample that arises from the 1779 trip days. The estimated consumer surplus for one day diving in the Exmouth region is \$136.39 AUD.

This estimate is derived for dive trips to the Exmouth region as a whole, not only the Navy Pier. If we assume this value also applies to dives at the Navy Pier, with approximately 3000 divers visiting the Navy Pier per year, this gives an aggregate consumer surplus of \$409,170 AUD per year.

Variable	Coefficient	Std. Err.	P-value
1/Travel Cost	262.933	64.517	0.015
Intercept	-1.330	0.796	0.170
R <sup>2</sup>	0.806		
Observations (zones)	6		





Figure 2: Demand curve for diving in the Exmouth region.

## 3.2 Busselton Jetty

## 3.2.1 Descriptive statistics

The individual travel cost survey yielded a total of 228 responses out of which 17 were excluded from the analysis because they had a postcode outside Western Australia. Hence, we obtained 211

usable responses who gave information on their total number of trips to Busselton Jetty in 2019. Just over half the respondents (51%) were resident in Busselton and 41% were male. The median number of trips that respondents made to the Busselton Jetty in that year was eight, although a significant proportion (14%) said they went more than 50 times in the year (Figure 3). The survey also revealed that the median expenditure associated with one visit on the Busselton Jetty per person is \$12 AUD.



Figure 3: Frequency of visits to the Busselton Jetty in 2019 (n=195)

Of the 93 who responded to the question: "During your last visit to the Busselton jetty, was going to the jetty the main reason for your visit to Busselton", 44% said yes, and 32% said it was one of the reasons. However, this question was obviously not relevant for those who live in Busselton. Figure 4 below gives the main reasons for their last visit to the Jetty.



Figure 4: Fraction of reasons that respondents visited the Busselton Jetty.

Respondents were also asked what they would have done if the Busselton Jetty had been closed, i.e. to what extent are there substitutes for the experience. The set of options was limited, and did not enquire about details of other activities. A relatively small proportion (14%) would have gone out for any activity, but 39% would have looked for the same activity elsewhere, suggesting the high degree of specificity about the values being derived from the jetty. 32% would have still come to Busselton, but looked for a different activity. About 15% of respondents said they would have stayed at home if they could not have visited the Busselton Jetty. This highlights the importance to Busselton of the jetty for attracting these cohorts.

# 3.2.2 Individual Travel Cost Model

Using a censored negative binomial model, we find a significant negative relationship between the travel costs of getting from their place of residence to the Busselton Jetty, as reported in Table 3. Based on the results of this model, we estimated the consumer surplus for one visit on the Busselton Jetty to be \$36 AUD. The Busselton Jetty attracts approximately 535,115 visitors per year (data from Busselton Jetty Itd). Accordingly, the consumer surplus generated by the Busselton Jetty for visitors is estimated to be \$19.26 million AUD per year. Aggregating the median visitors' *expenditure* over that population, we estimate that an annual expenditure of \$6.4 million AUD in 2019 can be attributed to the pier. Note that in this case the estimates of the surplus value (that attained by the user) is substantially greater than the expenditure estimate which reflects a low cost to visit the Busselton Jetty compared to the welfare that visitors receive from the visit. The result also is relatively high compared to consumer surplus values of a trip to e.g. a WA beach. This can probably be explained by the low number of substitute sites of the Busselton Jetty compared to other attractions in the region.

Variable	Coefficient	Std. Err.	P-value
Travel Cost	-0.028	0.007	<0.001
Intercept	2.488	0.088	<0.001
Dispersion	-0.251	0.118	0.034
Observations	195		

Table 3: Summary regression results of number of trips on the estimated travel cost: Busselton Jetty

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# Appendix A: FRDC Navy Pier- Dive Tourist Survey

#### **Participant Information Form**

Thank you for your interest in this survey which examines the economic value associated with man-made aquatic structures.

Structures such as piers and jetties are playing an increasing role in shaping the diving landscape. In order to plot the future direction and potential development of these structures, a better understanding is needed of the economic value these structures provide the community. Your participation in this survey will help develop a clearer understanding of how divers are using these structures and their importance as assets for communities.

At the end of this survey, you will have the option to enter a second survey which will ask you about your social values towards artificial structures in the marine environment. Full details of the research are available at <a href="http://www.frdc.com.au/project/2018-053">http://www.frdc.com.au/project/2018-053</a>

#### Confidentiality and completing the survey

Taking part in a research project is voluntary. Should you change your mind at any point in the survey before submitting it, you can withdraw from the project. Any information we collect will be treated as confidential and all data collected is anonymous. The results of this research may be presented at conferences or published in professional journals. You will not be identified or be identifiable in any results that are published or presented. The survey should take no more than ten minutes to complete.

Curtin University Human Research Ethics Committee (HREC) has approved this study (HREC number HRE2019-0465). Should you wish to discuss the study with someone not directly involved, in particular, any matters concerning the conduct of the study or your rights as a participant, or you wish to make a confidential complaint, you may contact the Ethics Officer on (08) 9266 9223 or the Manager, Research Integrity on (08) 9266 7093 or email <u>hrec@curtin.edu.au</u>

By continuing with the survey, you agree with the following statement: "I have received information regarding this research and have had an opportunity to ask questions. I believe I understand the purpose, extent and possible risks of my involvement in this project and I voluntarily consent to take part."

#### The prize-draw

Upon completion of the survey, you will be invited to take part in a prize draw with the chance to win one of three \$50 Coles gift cards. If you opt in to participate in the second survey, you will be entered twice into the prize draw which doubles your chances to win.

1) Winners will be chosen by selecting three random entrants. This selection will be undertaken by the Chair of the Research Project Steering Committee who will not be permitted to enter the survey. This selection will

be witnessed by two other members of the Steering Committee, who will also not be permitted to enter the survey.

2) Prize winners will be contacted by the researchers via email and/or phone within 48 hours of the prize draw. Verbal confirmation of age will be requested to ensure that the recipient is aged 18 or over as required by the online survey. Recipients will not be identified or identifiable publically. Only the postcode of the three winners will be published on the FRDC website.

3) Should any prize winner not be able to be contacted within one week of the draw, the above procedure will be repeated until all three prizes are claimed.

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#### **Block: Demographics**

You have been asked to complete this survey because you are in the email list of a dive operator in Exmouth.

Have you done any dive activities in the Exmouth Region in 2019 or 2020? By diving we mean scuba diving, snorkelling and free diving for recreation (opposed to extractive activities).

O Yes

🔘 No

Q1 Please indicate your age

▼ Under 18 ... Over 75

Q2 Please indicate your gender

🔵 Male

**Female** 

Other/ prefer not to say

# Q3 Where do you live?

O Exmouth region (as on map)

O Elsewhere in Australia

Other country (please indicate) \_\_\_\_\_

Display This Question:

*If Where do you live? = Elsewhere in Australia* 

Q4 Please type the postcode of your place of usual residence

Display This Question:

*If Where do you live? = Exmouth region (as on map)* 

Q5 Where do you live in the Exmouth region?

O Exmouth town

Coral Bay

Onslow

O Other (please specify) \_\_\_\_\_\_

#### Block: Not eligible - link to second survey

Q6 Thank you for your time, you are not eligible for this survey.

However, there is a second survey which asks about more general information about other man made marine infrastructure. If you would like to complete this survey, select 'Yes' below. If you complete that survey you will be given an entry into the draw to win one of three \$50 Coles gift cards.

O Yes

🔘 No

#### **Block: General Diving Questions**

**Q7** We are going to ask you about your diving experience in general. By diving we mean scuba diving, snorkelling and free diving for recreation (opposed to extractive activities).

#### APPENDIX A

Q8 In total, how many times have you gone diving?



#### **Block: Exmouth Diving - Non-residents**

## Q9

The following questions will ask you about your visit(s) to the Exmouth region (as shown on map). A "visit" is defined as a period of one or more days spent in the Exmouth region (i.e. for holidays, visit friends or family, or for work).

**Q10** How many visits have you made to the Exmouth region in which you went diving, in 2019 and 2020?

▼ 1 ... More than 50 times

Q11 Where were you staying in the Exmouth region during the most recent visit?

Onslow town

Exmouth town

Coral Bay town

Campground outside of towns (please specify)

O Other (please specify) \_\_\_\_\_

Q12 How many days were you staying in the Exmouth region during the most recent visit?

**Q13** What do you think the total cost was for that visit (including travel, accommodation, dive activities, fees, food, drink, and other costs)?

### **Q14** Please tell us about your dive activities during the most recent visit.

	Date	Dive activity	Expenditure on the dive activity (including fees, boat fuel and any other costs related to the dive)
	(dd/mm/yyyy)		(AUD)
Activity 1		▼ W hale shark tour Other	
Activity 2		▼ W hale shark tour Other	
Activity 3		▼ W hale shark tour Other	
Activity 15		▼ W hale shark tour Other	

Q15 How many times have you dived the Navy Pier in total (including all visits ever made)?

▼ 0 ... More than 5

Display This Question:

If Please tell us about your dive activities during the most recent visit. : Dive activity = Navy Pier

Q16 If the Navy Pier was not available for diving activities, what would you have done instead?

- O Dive at another dive site in Exmouth
- O Do non-diving activities in Exmouth
- O Dive at another dive site somewhere else
- O Do non-diving activities somewhere else
- O Stay at home

# **Block: Exmouth Diving - Residents**

Q17 How many times have you done dive activities in the Exmouth region in 2019 and 2020?

▼ 1 ... More than 15

**Q18** Please tell us about your dive activities in 2019 and 2020.

	Date	Dive activity	Expenditure on the dive activity (including fees, boat fuel and any other costs related to the dive)
	(dd/mm/yyyy)		(AUD)
Activity 1		▼ Whale shark tour Other	
Activity 2		▼ Whale shark tour Other	
Activity 3		▼ Whale shark tour Other	
Activity 15		▼ Whale shark tour Other	

Q19 How many times have you dived the Navy Pier in total?

▼ 0 ... More than 5

Display This Question:

If Please tell us about your dive activities during the most recent visit. : Dive activity = Navy Pier

Q20 If the Navy Pier was not available for diving activities, what would you have done instead?

O Dive at another dive site in Exmouth

O Do non-diving activities in Exmouth

O Dive at another dive site somewhere else

O Do non-diving activities somewhere else

O Stay at home

#### **Block: Comments**

Q21 Do you have any other comments you would like to make?

Q22 Thank you!

If you would like to be entered into the prize draw for one of three \$50 Coles gift cards, please enter your email address and mobile number below. Multiple survey entries from the same individual or from respondents outside of Australia will not be eligible for the prize draw.

We will only use this information to contact you if you are selected in the prize draw.

Email address:

Phone number: \_\_\_\_\_\_

**Q23** Would you like to continue to the second survey on the social values of marine man-made structures?

If you proceed, you will double your chances to win one of three \$50 Coles gift cards.

O Yes

🔘 No

# Appendix B: Busselton Jetty Individual Travel Cost Survey

#### **Participant Information Form**

Thank you for your interest in this survey which examines economic value associated with man-made aquatic structures. Structures such as piers and jetties are playing an increasing role in shaping the recreation landscape. In order to plot the future direction and potential development of these structures, a better understanding is needed of the economic value these structures provide the community. Your participation in this survey will help develop a clearer understanding of how people are using these structures and their importance as assets for communities.

Full details of the research are available at http://www.frdc.com.au/project/2018-053

#### Confidentiality and completing the survey

Taking part in a research project is voluntary. Should you change your mind at any point in the survey before submitting it, you can withdraw from the project. Any information we collect will be treated as confidential and all data collected is anonymous. The results of this research may be presented at conferences or published in professional journals. You will not be identified or be identifiable in any results that are published or presented. The survey should take no more than ten minutes to complete.

Curtin University Human Research Ethics Committee (HREC) has approved this study (HREC number HRE2019-0465). Should you wish to discuss the study with someone not directly involved, in particular, any matters concerning the conduct of the study or your rights as a participant, or you wish to make a confidential complaint, you may contact the Ethics Officer on (08) 9266 9223 or the Manager, Research Integrity on (08) 9266 7093 or email hrec@curtin.edu.au

By continuing with the survey, you agree with the following statement: "I have received information regarding this research and have had an opportunity to ask questions. I believe I understand the purpose, extent and possible risks of my involvement in this project and I voluntarily consent to take part."

#### The prize-draw

Upon completion of the survey, you will be invited to take part in a prize draw with the chance to win one of three \$50 Coles gift cards.

1) Winners will be chosen by selecting three random entrants. This selection will be undertaken by the Chair of the Research Project Steering Committee who will not be permitted to enter the survey. This selection will be witnessed by two other members of the Steering Committee, who will also not be permitted to enter the survey.

2) Prize winners will be contacted by the researchers via email and/or phone within 48 hours of the prize draw. Verbal confirmation of age will be requested to ensure that the recipient is aged 18 or over as required by the online survey. Recipients will not be identified or identifiable publically. Only the postcode of the three winners will be published on the FRDC website.

3) Should any prize winner not be able to be contacted within one week of the draw, the above procedure will be repeated until all three prizes are claimed.

o lagree

#### **Block: Demographics**

Q1 Please indicate your age

O under 18

0 18 - 19

- 0 20 24
- 0 25 29
- 0 30 34
- 0 35 39
- 0 40 44
- 0 45 49
- 0 50 54
- 0 55 59
- 0 60 64
- 0 65 69
- 0 70 74

Over 75

Q2 Please indicate your gender Male Female Other / prefer not to say Q3 Are you a resident of Busselton? Yes No

**Q4** Please indicate the postcode of your usual residence

## **Block: Trips**

Q5 How often have you visited the Busselton Jetty in 2019?

O More than 50 times

Block: Not eligible, link to mapping survey

Display This Question:

*If How often have you visited the Busselton Jetty in 2019? = 0* 

**Q6** Thank you for your time, you are not eligible for this survey. However, there is a second survey which asks you more general information about other man made marine infrastructure. If you would like to complete this survey, select 'Yes' below. If you complete that survey you will be given an entry into the draw to win one of three \$50 Coles gift cards.

O Yes

O No

#### **Block: Activities**

Display This Question:	
If Are you a resident of Busse	lton? = No

**Q7** During your last visit to the Busselton Jetty, was going to the Jetty the main reason for your visit to Busselton?

O Yes

🔘 No

It was one of the reasons

Q8 What was the main reason for your last visit to Busselton Jetty?

○ Sightseeing
O Fishing
O Exercising
O Diving
O Underwater Observatory
O Interpretive Centre and Museum
O Socialising
O Underwater dining
O Other (please indicate)

Q9 How many people were in your group during your last visit to the Busselton Jetty?



O More than 20

Display This Question:

If How many people were in your group during your last visit to the Busselton Jetty? = 1

**Q10** Apart from the costs of getting to the Busselton Jetty, what has been your expenditure (in AUD), associated with the visit to Busselton Jetty (food, drink, bait, entrance fees, etc.)

Display This Question:

If How many people were in your group during your last visit to the Busselton Jetty? != 1

**Q11** Apart from the costs of getting to the Busselton Jetty, what has been the expenditure (in AUD) of your group, associated with the visit to Busselton Jetty (food, drink, bait, entrance fees, etc.)

Q12 If for some reason the Jetty was closed, what would you have done instead?

- O Another activity in Busselton
- O The same activity somewhere else
- Another activity somewhere else

O Stayed home

#### **Block: Comments**

Q13 Do you have any other comments you would like to make?

#### **Block: Prize Draw**
#### APPENDIX B

Q14 Thank you!

If you would like to be entered into the prize draw for one of three \$50 Coles gift cards, please enter your email address and mobile number below. Multiple survey entries from the same individual or from respondents outside of Australia will not be eligible for the prize draw.

We will only use this information to contact you if you are selected in the prize draw.

Email address:

Phone number: \_\_\_\_\_\_

#### Block: Eligible, link to mapping survey

**Q15** There is a second survey which asks you more general information about other man made marine infrastructure. If you would like to complete this survey, select 'Yes' below. If you complete that survey you will be given a second entry into the draw to win one of three \$50 Coles gift cards.

O Yes

O No



# Appendix 6 The use of man-made marine structures in Western Australia: A random utility model

Johanna Zimmerhackel & Michael Burton

This appendix is part of the final report for:

# Enhancing the Understanding of the Value Provided to Fisheries by Man-made Aquatic Structures.

Euan S. Harvey, Fran Ackermann, Michael Burton, Julian Clifton, Carmen Elrick-Barr, Johanna Zimmerhackel, Georgina Hill, Stephen J Newman, Jenny Shaw, Mark Pagano, Paul McLeod, Dianne McLean, Julian Partridge

24<sup>th</sup> August 2021

FRDC Project No 2018-053

# The use of man-made marine structures in Western Australia: A random utility model

# 1 Abstract

Man-made marine structures (MMS) attract significant marine life which creates socio-economic impact for a range of users such as commercial and recreational fishers, and divers. This work (i) analyses to what extent MMS influence the site choice and (ii) estimates the economic value of MMS using a multiple site choice model of boat-based recreational fishing and diving activities in four regions in Western Australia: Geographe Bay, Coral Bay, Exmouth and Onslow.

Results show that artificial reefs and jetties positively influence recreational fishers' site choice. Similarly, jetties and shipwrecks significantly influence divers' site choice. In Geographe Bay, recreational fishers valued most the Dunsborough Artificial Reef, followed by the Busselton Jetty whereas divers valued the HMAS Swan wreck the most, followed by the Busselton Jetty and the FV Lena wreck. We also found that a hypothetical new MMS in Geographe Bay was valued more the closer to a boat ramp it would be built. This was confirmed in the Onslow region, where we estimated the value of re-purposing nine oil and gas structures into artificial reefs accessible for recreational fishers or divers. We found that converting the two structures the closest to the boat ramp generated almost half of the value compared to converting all nine structures. The results of this work can inform decision-making processes of existing and prospective MMS in Western Australia.

# 2 Introduction

Man-made marine structures (MMS) attract significant marine life which creates socio-economic impact for a range of users such as commercial and recreational fishers, and divers. In Western Australia, there are an estimated 7200 MMS including shipwrecks, piers and jetties, purpose built artificial reefs and oil and gas infrastructure (Harvey et al 2021, Appendix 1). However, there is limited information on the socio-economic impact of MMS globally, and (to the best of our knowledge) only two studies on the economic value of MMS in Australia.

Dowling and Nichol (2001) analysed the expenditures from dive tourists that visit the HMAS Swan shipwreck in Western Australia and estimated the annual economic impact to be USD 1.39 million. Rogers et al. (2018) did a benefit-cost-analysis for an oyster reef restoration project in South Australia. They estimated that the project would demonstrate a two and four return on investment and generated net benefits between AUD 4 million and AUD 10 million.

However, these estimates are based on single sites and do not take the substitution activities of users from/to other MMS and other natural sites into consideration. This is important because users have a whole range of options of sites they could visit. Hence, removing or adding a MMS at a site will likely result in users reallocating their activities within the region. Therefore users do not lose or gain the benefits of the entire trip to the MMS, but the difference in value between the first choice and the second choice site.

This work will address these gaps by using a multiple site choice model of boat-based recreational fishers and divers in four regions in Western Australia that contain a variety of MMS: Geographe Bay, Coral Bay, Exmouth and Onslow. The objectives of this work are to

- analyse to what extent MMS influence the site choice of recreational fishers and divers in Western Australia
- estimate the economic value of MMS for recreational fishers and in Western Australia, where users can substitute with other sites within the region

The results of this work can inform decision-making processes of existing and prospective MMS in Western Australia.

# 3 Methods

# 3.1 Survey

We used an online survey with recreational fishers and divers that was distributed on various channels:

- Recfishwest monthly 'Broadcast' newsletter between December 2019 and January 2020
- Recfishwest Facebook page and Instagram posts between December 2019 and February 2020
- 500 flyers and 100 posters mailed to 40 dive and tackle shops across all four WA fishing regions in January 2020
- Link from two online travel cost surveys conducted by this research team at the Busselton Jetty and the Navy Pier between May and September 2020

In the first three distribution channels, respondents first completed a survey on their social values of MMS (not part of this report) and were then directed to the site choice survey. By finishing these surveys, they had the option to participate in a prize draw to win AUD 750. Respondents that participated coming from the other two online travel cost surveys could partake in a prize draw for AUD 50. The difference in rewards reflects the differing sizes of the combined surveys being completed.

The social survey asked participants whether they would classify themselves as either recreational fishers, divers or neither. The neither group was not forwarded to the site choice survey while the recreational fishers and divers were asked to only give information about the activity that they classified themselves as.

Respondents were asked about their boat-based trips in the four regions: Geographe Bay, Coral Bay, Exmouth and Onslow in the last 12 months. For each region they visited, they were presented with a map on which they could give information about up to five day trips in the region. The information included on-the-water travel distance, travel costs to arrive at the destination, other costs associated with trips and factors that determine the quality of the sites (e.g., target fish species). For each day trip, they were then presented with the map of the region where they could indicate up to three locations that they were fishing or diving at on that particular day. The survey also collected information about the place of residence, age and gender of respondents. The full survey can be accessed in Appendix A.

# 3.2 Random Utility Model

This work used a Random Utility Model (RUM) to analyse to what extent MMS influence the site choice of recreational fishers in Western Australia. This model assumes that each user *i* selects a site *j* that maximises the expected utility  $U_{ij}$ :

$$U_{ij} = \beta' x_{ij} + e_{ij} \tag{1}$$

Where  $x_{ij}$  are the observed characteristics of each site option,  $\beta$  are the coefficients of these characteristics and  $e_{ij}$  is the error term. Assuming that the errors are independent and identically distributed (iid) extreme values, the probability that a site is selected can be expressed by the conditional logit formula:

$$prob_{ij} = \frac{\exp(\beta' x_{ij})}{\sum_{k=1}^{K} \exp(\beta' x_{ik})}$$
(2)

The advantage of this approach is that RUMs can not only test how site specific (and individual specific) factors influence their recreational fishing site choice, they can also estimate the monetary value of these effects. Moreover, this method allows one to predict the economic consequences of future scenarios (such as the removal or addition of MMS) for recreational users by simulating site choice under the new scenario.

As respondents could choose up to three locations on each map, we used only those responses where either only one location was selected or where all selected locations were situated within the same grid cell.

## 3.2.1 Variables

The dependent variable is the recreational site choice where each choice option is one cell on a map of the according regions divided into a grid of 10 x 10 nm (Figure 1). The limit of the grid was determined by the extent of the map shown to respondents in the survey.

We tested a range of site specific factors such as the on the water travel cost which was calculated as the costs for a return trip from the nearest boat ramp to the fishing or diving location times the fuel costs. Fuel costs were estimated to be AUD 0.56 per km travelled (Navarro et al. 2018). On the water travel costs to all grid cells the respondent did not choose were based on the distance from the boat ramp the respondent left from to the centre of each grid cell.

We also tested whether the presence of a MMS in a certain grid cell has a significant influence on the site choice of fishers. We distinguished between different MMS types to measure the effect on recreational fishers and divers because they are being used differently by the user groups:

- Shipwrecks in the study area are only open for access to divers.
- Artificial reefs in the study regions were mainly designed for recreational fishing activities and are mainly used by them. However, they are open to divers.
- Piers and jetties were represented by the Busselton Jetty which is open to both recreational fishing and diving, except for a sanctuary zone that is only open to diving.

As Thevenard O&G infrastructure are closed to any recreational activity, we could not measure the values associated with this structure type. In the Exmouth region, we did not consider the Navy Pier in the scenarios because it is closed to boat-based activities.

A limitation of the mapping process is the accuracy to which respondents could identify where they had gone when placing a marker on the map. Some respondents explicitly noted that they had

visited the MMS. Using this subset of respondents, we evaluated the distance from the MMS and where they placed their marker, and the maximum distance in the set, and used this as a measure of accuracy. We then defined someone to have visited a MMS by drawing a buffer zone around each MMS where the size of this zone was determined by the maximum distance.

Environmental site specific factors that could influence recreational fishers' site choice were added to the model as the mean water depth (m) of each grid cell. Due to the shoreline, some grid cells had a smaller surface area than the 10 x 10 nm grid. Therefore, we accounted for this by adding the variable grid size which was calculated as the  $km^2$  area of each grid cell. We also tested whether the distance from the centre of each grid cell to the shore had a significant influence on site choice.

We estimated the model by pooling data across all 4 regions.

# 3.3 Policy scenarios

The model results of the RUM give information about how the site specific variables influence the probability of visitors to choose the different sites (grid cells) within the study area. Consequently, this approach is able to predict the change probabilities for an individual to choose a certain site as well as the change in value derived from the visit when conditions of a certain site change. We predicted the change in welfare for boat-based recreational fishers and divers associated with various hypothetical scenarios (Table 1). Scenarios included the removal of existing MMS as well as the addition of new MMS at certain sites (Figure 1). The loss in value associated with the removal of a particular MMS represents the value of that MMS. Added prospective MMS were assumed to be in the centre of the grid cells and the on-the-water travel cost was estimated from the boat ramp each respondent left to the centre of that grid cell. Note that we do not model selection of boat ramp, and hence cannot account for any change in choice of boat ramp prior to launch that may occur as a result of changing the MMS.

As Thevenard O&G infrastructure are closed to any recreational activity, we could not measure the values associated with this structure type. To understand the value associated with the potential diving and recreational fishing on Thevenard O&G infrastructure, we therefore changed the structure types into either "shipwrecks" or "artificial reefs" to imitate conditions that are more favourable to divers or recreational fishers, respectively (i.e. if a new MMS is designated as a "shipwreck" that is only intended to indicate that it has access settings equivalent to a shipwreck).





*Figure 1: Study regions with grid, MMS and locations where MMS were hypothetically added for (A) Geographe Bay, (B) Coral Bay, Exmouth, and Onslow region, and (C) close-up of oil and gas structures in the Onslow region.* 

Scenario	Description						
Geograph	Geographe Bay						
BJ	Remove Busselton Jetty						
SW	Remove Swan Wreck						
LW	Remove Lena Wreck						
DAR	Remove Dunsborough AR						
BAR	Remove Bunbury AR						
G25	Add MMS in Geographe Bay (cell 25)*						
G28	Add MMS in Geographe Bay (cell 28)*						
Coral Bay							
C36	Add MMS (cell 36)*						
Exmouth	region						
EAR	Remove EIAR						
EW	EIAR diver access only						
E37	Add MMS (cell 37)*						
Onslow re	gion						
AR9	Access O&G structure: 9 "artificial reefs"						
W9	Access O&G structure: 9 "wrecks"						
AR4W5	Access O&G structure: 4 "artificial reefs" (Roller A, Roller B, Cowle, Saladin A, Saladin C) and 5 "wrecks" (Roller B, Skate, Yammaderry, Saladin B)						
AR2	Access O&G structure: 2 "artificial reefs" (Roller B, Roller C)						
W2	Access O&G structure: 2 "wrecks" (Roller B, Roller C)						

Table 1: Hypothetical scenarios describing the change of MMS at study sites.

\* Added "artificial reefs" for recreational fishers and "wrecks" for divers a) Note that the MMS are assumed to be in the centre of the grid cell

# 4 Results and Discussion

# 4.1 Descriptive Analysis

## 4.1.1 Respondents' characteristics

The random utility survey yielded 174 valid responses, out of which 123 were from recreational fishers and 51 from divers. Respondents' characteristics are show in Table 2. Recreational fishers were on average eight years older than divers and were mainly male. Divers were on average more avid in their activity than recreational fishers, but both groups also engaged in the other activity. The majority of respondents live in the Perth metropolitan area.

Respondent characteristics	Divers	<b>Recreational Fishers</b>	Total
Average age (years)	37	45	43
Gender (% male)	63.92	88.10	82.89
Avidity: Recreational fishing (%)			
Around once a year	8.89	4.09	5.03
Around once every three months	22.22	15.53	16.85
At least once a month	27.78	47.41	43.54
At least once a week	17.78	29.70	27.35
Never	23.33	0.00	11.67
Avidity: Diving (%)			
Around once a year	5.10	24.23	20.09
Around once every three months	18.37	24.23	22.96
At least once a month	38.78	18.59	22.96
At least once a week	36.73	2.82	10.15
Never	0.00	30.14	15.07
Postcode (%)			
Western Australia (total)	89.58	90.28	90.13
Perth metropolitan area	72.92	61.11	63.60
Margaret River region	7.29	16.11	14.25
Northwest	1.04	6.67	5.48
Other regions in WA	8.33	6.39	6.80
Other states	7.29	7.78	7.68

Table 2: Respondents' characteristics from divers (n=51) and recreational fishers (n=123).

## 4.1.2 Level of Use of MMS

We found that for recreational fishers, the level of use of our case study regions decreased with increasing distance from Perth. The most visited area was Geographe Bay where recreational fishers spent about almost two thirds and divers about 40% of their trips. In the Exmouth region, one third of fishing trips and 57% of dive trips took place, hence Exmouth being the most visited region for divers. Only 4% of fishing and diving trips took place in the Onslow region.

In Geographe Bay, recreational fishers indicated 307 places they visited, out of which 94 (30.6%) were on MMS. Divers used MMS relatively more with 40 out of 61 locations (66.7%) being on MMS (Figure 2). In the Exmouth Region, use of MMS was overall lower than in Geographe Bay. Recreational fishers added 161 locations, out of which 25 (15.5%) were on MMS and about 12.2% of divers' locations (11 out of 90) were taking place on MMS (Figure 3). This could be explained by the fact that there is only one artificial reef and one jetty in the Exmouth region whereas Geographe Bay has five different MMS available in a smaller area. We found very small numbers of visitors to the Onslow Region (Figure 4). Recreational fishers indicated 21 locations they visited, four being on MMS. Divers added six locations, three being on MMS. Coral Bay has got no MMS, so all trips recorded were taking place on natural sites (Figure 5).



Figure 2: Frequency of trips for boat based (A) recreational fishing and (B) diving in Geographe Bay.



*Figure 3: Frequency of trips for boat based (A) recreational fishing and (B) diving in the Exmouth region.* 



Figure 4: Frequency of trips for boat based (A) recreational fishing and (B) diving in the Onslow region.



Figure 5: Frequency of trips for boat based (A) recreational fishing and (B) diving in Coral Bay.

# 4.2 Random Utility Model

We estimated a random utility model for both recreational fishers and divers (Table 3). As expected from economic theory, the travel cost coefficient has a significant and negative effect in both models. Artificial reefs influence site choice for recreational fishers strongly and positively, whereas there is a positive but not significant effect for divers. The Busselton Jetty influenced strongly and positively the site choice of divers and fishers. Shipwrecks influenced both recreational fishers' and divers' site choice positively, but this effect is only significant for divers. This is not surprising because both the Lena and the Swan shipwrecks are no-take zones (although note that a site was defined as to the zone as a whole, and hence it is possible that fishers visit a zone, without directly fishing on the wreck). However, recreational fishers might still benefit from spill-over effects from these zones. Respondents might also combine different activities and go fishing in the surroundings of the wrecks as well as dive on the wrecks during one trip. However, there is also indications of recreational fishing activities on the shipwrecks (local dive operator, personal comment).

The area of the grid positively affect site choice for both user groups. Moreover, fishers and divers have a preference for sites more distant from shore (conditional upon travel cost being a negative impact). This result might be explained by users trying to avoid overcrowding in areas closer to shore. This result might also be an indicator of overfishing in areas closer to shore.

Results of this model also reveal the willingness to pay (WTP) for MMS types for those who actually visit them and hence does not account for the substitution effect. Given that shipwrecks are closed to fishers it is not surprising that recreational fishers' WTP for access to zones containing artificial reefs is about twice that for shipwrecks. Also, the WTP of divers for jetties is about twice that for shipwrecks. This can probably be explained by the lower travel costs to the jetty than to the shipwrecks.

	Recre	eational fishe	rs	Recreational divers			
Variable	Coef.	Std. Err.	P-value	Coef.	Std. Err.	P-value	
Travel cost	-0.117	0.009	0.000	-0.117	0.012	0.000	
Artificial reef	1.126	0.335	0.001	0.428	0.536	0.425	
Shipwreck	0.353	0.358	0.325	2.113	0.559	0.000	
Jetty	1.391	0.408	0.001	2.729	0.710	0.000	
Area	0.007	0.002	0.000	0.008	0.002	0.000	
Distance from shore	0.022	0.010	0.027	0.020	0.012	0.105	
Number of trips	130			79			
Respondents	70			40			
Log-likelihood	-316.881			-179.942			
WTP artificial reef	-9.620	3.014	0.001				
WTP shipwreck				-18.045	5.282	0.001	
WTP jetty	-11.909	3.725	0.001	-23.311	6.786	0.001	

Table 3: Results of the random utility model for recreational fishers' and divers' site choice in Western Australia.

# 4.3 Change in Welfare under policy scenario

We estimated the value associated with existing MMS in the four regions by calculating the change in welfare (in AUD per trip) that occurs when MMS are hypothetically removed (Table 4). The simulation of site choice under the removal scenarios include the redistribution of users across the region, also called the substitution effect. Therefore, the values associated with these structures are lower than the WTP of respondents when not taking substitution into consideration. This estimate of the value is generated from the inclusive value of a region, with and without the change in MMS provision. Note that each region is considered separately i.e. there are no spill over effects across regions.

For recreational fishers, the removal of the Dunsborough artificial reef (DAR) has the highest welfare impact, followed by removing the Busselton Jetty (BJ). For divers, the removal of the Swan wreck (SW) has the highest welfare impact, followed by the Busselton Jetty (BJ). Overall, the removal of MMS has a higher loss in welfare on divers than on fishers.

As expected, the sum of welfare change when removing MMS in Geographe Bay separately is lower than when removing all MMS in Geographe Bay at once for divers. This is because the sum of the welfare change of all MMS reflects the welfare change where users still can substitute among different MMS. Conversely, in the scenario that removes all MMS at once, users can only substitute their sites with non-MMS sites. However, fishers' loss in welfare as the sum of removing all MMS separately is higher than removing them all at once. We suspect that this is because there are two MMS (the Swan wreck and the Dunsborough artificial reef) in the same grid cell. The model suggests that dropping both together is less harmful than the sum of dropping each in turn. However, this

likely depends on the number of MMS per cell (having a high number of MMS in single cells probably will cause the substitution effect to overcome the marginal effect of two MMS in one cell).

We also simulated the site choice and associated welfare changes under scenarios in which we added MMS to the study regions. We used MMS types that were significant to recreational fishers (artificial reefs) and divers (wrecks) as a proxy. It is noticeable that these two structure types have different characteristics: artificial reefs give access to recreational fishers and divers, however divers rarely use these structures due to the incompatibility of the two activities. Wrecks are only open to divers but have shown to have a positive effect on recreational fishers as well (Table 4). Consistent with the negative travel cost variable, the added value of a MMS to a grid cell closer to boat ramps (G28) was much higher than when adding a MMS further away (G25) for both recreational fishers and divers.

Lastly, we simulated different scenarios of opening access to fishers and/or divers to the Thevenard O&G structures (Table 4). Again, we used the coefficients from "artificial reefs" and "wrecks" as a proxy because we have no estimates for O&G structures. Results indicate a decreasing marginal utility with additional MMS. For example, divers and recreational fishers had a higher value per structure when opening the access to two structures (AR2 and W2) than when giving access to all nine structures (AR9 and W9). This result is also influenced by the fact that the scenario AR2 and W2 gave access to the two structures closest to shore which reduces travel costs. The scenario that combined O&G structures that are significant to fishers (artificial reefs) with those that are significant to divers (wrecks) (AR4W5) has the most equitable benefits.

Scenario	Description	Change in rec. fishers' CS (AUD/trip)	Change in divers' CS (AUD/trip)	Aggregate change in rec fishers' CS (AUD/year)	Aggregate change in rec divers' CS (AUD/year)
Geograph	e Bay				
BJ	Remove Busselton Jetty	-0.45	-0.56		
SW	Remove Swan Wreck	-0.27	-0.75		
LW	Remove Lena Wreck	-0.07	-0.36		
DAR	Remove Dunsborough AR	-0.68	-0.21		
BAR	Remove Bunbury AR	-0.20	-0.01		
G25	Add MMS in Geographe Bay (cell 25)*	0.04	0.01		
G28	Add MMS in Geographe Bay (cell 28)*	0.42	0.19		
Sum of re separate	moving all MMS	-1.67	-1.89		
Remove a	ll MMS at once	-1.59	-1.97		
Coral Bay					
C36	Add MMS (cell 36)*	0.02	-0.04		
Exmouth	region				
EAR	Remove EIAR	-0.20	-0.09	-3,042	
EW	EIAR diver access only	-0.16	0.95	-2,434	
E37	Add MMS (cell 37)*	0.12	0.15	1,825	

Table 4: Hypothetical scenarios for MMS in Western Australia and the associated change in welfare (CS) for recreational fishers and divers.

#### **Onslow region**

AR9	Access O&G structure: 9 "artificial reefs"	1.19	0.10	1,188
W9	Access O&G structure: 9 "wrecks"	0.21	1.06	210
AR4W5	Access O&G structure: 4 "artificial reefs" and 5 "wrecks"	0.50	0.60	499
AR2	Access O&G structure: 2 "artificial reefs"	0.53	0.05	529
W2	Access O&G structure: 2 "wrecks"	0.09	0.54	90

\* "artificial reefs" for recreational fishers and "wrecks" for divers

Our results are consistent with previous studies that have analysed the access value for recreational fishers to sites along the coast of Western Australia. The importance of MMS to recreational fishers in this area is highlighted when comparing the welfare impact of removing all recreational fishing sites in Busselton (\$-3.76 AUD) (from (Raguragavan and Hailu, 2013) to the sum of welfare loss from removing all MMS in the area (\$ -1.40 AUD) (from Table 20 above, for artificial reefs only). In other regions, such as Exmouth, such a comparison suggests that the relative importance of MMS to recreational fishers is lower (\$-6.16 AUD for removing all sites (from Raguragavan and Hailu, 2013) compared to our estimate of \$-0.20 AUD for removing the EIAR). The access value of the Onslow region is relatively low (\$2.95 AUD; Raguragavan and Hailu, 2013), hence, opening access to the O&G structures could increase the welfare of users significantly. Conversely, adding an MMS in Coral Bay would not add much to the welfare of users.

We did not have access to fishing data and could therefore not add the expected catch as a variable into our model. Previous studies have shown that the expected catch influenced site choice of recreational fisher significantly (Navarro et al. 2018, Raguragavan et al. 2013). Adding expected catch as a variable in future studies would be advisable to improve the results of this model.

# 5 References

Mean depth per grid cell: <u>https://www.ga.gov.au/scientific-topics/national-location-information/topographic-maps-data/topographic-maps</u>

http://www.ga.gov.au/scientific-topics/marine/survey-techniques/bathymetry

https://ecat.ga.gov.au/geonetwork/srv/eng/catalog.search#/metadata/67703

# Appendix A: Random Utility Survey

**BLOCK: RECREATIONAL FISHING** 

**F.1** Have you done any private boat-based recreational fishing trips to any of the following areas in WA in the last 12 months? Please tick all boxes that apply. If none apply, please click the blue arrow button.

- □ Onslow (e.g. Thevenard Island)
- Coral Bay
- Exmouth
- □ Geographe Bay

#### Display This Question:

If If Have you done any private boat-based recreational fishing trips to any of the following areas in WA in the last 12 months? Please tick all boxes that apply. If none apply, please click th... q://QID4/SelectedChoicesCount Is Greater Than or Equal to 1

**F.2** We are going to ask you now about your recent private boat-based recreational fishing trips. We are only interested in trips undertaken in the last 12 months. Each trip is defined as one day of activity. The information will help us to understand your reasons to choose a specific fishing site.

## Block: Recreational fishing: Geographe bay

### Display This Question:

If Have you done any private boat-based recreational fishing trips to any of the following areas in... = Geographe Bay

**FG.0** Please tell us for each of your most recent fishing trips to Geographe bay, by boat, when it was, how far you traveled that day (in either km or nautical miles) and what you intended to catch.

	Date	Distance traveled on water			Intended catc	Intended catch				
	(dd/mm/yyyy)	km nm	bottom dwelling finfish (eg emperor, groper, snapper)	large pelagics (eg mackerel, tuna, marlin)	nearshore finfish (eg barramundi, whiting)	baitfish (eg sardine, anchovy)	crustaceans	molluscs and invertebrates		
Trip 1			0	0	0	0	0	0		
Trip 2			0	0	0	0	0	0		
Trip 3			0	0	0	0	0	0		
Trip 4			0	0	0	0	0	0		
Trip 5			0	0	0	0	0	0		

Display This Question:

If If Please tell us for each of your most recent fishing trips to Geographe bay, by boat, when it was,... Trip 1 - Date -(dd/mm/yyyy) Is Not Empty

## FG.1 Please indicate where you spent the most time fishing on Trip 1 (on the

\${FG.0%231/ChoiceTextEntryValue/1/1}, by clicking on a maximum of 3 locations on the map.



Repeated for a maximum of 5 trips.

#### APPENDIX A

Block: Recreational fishing: Coral Bay

Display This Question:

If Have you done any private boat-based recreational fishing trips to any of the following areas in... = Coral Bay

**FC.0** Please tell us for each of your most recent fishing trips to Coral Bay when it was, how far you traveled that day (in either km or nautical miles) and what you intended to catch.

	Date	Distance tra on wate	veled er			Intended catcl	Intended catch				
	(dd/mm/yyyy)	km	nm	bottom dwelling finfish (eg emperor, groper, snapper)	large pelagics (eg mackerel, tuna, marlin)	nearshore finfish (eg barramundi, whiting)	baitfish (eg sardine, anchovy)	crustaceans	molluscs and invertebrates		
Trip 1				0	0	0	0	0	0		
Trip 2				0	0	0	0	0	0		
Trip 3				0	0	0	0	0	0		
Trip 4				0	0	0	0	0	0		
Trip 5				0	0	0	0	0	0		

Display This Question:

If If Please tell us for each of your most recent fishing trips to Coral Bay when it was, how far you t… Trip 1 - Date -(dd/mm/yyyy) Is Not Empty



FC.1 Please indicate where you spent the most time fishing on Trip 1 (on the \${FC.0%231/ChoiceTextEntryValue/1/1}, by clicking on a maximum of 3 locations on the map.

Repeated for a maximum of 5 trips.

### Block: Recreational fishing: Onslow region

Display This Question:

If Have you done any private boat-based recreational fishing trips to any of the following areas in... = Onslow (e.g. Thevenard Island)

**FO.0** Please tell us for each of your most recent fishing trips to the Onslow region when it was, how you traveled on the water (in either km or nautical miles) and what you intended to catch.

	Date	Distance traveled by water	Distance traveled by water		Intended catch				
	(dd/mm/yyyy)	(km)	(nautical miles)	bottom dwelling finfish (eg emperor, groper, snapper)	large pelagics (eg mackerel, tuna, marlin)	nearshore finfish (eg barramundi, whiting)	baitfish (eg sardine, anchovy)	crustaceans	molluscs and invertebrates
Trip 1				0	0	0	0	0	0
Trip 2				0	0	0	0	0	0
Trip 3				0	0	0	0	0	0
Trip 4				0	0	0	0	0	0
Trip 5				0	0	$\bigcirc$	0	0	0

# Display This Question:

If If Please tell us for each of your most recent fishing trips to the Onslow region when it was, how y... Trip 1 - Date -(dd/mm/yyyy) Is Not Empty

# **FO.1** Please indicate where you spent the most time fishing on Trip 1 (on the \${FO.0%231/ChoiceTextEntryValue/1/1}, by clicking on a maximum of 3 locations on the map.



Repeated for a maximum of 5 trips.

### Block: Rec. fishing: Exmouth region

#### Display This Question:

If Have you done any private boat-based recreational fishing trips to any of the following areas in... = Exmouth

**FE.0** Please tell us for each of your most recent private boat-based fishing trips to the Exmouth region when it was, from where you launched the boat and what you intended to catch.

	Date	Distance traveled on water		Intended catch						
	(dd/mm/yyyy)	(km)	(nautical miles)	bottom dwelling finfish (eg emperor, groper, snapper)	large pelagics (eg mackerel, tuna, marlin)	nearshore finfish (eg barramundi, whiting)	baitfish (eg sardine, anchovy)	crustaceans	molluscs and invertebrates	
Trip 1				0	0	0	0	0	0	
Trip 2				0	0	0	0	0	0	
Trip 3				0	0	0	0	0	0	
Trip 4				0	0	0	0	0	0	
Trip 5				0	0	0	0	0	0	

### Display This Question:

If If Please tell us for each of your most recent private boat-based fishing trips to the Exmouth regio… Trip 1 - Date -(dd/mm/yyyy) Is Not Empty

# **FE.1** Please indicate where you spent the most time fishing on Trip 1 (on the

\${FE.0%231/ChoiceTextEntryValue/1/1}, by clicking on a maximum of 3 locations on the map.



Repeated for a maximum of 5 trips.

#### **Block: Recreational diving**

**D.1** Have you done any private boat-based diving trips to any of the following areas in WA in the last 12 months? Please tick all boxes that apply

- □ Onslow (e.g. Thevenard Island)
- Coral Bay
- Exmouth
- □ Geographe Bay

#### Display This Question:

If If Have you done any private boat-based diving trips to any of the following areas in WA in the last... q://QID70/SelectedChoicesCount Is Greater Than or Equal to 1

**D.2** We are going to ask you now about your recent private boat-based diving trips. Each trip is defined as one day of activity. The information will help us to understand your reasons to choose a specific diving site.

#### **Block: Recreational diving: Geographe bay**

#### Display This Question:

*If Have you done any private boat-based diving trips to any of the following areas in WA in the last... = Geographe Bay* 

**DG.0** Please tell us for each of your most recent **private boat-based diving trips** to the Geographe Bay region when it was, the distance you traveled on water in that trip, either in km or nautical miles, and what you intended to see underwater.

	Date	Distance trave	eled on water	Intended observation
	(dd/mm/yyyy)	(km)	(nautical miles)	(maximum 3 species or attractions)
Trip 1				
Trip 2				
Trip 3				
Trip 4				
Trip 5				

Display This Question:

If If Please tell us for each of your most recent private boat-based diving trips to the Geographe Bay region when it was, the distance you traveled on water in that trip, either in km or nautical ... Trip 1 - Date - (dd/mm/yyyy) Is Not Empty

# **DG.1** Please indicate where you spent the most time diving on Trip 1 (on the \${DG.0%231/ChoiceTextEntryValue/1/1}, by clicking on a maximum of 3 locations on the map.



Repeated for a maximum of 5 trips.

#### **Block: Recreational diving Exmouth region**

Display This Question:

If Have you done any private boat-based diving trips to any of the following areas in WA in the last... = Exmouth

**DE.0** Please tell us for each of your most recent private boat-based diving trips to the Exmouth region when it was, from where you launched the boat and what you intended to see underwater.

	Date	Distance trave	led on water	Intended observation
	(dd/mm/yyyy)	(km)	(nautical miles)	(maximum 3 species or attractions)
Trip 1				
Trip 2				
Trip 3				
Trip 4				
Trip 5				

#### Display This Question:

If If Please tell us for each of your most recent private boat-based diving trips to the Exmouth region... Trip 1 - Date - (dd/mm/yyyy) Is Not Empty **DE.1** Please indicate where you spent the most time diving on Trip 1 (on the \${DE.0%231/ChoiceTextEntryValue/1/1}, by clicking on a maximum of 3 locations on the map.



Repeated for a maximum of 5 trips.

#### **Block: Recreational diving Coral Bay**

Display This Question:

If Have you done any private boat-based diving trips to any of the following areas in WA in the last... = Coral Bay

**DC.0** Please tell us for each of your most recent **private boat-based** diving trips to the Coral Bay when it was, from where you launched the boat and what you intended to see underwater.

	Date	Distance trave	led on water	Intended observation
	(dd/mm/yyyy)	(km)	(nautical miles)	(maximum 3 species or attractions)
Trip 1				
Trip 2				
Trip 3				
Trip 4				
Trip 5				

#### Display This Question:

If If Please tell us for each of your most recent private boat-based diving trips to theCoral Bay when it was, from where you launched the boat and what you intended to see underwater. Trip 1 - Date - (dd/mm/yyyy) Is Not Empty

**DC.1** Please indicate where you spent the most time diving on Trip 1 (on the  ${DC.0%231/ChoiceTextEntryValue/1/1}$ , by clicking on a maximum of 3 locations on the map.



Repeated for a maximum of 5 trips.

#### **Block: Recreational diving Onslow region**

Display This Question:

If Have you done any private boat-based diving trips to any of the following areas in WA in the last... = Onslow (e.g. Thevenard Island)

**DO.0** Please tell us for each of your most recent **private boat-based** diving trips to the Onslow region when it was, from where you launched the boat and what you intended to see underwater.

	Date	Distance traveled on water		Intended observation
	(dd/mm/yyyy)	(km)	(nautical miles)	(maximum 3 species or attractions)
Trip 1				
Trip 2				
Trip 3				
Trip 4				
Trip 5				

#### Display This Question:

If If Please tell us for each of your most recent private boat-based diving trips to the Onslow region when it was, from where you launched the boat and what you intended to see underwater. Trip 1 - Date - (dd/mm/yyyy) Is Not Empty



**DO.1** Please indicate where you spent the most time diving on Trip 1 (on the \${DO.0%231/ChoiceTextEntryValue/1/1}, by clicking on a maximum of 3 locations on the map.

Repeated for a maximum of 5 trips.

### **Block: Comments**

Q44 Do you have any other comments you would like to make?


# Appendix 7 Community perceptions of rigs-to-reefs in Western Australia

Verónica Mariana Recondo, Michael Burton & Johanna Zimmerhackel

This appendix is part of the final report for:

# Enhancing the Understanding of the Value Provided to Fisheries by Man-made Aquatic Structures.

Euan S. Harvey, Fran Ackermann, Michael Burton, Julian Clifton, Carmen Elrick-Barr, Johanna Zimmerhackel, Georgina Hill, Stephen J Newman, Jenny Shaw, Mark Pagano, Paul McLeod, Dianne McLean, Julian Partridge

24<sup>th</sup> August 2021

FRDC Project No 2018-053

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## Community perceptions of rigs-to-reefs in Western Australia

#### Verónica Mariana Recondo, Michael Burton, Johanna Zimmerhackel

## Abstract

Current regulations in Australia favour complete removal of decommissioned offshore oil and gas infrastructure. However, regulators could consider an *in-situ* decommissioning policy if this provides ecological and socio-economic values to different stakeholders, including the wider community. Therefore, the aim of this study was to assess Western Australia community members' preferences towards rigs-to-reefs as an alternative option to complete removal and estimate the extent to which these preferences could be influenced by their attitudes towards the oil and gas sector. Hence, a discrete choice experiment and a social licence to operate survey were conducted on a random sample of Perth residents. 9.4% of respondents opposed to rigs-to-reefs under any scenario presented to them. The remaining proportion revealed preferences for rigs-to-reefs depending on the individual's characteristics and the nature of the reef presented. Preferences for reefs increased if it could provide either habitat for threatened species, increased fish biomass, production of fishes, access for divers, or increased revenue for the State budget. However, preferences for rigs-to-reefs were reduced if liability lay with the Government, or social licence granted to the oil and gas sector was low.

Key words: decommissioning, discrete choice experiment, oil and gas, rigs to reefs, social licence to operate

## 1. Introduction

Australia has a significant number of offshore oil and gas platforms, with some of them currently reaching the end of their life cycle (Shaw et al. 2018). Regulations such as the Offshore Petroleum and Greenhouse Gas Storage (Environment) Act 2009, and the Environment Protection (Sea Dumping) Act 1981, favour their complete removal from the ocean by safely plugging wells and removing all the associated equipment (DIIS 2018; Shaw et al 2018). However, the Australian regulator in charge of decommissioning - the National Offshore Petroleum Safety and Environmental Management Authority (NOPSEMA) - is currently evaluating an *in-situ* decommissioning policy, which may include partial removal, nearby relocation or leaving the structures in place (Chandler et al. 2017; DIIS 2018; Bull and Love 2019). This alternative approach may be implemented if a company can prove that it generates equal or better environmental, safety and well integrity outcomes, or if complete removal would present a greater risk or cost for the environment (Chandler et al. 2017; DIIS 2018). Such a scenario would be possible in cases where marine life has developed around rigs, therefore allowing these structures to be used as artificial reefs through the creation of rigs-toreefs programs (Chandler et al. 2017). These programs have already been established in some countries such as the USA, Malaysia and Brunei (Advisian 2017; Bull and Love 2019). In the USA, the National Rigs-to-Reefs Plan was created in 1985 and it is regulated by the Bureau of Safety and Environmental Enforcement (BSEE) (Advisian 2017). In other regions, such as the North Sea, policies still favour complete removal of structures due to the regulations of the 1992 Convention for the Protection of the Marine Environment of the North East Atlantic (OSPAR) and the OSPAR Decision 98/3, which prohibits the disposal of decommissioned offshore oil and gas platforms in the sea (Bull and Love 2019).

The different decommissioning approaches that allow the structures to be disposed *in-situ* (Figure 1) consider the potential ecological values of the ecosystems that have developed around them (Sommer et al. 2018). These potential ecological values may include: habitat provision for biological communities (Sommer et al. 2018); potential fish biomass production – although it is not entirely clear if fishes are being reproduced in the vicinity of the platforms or just being attracted to them (Bohnsack 1989; Claisse et al. 2014); enhancement of biodiversity (van der Stap et al. 2016; Coolen et al. 2018); biota protection from trawl fishing within platform exclusion zones through the risk of snagging (Schroeder and Love 2004; Inger et al. 2009); and connectivity of native populations over large distances through the "stepping-

stone" effect, including protected or endangered species (Bishop et al. 2017; Henry et al. 2018). However, these structures may also facilitate the expansion of non-native and invasive species (Bulleri and Airoldi 2005; Page et al. 2006; Glasby et al. 2007; Sheehy and Vik 2010). Also, navigational and snagging hazards to shipping and fishing may occur if the rigs are not adequately identified (Advisian et al. 2017). In addition, *in situ* decommissioning of structures may involve a risk of corrosion, which may lead to the release of contaminants to the environment. Yet, removing the structures from the sea may also include a risk of contamination due to seabed disturbance and possible resuspension of contaminants (Advisian et al. 2017). As noted by Shaw et al. (2018), there is still limited information regarding these issues in Australia, as there are few decommissioned assets.



Figure 1. Offshore oil and gas decommissioning options (Source: Sommer et al. 2018)

In the case of Australia, some ecological values have been reported by several studies conducted in the North West Shelf (NWS) of Western Australia, suggesting that subsea oil and gas infrastructure in this region may be important habitats for fishes, as well as support high biomass and diversity of species, including commercially targeted ones (Pradella et al. 2014; McLean et al. 2017; Bond et al. 2018a, Bond et al. 2018b; McLean et al. 2018; McLean et al. 2019). Moreover, McLean et al. (2018) and McLean et al. (2019) have found IUCN endangered and vulnerable species associated with platforms' jackets. Hence, offshore oil and gas infrastructure could be also presenting potential socio-economic values for local fisheries and tourism industry through the provision of fishing and diving opportunities (Advisian 2017). Therefore, it becomes essential to evaluate information using a multi-disciplinary and holistic approach that includes the environmental, technical and socio-economic aspects of decommissioning, as well as the interests of different stakeholders (Chandler et al. 2017; DIIS 2018; Shaw et al. 2018). As noted by Chandler et al. (2017, p. 346) "one critical input to such a holistic approach will be determining the value for stakeholders - including the broader community - of various potential re-uses of decommissioned infrastructure, including the

*development of artificial reefs*". Moreover, for some stakeholders this is a contested space, with some of them opposed to the disposal of oil and gas infrastructure in the sea (Abott 1996). In this regard, Shaw et al. (2018, p. 4) highlights that *"it is not clear if stakeholders and the general community will support a shift in policy to regularly support options other than complete or near-complete removal"*. Therefore, community perception of different decommissioning approaches becomes an important issue to be considered in decision making, being of primary relevance for State and Commonwealth Government Agencies (Shaw et al. 2018).

Moreover, it may be the case that people's attitudes towards the oil and gas sector influence their perception of different environmental outcomes related to this industry, and hence whether they would be willing to accept a change in policy from complete removal (Salcido 2005). In this regard, a Social License to Operate (SLO) has been previously used by other authors (Richert et al. 2015; Burton et al. 2017) to measure these attitudes and explain people's choices.

Regarding the value of rigs-to-reef for different stakeholders, several studies have assessed the economic impact of this alternative using market and non-market valuation in countries where this policy has been implemented. In a recent report, McLeod et al. (2019) found five studies that evaluate the potential economic value of artificial reefs derived from oil and gas infrastructure, for different stakeholders. Among these studies, Islam et al. (2014) examined the economic benefits of oil and gas reefs on artisanal fishers in Malaysia, while McGurrin and Fedler (1989) studied the willingness to pay of recreational fishermen for the development of artificial reefs projects on a petroleum platform in Florida, USA. Likewise, Roberts et al. (1985) used a contingent valuation to estimate the economic value of recreational diving on oil rigs in Louisiana, USA, while Ditton et al. (2002) and Oh et al. (2008) estimated the economic impacts of recreational diving for scuba divers in both natural and rigs-to-reefs habitats in Texas, USA using divers' expenditure per dive trip in the former, and a contingent valuation study in the latter. In addition, Hiett and Milon (2002) estimated the overall economic impact of recreational fishing and diving associated with offshore oil and gas structures in the Gulf of Mexico, USA. However, none of these economic studies have analysed public acceptance, perceptions and/or valuation of rigs-to-reefs, nor has this been analysed in the Australian context despite its current relevance.

Therefore, the aims of this study are:

1) Assess Western Australia community members' preferences towards rigs-to-reefs as an alternative option to complete removal of offshore oil and gas infrastructure, and estimate the relative values hold by the community members for different attributes of rigs-to-reefs policy.

2) Assess Western Australia community members' attitudes towards the oil and gas sector by measuring the SLO by the community members granted to this sector, and estimate the extent to which these attitudes could influence their preferences among the two policy alternatives: complete removal vs. rigs-to-reefs.

Regarding the second aim, the hypothesis is that the degree of SLO granted by the Western Australian community members to the oil and gas sector will significantly influence their attitudes towards rigs-to-reefs, and hence their choices in any discrete choice experiment (DCE).

This research intends to contribute to the decision process regarding community preferences towards rigs-to-reefs, as well as improve our understanding of the elements of this approach that could increase or decrease their acceptance.

#### 2. Methodology

#### 2.1 Choice modelling theory

Non-market valuation is a methodology that allows one to assign economic value to environmental goods and services that are not traded in markets, and quantify people's preferences towards potential changes in environmental outcomes. Stated preference studies are a subset of the valuation techniques, which use surveys to evaluate hypothetical behaviour (as compared to revealed preference studies that rely on observed behaviour). Stated preference studies can potentially identify values related to both 'use' and 'existence' values (i.e. use-values which relate to values that depend on direct interaction with the resource of interest, such as fishing, and existence-values that may be held by people who do not have direct interaction with the resource, but who still hold values for the state of that environment). Further, it is possible that within a single study both values may be expressed, potentially by the same respondent i.e. a recreational fisher may consider both the positive consequences for their fishing activity, and the impacts on endangered species , when asked about their support for the development of an artificial reef. Within the statistical analysis it is possible to identify if these multiple values are being expressed. One of the stated preference techniques commonly used to estimate these preferences are discrete choice experiments (DCEs) (Bateman et al. 2002). This technique allows one to assess people's preferences across alternative policy scenarios, which are described by a number of characteristics (called attributes) that can take a number of different levels. Therefore, by making a choice between the different alternatives, the respondents evaluate the utility they obtain from the attributes of the chosen option. This behaviour can be described by the random utility model (RUM) (McFadden 1974; Train 2009) such that the utility ( $U_{ij}$ ) that individual *i* gains from selecting alternative *j* in a choice set is given by:

$$U_{ij} = \beta X_j + \varepsilon_{ij} \tag{1}$$

where X denotes a vector of observable attribute levels describing alternative j;  $\beta$  the utility weights that apply to them; and  $\varepsilon_{ij}$  a random component unobservable to the researcher (error). The error is introduced in the model given that respondents may evaluate the different alternatives according to information other than that shown in the choice set (Bateman et al. 2002). Therefore, the probability of individual *i* choosing alternative *j* over all other alternatives in a choice set, can be expressed as the probability that the utility associated with that alternative exceeds the utility associated with any other alternative *k*, which is given by:

$$P_{ij} = P[\{\beta X_j + \varepsilon_{ij}\} \ge \{\beta X_k + \varepsilon_{ik}\}] \quad \forall_j \neq k$$
(2)

Assuming that the errors,  $\varepsilon_{ij}$ , are independently and identically distributed with an extremevalue type I (Gumbel) distribution, then the respondent's probability of choosing alternative *j* as the most preferred, can be expressed as a multinomial logit model (McFadden 1974):

$$P_{ij} = \frac{\exp(\beta X_j)}{\sum_{k=1}^{J} \exp(\beta X_j)}$$
(3)

This model produces estimates of the coefficient vector  $\beta$  for each attribute, which is interpreted as the utility weights, and hence the relative values held for the different attributes. Since the attributes in this study also include a monetary attribute *m* (explained in the next section), for which the estimated parameter is  $\beta_m$ , mean willingness to pay (WTP) for any nonmonetary attribute *n* was calculated as

$$WTP_n = -\frac{\beta_n}{\beta_m} \tag{4}$$

where  $\beta_n$  denotes the coefficient of the attribute *n*.

It is worth noting that, if the monetary attribute represents a cost for the respondent, that formula gives the WTP for a unit increase in a non-monetary attribute. But, if the monetary attribute represents a payment to the respondent (and hence  $\beta_m$  is expected to be +ve), then (4) without a negative sign gives the amount of money they are WTP (i.e. forgo) to get a unit increase in the attribute.

The DCE approach was considered an appropriate methodology for this research as it allows one to elicit community preferences and analyse the trade-offs that people are ready to make between the policy scenarios.

#### 2.2 Choice experiment design and selection of attributes

A DCE was designed to identify public preferences regarding rigs-to-reefs and quantify what aspects of this policy could influence acceptance of the community members. The DCE included attributes that reflect potential ecological, social and economic outcomes, so preferences can be revealed. The framing and attributes are described as follows.

Respondents were first provided with some background information, in which it was indicated that the complete removal option is the current decommissioning policy and it would mean returning the seabed as close as possible to its natural condition. The removed structures would be brought onshore for recovering and recycling of the steel, and those parts that cannot be recycled would be disposed to landfill. Regarding the rigs-to-reefs option, it was specified that they could provide habitat for marine species and increase species diversity, as well as be used for recreational fishing and diving. It was also indicated that corrosion on structures left in the sea may occur, resulting in the release of contaminants to the marine environment. It was added that, complete removal would eliminate this possibility, although it could also increase the risk of seabed disturbance and re-suspension of contaminants during removal.

The choice sets were based on a hypothetical scenario in which an oil platform is coming to the end of its lifecycle in the NWS of Western Australia and needs to be decommissioned. Such a procedure would require AU\$ 200 million expenditure by the oil and gas company if the structure has to be entirely removed from the sea, this being the base case scenario (*status quo*). This value was estimated using the projections made by DIIS (2018, p.5), who reported that "approximately 136 fixed facilities (including pipelines) are likely to commence decommissioning activities in the coming decade, and over the next 50 years Australia's offshore petroleum industry's decommissioning liability is estimated to be US\$21 billion".

Thus, US\$ 21 billion/136 = US\$ 154.411.764 = AU\$ 223.464.704 according to the exchange rate on 16/1/2020 (XE 2020). This number was then rounded to AU\$ 200 million.

The alternative to the status quo was the option to convert the rig to a reef, under alternative ecological and policy frameworks. Each policy scenario was described by six attributes (five non-monetary and one monetary).

The first attribute was total fish biomass, which is a measure of the amount of fishes that could be found on these structures. Harvey et al. (2020) estimate the value to be 1 tonne for one platform jacket. In the choice experiment respondents were told that the amount of total fish biomass could be 0.5 tonnes, 1 tonne or 1.5 tonnes.

The second attribute was attraction of fishes to the reef vs. production of fishes on the rig. Respondents were told that if fishes are being attracted to the rig, it could be good for recreational divers and fishers, but could mean they become vulnerable to exploitation; but, if fishes are being produced on the rig, they would be contributing to the total regional fish production. Therefore, the attribute's options were either fishes attracted to the rig or fishes produced on the rig.

The third attribute was habitat for threatened species, which was based on findings reporting the presence of IUCN threatened species (Whale shark, Giant manta ray and Round ribbontail ray) in the vicinity of a platform jacket in the NWS (McLean et al. 2018; McLean et al. 2019). The attribute was defined as either providing habitat for these species, or not.

The fourth attribute was the type of access that could be assigned to these areas, which was based on access that are currently allowed on rigs-to-reefs programs in the USA (Bull and Love 2019). Then, the levels for this attribute were either no access (essentially establishing reserve area), access for recreational fishing, or access for recreational diving.

The fifth attribute was the long-term civil liability, which is defined by DIIS (2018, p. 31) as the *"liability for any damage or loss associated with any property left in the marine environment, or associated with other incidents arising from the title area after the end of operations (such as well leakage)"*. Liability is an important issue that has not yet been resolved for rigs-to-reefs and, since potential environmental negative impacts of *in-situ* decommissioning remain limited (Shaw et al. 2018; NERA 2019), this attribute intends to account for this issue. Therefore, the options for liability were either that it lies with the oil and gas company, or the government or shared liability.

The last attribute was the payment vehicle, which was assumed to be a percentage of the savings that companies would make from not undertaking complete removal and would be paid out to the State budget as additional revenue. Although there was no individual payment, respondents were told that there could be possible individual benefits such as increased State funding for health, education, or environmental issues. This mechanism has been used elsewhere e.g. Burton et al. (2012). The levels of increased royalties selected for this experiment are based on percentages of savings (between 50% and 80%) that companies attributes to rigs-to-reefs programs in the USA (Advisian 2017; Bull and Love 2019).

The survey involved 36 choice sets, blocked into six groups of six, with each choice scenario including two rigs-to-reefs options and a complete removal option. The choice scenarios were designed using the Ngene 1.1 software, which allows to efficiently arrange the attributes and their levels. The value of the S estimate reported by Ngene was 7.29. The attributes and their levels are described in Table 1 and an example of choice set is shown in Figure 2.

 Table 1. Attributes and levels.

Attributes	Rig-to-reef levels	Status quo levels
Total fish biomass (tonnes)	0.5, 1, 1.5	Negligible
Fish attracted vs. Fish produced	Attracted, Produced	N/A
Habitat for threatened species	Yes, No	N/A
Who can access the reef	None, Rec. Fishing, Rec. Diving	N/A
Future liability in case of any environmental damage occurring	Company, Government (taxpayer), Shared	N/A
Amount of money paid to the State budget by the company (AU\$)	100 million, 130 million, 160 million	0

	OPTION 1 Rig-to-reef	OPTION 2 Rig-to-reef	OPTION 3 Complete removal
	Æ	1	
Total fish biomass (tonnes)	0.5	1.5	Negligible
Fish attracted vs. Fish produced	Produced	Produced	
Habitat for threatened species	Yes	No	
Who can access the reef	Recreational Fishers	Recreational Divers	N/A
Future liability in case of any	Government	Government	
environmental damage occurring	(taxpayer)	(taxpayer)	
Amount of money (AU\$) paid to the State budget by the Company	160 million	100 million	0

Figure 2. Example of choice set.

## 2.3 Social Licence to Operate survey

A SLO is defined by Boutilier and Thomson (2011, p. 2) as the "*community's perceptions of the acceptability of a company and its local operations*" and it can be divided into four hierarchical levels that are described in Table 2 and Figure 3. The general idea of this approach is that a higher hierarchical level of SLO will rarely be granted by a stakeholder if the lower level is not granted.

SLO Level	Description
1. Economic legitimacy	Refers to the perception of economic benefit from the company.
2a. Socio-political legitimacy	Refers to the perception that the well-being of the region can be improved by the company.
2b. Interactional trust	Refers to the perception that the company is involved in mutual dialogue with the community and demonstrates reciprocity.
3. Institutionalized trust	Is the highest level of SLO that can be achieved by a company and refers to the perception that relations between the community and the company are based on the consideration of each other's interests.

**Table 2**. Description of levels of SLO (Source: Boutilier and Thomson 2011)



Figure 3: Levels of SLO (Source: Boutilier and Thomson 2011)

In this study, the SLO granted by the Western Australian community members to the oil and gas sector was measured in order to identify people's attitudes towards this sector using the question bank developed by Richert et al. (2015). In this questionnaire, respondents were asked a number of questions to address the four levels of SLO identified by Boutilier and Thomson (2011): economic legitimacy, interactional trust, socio-political legitimacy, and institutionalized trust. These questions were presented in the form of statements (Table 3) and respondents had to rate their agreement on a five point Likert scale, where 1=strongly disagree, 2=disagree, 3=neither agree nor disagree, 4=agree, and 5=strongly agree, thus higher values implying higher levels of SLO being granted. The questions are derived from those used by Boutilier and Thomson (201). 1 It is important to note that EL2.1–2.4 derive from the original EL2 statement used by Boutilier and Thomson (2011, p.10), which says "we need to have the cooperation of the mine to reach our most important goals", for which Richert et al. (2015) specified four goals related to the environment, the economy, local communities, and future generations. As noted by Richert et al. (2015, p. 124) this specification was made in order to "understand which issues are of particular importance to respondents before we can assess whether they believe industry is impacting negatively on those issues". Therefore, respondents were asked to rate the importance of the environment, the economy, local communities, and future generations on a seven point Likert scale, where 1=not at all important, 2=very unimportant, 3=somewhat important, 4=neither important nor unimportant, 5=somewhat important, 6=very important, and 7=extremely important. Then, if respondents considered those issues important (scores of five or more), the questions relating to them (EL2.1-2.4) were averaged and included in the analysis of SLO. A factor analysis was applied to the SLO questions to test if it was possible to identify a set of four factors that align with the four measures of SLO identified by Boutilier and Thomson (2011).

Finally, in order to assess if these attitudes influence peoples' choices in the DCE, the results obtained from the SLO analysis were interacted with the status quo option of the choice model i.e. the null hypothesis is that social license influences the acceptance of the R2R program as a whole, not the individual attributes of the reef.

Table 3. Statements that measure the different levels of SLO (Source: Richert et al. 2015)

## Statements measuring the level of "Economic legitimacy"

EL 1: "Western Australia can economically benefit from the oil and gas sector"

EL 2.1: "Western Australia needs the cooperation of the oil and gas sector to protect the environment"

EL 2.2: "Western Australia needs the cooperation of the oil and gas sector to maintain or improve its economic performances"

EL 2.3: "Western Australia needs the cooperation of the oil and gas sector to maintain or improve the well-being of local communities"

EL 2.4: "Western Australia needs the cooperation of the oil and gas sector to guarantee the wellbeing of the future generation"

## Statements measuring the level of "Interactional trust"

IT 1: "Companies in the oil and gas sector do what they say they will do in the media"

IT 2: "I am very satisfied by the oil and gas sector in Western Australia"

IT 3: "The presence of the oil and gas sector in Western Australia is a benefit to the Western Australian population"

IT 4: "Companies from the oil and gas sector listen to the Western Australian population concerns" **Statements measuring the level of "Socio-political legitimacy"** 

SPL 1: "In the long-term, the oil and gas sector makes a contribution to the well-being of Western Australia"

SPL 2: "The oil and gas sector in Western Australia treats everyone fairly"

SPL 3: "The oil and gas sector respects the Western Australian population way of doing things"

SPL 4: "The Western Australian population and the oil and gas sector have a similar vision for the future of Western Australia"

#### Statements measuring the level of "Institutionalized trust"

InstT 1: "Companies of the oil and gas sector give more support to those it negatively affects" InstT 2: "The oil and gas sector shares decision-making with the Western Australian government" InstT 2: "The oil and gas sector takes into account the interacts of the Western Australian

InstT 3: "The oil and gas sector takes into account the interests of the Western Australian population"

InstT 4: "The oil and gas sector is concerned about the Western Australian population"

InstT 5: "Companies of the oil and gas sector openly share information that is relevant to the Western Australian population"

## 2.4 Survey administration and additional questions

Initially, the questionnaire was distributed to a focus-group of seven people in order to collect comments and suggestions that could improve the quality of the final survey. The final version was distributed by a market research company to a random sample (stratified by age and gender) from the Perth metropolitan area in March 2020. The selection of Perth as a sample of the Western Australia community stems from the need to measure the values that may be hold for the environmental goods and services by those who may not be directly affected by the operations of the oil and gas companies, i.e. the "existence" values.

The first part of the questionnaire consisted of the SLO questions, as well as attitudinal questions regarding involvement with the oil and gas sector or environmental groups, previous knowledge about rigs-to-reefs, and attitudes towards recreational fishing and diving. Afterwards, respondents were provided with background information regarding offshore oil and gas decommissioning and rigs-to-reefs, a description of the attributes and levels of each policy scenario, and the choice sets. In addition, debriefing questions were asked to check for any specific problems that could have been faced by respondents when answering the choice set. The final section of the survey consisted of questions related to respondent's socio-demographic information (age, gender, educational level and income). Overall, the survey consisted of five sections, as shown in Table 4. The full survey is reported in Appendix A.

Table 4. Su	mmary of surv	vey sections.
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Sur	ey sections
1.	SLO and attitudinal questions

- 2. Background information on offshore oil and gas decommissioning and rigs-to-reefs
- 3. Description of the attributes and choice experiment questions
- 4. Debriefing questions about the choice task
- 5. Socio-demographic information about the respondents

#### 3. Results

#### 3.1. Sample characteristics

The survey was completed by a total of 431 respondents, each of them completing six choice sets. The respondents that completed the survey too fast, in less than five minutes, were excluded from the data set, leaving a final sample of 392 respondents. A common feature of DCE is the presence of respondents who use heuristics, rather than the compensatory behaviour

implied by (3). A common form of this is 'protest' behaviour, where respondents adopt a response to the questions that implies they are rejecting some aspect of the framing of the questions. We identify this as respondents who always selected the 'status quo' option in all 6 questions. These were excluded from the analysis of the choice data, although their answers were retained in the SLO and descriptive statistics. This group of respondents represented 9.4% of the final sample and explicitly objected the idea of leaving oil and gas rigs in the sea, as reported in the debriefing questions.

Overall, respondents in the sample reflected the demographic structure of the Western Australia population (Table 5).

Table 5. Demographic characteristics of survey respondents.				
Demographics	Sample (%)	Western Australia population (%)		
Gender				
Male	51	50		
Female	49	50		
Age				
18-30	17	23		
31-45	28	28		
46-60	27	25		
61-75	20	17		
Over 76	8	7		

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Source: Australian Bureau of Statistics (2016)

## 3.2 Social Licence to Operate

The SLO results were obtained following the same analysis as Richert et al. (2015). First, a single average measure was generated from questions EL2.1–2.4 (Table 3), with answers to a question only being retained if the respondent specified that the environment, the economy, the local communities and the future generations were "somewhat important", "important" or "extremely important" to them. Similar to Richert et al. (2015) results, the analysis showed that a large majority of the respondents considered that all the issues were important (Table 6).

Table 6. Percentage of the respondents who found important the environment, the economy, the local communities, and the future generations.

Environment	Economy	Local Communities	Future Generations
85.72	86.22	82.91	85.72

Then, using the composite variable for EL2 along with the responses to the other 14 SLO questions, an exploratory factor analysis was used, applying Kaiser's criterion to define the significant factors, i.e. the factors with an eigenvalue greater than one (Kaiser 1960). The factor analysis revealed the same results as those obtained by Richert et al. (2015), with the same questions loaded on the same two factors: Factor 1, containing the two questions that evaluate the economic legitimacy of the oil and gas sector in Western Australia (EL1 and EL2), along with one question of interactional trust (IT3) and one question of socio-political legitimacy (SPL1); and Factor 2, containing the remaining questions, as shown in Table 7. With these results, we created a measure of the "Extended economic legitimacy" by averaging the score for the variables that were grouped within Factor 1, and a measure of "Social legitimacy" by averaging the score of the remaining variables that were grouped within Factor 2. In addition, the Cronbach alpha coefficient of these two measures was calculated in order to estimate their internal consistency (Cronbach 1951). The results showed a value of the Cronbach alpha coefficient of 0.84 for the "Extended economic legitimacy" and 0.95 for the "Social legitimacy", which confirms that it is acceptable to treat the questions within each of these categories, as a value of this coefficient higher than 0.7 indicates that the questions measure a single construct (Nunnally and Bernstein 1994).

Level of SLO	Variable	Factor 1	Factor 2
Economic legitimacy	el1	0.6975	
	el2	0.4867	
Interactional trust	it1		0.4702
	it2		0.4257
	it3	0.7699	
	it4		0.6601
Socio-political legitimacy	spl1	0.6613	
	spl2		0.8025
	spl3		0.8247
	spl4		0.7778
Institutional trust	inst1		0.6217
	inst2		0.5574
	inst3		0.7861
	inst4		0.8167
	inst5		0.7855

Table 7. Estimated weights for significant factors.

Table 8 reports a summary and the relative distributions of the two measures of SLO. As it can be seen, respondents held an average score of 3.88 for "Extended economic legitimacy", indicating that they tended to agree that the oil and gas sector contributes to the economy of Western Australia (recall that in a range from one to five, higher scores indicate a higher SLO), whereas they neither agree nor disagree on average (mean = 3.15) with the measure of "Social legitimacy".

Score	Extended economic legitimacy (%)	Social legitimacy (%)
1 - 1.99	2	7
2 - 2.99	7	28
3 - 3.99	39	48
4 - 5	52	17
Mean	3.88	3.15
Std. dev.	0.734	0.805
n	392	392

Table 8. Summary of the "Extended economic legitimacy" and the "Social legitimacy" measures.

However, the sample mean score only detects general perceptions. To analyse the perceptions at a respondent level, Boutilier and Thomson (2011) suggests that one should rarely see a score for the higher levels of SLO (here "Social legitimacy") exceeding that of the lower (here "Extended economic legitimacy"), as economic legitimacy has to be achieved before social legitimacy is granted. Also, if the lowest level of SLO is granted, it will not necessary guarantee the achievement of the following level. This can be confirmed with the scatter plot of individual scores for the measures of "Extended economic legitimacy" and "Social legitimacy" presented in Figure 4. Note that this is the same relationship as found by Richert et al. (2015, p.126), "*the fact that the majority of points lie above the* 45° *line confirms that each respondent generally held a higher value for "Extended economic legitimacy" than for "Social legitimacy"*.



Figure 4. Scatter plot of individual scores for "Extended economic legitimacy" vs. "Social legitimacy".

## 3.3 Attitudinal questions

Prior to answering the choice sets, respondents were asked about their awareness of the process of "rigs-to-reefs". 58% were not aware of rigs-to-reefs before taking the survey, whereas 30% of them had some degree of awareness. Therefore, it is worth highlighting that for more than a half of the respondents, their understanding of decommissioning options, and hence their choices, were conditioned by the information and context provided by the framing of the DCE. In addition, respondents were asked a set of questions regarding their involvement in recreational fishing and diving. The majority of the respondents (78%) answered 'yes' to the question whether they have ever been fishing, whereas only 35% of them answered 'yes' to the question whether they have ever been diving (Table 9). After the choice sets were completed, respondents were asked which of the attributes that were used to describe the decommissioning options were relevant to them. The results revealed that each attribute was relevant to 41 - 63% of the respondents (Table 9), which might be indicating that they were very selective in their choices.

Questions	Yes (%)	Variable name
Have you ever been		
Fishing?	78	FISH
Diving?	35	DIV
Which attributes used to describe the options were relevant to you?		
Habitat for threatened species	63	ATTHAB
Total fish biomass	43	ATTBIO
Fish attracted vs. fish produced	41	ATTPROD
Access to the reef	50	ACCDIVER/ACCFISHER
Future liability	55	LIABGOVT/LIABJOINT
Revenue for the State budget	48	ATTREV

Table 9. Attitudinal questions (% of respondents answering 'Yes').

## 3.4 Choice experiment models

In order to estimate the relative value held by the respondents for the different attributes of the rig-to-reef option, an initial conditional logit model focussed only on attributes was applied, while in a second model the interactions with attitudinal questions were added. Table 10 reports the description of the variables used in both models.

	Description		
Attributes			
SQ	Status Quo (complete removal of rigs)		
HAB	Habitat for threatened species (1=Yes, 0=No)		
BIO	Fish biomass		
PROD	Fish production (1=Fish Produced, 0=Fish attracted)		
ACCDIVER	Access for recreational divers (1=Access, 0=No access)		
ACCFISHER	Access for recreational fishers (1=Access, 0=No access)		
LIABGOVT	Liability lies with the Government (1=Liable, 0=Company liable)		
LIABIOINT	Liability shared between Government and company		
LIADJOINT	(1=Liable, 0= Company liable)		
REV	Revenue for the State budget		
<b>-</b> .			
Interactions			
SQ*EEL	Status quo*Extended economic legitimacy		
HAB*ATTHAB	Habitat for threatened species*Attended to habitat for threatened species		
<b>BIO*ATTBIO</b>	Fish biomass*Attended to fish biomass		
PROD* ATTPROD	Fish production*Attended to fish production		
ACCDIVER*DIV	Access for recreational divers*Divers		
ACCFISHER*FISH	Access for recreational fishers*Fishers		
<b>REV*ATTREV</b>	Revenue for the State budget*Attended to revenue		
<b>REV*NOATTREV</b>	Revenue for the State budget*Not attended to revenue		

 Table 10. Description of variables used in the models.

In the initial model, reported in Table 11, the coefficients of habitat for threatened species (HAB), fish biomass (BIO) and revenue for the State budget (REV) were positive, implying that respondents preferred the provision of habitat for threatened species, increased fish biomass and increased revenue for the State budget rather than other options. Conversely, the status quo scenario (SQ) and government liability (LIABGOVT) affected choices in a negative way, suggesting that respondents preferred the structure to be left in the sea for reefing purposes, but without the government -and consequently the taxpayer- being liable in case of any future environmental damage occurring as a result of this decision. This model detected clear preferences for these attributes given that their coefficients were significant, but did not detect any significant effect of fish production (PROD), access for recreational divers (ACCDIVER), access for recreational fishers (ACCFISHER) and shared liability between the government and the company (LIABJOINT).

Choi	Coef.	Std. Err.	P> z	95% Conf. Interval
SQ	-0.997	0.219	0.000	-1.426 -0.568
HAB	0.583	0.091	0.000	0.404 0.762
BIO	0.222	0.091	0.015	0.042 0.401
PROD	0.155	0.104	0.135	-0.048 0.359
ACCDIVER	0.183	0.108	0.090	-0.028 0.394
ACCFISHER	0.041	0.065	0.527	-0.086 0.169
LIABGOVT	-0.127	0.083	0.000	-1.017 -0.603
LIABJOINT	-0.81	0.106	0.126	-0.289 0.036
REV	0.0025	0.0009	0.008	0.001 0.004

 Table 11. Conditional logit model, attributes only.

*Number of observations* = 6,354; *LR chi2* (9) = 817.38; *Pseudo R2* = 0.1756; *Log likelihood* = -1918.17

In the full model, which is reported in Table 12 and includes the interactions between the attributes and the attitudinal questions, it was possible to detect significant effects for most of the interactions. A negative and significant effect in the interaction between the status quo and the economic legitimacy (SQ\*EEL) was noticed, indicating that those respondents that tended to grant economic legitimacy to the oil and gas sector in Western Australia, preferred the structure to be left in the sea for reefing purposes. Those who did not grant economic legitimacy were less supportive of the idea of leaving the rig as a reef. Therefore, a lower score in economic legitimacy may be leading to a higher utility associated with the complete removal option compared to that generated by the rigs-to-reefs option. Social legitimacy was also interacted with the SQ, but it did not have any significant impact in the model.

A positive and significant effect in the interaction of habitat for threatened species, fish biomass and fish production were observed, with the answer of the respondents stating that these attributes were relevant to them (HAB\*ATTHAB, BIO\*ATTBIO and PROD\*ATTPROD). This suggests that these respondents held higher values for the provision of habitat for threatened species, increased fish biomass, and production of fishes on the rigs, than those who did not consider these attributes as relevant to them (HAB, BIO and PROD). These results are consistent with literature related to attribute non-attendance (Kragt 2013). A similar positive and significant effect was observed with the access to the rig-to-reef for recreational divers and fishers: those who answered 'yes' to the questions of whether they have ever been diving and fishing i.e. divers and fishers, preferred the rig-to-reef to be accessible for recreational divers and recreational fishers (ACCDIVER\*DIV and ACCFISHER\*FISH), respectively, whereas those who had never been diving were indifferent to the idea of the rig-to-reef being accessible for recreational divers (ACCDIVER). However, those respondents that had never been fishing revealed a significant reduction in the utility associated with the rig-to-reef being accessible by recreational fishers (ACCFISHER), which can be noticed by the negative and significant value of the attribute's coefficient. Finally, a significant and positive effect was detected for the interaction between the increased revenue for the State budget and the respondents who considered this attribute to be relevant to them (REV\*ATTREV). This implies that those who paid attention to this attribute preferred an increased revenue for the State budget, whereas those who did not pay attention to revenue (REV\*NOATTREV) were indifferent to this variable. The liability attributes in this model (LIABGOVT and LIABJOINT) revealed similar results to those obtained in the initial model: government liability affected choices in a negative way with a significant reduction of the utility associated to it. A shared liability between the Government and company was significant only at 10% i.e. was seen as almost equivalent to company liability. These attributes were also interacted with the attitudinal questions, but they were not included in the model as they did not add any substantial improvement to the model. Also, all the variables were interacted with attitudes towards the environment, involvement with the oil and gas sector, involvement with environmental NGOs, and awareness of rigs-toreefs, but none had a significant effect in the model.

Overall, the fit of the full conditional logit model to the data was better than in the initial model as shown by the higher pseudo R2 (0.1948) and the higher log likelihood (-1873.507).

Choi	Coef.	Std. Err.	P> z	95% Conf. Interval
SQ	0.583	0.433	0.179	-0.267 1.432
HAB	0.180	0.117	0.124	-0.050 0.409
BIO	0.087	0.104	0.404	-0.117 0.290
PROD	-0.011	0.122	0.925	-0.251 0.228
ACCDIVER	0.037	0.122	0.764	-0.203 0.277
ACCFISHER	-0.329	0.122	0.007	-0.567 -0.090
LIABGOVT	-0.138	0.084	0.000	-0.301 0.026
LIABJOINT	-0.815	0.107	0.100	-1.024 -0.606

 Table 12. Conditional logit model, full model.

Attributes interacted with SLO and attitudinal questions

SQ*EEL	-0.429	0.100	0.000	-0.625	-0.232
HAB*ATTHAB	0.619	0.112	0.000	0.399	0.839
<b>BIO*ATTBIO</b>	0.298	0.106	0.005	0.090	0.506
PROD* ATTPROD	0.399	0.147	0.007	0.111	0.687
ACCDIVER*DIV	0.442	0.164	0.007	0.121	0.762
ACCFISHER*FISH	0.490	0.132	0.000	0.230	0.750
<b>REV*ATTREV</b>	0.003	0.001	0.003	0.001	0.005
<b>REV* NOATTREV</b>	0.002	0.001	0.161	-0.000	0.004

Number of observations = 6,354; LR chi2 (9) = 906.71; Pseudo R2 = 0.1948; Log likelihood = -1873.5072

#### 3.5 Partworths

Partworths, also called implicit prices, were estimated for a change in the non-monetary attributes using equation (4). In this study, the partworths are defined as the amount of money the respondent - who attended to the revenue attribute - is willing to pay in forgone tax revenue for a unit increase in the level of an attribute. In the initial model (Table 13), the estimated partworth for the provision of habitat for threatened species was significant and positive, suggesting that respondents are willing to pay AU\$ 233.28 million in forgone tax revenue if a rig-to-reef provides habitat for threatened species. Conversely, the estimated part-worth for government liability was significant and negative, indicating that respondents would require a compensation of AU\$ 324.22 million in revenue to the State budget in order to let the government, i.e. the taxpayer, to be liable in case of any future environmental damage occurring as a result of leaving the rig in the sea. On average, respondents' willingness to be compensated for the complete removal of the structures or a shared liability between the government and the company, as well as respondents' willingness to pay for increased fish

biomass, production of fishes on the rig or access for recreational fishers and divers, were not significant.

	Coef.	Std. Err.	P> z	95% Conf. Interval
SQ	-398.97	213.386	0.062	-817.200 19.259
HAB	233.28	95.969	0.015	45.188 421.382
BIO	88.67	49.628	0.074	-8.597 185.942
PROD	62.14	48.182	0.197	-32.298 156.572
ACCDIVER	73.13	51.204	0.153	-27.232 173.484
ACCFISHER	16.46	26.432	0.533	-35.346 68.269
LIABGOVT	-324.22	129.961	0.013	-578.941 -69.504
LIABJOINT	-50.68	38.313	0.186	-125.771 24.411

Table 13. Partworths in the initial model (AU\$ million per decommissioned rig).

In the full model, which includes the interactions between the attributes and the attitudinal questions, a significant heterogeneity in values is identified. The estimated partworths (in millions) for the provision of habitat for threatened species (AU\$ 247.42), increased fish biomass (AU\$ 119.19) and production of fishes on the rig (AU\$ 119.99) were significant and positive for those respondents who considered these attributes to be relevant; thus, revealing a significant WTP in terms of forgone tax revenue. These were not significant for those who not consider these attributes to be relevant. Likewise, the estimated part-worth for divers being allowed to access the rig-to-reef was significant and positive if the respondent was a diver (AU\$ 148.26), but not for non-divers. Conversely, the part-worth for the access of fishers to the rig-to-reef was significant and negative for respondents that were not fishers (AU\$ - 101.76), i.e. for non-fishers, allowing access to the reef reduced utility compared to it being a closed protected area. For fishers, having access to the reef the WTP was also positive, but only significant at 10%. This low effect in WTP may be due to a very broad definition of what a fisher is.

The implicit price for government liability was again significant and negative (AU\$ -252.46); thus, requiring compensation for the utility reduction attached to this outcome. Additionally, the implicit prices associated with the interaction between the status quo and the different levels of economic legitimacy granted to the oil and gas sector in Western Australia was calculated. The results revealed that the value attached to the reef being removed gets higher for respondents granting higher levels of economic legitimacy (AU\$ 350.66 - AU\$ 483.45 million). However, it is worth highlighting that these numbers may not very robust given that

they are outside of the range for the revenue used in the survey. They should only be used as an indicator that respondents granting higher degree of economic legitimacy to the oil and gas sector in Western Australia, have seldom chosen the status quo option. Likewise, those granting lower degree of economic legitimacy, may have chosen the option of complete removal more often.

	Coef.	Std. Err.	P> z	95% Conf. Interval			
SO	180.51	134.884	0.181	-83.863	444.876		
HAB	55.74	40.706	0.171	-24.044	135.552		
BIO	26.84	33.262	0.420	-38.351	92.035		
PROD	-3.56	37.818	0.925	-77.682	70.563		
ACCDIVER	11.41	38.139	0.765	-63.344	86.158		
ACCFISHER	-101.76	51.666	0.049	-203.025	49679		
LIABGOVT	-252.46	90.806	0.005	-430.439	-74.487		
LIABJOINT	-42.64	29.630	0.150	-100.715	15.434		
Attributes + interactions with attitudinal questions							
HAB+ATTHAB	247.42	88.795	0.005	73.390	421.461		
BIO+ATTBIO	119.19	52.714	0.024	15.873	222.510		
PROD+ATTPROD	119.99	58.701	0.041	4.943	235.046		
ACCDIVER + DIVACCDIVER	148.26	68.175	0.030	14.642	281.886		
ACCFISHER + FISHACCFISHER	50.04	27.420	0.068	-3.701	103.784		
Status Quo + interactions with different levels of economic legitimacy							
SQ+SQEEL*1	47.71	105.429	0.651	-158.921	254.352		
SQ+SQEEL*2	-85.07	100.693	0.398	-282.431	112.280		
SQ+SQEEL*3	-217.87	123.555	0.078	-460.030	24.297		
SQ+SQEEL*4	-350.66	162.774	0.031	-669.688	-31.627		
SQ+SQEEL*5	-483.45	209.350	0.021	-893.766	-73.130		

Table 14. Partworths in the full model (AU\$ million per decommissioned rig).

#### 3.6 Probabilities

Although partworths are conventionally reported in such DCE studies, in the current context what may be of more interest is the degree to which different types of reefs are acceptable to respondents, as well as the influence that each attribute may have on respondents' choices. Therefore, we used equation (3) to create hypothetical scenarios of rig-to-reef vs. complete removal and worked out what is the probability that a respondent would accept the reef option. Each hypothetical scenario was constructed by varying the levels of the attributes of the reef one at a time and, because of the interaction of the status quo with the extended economic legitimacy (EEL), we obtained a different probability of choosing the rig-to-reef for each one

of the 5 levels of EEL. Then, we compared those probabilities with the probabilities obtained for a 'base reef' (Table 15).

The probabilities of the 'base reef', shown in Table 15, row 1, were obtained assuming that the reef does not provide habitat for threatened species, has 0.5 tonnes of fish biomass, the fishes are attracted to the rig, there is no access for anyone, the company is liable, it provides AU\$100 million in revenue to the State budget, and the respondent does not attend to any of the attributes. The results revealed that the probability of choosing a rig-to-reef with these characteristics decreases by 34 percentage points from 0.85 for someone granting the highest level of EEL to the oil and gas sector, to 0.51 for someone that does not grant EEL. Then, the level of the attribute habitat for endangered species was changed in order to obtain the probabilities of choosing a rig-to-reef with this attribute, which is shown in Table 15, row 2a. Compared to the base reef, it would increase the chance of choosing the reef by 0.19 for someone that does not grant EEL, but it would increase by just 0.08 for someone with the highest degree of that. In this case, the probability also decreases with the level of EEL, from 0.93 to 0.70, which shows the impact that the attribute may have on the decision. A similar trend was observed when adding the fish biomass attribute to the base reef (Table 15, row 2b), revealing that higher amounts of fish biomass will result in higher probabilities of the reef being chosen compared to the base reef. Also, the probabilities of choosing the reef decreases significantly as the degree of EEL decreases. A similar situation was observed for fish production (Table 15, row 2c).

For the access to the reef for divers (Table 15, rows 3a and 3b), the results presented a very small increase (0.01) in the probability of choosing the reef option when the respondent is not a diver, but a high increase in the probabilities for those who are divers. Conversely, the probability of choosing the reef option when the access is allowed for fishers substantially decreases if the respondent is not a fisher, and slightly increases when the respondent is a fisher.

The results regarding the liability attributes (Table 15, row 4a) revealed that, compared to the base reef, there is a substantial decrease (0.19) in the probability of choosing the reef when the respondent does not grant EEL and the liability lies with the Government; and a smaller decrease in the probability for someone granting the higher degree of EEL (0.13). In the case of the liability being shared between the Government and the company, the results also showed a decrease in the probabilities, but to a lesser extent.

Finally, the revenue attribute (Table 15, row 4b) revealed similar results to those obtained with the other numerical variable in the experiment, fish biomass. Thus, the probability of choosing the reef option increases when higher amounts of revenue are paid by the company to the State budget (when considering those who attended to revenue).

Attributes	Levels of economic legitimacy				
	1	2	3	4	5
1. Base reef	0.51	0.62	0.71	0.79	0.85
2 Biological					
2. Diviogical $x$ attend to babitat	0.70	0.78	0.85	0.80	0.93
a. Habitat & attend to habitat	0.70	0.70	0.05	0.07	0.75
b. Fish biomass (tonnes) & attend					
to biomass	0.55	0.65	0.74	0.91	0.97
0.5	0.55	0.05	0.74	0.81	0.87
1	0.60	0.69	0.78	0.84	0.89
1.5	0.64	0.73	0.81	0.87	0.91
c. Fish production & attend to fish					
production	0.61	0.70	0.78	0.85	0.90
3. Access to the reef					
a. For divers, if					
Not a diver	0.52	0.63	0.72	0.80	0.86
Diver	0.63	0.72	0.80	0.86	0.90
b. For fishers, if					
Not a fisher	0.43	0.54	0.64	0.73	0.81
Fisher	0.55	0.65	0.74	0.82	0.87
4. Socio-economic					
a. Liability					
Government	0.32	0.42	0.52	0.63	0.72
Shared	0.48	0.58	0.68	0.77	0.84
b. Revenue (AU\$ million) & attend					
to revenue					
100	0.55	0.65	0.74	0.82	0.87
130	0.58	0.68	0.76	0.83	0.88
160	0.60	0.70	0.78	0.84	0.89

**Table 15**. Probabilities of choosing the rig-to-reef option depending on different levels of attributes and degree of economic legitimacy.

#### 4. Discussion and conclusions

The results of the DCE models revealed respondents' preferences for rigs-to-reefs as an alternative option to complete removal of offshore oil and gas infrastructure, given a set of potential ecological and socio-economic characteristics that could be part of a rigs-to-reefs policy. However, recall that 9.4% of the respondents objected the idea of leaving oil and gas rigs in the sea; hence, putting higher values on a clear seabed (Ekins et al. 2006).

We confirmed our hypothesis that the degree of SLO granted by respondents to the oil and gas sector in Western Australia (at least in terms of extended economic legitimacy), influences their attitudes towards rigs-to-reefs, with respondents being less likely to support a rigs-to-reefs policy if they grant a lower SLO to the industry. Similar results were found by Burton et al. (2017) in a study measuring community acceptance of biodiversity offsets in Western Australia.

Regarding the values held for different attributes of a potential rigs-to-reefs policy, we found that respondents attached large values to the habitat that these structures could provide for threatened species, with a significant and positive WTP. These results may be explained not only because of the value attached to threatened species as such, but also because the threatened species indicated in this study, i.e. Giant manta ray and Whale shark, may also be charismatic or 'iconic' species, which according to previous studies (Jacobsen et al. 2008; Morse-Jones et al. 2014; Colleony et al. 2017) is a significant determinant of preferences and could result in very high values.

The results for the other two ecological attributes revealed that respondents held, on average, a positive value for higher amounts of fish biomass on the rig, whereas the possible production of fishes on the rig -as opposed to the attraction of fishes- had a significant value for those who considered this attribute to be relevant. Also, respondents who considered these attributes to be relevant, showed a significant and positive WTP. Although previous work has identified values for ecological attributes of artificial reefs (Borger et al. 2015), we believe that this is the first time that the differentiation in values between fishes being produced on the rig vs. fishes being attracted has been identified.

With respect to the accessibility to the rig-to-reef, respondents that were identified as divers and fishers, attached large values to the possibility of the artificial reef being accessible for divers and fishers, with divers revealing a significant and positive WTP. These results are in line with previous studies (Roberts et al. 1985; Oh et al. 2008; McGurrin and Fedler 1989) indicating that rigs-to-reefs are highly valued by scuba-divers and recreational fishers. However, those respondents that were identified as non-fishers revealed a significant reduction of the utility associated to the reefs being accessible for recreational fishers. A possible explanation for this result is that fishing, as an extractive activity, could be reducing the value that respondents hold for the ecological attributes; hence, they might prefer the artificial reef to be used for conservation purposes.

Respondents expect a strong welfare loss if the liability for any possible environmental damage lies with the Government, as shown by the significant and negative WTP. Therefore, these results show that taxpayers would not be willing to accept responsibility, including meeting the associated costs, if an environmental incident occurred as a result of leaving the oil and gas rigs in the sea (DIIS 2018).

With respect to the revenue component, the results showed that respondents held a positive value for the money that could be potentially paid to the State budget by oil and gas companies if not undertaking complete removal of infrastructure. This could be explained by the fact that respondents were told that this extra revenue could be used for funding for health, education, or other environmental issues (Burton et al. 2012).

Finally, the probabilities indicated that rigs-to-reefs attributes such as habitat for threatened species, increased fish biomass, production of fishes on the rig, increased revenue to the State budget and access for recreational divers or fishers when the respondent is a diver, non-diver or fisher, would increase the probability that a respondent who attends to those attributes chooses the reef option compared with a reef that does not provide those benefits. Conversely, the probability of a reef being chosen by a respondent decreases if it involves Government liability, shared liability or access for fishers in the case that the respondent is not a fisher.

#### 4.1 Policy implications and suggestions for further research

The findings of this study are of primary relevance to decision processes because they identify the preferences and values that Western Australia community members may hold for possible outcomes of a rigs-to-reefs policy. Although respondents supported rigs-to-reefs in the majority of the scenarios presented in the survey, 9.4% of them opposed any reefing; hence, indicating that there is not an overall support for this policy. Given that there is still limited information and uncertainty regarding the outcomes of rigs-to-reefs, these findings could contribute to identify relevant areas for further research on the value that the Western Australian community

may attach to them. For instance, it would be valuable to increase research on how these structures are being used by threatened species, or if fishes are being produced on the rigs.

Also, it is worth mentioning some improvements that could be done within this research. It was noted that respondents were very selective in their choices regarding the attributes they considered relevant. Therefore, the use of models that account for heterogeneity in preferences, such as latent class models, could improve the results. In addition, interactions between attributes and demographic variables such as gender, age and income of the respondents, could also be useful.

There are a number of ways in which the design of the DCE could be improved. For instance, rigs to reefs providing habitat for invasive species could be included as an attribute in future studies. Also, it is possible that the value calculated for the savings that companies would be making from not undertaking complete removal (AU\$200 million) could have been overestimated given that it was derived from a general estimation (DIIS 2018); therefore, having access to more accurate estimates would be useful for future studies. In addition, the sample was relatively small and limited to the Perth metropolitan area in Western Australia; hence, the use of a bigger and more representative national sample would be valuable. Finally, it is worth highlighting that respondents' preferences may be based on a limited knowledge of the topic. Therefore, it is suggested to consider the results of this study taking into account this limitation.

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# Appendix A: PDF version of online survey instrument

# PARTICIPANT INFORMATION

# University of Western Australia Research Project

#### "Community acceptance of Rigs-to-Reefs in Western Australia"

#### Human ethics reference number RA/4/20/5924

Thank you for considering participation in this research project, involving completion of an online survey about attitudes towards the management of decommissioned oil and gas platforms in the marine environment.

This project is part of a master's research project, being undertaken by Veronica Recondo, supervised by Dr Michael Burton, and Dr Johanna Zimmerhackel, from the Faculty of Science, University of Western Australia.

# What is the project about?

The aim of the study is to understand the public's perceptions of the oil and gas industry, and what the preferred methods are of disposing of oil and gas infrastructure at the end of its useful life.

# What does participation involve?

Participation in the survey means that you will be asked to complete an online survey. You will be provided with information about possible hypothetical management of oil and gas infrastructure, and asked to indicate which you think is better. It should take no more than 10-15 minutes to complete.

# Voluntary Participation and Withdrawal from the Study

Your participation will be on a voluntary basis and you can withdraw your participation at any stage of research without prejudice. If you withdraw before completing the survey, your answers will be discarded. If after completing the survey you later wish to withdraw your answers, this may not be possible, as the data is anonymised.

## Your privacy

Your information will be anonymously stored online in the questionnaire software initially and later on the researcher's laptop and finally in University of Western Australia (UWA) data backup system for at least seven years. This information will be kept strictly confidential and will not be made available to other people.

#### **Possible Benefits**

This research project will identify community preferences for different forms of management of offshore oil and gas infrastructure. There is ongoing debate on how best to achieve this, and it is important that the publics preferences are represented.

# Possible Risks and Risk Management Plan

There are no foreseeable risks and potential harm associated on providing personal information and opinions. If any aspects of this research project distresses you, you can contact me at the above address or the UWA Human Research Ethics office at the below address.

#### Contacts

if you have any questions with any aspects of this interview, please feel free to contact me at my work phone number (+61864882531) or by email (michael.burton@uwa.edu.au).

Sincerely,

Dr. Michael Burton, Chief Investigator

Approval to conduct this research has been provided by The University of Western Australia (ethics reference number: RA/4/20/5924), in accordance with its ethics review and approval procedures. Any person considering participation in this research project, or agreeing to participate, may raise any questions or issues with the researchers at any time. In addition, any person not satisfied with the response of researchers may raise ethics issues or concerns, and may make any complaints about this research project by contacting the Human Ethics office at UWA on (08) 6488 4703 or by emailing to humanethics@uwa.edu.au.

If you wish you can keep a copy of the Participant information

What is your gender?

Male

Female

Which of the following age brackets applies to you?

under 18

- 18-30
- 31-45
- 0 46-60
- 61-75
- Over 75

<u>PART 1:</u> We would like to start with some questions about your perception of the environment, and the c and gas industry in Western Australia.

Does the state of the environment concern you?

- Not at all
- Not much
- I am not sure
- A little
- A lot

Are you involved or have ever been involved with any environmental organisation (such as an NGO)?

Yes

No

Are you working or have ever worked in the oil and gas industry?

Yes

No

How much do you know about the oil and gas sector in Australia?

- I know nothing about it
- I only know the names of the companies
- I am roughly aware of its activities
- I am aware of its activities: I know quite precisely what the oil and gas companies do
- I am well aware of its activities: I know what the oil and gas companies do and how their activities interact with people and with the natural environment

In your opinion, how does the oil and gas sector affect the West Australian economy?

- It has a very negative impact on the economy
- It has a negative impact on the economy
- Its impact on the economy is neither negative nor positive
- It has a positive impact on the economy
- It has a very positive impact on the economy
- I don't know

In your opinion, how does the oil and gas sector affect the West Australian natural environment?

- It has a very negative impact on the natural environment
- It has a negative impact on the natural environment
- Its impact on the natural environment is neither negative nor positive
- It has a positive impact on the natural environment
- It has a very positive impact on the natural environment
- I don't know

In your opinion, how does the oil and gas sector affect West Australian local communities?

- It has a very negative impact on local communities
- It has a negative impact on local communities
- Its impact on local communities is neither negative nor positive
- It has a positive impact on local communities
- It has a very positive impact on local communities
- I don't know

In your opinion, how will current activities of the oil and gas sector affect the well-being of future generations in Western Australia?

- They will very negatively impact on the well-being of future generations
- They will negatively impact on the well-being of future generations
- O Their impact on the well-being of future generations will be neither negative nor positive
- O They will positively impact the well-being of future generations
- $\hfill \bigcirc$  They will very positively impact the well-being of future generations
- I don't know

How important is the well-being of the following to you:

	Neither Important						
	Not at all Important	Very Unimportant	Somewhat Unimportant	nor Unimportant	Somewhat Important	Very Important	Extremely Important
Environment	0	$\bigcirc$	$\bigcirc$	$\bigcirc$	$\bigcirc$	$\bigcirc$	$\bigcirc$
Economy	$\bigcirc$	$\bigcirc$	$\bigcirc$	$\bigcirc$	$\bigcirc$	$\bigcirc$	$\bigcirc$
Local communities	$\bigcirc$	$\bigcirc$	$\bigcirc$	$\bigcirc$	$\bigcirc$	$\bigcirc$	$\bigcirc$
Future generations	0	$\bigcirc$	$\bigcirc$	$\bigcirc$	$\bigcirc$	$\bigcirc$	$\bigcirc$

Please state whether you agree/disagree with the following statements:

	Neither Agree				
	Strongly Disagree	Disagree	nor Disagree	Agree	Strongly Agree
Western Australia can economically benefit from the oil and gas sector	$\bigcirc$	$\bigcirc$	$\bigcirc$	$\bigcirc$	$\bigcirc$
Western Australia needs the cooperation of the oil and gas sector to protect the environment	$\bigcirc$			$\bigcirc$	
Western Australia needs the cooperation of the oil and gas sector to maintain or improve its economic performances	$\bigcirc$	$\bigcirc$	$\bigcirc$	$\bigcirc$	$\bigcirc$
Western Australia needs the cooperation of the oil and gas sector to maintain or improve the well-being of local communities	$\bigcirc$	$\bigcirc$	$\bigcirc$	$\bigcirc$	$\bigcirc$
Western Australia needs the cooperation of the oil and gas sector to guarantee the well-being of future generations	$\bigcirc$		$\bigcirc$	$\bigcirc$	
Companies in the oil and gas sector do what they say they will do in the media	$\bigcirc$	$\bigcirc$	$\bigcirc$	$\bigcirc$	$\bigcirc$
I am very satisfied with the oil and gas sector in Western Australia	$\bigcirc$	$\bigcirc$	$\bigcirc$	$\bigcirc$	$\bigcirc$

#### Please state whether you agree/disagree with the following statements:

	Neither Agree				
	Strongly Disagree	Disagree	nor Disagree	Agree	Strongly Agree
The presence of the oil and gas sector in Western Australia is a benefit to the Western Australian population	0	0	0	0	0
Companies from the oil and gas sector listen to the Western Australian population concerns	•	$\bigcirc$	$\bigcirc$	$\bigcirc$	$\bigcirc$
In the long-term, the oil and gas sector makes a contribution to the well-being of Western Australia	0	$\bigcirc$	$\bigcirc$	$\bigcirc$	$\bigcirc$
In the long term, the oil and gas sector makes a positive contribution to environmental outcomes in Western Australia	0	$\bigcirc$	$\bigcirc$	$\bigcirc$	$\bigcirc$
The oil and gas sector in Western Australia treats everyone fairly	$\bigcirc$	$\bigcirc$	$\bigcirc$	$\bigcirc$	$\bigcirc$
The oil and gas sector respects the Western Australian population way of doing things	0	$\bigcirc$	$\bigcirc$	$\bigcirc$	$\bigcirc$
The Western Australian population and the oil and gas sector have a similar vision for the future of Western Australia		$\bigcirc$	$\bigcirc$	$\bigcirc$	$\bigcirc$

Please state whether you agree/disagree with the following statements:

	Neither Agree				
	Strongly Disagree	Disagree	nor Disagree	Agree	Strongly Agree
The presence of the oil and gas sector in Western Australia is a benefit to the Western Australia environment		0	$\bigcirc$	$\bigcirc$	$\bigcirc$
Companies of the oil and gas sector give more support to those it negatively affects	$\bigcirc$	$\bigcirc$	$\bigcirc$	$\bigcirc$	$\bigcirc$
The oil and gas sector shares decision-making with the Western Australian government	$\bigcirc$	$\bigcirc$	$\bigcirc$	$\bigcirc$	$\bigcirc$
The oil and gas sector takes into account the interests of the Western Australian population				$\bigcirc$	$\bigcirc$
The oil and gas sector is concerned about the Western Australian population	$\bigcirc$	$\bigcirc$	$\bigcirc$	$\bigcirc$	$\bigcirc$
The oil and gas sector is concerned about the Western Australian environment	$\bigcirc$	$\bigcirc$	$\bigcirc$	$\bigcirc$	$\bigcirc$
Companies of the oil and gas sector openly share information that is relevant to the Western Australian population					

In the rest of the survey, we are going to focus on a particular issue that is important for the oil and gas industry and regulators in Western Australia: what to do with the oil and gas rigs at the end of their productive lives?

The purpose of this survey is to determine the West Australian community's preferences regarding the creation of artificial reefs as an alternative option to complete removal of offshore oil and gas platforms, also known as Rigs-to-Reefs.

The rest of the survey comprises of 3 main parts:

<u>PART 2</u>: You will be given some background information on offshore oil and gas decommissioning and rigs-to-reefs.

<u>PART 3</u>: We will describe a hypothetical decommissioning scenario and you will be presented with three possible options. Each option will be described by a set of characteristics and you will be asked to choose your most preferred.

<u>PART 4</u>: We will ask some questions about you, to make sure we have a representative sample of the West Australian community.

PART 2:

Some **offshore oil and gas platforms** in Western Australia are reaching the end of their lifecycle which means that they must be **decommissioned**.

**Decommissioning** is the process of removing or otherwise satisfactorily dealing with offshore petroleum structures at the end of their useful life.

**Complete removal** of the structure from the sea is required under current decommissioning regulations when they are no longer productive.

This would return the seabed as close as possible to its natural condition.

The removed structures would be brought onshore for recovering and recycling of the steel, as well as disposing to landfill those parts that cannot be recycled.

**Rigs-to-reefs** is an alternative option currently considered by regulators, such as leaving the majority of the platforms in the sea so they can become artificial reefs.



Images: Offshore oil platform; Decommissioning options (based on Sommer et al. 2019).

These rigs-to-reefs could **provide habitat** (food, shelter, protection) for many marine species such as sponges, anemones, clams, sea stars and fishes. They could also contribute to **increase marine species diversity** and could be used for recreational activities such as **fishing and diving**.





Images: Rigs-to-reefs (courtesy of Greg Boland; capeandislands.org; guyharveymagazine.com).

Corrosion on structures left in the sea may occur, resulting in the release of contaminants to the marine environment.

Complete removal will eliminate this possibility, although it could also increase the risk of seabed disturbance and re-suspension of contaminants during removal.

Before this survey, how familiar were you with the idea of "rigs-to-reefs"?

- I didn't know what "rigs-to-reefs" was
- I had a vague idea of what "rigs-to-reefs" was
- I knew what was meant by "rigs-to-reefs"

# Have you ever been fishing?

- No, never
- Yes, but I rarely go
- Yes, I go about once a year
- Yes, I go monthly
- Yes, I go weekly

# Have you ever been scuba or free diving?

- No, never
- Yes, but I rarely go
- Yes, I go about once a year
- O Yes, I go monthly
- Yes, I go weekly

# PART 3:

Now we'd like you to think about a **<u>hypothetical scenario</u>** in which there is a petroleum platform that needs to be decommissioned in the North West Shelf of Western Australia and there are three possible options from which you will have to choose:

**OPTIONS 1 and 2: Rig-to-reef**, which involve leaving the platform (entirely or parts of it) in the sea for reefing purposes. Because there are different ways the platform could be decommissioned, the two options will have different outcomes.

**OPTION 3: Complete removal** of the platform from the sea, which is the current regulatory requirement and involves leaving a clear seabed.



Each option will be characterised by the following 6 features:

- 1. Total fish biomass.
- 2. Attraction of fish to the rigs vs. production of fish on the rigs.
- 3. Habitat for threatened species.
- 4. Who can access the reef.
- 5. Future liability in case of any environmental damage occurring.
- 6. Amount of money paid to the State budget by the company.

We are now going to describe each feature:

#### FEATURE 1: Total fish biomass

Total fish biomass is the **total weight of fishes** that can be found around a rig. It is a measure of the overall amount of fish that may be using the reef as habitat.



Image: Example of different amounts of fish biomass

In the options, this feature will be displayed as:

Total fish biomass (tonnes)	0.5 or 1 or 1.5
-----------------------------	-----------------

# FEATURE 2: Attraction of fish to the rigs vs. production of fish on the rigs

The fish biomass that can be found around a rig could consist of either **new fishes <u>produced</u>** because of the new reef or, they are **existing fishes** <u>attracted</u> from nearby places to the rig.

It is thought that if fishes are being **attracted** to the rig, and consequently become concentrated in one place, it would be good for recreational divers and fishers, but could mean they become vulnerable to exploitation.

But, if fishes are being **produced** in the rig, they would be contributing to the total regional fish production.



Image: Fish attracted to the rig vs. fish produced on the rig

In the options, this feature will be displayed as:

Fish attracted vs. Fish produced Attracted or Produced

#### FEATURE 3: Habitat for threatened species

Scientists from UWA have found the presence of threatened species in the vicinity of petroleum rigs in WA.

These species are: Whale Sharks (endangered), Round Ribbontail Rays (vulnerable), and Giant Manta Rays (vulnerable).

It is thought that these structures could provide habitat for these species.



Images: Whale Shark; Round Ribbontail Ray; Giant Manta Ray (courtesy of Ningaloo Marine Interactions)

Vulnerable species are ones that have a high risk of extinction in the wild, while endangered species have a very high risk of extinction in the wild, according to IUCN (International Union for Conservation of Nature).

In the options, the new reef may or may not provide habitat for threatened species. This will be displayed as:

Habitat for threatened species	Yes or No
--------------------------------	-----------

# FEATURE 4: Who can access the reef

The rig-to-reef could be accessed by **recreational fishers** or **recreational divers**, or it could have **no access** permitted, so it becomes a marine protected area.



Image: Divers on oil rigs (courtesy of Getty Images).

In the options, this feature will be displayed as:

Who can access the reef	Recreational Fishers or
	Recreational Divers or
	No Access

## FEATURE 5: Future liability in case of any environmental damage ocurring

Liability is defined as the state of being legally responsible for something.

In this case it refers to the **responsibility for any damage or loss** associated with the platform left in the sea.

If an incident occurred, the responsibility (and the associated costs) would fall on either the Australian Government (the Australian taxpayer), the Oil and Gas Company that initially owned the rig, or it could be shared between both the Government and the Company.



(Image courtesy of freepng.com)

In the options, this feature will be displayed as:

Future liability in case of any	Government (taxpayer) or
environmental damage	Oil and Gas Company or
occurring	Shared

#### FEATURE 6: Amount of money paid to the State budget by the company

If the **company** has to **completely remove** the platform from the sea, it would have to **spend money** in the process (AU\$200 million in our <u>hypothetical scenario</u>).

But, if the **company** is allowed to **leave the platform** in the sea (entirely or parts of it) for reefing, it would be **saving money**. This would increase their profits and hence the amount of money that could be paid in taxes.

We assume that, as part of the permission to use the rig for a reef program, **a percentage of this increase in profit** would be paid out to the State budget, which could be used to increase **funding for public health**, **education**, **transport** or **environmental** issues.



(Images courtesy of cleanpng.com)

In the options, we state the **amount of funding** that would come to the State budget, which will be displayed as:

Amount of monory (ATTS) noid to	100 million or
Amount of money (AU\$) paid to	130 million or
the State budget by the company	160 million

#### Please, read the following guidelines before proceeding further:

In the following part you will be presented with 6 possible decommissioning scenarios and you will be asked to choose the option that you most prefer.

Each question should be treated independently.

We will be surveying a large number of people to work out the preferences held across the WA community. The findings that emerge from this study may be used to adapt the current policy regarding offshore oil and gas decommissioning in WA.

<u>SAMPLE SCENARIO</u>: below is an example of the type of question you will be presented with (you don't need to answer this one).

When answering the scenarios, don't forget to:

- Consider each option (looking down each column)
- Choose your most preferred option based on the assumption that these are the only options available to you.

Treat each scenario independently. You don't need to remember or anticipate the choices you make across the series of scenarios.

	OPTION 1 Rig-to-reef	OPTION 2 Rig-to-reef	OPTION 3 Complete removal
	1	1	
Total fish biomass (tonnes)	0.5	1.5	Negligible
Fish attracted vs. Fish produced	Produced	Attracted	
Habitat for threatened species	No	Yes	
Who can access the reef	Recreational Fishers	Recreational Divers	N/A
Future liability in case of any environmental damage occurring	Oil and Gas Company	Government (taxpayer)	
Amount of money (AU\$) paid to the State budget by the Company	100 million	160 million	0

N/A: Not Applicable

For example, if you chose option 1, it would mean that you prefer:

• The creation of a rig-to-reef that involves the presence of 0.5 tonnes of fish produced in the rig site, as well as the absence of habitat for threatened species and access for recreational fishers, while the Oil and Gas Company is liable for any possible environmental damage and pays to the State Government AU\$100 milion.

Rather than:

- The creation of a rig-to-reef that involves the presence of 1.5 tonnes of fish attracted to the rig site, as well as habitat for threatened species and access for recreational divers, while the Government (taxpayer) is liable for any possible environmental damage and the Oil and Gas Company pays to the State Government AU\$160 million.
- The complete removal of the rig, which involves that there won't be fish biomass produced or attracted to the rig site, and there won't be a potential habitat for threatened species and no access for recreational activities, while there won't be any liability for any possible environmental damage and there won't be extra money paid to the State Government.

<u>SCENARIO 1</u>: Consider the following options. Assuming these are the only options available to you, which one would you choose?

Please, click on the column of your preferred option.

	OPTION 1 Rig-to-reef	OPTION 2 Rig-to-reef	OPTION 3 Complete removal
	<b></b>	1	
Total fish biomass (tonnes)	0.5	0.5	Negligible
Fish attracted vs. Fish produced	Produced	Produced	
Habitat for threatened species	Yes	Yes	
Who can access the reef	Recreational Divers	Recreational Divers	N/A
Future liability in case of any	Oil and Gas	Oil and Gas	
environmental damage occurring	Company	Company	
Amount of money (AU\$) paid to the State budget by the Company	100 million	160 million	0

- Feature 1 Total fish biomass
- Feature 2 Attraction of fish to the rigs vs. production of fish on the rigs
- Feature 3 Habitat for threatened species
- Feature 4 Who can access the reef
- Feature 5 Future liability in case of any environmental damage ocurring
- Feature 6 Amount of money paid to the state budget by the company

<u>SCENARIO 2</u>: Consider the following options. Assuming these are the only options available to you, which one would you choose?

Please, click on the column of your preferred option.

	OPTION 1 Rig-to-reef	OPTION 2 Rig-to-reef	OPTION 3 Complete removal
		1	3
Total fish biomass (tonnes)	1.5	0.5	Negligible
Fish attracted vs. Fish produced	Attracted	Attracted	
Habitat for threatened species	No	Yes	
Who can access the reef	No Access	Recreational Fishers	N/A
Future liability in case of any environmental damage occurring	Shared	Oil and Gas Company	
Amount of money (AU\$) paid to the State budget by the Company	130 million	130 million	0

- Feature 1 Total fish biomass
- Feature 2 Attraction of fish to the rigs vs. production of fish on the rigs
- Feature 3 Habitat for threatened species
- Feature 4 Who can access the reef
- Feature 5 Future liability in case of any environmental damage ocurring
- Feature 6 Amount of money paid to the state budget by the company

<u>SCENARIO 3</u>: Consider the following options. Assuming these are the only options available to you, which one would you choose?

Please, click on the column of your preferred option.

-	OPTION 1 Rig-to-reef	OPTION 2 Rig-to-reef	OPTION 3 Complete removal
Total fish biomass (tonnes)	1.5	1	Negligible
Fish attracted vs. Fish produced	Attracted	Produced	
Habitat for threatened species	No	No	
Who can access the reef	Recreational Fishers	No Access	N/A
Future liability in case of any environmental damage occurring	Government (taxpayer)	Shared	
Amount of money (AU\$) paid to the State budget by the Company	160 million	100 million	0

- Feature 1 Total fish biomass
- Feature 2 Attraction of fish to the rigs vs. production of fish on the rigs
- Feature 3 Habitat for threatened species
- Feature 4 Who can access the reef
- Feature 5 Future liability in case of any environmental damage ocurring
- Feature 6 Amount of money paid to the state budget by the company

<u>SCENARIO 4</u>: Consider the following options. Assuming these are the only options available to you, which one would you choose?

Please, click on the column of your preferred option.

	OPTION 1 Rig-to-reef	OPTION 2 Rig-to-reef	OPTION 3 Complete removal
Total fish biomass (tonnes)	1.5	1	Negligible
Fish attracted vs. Fish produced	Attracted	Produced	
Habitat for threatened species	Yes	No	
Who can access the reef	Recreational Fishers	Recreational Divers	N/A
Future liability in case of any environmental damage occurring	Government (taxpayer)	Shared	
Amount of money (AU\$) paid to the State budget by the Company	160 million	100 million	0

- Feature 1 Total fish biomass
- Feature 2 Attraction of fish to the rigs vs. production of fish on the rigs
- Feature 3 Habitat for threatened species
- Feature 4 Who can access the reef
- Feature 5 Future liability in case of any environmental damage ocurring
- Feature 6 Amount of money paid to the state budget by the company

<u>SCENARIO 5</u>: Consider the following options. Assuming these are the only options available to you, which one would you choose?

Please, click on the column of your preferred option.

	OPTION 1 Rig-to-reef	OPTION 2 Rig-to-reef	OPTION 3 Complete removal
Total fish biomass (tonnes)	0.5	1	Negligible
Fish attracted vs. Fish produced	Attracted	Attracted	
Habitat for threatened species	Yes	No	
Who can access the reef	Recreational Fishers	No Access	N/A
Future liability in case of any	Oil and Gas	Oil and Gas	
environmental damage occurring	Company	Company	
Amount of money (AU\$) paid to the State budget by the Company	130 million	130 million	0

- Feature 1 Total fish biomass
- Feature 2 Attraction of fish to the rigs vs. production of fish on the rigs
- Feature 3 Habitat for threatened species
- Feature 4 Who can access the reef
- Feature 5 Future liability in case of any environmental damage ocurring
  Feature 6 Amount of money paid to the state budget by the company

<u>SCENARIO 6</u>: Consider the following options. Assuming these are the only options available to you, which one would you choose?

Please, click on the column of your preferred option.

	OPTION 1 Rig-to-reef	OPTION 2 Rig-to-reef	OPTION 3 Complete removal
Total fish biomass (tonnes)	0.5	1	Negligible
Fish attracted vs. Fish produced	Produced	Attracted	
Habitat for threatened species	No	Yes	
Who can access the reef	Recreational Divers	Recreational Divers	N/A
Future liability in case of any environmental damage occurring	Shared	Government (taxpayer)	
Amount of money (AU\$) paid to the State budget by the Company	160 million	100 million	0

# If the respondent always chose the Status Quo:

You always preferred the 'Complete Removal' option over 'Rigs-to-Reefs'. Please provide your reason why:

- I object to the idea of leaving oil rigs in the sea. I think they contribute to ocean pollution
- I need to know more about decommissioning options before I would feel comfortable deciding on which option is suitable
- I don't trust governments to implement and regulate decommissioned oil rigs
- I found the choices difficult or confusing, so I preferred the 'Complete Removal' option
- Other:

Please, indicate how certain you were of the answers you gave in the different scenarios, from "Not certain at all" (1) to "Very certain" (7)

	Not at all certain				Very certain		
	1	2	3	4	5	6	7
How certain were you of the answers you gave in the different scenarios?	-						

Did you think that the scenarios were confusing?

O Yes

No

What did you think about the information that was provided to describe the decommissioning options?

- It was confusing
- I thought the description was insufficient
- I thought it was an informative and sufficient information

Which features used to describe the decommissioning options were relevant to you?

- Habitat for endangered species
- Total fish biomass
- Fish attracted vs. fish produced
- Who can access the reef
- Future liability
- Amount of money paid to the State budget by the company
- None

# If the respondent answered "None":

In your opinion, which other features should have been included to describe the decommissioning options?

٦.
2

Please, indicate on the following scale how likely you think it is that the results of this study will influence future policy decisions regarding offshore oil and gas decommissioning in Western Australia from "Not at all likely" (1) to "Very likely" (7)

	Not at all likely				Very li	Very likely	
	1	2	3	4	5	6	-
How likely do you think it is that the results of this study							
will influence future policy decisions?							

<u>PART 4:</u> In this section of the survey, we will ask some questions about you. The information collected will be kept anonymous.

Do you have any children?

- Yes-dependent
- Yes-independent
- No

What is the highest level of education you have achieved?

- Primary
- Secondary
- TAFE or other college
- University undergraduate
- University postgraduate

Which of the following household incomes before tax applies to you?

- Ounder \$20.000
- \$20.000 \$35.000
- \$35.000 \$50.000
- \$50.000 \$70.000
- \$70.000 \$100.000
- \$100.000 \$130.000
- Over \$150.000
- I would rather not say

What is your residential postcode?

Thank you very much for your time! If you have comments you want to make about the survey, or the issues raised in it, please add them below:



# Appendix 8 Combined workshop feedback report

Fran Ackermann & Georgina Hill

This appendix is part of the final report for:

Enhancing the Understanding of the Value Provided to Fisheries by Man-made Aquatic Structures.

Euan S. Harvey, Fran Ackermann, Michael Burton, Julian Clifton, Carmen Elrick-Barr, Johanna Zimmerhackel, Georgina Hill, Stephen J Newman, Jenny Shaw, Mark Pagano, Paul Mcleod, Dianne McLean, Julian Partridge

24<sup>th</sup> August 2021

# Enhancing the Understanding of the Value Provided to Fisheries by Man-Made

# **Aquatic Structures**

Exmouth Workshops Feedback Report





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# **Executive Summary**

As part of the research project focusing on "Enhancing the Understanding of the Value Provided to Fisheries by Man-Made Aquatic Structures" two workshops were conducted in Exmouth in October 2019. These workshop focused on exploring the issues and opportunities regarding manmade marine infrastructure (MMI) along with determining social values associated with a prioritised subset of themes. The two workshops, both facilitated by Fran Ackermann, involved 15 members of the Exmouth community and used a computer – based system to capture, model and synthesise views. The report focuses purely on the material generated from the two workshops and will be augmented with further workshops in Onslow, Karratha and Busselton, the results of a survey and various economic value assessment analyses.

This short report comprises of:

- 1. Project Background
- 2. A brief overview of the method underpinning the workshops and outcomes
- 3. An overview map detailing the social values relating to MMI for both workshops
- 4. A list of project next steps regarding social value

*Curtin University Human Research Ethics Committee (HREC) has approved this study (HREC number CTR-10729).* 

# **Project Background**

This project is a collaboration between the Fisheries Research and Development Corporation, Curtin University, The University of Western Australia and the West Australian Marine Science Institute to explore the socioeconomic values associated with MMI. The project has four aims:

- 1. To develop conceptual qualitative, semi-quantitative and quantitative models for describing the socioeconomic values and decide what information is needed to give stakeholders an understanding of the value of manmade aquatic structures in the marine environment.
- To collate a list and description of the manmade aquatic structures in the marine environment in Western Australian and the associated social, economic and biodiversity data.
- **3.** To collect and collate data on four manmade aquatic structures in the marine environment and develop and compare the costs and benefits of qualitative, semi-quantitative and quantitative models.
- 4. To develop a decision support system or framework for undertaking socio-economic evaluations of manmade aquatic structures which can be used throughout Australia and guide end users on how to develop qualitative, semi-quantitative and quantitative models depending on their information requirements.

Initial findings from a literature review exploring social and economic values associated with MMI demonstrated that gaps exist within the current body of available research. These include: being discrete in nature, limited diversity of stakeholder view (e.g. focused on one or two groups only), limited specific exploration of MMI (e.g. natural reefs rather than artificial), and not being specifically applicable to a West Australian context (e.g. primarily from other states or countries). As such, using only existing literature to inform this research project would be insufficient.

In order to achieve our research aims the team are undertaking further data collection to including holding workshops using decision support systems in Exmouth, Karratha, Onslow, Dunsborough, and Busselton, creating and disseminating a survey for recreational fishers and divers, and determining the monetary value MMI generated by the structures and associated activities Throughout the data collection process integration between social and economic findings will be completed to achieve a broad and well-informed picture of qualitative, semi-quantitative and quantitative aspects associated with MMI.

# **Brief Overview**

# Exmouth Workshops, the Ningaloo Centre Bundegi Boardroom

# 15<sup>th</sup> of October 2019

- Participant 1
- Participant 2
- Participant 3
- Participant 4
- Participant 5
- Participant 6
- Participant 7

# 16<sup>th</sup> of October 2019

- Participant 1
- Participant 2
- Participant 3
- Participant 4
- Participant 5
- Participant 6
- Participant 7
- Participant 8

# Facilitator: Fran Ackermann

# Overview

The workshops focused on "what are the issues and opportunities regarding man-made marine infrastructure?" Participants were asked to consider this from the perspective of 'you as part of your community' rather than representing their organisation. Using a group mapping process, each individual was able to anonymously contribute to the focal question, seeing their ideas appear on a public screen as well as their own laptop. Members were then able to 'piggy back' off one another providing a rich reservoir of contributions (see appendix for a photograph of the group using the system).

These contributions were clustered by the facilitator according to content and then reviewed by the group to ensure coherence. New material that emerged from the review discussion was captured. This was both in the form of statements and also relationships. As a systemic understanding was sought (for greater robustness) where one contribution impacted another – causal relationships in the form of arrows were captured. This combination of ideas and associations helped in building a shared and detailed understanding of the considerations regarding key issues and opportunities. The process thus helped tease out a rich picture of the components and their systemic properties reflecting the complexity of the topic. In Workshop One, 28 contributions were collected and clustered into 10 themes. Workshop Two produced 52 contributions which were clustered 13 themes. Initial themes can be viewed in Table 1.

Following the initial capture and structuring of the material into themes a prioritisation exercise was undertaken. The prioritisation process first asked participants to determine which of the themes they believed were 'important to you personally' (blue preferences) and which were 'important to the community' (green preferences). Statements could be allocated both green and blue preferences. The results from these activities were appended to the statements e.g. [2B 4G] B=Blue and G=Green (see Table 1).

Workshop One prioritised the theme of "*increased habitat*" as most important to individuals and the theme of "*careful consideration of location*" of MMI as most important to the community. Workshop Two viewed themes "*increased impact (on land/marine) of more people in an area that they were not visiting previously*" and "*opportunity to test novel techniques for building resilience in marine communities in face of climate change*" as equally important to the individual. Additionally, "increased visitation to the area which would need to be carefully managed and planned for" and "increased tourism industry opportunities" were prioritised as equal first for most important to the community.

Workshop One	Workshop Two
Careful consideration of location [3B	• Increased visitation to the area which would
6G]	need to be carefully managed and planned for
<ul> <li>Increased habitat [8B 5G]</li> </ul>	[4B 8G]
<ul> <li>Spread of pressure on reef systems         [4B 4G]</li> </ul>	<ul> <li>Increased tourism industry opportunities [3B 8G]</li> </ul>
<ul> <li>Increase awareness and appreciation of what is in the marine environment</li> </ul>	<ul> <li>Ensure community engaged &amp; involved in process of MMI [5B 7G]</li> </ul>
<ul> <li>[3B 2G]</li> <li>Recognise competing interest [1B 3G]</li> <li>Responsibility for long term</li> </ul>	<ul> <li>Increased impact (on land/marine) of more people in an area that they were not visiting previously [68 5G]</li> </ul>
<ul> <li>Maintenance [1B 2G]</li> <li>Able to gain evidence of benefits of artificial reefs [4B 1G]</li> </ul>	<ul> <li>Potential pollution of marine environment from poorly thought out or maintained infrastructure [5B 4G]</li> </ul>
<ul> <li>Detrimental impacts to adjacent areas and species [2B 1G]</li> </ul>	<ul> <li>Provide education to users (and potential users) [5B 4G]</li> </ul>
• Job/employment opportunities [1B	Opportunity to test novel techniques for
<ul><li>3G]</li><li>Potential for pollution ([1B 1G]</li></ul>	building resilience in marine communities in face of climate change [6B 2G]
	<ul> <li>Rehabilitation of /creation of new coral reef systems [4B 3G]</li> </ul>
	• Provide for an increase in fish stocks [5B 3G]
	• Provide infrastructure for marine use [2B 2G]
	<ul> <li>Negatively change the natural environment [4B 2G]</li> </ul>
	• Can create hazards (human safety and marine life) if not planed out correctly [4B 1G]
	<ul> <li>Uncertainty around ongoing burden of responsibility of any maintenance and safety around artificial structures [28,66]</li> </ul>

Table 1. Identified themes and their prioritisations to the individual and the community.

After a coffee break activities focused on developing the value system. In Workshop One, each individual theme was focused on to tease out associated social values. This was due to the more discrete nature of the themes. In Workshop Two, a more systemic view was taken and social values were teased out in relation to all identified themes. Maps detailing all social values extracted from each workshop can be viewed below. It was interesting to note that whilst there was a high degree of homogeneity there were also some significant differences between the two value systems. To conclude the workshops, each participant voted anonymously on which social value they personally cared about most. Workshop One's key social value was determined as "keep all areas healthy" while Workshop Two's was "protect the natural environment".

In summary, each workshop provided a good understanding of the issues and opportunities – in terms of themes and their interconnections – giving a rich appreciation of considerations to be borne in mind whenever contemplating the use of MMI. The workshops also gave rise to 2 value

systems providing not only a far more nuanced understanding of the wealth of values to be considered (beyond much of what is already asserted) but a systemic understanding of the values – reflecting the complexity of the topic. The workshops allowed the views of those from a range of different backgrounds/knowledge bases and organisational stances to contribute enabling both a deeper understanding for the researchers as well as those attending. As a general observation it was clear that the Exmouth community involved in the workshops care deeply about the protection and sustainability of the marine environment

This material will be augmented with that captured from further workshops, the survey and other analyses to provide decision makers and interested parties with a detailed understanding of the social and economic values associated with man-made marine infrastructure.

Overview of Social Values Associated with Man-Made Marine Infrastructure in Exmouth

# Figure 1. Workshop One Social Value Associated with MMI Diagram



*Note:* Numbers displayed in brackets '[1]' represent how many participants voted that social value or goal as 'most important' to them. Arrows are read as 'may lead to' i.e. increase understanding of the marine environment may lead to keep all areas healthy. A minus sign on the arrow head reflects the opposite i.e. contaminate site/fish may lead to [not] avoid negative press

Figure 2. Workshop Two Social Value Associated with MMI Diagram



*Note:* Numbers displayed in brackets '[1]' represent how many participants voted that social value or goal as 'most important' to them.

A double headed arrow between protect lifestyle and protect the natural environment illustrates the self-sustaining nature of the relationship.

# Next Steps

- **1.** Conduct further 'workshops' with multiple stakeholder groups in Onslow, Karratha, and Busselton
- **2.** Integrate, compare and contrast findings from all workshops along with material from a workshop undertaken with the steering committee
- **3.** Develop a causal model depicting social values and man-made aquatic infrastructure within the West Australia context
- **4.** Develop semi quantitative models including Multi-Criteria Decision Models to further assess and understand social value
- **5.** Integrate workshop findings with findings from other parts of the research project (literature review, survey data, economic data etc.)

# Appendix



Exmouth workshop participants and facilitator pictured with group mapping system

# Enhancing the Understanding of the Value Provided to Fisheries by Man-Made Aquatic Structures

Chevron Workshop Feedback Report





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# **Executive Summary**

As part of the research project focusing on "Enhancing the Understanding of the Value Provided to Fisheries by Man-Made Aquatic Structures" an online workshop was conducted on the 23<sup>rd</sup> of April 2020. This workshop focused on exploring the issues and opportunities regarding man-made marine structures (MMS) along with determining social values associated with a prioritised subset of themes. The workshop, facilitated by Fran Ackermann, involved 3 members of Chevron and 1 member WAMSI and used an online computer – based system to capture, model and synthesise views. The report focuses purely on the material generated from the workshop and will be augmented with further online workshops, the results of a survey and various economic value assessment analyses.

This short report comprises of:

- 1. Project Background
- 2. A brief overview of the method underpinning the workshops and outcomes
- **3.** An overview map detailing the, opportunities, issues and social values relating to MMS for both workshops
- 4. A list of project next steps regarding social value

*Curtin University Human Research Ethics Committee (HREC) has approved this study (HREC number CTR-10729).*
#### Project Background

This project is a collaboration between the Fisheries Research and Development Corporation, Curtin University, The University of Western Australia and the West Australian Marine Science Institute to explore the socioeconomic values associated with MMS. The project has four aims:

- To develop conceptual qualitative, semi-quantitative and quantitative models for describing the socioeconomic values and decide what information is needed to give stakeholders an understanding of the value of manmade aquatic structures in the marine environment.
- 2. To collate a list and description of the manmade aquatic structures in the marine environment in Western Australian and the associated social, economic and biodiversity data.
- **3.** To collect and collate data on four manmade aquatic structures in the marine environment and develop and compare the costs and benefits of qualitative, semi-quantitative and quantitative models.
- 4. To develop a decision support system or framework for undertaking socio-economic evaluations of manmade aquatic structures which can be used throughout Australia and guide end users on how to develop qualitative, semi-quantitative and quantitative models depending on their information requirements.

Initial findings from a literature review exploring social and economic values associated with MMS demonstrated that gaps exist within the current body of available research. These include: being discrete in nature, limited diversity of stakeholder view (e.g. focused on one or two groups only), limited specific exploration of MMS (e.g. natural reefs rather than artificial), and not being specifically applicable to a West Australian context (e.g. primarily from other states or countries). As such, using only existing literature to inform this research project would be insufficient.

In order to achieve our research aims the team are undertaking further data collection to including holding online workshops using decision support systems with people from Perth, Exmouth, Karratha, Onslow, Dunsborough, and Busselton, creating and disseminating a survey for recreational fishers and divers, and determining the monetary value MMS generated by the structures and associated activities. Throughout the data collection process integration between social and economic findings will be completed to achieve a broad and well-informed picture of qualitative, semi-quantitative and quantitative aspects associated with MMS.

**Brief Overview** 

# Online Chevron Workshop, 23rd of April 2020

- Participant 1
- Participant 2
- Participant 3
- Participant 4

Facilitator: Fran Ackermann, Euan Harvey

# Overview

The workshops focused on "what are the issues and opportunities regarding man-made marine infrastructure?" Each participant was given the opportunity to contribution both Issues and Opportunities (denoted by 'l' or 'O') in relation to the focal question. Using a group mapping process, each participant could anonymously contribute to the focal question, seeing their ideas and the contributions of others on their screen and thus 'piggy back' off one another providing a rich reservoir of contributions. This process generated 51 statements. There were 26 Opportunities and 25 Issues reflecting an *even balance*. The surfaced material was put into rough 'content oriented' clusters and subsequently reviewed by the group allowing for new material to be surfaced as well as to ensure all were clear as to the meaning of the statements.

During the process of elaboration, it became clear that a number of the statements impacted others and so the process of causally linking the statements together was undertaken. This resulted in a 'map' of interconnected issues and opportunities helping tease out a rich picture of the statements along with their systemic properties reflecting the complexity of the topic The linked clusters were reviewed and 'headline' statements (10 in total) identified and given a different style (blue box). Each represented a specific theme. Map 1 shows the issues, opportunities and headline statements.

To conclude the first part of the morning session, a prioritisation process was undertaken asking the participants to rate the headline statements (see Appendix 1).

**Results**. After a brief break, the group reviewed the headline issues and explored the implications of each, i.e. what value they either supported (opportunities) or attacked (issues). A resulting set of 5 values was identified (grey box). Map 2 showings the headline issues, values and interconnecting material.

#### Map 1. Issues and opportunities identified in the workshop



Note: 'Blue boxes' refer to headline statements. A minus sign on the arrowhead reflects a negative link

#### Map 2. Social values identified in the online workshop



Note: 'Grey boxes' refer to social values. A minus sign on the arrowhead reflects the opposite.

#### Next Steps

- 1. Conduct further 'workshops' with multiple stakeholder groups for example regulators, commercial fishing, Onslow, Karratha, and Busselton
- 2. Integrate, compare and contrast findings from all workshops along with material from a workshop undertaken with the steering committee and 2 undertaken with Exmouth participants
- **3.** Develop a causal model depicting social values and man-made aquatic infrastructure within the West Australia context
- 4. Develop semi quantitative models including Multi-Criteria Decision Models to further assess and understand social value
- 5. Integrate workshop findings with findings from other parts of the research project (literature review, survey data, economic data etc.)

# Appendix 1

# Rating of importance of issues and opportunities as a Chevron employee

Headline Statement	Average	Degree of
	Rating (out of	Consensus
	10)	
Long term liability – who owns if proponent walks away	9.0	0.71
Reduce the cost of decommissioning for proponents and	8.30	1.90
general public government (O)		
Understanding the cost-benefit economic life cycle	6.50	2.50
analysis to capture short term benefits (smelting) offset		
against long term benefits (fisheries) (O)		
Policy not able to keep pace with resource sharing issues	6.30	1.50
(1)		
Retain existing habitat for value (O)	5.80	2.50
Concerns re residual contamination of O&G structure (I)	5.50	1.80
Navigational hazard for general shipping (I)	4.30	2.80
Sharing of potential resources between user groups (I)	3.50	3.30
Potential for invasive species presence (I)	3.30	1.80
Potential fish populations not managed properly with	3.0	0.71
fishing restrictions (I)		

Note that liability emerged as not only being the most important but also with the highest degree of consensus. Second was reducing the cost of decommissioning but with less consensus.

# Enhancing the Understanding of the Value Provided to Fisheries by Man-Made Aquatic Structures

Online Oil and Gas Workshop Feedback Report





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#### **Executive Summary**

As part of the research project focusing on "Enhancing the Understanding of the Value Provided to Fisheries by Man-Made Aquatic Structures" two online workshops were conducted. The first was on the 23<sup>rd</sup> of April 2020 and the second on the 21<sup>st</sup> May 2020. These workshops focused on exploring the issues and opportunities regarding man-made marine structures (MMS) along with determining social values associated with a prioritised subset of themes. The workshops, facilitated by Fran Ackermann and supported by Euan Harvey and Georgie Hill, involved a number of participants and used an online computer – based system to capture, model and synthesise views. This report focuses purely on the material generated from the workshops, however, this material will be integrated with material from other online workshops and those conducted face to face, as well as with the results of a survey and various economic value assessment analyses.

#### This short report comprises of:

- 5. Project Background
- 6. A brief overview of the method underpinning the workshops and outcomes
- **7.** An overview map detailing the, opportunities, issues and social values relating to MMS for both workshops
- 8. A list of project next steps regarding social value

*Curtin University Human Research Ethics Committee (HREC) has approved this study (HREC number CTR-10729).* 

#### Project Background

This project is a collaboration between the Fisheries Research and Development Corporation, Curtin University, The University of Western Australia and the West Australian Marine Science Institution to explore the socioeconomic values associated with MMS. The project has four aims:

- 5. To develop conceptual qualitative, semi-quantitative and quantitative models for describing the socioeconomic values and decide what information is needed to give stakeholders an understanding of the value of man-made aquatic structures in the marine environment.
- 6. To collate a list and description of the man-made aquatic structures in the marine environment in Western Australian and the associated social, economic and biodiversity data.
- **7.** To collect and collate data on four man-made aquatic structures in the marine environment and develop and compare the costs and benefits of qualitative, semi-quantitative and quantitative models.
- 8. To develop a decision support system or framework for undertaking socio-economic evaluations of man-made aquatic structures which can be used throughout Australia and guide end users on how to develop qualitative, semi-quantitative and quantitative models depending on their information requirements.

Initial findings from a literature review exploring social and economic values associated with MMS demonstrated that gaps exist within the current body of available research. These include: being discrete in nature, limited diversity of stakeholder view (e.g. focused on one or two groups only), limited specific exploration of MMS (e.g. natural reefs rather than artificial), and not being specifically applicable to a West Australian context (e.g. primarily from other states or countries). As such, using only existing literature to inform this research project would be insufficient.

In order to achieve our research aims the team are undertaking further data collection to including holding online workshops using decision support systems with people from Perth, Exmouth, Karratha, Onslow, Dunsborough, and Busselton, creating and disseminating a survey for recreational fishers and divers, and determining the monetary value MMS generated by the structures and associated activities. Throughout the data collection process integration between social and economic findings will be completed to achieve a broad and well-informed picture of qualitative, semi-quantitative and quantitative aspects associated with MMS.

#### **Brief Overview**

#### Online Oil and Gas Workshop, 21<sup>st</sup> of May 2020

- Participant 1
- Participant 2
- Participant 3
- Participant 4
- Participant 5

# Online Chevron Workshop, 23<sup>rd</sup> of April 2020

- Participant 1
- Participant 2
- Participant 3
- Participant 4

Facilitators: Fran Ackermann, Euan Harvey, Georgie Hill

#### Overview

The workshops focused on "what are the issues and opportunities regarding manmade marine infrastructure?" Each participant was given the opportunity to contribution both Issues and Opportunities (denoted by 'l' or 'O') in relation to the focal question. Using a group mapping process, each participant could anonymously contribute to the focal question, seeing their ideas and the contributions of others on their screen and thus 'piggyback' off one another providing a rich reservoir of contributions. The surfaced material was put into rough 'content oriented' clusters and subsequently reviewed by the group allowing for new material to be surfaced as well as to ensure all were clear as to the meaning of the statements.

During the process of elaboration, it became clear that a number of the statements impacted others and so the process of causally linking the statements together was undertaken. This resulted in a 'map' of interconnected issues and opportunities helping tease out a rich picture of the statements along with their systemic properties reflecting the complexity of the topic The linked clusters were reviewed and 'headline' statements identified and given a different style (blue box). Each represented a specific theme. Map 1 shows the issues, opportunities and headline statements for the Oil and Gas workshop and Map 2 shows the same for the Chevron workshop.

To conclude the first part of the morning session, a prioritisation process was undertaken asking the participants to rate the headline statements (see Table 3 for Oil and Gas and table 6 for Chevron).

**Results**. After a brief break, the group reviewed the headline issues and explored the implications of each, i.e. what value they either supported (opportunities) or attacked (issues). Each value was identified and given a particular attribute (grey box). Map 3

showings the headline issues, values and interconnecting material for Oil and Gas and Map 4 shows this for Chevron.

#### Map 1. Issues and opportunities identified in the oil and gas workshop



Note: 'Blue boxes' refer to headline statements. A minus sign on the arrowhead reflects a negative link

#### FRDC 2018-053

28



#### Map 2. Issues and opportunities identified in the Chevron workshop

Note: 'Blue boxes' refer to headline statements. A minus sign on the arrowhead reflects a negative link

# Map 3. Social values identified in the oil and gas workshop



*Note:* 'Grey boxes' refer to social values. A minus sign on the arrowhead reflects the opposite.

# Map 4. Social values identified in the Chevron workshop



Note: 'Grey boxes' refer to social values. A minus sign on the arrowhead reflects the opposite.

# Reflections from the Oil and Gas Workshop

# Reviewing the Issues and Opportunities

• Number of issues = 36, number of opportunities = 18 – revealing that participants believed there were more potential issues than opportunities.

# Table 1. Themes (headlines) and supporting issues and opportunities (identified through links)

Theme	Issues and Opportunities
58. Unable to compare what was to what is to demonstrate	39 (I), 38 (I), 44 (I), 34 (I),
benefits (big data gaps) (I)	
24. Cumulative impacts of multiple structures (I)	50 (I), 53 (I), 52 (I), 57 (O)
47. The 'value' is different to different people or groups e.g.	49 (I), 62 (I), 28 (I), 48 (O),
the value to commercial fishers or recreational fishers is	22 (O), 35 (I), 18 (O), 21 (O),
the commercial fish on the infrastructure but it could be	16 (O), 33 (O), 52 (I), 43 (O)
value of the habitat to protect or support vulnerable	
species (I)	
13. Provides valuable habitat (O)	32 (I), 45 (O), 9 (O), 30 (O),
	23 (O), 59 (I), 17 (I), 60 (I),
	25 (I), 19 (O), 29 (O)
15. Legal liability for impacts to users of the sea (I)	14 (I), 26 (I), 20 (I), 43 (I), 68
	(I), 51 (I), 10 (I), 34 (I), 12 (I),
	41 (I),
40. Balancing risks of leaving in the marine environment	20 (I), 54 (O), 43 (I), 36 (O),
versus impact of disposing onshore tradeoffs (O)	

- The themes are not mutually exclusive they share statements representing the systemic nature.
- In some instances themes comprise both Issues and Opportunities demonstrating potential dilemmas. The theme concentrating on 'Provide Valuable Habitat' is one such theme
- Some themes are more developed than others

Statements	Themes linked
43. Difficulty of removal (I)	<ul> <li>15. Legal Liability for impacts to users of the sea (I)</li> <li>40. Balancing risks of leaving in the marine environment versus impact of disposing onshore tradeoffs (O)</li> <li>47. The 'value' is different to different people or groups e.g. the value to commercial fishers or recreational fishers is the commercial fish on the infrastructure but it could be value of the habitat to protect or support vulnerable species (I)</li> </ul>
20. Hazard for users of ocean long term – degradation (environmental) (I)	<ul> <li>15. Legal Liability for impacts to users of the sea (I)</li> <li>40. Balancing risks of leaving in the marine environment versus impact of disposing onshore tradeoffs (O)</li> <li>58. Unable to compare what was to what is to demonstrate benefits (big data gaps) (I)</li> </ul>
34. Unknown future environmental hazards that the leaving of infrastructure in-situ may create	<ul> <li>54. Unable to compare what was to what is to demonstrate benefits (big data gaps (I)</li> <li>15. Legal liability for impacts to users of the sea</li> </ul>
52. Lack of understanding of impact of total removal on fishing populations (I)	<ul> <li>24. Cumulative impacts of multiple structures (I)</li> <li>47. The 'value' is different to different people or groups e.g. the value to commercial fishers or recreational fishers is the commercial fish on the infrastructure but it could be value of the habitat to protect or support vulnerable species (O)</li> </ul>

# Table 2. Statement that contributed to more than one theme

• Statement 20 given the extensiveness of links around it, could also be seen as a headline

#### Reviewing the values

- There emerged 12 values (with one of the headlines 55 *bring benefit to local economy* being upgraded to a value).
- The values appeared to form a number of clusters namely
  - legislation and clarity of liability (84 and 67),
  - o benefits to community/economy (55, 73, 70, 72, 71)
  - o developing new industry (76)
  - o integrated, collaborative systemic approach (80, 82 and 79)

Theme	Average Rating (out of 10)	Degree of Consensus
58. Unable to compare what was to what is to demonstrate	7.60	1.40
benefits (big data gaps) (I)		
24. Cumulative impacts of multiple structures (I)	6.40	3.10
47. The 'value' is different to different people or groups e.g.	6.40	3.10
the value to commercial fishers or recreational fishers is the		
commercial fish on the infrastructure but it could be value		
of the habitat to protect or support vulnerable species (I)		
13. Provides valuable habitat (O)	5.80	2.70
15. Legal liability for impacts to users of the sea (I)	4.60	3.10
40. Balancing risks of leaving in the marine environment	3.00	2.40
versus impact of disposing onshore tradeoffs (O)		

# Table 3. Rating of importance of issues and opportunities as an oil and gas employee

The lower the number the greater the degree of consensus. As such Statement 58 not only had the highest average but also received the greatest degree of consensus.

#### **Reflections from the Chevron Workshop**

#### Reviewing the Issues and Opportunities

• 26 Opportunities and 25 Issues revealing an almost even balance between the two categories.

# Table 4. Themes (headlines) and supporting issues and opportunities (identified through links)

Theme	Issues and Opportunities
27. Long term liability – who owns if proponent walks away	11 (I), 19 (I), 42 (I)
(1)	
41. Reduce the cost of decommissioning for proponents and	40 (O), 43 (O), 36 (O), 50
general public government (O)	(I), 53 (O), 11 (I), 28 (I), 59
	(1)
55. Understanding the cost-benefit economic life cycle	51 (O), 44 (O), 23 (O), 31
analysis to capture short term benefits (smelting) offset	(O)
against long term benefits (fisheries) (O)	
25. Policy not able to keep pace with resource sharing issues	58 (I), 35 (I), 57 (I)
(1)	
13. Retain existing habitat for value (O)	38 (O), 22 (O), 17 (O), 26
	(0), 44 (0)
45. Concerns re residual contamination of O&G structure (I)	9 (I)
10. Navigational hazard for general shipping (I)	12 (I), 56 (I)
14. Sharing of potential resources between user groups (I)	48 (I), 30 (O), 34 (O)
24. Potential for invasive species presence (I)	46 (I), 60 (I)
32. Potential fish populations not managed properly with	18 (I), 48 (I)
fishing restrictions (I)	

- The themes are not mutually exclusive they share statements representing the systemic nature.
- In some instances themes comprise both Issues and Opportunities demonstrating potential dilemmas. The theme concentrating on 'Reduce the cost of decommissioning' is one such theme
- Some themes are more developed than others

Statements	Themes linked
11. Resourcing of infrastructure maintenance long term (I)	<ul> <li>41. Reduce the cost of decommissioning for proponents and general public government (O)</li> <li>27. Long term liability – who owns if proponent walks away (I)</li> </ul>
44. Reduce GHG associated with onshore disposal/smelting and instead have blue carbon potential (O)	<ul> <li>55. Understanding the cost-benefit economic life cycle analysis to capture short term benefits (smelting) offset against long term benefits (fisheries) (O)</li> <li>13. Retain existing habitat for value (O)</li> </ul>
48. Balancing access rights between competing user groups (I)	<ul> <li>Potential fish populations not managed properly with fishing restrictions (I)</li> <li>Sharing of potential additional resources between user groups (I)</li> </ul>

# Table 5. Statement that contributed to more than one theme

Reviewing the values

- There emerged 5 values
- The values straddled economic, environmental, and social considerations with the strongest emphasis on economics/cost.

# Table 6. Rating of importance of issues and opportunities as a Chevron employee

Theme	Average Rating (out of 10)	Degree of Consensus
27. Long term liability – who owns if proponent walks away (I)	9.0	0.71
41. Reduce the cost of decommissioning for proponents and general public government (O)	8.30	1.90
55. Understanding the cost-benefit economic life cycle analysis to capture short term benefits (smelting) offset against long term benefits (fisheries) (O)	6.50	2.50
25. Policy not able to keep pace with resource sharing issues (I)	6.30	1.50
13. Retain existing habitat for value (O)	5.80	2.50
45. Concerns re residual contamination of O&G structure (I)	5.50	1.80
10. Navigational hazard for general shipping (I)	4.30	2.80
14. Sharing of potential resources between user groups (I)	3.50	3.30
24. Potential for invasive species presence (I)	3.30	1.80
32. Potential fish populations not managed properly with fishing restrictions (I)	3.0	0.71

Note that liability emerged as not only being the most important but also with the highest degree of consensus. Second was reducing the cost of decommissioning but with less consensus.

# Next Steps

- **1.** Conduct further 'workshops' with multiple stakeholder groups for example regulators, commercial fishing, Onslow, Karratha, and Busselton
- 2. Integrate, compare and contrast findings from all workshops along with material from a workshop undertaken with the steering committee and 2 undertaken with Exmouth participants
- **3.** Develop a causal model depicting social values and man-made aquatic infrastructure within the West Australia context
- 4. Develop semi quantitative models including Multi-Criteria Decision Models to further assess and understand social value
- 5. Integrate workshop findings with findings from other parts of the research project (literature review, survey data, economic data etc.)

# Enhancing the Understanding of the Value Provided to Fisheries by Man-Made Aquatic Structures

Online Regulator Workshop Feedback Report Online Regulator Workshop Feedback Report

Online Regulator Workshop Feedback Report



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#### **Executive Summary**

As part of the research project focusing on "Enhancing the Understanding of the Value Provided to Fisheries by Man-Made Aquatic Structures" two online workshop were conducted with those involved with regulatory matters on the 18<sup>th</sup> and 22<sup>nd</sup> of May 2020. These workshop focused on exploring the issues and opportunities regarding man-made marine structures (MMS) along with determining social values associated with a prioritised subset of themes. The workshops, facilitated by Fran Ackermann, involved 12 participants in total and used an online computer – based system to capture, model and synthesise views. The report focuses purely on the material generated from the workshop and will be augmented with further online workshops, the results of a survey and various economic value assessment analyses.

#### This short report comprises of:

- 1. Project background
- 2. A brief overview of the method underpinning the workshops and outcomes
- **3.** An overview maps detailing the, opportunities, issues and social values relating to MMS for both workshops
- 4. Reflections from both workshops
- 5. A list of project next steps regarding social value

*Curtin University Human Research Ethics Committee (HREC) has approved this study (HREC number CTR-10729).* 

#### **Project Background**

This project is a collaboration between the Fisheries Research and Development Corporation, Curtin University, The University of Western Australia and the West Australian Marine Science Institute to explore the socioeconomic values associated with MMS. The project has four aims:

- 1. To develop conceptual qualitative, semi-quantitative and quantitative models for describing the socioeconomic values and decide what information is needed to give stakeholders an understanding of the value of man-made aquatic structures in the marine environment.
- 2. To collate a list and description of the man-made aquatic structures in the marine environment in Western Australian and the associated social, economic and biodiversity data.
- **3.** To collect and collate data on four man-made aquatic structures in the marine environment and develop and compare the costs and benefits of qualitative, semi-quantitative and quantitative models.
- 4. To develop a decision support system or framework for undertaking socio-economic evaluations of man-made aquatic structures which can be used throughout Australia and guide end users on how to develop qualitative, semi-quantitative and quantitative models depending on their information requirements.

Initial findings from a literature review exploring social and economic values associated with MMS demonstrated that gaps exist within the current body of available research. These include: being discrete in nature, limited diversity of stakeholder view (e.g. focused on one or two groups only), limited specific exploration of MMS (e.g. natural reefs rather than artificial), and not being specifically applicable to a West Australian context (e.g. primarily from other states or countries). As such, using only existing literature to inform this research project would be insufficient.

In order to achieve our research aims the team are undertaking further data collection to including; holding online workshops using a group support system with people from Perth, Exmouth, Karratha, Onslow, and Busselton, creating and disseminating a survey for recreational fishers and divers, and determining the monetary value MMS generated by the structures and associated activities. Throughout the data collection process integration between social and economic findings will be undertaken to achieve a broad and well-informed picture of qualitative, semi-quantitative and quantitative aspects associated with MMS.

#### **Brief Overview**

# Online Regulators Workshop One, 18th of May 2020

- Participant 1, Department of Mines, Industry Regulation and Safety
- Participant 2, Department of Mines, Industry Regulation and Safety
- Participant 3, Department of Water and Environmental Regulation
- Participant 4, Department of Primary Industries and Regional Development

#### Online Regulators Workshop Two, 22<sup>nd</sup> of May 2020

- Participant 1, Australian Petroleum Production and Exploration Association
- Participant 2, Department of Primary Industries and Regional Development
- Participant 3, Department of Industry, Science, Energy and Resources
- Participant 4, Department of Industry, Science, Energy and Resources
- Participant 5, Department of Industry, Science, Energy and Resources
- Participant 6, Department of Primary Industries and Regional Development
- Participant 7, NOPSEMA
- Participant 8, Department of Water and Environmental Regulation
- Facilitators: Fran Ackermann, Euan Harvey and Georgie Hill

#### **Overview**

The workshops commenced with a brief introduction before focusing on "what are the issues and opportunities regarding man-made marine infrastructure?" Each participant was given the opportunity to contribute both Issues and Opportunities (denoted by 'I' or 'O') in relation to the focal question. Using a group mapping process, each participant could a) anonymously contribute, b) see their ideas alongside the contributions of others and c) 'piggyback' off one another. This provided a rich reservoir of contributions. This process generated 51 statements in the first workshop (18 Issues, 29 Opportunities and 4 statements that were considered both an issue and an opportunity) and 53 statements in the second (28 Issues, 22 Opportunities and 3 statements that were considered both an issue and an opportunity). The surfaced material was put into rough 'content oriented' clusters during the generation process and subsequently reviewed by the group allowing for new material to be surfaced as well as to ensure all were clear as to the meaning of the statements and statements were in the most appropriate cluster.

During the process of elaboration, it became clear statements impacted one another and so the process of causally linking the statements together was undertaken. This resulted in a 'map' of interconnected issues and opportunities helping tease out a nuanced and systemic representation reflecting the complexity of the topic. The linked clusters were subsequently re-reviewed and 'headline' statements identified and given a different style (blue box). Each headline represented a specific theme. Maps 1 and 2 shows the issues, opportunities and headline statements for each workshop. To conclude the first part of the morning session, a prioritisation process was undertaken asking the participants to rate the headline statements (see Tables 3 and 6) taking into account the entire cluster.

After a brief break, the group reviewed the headline issues and explored the implications of each, i.e. what value they either supported (opportunities) or 'challenged' (issues). Each value identified was allocated a distinct style (grey box). Maps 3 and 4 showings the headline issues, values and interconnecting material.

#### Maps of Issues, Opportunities and Social Values Associated with Man-Made Marine Infrastructure

#### Map 1. Issues and opportunities identified in the regulator workshop one



*Note:* 'Blue boxes' refer to headline statements and grey boxes the values. A minus sign on the arrowhead reflects a negative link

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#### Map 2. Issues and opportunities identified in the regulator workshop two



*Note:* 'Blue boxes' refer to headline statements. A minus sign on the arrowhead reflects a negative link



# Map 3. Social values identified in the regulator workshop one

*Note:* 'Grey boxes' refer to social values. A minus sign on the arrowhead reflects the opposite.



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# Map 4. Social values identified in the regulator workshop two

*Note:* 'Grey boxes' refer to social values. A minus sign on the arrowhead reflects the opposite.

# **Reflections from the Regulator Workshop One**

# Reviewing the Issues and Opportunities

- There emerged 19 Issues and 32 Opportunities and 4 that were considered both an issues and an opportunity revealing that there were more opportunities than there were issues.
- 5 themes/headlines existed

# Table 1. Themes/clusters and number of linked issues and opportunities

Theme	Issues and Opportunities
11. Research opportunities gained from MMI (O)	45 (1/0), 47 (0), 46 (0), 49, (0), 37 (1),
	15 (O), 36 (O), 53 (I), 56 (I/O), 41 (O),
	32 (I), 55 (O)
10. Establish regulation - duplication/overlap (I)	65 (I), 66 (I), 31 (I/O), 41 (O), 42 (I), 55
and (O)	(O), 7 (I), 13 (I), 50 (O), 22 (I), 20 (I),
	36 (O)
43. Is this pollution of the sea? [public	19 (I), 16 (I), 9 (I), 14 (O), 52 (I), 38
perception] (I)	(O), 56 (I/O)
50. Planning for future decommissioning	9 (I), 27 (O), 55 (O), 42 (I), 36 (O), 22
considered early to use appropriate materials for	(1)
leaving in situ etc. (O)	
40. Managing multi-user risks e.g. divers vs	28 (O), 22 (I), 30 (O), 18 (O)
fishers (I)	

- The themes are not mutually exclusive they share statements representing the systemic nature.
- In all of the themes there were both Issues and Opportunities demonstrating potential dilemmas.
- Some themes are more developed than others particularly of note were 'Research opportunities gained from MMI' and 'Establish regulation duplication/overlap'

Statements	Themes linked
9. Contamination potential from old oil and gas	• 43. Is this pollution of the sea? [public
infrastructure (I)	perception] (I)
	<ul> <li>50. Planning for future</li> </ul>
	decommissioning considered early to
	use appropriate materials for leaving in
	situ etc. (O)
22. Increased environmental hazard (I)	10. Establish regulation -
	duplication/overlap (I) and (O)
	• 50. Planning for future
	decommissioning considered early to
	use appropriate materials for leaving in
	situ etc. (U)
	• 40. Managing multi-user risks e.g. divers vs fishers (I)
36. O&G case studies to review where sea	• 11. Research opportunities gained from
dumping permits have been approved – e.g.	MMI (O)
Exmouth king reef PTTEP Jabiru, RTM and challis	• 10. Establish regulation -
SALRAM, Conoco Elang/Kakatua RTM (O)	duplication/overlap (I) and (O)
	• 50. Planning for future
	decommissioning considered early to
	use appropriate materials for leaving in
41 Decommissioning requirements in	situ etc. (O)
Commonwealth waters are currently being	• 11. Research opportunities gamed from
reviewed – the study could play into this (O)	<ul> <li>10 Establish regulation -</li> </ul>
	duplication/overlap (I) and (O)
42. Precedence setting (I)	<ul> <li>10. Establish regulation -</li> </ul>
	duplication/overlap (I) and (O)
	• 50. Planning for future
	decommissioning considered early to
	use appropriate materials for leaving in
	situ etc. (O)
55. Recognise that regulations work on a case by	• 11. Research opportunities gained from
case basis and that what is acceptable for one	MMI (0)
might not be acceptable for another (O)	<ul> <li>10. Establish regulation -</li> </ul>
	duplication/overlap (I) and (O)
	<ul> <li>50. Planning for future</li> </ul>
	decommissioning considered early to
	use appropriate materials for leaving in
	situ etc. (O)
56. Research into production vs attraction (I/O)	<ul> <li>11. Research opportunities gained from</li> </ul>
	IVIIVII (U)
	• 43. Is this pollution of the sea? [public
	perception] (I)

# Table 2. Statements that contributed to more than one theme through links

• Statements contributing to >1 theme are potentially 'potent' that is they have considerable contribution.

# Reviewing the values

- There emerged 8 values.
- That the values appeared to form clusters relating to standards and regulations, environmental outcomes and local economy

# Table 3. Rating of importance of issues and opportunities

Theme	Average Rating (out of 10)	Degree of Consensus
11. Research opportunities gained from MMI (O)	8.30	1.50
10. Establish regulation - duplication/overlap (I) and (O)	7.00	1.20
43. Is this pollution of the sea? [public perception] (I)	6.80	1.60
50. Planning for future decommissioning considered early to use appropriate materials for leaving in situ etc. (O)	6.50	1.70
40. Managing multi-user risks e.g. divers vs fishers (I)	6.50	2.10

# **Reflections from the Regulator Workshop Two**

#### Reviewing the Issues and Opportunities

- There emerged 28 Issues and 22 Opportunities and 3 that were considered both an issues and an opportunity suggesting a relatively even mix.
- There emerged 6 themes

# Table 4. Themes/clusters and number of directly linked issues and opportunities

Theme	Issues and Opportunities
12. Ensure environmental protection/sustainability	45 (I), 43 (I), 14 (I), 16 (I),
(1)	
35.Understand social and environmental impacts of	27 I(), 48 (O), 44 (O), 64 (O)
removing man made marine structures (I)	
42. Reduce regulator uncertainty (O)	62 (I), 29 (I), 30 (I), 38 (I), 65 (I/O),
	15 (I), 36 (I), 25 (I)
19. Increased market and collaboration (O)	33 (O), 60 (O), 59 (O), 72 (I), 58
	(O), 61 (I), 49 (O), 63 (I), 64 (O), 68
	()
51. Management of associated of marine	52 (I), 28 (I), 41 (I), 34 (), 39 (O), 53
environment to maintain ongoing social and	(I), 59 (O), 31 (I/O), 20 (I), 24 (O),
commercial benefit (I)	47 (O),
21. Increasing carrying capacity (of the environment)	13 (O), 23 (O), 17 (O), 22 (O), 45 (I)
at local level (O)	

- Themes not independent of one another instead they influenced and impacted one another. Some themes were quite extensive e.g. 51 Management of associated of marine environment to maintain ongoing social and commercial benefit (I)
- Themes were augmented with additional material during the discussions those without I or O appended
| Statements   | Themes linked  |
|--|--|
| 45. Ensuring fishing activities are appropriately regulated to protect fish stocks and the environment (I) | <ul> <li>12. Ensure environmental protection/sustainability (I)</li> <li>21. Increasing carrying capacity (of the environment) at local level (O)</li> </ul>                             |
| 59. See increased collaboration between all marine users (O)   | <ul> <li>19. Increased market and collaboration (O)</li> <li>51. Management of associated of marine<br/>environment to maintain ongoing social and<br/>commercial benefit (I)</li> </ul> |
| 64. See large surge of decommissioning cases (O)   | <ul> <li>35.Understand social and environmental<br/>impacts of removing man made marine<br/>structures (I)</li> <li>19. Increased market and collaboration (O)</li> </ul>                |

### Table 5. Statement that contributed to more than one theme

• Statements contributing to >1 theme are potentially 'potent' that is they have considerable contribution.

### Reviewing the values

• 7 values forming 'apparent clusters'. For example, regulatory, marine environmental health, quality of decision making, community benefit and economic benefits.

### Table 6. Rating of importance of issues and opportunities

Theme	Average	Degree of
	Rating (out of	Consensus
	10)	
12. Ensure environmental protection/sustainability (I)	9.40	0.86
35. Understand social and environmental impacts of	8.60	1.90
removing man made marine structures (I)		
42. Reduce regulator uncertainty (O)	8.00	1.70
19. Increased market and collaboration (O)	6.40	2.50
51. Management of associated of marine environment	5.80	3.10
to maintain ongoing social and commercial benefit (I)		
21. Increasing carrying capacity (of the environment) at	5.50	2.20
local level (O)		

### **Next Steps**

- **1.** Conduct further 'workshops' with multiple stakeholder groups for example regulators, commercial fishing, Onslow, Karratha, and Busselton
- 2. Integrate, compare and contrast findings from all workshops along with material from a workshop undertaken with the steering committee and 2 undertaken with Exmouth participants
- **3.** Develop a causal model depicting social values and man-made aquatic infrastructure within the West Australia context
- **4.** Develop semi quantitative models including Multi-Criteria Decision Models to further assess and understand social value
- 5. Integrate workshop findings with findings from other parts of the research project (literature review, survey data, economic data etc.)

# Enhancing the Understanding of the Value Provided to Fisheries by Man-Made Aquatic Structures

Aquatic Structures

Online Recreational Fishing Workshop Feedback Report





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### **Executive Summary**

As part of the research project focusing on "Enhancing the Understanding of the Value Provided to Fisheries by Man-Made Aquatic Structures" an online workshop was held on the 9<sup>th</sup> June. This workshop focused on exploring the issues and opportunities regarding man-made marine structures (MMS) along with determining social values associated with a prioritised subset of themes. The workshops, facilitated by Fran Ackermann and supported by Euan Harvey and Georgie Hill, involved a number of participants and used an online computer – based system to capture, model and synthesise views. This report focuses purely on the material generated from the workshops, however, this material will be integrated with material from other online workshops and those conducted face to face, as well as with the results of a survey and various economic value assessment analyses.

### This short report comprises of:

- 1. Project Background
- 2. A brief overview of the method underpinning the workshops and outcomes
- **3.** An overview map detailing the, opportunities, issues and social values relating to MMS for both workshops
- 4. A list of project next steps regarding social value

*Curtin University Human Research Ethics Committee (HREC) has approved this study (HREC number CTR-10729).* 

### Project Background

This project is a collaboration between the Fisheries Research and Development Corporation, Curtin University, The University of Western Australia and the West Australian Marine Science Institution to explore the socioeconomic values associated with MMS. The project has four aims:

- **9.** To develop conceptual qualitative, semi-quantitative and quantitative models for describing the socioeconomic values and decide what information is needed to give stakeholders an understanding of the value of man-made aquatic structures in the marine environment.
- 10. To collate a list and description of the man-made aquatic structures in the marine environment in Western Australian and the associated social, economic and biodiversity data.
- **11.** To collect and collate data on four man-made aquatic structures in the marine environment and develop and compare the costs and benefits of qualitative, semi-quantitative and quantitative models.
- 12. To develop a decision support system or framework for undertaking socio-economic evaluations of man-made aquatic structures which can be used throughout Australia and guide end users on how to develop qualitative, semi-quantitative and quantitative models depending on their information requirements.

Initial findings from a literature review exploring social and economic values associated with MMS demonstrated that gaps exist within the current body of available research. These include: being discrete in nature, limited diversity of stakeholder view (e.g. focused on one or two groups only), limited specific exploration of MMS (e.g. natural reefs rather than artificial), and not being specifically applicable to a West Australian context (e.g. primarily from other states or countries). As such, using only existing literature to inform this research project would be insufficient.

In order to achieve our research aims the team are undertaking further data collection including holding online workshops with people from Perth, Exmouth, Karratha, Onslow, and Busselton, creating and disseminating a survey for recreational fishers and divers, and determining the monetary value MMS generated by the structures and associated activities. Throughout the data collection process integration between social and economic findings will be completed to achieve a broad and well-informed picture of qualitative, semi-quantitative and quantitative aspects associated with MMS.

### **Brief Overview**

### **Online Recreational Fishing Workshop, 9th June 2020**

- Participant 1
- Participant 2
- Participant 3
- Participant 4
- Participant 5
- Participant 6

Facilitators: Fran Ackermann, Euan Harvey

### **Overview**

The workshop focused on "what are the issues and opportunities regarding manmade marine infrastructure?" Each participant was given the opportunity to contribution both Issues and Opportunities (denoted by 'l' or 'O') in relation to the focal question. Using a group mapping process, each participant could anonymously contribute to the focal question, seeing their ideas and the contributions of others on their screen and thus 'piggyback' off one another providing a rich reservoir of contributions. The surfaced material was put into rough 'content oriented' clusters and subsequently reviewed by the group allowing for new material to be surfaced as well as to ensure all were clear as to the meaning of the statements.

During the process of elaboration, it became clear that a number of the statements impacted others and so the process of causally linking the statements together was undertaken. This resulted in a 'map' of interconnected issues and opportunities helping tease out a rich picture of the statements along with their systemic properties reflecting the complexity of the topic The linked clusters were reviewed and 'headline' statements identified and given a different style (blue box). Each represented a specific theme. Map 1 shows the issues, opportunities and headline statements.

To conclude the first part of the morning session, a prioritisation process was undertaken asking the participants to rate the headline statements (see Table).

**Results**. After a brief break, the group reviewed the headline issues and explored the implications of each, i.e. what value they either supported (opportunities) or attacked (issues). Each value was identified and given a particular attribute (grey box). Map 3 showings the headline issues, values and interconnecting material.



### Map 1. Issues and opportunities identified in the recreational fishing workshop

Note: 'Blue boxes' refer to headline statements. A minus sign on the arrowhead reflects a negative link



### Map 2. Social values identified in the recreational fishing workshop

Note: 'Grey boxes' refer to social values. A minus sign on the arrowhead reflects the opposite.

### **Reflections from the Recreational Fishing Workshop**

### Reviewing the Issues and Opportunities

- Number of issues = 33, number of opportunities = 43, 6 of both issues and opportunities revealing that participants believed .....
- The themes are not mutually exclusive they share statements representing the systemic nature.
- In many instances themes comprise both Issues and Opportunities demonstrating potential dilemmas.
- Some themes are more developed than others

Given the breadth of material detailed 'maps' of each theme are provided in Maps 3-9

### Reviewing the values

- There emerged 15 values (with one of the headlines 26 *increase quality abundancies re marine biodiversity particularly fish stocks (o)* being upgraded to a value).
- The values appeared to form a number of clusters namely
  - Regulatory transparency and evidence based policy (108, 111, 110),
  - o Sustainability from a range of perspectives (113,100, 98, 26, 104, 102, 99)
  - Economic viability (114)
  - o Safety (106)
  - o Trust (112, 101)
  - Improving fishing experience (97)
- Two statements namely 26. Increase quality abundancies re marine biodiversity particularly fish stocks o and 86. Carry out more targeted research on the role and value of habitat with clear objectives and outcomes appear to be 'potent' contributing to 7 values

### Map 3. Focus on 'carrying out more targeted research'



62



### Map 4. Focus on 'ensuring good financial assessment and management'

Map 5: focus on 'increasing quality and abundance'



### Map 6. Focus on 'economic enhancement'





### Map 7. Focus on 'managing the opposition and variation of governmental responses' through 'establishing a playbook'

### Map 8. Focus on 'having a sound understanding of infrastructure design'





### Map 9. Focus on 'ensuring effective engagement' through 'showing examples of environmental stewardship'

# Table 1. Rating of importance of issues and opportunities from the perspective of recreational fishing

Theme	Average	Degree of
	Rating (out of	Consensus
	10)	
79. Have a sound understanding of what infrastructure	9.50	0.87
design and scale - fit for purpose - could provide benefit		
as opposed to being problematic		
66. Establishment of standards, playbook and goal	8.80	0.83
setting to make future processes easier (o)		
72. Ensure effective engagement with and between all	8.00	1.90
stakeholders		
82. Local economies enhancement through increased	7.80	0.83
and diverse opportunities (o)		
26. Increase quality abundancies - re marine biodiversity	7.30	2.70
particularly fish stocks o		
74. Share examples of benefits of environmental	6.50	1.50
stewardship		
86. Carry out more targeted research on the role and	6.30	1.80
value of habitat with clear objectives and outcomes		
76. Manage the opposition and variation of government	6.30	2.90
responses		
89. Ensure good financial assessment and management	5.00	3.20
is carried out for any MMI		

Note: The lower the number the greater the degree of consensus. As such Statement 79 had the highest average. 66 and 82 received the greatest degree of consensus.

### **Next Steps**

- **1.** Conduct further 'workshops' with multiple stakeholder groups for example; commercial fishing, Onslow, Karratha, and Busselton
- 2. Integrate, compare and contrast findings from all workshops along with material from a workshop undertaken with the steering committee and 2 undertaken with Exmouth participants
- **3.** Develop a causal model depicting social values and man-made aquatic infrastructure within the West Australia context
- **4.** Develop semi quantitative models including Multi-Criteria Decision Models to further assess and understand social value
- 5. Integrate workshop findings with findings from other parts of the research project (literature review, survey data, economic data etc.)

## Enhancing the Understanding of the Value Provided to Fisheries by Man-Made

### **Aquatic Structures**

Online Karratha and Onslow Workshop Feedback Report



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### **Executive Summary**

As part of the research project focusing on "Enhancing the Understanding of the Value Provided to Fisheries by Man-Made Aquatic Structures" an online workshop was held on the 24<sup>th</sup> June with representatives from the Karratha and Onslow community. This workshop focused on exploring the issues and opportunities regarding man-made marine structures (MMS) along with determining social values associated with the prioritised themes. The workshops, facilitated by Fran Ackermann and supported by Euan Harvey and Georgie Hill, involved 4 participants and used an online computer – based system to capture, model and synthesise views. This report focuses purely on the material generated from the workshop, however, this material will be integrated with material from other online workshops and those conducted face to face, as well as with the results of a survey and various economic value assessment analyses.

This short report comprises of:

- 1. Project Background
- 2. A brief overview of the method underpinning the workshops and outcomes
- 3. An overview map detailing the opportunities, issues and social values relating to MMS including an appendix detailing each theme with its associated issues and opportunities
- 4. A list of project next steps regarding social value

*Curtin University Human Research Ethics Committee (HREC) has approved this study (HREC number CTR-10729).* 

### Project Background

This project is a collaboration between the Fisheries Research and Development Corporation, Curtin University, The University of Western Australia and the West Australian Marine Science Institution to explore the socioeconomic values associated with MMS. The project has four aims:

- **13.** To develop conceptual qualitative, semi-quantitative and quantitative models for describing the socioeconomic values and decide what information is needed to give stakeholders an understanding of the value of man-made aquatic structures in the marine environment.
- 14. To collate a list and description of the man-made aquatic structures in the marine environment in Western Australian and the associated social, economic and biodiversity data.
- **15.** To collect and collate data on four man-made aquatic structures in the marine environment and develop and compare the costs and benefits of qualitative, semi-quantitative and quantitative models.
- **16.** To develop a decision support system or framework for undertaking socio-economic evaluations of man-made aquatic structures which can be used throughout Australia and guide end users on how to develop qualitative, semi-quantitative and quantitative models depending on their information requirements.

Initial findings from a literature review exploring social and economic values associated with MMS demonstrated that gaps exist within the current body of available research. These include: being discrete in nature, limited diversity of stakeholder view (e.g. focused on one or two groups only), limited specific exploration of MMS (e.g. natural reefs rather than artificial), and not being specifically applicable to a West Australian context (e.g. primarily from other states or countries). As such, using only existing literature to inform this research project would be insufficient.

In order to achieve our research aims the team are undertaking further data collection including holding online workshops with people from Perth, Exmouth, Karratha, Onslow, and Busselton, creating and disseminating a survey for recreational fishers and divers, and determining the monetary value MMS generated by the structures and associated activities. Throughout the data collection process integration between social and economic findings will be completed to achieve a broad and well-informed picture of qualitative, semi-quantitative and quantitative aspects associated with MMS.

### **Brief Overview**

### **Online Recreational Fishing Workshop, 24th June 2020**

- Participant 1
- Participant 2
- Participant 3
- Participant 4

Facilitators: Fran Ackermann, Euan Harvey, Georgie Hill

### Overview

The workshop focused on "what are the issues and opportunities regarding manmade marine infrastructure?" Each participant was given the opportunity to contribute both Issues and Opportunities (denoted by 'l' or 'O') in relation to the focal question. Using a group mapping process, each participant could anonymously contribute to the focal question, seeing their ideas and the contributions of others on their screen and thus 'piggyback' off one another providing a rich reservoir of contributions. The surfaced material was put into rough 'content oriented' clusters and subsequently reviewed by the group allowing for new material to be surfaced as well as to ensure all were clear as to the meaning of the statements.

During the process of elaboration, it became clear that a number of the statements impacted others and so the process of causally linking the statements together was undertaken. This resulted in a 'map' of interconnected issues and opportunities helping tease out a rich picture of the statements along with their systemic properties reflecting the complexity of the topic The linked clusters were reviewed and 'headline' statements identified and given a different style (blue box). Each represented a specific theme. Map 1 shows the issues, opportunities and headline statements.

To conclude the first part of the morning session, a prioritisation process was undertaken asking the participants to rate the headline statements (see Table 1).

**Results**. After a brief break, the group reviewed the headline issues and explored the implications of each, i.e. what value they either supported (opportunities) or attacked (issues). Each value was identified and given a particular attribute (grey box). Map 3 showings the headline issues, values and interconnecting material.



### Map 1. Issues and opportunities identified in the Karratha and Onslow workshop

*Note:* 'Blue boxes' refer to headline statements. A minus sign on the arrowhead reflects a negative link

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### Map 2. Social values identified in the Karratha and Onslow workshop

Note: 'Grey boxes' refer to social values. A minus sign on the arrowhead reflects the opposite.

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### Reflections from the Karratha and Onslow Workshop

### **Reviewing the Issues and Opportunities**

- Number of issues =19, number of opportunities = 20, 5 of both issues and opportunities – revealing that participants tended to view man-made marine infrastructure ....
- The themes are not mutually exclusive they share statements representing the systemic nature inherent in considering MMS
- In many instances themes comprise both Issues and Opportunities demonstrating potential dilemmas.
- Some themes are more developed than others. For example 49 safe environment has only 3 statements supporting it (and it is linking to only 1 other statement). 11 economic diversification however has not only a large number of statements (issues and opportunities) linking to it but also 3 other themes
- There are a number of issues/opportunities that impact more than 1 theme e.g. 40 carry out monitoring of infrastructure to ensure integrity of structure, 36 ensure structures are safe to use e.g Navy Pier shut down, 53 ensure public liability is managed re school engagement, and 47 reverse impact of over fishing.
- There were a number of instances where an issue or opportunity would negatively impact a theme e.g. 28 forced to share locations with others or visit during hot season, which potentially had a negative effect on 16 Liveability for locals through good fishing/diving (O). Thus increasing the number of visitors coming to Karratha and Onslow has both positive and negative consequences when considering the economic diversity theme.

### **Reviewing the values**

- There emerged 5 values ranging from economic diversification to accessibility, from moral responsibility to clarity regarding liability and local budgets.
- Whilst the theme relating to 'safe environment' (49) did not have much in terms of material supporting it, its impact on the values was considerable as it either directly or indirectly impacted 4 of the 5 values. In addition, because it was linked to 49, 51 – careful consideration of location also contributed to 4 of the 5 goals as did 12 – maintenance issues.
- The headline considered to be the most important namely 42 only addressed two of the values.

# Table 1. Rating of importance of issues and opportunities from the perspective of Karratha and Onslow

Theme	Average Rating (out of	Degree of Consensus
	10)	
49. Ensure a safe environment for recreational as well	8.00	2.30
as commercial users		
42. Develop a clear understanding of the risks and	7.50	1.50
opportunities associated with MMI - particularly re		
submerged structures		
51. Carefully consider location of MMI	6.50	1.50
12. Long term maintenance cost liability issues (I)	5.80	2.20
11. Economic diversification - tourism, commercial	5.30	6.30
fishing. (O)		
25. Increase the number of people coming to K and O	5.00	1.90

Note: The lower the number the greater the degree of consensus.

As such Statement 49 *safe environment* - had the highest average. 42 *clear understanding* and 51 *carefully consider location* received the greatest degree of consensus with 42 also having the second highest average.

### **Next Steps**

- **1.** Conduct further 'workshops' with additional stakeholder groups for example; commercial fishing, and Busselton
- 2. Integrate, compare and contrast findings from all workshops along with material from a workshop undertaken with the steering committee and 2 undertaken with Exmouth participants
- **3.** Develop a causal model depicting social values and man-made aquatic infrastructure within the West Australia context
- **4.** Develop semi quantitative models including Multi-Criteria Decision Models to further assess and understand social value
- 5. Integrate workshop findings with findings from other parts of the research project (literature review, survey data, economic data etc.)

# Enhancing the Understanding of the Value Provided to Fisheries by Man-Made Aquatic Structures

Online Busselton Workshop Feedback Report





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### **Executive Summary**

As part of the research project focusing on "Enhancing the Understanding of the Value Provided to Fisheries by Man-Made Aquatic Structures" an online workshop was held on the 14<sup>th</sup> July with representatives from the Busselton community. This workshop focused on exploring the issues and opportunities regarding man-made marine structures (MMS) along with determining social values associated with the prioritised issue/opportunity themes. The workshop, facilitated by Fran Ackermann and supported by Euan Harvey and Georgie Hill, involved 4 participants and used an online computer – based system to capture, model and synthesise views. This report focuses purely on the material generated from the workshop, however, this material will be integrated with material from other online workshops and those conducted face to face, as well as with the results of a survey and various economic value assessment analyses.

### This short report comprises of:

- 1. Project Background
- 2. A brief overview of the method underpinning the workshops and outcomes
- **3.** An overview map detailing the opportunities, issues and a map detailing the social values relating to MMS
- 4. A list of project next steps regarding social value

*Curtin University Human Research Ethics Committee (HREC) has approved this study (HREC number CTR-10729).* 

### Project Background

This project is a collaboration between the Fisheries Research and Development Corporation, Curtin University, The University of Western Australia and the West Australian Marine Science Institution to explore the socioeconomic values associated with MMS. The project has four aims:

- To develop conceptual qualitative, semi-quantitative and quantitative models for describing the socioeconomic values and decide what information is needed to give stakeholders an understanding of the value of man-made aquatic structures in the marine environment.
- 2. To collate a list and description of the man-made aquatic structures in the marine environment in Western Australian and the associated social, economic and biodiversity data.
- **3.** To collect and collate data on four man-made aquatic structures in the marine environment and develop and compare the costs and benefits of qualitative, semi-quantitative and quantitative models.
- 4. To develop a decision support system or framework for undertaking socio-economic evaluations of man-made aquatic structures which can be used throughout Australia and guide end users on how to develop qualitative, semi-quantitative and quantitative models depending on their information requirements.

Initial findings from a literature review exploring social and economic values associated with MMS demonstrated that gaps exist within the current body of available research. These include: being discrete in nature, limited diversity of stakeholder view (e.g. focused on one or two groups only), limited specific exploration of MMS (e.g. natural reefs rather than artificial), and not being specifically applicable to a West Australian context (e.g. primarily from other states or countries). As such, using only existing literature to inform this research project would be insufficient.

In order to achieve our research aims the team has carried out online workshops with people from Perth, Exmouth, Karratha, Onslow and particular cohorts e.g. regulators, oil and gas, as well as creating and disseminating a survey for recreational fishers and divers, and determining the monetary value MMS generated by the structures and associated activities. Throughout the data collection process integration between social and economic findings will be completed to achieve a broad and wellinformed picture of qualitative, semi-quantitative and quantitative aspects associated with MMS.

#### **Brief Overview**

### Online Busselton Workshop, 14<sup>th</sup> July 2020

- Participant 1
- Participant 2
- Participant 3
- Participant 4

Facilitators: Fran Ackermann, Euan Harvey

### **Overview**

The workshop focused on "what are the issues and opportunities regarding manmade marine infrastructure?" Each participant was given the opportunity to contribute both Issues and Opportunities (denoted by 'l' or 'O') in relation to the focal question. Using a group mapping process, each participant could anonymously contribute to the focal question, seeing their ideas and the contributions of others on their screen and thus 'piggyback' off one another providing a rich reservoir of contributions. The surfaced material was put into rough 'content oriented' clusters and subsequently reviewed by the group allowing for new material to be surfaced as well as to ensure all were clear as to the meaning of the statements.

During the process of elaboration, it became clear that a number of the statements impacted others and so the process of causally linking the statements together was undertaken. This resulted in a 'map' of interconnected issues and opportunities helping tease out a rich picture of the statements along with their systemic properties reflecting the complexity of the topic The linked clusters were reviewed and 'headline' statements identified and given a different style (blue box). Each represented a specific theme. Map 1 shows the issues, opportunities and headline statements.

To conclude the first part of the morning session, a prioritisation process was undertaken asking the participants to rate the headline statements (see Table 1).

**Results**. After a brief break, the group reviewed the headline issues and explored the implications of each, i.e. what value they either supported (opportunities) or attacked (issues). Each value was identified and given a particular attribute (grey box). Map 2 showings the headline issues, values and interconnecting material.

Map 1. Issues and opportunities identified in the Busselton



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### Map 2. values identified in the Busselton



*Note:* 'Grey boxes' refer to social values. A minus sign on the arrowhead reflects the opposite.
#### Reflections from the Busselton Workshop

#### Reviewing the Issues and Opportunities

- Number of issues = 26, number of opportunities = 21, 3 of both issues and opportunities – revealing that participants were aware of a range of considerations and took a balanced perspective
- The themes are not mutually exclusive they share statements representing the systemic nature inherent in considering MMS
- In many instances themes comprise both Issues and Opportunities demonstrating potential dilemmas.
- Some themes are more developed than others for example, the theme 38 *manage the type and extent of use of MMI* had 9 statements whereas 19 *cost of ongoing maintenance* and 56 *enhance economic variability and diversity* were less developed.
- There are eight themes as noted on the map (as reflected by the dotted ellipses)

#### Reviewing the values

- There emerged 5 values addressing economic, regulatory, marine health, awareness and culture.
- The theme 'manage the type and extend of use of MMI' addressed 4 of the 5 values making it quite significant

# Table 1. Rating of importance of issues and opportunities from the perspective of recreational fishing

Theme	Average Rating	Degree of
	(out of 10)	Consensus
38. Manage the type and extent of the use of	8.80	1.10
MMI		
28. Risk to users safety	7.00	2.10
17. Creating new habitat for more life/coral	6.50	1.50
rehabilitation areas		
51. Threaten natural environment (marine and	6.50	2.50
costal)		
45. Legislation isn't keeping up with current	6.00	1.90
scientific knowledge		
15. Cost of ongoing maintenance	5.80	2.90
53. Understand the marine environment –	5.50	2.70
greater awareness functions		
56. Enhance economic viability and diversity	5.00	1.40

Note: The lower the number the greater the degree of consensus. As such, statement 38 had the highest average and the greatest degree of consensus.

#### **Next Steps**

- **1.** Conduct further 'workshops' with additional stakeholder groups for example; commercial fishing
- **2.** Integrate, compare and contrast findings from all workshops along with material from a workshop undertaken with the steering committee
- **3.** Develop a causal model depicting social values and man-made aquatic infrastructure within the West Australian context
- **4.** Develop semi quantitative models including Multi-Criteria Decision Models to further assess and understand social value
- 5. Integrate workshop findings with findings from other parts of the research project (literature review, survey data, economic data etc.)

# Enhancing the Understanding of the Value Provided to Fisheries by Man-Made Aquatic Structures

Commercial Fishing Workshop Feedback Report





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#### **Executive Summary**

As part of the research project focusing on "Enhancing the Understanding of the Value Provided to Fisheries by Man-Made Aquatic Structures" an online workshop was held on the 21<sup>st</sup> July with representatives from Commercial Fishing. This workshop focused on exploring the issues and opportunities regarding man-made marine structures (MMS) along with determining social values associated with the prioritised issue/opportunity themes. The workshop, facilitated by Fran Ackermann and supported by Euan Harvey and Georgie Hill, involved 7 participants and used an online computer – based system to capture, model and synthesise views. This report focuses purely on the material generated from the workshop, however, this material will be integrated with material from other online workshops and those conducted face to face, as well as with the results of a survey and various economic value assessment analyses.

#### This short report comprises of:

- 1. Project Background
- 2. A brief overview of the method underpinning the workshops and outcomes
- **3.** An overview map detailing the opportunities, issues and a map detailing the social values relating to MMS
- 4. A list of project next steps regarding social value

*Curtin University Human Research Ethics Committee (HREC) has approved this study (HREC number CTR-10729).* 

#### Project Background

This project is a collaboration between the Fisheries Research and Development Corporation, Curtin University, The University of Western Australia and the West Australian Marine Science Institution to explore the socioeconomic values associated with MMS. The project has four aims:

- To develop conceptual qualitative, semi-quantitative and quantitative models for describing the socioeconomic values and decide what information is needed to give stakeholders an understanding of the value of man-made aquatic structures in the marine environment.
- 2. To collate a list and description of the man-made aquatic structures in the marine environment in Western Australian and the associated social, economic and biodiversity data.
- **3.** To collect and collate data on four man-made aquatic structures in the marine environment and develop and compare the costs and benefits of qualitative, semi-quantitative and quantitative models.
- 4. To develop a decision support system or framework for undertaking socio-economic evaluations of man-made aquatic structures which can be used throughout Australia and guide end users on how to develop qualitative, semi-quantitative and quantitative models depending on their information requirements.

Initial findings from a literature review exploring social and economic values associated with MMS demonstrated that gaps exist within the current body of available research. These include: being discrete in nature, limited diversity of stakeholder view (e.g. focused on one or two groups only), limited specific exploration of MMS (e.g. natural reefs rather than artificial), and not being specifically applicable to a West Australian context (e.g. primarily from other states or countries). As such, using only existing literature to inform this research project would be insufficient.

In order to achieve our research aims the team has carried out online workshops with people from Perth, Exmouth, Karratha, Onslow, Busselton and particular cohorts e.g. regulators, oil and gas, recreational fishing as well as creating and disseminating a survey for recreational fishers and divers, and determining the monetary value MMS generated by the structures and associated activities. Throughout the data collection process integration between social and economic findings will be completed to achieve a broad and well-informed picture of qualitative, semi-quantitative and quantitative aspects associated with MMS.

#### **Brief Overview**

#### Commercial Fishing Workshop, 21<sup>st</sup> July 2020

- Participant 1
- Participant 2
- Participant 3
- Participant 4
- Participant 5
- Participant 6 Participant 7 Facilitators: Fran Ackermann, Euan Harvey

#### **Overview**

The workshop focused on "what are the issues and opportunities regarding manmade marine infrastructure?" Each participant was given the opportunity to contribute both Issues and Opportunities (denoted by 'l' or 'O') in relation to the focal question. Using a group mapping process, each participant could anonymously contribute to the focal question, seeing their ideas and the contributions of others on their screen and thus 'piggyback' off one another providing a rich reservoir of contributions. The surfaced material was put into rough 'content oriented' clusters and subsequently reviewed by the group allowing for new material to be surfaced as well as to ensure all were clear as to the meaning of the statements.

During the process of elaboration, it became clear that a number of the statements impacted others and so the process of causally linking the statements together was undertaken. This resulted in a series of 'maps' of interconnected issues and opportunities helping tease out a rich picture of the statements along with their systemic properties reflecting the complexity of the topic. The linked clusters were reviewed and 'headline' statements identified and given a different style (blue box). Each represented a specific theme. Map 1-3 shows the issues, opportunities and headline statements.

**Results**. After a brief break, the group reviewed the headline issues and explored the implications of each, i.e. what value they either supported (opportunities) or attacked (issues). Each value was identified and given a particular attribute (grey box). Map 4 showings the headline issues, values and interconnecting material.



Note: 'Blue boxes' refer to headline statements. A minus sign on the arrowhead reflects a negative link

#### Map 2. Issues and opportunities



#### Map 3. Issues and opportunities



#### Map 4. The values



*Note:* 'Grey boxes' refer to social values. A minus sign on the arrowhead reflects the opposite.

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#### **Reflections from the Commercial Fishing Workshop**

#### Reviewing the Issues and Opportunities

- The workshop surfaced 40 issues and 26 opportunities with 7 statements that were both issues and opportunities resulting in 73 statements. This suggests that there are a number of factors to consider when considering the social value of MMS and that participants were aware of a range of considerations and took a balanced perspective.
- The three emergent themes were identified revealing the areas concerning commercial fishing representatives and that these could be compared with those themes concerning other populations ensuring a comprehensive understanding. Moreover they are not mutually exclusive they share statements representing the importance of taking a systemic view when considering MMS. This interconnectivity is illustrated through the 'hidden' arrows (dotted arrows with numbers at the head) showing the links between the three theme based maps. Systemicity not only is important when considering actions for today but also for the long term.
- The themes comprise both Issues and Opportunities demonstrating potential dilemmas (where an action can have both a positive and negative effect on the outcome) and therefore careful thought was required.
- Some themes are more elaborated than others for example, the theme 29 potential for interaction between sector groups had 13 statements related to it, whereas 19 cost of ongoing maintenance and 56 enhance economic variability and diversity were less developed.

### Reviewing the values

- There emerged 5 values
  - Three (60%) of the values related to 'users'. This emphasis reflected the challenges in balancing potentially competing interests, importance of understanding the different aspirations and expectations to enable collaboration and leveraging new approaches/technologies.
  - The other two values dealt with regulation (being apolitical) and the need for science based research (which would assist with the apolitical process.

#### General observations

The workshop highlighted the importance of considering MMI in the context of users and their aspirations for the structure alongside the different economic benefits accrued. As

such research into the value of options was important as well as disseminating that information.

It was also noted that considering cohorts as a single entity such as 'commercial fishers' was too high a level of aggregation as there was consider differences in objectives/impact of trawling, trap, aquarium etc.

In addition, thinking creatively, adopting new technologies and taking into account the location/conditions of the proposed location were seen as key factors.

#### Next Steps

- **1.** Conduct further 'workshops' with additional stakeholder groups for example; commercial fishing
- **2.** Integrate, compare and contrast findings from all workshops along with material from a workshop undertaken with the steering committee
- **3.** Develop a causal model depicting social values and man-made aquatic infrastructure within the West Australian context
- 4. Develop semi quantitative models including Multi-Criteria Decision Models to further assess and understand social value
- 5. Integrate workshop findings with findings from other parts of the research project (literature review, survey data, economic data etc.)

# Enhancing the Understanding of the Value Provided to Fisheries by Man-Made Aquatic Structures

NGO Conservation Workshop Feedback Report





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#### **Executive Summary**

As part of the research project focusing on "Enhancing the Understanding of the Value Provided to Fisheries by Man-Made Aquatic Structures" an online workshop was held on the 21<sup>st</sup> July with representatives from NGO Conversation. This workshop focused on exploring the issues and opportunities regarding man-made marine structures (MMS) along with determining social values associated with the prioritised issue/opportunity themes. The workshop, facilitated by Fran Ackermann and supported by Luke Twomey and Carmen Elrick-Barr, involved 6 participants and used an online computer – based system to capture, model and synthesise views. This report focuses purely on the material generated from the workshop, however, this material will be integrated with material from other online workshops and those conducted face to face, as well as with the results of a survey and various economic value assessment analyses.

#### This short report comprises of:

- 1. Project Background
- 2. A brief overview of the method underpinning the workshops and outcomes
- **3.** An overview map detailing the opportunities, issues and a map detailing the social values relating to MMS
- 4. A list of project next steps regarding social value

*Curtin University Human Research Ethics Committee (HREC) has approved this study (HREC number CTR-10729).* 

#### Project Background

This project is a collaboration between the Fisheries Research and Development Corporation, Curtin University, The University of Western Australia and the West Australian Marine Science Institution to explore the socioeconomic values associated with MMS. The project has four aims:

- To develop conceptual qualitative, semi-quantitative and quantitative models for describing the socioeconomic values and decide what information is needed to give stakeholders an understanding of the value of man-made aquatic structures in the marine environment.
- 2. To collate a list and description of the man-made aquatic structures in the marine environment in Western Australian and the associated social, economic and biodiversity data.
- **3.** To collect and collate data on four man-made aquatic structures in the marine environment and develop and compare the costs and benefits of qualitative, semi-quantitative and quantitative models.
- 4. To develop a decision support system or framework for undertaking socio-economic evaluations of man-made aquatic structures which can be used throughout Australia and guide end users on how to develop qualitative, semi-quantitative and quantitative models depending on their information requirements.

Initial findings from a literature review exploring social and economic values associated with MMS demonstrated that gaps exist within the current body of available research. These include: being discrete in nature, limited diversity of stakeholder view (e.g. focused on one or two groups only), limited specific exploration of MMS (e.g. natural reefs rather than artificial), and not being specifically applicable to a West Australian context (e.g. primarily from other states or countries). As such, using only existing literature to inform this research project would be insufficient.

In order to achieve our research aims the team has carried out online workshops with people from Perth, Exmouth, Karratha, Onslow, Busselton and particular cohorts e.g. regulators, oil and gas, recreational fishing as well as creating and disseminating a survey for recreational fishers and divers, and determining the monetary value MMS generated by the structures and associated activities. Throughout the data collection process integration between social and economic findings will be completed to achieve a broad and well-informed picture of qualitative, semi-quantitative and quantitative aspects associated with MMS.

#### **Brief Overview**

#### NGO Conservation workshop, 12<sup>th</sup> August 2020

- Participant 1
- Participant 2
- Participant 3
- Participant 4
- Participant 5
- Participant 6

Facilitators: Fran Ackermann, Carmen Elrick-Barr

#### **Overview**

The workshop focused on "what are the issues and opportunities regarding manmade marine infrastructure?" Each participant was given the opportunity to contribute both Issues and Opportunities (denoted by 'l' or 'O') in relation to the focal question. Using a group mapping process, each participant could anonymously contribute to the focal question, seeing their ideas and the contributions of others on their screen and thus 'piggyback' off one another providing a rich reservoir of contributions. The surfaced material was put into rough 'content oriented' clusters and subsequently reviewed by the group allowing for new material to be surfaced as well as to ensure all were clear as to the meaning of the statements.

During the process of elaboration, it became clear that a number of the statements impacted others and so the process of causally linking the statements together was undertaken. This resulted in a series of 'maps' of interconnected issues and opportunities helping tease out a rich picture of the statements along with their systemic properties reflecting the complexity of the topic. The linked clusters were reviewed and 'headline' statements identified and given a different style (blue box). Each represented a specific theme. Map 1 shows the issues, opportunities and headline statements. The group prioritised the headlines according to their level of importance in relation to social value

**Results**. After a brief break, the group reviewed the headline issues and explored the implications of each, i.e. what value they either supported (opportunities) or attacked (issues). Each value was identified and given a particular attribute (grey box). Map 4 showings the headline issues, values and interconnecting material.

#### Map 1. Issues and opportunities



Note: 'Blue boxes' refer to headline statements. A minus sign on the arrowhead reflects a negative link

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#### Map 2. The values



Note: 'Grey boxes' refer to social values. A minus sign on the arrowhead reflects the opposite.

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#### **Reflections from the NGO Conservation Workshop**

#### Reviewing the Issues and Opportunities

- The workshop surfaced 30 issues and 21 opportunities with 1 statement that were both issues and opportunities resulting in 52 statements with potentially a concerned outlook (i.e. more issues than opportunities). As such the workshop revealed that there are a number of factors to consider when considering the social value of MMS and that participants took a wide ranging perspective.
- The largest of the themes (in terms of supporting material) was 58 potential impact on the marine environment – not surprisingly given the participants were from conversation NGOs. The second largest theme focused on 32 Tourism/business opportunities – which was influenced by material supporting the marine impact theme as well as the safety theme (thus reflecting the need to take a systemic approach). The smallest theme focused on potential conflict between stakeholder/user groups – containing only 2 statements and not being linked to any of the other themes (potentially due to time constraints).
- The majority of the themes comprise both Issues and Opportunities demonstrating potential dilemmas (i.e. where an action can have both a positive and negative effect on the outcome) and therefore careful thought was required when considering any action.

#### Reviewing the priorities

Each of the theme headlines was rated according to its importance towards social and economic value.

The headline that had the highest average (i.e. was seen as the most important in relation to social value) was that of *potential impact on the marine environment* (8.7/10) however the degree of consensus/standard deviation (2.3) reflected that whilst the majority saw it as the most important not all did. The second 'most important' headline was *tourism/business opportunities* (8.3/10) with a higher degree of consensus (0.94). The third most important was *boost the economy* (8/10) with high degree of consensus (1.0). *Tourism/business opportunities* directly linked to *boost the economy* and *impact on marine environment* indirectly (through intermediary issues/opportunities) impacted *tourism/business opportunities* suggesting they were integrated and would benefit from being seen as a 'package'. There was then a considerable gap to the next most important suggesting that these three were seen as the key themes. Moreover they either directly, or through intermediary statements connected to one another.

Theme	Average Rating (out	Degree of
	of 10)	Consensus
58. potential impact on the marine environment (8)	8.70	2.60
32. tourism/business opportunities (12)	8.30	0.97
56. boost economcy in regional areas (20)	8.00	1.00
16. re-use of O&G infrastrucutre (19)	6.20	2.50
62. ensure effective risk analysis undertaken (29)	5.50	2.40
63. safety concerns associated with recreational	5.20	2.50
use through time (13)		
47. Challenges re compliance with licensing	4.30	1.10
conditions (6)		
39. Conflict between structure users (5)	3.00	1.30

# Table 1. Rating of importance of issues and opportunities from the perspective of NGOConservation participants

Note: The lower the number the greater the degree of consensus. As such Statement 58 had the highest average. 32 received the greatest degree of consensus.

# Reviewing the values

- There emerged 9<sup>1</sup> values
  - Whilst social value was viewed as important, the discussion and resultant material reflected the need to take a very wide consideration of value associated with MMS – going beyond social and economic values.
  - The values reflected the breadth of stakeholders ranging from indigenous communities, to commercial fishers, from those taking decisions to enjoyment by recreational fishers.
  - The most central value related to 'ensuring a healthy marine environment with links (direct or via other material) to all bar two of the values

### General observations

The focus group provided valuable material to the study, not only reinforcing a number of the themes and values (identified from other focus group workshops) but in addition generating new values to be considered. The process enabled both the capture of material (issues, opportunities and values) but also the structuring of the material and development of prioritised themes.

<sup>&</sup>lt;sup>1</sup> Statements 66, 71 and 73 were closely connected and deemed one value

#### Next Steps

- **1.** Integrate, compare and contrast findings from all workshops along with material from a workshop undertaken with the steering committee
- 2. Develop a causal model depicting social values and man-made aquatic infrastructure within the West Australian context
- **3.** Develop semi quantitative models including Multi-Criteria Decision Models to further assess and understand social value
- **4.** Integrate workshop findings with findings from other parts of the research project (literature review, survey data, economic data etc.)



# Appendix 9 Economic impact of removing Echo Yodel on commercial fishing

Paul McLeod & Michael Burton

This appendix is part of the final report for:

Enhancing the Understanding of the Value Provided to Fisheries by Man-made Aquatic Structures.

Euan S. Harvey, Fran Ackermann, Michael Burton, Julian Clifton, Carmen Elrick-Barr, Johanna Zimmerhackel, Georgina Hill, Stephen J Newman, Jenny Shaw, Mark Pagano, Paul McLeod, Dianne McLean, Julian Partridge

24<sup>th</sup> August 2021

FRDC Project No 2018-053

# **Economic Impact of Removing Echo Yodel on Commercial Fishing**

Prepared for the FRDC Project: Enhancing the Understanding of the Value Provided to Fisheries by Man-Made Aquatic Structures





### **Report Prepared By:**

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# **1** INTRODUCTION

Large-scale subsea infrastructure is a feature of the offshore oil and gas industry. One challenge for the industry is the management of this infrastructure when it reaches the end of its production life. It requires decommissioning. Options for decommissioning include in situ abandonment after required treatment, removal, and relocation, for example, to form artificial reefs, and complete removal.

While it would seem logical that to require removal of these artificial structures, the decision is not so simple. This is because, in situ, they have over time had arrange of impacts on the marine environment. Removal will likewise have potential and complex effects.

This paper looks at one aspect of this process—the potential impact on commercial fishers who operate on and around the subsea structure.

The structure of interest for this report is Echo Yodel.

Echo Yodel is a Woodside energy pipeline located 137 km north-west of Dampier in Western Australia. Woodside is the operator of the Echo Yodel and Capella-1 infrastructure on behalf of the North West Shelf Project participants. The participants are Woodside Energy Ltd, BHP Billiton Petroleum (North West Shelf) Pty Ltd, BP Developments Australia Pty Ltd, Chevron Australia Pty Ltd, Japan Australia LNG (MIMI) Pty Ltd and Shell Australia Pty Ltd. (Woodside, 2019)

Installed in 2001, it transported gas from the Echo Yodel gas and condensate field to the Goodwyn Alpha platform, some 23 km. The gas and condensate wells ceased production in 2012.

The current proposal for decommissioning permanently plugs and abandons the two production wells (Yodel-3 and Yodel-4) but leaves in-situ the Echo Yodel infrastructure. This includes the pipeline, the umbilical and subsea wellheads.

The final decision on the future management of Echo Yodel is still being considered.

The Echo Yodel infrastructure has been in place for 18 years. In that time, it has provided habitat and support for a range of marine fauna. Recent studies have identified a range of commercially relevant species that have established on the infrastructure. (Bond et al., 2018)

Commercial fishers do fish in the area. They are participants in the Pilbara Trap fishery, which harvests a range of demersal species.

To assess the impact on these fishers from removal of the structure, we need an appropriate framework. The next section considers a generic framework for assessing the impact on fishers of subsea infrastructure removal. This establishes the principles and data requirements needed to develop estimates of economic consequences for any case.

# **1.1** ECONOMIC CONSEQUENCES OF REMOVING SUBSEA INFRASTRUCTURE – THEORETICAL CONSIDERATIONS

For this exercise we assume a managed fishery with a management regime that can match harvest levels with known biomass to ensure sustainable harvest.

Subsea structures potentially enhance the fishing outcomes for commercial fishers in several ways.

Structures act as potential aggregators of fish species of commercial interest. Aggregation increases fish density and allows fishers to harvest more efficiently. Their catch per unit of effort will be higher on the structure compared to locations away from the structure. Aggregation without production is not a reason to revise the harvest strategy. The benefits to fishers arise because with the denser biomass and higher catch per unit of effort, operating costs are reduced and, all other things equal, operating surplus increases. With unchanged total catch revenue will not change.

Beyond aggregation structures may increase production. Where this happens, there is enhanced density on the structure but also an enhanced biomass overall. Fishing on the structure will have enhanced catch per unit of effort as above, but the enhanced production allows a potential revision of the harvest strategy with an increased harvest. There is a potential revenue increase from the increased harvest and a cost reduction from the increase in catch per unit of effort.

Harvest strategies do not restrict fishers to the area on and in the near vicinity of the subsea structure. They have available a much wider range of locations. Therefore, the subsea structure location is best interpreted as just one area of operation for which there are available alternatives or substitutes. Given the impact of the subsea structure on the ecosystem in encouraging aggregation and perhaps production, it likely is one of the more attractive locations to fish. Hence the expectation is that it will feature in the fisher's harvest planning.

In practice, the relative attractiveness of the subsea infrastructure as a fishing location, will be reflected in fisher behaviour. Fishers will schedule the location into their fishing programme if utilising it improves their overall economic performance. This is indicative that the location offers improved catchability, compared to at least some alternative locations they could fish.

The idea of substitutes in fishing locations goes to the question of spatial heterogeneity in the marine environments and species population characteristics in the ocean areas where the fishers can operate.

Two broad simplifying assumptions are useful. These are:

- Spatial homogeneity of environmental conditions, and stock distribution.
- Spatial heterogeneity of environment conditions, population characteristics and stock distribution.

# **1.2** A SIMPLE MODEL BASED ON HOMOGENEITY

Absent the subsea structure, the permitted fishing area has spatial homogeneity. The installation of the structure creates a subsea environment different from that which had prevailed homogeneously before. It has favourable fishing attributes – higher density and catchability, higher catch per unit of effort and lower unit costs.

Figure 1 illustrates this case.

The subsea structure is in an otherwise homogeneous fishing area. The homogeneous area average fishing cost is ACopen per unit of catch. The subsea area offers economic advantages with the lower average fishing costs ACsubsea.

The allowed or managed harvest is H. Fishers plan to catch Hsubsea in the subsea area and the balance H-Hsubsea across the wider area.

The shaded area Ss (area abcd) is the surplus being earned from the subsea area harvest. Area So is the surplus being earned from the open area harvest.

The lower average cost per unit of catch in the subsea area arises from the marine environment created on the subsea structure with improved density and catchability and an increase in availability of commercial species.

The longer the structure remains in place, the more changed is the associated marine environment.

With removal of the subsea structure, the marine environment is potentially changed back to a state closer to the original state that existed before the structure was installed.

This will take some time. For exposition purposes, assume that the new ecosystem equilibrium approximates the original conditions. In this simple model, this restores the average harvest cost back to the open area level. The entire catch has the unit average cost ACopen. For this straightforward case, the loss to the commercial fishers depends on the difference between the average harvest costs. This leads to an estimated loss of abef. The harvest that was or is still caught in the subsea area is now caught at ACopen and earns the surplus efcd. With the structure in place this harvest was caught at the lower unit cost ACsubsea.

The loss or surplus is efcd.

The difference in cost depends on catchability and catch per unit effort in the subsea area compared to the substitute area, in this case, the wider ocean fishing area.

Enhancements could be added to this simple model. The subsea area ecosystem may not revert simply to the previous state and may still offer some residual fishing advantages. Here, the surplus loss is smaller than that represented by the diagram.

Depending on the significance of the subsea area in their overall operations, its removal may cause fishers to recalibrate their fishing strategies when they revert to fishing optimally from the wider area. This might reduce the harvesting cost in the open area, ACopen. Again, the consequent loss of surplus would be smaller.

While these enhancements are potentially interesting, they do not change the basic conclusion. If the subsea area has become a preferred fishing location, its removal will increase overall fishing costs and reduce surpluses earned. The loss depends on the difference in catchability, catch per unit of effort and cost per unit of catch between the two areas.



Figure 1: Two Zone Model Based on Spatial Homogeneity Without Subsea Structure

# **1.3** A SIMPLE MODEL BASED ON HETEROGENEITY

One way to consider heterogeneity is to divide extensive fishing grounds with variability in environmental conditions, abundance heterogeneity, and variable growth and mortality patterns into smaller sub areas that can be considered independent units. Each subarea is then assumed homogeneous within the subarea.(Seijo, Defeo, & Salas, 1998) Catchability and fishing costs will vary between sub areas.

Taking this approach, optimal allocation of fishing effort spatially across the subareas would require the surplus earned in each area (Price-Marginal Cost) to be equal at the margin. This optimizes economic performance (maximizes earned surpluses) allowing for differential harvesting costs.

Absent the subsea structure, with heterogeneity, the permitted fishing area consists of different subareas.

The subsea structure is located within one of the subareas. The structure creates a subsea environment different from that which prevailed previously in that subarea. Compared to the pre-structure situation, the subarea now has more favourable fishing attributes – higher density and catchability, higher catch per unit of effort and lower unit costs.

As with the previous model, the key result is the difference that the subsea structure and associated environment make to the fishers' cost of fishing and economic returns.

However, unlike the previous model, in the heterogeneous case, the outcome depends on the relative attractiveness of the subarea containing the structure for commercial fishing.

The structure area may be in a sub area that was previously not fished because its attributes were not conducive compared to other areas. In this case, its enhanced performance causes it to be fished whereas previously it was not. Fishers rearrange the spatial fishing activity to incorporate the new subarea.

Alternatively, the subarea might be an area that was fished previously because it was commercially attractive even without the structure, but the new structure has enhanced this attractiveness. In this case, its relative attractiveness improves and its ranking within the locations to fish increases. It is now higher in the order of priority, ceteris paribus.

Figure 2 illustrates this case.

There are four subareas with marginal costs of harvest MC1 through MC4. Market price is indicated by the demand curve and is the same for harvest from each area. The subsea structure is in area 2 and has lowered the marginal cost of harvest to MC2. If effort could be pursued without limit, fishers could expand until P=MC in each area. However, as in the first model, we assume a harvest strategy which restricts the total catch. This being the case, as explained above, fishers allocate effort to make the marginal surplus (Price -Marginal Cost or P-MC) the same in each area.

With the subsea structure in place, the marginal cost in area 2 is lowered to MC2. Allocation is optimal along the "Allocation with" line with harvests of H1, H2, H3 and H4. The structure has attracted effort to area 2. The surplus is PC in area 2 and is the same for all areas.

When the structure is removed, and the environment returns to something like the previous condition, the harvest costs in area 2 increase to MC2'. Immediately the marginal returns in area 2 are reduced and are below the marginal returns in areas 1, 3, and 4. Marginal returns fall to PC' in area 2. Fishers reallocate effort away from area 2 toward the other areas where the marginal returns are now higher than in area 2. The process finds a new equilibrium when the marginal returns are equalized. This occurs at harvests H1', H2', H3' and H4'. The marginal returns are lower. In area 2, the reduction in harvest incurs losses equal to area ADCP. On the remaining harvest H2', costs are now higher with a loss equal to EFBD. Output is expanded in each other area with some surplus gain. In area 1 this is HIJK. There is a similar gain in areas 3 and 4. Therefore the net effect is the difference between the loss of surplus in area 2 and the gains in areas 1, 3, and 4. With the same target harvest there will be net loss, but this shows that its magnitude will depend on how significant the harvest cost difference is with and without the structure and the closeness of area 1, 3 and 4 as substitutes for area 2.

Although modelling spatial heterogeneity has a long history and its importance is generally accepted, models incorporating heterogeneity are data intensive and have proved difficult to calibrate. (Jardim et al., 2018).

Figure 2 Two Zone Model Based on Spatial Heterogeneity Without Subsea Structure



# 2 ECHO YODEL DECOMMISSIONING

# **2.1** PILBARA TRAP FISHERY

The Echo Yodel pipeline is within the area fished by fishers in the Pilbara Trap Managed Fishery. This managed fishery is within the North Coast Bioregion.

There are 15 different State-managed commercial fisheries operating within the North Coast Bioregion (Gaughan & Santoro, 2020). The main commercial fisheries in the area harvest tropical finfish. High-value emperors, snappers and cods that are the focus of the Pilbara trap, line and trawl fisheries and the Northern Demersal Scalefish Fishery.

The typical catch across these fisheries is in the order of 3,000-4000 tonnes annually. Estimated combined annual value is \$10 -\$20 million (Gaughan & Santoro, 2020). The implied average price range is\$3 - \$5 per kg. At this value, they are the most valuable finfish fisheries in Western Australia.

Within the Inshore Demersal region, there are four managed fisheries, the Pilbara Fish Trawl (Interim) Managed Fishery (PFTIMF); the Pilbara Trap Managed Fishery (PTMF); the Pilbara Line Fishery (PLF); and the Northern Demersal Scalefish Managed Fishery (NDSF).

The major demersal scalefish catches in the Pilbara come from the three managed fisheries - the Pilbara Fish Trawl (Interim) Managed Fishery (PFTIMF); the Pilbara Trap Managed Fishery (PTMF); the Pilbara Line Fishery (PLF). Management of these fisheries is primarily through input controls. There is a total allowable effort (TAE) allocation system via individually transferable effort (ITE) allocations. The management regime within the current harvest strategy defines an acceptable catch range for each fishery (DPIRD, 2017).

The accepted catch ranges are 94-1,416 tonnes for the Pilbara Fish Trawl (Interim) Managed Fishery (PFTIMF), 241-537 tonnes for the Pilbara Trap Managed Fishery (PTMF) and 36-127 tonnes for the Pilbara Line Fishery (PLF).

The Pilbara Fish Trawl Fishery demersal scalefish catch primarily harvests lower-valued species such as bluespotted emperor and threadfin bream. Gross value is estimated to be \$5-10 million The Pilbara Trap and Pilbara Lines fisheries harvest more valuable species such as red emperor and goldband snapper. The value of the demersal scalefish catch from these sectors is around \$1-5 million.

The Pilbara Fish Trawl Fishery employs around 10 fishers on 2 vessels. The Pilbara Trap Managed Fishery employment is around 8 fishers on 3 vessels. The Pilbara Line Fishery employs around 15 fishers on 5 vessels (Gaughan & Santoro, 2020).

Over recent years, the trawl catch averages around 1,200 tonnes annually, while the annual caches by the trap fishery and the line fishery are smaller at around 400 tonnes and within the range 40 to 260 tonnes, respectively.

The demersal fisheries in the North Coast Bioregion are not large in absolute terms, although they are relatively important in the spectrum of commercial fishing in Western Australia.
The estimated 2018 the catch and gross values are shown in Table 1.

Table 1: Catch and Gross Catch Values in Pilbara Fisherie
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Fishery	Catch	Value
Pilbara Trawl	1,996	\$5-10 million
Pilbara Trap	563	\$1-5 million
Pilbara Line	93	\$1-5 million

Source: (Gaughan & Santoro, 2020)

The Echo Yodel pipeline is in the trap fishery area.

In summary, in 2018 the trap fishery harvested 563 tonnes which was slightly outside of the acceptable harvest range. However, average catches over recent years have been around 400 tonnes.

At \$5 per kg, harvest value is around \$2.8 million in 2018 and \$2 million on average. It directly employs around 8 fishers on three vessels. There are 6 licences permitted to operate in the fishery. Available information indicates that two owners hold all 6 licences.

The allowed fishing area for the trap fishery is shown in Figure 3.

Figure 3: Fishing Zones for the Pilbara Fisheries



This area is extensive and the area around Echo Yodel is a relatively small area within the larger area of operation.

## 2.2 COMMERCIAL VALUE OF ECHO YODEL

The limited data available means that applying the heterogeneous model as outlined above is not feasible for the Pilbara Trap Fishery and the Echo Yodel pipeline. Hence, we will work with the simpler homogeneous model. However, even for this model, data availability is a constraint.

There is evidence that the marine environment along the pipeline has become more favourable as a fish habitat since the pipeline was installed 18 years ago. Recent surveys reveal an increase in fish stocks, including of commercially valuable species (Bond et al., 2018). Clearly aggregation has occurred, but the evidence does not allow an assessment of the extent to which production has also occurred. This suggests that the Echo Yodel pipeline fits the basic premise of the homogeneous model. It has improved fishing conditions in the vicinity of the pipeline and makes the area a relatively more attractive location for commercial fishing than would have previously been the case without the subsea pipeline infrastructure.

There are significant data limitations in estimating the model for Echo Yodel.

The average annual catch is known. The average price can be estimated so the value of the catch is known. In essence, we can calculate the gross revenue.

However, what the model makes clear is that the estimate required is an estimate of the surplus with and without the pipeline. That is the area abcd +So compared to area abef + So.

The recent catch from the Pilbara Trap fishery is at the upper limit of the acceptable harvest strategy catch range. The removal of Echo Yodel is unlikely to cause a revision of the harvest strategy. Effectively fishers will have the same aggregate harvest targets with or without Echo Yodel.

The impact of the pipeline therefore comes down to fishing costs on and away from the pipeline and the share of the current catch that is on the pipeline. Critical to any assessment is the way fishers adapt their fishing strategies with and without the pipeline.

There is no public data on the share of the catch that currently taken along the Echo Yodel Pipeline. The average harvest cost per unit is not public information and is therefore not available for either the pipeline area or the overall fishery. Detailed surveys of the financial performance of Pilbara demersal fisheries are not available.

Relevant data needs to be obtained directly from fishers or estimated from third party sources.

## 2.2.1 The role of Echo Yodel in current fishing operations

Discussion with a major trap fishing operator has provided insights into the fishery operation and role of Echo Yodel.

Trap fishing is opportunistic. Fishers place traps where they anticipate good catches but need to move on quickly if catch is poor. Therefore, trap fishers like having proximate locations to try so they do not have to steam far to try the next location. Effectively, they prefer a suite of close substitute locations.

Echo Yodel fits this pattern. It has attractive nearby/surrounding locations. It can be "tried" without great cost. The proximate locations can be accessed quickly.

However, within this approach, Echo Yodel does not get routinely tried. Pipelines are easy to hit and initial fishing is typically good, but then as fishing occurs, the relative advantage disappears quickly. Trap fishers require good stock density, so pipelines are typically good the first time but then become just another location. After the initial effort, pipelines are essentially then hit and miss for traps. Once this occurs, the pipeline location is part of the suite available for opportunistic fishing. No regular share of aggregate fishery catch is coming from Eco Yodel. There is unlikely to be a significant impact on profits from not having it, because it is fished occasionally, perhaps every few years, and alternative locations are available nearby.

In summary, the evidence is that there has been an increase in species available along Echo Yodel, but that it is not an area that is routinely incorporated in annual fishing plans. Rather, it is "pulsed" and then left for a few years.

Arguably, the ongoing benefit is the potential role of the pipeline in the production of feeder stock that then spreads out into the wider environment. Even if the science on this is still uncertain, purely from a commercial fisher perspective, it is better kept than removed.

## 2.2.2 Indicative estimate of the Commercial Fishing Value of Echo Yodel

The discussions with fishers indicate that, while good to have as another option, Echo Yodel does not play a key role in the fishing strategies for the Pilbara Trap Fishery. Its commercial value is likely modest.

Combining available information on aggregate catch and prices, combined with third party survey data on margins, allows an indicative estimate of this, albeit modest, value.

A survey-based analysis of South Australian marine scalefish operators documented their revenues, fixed and variable costs. Across the operators, the average gross margin (revenue minus variable costs) was 46% of revenue. (BDO EconSearch, 2020). We adopt this as indicative of gross margins in scalefish operations. In 2013, a small sample of Pilbara fishers provided information to the author for analysis as part of a submission into management and compensation decisions. The average gross margin was 47%.

Using the gross margin (revenue minus variable costs) assumes that the fixed costs (licence fees, rent, lease costs etc) would be unaffected by the decommissioning of the pipeline. Although applicable for the short run, in the long run, absent the pipeline, fishers may adjust the configuration of their operations, which could affect fixed costs.

Using the 46% gross margin figure, allows an estimate of the surplus without the pipeline in place. Surplus with the pipeline is the area So plus Ss (=abcd) in Figure 1. Without the pipeline surplus is reduced to area So plus area plus the smaller on-pipeline surplus abef.

To estimate the loss of surplus we need an estimate of area efcd. At this stage we can only make a "best guess" as to the proportion of catch on the pipeline and the cost advantage of fishing on the pipeline.

Figure 3 gives an estimate of the potential lost surplus from removing the fishing opportunity provided by Echo Yodel. It uses current catch (563 tonnes), a high-end price (\$6 per kg) and the South Australian fishery gross margin (46%).

Consistent with pulse fishing every few years, it is assumed that, on average, 5% of the catch occurs within the Echo Yodel area and that the improved catchability in pulse years equates to a 10% lower fishing cost per kg for fish caught in the area.

The loss is surplus under these conditions is estimated to be \$9,121. The calculation is shown in Table 2.

# 2.3 SIGNIFICANCE

The estimated surplus loss of \$9,121 is around 0.3 percent of estimated industry gross revenue. However, allowing for both variable costs and fixed cash costs (i.e. excluding non-cash costs like depreciation) the net cash income was estimated to be 20 percent of revenue for the South Australian marine scalefish fishery (BDO EconSearch, 2020). Applying this as an indicative estimate for the Pilbara Trap managed Fishery, the estimated loss is around 1.35 percent of the gross revenue in the Pilbara Trap managed Fishery.

Table 2: best Guess Estimate of Lost Commercia	<i>I Fishing Surplus from loss of Echo Yodel Pipeline.</i>
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		Average Beach Price	Gross	Variable Costs as % of Gross	Variable Costs No	Gross margin/Surplus - no Echo	Surplus (price - variable costs) as % of Gross	Echo Yodel Cost	Variable	Gross margin/Surplus	Surplus Gain from Echo
	Catch(tonnes)	per Kg	Revenue	Revenue	Echo Yodel	Yodel	Revenue	Advantage	Costs	- Echo Yodel	Yodel
Total Catch	563	6	3,378,000	54%	\$1,824,120	\$1,553,880	46%	0%	1,814,999	\$1,563,001	\$9,121
% on Echo											
Yodel	5%										
Catch Echo											
Yodel	28	6	168,900	54%	\$91,206	\$77,694	46%	10%	82,085	\$86,815	\$9,121
Balance Catch	535	6	3,209,100	54%	\$1,732,914	\$1,476,186	46%	0%	1,732,914	\$1,476,186	

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# Appendix 10 Map illustrating the interconnectivity of the values highlighting the systemic nature of the values system

Fran Ackermann & Georgina Hill

This appendix is part of the final report for:

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Euan S. Harvey, Fran Ackermann, Michael Burton, Julian Clifton, Carmen Elrick-Barr, Johanna Zimmerhackel, Georgina Hill, Stephen J Newman, Jenny Shaw, Mark Pagano, Paul McLeod, Dianne McLean, Julian Partridge

24<sup>th</sup> August 2021

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### Appendix 11 Issues and opportunities underpinning the meta and generic values

Fran Ackermann & Georgina Hill

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Generic and Meta-Values	Contributing Issues and Opportunities
Ensure a healthy marine	• Access by disadvantaged people (closer in shore - fish and dive)
environment	Access to sheltered waters
	Access to the site opportunities
	Additional habitat for fish and corals
	• Artificial reef infrastructure act as fads rather than areas for fish
	population growth
	<ul> <li>Assess the seabed/area e.g. Acidic soils</li> </ul>
	<ul> <li>Avoid putting an artificial on top of a natural</li> </ul>
	<ul> <li>Avoid putting artificial reefs on top of other sensitive areas</li> </ul>
	<ul> <li>Be clear re the objectives of the reef</li> </ul>
	Be clear who users are
	Bleaching damage
	<ul> <li>Can be used to gain social licence but not suitable for</li> </ul>
	environmental offset
	Careful consideration of location
	Change in current/ sand movement, impacts to coastal erosion.
	Clarify liability issues
	Concerns of contaminants from mms on existing environment
	Concerns re residual contamination of o&g structure
	Contamination potential from old oil and gas infrastructure
	Cost of removal could be cheaper than mms remaining because
	of consultation time, liability and community reimbursement of
	<ul> <li>Cost reduction for operators may be perceived but not always</li> </ul>
	reality
	Cost savings in using existing mms to build artificial reefs over
	creating new materials for future fisheries enhancement
	<ul> <li>Creates more living areas/homes for fish stocks greater diversity of fish</li> </ul>
	• Creating new habitat for marine life/coral rehabilitation areas etc
	• Creation of additional environment for rare/threatened species
	Cut down total catch quantum
	Damage to natural environment
	Decommissioning requirements in commonwealth waters are
	currently being reviewed - the study could play into this
	<ul> <li>Depletion of fish stocks from increased effort encouraged by artificial reefs</li> </ul>
	Different issues and opportunities with decomm of pipelines and
	other o&g infrastructure
	Displacement and impacts on natural marine communities
	Do they impinge on perceptions of naturalness
	Ease of access to sites - decrease of boat traffic
	Easier access for those with limited resources
	<ul> <li>Easy to find - for those less familiar with reefs</li> <li>Easy to identify use of the reef (herefite)</li> </ul>
	<ul> <li>Easy to identify use of the reef (Deficients)</li> <li>Ecosystem research - cruntic species (hard to find) aggregating</li> </ul>
	around structures

<ul> <li>Employment opportunities through research, fishing and dive</li> </ul>
charters
<ul> <li>Ensuring fishing activities are appropriately regulated to protect fish stocks and the environment</li> </ul>
<ul> <li>Environmental contamination - potential or otherwise</li> </ul>
<ul> <li>Establish regulation - duplication/overlap</li> </ul>
• Establish who is the 'lead' agency - lack of clarity re process wrt to
mmi
<ul> <li>Future direction of decommissioning considered earlier on in activity planning</li> </ul>
<ul> <li>If cluster of mms -could act as potential steppingstones for</li> </ul>
invasive species
<ul> <li>Increase awareness and appreciation of what is in the marine anvironment</li> </ul>
environment
<ul> <li>Increase of habitat for demensal lish and lobster. Different to mandruab-hunbury-dunchorough</li> </ul>
Increase safety
<ul> <li>Increased (man-made) structures for improving commercial and</li> </ul>
aquaculture production and profitability (o)
<ul> <li>Increased ease to get to site - balance between depth and</li> </ul>
distance from shore/ boat ramp
<ul> <li>Increased habitat in barren areas</li> </ul>
<ul> <li>Increased participation in community engagement through</li> </ul>
monitoring
<ul> <li>Increased pressure on fish stocks from concentrating existing fish</li> </ul>
around an attraction device
<ul> <li>Increased vertical relief in water column</li> </ul>
Increasing carrying capacity (of the environment) at local level
Is this pollution of the sea? [public percention]
Ich/employment opportunities
Legal liability of mms left in environment
Less complex decommissioning projects with potential
social/environment benefits (in relation to oil and gas
infrastructure) minimises impacts to ecosystems that have
established around infrastructure.
<ul> <li>Liability - long term, when it passes to artificial reef etc.</li> </ul>
<ul> <li>Lose natural diversity</li> </ul>
<ul> <li>Maintaining/nurturing marine ecosystems that develop around</li> </ul>
infrastructure
<ul> <li>Managing multi-user risks e.g. Divers vs fishers</li> </ul>
Increased hazards in the environment
Negatively change the natural environment     Obstacle for trolling/trawling - mackerel and waboo and prawps
Opportunity for fish sanctuaries (no take)
<ul> <li>Pier infrastructure changes the ecology of the natural</li> </ul>
environment
<ul> <li>Planning for future decommissioning considered early to use</li> </ul>
appropriate materials for leaving in situ etc
<ul> <li>Potential disruption of current flow</li> </ul>

	•	Potential environmental impact of the structure itself
	•	Potential for invasive species presence
	•	Potential for transportation of invasive species if structures
		moved to reefing site
	•	Potential refuge for rare/endangered species
	•	Potential to improve sustainability of commercial fishing industry
		in Australia
	•	Precedence setting
	•	Protecting new reefs allows for population growth allowing the natural spill over effect
	٠	Protection for natural sites by redirecting fishing efforts
	•	Provide for an increase in fish stocks
	•	Public perception of "dumping" of infrastructure
	•	Recognise depth impacts use i.e. >19 meters limits spear fishing
	•	Recognise that regulations work on a case by case basis and that
		what is accepted for one, might not be for another
	٠	Reduce the cost of decommissioning for proponents and general
		public/governments
	٠	Reduced transport of wastes overseas as opposed to retaining
		our own waste products
	٠	Relocate corals etc
	٠	Resourcing of infrastructure maintenance in long term
	٠	Retain existing habitat for value
	•	Retention of some of the largest structures in the ocean for
		habitat value
	٠	Reuse of material and reduction in waste
	٠	Set up dive trails
	٠	Set up employment
	٠	Spread of pressure on reef systems
	•	Stock depletion from rediverting fish from usual habitat
	٠	Threaten natural environment marine and coastal
	٠	Trawler damage
	•	With larger fish populations growing on new habitat creating new dive sites
Desire to protect the	•	Aggregation devices can bring in predators, potentially creating
environment		false perception that might be a public hazard
	•	Better understanding of the marine environment (and the impact
		of mmi)
	•	Better understanding of viability and sustainability of oceans
	•	Carry out monitoring of infrastructure to ensure integrity of
		structure
	•	Carry out research on environmental impacts
	•	Commercial Fishing
	•	Commercial tourism
	•	Creation of single use areas for specific activities- e.g. fishing
		only, diving only (no take) for safety and social reasons
	•	Develop a clear understanding of the risks and opportunities
		associated with MMI - particularly re submerged structures
	•	Fish aggregation possibility of rec fishes depleting stocks.
	•	Great opportunity to work with school kids and raise awareness

	• Keep impact to the environment at reasonable levels	
	<ul> <li>Manage the type and extent of use of MMI</li> </ul>	
	<ul> <li>Potential hazard for boats and other water users</li> </ul>	
	<ul> <li>Reverse impact of overfishing</li> </ul>	
	• Understand the benefits of marine sanctuary	
	• Understand the marine environment - greater awareness -	
	functions	
	<ul> <li>Use for other recreational activities. E.g. Surfing</li> </ul>	
	What is a 'good' number of structures for the environment -	are
	there any long term negative effects known?	
Marine biodiversity	<ul> <li>Access by disadvantaged people (closer in shore - fish and d</li> </ul>	ive)
	• Access to the site opportunities	
	All structures are removed	
	• Assess the seabed/area e.g. Acidic soils	
	• Avoid putting an artificial on top of a natural	
	• Avoid putting artificial reefs on top of other sensitive areas	
	• Be clear re the objectives of the reef	
	Bleaching damage	
	Careful consideration of location	
	<ul> <li>Citizen science and community stewardship of the environm</li> </ul>	nent
	translating to wider environment	
	<ul> <li>Ease of access to sites - decrease of boat traffic</li> </ul>	
	<ul> <li>Easier access for those with limited resources</li> </ul>	
	<ul> <li>Easy to find - for those less familiar with reefs</li> </ul>	
	<ul> <li>Easy to identify use of the reef (benefits)</li> </ul>	
	• Fishers to be better engaged in design, site identification,	
	monitoring and assessment	
	<ul> <li>Increase safety</li> </ul>	
	<ul> <li>Increased ease to get to site - balance between depth and</li> </ul>	
	distance from shore/ boat ramp	
	<ul> <li>Increased habitat</li> </ul>	
	<ul> <li>Increased habitats for fish life</li> </ul>	
	<ul> <li>Is habitat enhancement the charismatic megafauna of habit</li> </ul>	at???
	• Lack of clear evidence of value of in-situ decommissioning.	
	New fish habitat	
	<ul> <li>New structures create new habitat for reef fish</li> </ul>	
	<ul> <li>NGOs to take the lead creating artificial opportunities.</li> </ul>	
	<ul> <li>Obstacle for trolling/trawling - mackerel and wahoo and pra</li> </ul>	iwns
	<ul> <li>Potential habitat for invasive marine species</li> </ul>	
	<ul> <li>Potential nursery habitat</li> </ul>	
	<ul> <li>Potential nursing/breeding grounds established</li> </ul>	
	<ul> <li>Potential repurposing of structures for alternative energy et</li> </ul>	.C
	<ul> <li>Provides habitat for endangered species</li> </ul>	
	Provides valuable habitat	
	<ul> <li>Recognise depth impacts use i.e. &gt;19 meters limits spear fish</li> </ul>	hing
	<ul> <li>Recognise different structures will attract different forms of</li> </ul>	fish -
	pelagic to reet	
	<ul> <li>Recognise not all increases in fish/ coral life is beneficial</li> </ul>	

	<ul> <li>Recognition of fishers as leaders in environmental management - not always about murdering fish</li> <li>Refuge for vulnerable species from over-fishing pressures</li> <li>Share examples of benefits of environmental stewardship</li> <li>Social licence for mining industries and recognition of good citizenship as potential offsets</li> <li>Some structures in deep water provide no benefit for either fish habitat or commercial/recreational use</li> <li>Trawler damage</li> </ul>
Maintain natural aesthetic	N/A
aesthetic Regional economic benefits (tourism & employment)	<ul> <li>(in relation to oil and gas infrastructure) minimises impacts to ecosystems that have established around infrastructure.</li> <li>Access to sheltered waters</li> <li>Access to the site opportunities</li> <li>Aging/breakdown of man-made structures over time</li> <li>Applying user pays model to eco-tourism</li> <li>Attract and retain staff - local govt, tourism providers etc</li> <li>Become more attractive to the Asian market</li> <li>Broader applicability for rivers and man-made freshwater impoundments</li> <li>Carry out monitoring of infrastructure to ensure integrity of structure</li> <li>Carry out research on environmental impacts</li> <li>Charge in current/ sand movement, impacts to coastal erosion.</li> <li>Charter and commercial fishing access competing with other users</li> <li>Collaborations with other countries with 50+ years' experience e.g. China. Japan, Vietnam</li> <li>Commercial fishing target o&amp;g structures</li> <li>Commercial fishing target o&amp;g structures</li> <li>Constraints in sharing fishery resources, sees policy look to "growing the pie"</li> <li>Cost of ongoing maintenance</li> <li>Create new industry sector re removal and management of infrastructure</li> <li>Creating new habitat for marine life/coral rehabilitation areas etc</li> <li>Creation of diverse fishing opportunities</li> <li>Creation of diverse fishing opportunities</li> <li>Creation of single use areas for specific activities- e.g. fishing only, diving only (no take) for safety and social reasons</li> <li>Damage to natural environment</li> <li>Delay in actions (e.g. Dispute)</li> </ul>
	<ul> <li>Develop a clear understanding of the risks and opportunities associated with MMI - particularly re submerged structures</li> </ul>

<ul> <li>Develop ocean/water based tourism facilities for a small town of</li> </ul>
Onslow (850 pax)
<ul> <li>Disruption of established marine ecosystems from</li> </ul>
decommissioning
<ul> <li>Duty of care/responsibility for site use</li> </ul>
<ul> <li>Eco-tourism vs consumptive use of resultant structures</li> </ul>
<ul> <li>Economic diversification - tourism, commercial fishing.</li> </ul>
• Economic multiplier to towns through employment, local spend,
accommodation etc.
<ul> <li>Ecosystem research - cryptic species (hard to find) aggregating</li> </ul>
around structures
<ul> <li>Employment opportunities through research, fishing and dive</li> </ul>
charters
<ul> <li>Enhance economic viability and diversity</li> </ul>
• Ensuring fishing activities are appropriately regulated to protect
fish stocks and the environment
• Fisher conflict with other user groups particularly inshore
infrastructure
<ul> <li>Increase of habitat for demersal fish and lobster. Different to</li> </ul>
mandruah-bunbury-dunsborough.
<ul> <li>Increase quality abundancies - re marine biodiversity particularly</li> </ul>
fish stocks
<ul> <li>Increase the number of people coming to k and o</li> </ul>
<ul> <li>Increased (man-made) structures for improving commercial and</li> </ul>
aquaculture production and profitability
<ul> <li>Increased hazards in the environment</li> </ul>
<ul> <li>Increased market and collaboration</li> </ul>
<ul> <li>Increased vertical relief in water column</li> </ul>
<ul> <li>Increasing carrying capacity (of the environment) at local level</li> </ul>
<ul> <li>Increasingly loss of fishing access from land-based infrastructure</li> </ul>
i.e. Ports
<ul> <li>Job/employment opportunities</li> </ul>
<ul> <li>K have a bigger town and open government</li> </ul>
Keep impact to the environment at reasonable levels
<ul> <li>Lack of understanding of benefits to tourism</li> </ul>
Less complex decommissioning projects with potential
social/environment benefits
<ul> <li>Local economies enhancement through increased and diverse</li> </ul>
opportunities
<ul> <li>Lose natural diversity</li> </ul>
<ul> <li>Maintaining/nurturing marine ecosystems that develop around</li> </ul>
infrastructure
<ul> <li>Manage different demands of stakeholders from divers to</li> </ul>
recreational fishers
<ul> <li>Manage the type and extent of use of MMI</li> </ul>
Fish aggregation possibility of rec fishes depleting stocks.
<ul> <li>Managing multi-user risks e.g. Divers vs fishers</li> </ul>
<ul> <li>Managing/mitigating potential environmental harm</li> </ul>
<ul> <li>Need for ongoing monitoring</li> </ul>
<ul> <li>Onslow perfect location apart from cyclone season</li> </ul>

- Potential hazard for boats and other water users
- Potential hazard for boats and other water users
- Potential to improve sustainability of commercial fishing industry in Australia
- Preserving maritime heritage
- Provide additional social benefit
- Provide job opportunities
- Provide opportunities for education allow marine life to be viewed in situ
- Provides for new fishing experiences
- Recreational fishing opportunities
- Reduce the attractiveness of k and o
- Regional economies disproportionally benefit from fishing related enhancement
- Regional interests competing for benefits
- Relocate corals etc
- Research and data
- Reverse impact of overfishing
- Risk of accident or injury user safety
- Risk that the existing infrastructure not able to cope
- Risks to user safety
- Seabed lease terminated/responsibility for removing structure
- See a range of repurposing uses from fish friendly locations to wind farms
- See increased collaboration between all marine users
- See large surge of decommission cases
- Set up dive trails
- Set up employment
- Shore based infrastructure often overlooked as benefits to community and disabled as well as habitat (e.g. Melbourne jetties, Busselton)
- Spatial and temporal access between sectors.
- Take a very broad interpretation of compliance beyond laws/ regulations (include policy, best practice)
- Threaten natural environment marine and coastal
- Understand social and environmental impacts of removing man made marine structures
- Understand the benefits of marine sanctuary
- Understanding long term environmental impacts of leaving (or creating) infrastructure (can include altering sand movement, construction material, selection, etc
- Use as an environmental/fishing offset to other industrial activity
- Use for other recreational activities. E.g. Surfing
- Volunteers get fed up and stop doing it burn out
- Well defined regulatory frameworks for understanding of all stakeholders
- What is a 'good' number of structures for the environment are there any Long term negative effects known? (I)

Safe accessible fishing	• Assess the second /area or a Asidic soils
environments	<ul> <li>Assess the seabed/area e.g. Actuic solis</li> <li>Carefully consider location of mmi</li> </ul>
	<ul> <li>Consider pollutants re the artificial reef materials</li> </ul>
	<ul> <li>Develop coastal management plan (weather fronts, tidal changes)</li> </ul>
	<ul> <li>Increased debris</li> </ul>
	<ul> <li>Increased hazards in the environment</li> </ul>
	<ul> <li>Managing multi-user risks e.g. Divers vs fishers</li> </ul>
	<ul> <li>Monitor/avoid invasive species e.g. Barnacles on ships, O&amp;G etc.</li> </ul>
	<ul> <li>Potential for pollution</li> </ul>
	<ul> <li>Potential to improve sustainability of commercial fishing industry</li> </ul>
	in Australia
	Provide opportunities for education - allow marine life to be
	viewed in situ
	Really deep structures require different maintenance regimes
	and associated costs
	Recognise different structures have different rates of marine
	growth
	Regularly used e.g. Recreational fishing structures require more
	maintenance Circum distributions for the structure operatible and listing and laws (high stide 2)
	Size and depth of structures - possible collision on low/hide lider
Local community viability	Applying user pays model to eco-tourism
	Broader applicability for rivers and man-made freshwater
	impoundments
	Charter and commercial fishing access competing with other
	users
	Constraints in sharing fishery resources, sees policy look to
	"growing the pie"
	Creation of diverse fishing opportunities
	Eco-tourism vs consumptive use of resultant structures
	Fisher conflict with other user groups particularly inshore
	Initastructure (
	fish stocks
	<ul> <li>Increasingly loss of fishing access from land-based infrastructure</li> </ul>
	i.e. Ports
	<ul> <li>Lack of understanding of benefits to tourism</li> </ul>
	Local economies enhancement through increased and diverse
	opportunities
	Provide additional social benefit
	Provides for new fishing experiences
	Regional economies disproportionally benefit from fishing related
	enhancement
	Regional interests competing for benefits
	Shore based infrastructure often overlooked as benefits to
	community and disabled as well as habitat (e.g. Melbourne
	jetties, Busselton)
	• Spatial and temporal access between sectors.
	<ul> <li>Use as an environmental/fishing offset to other industrial activity</li> </ul>

Community funding &	Additional biological information being available
resource management	<ul> <li>Applying user pays model to eco-tourism</li> </ul>
	<ul> <li>Assess the seabed/area e.g. Acidic soils</li> </ul>
	Broader applicability for rivers and man-made freshwater
	impoundments
	Charter and commercial fishing access competing with other
	users
	Citizen science and community stewardship of the environment
	translating to wider environment
	Consider pollutants re the artificial reef materials
	Constraints in sharing fishery resources, sees policy look to
	"growing the pie"
	Create new fit-for-purpose fishing opportunities
	Creation of diverse fishing opportunities
	Desire for a one size fits all approach     For touring up one size fits all approach
	<ul> <li>Eco-tourism vs consumptive use of resultant structures</li> <li>Ensure good financial accessment and management is considered with</li> </ul>
	<ul> <li>Ensure good mancial assessment and management is carried out for any mmi</li> </ul>
	<ul> <li>Evalure both horizontal (breadth of scope - social versus)</li> </ul>
	economic etc) and vertical (assessment of type and design of
	mmi) analysis
	<ul> <li>Fisher conflict with other user groups particularly inshore</li> </ul>
	infrastructure
	• Fishers to be better engaged in design, site identification,
	monitoring and assessment
	• Funding for research into best designs (seems to be left to the
	private sector)
	Identifying critical life stages to recruitment and whether they
	can be enhanced with habitat
	Increase quality abundancies - re marine biodiversity particularly
	fish stocks
	Increased debris
	<ul> <li>Increasingly loss of fishing access from land-based infrastructure i.e. Ports</li> </ul>
	I.C. FUILS
	Is national enhancement the charismatic megalating of habitat???     Iack of learning culture from across Australia
	<ul> <li>Lack of understanding of benefits to tourism</li> </ul>
	<ul> <li>Local economies enhancement through increased and diverse</li> </ul>
	opportunities
	<ul> <li>Measuring the social and economic impact of fishing from man-</li> </ul>
	made structures
	• Monitor/avoid invasive species e.g. Barnacles on ships, O&G etc.
	NGOs to take the lead creating artificial opportunities.
	Often limited information on biological benefits / impacts to
	species or stocks
	<ul> <li>Possibility to export learnings and designs to the world</li> </ul>
	Potential for pollution
	<ul> <li>Prove objectives for fishing/eco productivity through robust</li> </ul>
	science
	<ul> <li>Provide additional social benefit</li> </ul>

	Provides for new fishing experiences
	Question whether structures aggregate or produce more fish
	<ul> <li>Recent discourse around "purpose built" impacting views on</li> </ul>
	repurposing structures as fish habitat
	<ul> <li>Recognition of fishers as leaders in environmental management - not always about murdering fish</li> </ul>
	<ul> <li>Reduced pressure on nearby targeted areas</li> </ul>
	<ul> <li>Regional economies disproportionally benefit from fishing related</li> </ul>
	enhancement
	Regional interests competing for benefits
	Share examples of benefits of environmental stewardship
	<ul> <li>Share examples of benefits of environmental stewardship</li> <li>Share based infrastructure often overlooked as benefits to</li> </ul>
	community and disabled as well as babitat (e.g. Melbourne
	ietties Russelton)
	<ul> <li>Social licence for mining industries and recognition of good</li> </ul>
	Social licence for filling industries and recognition of good     sitizanship as notantial offsats
	Citizenship as potential onsets
	• Spatial and temporal access between sectors.
	Use as an environmental/tisning offset to other industrial activity
where the second second state	•
Food sustainability	N/A
Ensure social licence to	Applying user pays model to eco-tourism
operate	Approvals processes associated with decommissioning are not
	currently streamlined or matured in Australia
	• Aust decomm policy uncertain & lagging. If follow e.g. Us, with
	any cost benefit going back to community - creates uncertainty
	with o&g operators.
	Broader applicability for rivers and man-made freshwater
	impoundments
	Charter and commercial fishing access competing with other
	users
	Citizen science and community stewardship of the environment
	translating to wider environment
	<ul> <li>Concern that proponents are walking away from obligation to remove structure</li> </ul>
	• Constraints in sharing fishery resources, sees policy look to
	"growing the pie"
	<ul> <li>Creation of diverse fishing opportunities</li> </ul>
	Eco-tourism vs consumptive use of resultant structures
	• Fisher conflict with other user groups particularly inshore
	infrastructure (
	• Fishers to be better engaged in design, site identification,
	monitoring and assessment
	• Future port use, limiting future port operations due to
	installation and nav risk
	• If cluster of mms -could act as potential steppingstones for
	invasive species
	• Increase quality abundancies - re marine biodiversity particularly
	fish stocks
	• Increasingly loss of fishing access from land-based infrastructure
	i.e. Ports

	•	Is habitat enhancement the charismatic megafauna of
		habitat???
	•	Lack of understanding of benefits to tourism
	•	Local economies enhancement through increased and diverse
		opportunities
	٠	Long term liability, who owns if proponent walks away
	٠	Navigational hazard for general shipping
	٠	NGOs to take the lead creating artificial opportunities.
	٠	Policy not able to keep pace with resource sharing issues
	٠	Political challenges for decommissioning
	٠	Potential for invasive species presence
	٠	Potential for transportation of invasive species if structures
		moved to reefing site
	٠	Potential refuge for rare/endangered species
	٠	Provide additional social benefit
	٠	Provides for new fishing experiences
	٠	Recognition of fishers as leaders in environmental management -
		not always about murdering fish
	•	Reduced area access or snagging risk for trawl fishing
	•	Regional economies disproportionally benefit from fishing related
		enhancement
	•	Regional interests competing for benefits
	•	Resourcing of infrastructure maintenance in long term
	•	Retain existing habitat for value
	•	Retention of some of the largest structures in the ocean for
		nabitat value
	•	Share examples of benefits of environmental stewardship
	•	shore based initiastructure often overlooked as benefits to
		ietties Busselton)
	•	Social licence for mining industries and recognition of good
		citizenship as potential offsets
	•	Spatial and temporal access between sectors.
	•	Use as an environmental/fishing offset to other industrial activity
Wellbeing from lifestyle	•	Change in current/ sand movement, impacts to coastal erosion.
and experience	•	Commercial Fishing
	•	Commercial tourism
	•	Counter act impact of social media
	•	Creating new habitat for marine life/coral rehabilitation areas etc
	•	Creation of additional environment for rare/threatened species
	•	Creation of single use areas for specific activities- e.g. fishing
		only, diving only (no take) for safety and social reasons
	٠	Damage to natural environment
	•	Ecosystem research - cryptic species (hard to find) aggregating
		around structures
	•	Encourage curiosity interest in environment
	•	Fish aggregation possibility of rec fishes depleting stocks.
	•	Help local ownership through education
	•	Increase of habitat for demersal fish and lobster. Different to
		mandruah-bunbury-dunsborough.

	Increased vertical relief in water column
	Keep impact to the environment at reasonable levels
	Lose natural diversity
	Manage the type and extent of use of MMI
	Potential hazard for boats and other water users
	Provide education to users (and potential users)
	Relocate corals etc
	• Tap into schools, universities etc.
	Threaten natural environment marine and coastal
	Use for other recreational activities. E.g. Surfing
Avoid negative press	Assess the seabed/area e.g. Acidic soils
	Consider pollutants re the artificial reef materials
	Increased debris
	• Monitor/avoid invasive species e.g. Barnacles on ships, O&G etc.
	Potential for pollution
Support cultural values	N/A
Moral structure purpose	Create offshore detention centres or quarantine areas for
	pandemics
	• Extract ammonia from produced water to make hydrogen gas
	Hydrogen gas - repurpose oil and gas infrastructure to make
	hydrogen gas from seawater
	Offshore aquaculture facilities, energy production through wave
	energy generators, kelp farms for carbon capture.
	Re-use of o&g infrastructure
Stakeholder	
collaboration &	All structures are removed
engagement	Balance and take account of opportunities and risks of different
	stakeholders
	Balancing risks of leaving in the marine environment versus
	impacts of disposing onshore trade off
	Carefully consider location of mmi
	Complete removal of infrastructure can create a new industry     (a.g. Newtherea)
	(e.g. North sea)
	Difficulty of removal
	Ensure a sale environment for recreational as well as commercial users
	<ul> <li>Ensure structures are safe to use e.g. Navy nier shut down</li> </ul>
	<ul> <li>Hazard for users of ocean long term - degradation</li> </ul>
	(environmental)
	<ul> <li>Lack of clear evidence of value of in-situ decommissioning</li> </ul>
	<ul> <li>Lack of long-term monitoring data to evaluate positive/negative</li> </ul>
	impacts
	<ul> <li>No baseline data pre-installation for many structures to compare</li> </ul>
	changed environment
	Potential habitat for invasive marine species
	Potential nursery habitat
	Potential repurposing of structures for alternative energy etc
	Provides habitat for endangered species
	Really deep structures require different maintenance regimes
	and associated costs

	<ul> <li>Recognise not all increases in fish/ coral life is beneficial</li> <li>Recognise that structures will need to either support commercial fishing or recreational structures</li> <li>Refuge for vulnerable species from over-fishing pressures</li> <li>Size and depth of structures - possible collision on low/hide tide?</li> <li>Some structures in deep water provide no benefit for either fish habitat or commercial/recreational use</li> <li>Unable to compare what was to what is to demonstrate benefits</li> </ul>
	(big data gaps)
	Onknown future environmental nazards that the leaving of infrastructure in-situ may create
	<ul> <li>What is our baseline for environmental impacts? Pre-trawling</li> </ul>
	and man-made impacts to benthic habitats or now?
Community sense of	N/A
ownership of MMS	
Manage stakeholder	<ul> <li>Access by disadvantaged people (closer in shore - fish and dive)</li> </ul>
Committ	Access control to prevent overuse
	Access to the site opportunities     Access the seebed (area e.g. Asidis soils
	<ul> <li>Assess the seabed/area e.g. Actual solis</li> <li>Avoid putting an artificial on top of a natural</li> </ul>
	<ul> <li>Avoid putting an artificial reefs on top of other sensitive areas</li> </ul>
	<ul> <li>Be clear re the objectives of the reef</li> </ul>
	<ul> <li>Biased consultative processes designed to reinforce philosophy -</li> </ul>
	stop when get answer you want
	Bleaching damage
	Careful consideration of location
	• Carry out more targeted research on the role and value of habitat
	with clear objectives and outcomes
	<ul> <li>Charter and commercial fishing access competing with other</li> </ul>
	users
	Chicken little opposition to any benefits being claimed
	<ul> <li>Citizen science and community stewardship of the environment translating to wider environment</li> </ul>
	Citizen science engagement.
	Commercial fishers e.g. Aquarium take considerable fish
	Commonwealth actually recognises recreational fishing
	Competition between commonwealth/state/local government -     only want credit, blame others early and often
	• Consider reafs for concervation for diving for rec fish and for
	commercial
	<ul> <li>Constraints in sharing fishery resources, sees policy look to</li> </ul>
	"growing the pie"
	Cynicism in community about government motives
	Cynicism in community about government motives
	Ease of access to sites - decrease of boat traffic
	Easier access for those with limited resources
	<ul> <li>Easy to find - for those less familiar with reefs</li> </ul>
	<ul> <li>Easy to identify use of the reef (benefits)</li> </ul>
	• Eco-tourism vs consumptive use of resultant structures

•	Encourage stakeholders to take a more sophisticated view re use
	of decommissioning rather than simplistic view
•	Ensure effective engagement with and between all stakeholders
•	Ensure regulations/ legislation is informed by science and
	transparent/consistent rather than snap judgements or
	regulatory constipation
•	Entrenched views about (against) man-made structures as fish
	habitat / fishery enhancement
•	Establishment of standards, playbook and goal setting to make
	future processes easier
•	Fisher conflict with other user groups particularly inshore
	infrastructure
•	Fishers to be better engaged in design, site identification,
	monitoring and assessment
•	Fundamentalism in commonwealth government policy
•	Government red tape and ideological opposition across
	government
•	Increase risk of collisions
•	Increase safety
•	Increased ease to get to site - balance between depth and
	distance from shore/ boat ramp
•	Increased habitat in barren areas
•	Increased sites for recreation
•	Insistence on environmental destruction as part of rehabilitation
	process (cutting pipes off below surface)
•	Insufficient stakeholder consultation.
•	Is habitat enhancement the charismatic megafauna of habitat???
•	Legal issues around risk and responsibility
•	Legitimise capping of stocks, use of reefs
•	Local economies enhancement through increased and diverse
	opportunities
•	Long-term upkeep/safety of structure
•	Management of conflicting activities (e g fishing whilst divers
	present
•	Mining companies using fishing as a front to cover for
	unsustainable practices
•	Navigating government planning and approvals process
•	Need to ensure monitoring and communication of monitoring
	results
•	Needs to be a dedicated person to facilitate the issues outside of
	the fisheries department with power
•	NGOs to take the lead creating artificial opportunities.
•	Obstacle for trolling/trawling - mackerel and wahoo and prawns
•	Perception and ideology of conservation and environmental
	groups
•	Poor legacy of materials of opportunity being used in the past
	only to degrade / cause environmental issues
•	Protecting new reefs allows for population growth allowing the
	natural spill over effect
•	Protection for natural sites by redirecting fishing efforts
	• •• • • • • • • • • • • • • • • • • • •

	•	Provide additional social benefit
	•	Provides for new fishing experiences
	•	Recognise competing interest
	•	Recognise depth impacts use i.e. >19 meters limits spear fishing
	•	Recognition of fishers as leaders in environmental management -
		not always about murdering fish
	•	Regional interests competing for benefits
	•	Rotate sites between users (recognising initial funding)
	•	Share examples of benefits of environmental stewardship
	•	Social licence for mining industries and recognition of good
		citizenship as potential offsets
	•	Spatial and temporal access between sectors.
	•	Spread of pressure on reef systems
	•	Stock depletion from rediverting fish from usual habitat
	•	Synergies between industries enhancing social licence
	•	Trawler damage
	•	Variability within and across government departments to
		approvals and principles
	•	Very poor legislation stopping all these issues.
	•	Water quality from disused platforms
	•	Who owns the infrastructure and the associated risk/liability?
	•	With larger fish populations growing on new habitat creating new
		dive sites
Evidence-based	•	Balancing access rights between competing user groups
regulations	٠	Can be used to gain social licence but not suitable for
		environmental offset
	•	Clarify liability issues
	•	Collaboration between industry and government evolving
		discussion
	•	Commercial Fishing
	•	Commercial tourism
	•	only, diving only (no take) for safety and social reasons
	٠	Decommissioning policy and regulatory uncertainty
	•	Decommissioning requirements in commonwealth waters are
		currently being reviewed - the study could play into this
	•	Do they affect water movement
	•	Duty of care/responsibility for site use
	•	Establish regulation - duplication/overlap
	•	Establish who is the 'lead' agency - lack of clarity re process wrt to
		mmi
	•	Fish aggregation possibility of rec fishes depleting stocks.
	•	High quality diving site due to habitat complexity and species diversity
	•	Keep impact to the environment at reasonable levels
	•	Legislation isn't keeping up with current scientific knowledge
	•	Liability - long term, when it passes to artificial reef etc.
	•	Liability - who is responsible
	•	Lots of existing rov footage etc in the o&g industry that could be

	•	Lots of o&g infrastructure coming to the end of its life that could
		be used in the study
	•	Manage the type and extent of use of MMI
	•	May be difficult to quantify wider benefits/impacts of structures
		in the marine environment e.g. How they may be used as
		ecological corridors/linkages, nurseries etc.
	•	Multiple layers of federal and state policy and regulation in this
		space
	•	Net environmental benefit analysis - expanding on tools available
		for demonstration
	•	O&G case studies to review where sea dumping permits have
		been approved – e.g. Exmouth king reef, pttep jabiru rtm and
		challis salram, conoco elang/kakatua rtm
	•	Ongoing legislative and regulatory reform for petroleum
		decommissioning
	•	Potential fish population depletion if not managed properly with
		fishing restrictions
	•	Potential hazard for boats and other water users
	•	Precedence setting
	•	Recognise that regulations work on a case by case basis and that
		what is accepted for one, might not be for another
	•	Reduce regulatory uncertainty
	•	Regulatory obligations need to be met
	•	Remain complaint with international regulations
	•	Research into production vs attraction
	•	Research opportunities gained from mmi
	•	Sharing of potential additional resources between user groups
	•	Use for other recreational activities. F.g. Surfing
	•	What is there social value
Regulatory transparency	•	Artificial reef infrastructure act as fads rather than areas for fish
& liability population		population growth
	•	Be clear who users are
	•	Benefits of commercial and recreational fishing on mms
	•	Can be used to gain social licence but not suitable for
		environmental offset
	•	Carefully consider location of mmi
	•	Carry out more targeted research on the role and value of habitat
		with clear objectives and outcomes
	•	Charter and commercial fishing access competing with other
		users
	•	Clarify liability issues
	•	Commonwealth actually recognises recreational fishing
	•	Competition between commonwealth/state/local government -
		only want credit - blame others early and often
	•	Concern that proponents are walking away from obligation to
		remove structure
	•	Constraints in sharing fishery resources, sees policy look to
		"growing the pie"
	•	Contamination potential from old oil and gas infrastructure
	•	Coordination and dissemination of information to industry

- Counter act impact of social media
- Cynicism in community about government motives
- Decommissioning requirements in commonwealth waters are currently being reviewed the study could play into this
- Difficulty of removal
- Discover that there are hazards from long term in situ
- Do they impinge on perceptions of naturalness
- Eco-tourism vs consumptive use of resultant structures
- Encourage curiosity interest in environment
- Ensure a safe environment for recreational as well as commercial users
- Ensure structures are safe to use e.g. Navy pier shut down
- Environmental contamination potential or otherwise
- Establish regulation duplication/overlap
- Establish who is the 'lead' agency lack of clarity re process wrt to mmi
- Establishment of standards, playbook and goal setting to make future processes easier
- Fisher conflict with other user groups particularly inshore infrastructure
- Fundamentalism in commonwealth government policy
- Future direction of decommissioning considered earlier on in activity planning
- Giving a targeted point for research in the habitats of marine flora and fauna
- Government red tape and ideological opposition across government
- Hazard for users of ocean long term degradation (environmental)
- Help local ownership through education
- Implement monitoring programs to understand the impacts and level of activity
- Is this pollution of the sea? [public perception]
- Lack of relevant experience holding back the issue.
- Legal issues around risk and responsibility
- Legal liability for impacts to users of the sea
- Liability long term, when it passes to artificial reef etc.
- Local economies enhancement through increased and diverse opportunities
- Long term liability, who owns if proponent walks away
- Manage safety issues re diving, fishing on the structure or trawl fishing ships being damage
- Many benefits with research, fishing recreational use and environmental growth
- Navigating government planning and approvals process
- Navigational hazard for e.g. Trawlers snagging structures
- NGOs to take the lead creating artificial opportunities.
- Opportunity to test novel techniques for building resilience in marine communities in face of climate change
- Ownership of long term residual liability

	Planned augmentation of structures in design phase
	• Planning for future decommissioning considered early to use
	appropriate materials for leaving in situ etc
	• Poor legacy of materials of opportunity being used in the past
	only to degrade / cause environmental issues
	Possible disruption of msc processes
	Potential cost benefit of carbon remaining in ecosystem (future
	blue carbon calculations)
	Precedence setting
	Provide additional social benefit
	<ul> <li>Provide education to users (and potential users)</li> </ul>
	Provides for new fishing experiences
	Public percention of "dumping" of infrastructure
	Really deep structures require different maintenance regimes
	and associated costs
	<ul> <li>Recognise that regulations work on a case by case basis and that</li> </ul>
	what is accepted for one, might not be for another
	<ul> <li>Recognise that regulations work on a case by case basis and that</li> </ul>
	what is accepted for one, might not be for another
	Recognise that structures will need to either support commercial
	fishing or recreational structures
	<ul> <li>Reduced transport of wastes overseas as opposed to retaining</li> </ul>
	our own waste products
	Regional interests competing for benefits
	<ul> <li>Research value added (tweaking the reef) of mmi</li> </ul>
	Resolve question of do they aggregate or augment a stock
	<ul> <li>Resourcing of infrastructure maintenance in long term</li> </ul>
	Reuse of material and reduction in waste
	<ul> <li>Scientific opportunity to study growth on structure and how long</li> </ul>
	it takes
	See teaming life on pipeline highway
	<ul> <li>Share examples of benefits of environmental stewardship</li> </ul>
	• Size and depth of structures - possible collision on low/hide tide?
	<ul> <li>Spatial and temporal access between sectors.</li> </ul>
	<ul> <li>Steppingstones of hard substrate (platform to platform) for</li> </ul>
	introduced and potential pest species to invade new habitats
	• Tap into schools, universities etc.
	Understanding the cost-benefit economic life cycle analysis to
	capture short term benefits (smelting) offset against long term
	benefits (fisheries)
	Unknown and generally poorly researched environmental
	impacts of man-made infrastructure
	Variability within and across government departments to
	approvals and principles
	Water quality from disused platforms
	What is the most productive material for structure
	• Who owns the infrastructure and the associated risk/liability?
Effectively designed	Able to gain evidence of benefits of artificial reefs
MMS	

	Increased participation in community engagement through
	monitoring
	Set up comparison sites
Limit costs	<ul> <li>Concern that proponents are walking away from obligation to remove structure</li> </ul>
	Cost of removal could be cheaper than mms remaining because
	of consultation time, liability and community reimbursement of perceived benefit
	<ul> <li>Cost reduction for operators may be perceived but not always reality</li> </ul>
	<ul> <li>Cost savings in using existing mms to build artificial reefs over creating new materials for future fisheries enhancement</li> </ul>
	• Different issues and opportunities with decomm of pipelines and other o&g infrastructure
	<ul> <li>Legal liability of mms left in environment</li> </ul>
	<ul> <li>Long term liability, who owns if proponent walks away</li> </ul>
	• Reduce the cost of decommissioning for proponents and general
	public/governments
	Resourcing of infrastructure maintenance in long term



# Appendix 12 Assessing the Social and Economic Value of Man-made Marine Structures: A Guidebook

Euan S. Harvey, Fran Ackermann, Michael Burton, Julian Clifton, Carmen Elrick-Barr, Johanna Zimmerhackel & Georgina Hill

This appendix is part of the final report for:

Enhancing the Understanding of the Value Provided to Fisheries by Man-made Aquatic Structures.

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# Assessing the Social and Economic Value of Man-made Marine Structures: A Guidebook

## Introduction

This guidebook provides support to those making decisions regarding the design, installation, adaptation and maintenance of man-made marine structures (e.g. policy makers, private sector managers): their use, development, placement and management. In particular, it guides users in selecting an approach to evaluate the social and economic values associated with man-made marine structures (MMS). The definition of MMS is broad, including: existing infrastructure (e.g. O&G or wind turbines), in particular when this infrastructure is decommissioned and either left *in situ* or relocated; manmade reefs; wrecks (purposefully or accidentally occurring); and piers and jetty's. The guidebook has been developed based on an identified need to support stakeholders in understanding the social and economic values of man-made marine structures and their underpinning rationale for those values across a range of sectors. Thus stakeholders will be able to incorporate this understanding within their decision-making.

#### Aiding Decision-Makers

Good decisions take place when a detailed and nuanced understanding is held of the situation/topic. Carrying out social-economic analysis provides valuable insight into a) the breadth of stakeholder values, b) the impact values have on one another and c) identification of economic and social values and opportunities that inform sustainable, supported, and nuanced decision outcomes.

By understanding the importance people place on the marine environment, the infrastructure within it, and its associated uses, a more informed case can be made for the installation or removal of MMS, taking into account considerations such as effective resource allocation, community engagement, and the wider context (thus avoiding unsustainable decisions from being made).

#### Scope of the guidebook

The guidebook was created as an output of an FRDC funded research program entitled 'Enhancing the Understanding of the Value Provided to Fisheries by Man-made Aquatic Structures' (Project No

2018-053). In this project, the social and economic values (also collectively termed 'social-economic values') of man-made marine structures were elicited for structures within Western Australia. The learnings from this project informed the design of this guidebook. The guidebook focuses predominantly on the methodologies that were applied in this project. However, there exist alternate and complementary approaches and methodologies that can obtain the desired information. Some such methodologies are discussed herein (e.g. stakeholders interviews), but the methodologies captured in this guidebook are not definitive. For further information on the range of social and economic assessment methods, refer to, for example: Bickman and Rog 2008 (social research) and Pannell et al (2013) (who provide a framework for evaluation of environmental projects from an economic perspective).

#### Social-economic values defined

Social and economic values associated with man-made marine structures are the values that people hold arising from the use (e.g. both direct and indirect use) and non-use (e.g. the existence of marine life) of man-made marine structures. Social-economic values are shaped by, and shape an individual's perceptions and behaviours, can be either positive or negative, and interact and change over space and time. Values therefore evolve in response to the social, economic, political and environmental context.

#### Why understand social and economic values?

#### **Decommissioning Oil and Gas structures**

When oil and gas infrastructure comes to the end of its operational life, a decision has to be made about how it is disposed of. Evaluating the economic values of alternative end states quantifies in monetary terms the benefits to different users different of decommissioning alternatives, while understanding the social values of stakeholders impacted (both directly and indirectly) can provide information to support decision-making on the options that will best address (i) social licence to operate; (ii) potential stakeholder conflicts; and (iii) provide social benefit to multiple stakeholders.

#### **Designing Artificial Reefs**

Artificial reefs can play an important role in environmental sustainability, protecting erodible coastlines, and as sites of subsistence, commercial and recreational activities. An assessment of the economic value of an artificial reef can provide the business case for its implementation and/or explore the potential value trade-offs across stakeholder groups (e.g. recreational fishers and divers) based on site location and user access. Social value assessments can, for example, contribute an understanding of stakeholders' views on artificial reefs and how these compare across sites or stakeholders, uncover potential stakeholder conflicts relating to access; and demonstrate the benefits or impacts to multiple stakeholders.

#### How to use this guidebook

In the following sections, we guide you through the identification of social and economic values, commencing with economic followed by social valuation approaches. A pre-cursor to this is, in some cases, the identification of the consequences of the MMS on the ecological system. For example, the quantification of economic and social values can require a quantification of the changes in the ecological values associated with the change in status of the MMS. Or there may be no changes in

the ecological system *per se* (e.g. changing access to an MMS), but there will still be a need to understand the change in environment that is being made *accessible*. The guidebook has been designed on the assumption that this information has been (or will be) obtained, if required.

At the start of each section, we briefly describe the nature of the values that can be identified. By navigating through the questions, users are provided with one or more approaches they can adopt to understand social and/or economic values. For both, different approaches can give information of different depths, and these are described.

The approaches are classified into three categories reflecting a different depth of understanding: basic, medium and detailed. A basic level of understanding of social and/or economic values of MMS might be sufficient where stakeholders have limited concerns or only have a limited budget. A basic level of understanding also might be enough where stakeholders do not desire to build a case to influence policy or where the alternatives are non-controversial. A detailed assessment might be necessary when regulators require an in-depth level of understanding of a case study (e.g. to accept a certain decommissioning scenario), where stakeholder's interests could be affected (particularly in situations where there can be competing interest), or when alternative scenarios of the management of MMS are complex.

Social and economic valuation approaches provide different yet complementary information. While the approaches are presented separately, they can be combined for more comprehensive and robust coverage, to inform subsequent methods and/or to answer multiple questions. For example, a survey-questionnaire can identify and quantify social and economic values, while a focus group workshop can understand the nuance of survey elicited preferences and their impact on one another. For other examples of the benefits of integrating social and economic values see Harvey et al (2021).

#### Integrating information on social and economic values

There are several ways to integrate social and economic research. Data from a survey could be augmented through a focus group which seeks to understand the values in more depth. For example, triggers (e.g. safe access) or opportunities (e.g. refuge for endangered species) can be identified. The survey data can also be examined against economic data to determine where perception and fact diverge.

# Understanding Economic Values

The defining aspect of economic values is that they are represented in monetary terms. This includes values that may be determined through markets (e.g. profits or expenditures), but also values that may be seen as intangible (e.g. the value of the recreational experience to the fisher). Placing all values in a common monetary metric allows for an easy comparison of outcomes across different stakeholders. Man-made marine structures can generate various value types for different stakeholder groups. These values include:

- *Commercial value:* The impact on commercial enterprises that directly interact with the MMS e.g. commercial fishers who may fish on the structures. This would typically be measured through changes in profits.
- *Recreational user value:* The benefits to the recreational users of MMS through that use, which is measured by the 'consumer surplus' associated with their use. This is the direct benefit to those users (recreational fishers, divers, tourists etc), and which should be differentiated from:
- *Community value:* The contribution of users of MMS to the local/regional economy through their expenditures, and potentially measured through the jobs that are supported by that expenditure
- *Existence value:* The values that the community may hold for changes in the ecological conditions arising from the MMS, that arise simply from it occurring, without any need for the person to directly interact with the MMS. For example, this could be positive if the MMS improves the status of endangered species that are valued by the community, or negative if the presence of the MMS is deemed to compromise those values.
- Subsistence and cultural value: The values a community may derive from the direct consumption of fish harvested due to the MMS (food security), or the ability to maintain cultural usage of marine resources.

It is important to frame values by a counterfactual: what value does this infrastructure in the water provide, compared to the situation where it is removed – what additional value would the creation of this MMS provide, compared to the situation where it is not. Quantifying the counterfactual is necessary and challenging, as one needs to identify the full extent of people's adaptation in behaviour in response to the change in the state of the MMS.

A particular value can be quantified in different ways. Table 1 gives an overview to the different approaches that quantify these values in monetary terms, including the consumer surplus and existence values. These approaches generate different levels of understanding: from those that are relatively low in resource needs, and which may generate relatively imprecise values (Basic), to those that are medium or high in resource needs, can be framed to be context specific, and which can give a richer and more accurate insight into the values (Medium/Detailed). The table also gives a summary of the main outputs one gets from each of the approaches.

Which approach might be the most suitable can be further explored in the question section below. Each of these approaches could stand alone, or they could be combined, depending on the interest of the user of this guidebook. For example, if there is a mixed fishery around the MMS, approaches on commercial and subsistence fisheries apply. Moreover, some approaches can estimate more than one value type. A Random Utility Model of site choice for instance can quantify the value to recreational user, and also estimate community values (expenditures) associated with that activity.

## Economic Value: Section 1 Recreational users

Q1 Is there a potential recreational use of MMS (recreational fishing, diving, and/or other tourism)?

- No: Go to Economic Value: Section 2
- Yes: Q2 Is there currently any recreational use in the region of a (prospective) MMS?
  - No: Q3 Could the MMS create new recreational use?

No: Go to Economic Value: Section 2

Yes: Q4 Are you interested in:

Recreational user value? Community value?

> Existing and/or new MMS Basic:

<u>Benefit transfer</u>

Yes: Q5 Are you interested in:

Recreational user value?

Existing and/or new MMS Basic: Detailed: Existing MMS only: Medium:

<u>Benefit transfer</u> <u>Random Utility Model</u>

Travel cost method

Community value? Existing and/or new MMS Basic: Medium: Detailed:

> Existing MMS only: Medium:

<u>Benefit transfer</u> <u>Random Utility Model</u> <u>Economic impact</u> <u>assessment</u>

Travel cost method

#### Economic Values: Section 2 Commercial fisheries

Q6 Is there a potential commercial fishery on the MMS?

No: Go to Economic Values: section 3

Yes:	Q7	Is the	Is there any commercial fishery in the region of the (prospective) MMS?				
	No:	Q8	Could the (prosp	ective) MMS create new commercial fisheries?			
		No: G	o to Economic Valu	les: section 3			
		Yes:					
		Basic:		<u>Benefit transfer</u>			
	Yes:						
		Basic:		<u>Benefit transfer</u>			
		Medi	um/detailed:	Survey of commercial enterprises			

#### Economic Values: Section 3 Subsistence fisheries

Q9 Is there any subsistence fishery in the region of the (prospective) MMS?

No: Go to Economic Values: section 4 Yes: Basic: <u>Benefit transfer</u> Detailed: <u>Sustainable livelihood assessment</u>

Economic Values: Section 4 General public

Q10 Is there any sign that the MMS potentially generates non-use/existence values to the general public?

No: There are no further economic values, you may want to continue to social values.

Yes:

Basic:Benefit transferMedium/detailed:Contingent Valuation Method/Discrete Choice Experiment

Question	Sub-question	Level of	Primary Output	Approach
		understanding		
Recreational users	Recreational user value	Basic	Aggregate consumer surplus based on non-case study specific user values that users derive/lose from the provision/removal of MMS	<u>Benefit transfer</u>
		Medium	Case study specific consumer surplus per trip and on aggregate that users lose from the removal of MMS	<u>Travel cost method</u>
		Detailed	Change in use of MMS and the region at large	Random Utility Model
			Case study specific consumer surplus per trip and on aggregate that users derive/lose from the provision/removal of MMS	
	Community value	Basic	Aggregate market value based on non-case study specific community values that users derive/lose from the provision/removal of MMS	<u>Benefit transfer</u>
		Medium	Market value per trip and on aggregate that users lose from the removal of MMS	<u>Travel cost method</u>
		Medium	Change in use of MMS and the region at large	Random Utility Model
			Case study specific market value per trip and on aggregate that users derive/lose from the provision/removal of MMS	
		Detailed	Case study specific market values per trip and on aggregate that users derive/lose from the provision/removal of MMS	Economic impact assessment
Commercial fisheries	Commercial value	Basic	Aggregate market values based on non-case study specific commercial values that users derive/lose from the provision/removal of MMS	<u>Benefit transfer</u>
		Medium to detailed	Case study specific aggregate market value of commercial fishery that users derive/lose from the provision/removal of MMS	<u>Survey of commercial</u> <u>enterprises</u>
Subsistence fisheries	Food security	Basic	Non-case study specific aggregate market price of fisheries catch	<u>Benefit transfer</u>
	Social-economic and cultural values	Detailed	Economic, social and/or cultural impact of MMS on the livelihood of subsistence fishers. Can identify pathways to enhance, supplement and/or diversify livelihoods	<u>Sustainable livelihood</u> <u>assessment</u>
General public	Existence value	Basic	Aggregate consumer surplus based on non-case study specific existence values that people derive/lose from the provision/removal of MMS	<u>Benefit transfer</u>
		Detailed	Case study specific per unit and aggregate existence values that people lose from the removal of MMS	<u>Contingent Valuation</u> <u>Method/Discrete Choice</u> Experiment
			Use value that people would derive/lose from the provision/removal of the MMS	

Table 1: Management questions, level of understanding sought, and associated outputs provided by different economic valuation approaches.
# Understanding Social Values

Social value can be seen as denoting the degree of importance of an object or action, with the aim of determining what actions are best to do, or what way is best to live, or to describe the significance of different actions in relation to a societal decision. Social values are influenced by, and influence, how people interact with and view man-made marine structures. In regard to social values and their use in the management, design and implementation of man-made marine structures, there are often three core areas of interest:

- Understanding how people use or interact with MMS
- Understanding the values that people derive from MMS
- Understanding people's perceptions of MMS (including the opportunities and issues associated with MMS)

Each of the three areas of interest could comprise a standalone question or they could be combined depending on the stakeholders' interest, for example, whether they seek a partial or 'whole of system' understanding. Each area is interrelated: an individual's perceptions can influence their behaviour, which in turn can shape their values; an individual's values can influence their perceptions and in turn their behaviours; finally, an individual's actions can change their perceptions and values (Figure 1).



Figure 1: Illustration of core areas of interest showing their interactive nature

Furthermore, for each question, there are different levels of understanding that can be obtained, and different data collection techniques that contribute to that level of understanding. We broadly describe these across three levels:

1. Basic: Provides a partial understanding of use/behaviour/values/perceptions of stakeholders. Does not provide information on what influences uses/behaviours.

- 2. Moderate: Provides an understanding of the uses/values/perceptions and the factors influencing use/values/perceptions; but does not explain why those influencing factors are important or how values, behaviours, and perceptions interrelate.
- 3. Detailed: Provides the information missing from the two prior levels of understanding, i.e. explanation for the influencing factors and any interrelationships between behaviour/values/perceptions.

We summarise these in the boxes below and then present them as questions leading to alternate approaches.

#### Why conduct a social values assessment?

#### **Decommissioning Oil and Gas Structures**

Understanding perceptions of key stakeholders in order to decide whether or not to convert a platform to an artificial reef.

- <u>Basic</u> understanding number of society pro or against a rigs to reef decision
- <u>Moderate</u> understanding a sense of which values are affected by the decision and to what degree
- <u>Detailed</u> understanding articulation of the range and interconnectivity of the issues (e.g. invasive species) and opportunities (protecting endangered species)

#### **Policy Makers**

If seeking to modify stakeholders' use of an existing structure, understanding the values and perceptions of stakeholders to support equitable decisions that can reduce potential conflicts arising from management choices.

- <u>Basic</u> number of users of the current structure and potential users of the modified structure
- <u>Moderate</u> insight into how different groups perceive the modification (positively or negatively) and why (values associated).
- <u>Detailed</u> comprehensive understanding of the different appetites for the modification along with explanations regarding the perceived issues and opportunities associated.

#### Peak Body

If seeking to present the case for installation (or maintenance) of an MMS, understanding the values users obtain (or could obtain) from these structures is important.

- <u>Basic</u> number of interested parties, % of sampled population
- <u>Moderate</u> information regarding the impact on a set of values affected by the installation (positively/negatively)
- <u>Detailed</u> understanding of the range of concerns held by the community e.g. services overloaded, ambience of location adversely affected

It is important to note that the level of detail obtained through application of different social research methods varies depending on the design and implementation of the tool. For example, an online survey questionnaire can include short, multiple choice questions sent to a discrete number of stakeholders, or it could include i) multiple Likert scale questions based on existing literature or theoretical models, or ii) open-ended questions and be distributed to a representative sample of stakeholders. In general, however, the depth of understanding gained through approaches lies on a continuum from Basic to Detailed as shown in Figure 2:



Data Continuum

#### Figure 2: Social value data continuum

See <u>Social Value: Approaches</u>, for further detail on each approach.

To help guide the selection of a research method, let's consider **what you would like to** know:

#### 1. How people use or interact with MMS

- a. Do you want to know who uses MMS?
  - i. If Yes apply: Quantitative survey (online or face-to-face)
- b. Would you also like to know why they are using MMS?
  - i. If Yes apply: Literature review and/or Quantitative survey (online or face-toface) and/or Focus group/Workshop

#### 2. People's perceptions/views on MMS

- a. Do you want a basic understanding of people's views of MMS?
  - i. If Yes apply: Quantitative survey (online or face-to-face)
- b. Do you want a moderate level of understanding of how people's views differ and what influences their views?
  - i. If Yes apply: Literature review and/or Quantitative and Qualitative survey (online or face-to-face) and/or Focus group/Workshop
- Do you want a detailed and systemic understanding of people's views so that you c. can explain why those views are held and what influences them and plan outcomes that are more likely to be accepted (social licence)?
  - i. If yes, apply: Qualitative survey (online or face-to-face), and/or Interviews and/or Focus group/Workshop

#### 3. The values people derive from MMS

- a. Do you want a moderate level of understanding of the values people derive from MMS and potential influencing factors?
  - i. If yes, <u>Literature review</u> and/or Quantitative and Qualitative survey (<u>online</u> or <u>face-to-face</u>)
- b. Do you want to be able to explain why those values are held, what are the issues and opportunities underpinning the values, how they change over time, how they impact on one another and the degree of homogeneity in values?
  - i. If yes, apply: <u>Interviews</u> and/or Focus group/<u>Workshop</u>

		Level of			
Question	Sub-question	understanding	Output	Approach	
1) Use of MMS			Number of		
	a) Who uses MMS	Basic	users	Quantitative survey (online or face-to-face)	
		Moderate	Number of	Literature review	
	b) Why are they using MMS		users		
			Influencing	Quantitative survey ( <u>online</u> or <u>face-to-face</u> )	
			factors		
		Detailed	Number of	Literature review	
			users		
			Influencing	Quantitative survey ( <u>online</u> or <u>face-to-face</u> )	
			factors		
			Explanation	Qualitative survey ( <u>online</u> or <u>face-to-face</u> ), <u>Interviews</u> , Focus	
2) Demonstiene of			Development	group/ <u>Worksnop</u>	
2) Perceptions of		Decie	Ranking	Quantitative survey	
MINIS	a) General perceptions	Basic	Develop	Literature review	
	b) Sub-groups of perceptions (e.g. by stakeholder group or MMS type)	woderate	Ranking	Literature review	
			Influencing	Quantitative survey ( <u>online</u> or <u>face-to-face</u> )	
			factors		
		Detailed	Ranking	Literature review	
			Influencing	Quantitative survey ( <u>online</u> or <u>face-to-face</u> )	
			factors		
			Explanation	Qualitative survey (online or face-to-face), Interviews, Focus	
				group/ <u>Workshop</u>	
3) Values of MMS	a) General values	Basic not possible			
		Moderate	Ranking	Literature review	
			Influencing	Quantitative survey (online or face-to-face)	
			factors		
	b) Sub-groups of perceptions (stakeholder group / MMS type)	Detailed	Ranking	Literature review	
			Influencing factors	Quantitative survey ( <u>online</u> or <u>face-to-face</u> )	
			Explanation	Qualitative survey ( <u>online</u> or <u>face-to-face</u> ), <u>Interviews</u> , Focus group/ <u>Workshop</u>	

# Table 2: Management questions, level of understanding sought, and associated outputs provided by different data collection approaches

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# Economic Value: Approaches

In this section, the advantages and limitations of different approaches are summarised, and examples of their application provided.

### Benefit transfer

#### Advantages

- Does not require any (or limited) primary data collection
- Potentially can be applied to any of the economic values identified.

#### Disadvantages

Requires there to be values in the literature that are relevant to the current context, and those values become less reliable the further from the current context those values are drawn from (e.g. transferring values across countries, or different ecological systems)

#### **Input Requirements**

- Access to (or creation of) a literature base from which to identify relevant values
  - The Environmental Valuation Reference Inventory <u>www.evri.ca</u> is a database for non-market values such as the consumer surplus of recreational users and existence values held by the general public
  - For commercial activities (e.g. fisheries or tourism) one needs market values such expenditures or profits
  - For subsistence fisheries one needs the market value of the catch.
- Given values are often per unit (e.g. value per trip), the quantum of use (e.g. number of trips, volume of fish caught) still needs to be estimated.

#### Outputs

• Estimate of the aggregate value, in monetary terms associated with the MMS.

#### Examples

• "The potential Economic Value Associated with the Development of Artificial Reefs in Western Australia" in Harvey et al (2021) Appendix 4.

- Rogers, A.A., Nedosyko, A., McLeod, I.M., Gillies, C. and Burton, M.P. (2018). Benefit-Cost Analysis of the Windara shellfish reef restoration project. Report to the National Environmental Science Program, Marine Biodiversity Hub. The University of Western Australia
- Subroy, V., Gunawardena, A., Polyakov, M., Pandit, R. & Pannell, D. J., 1 Oct 2019 Ecological Economics. 164, 106374.
- Johnston, R.J., J. Rolfe, R.S. Rosenberger and R. Brouwer, eds. 2015. Benefit Transfer of Environmental and Resource Values: A Guide for Researchers and Practitioners. Dordrecht, the Netherlands: Springer
- Food and Agriculture Organisation (2005) Increasing the contribution, role and importance of small-scale fisheries in poverty alleviation and food security. FAO Fisheries Technical Paper No.481, Rome, Italy.

# Travel cost method

#### Advantages

- Is based on observed behaviour
- Is relatively easy to implement in terms of data requirements

#### Disadvantages

- Can only be used to value an existing MMS, not prospective MMS, as it relies on a survey of users.
- It can only identify the recreational use values (and the expenditures associated with them) but not existence values.

#### **Input Requirements**

- There are a variety of methods available, which differ in the data collected, but all require a survey that identifies the level of use by individuals, and an estimate of the costs they incurred in order to access the MMS. Mostly commonly employs an on-site survey.
- If sufficiently comprehensive, the survey will provide an estimate of the aggregate use of the MMS, otherwise an external source for that information is required.

#### Outputs

- Estimate of the "consumer surplus" per trip to the MMS (i.e. the value to the user over and above the amount they have spent on the activity).
- Combination of the value per trip and an estimate of aggregate use leads to an estimate of the value of the MMS to the users.
- If information on all costs is collected (i.e. both travel and local expenditure), estimates of the value of the activity to the regional economy can also be generated.

#### Examples

• Appendix 5 "The Economic Value of the Exmouth Navy Pier and Busselton jetty, Western Australia" in Harvey et al (2021) "Enhancing the Understanding of the Value Provided to Fisheries by Man-made Aquatic Structures", FRDC project No 2018-053.

- Chen J., Chuang C., Jan R., Liu L., Jan M. (2013) Recreational benefits of ecosystem services on and around artificial reefs: a case study in Penghu, Taiwan. Ocean and Coastal Management, 85: 58-64.
- Lupi,F., Phaneuf,D.J., von Haefen,R. (2020) Best practices for implementing recreational demand models. *Review of Environmental Economics and Policy*, volume 14, issue 2, Summer 2020, pp. 302–323
- Pendleton L. (2005) Creating underwater value: The economic value of artificial reefs for recreational diving. Report for the San Diego Oceans Foundation, San Diego, USA.

# Random Utility Model

#### Advantages

- Is based on observed behaviour
- Once developed it can simulate the consequences (and hence value) of prospective MMS at different locations
- It can identify the substitution effects arising from the change in MMS i.e. the way that users shift effort in space as a result of removing/introducing an MMS

#### Disadvantages

- It can only identify the recreational use values (and the expenditures associated with them) but not existence values.
- It has a relatively data intensive approach, requiring information on all site choices that are possible substitutes for the MMs of interest (i.e. diving trips to natural sites as well as to the MMS that one may be interested in), and a full complement of data about all potential sites, even if not selected by a respondent.

#### **Input Requirements**

- Data from a survey of users identifying all relevant trips within the area of interest, including site specific information on costs of accessing site, and expectations (or proxies thereof) of the expected outcomes/experience of the visit (e.g. expected catch rates, species caught, expected species seen). This data needs to be extrapolated to all available 'sites' even if an individual has not visited them through e.g. an estimated expected catch function.
- Statistical analysis is relatively complex.

#### Outputs

- Estimate of the "consumer surplus" per trip to a specific MMS (i.e. the value to the user over and above the amount they have spent on the activity), derived through simulating their site choices with the MMS present v those when it is not.
- Combination of the value per trip and an estimate of aggregate use leads to an estimate of the value of the MMS to the users.
- An estimate of the change in use (i.e. visitation rate/level of effort) applied at the MMS and *all other sites* as a result of MMS removal/creation.
- If information on all costs is collected (i.e. both travel and local expenditure) estimates of the value of the activity to the regional economy can also be generated.

#### Examples

• Appendix 6 "The use value of man-made marine structures in Western Australia: A random utility model" in Harvey et al (2021) "Enhancing the Understanding of the Value Provided to Fisheries by Man-made Aquatic Structures", FRDC project No 2018-053.

### Literature Examples

 Raguragavan, J., and Hailu, A. (2013). Economic valuation of recreational fishing in Western Australia: statewide random utility modelling of fishing site choice behaviour. *Australian Journal of Agricultural and Resource Economics*. Available at: <u>https://onlinelibrary.wiley.com/doi/abs/10.1111/1467-8489.12009</u>.

# Economic impact assessment

#### Advantages

- Can quantify the monetary value that an MMS contributes to the economy in a specified area
- Is based on observed behaviour

#### Disadvantages

• Strictly speaking, the relevant measure of the economic impact is the business profit. However, this measure is typically hard to quantify because few businesses are willing to provide this sensitive information. This is why other measures are used as proxy for profit.

#### **Input Requirements**

- Data from users on expenditures associated with an activity on a MMS
- Interview(s) with relevant businesses on employment, expenditures in the local economy and profits

#### Outputs

• Value is typically measured as direct and indirect business revenues, employee salaries and job creation and/or business profit

#### Examples

• Appendix 4 "The potential Economic Value Associated with the Development of Artificial Reefs in Western Australia" in Harvey et al (2021) "Enhancing the Understanding of the Value Provided to Fisheries by Man-made Aquatic Structures", FRDC project No 2018-053.

- Brock (1994). Beyond fisheries enhancement: Artificial reefs and ecotourism. Bulletin of Marine Science, 55(2-3): 1181-1188.
- Brandini (2014). Marine biodiversity and sustainability of fishing resources in Brazil: a case study of the coast of Parana state. Reg. Environ. Change, 14: 2127-2137
- Crabbe M., McClanahan T.R. (2006). A biosocioeconomic evaluation of shipwrecks used for fishery and dive tourism enhancement in Kenya. Western Indian Ocean J. Mar. Sci., 5(1): 35-53.
- Dowling R.K., Nichol J. (2001). The HMAS Swan Artificial Dive Reef. Annals of Tourism Research, 28(1): 226-229.

# Contingent Valuation Method/Discrete Choice Experiment

#### Advantages

- The only approach that can identify the existence values associated with a change in MMS that are held by those who do not directly use the MMS
- Can potentially capture both use and non-use values if the definition of the sample used is representative and sufficiently large.

#### Disadvantages

- Based on stated preferences, in hypothetical contexts.
- Can potentially conflate existence values and use values, so may lead to double counting if one has estimates of use value elsewhere in the analysis.
- Can be relatively resource intensive if a large representative study is to be undertaken.

#### **Input Requirements**

- A survey of the relevant population, who may hold values for the outcomes associated with changes in MMS. Typically this will need to be 1000+ for robust results, and if subsectors within the sample are to be identified.
- There are a variety of approaches that can be employed, depending on the specific context: contingent valuation techniques are relatively straight forward, but value the MMS as a whole, while the more complex discrete choice models allow the decomposition of value between the elements of the MMS, and allow one to value prospective MMS provision.

#### Outputs

The existence values associated with the MMS, held by those who may never use the MMS. Potentially, given the sampling frame and the context of the question (e.g. a national reefing program) it may include user's evaluation of the use value that they would derive/lose from the provision/removal of the MMS (as respondents are typically asked to value the resource, and not categorise the source of those values). If information on actual (or prospective) use is included then one may be able to segregate different groups of stakeholders, and draw inferences about why values may be different. If a representative sample is drawn, then aggregate values can be made for regional or national populations.

#### Examples

• Appendix 7 "Community perceptions of rigs-to-reefs in Western Australia" in Harvey et al (2021) "Enhancing the Understanding of the Value Provided to Fisheries by Man-made Aquatic Structures", FRDC project No 2018-053.

- Börger T., Hooper T.L., Austen M.C. (2015) Valuation of ecological and amenity impacts of an offshore windfarm as a factor in marine planning. Environmental Science and Policy 54: 126-133.
- Chi-Ok Oh, Robert B. Ditton & John R. Stoll (2008) The Economic Value of Scuba-Diving Use of Natural and Artificial Reef Habitats, Society & Natural Resources, 21:6, 455-468, DOI: <u>10.1080/08941920701681953</u>

• Morgan O.A., Huth W.L., Hindsley P. (2018) Examining the perceptions and effects of survey consequentiality across population subgroups. J. Benefit Cost Anal., 9(2): 305-322. doi:10.1017/bca.2017.32

# Survey of commercial enterprises

#### Advantages

- One gets direct estimates of the economic data relevant to identify profits of commercial enterprises working with the MMS
- Can provide detailed information on expenditure/jobs potentially at a regionally specific level.

#### Disadvantages

- Unless a sector is entirely dependent on the MMS one has to infer contribution of MMS to the aggregate profit
- High level of detail required, and dependent on cooperation of industry to provide commercially sensitive information

#### **Input Requirements**

• A survey of the relevant population, identifying information on costs and revenues, preferably at a level of disaggregation that allows one to attribute values to the MMS of interest.

#### Outputs

- Estimates of profit per unit output/effort, that reflect the economic value of the activity to the business.
- Estimates of the total expenditure, which may give indication of the contribution to local economies.

#### **Literature Examples**

Pascoe, S., Innes, J., Tobin, R., Stoeckl, N., Paredes, S. and Dauth, K. (2016) Beyond GVP: The value of inshore commercial fisheries to fishers and consumers in regional communities on Queensland's east coast July 2016 FRDC Project No 2013-301

# Sustainable livelihood assessment

#### Advantages

- Can identify and estimate a wide range of impacts on subsistence fisheries (economic, social, cultural)
- Is able to integrate economic and social approaches to assessing values
- Applies an ecosystem-based approach to fisheries management

#### Disadvantages

• In contrast to other classical economic approaches, this approach does not quantify all impacts in monetary terms

#### **Input Requirements**

• Surveys with relevant members of the fisheries community to collect information on diversity of coastal people, their capacity to adapt to risks, the incentives that influence their decisions and sources of their vulnerability.

#### Outputs

- Economic, social and/or cultural impact of MMS on the livelihood of subsistence fishers
- Can identify pathways to enhance, supplement and/or diversify livelihoods

- Pomeroy R.S. (2013) Sustainable livelihoods and an ecosystem approach to fisheries management. Coral Triangle Initiative on Coral Reefs, Fisheries and Food Security Report, Jakarta, Indonesia.
- Islam et al. (2014) Economic impact of artificial reefs: A case study of small scale fishers in Terengganu, Peninsular Malaysia. Fisheries Research 151: 122-129.

# Social value: Approaches

In this section, the advantages and limitations of different approaches are summarised, and examples of their application provided. While the approaches are separated here, they can be combined for more comprehensive coverage, to inform subsequent methods or to answer multiple questions. See for example: Harvey et al 2021, Evans et al 2017, Barclay et al 2017.

The 'best' approach will vary depending on the depth of information sought, the target group, the education and engagement levels sought, available resources, and geographic scope. Appendix 1 provides a 'checklist' from which users of this guidebook can quickly see the advantages and disadvantages of the different data collection techniques. By adopting more than one approach, the limitations of one can be offset by another. This is termed data triangulation.

# Literature Review

#### Advantages

- Does not require independent data collection which can be time and resource intensive
- Provides a baseline that can be used to guide/inform future research.

#### Disadvantages

- If a topic of limited current knowledge, a literature review will provide limited contribution to understanding your questions
- The findings are often not related to your specific context (e.g. different geographic location; different user groups) and therefore whether the outputs are transferrable to your context remains unclear in the absence of independent data collection.

#### **Input Requirements**

- Time to complete the review
- Cost of accessing literature databases (e.g. Universities have licences to access these systems)

#### Outputs

Provides a broad understanding of the depth and breadth of current knowledge in relation to the research question. This knowledge may or may not be specific to the location or users of interest to the individual conducting the literature review.

The results can be used to inform/guide additional research into the proposed questions. For example, the literature review may identify key topics that are of interest; and/or provide examples and lessons that inform/shape future research.

#### Examples

• Appendix 2, "Socioeconomic Values Associated with Man-made Aquatic Infrastructure Academic Literature Review" in Harvey et al (2021) "Enhancing the Understanding of the Value Provided to Fisheries by Man-made Aquatic Structures", FRDC project No 2018-053.

#### Literature Examples

- Sutton S.G., Bushnell S.L. (2007) Socio-economic aspects of artificial reefs: Considerations for the Great Barrier Reef Marine Park, Ocean and Coastal Management, 50(10): 829-846
- Stolk P., Markwell K., Jenkins J.M. (2007) Artificial reefs as recreational scuba diving resources: A critical review of research, Journal of Sustainable Tourism, 15(4): 331-350
- Lima, J.S., Zalmon, I.R. and Love, M., 2019. Overview and trends of ecological and socioeconomic research on artificial reefs. Marine Environmental Research, 145: 81-96.

# Online Survey (Quantitative, Qualitative or both)

#### Advantages

- Low cost of data collection due to limited researcher costs
- Obtain large sample sizes through maintaining active survey online
- Random choice of respondent, hence no researcher bias associated with sampling
- Automated recording of responses in format amenable for statistical analysis
- Able to provide incentives to boost response rates if necessary
- Low cost of subscription to well-known and professionally managed survey sites (e.g. Qualtrics)
- Survey can be retitled and given online URL with a catchy or memorable phrase to aid publicity

#### Disadvantages

- Survey cannot be overlong, hence tendency to focus on methods to achieve quick responses (Likert scale; closed option responses) which do not provide opportunity for respondent comment, reaction or discussion
- Limited opportunity for triangulation to verify responses
- No control over choice of respondent: potential for bias due to multiple or duplicate responses requires surveyor to verify each survey response manually
- Unable to ensure respondents are representative of a particular stakeholder group or population
- Limits respondents to those with internet access
- Lack of interaction with surveyor opens possibility for respondent misunderstanding of questions
- Slight risk of survey being hacked or respondent data otherwise illegally accessed. Complete respondent anonymity is usually essential.

#### Input requirements

- Time costs are mostly incurred when designing the survey. Questions and sub-routines (eg 'if answer to Q1 is Yes, then skip to Q5') must be completely internally consistent. All questions must be completely clear, with no words or phrases that could be interpreted in a different way. Instructions to respondent must be absolutely clear and as simple as possible. Survey must be road tested by multiple respondents to ensure that there are no 'dead ends' or incorrect sub-routines through the survey.
- Having designed the survey, costs are minimal. The only costs required are occasional checking of the survey status online and the costs of promotion and/or advertising.

• Analysis costs will vary, but if the survey is mostly quantitative then automated processes of data conversion and analysis can be used. Any qualitative responses (i.e. 'have you any comments to make on X') must be treated separately and coded manually for analysis, which can be time consuming.

#### Outputs

- End users obtain a highly detailed dataset of mainly quantitative responses to questions. These can be analysed as a whole (e.g. X% of survey respondents stated that...), cross tabulated to show relationships between variables or subjected to a wide variety of more advanced analysis and modelling. The choice of technique depends upon the objective of the research, but given a sufficient sample size, a wide range of techniques are available.
- If qualitative questions are employed then these can enrich data analysis through providing direct insights into why respondents answer questions in a certain way. Quotations also enhance the impact of the final report.

#### Examples

• See Sections 'Social Value Individual', in Harvey et al (2021) "Enhancing the Understanding of the Value Provided to Fisheries by Man-made Aquatic Structures", FRDC project No 2018-053.

#### Literature examples

- Kirkbride-Smith A.E., Wheeler P.M., Johnson M.L. (2013) The Relationship between Diver Experience Levels and Perceptions of Attractiveness of Artificial Reefs Examination of a Potential Management Tool, PLoS ONE, 8(7)
- Belhassen, Y., Rousseau, M., Tynyakov, J., & Shashar, N (2017) Evaluating the attractiveness and effectiveness of artificial coral reefs as a recreational ecosystem service, Journal of Environmental Management, 203 (1): 448 – 456
- Sue, V.M., Ritter, L.A. Conducting online surveys (2011) Sage Publishing

# In-person Survey (Quantitative, Qualitative or both)

#### Advantages

- Ability to clearly explain and clarify any questions respondents have to ensure accurate interpretation of survey questions
- Ability to obtain more detailed responses to open-ended survey questions, as respondents are often more willing to 'discuss' their views, than to physically write them down.
- Control over the choice of respondents to ensure they are representative of the target stakeholder group

#### Disadvantages

- Survey cannot be overlong, as interviewee is often taking peoples time from their work or recreation activities; therefore there is a tendency to focus on methods that achieve a quick response (i.e. the inclusion of Likert scale, close option responses) despite the ability for more in-depth interaction with respondents.
- Higher costs of data collection, as requires researchers to physically meet and run-through survey with each participant

- Potential research bias as targeting select groups. To avoid bias, strategies such as surveying every X number of users, can be adopted.
- Smaller sample sizes as constrained by researcher times/costs and site-collection
- Depending on collection technique, e.g. hand written at point of collection, can require additional time to convert responses into digital database/record

#### Input requirements

- Time and travel costs associated with getting to survey sites and data collection
- Analysis costs will vary, but if the survey is mostly quantitative then automated processes of data conversion and analysis can be used. Any qualitative responses (e.g. 'have you any comments to make on X') must be treated separately and coded manually for analysis, which can be time consuming.

#### Outputs

- End users obtain a geographically-specific or user-specific dataset of mainly quantitative responses to questions. These can be analysed as a whole (e.g. X% of survey respondents stated that...), cross tabulated to show relationships between variables or subjected to a wide variety of more advanced analysis and modelling. The choice of technique depends upon the objective of the research, but given a sufficient sample size, a wide range of techniques are available.
- If qualitative questions are employed then these can enrich data analysis through providing direct insights into why respondents answer questions in a certain way. Quotations also enhance the impact of the final report.

#### **Literature Examples**

- Ramos, J., Santos, M., Whitmarsh, D., & Monteiro, C. (2011b) Stakeholder analysis in the Portuguese artificial reef context: winners and losers, Braz. J. Oceanogr, 59: 133-143
- Hooper T., Ashley M., Austen M. (2015) Perceptions of fishers and developers on the colocation of offshore wind farms and decapod fisheries in the UK, Marine Policy, 61: 16- 22
- Shani A., Polak O., Shashar N. (2012) Artificial Reefs and Mass Marine Ecotourism, Tourism Geographies, 14 (3): 361-382

#### In-person or online Interviews

#### Advantages

- Ability to obtain more detailed responses than open-ended survey questions and in-person surveys, as respondents are able to more broadly discuss their views, rather than being confined to answering set discrete questions. The interviewee also has the ability to ask additional questions and delve more deeply into specific topics that are raised during the interview process
- Interviews are conducted over a long period of time (e.g. average of 1 hour) allowing ample opportunity to explore a topic/question in-depth.
- Control over the choice of respondents to ensure they are representative/key stakeholders of the target stakeholder group

• The descriptive nature of interviews provides useful quotes that can applied to demonstrate key research themes or to provide additional depth to quantitative research if being conducted in combination with quantitative methods.

#### Disadvantages

- Higher costs of data collection, as requires time to conduct, transcribe and analyse transcripts each interview. Specialist skills in social research required for data analysis.
- Potential research bias as targeting select stakeholders.
- Smaller sample sizes as constrained by researcher times/costs and (when not conducted online) site-collection

#### Input requirements

- Time and travel costs associated with getting to survey sites (for in-person interviews) and data collection
- Analysis costs will vary depending on the number of interviews conducted, but each interview must be coded manually for analysis, which can be time consuming.

#### Outputs

- End users obtain an in-depth understanding of the target issue, from the perspective of the interviewees
- If coupled with other research techniques, such as surveys, interviews provide an enriched data analysis through providing direct insights into why respondents answer questions in a certain way. Quotations also enhance the impact of the final report.

- Lima J.S., Zappes C.A., Di Beneditto A.P.M., Zalmon I.R. (2018), Artisanal fisheries and artificial reefs on the southeast coast of Brazil: Contributions to research and management, Ocean and Coastal Management, 163: 372-382
- Pike, K., Johnson, D., Fletcher, S., Wright, P., & Lee, B (2010), Social Value of Marine and Coastal Protected Areas in England and Wales, Coastal Management, 38(4): 412 432
- Ten Brink T.S., Dalton T. (2018) Perceptions of commercial and recreational fishers on the potential ecological impacts of the Block Island Wind Farm (US), Frontiers in Marine Science, 5: 439

# Workshops/Focus groups

There are multiple techniques for running group workshops/focus groups. In this section we focus on three approaches, all involving causal mapping – a structuring technique. Two of the approaches adopt software (as applied in Harvey et al, 2021), and one that does not apply software. See Table 3 below for a summary. However, it is also possible to run focus groups with a facilitator capturing the views on a flip chart, using brainstorming to generate material into content-oriented clusters, or simple group electronic prioritisation systems.

Technique/application	Manual F2F	Software supported	Software supported	
		F2F	on-line	
Causal mapping – structured conversations	Use of Oval Mapping	Group Explorer	Strategyfinder	
Brainstorming	Facilitator as scribe Post it exercise on wall	Group electronic prioritisation systems	Miro and other software packages	

Table 3 Illustrating the techniques

# Face to face software supported mapping-oriented focus groups

#### Advantages

- Able to capture a wide range of issues and opportunities through participants having direct entry allowing for simultaneous contribution = highly productive use of time
- Reduce conformity pressures through anonymity allowing for greater openness and thus representativeness of view
- Capture participant's contributions accurately rather than risks of paraphrasing or getting lost = ownership increased
- Able to understand how issues and opportunities impact one another and thus capture the systemic nature of the focal issue better systemic understanding
- Ability to identify clusters content oriented themes helping participants navigate the material and ensuring that complexity is managed, not simply reduced.
- Ability to ask why issues matter enabling participants to reflect on values that drive them
  rather than responding to provided values (bounded list) or those that are currently topical
  and given lip service to -> Able to tease out values 'in action' those that are acted upon and
  drive behaviour
- Able to prioritise themes, issues, values and opportunities to determine degree of consensus as well as priorities
- Able to develop a network of issues, opportunities and values (through chains of argument) which can be analysed for key properties such as dominant issues/opportunities, feedback dynamics etc and can feed into more quantitative models. A series of workshops can be reviewed and analysed to determine intra and inter levels of homogeneity etc.
- Enables participants to gain a deeper more nuanced understanding of the topic being focused upon and increased ownership for outcomes

#### Disadvantages

• Complex maps which are challenging to read by those not involved in generating them

- An array of issues to tackle when considering MMS (or whichever topic is focused upon) which may feel overwhelming and may raise expectations in the minds of those involved
- Non quantifiable data but the map's structure can be used to develop quantifiable models (e.g. MCDM, SD simulations etc.)

#### Input requirements

- 3-3.5 hours participant time
- Software availability
- Facilitator time (including time expended for set up, managing the workshop, analysing the data, producing the report)
- Trained facilitators
- Group Support System equipment
- Appropriate venue

#### Outputs

- <u>Policy makers</u> are provided with a clear sense of the priorities, concerns and aspirations of particular communities/cohorts and how these impact one another thus able to make more robust and sustainable decisions
- <u>Policy makers/local government</u> have clarity re competing values/aspirations of stakeholder groups enabling increased 'buy-in' and facilitating communication
- <u>Policy makers</u> are able to use the information to feed into semi-quantitative and quantitative models (through provision of structure) for further analysis
- <u>Oil and Gas industry</u> are able to make decisions about decommissioning which take account of community views (both issues and opportunities)
- <u>Regulators</u> are provided with a mandate to work with stakeholder groups to develop effective and evidence based (informed by identified research needs) regulations reflecting the diversity of values
- <u>Recreational and Commercial fishing</u> decision makers are given insight into the competing uses
- <u>Participants</u> gain a deeper understanding of the topic, allowing them to understand more effectively their own views and seeing them in the context of others thus building shared understanding, alignment of view and a platform for action
- <u>All</u> are made aware of the multiple different stakeholder cohorts and the variations of issues, opportunities and values both within and across cohorts

#### Examples

 See Sections 'Social Value Group', in Harvey et al (2021) "Enhancing the Understanding of the Value Provided to Fisheries by Man-made Aquatic Structures", FRDC project No 2018-053.

- Ackermann, F. and Eden, C. (2020) Group Support Systems: Concepts to Practice. In C. Eden and M. Kilgour (Eds) Handbook of Group Decision and Negotiation. Springer
- Bryson, J., F. Ackermann, and C. Eden. 2016 "Discovering Collaborative Advantage: The Contributions of Goal Categories and Visual Strategy Mapping. Public Administration Review 76 p912-925

• Franco, L.A., Rouwette, E.A.J.A. (2011) Decision development in facilitated modelling workshops. European Journal of Operational Research, 2011, 212(1), pp. 164–178

# On-line software supported mapping based focus groups

#### Advantages

- Able to capture a wide range of issues and opportunities through participants having direct entry allowing for simultaneous contribution = highly productive use of time
- Reduce conformity pressures through anonymity allowing for greater openness and thus representativeness of view. On line system yields greater degrees of anonymity and also provides time for reflection increasing quality of surfaced material
- Capture participant's contributions accurately rather than risks of paraphrasing or getting lost = ownership increased
- Able to understand how issues and opportunities impact one another and thus capture the systemic nature of the focal issue better systemic understanding
- Ability to identify clusters content oriented themes helping participants navigate the material and ensuring that complexity is managed, not simply reduced.
- Ability to ask why issues matter enabling participants to reflect on values that drive them
  rather than responding to provided values (bounded list) or those that are currently topical
  and given lip service to -> Able to tease out values 'in action' those that are acted upon and
  drive behaviour
- Able to prioritise themes, issues, values and opportunities to determine degree of consensus as well as priorities
- Development of a network of issues, opportunities and values (through chains of argument) which can be analysed for key properties such as dominant issues/opportunities, feedback dynamics etc and can feed into more quantitative models. A series of workshops can be reviewed and analysed to determine intra and inter levels of homogeneity etc.
- Able to involve those that are geographically dispersed (no costs time or \$\$)
- Enables participants to gain a deeper more nuanced understanding of the topic being focused upon and increased ownership for outcomes

#### Disadvantages

- Complex maps which are challenging to read by those not involved in generating them
- An array of issues to tackle when considering MMS (or whichever topic is focused upon) which may feel overwhelming and may raise expectations in the minds of those involved
- Non quantifiable data but the map's structure can be used to develop quantifiable models (e.g. MCDM, SD simulations etc.)
- less building of a team/a shared sense of commitment
- relies on a good internet access speed

#### Input requirements

- 3-3.5 hours participant time x # participants
- Software requirements
- Facilitator time (including time expended for set up, managing the workshop, analysing the data, producing the report)
- Trained facilitators

#### Outputs

- <u>Policy makers</u> are provided with a clear sense of the priorities, concerns and aspirations of particular communities/cohorts and how these impact one another thus able to make more robust and sustainable decision making
- <u>Policy makers/local government</u> have clarity re competing values/aspirations of stakeholder groups enabling increased 'buy-in' and facilitating communication
- Policy makers are able to use the information to feed into semi-quantitative and quantitative models (through provision of structure) for further analysis
- <u>Oil and Gas</u> are able to make decisions about decommissioning which take account of community views (both issues and opportunities)
- <u>Regulators</u> are provided with a mandate to work with stakeholder groups to develop effective and evidence based (informed by identified research needs) regulations reflecting the diversity of values
- <u>Recreational and Commercial</u> fishing decision makers are given insight into the competing uses
- <u>Participants</u> gain a deeper understanding of the topic, allowing them to understand more effectively their own views and seeing them in the context of others thus building shared understanding, alignment of view and a platform for action
- <u>All</u> are made aware of the multiple different stakeholder cohorts and the variations of issues, opportunities and values both within and across cohorts

#### Examples

• See Sections 'Social Value Group', in Harvey et al (2021) "Enhancing the Understanding of the Value Provided to Fisheries by Man-made Aquatic Structures", FRDC project No 2018-053.

### Literature Examples

• Not currently available.

# Face to face manual mapping-based focus groups

#### Advantages

- Able to capture a wide range of issues and opportunities through participants writing views on post-it notes allowing for simultaneous contribution = highly productive use of time and more even distribution of contribution.
- Reduce conformity pressures through a degree of anonymity allowing for increased openness and thus representativeness of view. Avoiding conformance pressures can be ensured through good facilitation – by, for example, ensuring silent time for all to write down their thoughts, providing participants with identical pens to avoid easily distinguishing authors.
- Capture participant's contributions accurately rather than risks of paraphrasing or getting lost = ownership increased
- Able to understand how issues and opportunities impact one another and thus capture the systemic nature of the focal issue
- Ability to identify clusters content oriented themes helping participants navigate the material and ensuring that complexity is managed, not simply reduced.
- Able to tease out values 'in action' through asking why issues matter, participants reflected on values that drive them rather rather than espoused values
- Able to prioritise themes, issues, values and opportunities to determine degree of consensus as well as priorities
- Development of a network of issues, opportunities and values (through chains of argument) which can be analysed for key properties such as dominant issues/opportunities, feedback dynamics etc. and can feed into more quantitative models
- Able to involve those that are geographically dispersed cutting out travel costs in terms of both participant time or \$\$ expended.
- Enables participants to gain a deeper more nuanced understanding of the topic being focused upon and increased ownership for outcomes
- Familiar and easy to set up approach

#### Disadvantages

- Complex maps which are challenging to read by those not involved in generating them
- An array of issues to tackle when considering MMS (or whichever topic is focused upon) which may feel overwhelming and may raise expectations in the minds of those involved
- Non quantifiable data but the map's structure can be used to develop quantifiable models (e.g. MCDM, SD simulations etc.)
- Either needs to be captured into a software package or analysed manually which is challenging
- Requires strong facilitation to avoid dominant members hijacking the meeting

#### Input requirements

- 3-3.5 hours participant time x # participants
- Appropriate Venue
- Facilitator time (including time expended for set up, managing the workshop, analysing the data, producing the report)
- Trained facilitators

#### Outputs

- <u>Policy makers</u> are provided with a clear sense of the priorities, concerns and aspirations of particular communities/cohorts and how these impact one another thus able to make more robust and sustainable decision making
- <u>Policy makers/local government</u> have clarity re competing values/aspirations of stakeholder groups enabling increased 'buy-in' and facilitating communication
- Policy makers are able to use the information to feed into semi-quantitative and quantitative models (through provision of structure) for further analysis
- <u>Oil and Gas</u> are able to make decisions about decommissioning which take account of community views (both issues and opportunities)
- <u>Regulators</u> are provided with a mandate to work with stakeholder groups to develop effective and evidence based (informed by identified research needs) regulations reflecting the diversity of values
- <u>Recreational and Commercial</u> fishing decision makers are given insight into the competing uses
- <u>Participants</u> gain a deeper understanding of the topic, allowing them to understand more effectively their own views and seeing them in the context of others thus building shared understanding, alignment of view and a platform for action
- <u>All</u> are made aware of the multiple different stakeholder cohorts and the variations of issues, opportunities and values both within and across cohorts
- NOTE: to fully leverage the material capturing the data into a software package would facilitate usage

#### Literature examples

- Eden, C. and Ackermann, F. (1998) Making Strategy: The Journey of Strategic Management. Sage: London
- Bryson, J. B.; Ackermann, F.; Eden, C., and Finn, C. (2004) The Oval Mapping Process: Identifying Strategic Issues and Formulating Effective Strategies. Strategic Planning for Public and Non-Profit Organisations. San Francisco: Jossey Bass; 2004; pp. 355-376.
- Ackermann, F. and Eden, C. (2020) Strategic Options Development and Analysis. In M. Reynolds and S. Howell Systems Approaches to Managing Change: A Practical Guide. Springer Verlag

# Brainstorming approaches

#### Advantages

- Familiarity with the process of brainstorming natural to all participants
- Easy to set up and manage
- (when using software) anonymity and speed of capture

#### Disadvantages

- Unstructured data making it hard to understand how to use this information for decision making.
- Lack of clarity in terms of meaning as the language used can be ambiguous
- Software access and participant devices required

#### Input requirements

- 3-3.5 hours participant time x # participants
- Appropriate Venue
- Facilitator time (including time expended for set up, managing the workshop, analysing the data, producing the report)
- Trained facilitators

#### Outputs

• Lists or clusters of material that can be used to inform decision making

- Osborn, A.F. (1963) Applied imagination: Principles and procedures of creative problem solving (Third Revised Edition). New York, NY: Charles Scribner's Son
- Nunamaker, Jay; Dennis, Alan; Valacich, Joseph; Vogel, Doug; George Joey (1991).
   "Electronic Meeting Systems to Support Group Work". Communications of the ACM. 34 (7): 40–61
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# Appendix 1

	In-person survey	Online survey	Stakeholder	Workshops/
To what extent will the data			Interviews	torums
To what extent will the data				
Represent all stakeholders				
Provide depth of understanding				
Uncover system interrelationships (systemicity)				
Is the data				
Quantifiable				
Context sensitive				
Does the approach				
Engage multiple stakeholder groups (direct)				
Engage multiple stakeholder groups (indirect)				
Increase the awareness/understanding of those that participate				
Require significant resource investment to implement				

 Table A1 Summary of the advantages and limitations of different data collection approaches

Legend – green = considerable contribution, orange = moderate contribute and red = low to no contribution

Notes:

- 1. Surveys can include both quantitative and qualitative questions. Ratings assigned based on predominantly quantitative survey questions that allow quick completion.
- 2. Note, that '<u>literature review'</u> is not included in the table, as the availability of published information on any chosen topic will differ by context and over time. **Click** on the column heading to see further information on that approach.
- 3. In principle an in-person survey could provide the same outcomes as an online survey if resources are available to achieve the same number and same representativeness of respondents, but this is likely to be prohibitively expensive in many circumstances.
- 4. The administrative ease of online surveys is conditional upon the availability of representative panels of online respondents to draw from, and an established infrastructure to distribute surveys.