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FRDC Project No. 2010/235

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2010/235 Research Priorities for Understanding Movements of Cross Jurisdictional Species

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OBJECTIVES:

1. Facilitate communication that will enable the development of effective management of shared stocks of highly mobile or migratory species
2. Develop a consensus around knowledge gaps and research priorities in relation to the management of highly mobile or migratory species.
3. Determine whether movement data from a national acoustic tracking network would provide the required information in relation to identified knowledge gaps and research priorities.

Contents

Non Technical Summary:

OUTCOMES ACHIEVED TO DATE

Understanding the movement patterns of fished species that move across jurisdictional boundaries is important for effective management of such species. The Opportunities to better understand these movements are growing as a result of technological development in the field of acoustic tagging as well as new infrastructure for tracking acoustic tags through Australia's Integrated Marine Observing System (IMOS). In order to optimally utilise this opportunity for management it is necessary to coordinate tagging and tracking activities among fisheries jurisdictions within Australia. This project listed and compiled information on cross-jurisdictional species provided by all Australian fisheries jurisdictions. Progress was made toward developing a consensus aligning priority research needs for management of cross jurisdictional species among State and Commonwealth management and research agencies through a workshop held as part of this project. While the list of priority species has reduced the number of potential target species there needs to be further discussion and analysis of which will be targeted as the highest priority for future work and potential funding applications. The workshop highlighted that there is still much work to be done to develop an understanding among jurisdictions of the potential benefits and synergies that could accrue through developing consensus priorities. A further outcome of the workshop was the recognition that in order to address the highest priority information gaps fisheries jurisdictions would likely need to influence the patterns of infrastructure deployment in key locations around Australia. A positive outcome of the workshop was the agreement by all state jurisdictions to work together and participate in a follow-up application to FRDC for funding to further develop priorities for addressing information gaps and a strategy for influencing IMOS infrastructure deployments.

Recent developments in the acoustic tracking of marine species and the deployment of national tracking infrastructure through IMOS/AATAMS[1] has provided an unprecedented opportunity to provide movement information, and to achieve synergies and efficiencies between fisheries research and management organizations across jurisdictions. AATAMS infrastructure includes hundreds of acoustic receivers placed around Australia in order to detect the location and movements of fish and sharks implanted with coded acoustic tags, These tags are inexpensive relative to satellite tags, and do not have to be detected from the surface. Development of a coordinated research program by fisheries management agencies also presents synergies and efficiencies for AATAMS, therefore developing a national strategy for tagging and monitoring the movement of key marine species presents a mutually beneficial opportunity.

The broad goal of this proposal was to explore and facilitate a national-scale coordinated approach among Australia's fishery management organizations

[1] * Integrated Marine Observing System / Australian Animal Tracking and Monitoring System

regarding the key species that should be targeted for research effort in the area of movements of cross-jurisdictional species. This was accomplished through a workshop attended by jurisdictional representatives from all Australian States as well as Commonwealth agencies. The workshop considered what the highest priority species for acoustic tagging and movement information were, based on their biology and overall stock status, as well as the potential risks posed by inconsistent jurisdictional management approaches. It also considered the opportunities presented by acoustic tracking infrastructure, and the potential to further leverage this capability, by assessing the extent to which key species might also match the priorities of AATAMS. While a level of consensus was achieved on what the highest priority species were, based on information need and risk, it was also recognised that there was a mismatch between the highest priority species and available AATAMS infrastructure. High priority species in terms of fisheries management need were often located in areas with poor coverage by infrastructure, and while a number of potential species were common on areas with good infrastructure coverage, there was relatively low management need for many of these species. It was agreed to try to further investigate the potential use of acoustic tagging and tracking of cross-jurisdictional species by the following approach; first establish whether a clear need and path for uptake of acoustic tagging based movement data could be demonstrated, and based on this develop a clear case to influence the placement of IMOS infrastructure. If both of these objectives can be achieved there would then be a sound basis for developing research programs based on acoustic tagging and tracking of high priority cross jurisdictional species.

KEYWORDS: Cross-jurisdictional species, acoustic tagging, tracking, movement.

ACKNOWLEDGEMENTS: We would like to thank the FRDC for funding this work and the representatives of all Australian fisheries jurisdictions who contributed to the project by providing written information on species relevant to their jurisdictions, and who attended the workshop contributing their time, knowledge and experience to this project

INTRODUCTION

Around Australia there are many species of sharks and finfish that range widely and even undertake long-distance migrations for spawning or foraging. There is a need to better describe and understand these aspects of the ecology and biology of these species in order to more effectively manage utilisation and conservation of them across both single and multiple jurisdictions. These species cross various jurisdictional boundaries (State and Commonwealth) and in this process are subject to a range of management regulations which may potentially be simplified to best meet the needs of an overall stock management approach. Given the realities of existing jurisdictional arrangements such simplification may be aspirational but, at the very least, management of these species at the level of constituent agencies can only benefit from additional information on the biology of species shared with other jurisdictions.

Recent developments in the acoustic tracking of marine species and the deployment of national tracking infrastructure through IMOS/AATAMS[2] has provided an unprecedented opportunity to provide movement information, and to achieve synergies and efficiencies between fisheries research and management organizations across jurisdictions. AATAMS infrastructure includes hundreds of acoustic receivers placed around Australia in order to detect the location and movements of fish and sharks implanted with coded acoustic tags, These tags are inexpensive relative to satellite tags, and do not have to be detected from the surface. Development of a coordinated research program by fisheries management agencies also presents synergies and efficiencies for AATAMS, therefore developing a national strategy for tagging and monitoring the movement of key marine species presents a mutually beneficial opportunity.

The broad goal of this proposal was to explore and facilitate a national-scale coordinated approach among Australia's fishery management organizations regarding the key species that should be targeted for research effort in the area of movements of cross-jurisdictional species. This was to be accomplished through a workshop attended by jurisdictional representatives from all Australian States as well as Commonwealth agencies. Consideration of what the highest priority species might be was based on their biology and overall stock status, as well as the potential risks posed by inconsistent jurisdictional management approaches. It also considered the opportunities presented by acoustic tracking infrastructure, and the potential to further leverage this capability, by assessing the extent to which key species might also match the priorities of AATAMS.

[2] * Integrated Marine Observing System/ Australian Animal Tracking and Monitoring System

OBJECTIVES

The formal objectives of the proposal were as follows;

- Facilitate communication that will enable the development of more effective monitoring, assessment and management of shared stocks of highly mobile or migratory cross-jurisdictional species
- Develop a national consensus on knowledge gaps and research priorities in relation to the assessment and management of cross-jurisdictional species.
- Determine whether movement data from a national acoustic tracking network would provide the required information in relation to identified knowledge gaps and research priorities

This project aims to develop a consensus amongst State and Commonwealth management and research agencies on research needs to assist management of cross-jurisdictional species. There is an opportunity to use this consensus to harness recent technological developments in the tracking of marine animal movements to achieve synergies that will benefit parties in all jurisdictions. Regardless of whether the workshop leads to the development of a proposal for a national acoustic tracking program, the information compiled by the project, in combination with the outcomes of the workshop, will provide a valuable basis for development of better alignment of cross-jurisdictional stock assessments and management policy.

Consensus on research priorities and the alignment of multi-jurisdictional interests would also provide benefits for agencies such as the FRDC. In addition to promoting more effective communication and better management outcomes across the board, it would also have the potential to achieve greater efficiencies and economies of scale through integrated cooperative programs rather than multiple one-off projects (in the cross-jurisdictional context). For example, FRDC currently funds two separate projects on temperate/subtropical whaler sharks in WA and NSW whose goals include studying the movements of individuals using acoustic tagging and tracking. These sharks are distributed around southern Australia, and may undertake large scale movements, however the infrastructure to record such movements is not present in Victoria and South Australia where AATAMS networks are not present, and fisheries agencies are not partners in a coordinated tagging program. Such a coordinated program would have the potential to more effectively leverage National Research Infrastructure resources from IMOS and AATAMS.

Fully leveraging AATAMS resources requires consideration of the priorities of IMOS and how they relate to acoustic tracking. An overarching goal of IMOS/AATAMS is to operate a national marine observing system, with the power to detect large scale change and variability in ocean ecosystems due to natural and anthropogenic effects at a range of spatial and temporal scales. While the IMOS/AATAMS observation network will have benefits to society it is strategic in nature and aimed at broad understanding of ocean ecosystems and has a strong temporal component. In order to do this, AATAMS has developed

a policy calling for a core group of species to be identified for long term observing (Appendix 3). These species will act as indicators of change at local, regional and wider scales and will address the IMOS strategic focus, namely the role of the oceans in the climate system, the impact of major boundary currents on the continental shelf, and the responses of ecosystems and biodiversity at multiple timescales relevant to these processes.

Core species for AATAMS should meet specific criteria in order to be able to address the above needs

1) Scale: National Backbone
    a) Large range (national scale) – spatial component large
    b) Migratory movements – temporal component large
    c) Trophic Level – include high and mid-trophic level species
2) Scale: Regional- Within specific Boundary Currents (EAC, Leeuwin)
    a) Medium range (within specific boundary currents)- spatial component large
    b) Migratory movements – spatial scale medium, phenology well known
    c) Trophic Level – include high and mid-trophic level species
3) Scale: Local: Within Bioregion- detect change in shelf/slope processes
    a) Small range (within bioregion) spatial component well defined
    b) Migratory movements- spatial scale low
    c) Trophic level- high and mid
4) Design: movements, boundaries must coincide with national design of IMOS infrastructure, and linkages to data streams must be explicit
5) Utility: Species selected should meet specific utility in terms of commercial value, recreational demand, iconic status , conservation value or be keystone species
6) Utility: Indicator species to be selected as appropriate for input into spatially explicit models

While the above criteria are key to achieving the goals of AATAMS, it is unlikely that all species selected on the basis of cross-jurisdictional fisheries management needs will map directly onto AATAMS strategic criteria. Rather, AATAMS criteria are likely to form part of determining priorities for management-related movement research on cross-jurisdictional species. However, significant gains and cost-effective collaboration will come from determining synergies between AATAMS strategic goals and the priority needs for cross-jurisdictional specie

METHODS

Consultation

The project provided an overview of R&D priorities for highly mobile or migratory cross-jurisdictional species across various State and Commonwealth jurisdictions by compiling and reviewing published R&D priorities as well as management regulations (whether congruent or conflicting) for these cross-jurisdictional species. We also undertook a survey of key policy makers in these jurisdictions to identify key questions and management priorities with respect to cross-jurisdictional issues (Appendix 4).

Based on this information a review document was prepared and presented to respondents and key research practitioners at a workshop held in Sydney. The workshop was a key component of developing a consensus on priority species and identifying where movement-related information gaps existed. A significant amount of additional information emerged at the workshop, particularly in relation to management relevance and risk in relation to potential priority species. This added an important perspective to other potential priority species that had emerged from compilations of responses to the questionnaires.

Table 1. Questions posed to participants/representatives in the cross-jurisdictional research priorities workshop.

1	What is a cross-jurisdictional species?
2	Which are the key cross-jurisdictional species in your jurisdiction?
3	Which jurisdictions do you share your species with (State, Commonwealth, sectoral)?
4	What are the key management issues with these species?
5	What are the management measures for these species?
6	What are the challenges in establishing complementary management approaches between jurisdictions?
7	What are the key information gaps (in terms of movement) and how do they relate to potential future management measures?
8	What other information sets exist for your cross-jurisdictional species that could improve the quality of guidance for fishery management decisions (e.g., genetic, parasites, hard-part chemistry)?
9	What are the priority species among those you have listed?
10	Are issues likely to change in future given trends in human populations and/or climate change
11	What documentation exists within your jurisdiction relating to these questions?

RESULTS

Jurisdictional responses to questions

A wide range of responses were obtained from the respondents to the questionnaire and, with the exception of one agency, all of those invited to participate provided some level of response. The data obtained from the survey is summarised in Table 2. Individual agency responses to the question in Table 1 are presented in their entirety in Appendix 5.

Table 2. Cross-jurisdictional research priorities, responses to questions posed to agencies.

Question 1	What is a cross-jurisdictional species?
Tasmania	A species where harvesting in one jurisdiction affects resources in another jurisdiction
South Australia	A species which moves between areas where several agencies are managing the potential impacts on the species
DAFF/ABARES	A marine species that has a range that encompasses more than one management jurisdiction (for example the species can be found in the waters of two or more state or territory jurisdictions or in both Commonwealth and state/territory waters or across the jurisdiction of two or more countries); and is taken by fisheries in significant quantities in both jurisdictions.
NSW	Species taken in more than one jurisdiction.
WA	A species occupying an area administered under different Governments' management regimes (jurisdictions), for which the activities in one jurisdiction can directly or indirectly impact the status of the species in another jurisdiction
QLD	A species which moves between areas where more than one agency (state and/or commonwealth) is responsible for managing that species.
NT	A species that traverses across geo-political boundaries
VIC	Any species that is targeted or caught in significant quantities by any type of fishing in two or more State/Territory/Commonwealth jurisdictions.

Consensus	A marine species that has a range that encompasses more than one management jurisdiction (for example the species can be found in the waters of two or more state or territory jurisdictions or in both Commonwealth and state/territory waters or across the jurisdiction of two or more countries); and is taken by fisheries in significant quantities in both jurisdictions. A species where harvesting in one jurisdiction affects resources in another jurisdiction. Species may be of commercial or recreational importance - or both. Species may also be cross jurisdictional in a conservation sense – e.g. differences in between State protection/ bycatch regulations/reporting requirements + efficacy (interactions) etc.

Table 2 (cont.). Cross-jurisdictional research priorities, responses to questions posed to agencies.

Question 2	Which are the key cross-jurisdictional species in your jurisdiction?
Tasmania	Southern Rock Lobster, Giant Crab, Commercial Scallop, Blue Warehou, Eastern Australian Salmon, Southern Bluefin Tuna
South Australia	White Shark, Dusky Whaler, Shortfin Mako, Bronze Whaler, School Shark, Thresher Shark, Sevengill Shark, Blue Shark, Gummy Shark, Murray Cod, Southern Bluefin Tuna, Mulloway, Blue-eye Trevalla, Snapper, Commercial Scallop, Australian Salmon (Eastern and Western), Samsonfish, King George Whiting
DAFF/ABARES	Sharks; Tunas; Snapper; The key species vary with respect to the issue, for example the key cross-jurisdictional species in the international context are covered by regional fisheries management organisations and agreements. Some species are also cross-jurisdictional with respect to state/territory waters, commercial species are covered by Offshore Constitutional Settlement arrangements, while the recreational component may not be.
NSW	see attachment
WA	Elasmobranchs - Gummy Shark (*Mustelus antarcticus*), WA, Comm; Dusky Whaler (*Carcharhinus obscurus*), WA, Comm, SA; Sandbar Shark (*Carcharhinus plumbeus*), WA, Comm; Blacktip Sharks (*C. limbatus* and *C. tilstoni*), WA, NT, Qld; Teleosts - Snapper (*Pagrus auratus*), WA, Comm; Goldband Snapper (*Pristipomoides* spp., mainly *P. multidens*), WA, Comm, NT; Spanish Mackerel (*Scomberomorus commerson*), WA, NT, Qld; Grey Mackerel (*Scomberomorus semifasciatus*), WA, NT, Qld; Tropical Lutjanids (Red Snappers, Ruby Snapper), WA, NT, Qld, Comm; Pilchards (*Sardinops sagax*), WA, SA, Comm?; Australian Herring (*Arripis georgianus*)?, WA, SA; Australian Salmon (*Arripis truttaceus*), WA, SA, Vic? [NB Tuna spp, legislated single jurisdiction under OCS]
QLD	Mud Crabs, Barramundi , (*Lates calcarifer*), Bugs–Balmain (*Ibacus chacei* and *I. brucei*), Moreton Bay (*Thenus australiensis* and *T. parindicus*), Crab–Mud , (Scylla spp.), Crab–Spanner, (*Ranina ranina*), Mackerel¬–Grey (*Scomberomorus semifasciatus*),

	Mackerel–Spanish (*Scomberomorus commerson*), Mackerel–Spotted, (*Scomberomorus munroi*), Sea Mullet , (*Mugil cephalus*), Shark spp., Snapper , (*Pagrus auratus*), Snapper–Crimson, (*Lutjanus erythropterus*), Snapper–Goldband, (*Pristipomoides multidens*), Snapper¬–Hussar, (*Lutjanus adetii* and *L. vitta*), Snapper–Rosy (*Pristipomoides filamentosus*), Snapper–Saddletail, (*Lutjanus malabaricus*), Tailor , (*Pomatomus saltatrix*), Threadfin–King (*Polydactylus macrochir*)
NT	Grey Mackerel, sharks, Red Snapper (Saddletail and Crimson), Goldband Snapper, Spanish Mackerel
VIC	Tunas (Southern Bluefin Tuna, Yellowfin, Bigeye, Albacore) - Vic/SA/Tas/NSW recreational catch; Commonwealth commercial catch: Pelagic Sharks (Shortfin Mako, Bronze Whaler) - Vic/SA/Tas/NSW recreational catch; Gummy/School Shark - Vic/SA/Tas/NSW recreational & commercial catches; Commonwealth commercial catch: Australian Salmon - Vic/SA/Tas/NSW recreational & commercial catches; Sardine - Vic/SA/Tas/NSW commercial catches; some Commonwealth commercial catch: Snapper - Vic recreational & commercial catches; some Commonwealth commercial catch: King George Whiting - Vic/SA recreational & commercial catches;
Question 2 (cont.) Consensus	A wide range of species cross jurisdictional boundaries and present issues for their effective management. The key species vary with respect to the issue, for example the key cross-jurisdictional species in the international context are covered by regional fisheries management organisations and agreements. Some species are also cross-jurisdictional with respect to state/territory waters, commercial species are covered by Offshore Constitutional Settlement arrangements, while the recreational component may not be.

Table 2 (cont.). Cross-jurisdictional research priorities, responses to questions posed to agencies.

Question 3	Which jurisdictions do you share your species with (State, Federal, sectoral)?
Tasmania	Adjacent states (SA, Vic) and Commonwealth.
South Australia	Western Australia, Victoria, New South Wales, Tasmania, Commonwealth, Antarctic waters, Queensland ,Northern Territory
DAFF/ABARES	All states and the Northern Territory, plus internationally across the Pacific Ocean, Indian Ocean, Arafura Sea, Torres Strait and the Southern Ocean; Within Commonwealth fisheries there are also some species shared across sectors, in cases such as the Southern and Eastern Scalefish and Shark Fishery most total allowable catches apply to all sectors.
NSW	Victoria, Queensland, Tasmania, Commonwealth
WA	South Australia, Northern Territory, Victoria, Queensland, Commonweal
QLD	Northern Territory, New South Wales, Commonwealth
NT	Queensland, Western Australia, Federal, In the case of Red Snapper, it is also shared with Indonesia
VIC	NSW, South Australia, Tasmania, Commonwealth
Consensus	All States and the Commonwealth share species across jurisdictions. The key number of jurisdictions identified which shared species, by State and Commonwealth were: TAS - 3 SA - 7 DAFF/ABARES - 8+ NSW - 4 QLD - 3 Vic - 4 WA - 4

Table 2 (cont.). Cross-jurisdictional research priorities, responses to questions posed to agencies.

Question 4	What are the key management issues with these species?
Tasmania	TACC/ catch management, managing regional differences in species biology and fleet dynamics, uncertainty in stock size, recruitment variability.
South Australia	The various and sometimes different legislation between States and agencies; Difference in priorities and values of some species between States and agencies; - Environmental factors which can increase vulnerability/catchability of some species (e.g., drought for fresh water species)
DAFF/ABARES	Cross-jurisdictional species management issues relate mainly to ensuring the consistent application of catch allowances and/or complementary management measures for species between jurisdictions. Particularly difficult when one jurisdiction uses output controls and another input controls; the collection and provision of information between jurisdictions for setting of appropriate catch limits or total allowable catches. This includes differences in the level of reporting in different jurisdictions; joint/agreed assessments and consistent reference points between jurisdictions. . Challenges exist when one of the key fisheries is recreational, particularly in terms of data, monitoring and management approaches
NSW	Sustainability, profitability of industry and sharing within and between jurisdictions (including the recreational sector).
WA	Gummy Sharks: Differential commercial gillnet management arrangements (permitted input/output controls, mesh sizes, etc) for Gummy Sharks and uncertainty in exchange rates between jurisdictions/management zones; Dusky & Sandbar: Recruitment of Dusky and Sandbar Sharks is particularly susceptible to mortality of older juvenile and adult sharks (by targeted fishing, bycatch, IUU, bait-bands, etc.); Blacktip Sharks: Uncertainty in Blacktip Shark catch species composition (hence uninformative CPUE) is an impediment to reliable assessment. Snapper & tropical lutjanids: Also limited information on exchange rates between WA, NT and Qld stocks; Assessing and managing the cumulative impacts of cross-sectoral and cross- jurisdictional exploitation of multiple demersal scalefish (teleost) species, including Snapper and tropical Lutjanids; Mackerel & Australian Herring: Greater certainty about the stock status and interconnectivity of mackerel and Australian Herring, stock components between

	areas. Western Australian Salmon: A better understanding of inter-annual movements of Salmon and impacts of environmental conditions on movement and abundance; Pilchards: Forecasting pilchard movements to improve the management response to a future virus outbreak; White Sharks: Mitigation of White Shark mortality, particularly in demersal gillnet fisheries; Sealion: Mitigation of Australian Sealion mortality, particularly in demersal gillnet fisheries; Snapper and lutjanids: Demersal scalefish species (including Snapper and some Lutjanids) improved understanding of stock dynamics and interconnectivity between areas; Long-term monitoring effects of climate change.
QLD	Mud Crabs, better data on recreational and commercial catches, data on the movement of female crabs, impact of spatial closures;
NT	Data sharing and data comparability leading to difficulty in cross-jurisdictional species stock assessments, Ability to respond to changes in stock health (monitoring issues, and appropriate trigger level issues), Lack of knowledge on movement and stock structure for many of these species
VIC	Lack of regular, credible estimates of recreational catch to use in stock assessments or to facilitate resource sharing decision making (tunas, sharks, Australian Salmon, Snapper, King George Whiting); Understanding of stock structure and sources of recruitment (some tunas/sharks, Eastern Australian Salmon, Pilchard, King George Whiting)
Consensus	Biological data (size, age, reproduction) Stock structure and movement Understanding environmental factors, regional variations in above sharing sustainability and profitability, Aligning differing priorities and legislations, given differing management measures, and sectoral groups data sharing, and compatibility of data collection consistent application of reference point consistent recreational catch estimates Differential management arrangements, differential susceptibility of different age/size classes Interannual variability of movements, climate change

Table 2 (cont.). Cross-jurisdictional research priorities, responses to questions posed to agencies.

Question 5	What are the management measures for these species?
Tasmania	Output controls for Rock Lobster and Giant Crab, block caps for Commercial Scallop, input controls for Warehou and Australian Salmon, bag and possession limits for recreational Southern Bluefin Tuna and other large pelagics
South Australia	This is a very broad question and a large range of input and output controls are currently in place in South Australia to manage cross-jurisdictional species. These include: quotas, min/max size limits, licenses and permits, spatial and temporal closures,
DAFF/ABARES	DOMESTICALLY: Offshore Constitutional Settlement arrangements between the Commonwealth and states/Northern Territory detail management responsibilities for certain marine species where they are caught in different Australian jurisdictions. Management measures relate primarily to catch limits including trip limits and total allowable catches. The management of key Commonwealth species is through the Fisheries Management Act 1991, relevant management plans and the Commonwealth Fisheries Harvest Strategy Policy. The Harvest Strategy Policy states that all sources of mortality should be taken into account in managing Commonwealth fisheries. INTERNATIONALLY: International agreements exist for migratory species such as tuna and Patagonian Toothfish, and through multilateral agreements of which Australia is a Party, including Regional Fisheries Management Organisations, the Convention of Migratory Species and the Convention on International Trade in Endangered Species. International agreements facilitate Australia's allocation of quota or prevent the take and/or trade of certain species. OTHER MEASURES: The Environmental Protection and Biodiversity Act 1999 and associated wildlife trade operation conditions specify management measures for conservation dependant, and threatened endangered and protected species. Provisions also apply to some migratory species including some sharks.
NSW	Commercial: predominately input controls (limited access, boat and gear capacity restrictions) complemented by basic output controls (bag/trip and size limits) and spatial and temporal closures. Consideration being given to ITQs for Spanner Crab *Ranina ranina* (including joint stock assessments). Recreational: input controls (gear restrictions) complemented by basic output controls (bag and size limits) and spatial and temporal closures.

WA	Various but generally input controls (except for Snapper, mackerels, pilchards). See State of the Fisheries and Aquatic Resources report 2009-10.
QLD	MUD CRAB - Gulf / NT & East coast/NSW: MLS; No female take; Apparatus restrictions (C-50; R-4 pots); Limited entry; Spatial closures;
NT	These fisheries are managed by strict and conservative input effort controls and precautionary management triggers: Sharks and Grey Mackerel are managed by ITE (fishing days), limits on net and line. Spanish Mackerel is a troll line fishery limited by the amount of line and hooks. Goldband and Red Snappers are managed by ITQ's that have been recently introduced.
VIC	Vic recreational fisheries - licence requirement (unless exempt); size/catch limits for all significant target species; equipment restrictions. Vic commercial fisheries - managed using input controls (limited entry licensing, equipment restrictions, closed seasons/areas) and size limits for key target species. Management of some fisheries (tunas, Gummy/School Shark, Pilchards, Snapper) partly defined by OCS agreements between Victoria and the Commonwealth
Consensus	A wide range of management arrangements are in place for cross-jurisdictional species. Key questions are 1; which arrangements can be informed or improved by better knowledge of movement and stock structure, key habitat use, seasonality etc, in some cases management arrangements specifically take into account cross-jurisdictional agreements (e.g. in VIC, management of some fisheries (tunas, Gummy/School Shark, Pilchards, Snapper) partly defined by OCS agreements between Victoria and the Commonwealth), 2; what species specific management measures are in conflict between jurisdictions that share them or present risk of management failure if they are not addressed in a cooperative way.

Table 2 (cont.). Cross-jurisdictional research priorities, responses to questions posed to agencies.

Question 6	What are the challenges in establishing complementary management approaches between jurisdictions?
Tasmania	Different acts and thus management objectives, different performance measures, uncertainty about larval sources, Stock Recruitment Relationship (SRR) and targets for reproductive outputs
South Australia	Lack of communication between agencies; Lack of knowledge of spatio-temporal dynamics of these species; Lack of knowledge of the stock structure and mixing rate of these species
DAFF/ABARES	One of the main challenges is obtaining sufficient data to determine the most appropriate management measures and the facilitation of data on catch and effort information (commercial and recreational) between jurisdictions; Differences in the legislative
NSW	Understanding stock structure and life-history parameters in addition to what each fishery harvests. Isolated cases of inconsistent stock assessment outcomes (e.g. Snapper). Substantiating the need for complementary (i.e. the same form of) management arrangements to achieve common or complementary goals. Inconsistent Act objectives and politics.
WA	OCS and Joint Authorities assist in providing for the orderly management of key species (e.g. Rock Lobster, tuna) and fishing methods (e.g. trap and trawl). The challenge arises where the species move across State boundaries (e.g. some shark species, mackerels, Australian Herring, Western Australian Salmon, Pilchards) and between State - Commonwealth jurisdiction when different fishing methods managed by each jurisdiction impact on a single stock/species (e.g. Snapper).
QLD	Understanding the differences in stock structures as well as the spatio-temporal variation in fisheries and life history parameters across jurisdictions. Long history of different fishing methods/gears legislated in different jurisdictions. Co-ordination and consistency of stock assessments.
NT	Comparative data (scale of data reporting and effort indicators i.e. days vs hours), Understanding of stock levels and collaborative data analysis, Governance and legal arrangements, Appropriate collaborative harvest strategy

VIC	Coordination of research, fishery monitoring & stock assessment approaches across jurisdictions; Negotiation and agreement on fisheries resource sharing across sectors/jurisdictions; Negotiation and agreement on sharing of management costs across sectors/jurisdictions.
Consensus	Understanding stock structure and life-history parameters in addition to what each fishery harvests. Lack of directly comparable data sets on catch and effort between jurisdictions and sectors. Isolated cases of inconsistent stock assessment outcomes (e.g. Snapper). Substantiating the need for complementary (i.e. the same form of) management arrangements to achieve common or complementary goals. Inconsistent Act objectives and political constraints. Coordination of research, monitoring and assessment.

Table 2 (cont.). Cross-jurisdictional research priorities, responses to questions posed to agencies.

Question 7	What are the key information gaps (in terms of movement) and how do they relate to potential future management measures?
Tasmania	Larval movement in SRL, GC and Commercial Scallops, movement of GC between size limit zones, movement of Warehou between commonwealth and state
South Australia	The connectivity between South Australia and Western Australia of Dusky Whaler populations; Extent of movements of Bronze Whalers; Extent of movements of adult Shortfin Makos; Extent of mixing and fine-scale stock structure of Australian White Shark populations; Origin of King George Whiting and Snapper populations (i.e., the spawning areas of King George Whiting from Victoria and from the southeast stock of Snapper is unknown)
DAFF/ABARES	In terms of movement, for key stocks (however they are defined) movement rates, geographic variability and stocks delineation are important. These are needed to ensure the management occurs at the appropriate geographic scale; As above, the more sharing of information to facilitate better science and understanding of the species should better inform appropriate management measures for cross-jurisdictional species.
NSW	Generally have a reasonable 'big picture' of movement patterns between jurisdictions, however this is often anecdotal. The key gaps for most, potentially all, species are what proportion of a stock is moving between jurisdictions and at what times and at what stage of the life-history is this movement occurring. This knowledge relates to developing sustainable harvest rates (and optimising yield/returns). Up to date information on recreational take is also lacking, noting that funding for a new survey was recently approved.
WA	Gummy Sharks: Linkages and exchange rates of Gummy Sharks between WA management zones and between WA and Commonwealth –managed fisheries; Dusky anbd Sandbar: Bycatch rates (or risk) of adult Dusky and Sandbar Sharks during natal migrations along WA west coast. Seasonal and intra-annual Dusky Whaler migrations to SA Gulfs and species-specific shark catches by the SA Marine Scalefish Fishery; BlacktipSharks; Abundance, fishing mortality, connectivity and exchange rates of Blacktip Sharks between WA, NT and Qld jurisdictions. Also, contemporary species-specific inshore-offshore movements as related to fine-scale catch distributions; Snapper & tropical lutjanids: For a number of demersal scalefish species including

	Snapper and some Lutjanids) that occur both inside and outside of the 200m isobath, information regarding stock structure and abundance outside the 200m jurisdictional boundary and movements between jurisdictions is necessary to underpin joint State/Commonwealth harvest strategies. mackerel, Australian Herring, Western Australian Salmon & Pilchards: For mackerel, Australian Herring, Western Australian Salmon and Pilchards, additional information on the extent of fish movement around the coastline and across State boundaries would be useful. Also sources and transportation of Australian Herring recruitment; White Sharks: Uncertainties in White Shark population structure, movements, catches, post-release mortality, abundance, etc. (See 2009 SEWPaC Issues Paper); Sealions: Uncertainty in gillnet (and other methods?) capture rates of Australian sea lions.
QLD	The key knowledge gaps for many cross-jurisdictional species relate to the proportion of a stock moving between jurisdictions and the spatial and temporal pattern of fishing of that stock. Spawning and recruitment dynamics of species and the importance of biotic and abiotic factors (particular oceanic currents) in determining the movement of various life history stages.
NT	No information for any species on the levels of movement between jurisdictional boundaries, No information on stock sizes shared across-jurisdictional boundaries, No information on environmental factors influencing movement, No information on timing (seasonality) of movements; All of these issues limit informed decision making on management of these species. Consequently, very precautionary management arrangements will continue to exist which will limit the productivity for the fisheries targeting these species.
VIC	Stock structure & degree of mixing between fish in waters adjacent to Victoria and fish in other state/Commonwealth jurisdictions (some tunas, pelagic sharks, Pilchards); . Sources of juvenile recruitment to/escapement from Victorian fisheries (Eastern Australian Salmon, King George Whiting)
Consensus	The key gaps for most, potentially all, species are: 1) what proportion of a stock is moving between jurisdictions and 2) at what times and at what stage of the life-history is this movement occurring. 3) sources of recruitment This knowledge relates to developing sustainable harvest rates (and optimising yield/returns). Up to date information on recreational take is also lacking, noting that funding for a new survey was recently approved. Movements of adult sharks (SA), movements of Snapper and King

	George Whiting (SA), larval movement (TAS spp), movement of Giant Crab, Warehou between catch areas, Commonwealth. (TAS), What proportion of stock moves across jurisdictions (general)

Table 2 (cont.). Cross-jurisdictional research priorities, responses to questions posed to agencies.

Question 8	What other information sets exist for your cross-jurisdictional species that could improve the quality of guidance for fishery management decisions (e.g., genetic, parasites, hard-part chemistry)?
Tasmania	Ocean modelling, tag recapture
South Australia	Stock structure of Snapper populations between South Australia and Victoria. However, this work is outdated and was undertaken in the 1970s; Otolith chemistry for King George Whiting and Snapper (although stock connectivity across jurisdiction was not investigated) Catch data and demographic data for many of the cross-jurisdictional species Genetic samples for Shortfin Mako, Bronze, and Dusky Whalers.
DAFF/ABARES	Depending on the species involved there may be studies available on the above elements. Routine information collection in Commonwealth fisheries includes primarily information on catch and effort and species biology (generally length frequency or aging).
NSW	Assuming this question relates to movement patterns and/or stock structure etc, all data sets available within NSW are already applied or incorporated into relevant management driven research.
WA	Various, including: long-term catch and effort data series, age-specific fishing mortality rate estimates, life-history data, stock assessments, biological samples (genetic, hard-part samples), tag movement data. . Movement/exchange rates of Gummy, Dusky and Sandbar Sharks between management zones are currently under investigation (FRDC project 2010/03).
QLD	Genetic and conventional tagging data for Snapper, Some conventional tagging information for Mud Crabs. Conventional tagging data for many other species.
NT	Genetic, parasite and otolith microchemistry data for Grey Mackerel, tagging data for Spanish Mackerel and Blacktip Sharks. Only genetic data for Goldband, Saddletail and Crimson Snapper.

VIC	Some genetic, tagging and otolith microchemistry data to inform stock structure and movement of some species. Much of these data are more than 10 years old
Consensus	Otolith chemistry, genetics, also classic biological differentiation, conventional tagging, anecdotal info. Information often old.

Table 2 (cont.). Cross-jurisdictional research priorities, responses to questions posed to agencies.

Question 9	What are the priority species among those you have listed?
Tasmania	SRL, Commercial Scallops, GC, finfish
South Australia	Dusky Whaler; Bronze Whaler; Shortfin Mako; recruitment origin of King George Whiting; recruitment origin of Snapper
DAFF/ABARES	Priority species would probably be focussed on commercially harvested species, and species considered to be at high risk (ie Snapper, tunas, billfish and sharks)
NSW	Pilchard; Eastern Australian Salmon, Eastern King Prawn; Gemfish; Sea Mullet, Silver Trevally; Southern Bluefin Tuna; Spanner Crab *Ranina ranina*
WA	All of them (and others). See the Department of Fisheries' Research, Monitoring, Assessment and Development Plan 2010 – 2011 for descriptions of their relative risks/priorities; NB the current acoustic telemetry infrastructure in Western Australia is most suited for providing information on wide-ranging continental shelf -associated species, including Gummy, Dusky, Sandbar and White Sharks, for which research is underway. Thus, this infrastructure is critical to the objectives of FRDC project 2010/03.
QLD	Mud Crab, *Spanner Crab Ranina ranina*, Grey Mackerel, Tropical Snapper, Sharks
NT	*Carcharinus tiltstoni/limbatus*, *Carcharinus sorrah*, Grey Mackerel, Spanish Mackerel, Goldband Snapper, Saddletail Snapper, Crimson Snapper, Guitarfish, Narrow Sawfish, Pigeye Shark, Winghead Hammerhead, Scallop Hammerhead, great Hammerhead, *Glyphis* sp., *Glyphis garricki*, Dwarf Sawfish, Freshwater Sawfish, Green Sawfish, Guitarfish.
VIC	Southern Bluefin Tuna, Shortfin Mako Shark, Snapper, King George Whiting, Eastern Australian Salmon, Pilchard.
Consensus	Pilchard; Australian Salmon, Eastern King Prawn; Gemfish; Sea Mullet, Silver Trevally; Southern Bluefin Tuna; Spanner Crab *Ranina ranina*. Southern Rock Lobster, Giant Crab SA Sharks, Snapper, King George Whiting DAFF Snappers, tunas, billfish, sharks NSW Pilchard, Salmon, Eastern King prawn, Gemfish, Sea Mullet, Silver Trevally, Southern Bluefin Tuna, Spanner Crab VIC Southern Bluefin Tuna, Shortfin Mako, Snapper, King George Whiting, Eastern Australian Salmon, Pilchards.

Table 2 (cont.). Cross-jurisdictional research priorities, responses to questions posed to agencies.

Question 10	Are issues likely to change in future given trends in human populations and/or climate change.
Tasmania	Perhaps Climate Change effects on larval dispersal patterns?
South Australia	Increasing fishing pressure, extension of distribution range of some species
DAFF/ABARES	Demand for improved/integrated management is likely to increase due to changes in population and subsequent demands for seafood, resulting in increasing pressures on fish stocks; Climate change may result in the movement of species from one jurisdiction to another that could potentially have implications for current/future management arrangements
NSW	No change in the issues, however, resource assessments and management approaches/arrangements may need to adapt accordingly.
WA	Yes and also due to the dynamic nature of the Department's management and research priority-setting processes. Climate change acknowledged as a likely issue.
QLD	Issues will remain the same in terms of trends in human population as these are already considered. The effect of future climate change on key issues may result in a more precautionary management approach but will also be affected by the magnitude of the climate change and its impact on fisheries resources.
NT	These issues will still remain and impacts from climate change and human population increases will be acknowledged as separate factors when considering management arrangements. However, management arrangements will probably become even more precautionary if the cross-jurisdictional issues are not resolved to account for these extra impacts
VIC	Meaning of question unclear - for discussion at the workshop
Consensus	"No change in the issues, however, resource assessments and management approaches/arrangements may need to adapt accordingly." Species range shifts, changing larval distributions, increasing fishing pressure, better integration of management responses, (or ""no change in issues"" as put by NSW)

Table 2 (cont.). Cross-jurisdictional research priorities, responses to questions posed to agencies.

Question 11	What documentation exists within your jurisdiction relating to these questions?
Tasmania	Many different projects include information on spatial differences in these species.
South Australia	Snapper and King George Whiting literature in SA and VIC (SARDI report series); Gummy and School Shark stock assessment through AFMA and Shark RAG; recent outcomes of preliminary work on Dusky Whaler and Bronze Whaler (SARDI)
DAFF/ABARES	Offshore constitutional settlement arrangements, international agreements and fishery specific management plans.
NSW	Little documentation exists in terms of active management of cross-jurisdictional species despite increased focus in recent times (level of documentation will inevitably increase). The 'Status of Fisheries Resources in NSW' report provides some information on cross-jurisdictional species and issues:http://www.dpi.nsw.gov.au/research/areas/systems-research/wild-fisheries/outputs/2010/1797
WA	Department of Fisheries. 2011. Research, Monitoring, Assessment and Development Plan 2010 – 2011. Fisheries Occasional Publication No. 88, 2011. Department of Fisheries, Perth, Western Australia; Brayford, H. G. and Lyon, G. E. 1995. Offshore Constitutional Settlement 1995. Fisheries Management Paper no. 77. Department of Fisheries, Perth, Western Australia; Fletcher, W. J and Santoro, K. (eds). 2010. State of the Fisheries and Aquatic Resources Report 2009/10. Department of Fisheries, Perth, Western Australia;
QLD	There is a range of species specific information in stock assessments, ecological risk assessments and research reports although many of these do not directly address cross-jurisdictional issues and are related to local management.
NT	Offshore constitutional settlements (OCS), draft shark research action plan (NMSWG), Ecological risk assessments, Stock assessments, Research reports, NT joint fisheries authority
VIC	Meaning of question unclear - for discussion at the workshop
Consensus	Little documentation specifically targeted at cross-jurisdictional issues. Mostly buried in jurisdictional management or research reports.

Priority species

All species that were nominated by the respondents as species where jurisdictional issues may influence management are listed in Table 3. Notes from the workshop relating to any discussion that took place in relation to each species is also included in Table 3. Species that were nominated as high priority by any particular state are shaded red and counts of nominated and high priority species are also presented. This assessment presumably includes an assessment of potential risk by the jurisdictional agency. Species emerged that were frequently nominated as being important or of high priority, as well as quite a long list of species (78 taxa) that were only nominated by one jurisdiction and were not considered by any to be high priority.

The responses described for the questions above cover cross-jurisdictional issues in general. In order to move towards answering the question of which issues might be addressed using acoustics tracking methods assessments need to be weighed against other factors, such as the suitability of the species for tagging and tracking, and the availability of infrastructure. Expert assessments as well as assessments against AATAMS criteria each make this assessment but with a weighting towards risk in the case of the expert evaluation, and a weighting towards AATAMS criteria (Appendix 3).in the case of the AATAMS assessment (Table 4).

Table 3. Cross-jurisdictional species listed by respondents to Table 2 as being either key or high priorities in terms of need for further information. If the species was nominated as a key species it is recorded as a "1" Numbers in columns Key spp count and High Priority are the sum for number of jurisdictions nominating that species. Those species listed as 'high priority' in respective state are shaded in red. Notes are based on discussion relating to each species recorded during the May 5th Sydney workshop.

Species	NT	QLD	NSW	Tas	Vic	SA	WA	CWTH	Key spp. count	High Priority	Notes
Australian Salmon			1	1	1	1	1		5	4	Two subspecies (Eastern and Western) Nursery areas in several states, which contribute to adult stock for each subspecies (western subspecies - nursery areas in SA; eastern subspecies - nursery areas in Tas, Vic and NSW?) This species was identified by most respondents due to the spatial scale of its movements more so than there being specific high priority management issues requiring resolution. It was identified that this species presented a good opportunity for acoustic tagging to provide sustained long-term observations across broad spatial scales in areas influenced by boundary currents and thus it was a good match to AATAMS strategic goals. Achieving this would require additional deployments of arrays to match the scale of movement to the scale of questions posed - some considered this may be easier (more cost effective) in western Australia, although the scale of AATAMS deployments was more significant in eastern Australia. Long term data on movements may also allow detection of changes in stocks or phenology that may be driven by activities across jurisdictions. Jurisdictions regarded Salmon as a low value fishery, States differed in their respective knowledge of stock-recruitment and while most recognised that there were knowledge gaps, on a cost-benefit basis, the priority for

										filling these gaps relative to other species issues was not the highest current management priority. That perspective was echoed by NSW, documents to come from strategic documents from NSW.
Australian Pilchard			1		1		1		3	3	Not a priority spp. to tackle using acoustic tracking technology at the present time
Snapper		1	1		1	1	1	1	6	3	Snapper are a widespread issue on local and possibly regional scale with movement across State/State and State/Commonwealth boundaries. Acoustic tracking methods may be most useful at local (e.g. inshore offshore or in and out of Port Phillip Bay) and perhaps regional scales. Western Victoria and southern SA share a Snapper stock, Information on spawning locations and sources of recruitment for this stock considered important. NSW strategic interest in Snapper and Climate Change. Tas identified as range extender. Level of detail for most relevant local issues is small scale. Approach needed is to coordinate a group of tactical local studies with a higher level strategic relevance. Snapper don't cross Wilsons Promontory?
Southern Bluefin Tuna			1		1	1	1	1	5	3	Commonweath - E/W movement proportions not well known, Tagging north of Rottnest with Sth coast line could help answer this, currently all tagging is done south of Rottnest line. Probably being covered pretty much by existing CSIRO “Global Spatial Analysis” project. TAS; Issue for them is Southern Bluefin Tuna catch variability and survival after release? Murray suggested one question of importance for fishery management that could be answered using acoustic tracking methods was to determine what proportions of Southern Bluefin Tuna move to locations where people actually can fish for them. Commonwealth argued there

										is a strategic need for better understanding of movement dynamics. Commonwealth says all this is good but doesn't want to set off another process when a lot is already going on with Southern Bluefin Tuna. Barry reckons not to cut off options for synergies.
tropical lutjanids (*L sebae, erythropterus & L. malabaricus*	1	1					1	1	4	3	NT; apart from Red Emperor, suffer from barotrauma, therefore restricted usefulness, cross-jurisdictional issues with QLD, Wayne Sumpton agreed . Both QLD and NT feel a line between NT and QLD is pretty vital for a range of spp. From FRDC perspective tagging of animals to be considered in context of array configuration. How different are management arrangements between NT and QLD and how different is fishing pressure??? Vic - is it movement of larvae or adults that determines distribution? Thor says probably larvae
Blacktip Shark (*C. limbatus*)	1	1	1				1	1	5	3	NT - Blacktip are "supposed" to be panmictic, but thought not to be so. Arrays in Gulf of Carpentaria needed to understand exchange. QLD also agreed this is an issue re NT. QLD/NSW *C. limbatus*: Is an issue in terms of different management arrangements from NSW. In terms of overall management priorities, For QLD, these Sharks lower priority than Grey Mackerel and *C. limbatus* in the gulf.
Shortfin Mako Shark					1	1		1	3	3	SA active in tagging Shortifin Mako, questions around need for declared TEPS status locally? Arising due to TEPS status in Nth Atl. Juveniles in shore could be viable targets of study but question about how much of a priority it is to know more about them at the local (Australian) scale when it is a "global" issue and really we will be reacting to a global issue. yes can use acoustic tracking methods to answer regional movement questions for this species, but hard to demonstrate real management needs. Management workshop made some statements about need for greater cooperation, not much in terms of how any thing might be done.

Dusky Whaler		1	1			1	1	1	5	2	
White Shark						1	1	1	3	2	
Grey Mackerel	1	1					1		3	2	NT - Grey Mackerel are "supposed" to be panmictic, but thought not to be so. Arrays in gulf needed to understand exchange. QLD also agreed this is an issue re NT. Highest priority for Qld. Some concern around levels of stock in both jurisdictions. Line of stock demarcation at Wessels Is. East coast stock could be two or three stocks. Follow up with QLD re importance within state - Qld says yes stock differentiation likely within state therefore knowledge of movements important.
Spanish Mackerel	1	1	1				1		4	2	
whaler Sharks - tropical (incl. *C. limbatus*)	1	1	1				1	1	5	2	
gold band Snapper	1	1					1	1	4	2	Similar to the lutjanids mentioned above. Hard to tag because of barotrauma. low fishing pressure, low priority management issue, more inshore offshore movements than longshore cross-jurisdictional movements.
King George Whiting					1	1			2	2	SA - priority for management project using otoliths etc. Vic says sources of recruitment and contribution of Victorian fish to spawning stock important. Recruitment of King George Whiting to central Victorian fisheries thought to occur through west to east movement of eggs and larvae, from spawning in western Victoria/southern SA waters, need to know more about how much cross-jurisdictional exchange there is in adults and sub-adults. If shared Vic/SA stock, then need to consider joint management strategy. Otolith studies planned, as back up in case otolith chemistry not reliable. Identifying spawning location (otoliths and tracking) much more powerful. Lack of infrastructure in area. School Whiting of interest to NSW and the Commonwealth. Abundance survey needed more than acoustic data. QLD shares the stock but not a major priority.

Glyphis spp.	1						1		2	1	
Giant Crab				1					1	1	Different size limits in Tas and Vic, east and west of Tassie, interactions with other Commonwealth fisheries. Small undersized crabs in Commonwealth, most action in West, but no infrastructure there. Could be seasonal movements up and down shelf. Lots of interactions of between movement and management. Possible synergies with Gulper Shark arrays off Flinders islands. Cross shelf lines could be important.
whaler Sharks - temperate (*C. brachyurus, C. obscurus, C. plumbeus*)		1	1					1	3	1	Bronze and Dusky Whalers predominantly. Issues NSW, Spinner Dusky Sandbar, Blacktip, generally high priority, facing a lot of pressure to have stronger management actions. QLD; FRDC would like to have more cooperation from QLD but QLD did not have arrays. QLD felt that Blacktip a priority, Spinner Dusky Sandbar probably not as much of a priority as other spp. SA - extent of movement of Dusky (and lesser extent Sandbar) SA and WA fisheries quite different, WA young of year, SA larger adult size classes targeted, potentially a major conflict in management. Vic, small fishery, but high priority for movement studies
Gummy Shark			1		1	1	1	1	5	1	Vic - good picture of broad movements Vic-SA-WA, if there were array out it would be good. Management issue for Vic is in relation to breeding females and vulnerability to inshore recreational fishery i.e. where exactly would arrays be needed in order to answer questions optimally? Vic - Breeding on either side of Kangaroo is different (annual vs biannual) Pelagic shelf sharks ontogenetic habitat use changes. SA/Vic border also a key area to have a curtain, between Port Phillip bay and Western Port.
Blue Warehou				1					1	1	Tasmania-Commonwealth issues, may not be well suited to acoustic technology, very hard to tag as a deepwater spp.
Hammerhead Sharks	1	1						1	3	1	

Yellowfin Tuna			1		1		1	1	4	1	
Guitarfish (*Rhynchobatus* spp.)	1								1	1	no take in NT - know very little about movements. Array down the Gulf?
Sawfish (Pristidae)	1								1	1	no take in NT - know very little about movements. Array down the Gulf?
Southern Rock Lobster				1					1	1	Issues relate to larval dispersal and regional egg production, rather than movement of adults.
Australian Herring							1		1	1	
Bronze Whaler (*C. brachyurus*) = whaler Sharks - temperate					1	1			2	1	
Gemfish			1						1	1	
Sea Mullet		1	1						2	1	NSW biggest finfish by weight. No burning issues, but shared with QLD - happy with movement, and proportion that run to sea, Questions; what proportion goes to QLD, where are spawning grounds? If you had a couple of hundred tags, would you put them on Mullet? QLD - probably not. Other more interesting questions but not necessarily for management. Easily covered by existing infrastructure
Sandbar Shark (= *C. plumbeus*), temperate whaler							1		1	1	
silvery trevally			1						1	1	Allocation type issue, not overfished anymore, NSW classified as growth overfished, biological issue, e.g. more spp? Know little of life history. Where do the morphs or spp (inshore vs offshore) spend their time? Some issues, but not particularly burning.
Spanner Crab		1	1						2	1	QLD, NSW good candidate, already has a joint NSW/QLD stock assessment. Climate change issues?
billfish								1	1	1	Important for all jurisdictions, Commonwealth; tuna long line fishing impacts on recreational fishery Black Marlin suitable as they stay on shelf. Commonwealth; Striped

											Marlin, on slope
oceanic sharks								1	1	1	
Commercial Scallops				1		1			2	1	
Albacore					1		1	1	3	0	
Bigeye Tuna					1		1	1	3	0	As for Billfish, but deep water - hard to track?
School Shark			1		1	1			3	0	VIC/SA; Similar issues for Gummy Shark, timing of movements and broad scale movement rates, from west coast Tasmania back to GAB and vice versa, hypotheses about movements exist but need validation. Spatial modelling needs to be informed by this. Currently movement is annual, should be seasonal in model.
King Threadfin Salmon		1							1	0	
Barramundi		1							1	0	
Blue Mackerel				1					1	0	
Blue Shark						1		1	2	0	
Blue Swimmer Crab			1						1	0	
bugs		1	1						2	0	
Dogfish (undefined) = School, Gummy Sharks			1					1	2	0	
Eastern King prawn			1						1	0	
Eastern school Whiting			1						1	0	
Eastern sea garfish			1						1	0	
jackass morwong			1						1	0	
mangrove jack									0	0	
mirror dory			1						1	0	
Mud Crab - east coast		1	1						2	0	
Mud Crab - GOC		1							1	0	
Mulloway			1			1			2	0	
ocean jacket			1						1	0	
ocean perch			1						1	0	
ocean trawl squid			1						1	0	

Pearl Perch			1						1	0	
Redfish			1						1	0	
Royal Red Prawn			1						1	0	
Sawsharks			1						1	0	
Sevengill Shark						1			1	0	
Spotted Mackerel		1	1						2	0	
Stout Whiting			1						1	0	
Tailor		1	1						1	0	QLD; Good fit to infrastructure, but we are not sure what the management uses would be immediately. Gap in infrastructure north of Brisbane, missing part of array. How long do they stay in the area. Good strategic species.
Teraglin			1						1	0	
Tiger Flathead			1						1	0	Tas. study showed very little movement, probably not a suitable target spp,
Yellowtail Scad			1						1	0	
Blue-eye Trevalla			1						1	0	
John Dory								1	1	0	
Yellowfin Bream		1							1	0	
Yellowtail Kingfish		1							1	0	Good fit to infrastructure, but we are not sure what the management uses would be immediately. Gap in infrastructure north of Brisbane, missing part of array, how long do they stay in the area. Good strategic species.
Bug - Moreton Bay									0	0	
Bugs - Balmain									0	0	
cetaceans									0	0	
Pinnipeds									0	0	
Samsonfish						1			1	0	Good fit to AATAMS infrastructure in WA, important recreational spp especially spawning aggregation in Rottnest Canyon. Good strategic species.
Thresher Shark						1			1	0	
Lutjanus adetti/vitta		1								0	

Table 4. Priority cross-jurisdictional species for developing further information. The priority list for "nominated" species was based on the number of times each species was identified by contributing jurisdictions, similarly the "high priority" was the count of number of high priority listings by jurisdictions. For the "nominated" and "high priority" columns, the order is higher to lower priority based on the number of times each species was identified. The "expert evaluation" and "AATAMS evaluation" are in rank order of high (1) to low (10) and based on lists from the Sydney workshop (expert assessment) and AATAMS evaluation and status (AATAMS/IMOS criteria (Appendix 3)) (*Backbone, regional* or *local Species*).

Nominated		"High priority"		Expert evaluation		AATAMS evaluation	
Species	priority	Species	priority	Species	priority	Species	priority
Snapper	6	Australian Salmon	4	Dusky Whaler/Sandbar Shark *C. obscurus /C. plumbeus*	1	Dusky Whaler/Sandbar Shark (*C. obscurus, C. plumbeus*) (*Regional)*	1
Tropical Whalers (*C. limbatus*/*C. tilstoni*)	5	Australian Sardine	3	Blacktip Sharks (*C. limbatus/C. tilstoni)*	2	Blacktip Sharks (*C. limbatus/C. tilstoni*) (*Regional)*	2
Australian Salmon	5	Snapper	3	Snapper	3	Snapper (*Local)*	3
Southern Bluefin Tuna	5	Southern Bluefin Tuna	3	Gummy Shark	4	Australian Salmon (*Regional)*	4
Gummy Shark	5	tropical lutjanids (*L sebae, L. erythropterus & L. malabaricus)*	3	School Shark	5	White Shark (*Backbone)*	5

Table 5. (cont.)

tropical lutjanids (*L sebae, L. erythropterus & L. malabaricus)*	4	Blacktip Shark (*C. limbatus*)	3	Spanner Crab	6	Tailor (*Regional)*	6
Dusky Whaler	4	Mako Shark	3	tropical lutjanids (*L sebae, L. erythropterus & L. malabaricus)*	7	Sea Mullet *(Regional)*	7
Spanish Mackerel	4	Dusky Whaler (*C. obscurus*)	2	Grey Mackerel	8	Southern Bluefin Tuna *(Backbone)*	8
Goldband Snapper	4	White Shark	2	King George Whiting	9	Australian Herring *(Regional)*	9
Yellowfin Tuna	4	Grey Mackerel	2	Southern Bluefin Tuna	10	Yellowtail Kingfish *(Regional)*	10

DISCUSSION

The top ten species, as determined by the frequency with which species were listed as key species in answer to the questionnaire was similar but not identical to the top ten species based on frequency of listing as “high priority” (Table 4.). There were six species in common, and Australian Salmon, Snapper and Southern Bluefin Tuna were in the top four of each list. The other three species on both lists were the Dusky Whaler *Carcharhinus obscurus*, tropical whaler sharks (mainly *Carcharhinus limbatus*) and tropical lutjanids (*L. sebae, L erythropterus, L. malabaricus*). The “nominated” species Gummy Shark, Spanish Mackerel, Goldband Snapper and Yellowfin Tuna were displaced by Pilchard, Shortfin Mako and White Shark, and Grey Mackerel as members of the “High priority” group. Both the Australian Sardine and the Grey Mackerel are commercially important species and this relevance was the reason they were given higher priority. Conversely Mako and White Sharks appeared to rise in importance due to their conservation status as Threatened, Endangered and Protected Species (TEPS).

Priorities that emerged as a result of the responses to the questionnaire were developed in isolation, as the various agencies had not had the opportunity to discuss among themselves how their priorities might interact. Nor did the respondents have the benefit of insights provided at the workshop into AATAMS’ acoustic tagging network and associated technology. Perhaps not surprisingly, the expert-based approach to establishing priority species produced a slightly different list again from that arrived at based on the frequency of “high priority” species across jurisdictions. New species on the expert based list were School Shark, King George Whiting and Spanner Crab. Gummy Shark had previously been listed by 5 jurisdictions and was one of the top ten “nominated” species.

King George Whiting was promoted in terms of its priority among the top cross-jurisdictional species due to uncertainty about the movements of the stock between South Australia and Victoria. Cross-jurisdictional issues relate to the spawning locations and sources of recruitment to fisheries in each State. While this species is a priority mainly for SA and Victoria and it did not figure prominently among other state’s priorities, it nevertheless appeared by consensus on the expert evaluation priority list.

As an inner to mid-shelf species that reproduces in shallow coastal areas Gummy Shark cross-jurisdictions among States as well as between States and the Commonwealth. Their vulnerability in coastal waters during reproductive periods was a significant factor in their being placed as a high priority species by the expert evaluation. Issues with the School Shark are similar to those for Gummy Sharks, with movements between Tasmania and the Great Australian Bight, as well as uncertainty about whether spawning is annual or biannual, raising their risk profile.

Spanner Crab was the only invertebrate species that was highlighted by the expert evaluation and was considered a potential candidate due to the fact that

this species is already subject to joint management, including a joint stock assessment, by Qld and NSW. It was also considered that there may be climate change issues that could emerge with this species which added to its relevance in the context of this list of priority species.

Finally, a list of species selected based on IMOS/AATAMS priorities was developed after the workshop in order to assess the level of overlap with the other agency-based priorities. This set of priorities was based more on match with existing AATAMS infrastructure (Figure 1). Several new species were included on this list and these included some of Australia's best examples of fish that undertake long distance seasonal migrations; Tailor, Herring, and Mullet, as well as Kingfish. These species are all reasonably abundant (in the case of Mullet, the largest fishery by weight in NSW) and not considered to be at particular risk in any of the relevant jurisdictions, resulting in a lower relative priority in terms the need to address information gaps for management. Nevertheless because these species have distinctive migratory behaviours, represent a cross-section of trophic various levels of the food web, and are coastal (thus more likely to be influenced by coastal boundary currents and relatively easy to tag and detect using acoustic tracking networks), they are considered to be a good fit to the AATAMS core-species strategic priorities.

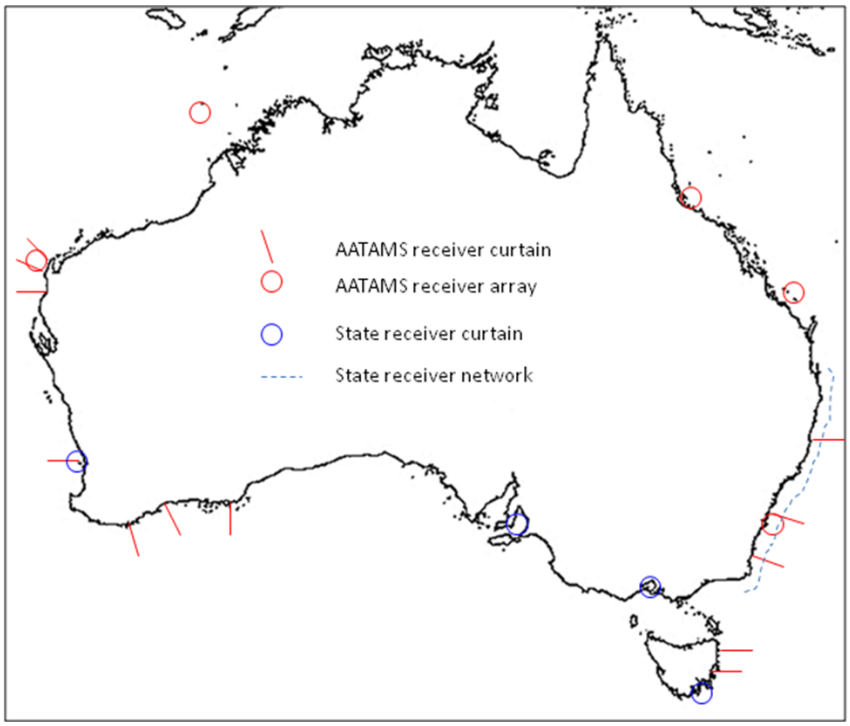
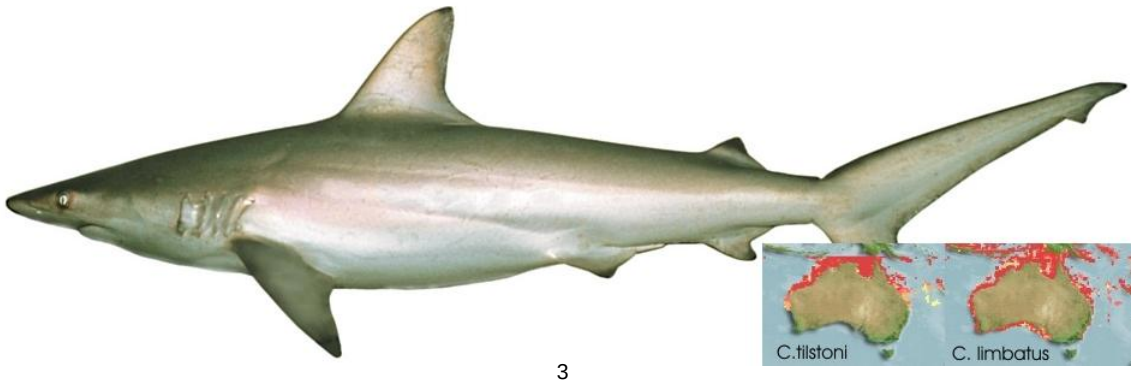


Figure 1. Major acoustic receiver infrastructure currently deployed in Australia. Acoustic receiver curtains are composed of from 15 to 30 receivers and extend across the shelf to the shelf break to intercept movements along the coast. Acoustic receiver arrays may be composed of from 20 to 60 receivers and are designed to understand movements at smaller scales. Receiver networks are receivers deployed at locations deemed to be strategic (e.g. aggregation sites) for studies of particular taxa, but which may not be designed to detect movements other than those of the target species.

Taking into account all four of these priority lists the following twenty four species were included in one or more of the top ten priority lists; Blacktip Shark (*C. limbatus*), Dusky/Sandbar Sharks (*C. obscurus/C. plumbeus*), Snapper, Southern Bluefin Tuna, Australian Salmon, tropical lutjanids, Gummy Sharks, Grey Mackerel, Spanish Mackerel, Goldband Snapper, Yellowfin Tuna, Australian Sardine, Mako Shark, White Shark, King George Whiting, Spanner Crab, School Shark, Tailor, Australian Herring, Australian Mullet, and Kingfish. These species are discussed in more detail below.

Blacktip Sharks (*Carcharhinus limbatus*/*C. tilstoni*).



[3]

These sharks occurred on all four of the priority lists, indicating that they were recognised as key species by numerous jurisdictions and were considered to be a high priority for addressing information gaps both in the questionnaire and based on expert evaluation. They also met important criteria for inclusion as core species in the AATAMS strategic priorities. *Carcharhinus limbatus* (picture above) and *C. tilstoni* are probably poorly differentiated in catch data, and there is also uncertainty about whether or not the stock is "panmictic". There is considerable uncertainty in movement patterns across northern Australia and the need to resolve this, particularly in the Gulf of Carpentaria, was considered to be high. However, AATAMS infrastructure is lacking across northern Australia and this presents a major impediment. These species also occur on the northeast coast where the stock straddles the Queensland and NSW border. The ability of *Carcharhinus limbatus* to recover from fishing is significantly less than *C. tilsonti* (Salini et al., 2007). *Carcharhinus limbatus* have slower growth, attain larger size, have higher age at first maturity. Accordingly, a risk assessment of East Coast Inshore Finfish Fishery (QLD) ranked this species in the top 5 of the least sustainable (Salini et al., 2007). Because of this, and because of different management measures between the two jurisdictions (maximum legal size in NSW, minimum legal size in QLD), these species are a management issue from the QLD perspective. Movements may take place over significant distances though they are not well understood, therefore this species falls within the Regional movements category for AATAMS core species.

Significant quantities of *C. limbatus* are taken in NSW waters (Macbeth et al., 2009) with the majority of catch dominated by animals larger than 160 cm TL (ie, larger than the maximum allowable size of sharks in QLD). The harvesting of juveniles in QLD and adults in NSW has the potential counteract management measures for this species. Carcharhinus limbatus has similar life

[3] Maps from http://www.aquamaps.org/, images from http://www.scienceimage.csiro.au

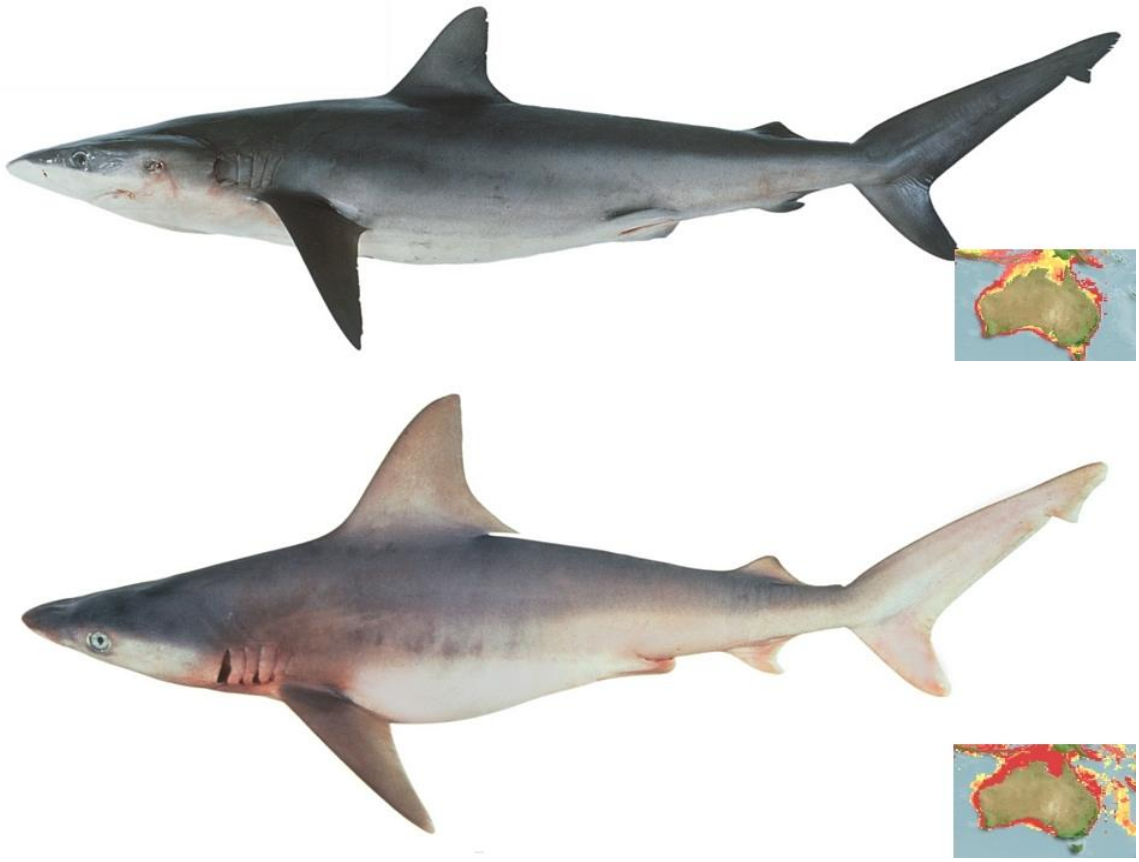
history parameters to *C. plumbeus*, where even low levels (1-2 %) of adult and sub-adult catch are thought to result in a decline in recruitment (McAuley et al., 2005). Research using arrays of acoustic receivers into the proportion of animals moving between zones and the identification of pupping/nursery areas is feasible on the east coast and a high priority (e.g. NSW FRDC VP004).

Macbeth et al. (2009) highlighted the important of complementary management of stocks shared between NSW and QLD and recommended that fisheries researchers and managers from NSW and Queensland determine what collaboration is necessary with respect to the appropriate management of shark stocks common to fisheries in both states. Macbeth et al. (2009) also noted that "Further research into the movements, migrations and rates of natural and fishing mortality via tagging studies would also greatly benefit the future management of targeted shark fishing in NSW waters".

Macbeth et al. (2009) also noted that "It is important to the long-term viability of commercial shark fishing in eastern Australian waters that I&I NSW and Qld DPI&F work closely to develop collaborative and complementary management strategies for their respective fisheries. These strategies should include co-operative research into the biology of east-coast populations of the relevant Whaler, Hammerhead and Mackerel sharks. This will be particularly important in the cases of Sandbar Shark, Dusky Whaler, Spinner Shark, Blacktip Shark and Scalloped Hammerhead, as these are species for which there is current or potential target fishing in both states."

The annual status report 2010 for the East Coast Inshore Fin Fish Fishery points out a number of data gaps for sharks in relation to general harvest rates and species composition, and Australia's National Plan of Action for the Conservation and Management of Sharks. Shark Plan 2 advocates among other things the need for greater coordination among management agencies in order to obtain the required information. In summary there appears to a recognised level of risk associated with the uncertainty in these fisheries and the establishment of a coordinated study on movement of these species would make a positive contribution in this regard.

Dusky/Sandbar Sharks (*C. obscurus/C. plumbeus*).



These sharks occurred on all four of the priority lists, indicating that they were recognised as key species by numerous jurisdictions and were considered to be a high priority for addressing information gaps both in the questionnaire and based on expert evaluation. *Carcharhinus obscurus* (pictured top) and *C. plumbeus* (pictured bottom) also met important criteria for inclusion as core species in the AATAMS animal tracking network. Although less abundant *C. brachyurus* (not pictured) and may also be included in this group. NSW is facing greater pressure to have stronger management actions for these species which they share with QLD and Victorian jurisdictions. NSW/QLD issues include the differing size limits between states similar to Blacktip Sharks. These species also span jurisdictions in SA and WA. There are already acoustic tracking projects addressing issues with these species relating to differing fisheries management zones within WA and NSW that utilise a combination of AATAMS affiliated receivers. It is hoped that this can be expanded to include SA. Movements may be over significant distances although this is not well understood. Therefore these species fall within the Regional Movements category for AATAMS core species.

In Western Australia, a recently funded FRDC project (RM021,McAuley, 2011) is taking advantage of existing AATAMS infrastructure to examine the level of risk to the four most important commercially harvested shark species (Dusky,

Sandbar, Gummy and Whiskery). While this project deals primarily with movements between different management zones in WA, it will also enable movement of animals into South Australian waters to be identified. This project is an excellent example of the utility of acoustic telemetry to answer questions relating to the implications of differential management within and between state jurisdictions; provide new stock assessment advice with greater reference to spatial and temporal dynamics of the stocks (short-term, seasonal and long term movements, immigration/emigration between management zones) and the fisheries that rely on them (temporal and spatial effort displacement/adjustment, and also the benefits of seasonal and area closures, etc). Another recently funded FRDC project (VP004 Peddemors 2011) will focus on tagging, tracking and movement (among other aspects of biology) of Dusky and Sandbar Sharks, also using acoustic tracking. Therefore there is already a nascent national network to understand the movements of these two species. However, such a network is incomplete given the gaps in the AATAMS network in South Australia and Victoria. The benefits for both states, and to a national program to understand movements of such mobile species if AATAMS resources could be established in these two states, are obvious.

Snapper (*Pagrus auratus*).

This species occurred on all four of the priority lists, indicating that it was recognised as a key species by numerous jurisdictions and was considered to be a high priority for addressing information gaps, both in the questionnaire and based on expert evaluation. It also met important criteria for inclusion as a core species in the AATAMS animal tracking network. Movements are mainly thought to be limited along-shelf and mainly cross-shelf, and therefore it falls into the Local (within bioregion) movements category for AATAMS core species. This also means that the cross-jurisdictional matters for this species are mainly between States and the Commonwealth. South Australia and

Victoria share a stock, but the proportion of population spawning in either state, and the origin of recruitment, is an important information gap. In NSW and Tasmania there is a strategic interest in Snapper and climate change. Because of the widespread nature of the species it presents significant potential, using comparative approaches, for understanding of process variations at larger scales and thereby obtaining broader strategic relevance.

Varying levels of risk are recognised for some Snapper stocks around Australia. Recent measures including spatial and or temporal closures have been enacted in Western Australia (spawning closures in Cockburn Sound, restrictions on catch in the Perth Metropolitan Region), and Queensland (Snapper have recently been classified as overfished with a 6 week ban on taking Snapper implemented).

Snapper have been successfully tagged and tracked in other systems and are currently the subject of small scale and isolated tagging programs in WA (D. Fairclough DoFWA), SA (T. Fowler SARDI), and NSW (J. Stewart DPI). A similar small scale study on movements of Snapper through Port Phillip Bay is being considered by Fisheries Victoria.

Southern Bluefin Tuna (*Thunnus maccoyii*).

This species occurred on all four of the priority lists, indicating that it was recognised as a key species by numerous jurisdictions and was considered to be a high priority for addressing information gaps both in the questionnaire and based on expert evaluation. It also met important criteria for inclusion as a core species in the AATAMS animal tracking network. One of the key questions in relation to this species was to determine what proportions of juvenile fish go either east or west after travelling down the west coast. This could potentially be achieved if fish were tagged north of the existing AATAMS acoustic receiver line at Rottnest Island acoustic line in WA. This tagging program is being conducted by CSIRO who also operate a series of receiver lines on the south coast of WA to detect migrating juvenile Southern Bluefin Tuna. This receiver line is dependent on renewal of short term funding cycles and is the basis of much of the WA coastal shark tracking program (FRDC RM021). Other issues

of local or tactical relevance have the potential to be addressed by tracking, including survival after release and whether fish actually move to locations where people can fish for them. These questions are the focus of a current proposal submitted by Fisheries Victoria. Movements occur over very significant distances; therefore Southern Bluefin Tuna falls within the Backbone category for AATAMS core species. While Southern Bluefin Tuna are of greatest interest to the Commonwealth and SA agencies, they are relevant to other States because of recreational fisheries. While questions relating to this species are to a large extent being covered by ongoing programs, it is clear that these programs would benefit from an expanded acoustic receiver network if this can be implemented.

Australian Salmon (*Arripis trutta* – East coast/*A. truttaceus* - West coast).

These fish occurred on three of the priority lists, indicating that they were recognised as key species by numerous jurisdictions and were considered to be a high priority for addressing information gaps in the questionnaire also met important criteria for inclusion as core species in the AATAMS animal tracking network. They were not, however, selected as a high priority species by the expert evaluation because they are currently considered to be adequately managed and their stocks are not thought to be at risk due to fishing. While it is not a valuable commercial species it does provide a significant recreational fishery. The main issues in terms of information gaps appear to revolve around identifying the relationships between adult stocks and particular juvenile or nursery areas. Most of the information we currently have about Salmon movement is quite old (Malcolm 1959, Stanley 1978). It was also acknowledged that the species presented a good opportunity to get long term data and would allow detection of change in stocks or migration timing (phenology) that may be driven by activities in other jurisdictions. This would be easier to achieve with minimal investment in additional infrastructure in WA and the east coast, where AATAMS infrastructure already exists, rather than on the

south coast (South Australia). Movements may occur over significant distances, therefore Australian Salmon fall within the Regional Movements category for AATAMS core species.

Tropical lutjanids (*L. sebae, L. erythropterus* & *L. malabaricus).*

These species occurred on three of the priority lists, indicating that they were recognised as key species by numerous jurisdictions and were considered to be a high priority for addressing information gaps both in the questionnaire and based on expert evaluation. They were not considered to meet important criteria for inclusion as core species in the AATAMS animal tracking network. All are deepwater species and only one of the species, *L. sebae* (pictured above) is believed to be a candidate for tagging due to its ability to survive barotraumas, and the match with existing infrastructure, with the possible exception of Acoustic receiver arrays operated by James Cook University and AIMS (with augmentation from AATAMS) are an exception (Tobin 2010, Simpfendorfer et al. pers. comm.). Between QLD and NT an acoustic line in the Gulf of Carpentaria would be required. Other cross-jurisdictional issues are between States (WA, NT, QLD) and the Commonwealth, again presenting difficulties in terms of putting in place acoustic tracking infrastructure. Some of these species (e.g. *L. sebae*) have well known ontogenetic cross-shelf movements, which would be relevant to Commonwealth cross-jurisdictional issues. Since movements are mainly thought to be cross-shelf it falls into the Local (within bioregion) movements category for AATAMS core species. Because of the widespread nature of these species they nevertheless present some potential for understanding of broader scale processes if opportunities for establishing appropriately placed infrastructure arise.

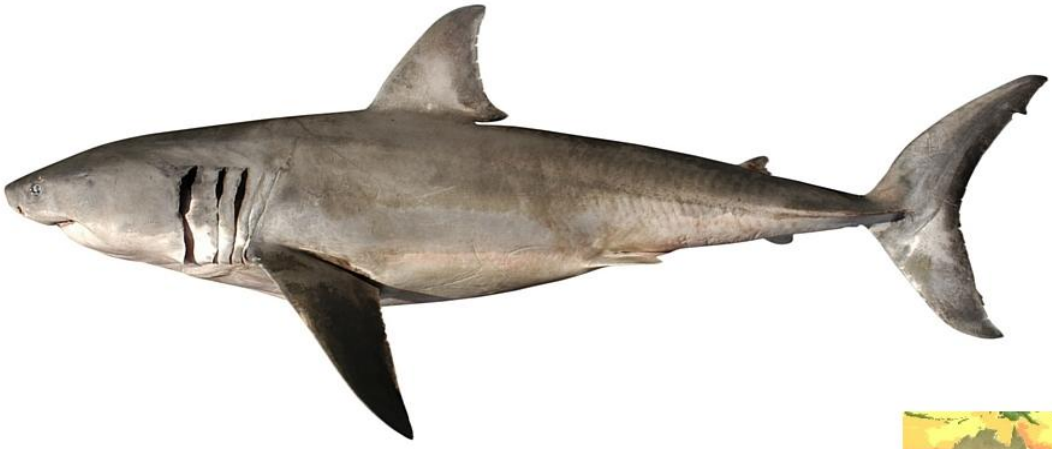
Gummy Sharks (*Mustelus antarcticus*).

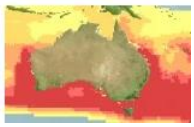
This shark occurred on two of the priority lists. It was recognised as a key species by numerous jurisdictions and was considered to be a high priority based on expert evaluation. Possibly because the centre of its distribution around Victoria and NSW it did not rank as a top ten high priority species in the questionnaire. It is worth noting that though it was not listed by WA it was nevertheless included in a current study to understand the movement of this species across internal management zones (McAuley 2010). Management issues relate to movements of breeding females and vulnerability to inshore recreational fisheries. Potentially there are small scale variations in the timing of migrations and breeding that could be important in terms of designing management measures (spatial and temporal restrictions). Movement may occur over significant distances, therefore Gummy Sharks fall within the Regional Movements category for AATAMS core species. It was not considered to be a good fit for criteria for inclusion as a core species in the AATAMS animal tracking network, due to the lack of AATAMS infrastructure in the regions of southern Australia (Tasmania to South Australia) at the centre of its distribution. This could change rapidly if appropriate infrastructure were deployed.

Grey Mackerel (*Scomberomorus semifasciatus*).

Grey Mackerel occurred on two of the priority lists. It was recognised as a top ten high priority species in the questionnaire and was considered to be a high priority based on expert evaluation. These priorities were driven by agencies from Queensland and the Northern Territory who considered there is some concern around the level of the stock in both jurisdictions. It was not considered to be a good fit for criteria for inclusion as a core species in the AATAMS animal tracking network, mainly due to the lack of AATAMS infrastructure in the cross-jurisdictional regions of northern Australia (Gulf of Carpentaria) at the centre of its distribution. It is not known how well this species would survive capture and tagging. There may be two or three stocks across northern Australia and further information on stock differentiation would address an important gap. Genetic studies of this species on the east coast suggest that there may also be important stock structure in eastern Queensland where some AATAMS infrastructure does exist. Movements may occur over significant distances, though this is not certain, therefore Grey Mackerel fall within the Regional Movements category for AATAMS core species.

White Shark (*Carcharodon carcharhias*).





This shark occurred on two of the priority lists. It was recognised as a high priority for addressing information gaps in the responses to the questionnaire, largely due to its threatened conservation status. It was not considered to be a high priority by expert evaluation mainly because it is not subject to a commercial or recreational fishery. White Sharks may still be vulnerable to beach protection schemes as well as incidental catch. In terms of criteria for inclusion as a core species in the AATAMS animal tracking network, it was considered to be a good match in terms of the scale of movement. Since there is already an acoustic tagging program underway it was given high priority since despite its relative rarity it can reliably be captured for acoustic tagging. Movements occur over significant distances, and good data are coming from projects coordinated by CSIRO with numerous returns coming from tagged sharks in SA, NSW and WA. Double tagging of White Sharks with satellite and acoustic tags have provided substantial validation of the reliability and accuracy of acoustic detections on CSIRO experimental receiver arrays in NSW (B. Bruce, unpublished data. White Sharks are a good candidate species for movement studies as they are long-lived, large enough to be tagged with long-life (10 yr duration) tags and some individuals predictability return of to sites (e.g. shark-cage dive sites) which means that some individuals can be re-tagged. Significant differences in abundance between years at some sites suggest distribution varies due to physical and or biological environment over monthly, annual and longer time scales, linking this species' biology to oceanographic phenomena. White Sharks have been demonstrated to undertake large scale annual migratory movements in Australian coastal waters therefore White Sharks fall within the Backbone/Regional Movements category for AATAMS core species.

Spanish Mackerel (*Scomberomorus commerson*).

This fish occurred on only one of the priority lists. It was recognised as a key species by numerous jurisdictions in the questionnaire presumably because it is a valuable fishery and important recreational species that does appear to undertake significant seasonal movements (e.g. from the tropics south to Perth or Sydney in the summer). While this species was not considered to be to be a high priority for addressing movement information gaps at cross-jurisdictional scales, or a high priority based on expert evaluation, it is the subject of local scale movement studies utilising acoustic tracking (Tobin 2010). It was not considered to currently be a good fit for criteria for inclusion as a core species in the AATAMS animal tracking network, due to the lack of success to date in using internal acoustic tags with this species. AATAMS infrastructure is present in some of the cross-jurisdictional regions of northern and subtropical Australia within its distribution therefore it does present some potential and novel methods of tag implantation are being explored. A current FRDC project (2010/007), utilising innovative technology, has had success attaching external acoustic tags to Spanish Mackerel and highlights the need for a better understanding of the movement patterns of this species. However these tags are short lived and further development is needed. Movements may occur over significant distances, though the proportion of individuals undertaking large scale movements is not certain, therefore Spanish Mackerel may fall within the Regional Movements category for AATAMS core species.

Goldband Snapper (*Pristipomoides multidens*).

This fish occurred on only one of the priority lists. It was recognised as a key species by numerous jurisdictions in the questionnaire but was not considered to be to be a high priority for addressing movement related information gaps or a high priority based on expert evaluation. It was not considered to be a good fit for criteria for inclusion as a core species in the AATAMS animal tracking network, due to its deep water habitat and likely problems with barotrauma. Since movements if any are mainly thought to be cross-shelf, Goldband Snapper likely fall into the Local (within bioregion) movements category for AATAMS core species. Because of the widespread nature of this species it nevertheless presents some potential for understanding of broader scale processes if opportunities for establishing infrastructure arise.

Yellowfin Tuna (*Thunnus albacares*).

This fish occurred on only one of the priority lists. It was recognised as a key species by numerous jurisdictions in the questionnaire but was not considered to be to be a high priority based on expert evaluation. However Commonwealth agencies considered it a high priority for addressing information gaps based on responses to the questionnaire. It was considered to be a reasonable fit in terms of criteria for inclusion as a core species in the AATAMS animal tracking network, though not one of the highest priorities due to its distribution being largely in deeper water off the continental shelf, and outside the range of most AATAMS infrastructure. Movements may occur over significant distances, therefore Yellowfin Tuna fall within the Regional Movements category for AATAMS core species.

Australian Sardine (*Sardinops sagax*).

This fish occurred on only one of the priority lists. It was recognised as a high priority for addressing information gaps in the responses to the questionnaire, but was only listed as a key species by 3 jurisdictions. It was not considered to be a high priority by expert evaluation or in terms of criteria for inclusion as a core species in the AATAMS animal tracking network, largely due to its small

size and difficulty of acoustic tagging. New tags developed for Salmon smolt may overcome some of these problems but are initially likely to be limited to a life of several months.

Mako Shark (*Isurus oxyrhincus*).

This shark occurred on only one of the priority lists. It was recognised as a high priority for addressing information gaps in the responses to the questionnaire, largely due to its threatened conservation status. It was not considered to be a high priority by expert evaluation since there was a consensus that its threatened conservation status was mainly relevant to the north Atlantic and not in Australian waters. In terms of criteria for inclusion as a core species in the AATAMS animal tracking network, it was not considered a high priority due to its relative rarity, although it can probably be tracked by AATAMS infrastructure. Movements may occur over significant distances, therefore Shortfin Mako Sharks fall within the Regional Movements category for AATAMS core species.

King George Whiting (*Sillaginoides punctatus*).

This fish occurred on only one of the priority lists (Table 4). It was considered to be a high priority by expert evaluation due to uncertainty in relation to the proportion of the population moving between jurisdictions to spawn. It was listed as a key species by 2 jurisdictions (Victoria and South Australia) with a high priority for addressing information gaps in the responses to the questionnaire. Main movements of King George Whiting are thought to be movement of eggs/larvae from coastal spawning grounds in western Vic/southern SA, to bay/inlet/Gulf nursery grounds, and movement of maturing sub-adults from nursery grounds to coastal spawning grounds. South Australia and Victoria share a stock, but the proportion of population spawning in each state, and contributing to recruitment in each state, is an important information gap. It was not considered to be a high priority in terms of criteria for inclusion as a core species in the AATAMS animal tracking network, partly due to its relatively limited distribution and lack of infrastructure in the central areas of its distribution in VIC/SA. It is large enough to tag however and therefore it falls into the within bioregion movements category for AATAMS core species.

Spanner Crab (*Ranina ranina*).

This crab occurred on only one of the priority lists. It was considered to be a high priority by expert evaluation due to uncertainty in relation to the proportion of the population moving between jurisdictions to spawn. It was listed as a key species by 2 jurisdictions (Queensland and New South Wales) and was recognised as a high priority for addressing information gaps by Queensland in the responses to the questionnaire. It was not considered to be a high priority in terms of criteria for inclusion as a core species in the AATAMS animal tracking network, largely due to relatively limited distribution and lack of infrastructure in the central areas of its distribution. As a crustacean it would not retain tags for long periods, nevertheless it is large enough to tag however and therefore it would fall into the Local (within bioregion) movements category for AATAMS core species.

School Shark (*Galeorhinus galeus*).

This shark occurred only in one of the priority lists (Table 4). It was considered to be a high priority by expert evaluation due to uncertainty in relation to the proportion of the population moving between jurisdictions to spawn. Nevertheless it was listed as a key species by 3 jurisdictions (New South Wales, Victoria and South Australia) but was not recognised as a high priority for addressing movement information gaps in the responses to the questionnaire by any of these jurisdictions. Information gaps for School Shark relate to the timing of movements and broad scale movement rates form the west coast of Tasmania back to the Great Australian Bight and return. Current management considers movement to be annual, but it is thought more likely to be seasonal. Spatial modelling of the stock needs to be informed by improved information. It was not considered to be a high priority in terms of criteria for inclusion as a core species in the AATAMS animal tracking network, largely due to lack of infrastructure in the central areas of its distribution. Movements may occur over significant distances, therefore School Sharks fall within the Regional Movements category for AATAMS core species.

Tailor (*Pomatomus saltatrix*)

This fish occurred on only one of the priority lists. It was considered to be a high priority in terms of criteria for inclusion as a core species in the AATAMS animal tracking network, largely due to its abundance, migratory habits and likely trophic importance as well as the presence of infrastructure in the central areas of its distribution. It was listed as a key species by two jurisdictions (New South Wales and Queensland) but was not recognised as a high priority for addressing information gaps in the responses to the questionnaire by any jurisdiction. It was not considered to be a high priority by expert evaluation as it was considered to be well understood and well managed at present. Movements may occur over significant distances, therefore Tailor fall within the Regional Movements category for AATAMS core species.

Australian Herring (*Arripis georgianus*).

This fish occurred on only one of the priority lists. It was considered to be a high priority in terms of criteria for inclusion as a core species in the AATAMS animal tracking network, largely due to its abundance, migratory habits and likely trophic importance. It was listed as a key species by one jurisdiction (Western Australia) where it was also recognised as a high priority for addressing information gaps in the responses to the questionnaire by any jurisdiction. It was not considered to be a high priority by expert evaluation as it was considered to be well understood and well managed at present. Movement may occur over significant distances, therefore Australian Herring fall within the Regional Movements category for AATAMS core species.

Australian Mullet (*Mugil cephalus*).

This fish occurred on only one of the priority lists. It was considered to be a high priority in terms of criteria for inclusion as a core species in the AATAMS animal tracking network, largely due to its abundance, migratory habits and likely trophic importance as well as the presence of infrastructure in the central areas of its distribution. It was listed as a key species by two jurisdictions (New South Wales and Queensland) where it was also recognised as a high priority for addressing information gaps in the responses to the questionnaire by NSW. It was not considered to be a high priority by expert evaluation as it was considered to be well understood and well managed at present though it was acknowledged that there were significant unknowns in relation to this species' movements, including the location of spawning grounds. Conventional tagging completed in NSW indicated that many Mullet undertake both northward and southward coastal movements. Sea Mullet tagged in estuaries were recaptured in the same estuary or north, but not south of the estuary of release. Those tagged on ocean beaches were recaptured both north and south of the area of release. Tagging data also indicated that fish spawn for more than 1 year with evidenced of animals returning from spawning runs (Virgona et al 1998). Interestingly the migrations recorded by Virgona et al. were of substantially smaller distances than those reported 45 years earlier by Kesteven (1953) in the same region.

Movements take place in areas well covered by existing acoustic infrastructure and may occur over significant distances, therefore Australian Mullet fall within the Regional Movements category for AATAMS core species.

Yellowtail Kingfish (*Seriola lalandi*).

This fish occurred on only one of the priority lists. It was considered to be a high priority in terms of criteria for inclusion as a core species in the AATAMS animal tracking network, largely due to its abundance, migratory habits and likely trophic importance as well as the presence of infrastructure in the central areas of its distribution. It was listed as a key species by one jurisdiction (New South Wales) though it was not recognised as a high priority for addressing movement information gaps in the responses to the questionnaire. It was not considered to be a high priority by expert evaluation as it was considered to be well understood and well managed at present. Movements may occur over significant distances (Gillanders et al. 2001) therefore Kingfish fall within the Regional Movements category for AATAMS core species.

BENEFITS AND ADOPTION

Recent developments in the acoustic tracking of marine species and the deployment of national tracking infrastructure through IMOS/AATAMS has provided an unprecedented opportunity to provide movement information, and to achieve synergies and efficiencies between fisheries research and management organizations across jurisdictions. AATAMS infrastructure includes hundreds of acoustic receivers place around Australia in order to detect the location and movements of fish and sharks implanted with coded acoustic tags, These tags are inexpensive relative to satellite tags, and do not have to be detected from the surface. Development of a coordinated research program by fisheries management agencies also presents synergies and efficiencies for AATAMS, therefore developing a national strategy for tagging an monitoring the movement of key marine species presents a mutually beneficial opportunity.

The broad goal of this proposal was to explore and facilitate a national-scale coordinated approach among Australia's fishery management organizations regarding the key species that should be targeted for research effort in the area of movements of cross-jurisdictional species. This was accomplished through a workshop attended by jurisdictional representatives from all Australian States as well as Commonwealth agencies. The workshop considered what the highest priority species for acoustic tagging and movement information were, based on their biology and overall stock status, as well as the potential risks posed by inconsistent jurisdictional management approaches. It also considered the opportunities presented by acoustic tracking infrastructure, and the potential to further leverage this capability, by assessing the extent to which key species might also match the priorities of AATAMS. While a level of consensus was achieved on what the highest priority species were, based on information need and risk, it was also recognised that there was a mismatch between the highest priority species and available AATAMS infrastructure. High priority species in terms of fisheries management need were often located in areas with poor coverage by infrastructure, and while a number of potential species were common on areas with good infrastructure coverage, there was relatively low management need for many of these species.

FURTHER DEVELOPMENT

It was agreed to try to further investigate the potential use of acoustic tagging and tracking of cross-jurisdictional species by the following approach; first establish whether a clear need and path for uptake of acoustic tagging based movement data could be demonstrated, and based on this develop a clear case to influence the placement of IMOS infrastructure. These goals will be coordinated as part of a recently submitted proposal to FRDC (RB021) led by Russ Babcock and with representatives of all state fisheries agencies as partner investigators. The direct involvement of the state agencies in order to ensure that realistic and practical outcomes and paths to adoption can be

identified for knowledge generated by research to increase our understanding of fish movements across jurisdictional boundaries. The multi-agency collaboration is also important since partner investigators will play a key role in working with IMOS nodes in each state to ensure that the science plans that underpin the development of future IMOS and AATAMS infrastructure incorporate and address the needs for cross-jurisdictional species. The resources requested in proposal RB021 are sufficient to facilitate both these processes.

If the first of these objectives is achieved, the collaborating agencies should be in a position to clearly argue the need for research to support ongoing studies of cross jurisdictional fish and shark movements using acoustic tracking, and to prioritise the work needed on the basis of need. Because of their very nature these will be collaborative and involve multiple agencies, and whether they are entirely new projects or build on and consolidate existing projects, they have the potential to offer significant synergies and economies of scale to funding agencies such as the FRDC. The requirements of such studies in terms of resources would be for tags (cost in the order of $300) and tagging (like to be significant in-kind contributions from partners), with potentially some acoustic receiver infrastructure. Maximising return from the data in terms of analysis will also require targeted resources with a significant level of technical and statistical expertise. In collaborative projects such as those envisaged there would be significant scope for economies at the analysis stages, by pooling data for analysis and identifying the most appropriate expertise to carry this out. If both of these objectives can be achieved, And the needs of fisheries management are explicitly incorporated in IMOS research plans, there would then be even greater benefits to cross-jurisdictional research since a significant proportion of infrastructure costs would be shared with IMOS. This would be true not only in terms of receivers in the water, but also in terms of the database being developed by IMOS which would provide a platform for data sharing.

PLANNED OUTCOMES

Dialogue among jurisdictions will benefit all parties by allowing them to achieve synergies and economies of scale when addressing challenges posed by managing cross-jurisdictional species. This will come about through an improved ability to influence national infrastructure developments, as well as by being able to demonstrate to funding agencies and improved value proposition due to economies of scales achieved through multi-level integrated approaches to research priorities.

CONCLUSION

The workshop highlighted that there is still work to be done to develop an understanding among jurisdictions of the potential benefits and synergies that could accrue through developing consensus priorities. A further outcome of the workshop was the recognition that in order to address the highest priority information gaps, fisheries jurisdictions would likely need to influence the patterns of infrastructure deployment in key locations around Australia. A positive outcome of the workshop was the agreement by all state jurisdictions to work together and participate in a follow-up application to FRDC (Appendix

6) for funding to further develop priorities for addressing information gaps and a strategy for influencing IMOS infrastructure deployments

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APPENDIX 1

Intellectual Property: There are no intellectual property issues related to this report or the work contained in it.

APPENDIX 2

Staff: Russ Babcock, Richard Pillans, Russ Bradford, Barry Bruce.

APPENDIX 3

AATAMS 2013 onwards: Towards a Sustained Observing System
28 Feb 2011

Rob Harcourt AATAMS

Tim Moltmann IMOS

Dave Smith CSIRO

Aim: To ensure that IMOS has the capability to operate a sustained animal tagging and monitoring network, as an integral part of the national marine observing system, with the power to detect large scale change and variability in ocean ecosystems due to natural and anthropogenic effects on mid to high trophic levels at a range of spatial and temporal scales.

Proposal:

Identify a core group of species for long term observing that will act as indicators of change at local, regional and wider scales and that will address IMOS strategic focus, namely the role of the oceans in the climate system, the impact of major boundary currents on the continental shelf, and the response of ecosystems and biodiversity.

Selection to address specific **Needs**

7) Power to detect ecosystem change and variability from monthly to multi-decadal timescales
8) Discovering and understanding the links between ocean and climate variability, marine chemical cycling and ecosystem biodiversity and distribution of indicator species
9) Selection of species that will provide robust indictors of ecosystem change and variability
10) Selection of appropriate scales at which to detect change and variability

Species should meet specific **Criteria** in order to be able to address the above Needs

6) Scale: National Backbone
    a. Large range (national scale) – spatial component large
    b. Migratory movements – temporal component large

c. Trophic Level – include high and mid-trophic level species

7) Scale: Regional- Within specific Boundary Currents
    a. Medium range (within specific boundary currents)- spatial component large
    b. Migratory movements – spatial scale medium, phenology well known
    c. Trophic Level – include high and mid-trophic level species
8) Scale: Local: Within Bioregion- detect change in shelf/slope processes
    a. Small range (within bioregion) spatial component well defined
    b. Migratory movements- spatial scale low
    c. Trophic level- high and mid

Design: movements, boundaries must coincide with national design of IMOS infrastructure, and linkages to data streams must be explicit

Utility: Species selected should meet specific utility in terms of commercial value, recreational demand, iconic status , conservation value or be keystone species

Utility: Indicator species to be selected as appropriate for input into spatially explicit models

Mechanism: Indicator species to be identified using above criteria, and a nationally coordinated program of sustained tagging (annual or biannual) implemented.

Identified in Node Plans as *Core Species*

Approach to National funding bodies (e.g. FRDC, AFMA, DAFF) and State Agencies for support

APPENDIX 4

Research Priorities for understanding movements of cross-jurisdictional species

Questions to Agency Research and Policy representatives

1) What is a cross-jurisdictional species?
2) Which are the key cross-jurisdictional species in your jurisdiction?
3) Which jurisdictions do you share your species with (state, federal, sectoral)?
4) What are the key management issues with these species?
5) What are the management measures for these species?
6) What are the challenges in establishing complementary management approaches between jurisdictions?
7) What are the key information gaps (in terms of movement) and how do they relate to potential future management measures?
8) What other information sets exist for your cross-jurisdictional species that could improve the quality of guidance for fishery management decisions (e.g., genetic, parasites, hard-part chemistry)?
9) What are the priority species among those you have listed?
10) Are issues likely to change in future given trends in human populations and/or climate change
11) What documentation exists within your jurisdiction relating to these questions?

APPENDIX 5

Full responses of management agencies to questionnaire (Appendix 4)

AFMA

With respect to the background information, please can you answer each of the following questions so that we can compile a discussion document prior to the workshop?

1. What is a cross-jurisdictional species?

Species that move over jurisdictional boundaries

2. Which are the key cross-jurisdictional species in your jurisdiction?

Goldband, Ruby, Hang Snapper etc. and Red-spot emperors (North West Slope Trawl Fishery and Western Deepwater Trawl Fishery). Commercial Scallops (Bass Strait Central Zone Commercial Scallop Fishery). Flathead, Whiting, School and Gummy Shark, Silver Trevally, Snapper (Southern and Eastern Scalefish and Shark Fishery). Sardines and mackerel (Small Pelagic Fishery).

3. Which jurisdictions do you share your species with (state, federal, sectoral)?

WA; Goldband, Ruby, Hang Snapper etc. and Red-spot emperors (North West Slope Trawl Fishery and Western Deepwater Trawl Fishery). Tasmania, Victoria; Commercial Scallops (Bass Strait Central Zone Commercial Scallop Fishery). New South Wales, Victoria; Flathead, Whiting, School and Gummy Shark, Silver Trevally, Snapper (Southern and Eastern Scalefish and Shark Fishery). NSW, Victoria, Tasmania, South Australia, Western Australia; Sardines and mackerel (Small Pelagic Fishery).

4. What are the key management issues with these species?

For the North West Slope and Western Deepwater Trawl Fishery these scalefish species are caught incidentally as bycatch in what is primarily a deepwater crustacean trawl fishery. There are currently no limits on the take of the Commonwealth take of these shared species. These species are important to State operators, who take them by trap and line.

For Commercial Scallops, this is thought to be a single stock managed by three jurisdictions (Commonwealth, Victoria and Tasmania) with different management arrangements.

In the Southern and Eastern Scalefish and Shark Fishery, and for small, pelagics many of these species are taken by state operators and are managed with different arrangements. Snapper is mainly a recreational catch (state managed) but caught as a byproduct by Commonwealth commercial operators.

5. What are the management measures for these species?

For the North West Slope and Western Deepwater Trawl Fishery there are no species specific Commonwealth management measures in place at present. Cod end mesh size in the NWS is limited to 50mm in order to minimise the take of scalefish in the NWS. Further, a voluntary closure is in place in an area of high incidental bycatch to reduce the impact on the State fishery. There are only a limited number of licences issued.

Commercial Scallops are managed with ITQs and area closures. Species in the Southern and Eastern Scalefish and Shark Fishery are managed with ITQ and some input restrictions.

The Small Pelagic Fishery is currently managed with input controls but is in the process of changing to ITQs

6. What are the challenges in establishing complementary management approaches between jurisdictions?

The main challenge is getting agreement on the best way to manage the stocks and overcoming the issues around current access/concession arrangements for different operators in different jurisdictions. A change of arrangements will often lead to winners and losers making change difficult.

For the North West Slope and Western Deepwater Trawl Fishery recognition of Commonwealth catches of state species and vice versa. Overall catch of species from both jurisdictions needs to consider when assessing the total mortality for each species. No complementary management measures are in place at the moment. The error in the definition of the 200m isobath under the OCS arrangements is also a hurdle in developing complementary management approaches.

7. What are the key information gaps (in terms of movement) and how do they relate to potential future management measures?

Coarseness of state catch data. The scale of reporting is generally finer for Commonwealth operators.

8. What other information sets exist for your cross-jurisdictional species that could improve the quality of guidance for fishery management decisions (e.g., genetic, parasites, hard-part chemistry)?

There is always uncertainty regarding stock structure genetics etc., but for the species listed above there is probably sufficient knowledge to improve stock based management with the implementation of complementary management arrangements. The biggest hurdle is getting the different jurisdictions to work together to overcome political issues.

9. What are the priority species among those you have listed?

Goldband, Ruby, Hang Snapper etc. and Red-spot emperors (North West Slope Trawl Fishery and Western Deepwater Trawl Fishery). Commercial Scallops (Bass Strait Central Zone Commercial Scallop Fishery). Flathead, Whiting, School and Gummy Shark, Silver Trevally, Snapper (Southern and Eastern Scalefish and Shark Fishery). Sardines and mackerel (Small Pelagic Fishery).

10. Are issues likely to change in future given trends in human populations and/or climate change?

Difficult to see how.

11. What documentation exists within your jurisdiction relating to these questions, particularly in direct relation to management of cross-jurisdictional species?

Offshore Constitutional Settlement arrangements

Harvest strategies for each fishery

Stock assessments

AFMA is currently reviewing the Western Trawl Fisheries Harvest Strategy, which applies to the North West Slope and Western Deepwater Trawl Fishery. This is being done in collaboration with the Western Australian Department of Fisheries and state fishers, to ensure that the targeting of state species is taken into account.

Statement of Management Arrangements for the fisheries is available on the AFMA website.

DAFF/ABARES

CSIRO cross-jurisdictional species management workshop – 4 May 2011.

Department of Agriculture, Fisheries and Forestry, including ABARES response to questions:

1. What is a cross-jurisdictional species?

A marine species that has a range that encompasses more than one management jurisdiction (for example the species can be found in the waters of two or more state or territory jurisdictions or in both Commonwealth and state/territory waters or across the jurisdiction of two or more countries); and is taken by fisheries in significant quantities in both jurisdictions.

2. Which are the key cross-jurisdictional species in your jurisdiction?

For the Commonwealth there are many cross-jurisdictional species that move between Commonwealth and state/territory waters and internationally into other countries jurisdictions. Groups of species include sharks, Snapper and tunas.

The key species vary with respect to the issue, for example the key cross-jurisdictional species in the international context are covered by regional fisheries management organisations and agreements. Some species are also cross-jurisdictional with respect to state/territory waters, commercial species are covered by Offshore Constitutional Settlement arrangements, while the recreational component may not be.

3. Which jurisdictions do you share your species with (state, federal, sectoral)?

All states and the Northern Territory, plus internationally across the Pacific Ocean, Indian Ocean, Arafura Sea, Torres Strait and the Southern Ocean.

Within Commonwealth fisheries there are also some species shared across sectors, in cases such as the Southern and Eastern Scalefish and Shark Fishery most total allowable catches apply to all sectors.

4. What are the key management issues with these species?

Cross-jurisdictional species management issues relate mainly to:

- ensuring the consistent application of catch allowances and/or complementary management measures for species between jurisdictions. Particularly difficult when one jurisdiction uses output controls and another input controls.
- the collection and provision of information between jurisdictions for seting of appropriate catch limits or total allowable catches. This includes differences in the level of reporting in different jurisdictions.
- joint/agreed assessments and consistent reference points between jurisdictions.
- challenges when one of the key fisheries is recreational, particularly in terms of data, monitoring and management approaches.

5. What are the management measures for these species?

Domestically:

Offshore Constitutional Settlement arrangements between the Commonwealth and states/Northern Territory detail management responsibilities for certain marine species where they are caught in different Australian jurisdictions. Management measures relate primarily to catch limits including trip limits and total allowable catches. The management of key Commonwealth species is through the *Fisheries Management Act 1991,* relevant management plans and the Commonwealth Fisheries Harvest Strategy Policy. The Harvest Strategy Policy states that all sources of mortality should be taken into account in managing Commonwealth fisheries.

Internationally:

International agreements exist for migratory species such as tuna and Patagonian toothfish, and through multilateral agreements of which Australia is a Party, including Regional Fisheries Management Organisations, the Convention of Migratory Species and the Convention on International Trade in Endangered Species. International agreements facilitate Australia's allocation of quota or prevent the take and/or trade of certain species.

Other measures

The *Environmental Protection and Biodiversity Act 1999* and associated wildlife trade operation conditions specify management measures for conservation dependant, and threatened endangered and protected species. Provisions also apply to some migratory species including some sharks.

6. What are the challenges in establishing complementary management approaches between jurisdictions?

One of the main challenges is obtaining sufficient data to determine the most appropriate management measures and the facilitation of data on catch and effort information (commercial and recreational) between jurisdictions.

Differences in the legislative and management frameworks between jurisdictions can also constrain complementary management.

7. What are the key information gaps (in terms of movement) and how do they relate to potential future management measures?

In terms of movement, for key stocks (however they are defined) movement rates, geographic variability and stocks delineation are important. These are needed to ensure the management occurs at the appropriate geographic scale.

As above, the more sharing of information to facilitate better science and understanding of the species should better inform appropriate management measures for cross-jurisdictional species.

8. What other information sets exist for your cross-jurisdictional species that could improve the quality of guidance for fishery management decisions (e.g., genetic, parasites, hard-part chemistry)?

Depending on the species involved there may be studies available on the above elements. Routine information collection in Commonwealth fisheries includes primarily information on catch and effort and species biology (generally length frequency or aging). Specific information may be collected through funded research projects.

9. What are the priority species among those you have listed?

Priority species would probably be focussed on commercially harvested species, and species considered to be at high risk (ie Snapper, tunas, billfish and sharks)

10. Are issues likely to change in future given trends in human populations and/or climate change

Demand for improved/integrated management is likely to increase due to changes in population and subsequent demands for seafood, resulting in increasing pressures on fish stocks.

Climate change may result in the movement of species from one area under one jurisdiction to another, that could potentially have implications for current/future management arrangements.

11. What documentation exists within your jurisdiction relating to these questions, particularly in direct relation to management of cross-jurisdictional species?

Offshore constitutional settlement arrangements, international agreements and fishery specific management plans.

NSW

Background information – cross-jurisdictional species management (NSW)

1. What is a cross-jurisdictional species?

Species taken in more than one jurisdiction.

2. Which are the key cross-jurisdictional species in your jurisdiction?

See Attachment 1 – list can be refined.

3. Which jurisdictions do you share your species with (state, federal, sectoral)?

See below.

4. What are the key management issues with these species?

Sustainability, profitability of industry and sharing within and between jurisdictions (including the recreational sector).

5. What are the management measures for these species?

Commercial: predominately input controls (limited access, boat and gear capacity restrictions) complemented by basic output controls (bag/trip and size limits) and spatial and temporal closures. Consideration being given to ITQs for Spanner Crabs (including joint stock assessments). Recreational: input controls (gear restrictions) complemented by basic output controls (bag and size limits) and spatial and temporal closures.

6. What are the challenges in establishing complementary management approaches between jurisdictions?

Understanding stock structure and life-history parameters in addition to what each fishery harvests. Isolated cases of inconsistent stock assessment outcomes (e.g. Snapper). Substantiating the need for complementary (i.e. the same form of) management arrangements to achieve common or complementary goals. Inconsistent Act objectives and politics.

7. What are the key information gaps (in terms of movement) and how do they relate to potential future management measures?

Generally have a reasonable ‘big picture’ of movement patterns between jurisdictions, however this is often anecdotal. The key gaps for most, potentially all, species are what proportion of a stock is moving between jurisdictions and at what times and at

what stage of the life-history is this movement occurring. This knowledge relates to developing sustainable harvest rates (and optimising yield/returns). Up to date information on recreational take is also lacking, noting that funding for a new survey was recently approved.

8. What other information sets exist for your cross-jurisdictional species that could improve the quality of guidance for fishery management decisions (e.g., genetic, parasites, hard-part chemistry)?

Assuming this question relates to movement patterns and/or stock structure etc, all data sets available within NSW are already applied or incorporated into relevant management driven research.

9. What are the priority species among those you have listed?

See Attachment 1, noting also recent discussions with the C/W on resource sharing with respect to SESSF quota managed species.

10. Are issues likely to change in future given trends in human populations and/or climate change?

No change in the issues, however, resource assessments and management approaches/arrangements may need to adapt accordingly.

11. What documentation exists within your jurisdiction relating to these questions, particularly in direct relation to management of cross-jurisdictional species?

Little documentation exists in terms of active management of cross-jurisdictional species despite increased focus in recent times (level of documentation will inevitably increase). The 'Status of Fisheries Resources in NSW' report provides some information on cross-jurisdictional species and issues:

http://www.dpi.nsw.gov.au/research/areas/systems-research/wild-fisheries/outputs/2010/1797

NSW list of key species

Species	NSW Resource Status	Joint jurisdictions	Priority species
Australian Sardine	Fully Fished	Commonwealth, Queensland, Victoria	High
Blue Mackerel	Moderately Fished	Commonwealth, Tasmania	
Blue Swimmer Crab	Fully Fished	Queensland	
Blue-eye Trevalla	Fully Fished	Commonwealth	
Bugs	Fully Fished	Queensland	
Dogfish	Undefined	Commonwealth	
Eastern Australian Salmon	Fully Fished	Queensland, Victoria, Tasmania	High
Eastern King Prawn	Growth Overfished	Queensland	High
Eastern School Whiting	Fully Fished	Commonwealth, Victoria	
Eastern Sea Garfish	Overfished	Queensland	
Gemfish	Recruitment Overfished	Commonwealth	High
Giant Mud Crab	Undefined	Queensland	
Gummy Shark	Fully Fished	Commonwealth	
Jackass Morwong	Overfished	Commonwealth	
John Dory	Fully Fished	Commonwealth	
Mangrove jack	Undefined	Queensland	
Mirror Dory	Fully Fished	Commonwealth	
Mulloway	Overfished	Queensland	
Ocean Jacket	Fully Fished	Commonwealth	
Ocean Perch	Fully Fished	Commonwealth	
Ocean Trawl Squid	Undefined	Queensland	
Pearl Perch	Undefined	Queensland	
Redfish	Growth Overfished	Commonwealth	
Royal Red Prawn	Lightly Fished	Commonwealth	
Sawsharks	Undefined	Commonwealth	
School Shark	Overfished	Commonwealth	
Sea Mullet	Fully Fished	Queensland	High
Silver Trevally	Growth Overfished	Commonwealth	High
Snapper	Growth Overfished	Queensland	High
Southern Bluefin Tuna	(overfished)	Commonwealth	
Spanish Mackerel	Fully Fished	Queensland	
Spanner Crab	Fully Fished	Queensland	High
Spotted Mackerel	Fully Fished	Queensland	
Stout Whiting	Moderately Fished	Queensland	
Tailor	Fully Fished	Queensland	
Teraglin	Fully Fished	Queensland	
Tiger Flathead	Fully Fished	Commonwealth	
Whaler Sharks	Undefined	Queensland	
Yellowfin Bream	Fully Fished	Queensland	
Yellowfin Tuna	Fully Fished	Commonwealth	
Yellowtail Kingfish	Growth Overfished	Queensland	
Yellowtail Scad	Fully Fished	Commonwealth	

Northern Territory

1. What is a cross-jurisdictional species?

A species that traverses across geo-political boundaries

2. Which are the key cross-jurisdictional species in your jurisdiction?

- Grey Mackerel
- Shark
- Red Snapper (Saddletail and Crimson)
- Gold band Snapper
- Spanish Mackerel

3. Which jurisdictions do you share your species with (state, federal, sectoral)?

Queensland, Western Australia, Federal

In the case of Red Snapper, it is also shared with Indonesia

4. What are the key management issues with these species?

- Data sharing and data comparability leading to difficulty in cross-jurisdictional species stock assessments
- Ability to respond to changes in stock health (monitoring issues, and appropriate trigger level issues)

Lack of knowledge on movement and stock structure for many of these species

5. What are the management measures for these species?

These fisheries are managed by strict and conservative input effort controls and precautionary management triggers:

- Sharks and Grey Mackerel are managed by ITE (fishing days), limits on net and line
- Spanish Mackerel is a troll line fishery limited by the amount of line and hooks.
- Goldband and Red Snappers are managed by ITQ's that have been recently introduced.

6. What are the challenges in establishing complementary management approaches between jurisdictions?

- Comparative data (scale of data reporting and effort indicators ie days vs hours)
- Understanding of stock levels and collaborative data analysis
- Governance and legal arrangements

- Appropriate collaborative harvest strategy

7. What are the key information gaps (in terms of movement) and how do they relate to potential future management measures?

- No information for any species on the levels of movement between jurisdictional boundaries
- No information on stock sizes shared across-jurisdictional boundaries
- No information on environmental factors influencing movement
- No information on timing (seasonality) of movements

All of these issues limit informed decision making on management of these species. Consequently, very precautionary management arrangements will continue to exist which will limit the productivity for the fisheries targeting these species.

8. What other information sets exist for your cross-jurisdictional species that could improve the quality of guidance for fishery management decisions (e.g., genetic, parasites, hard-part chemistry)?

Genetic, parasite and otolith microchemistry data for Grey Mackerel, tagging data for Spanish Mackerel and Blacktip Sharks. Only genetic data for Goldband, Saddletail and Crimson Snapper.

9. What are the priority species among those you have listed?

Carcharinus tiltstoni/limbatus, Carcharinus sorrah, Grey Mackerel, Spanish Mackerel, Goldband Snapper, Saddletail Snapper, Crimson Snapper, guitar fish, Narrow Sawfish, Pigeye Shark, Winghead Hammerhead, Scallop Hammerhead, great Hammerhead, *Glyphis sp., Glyphis garricki*, Dwarf Sawfish, Freshwater Sawfish, Green Sawfish, Guitarfish.

10. Are issues likely to change in future given trends in human populations and/or climate change

These issues will still remain, impacts from climate change and human population increases will be acknowledged as separate factors when considering management arrangements. However, management arrangements will probably become even more precautionary if the cross-jurisdictional issues are not resolved to account for these extra impacts.

11. What documentation exists within your jurisdiction relating to these questions, particularly in direct relation to management of cross-jurisdictional species?

- Offshore constitutional settlements (OCS)
- Draft shark research action plan (NMSWG)
- Ecological risk assessments
- Stock assessments
- Research reports
- NT joint fisheries authority

Queensland

1. What is a cross-jurisdictional species?

A species which moves between areas where more than one agency (state and/or commonwealth) is responsible for managing that species.

2. Which are the key cross-jurisdictional species in your jurisdiction?

Mud Crabs, Barramundi , (*Lates calcarifer*), Bugs–Balmain (*Ibacus chacei* and *I. brucei*), Moreton Bay (*Thenus australiensis* and *T. parindicus*), Crab–mud , (Scylla spp.), Crab–Spanner, (*Ranina ranina*), Mackerel¬–Grey (*Scomberomorus semifasciatus*), Mackerel–Spanish (*Scomberomorus commerson*), Mackerel–Spotted, (*Scomberomorus munroi*), Sea Mullet , (*Mugil cephalus*), Shark spp., Snapper , (*Pagrus auratus*), Snapper–Crimson, (*Lutjanus erythropterus*), Snapper–Goldband, (*Pristipomoides multidens*), Snapper¬–Hussar, (*Lutjanus adetii* and *L. vitta*), Snapper–Rosy (*Pristipomoides filamentosus*), Snapper–Saddletail, (*Lutjanus malabaricus*), Tailor , (*Pomatomus saltatrix*), Threadfin–King (*Polydactylus macrochir*)

3. Which jurisdictions do you share your species with (state, federal, sectoral)?

Northern Territory, New South Wales, Commonwealth

4. What are the key management issues with these species?

MUD CRABS, better data on rec and commercial catches, data on the movement of female crabs, impact of spatial closures;

5. What are the management measures for these species?

MUD CRAB - Gulf / NT & East coast/NSW: MLS; No female take; Apparatus restrictions (C-50; R-4 pots); Limited entry; Spatial closures;

6. What are the challenges in establishing complementary management approaches between jurisdictions?

Understanding the differences in stock structures as well as the spatio-temporal variation in fisheries and life history parameters across jurisdictions. Long history of different fishing methods/gears legislated in different jurisdictions. Co-ordination and consistency of stock assessments.

7. What are the key information gaps (in terms of movement) and how do they relate to potential future management measures?

The key knowledge gaps for many cross-jurisdictional species relate to the proportion of a stock moving between jurisdictions and the spatial and temporal pattern of fishing of that stock. Spawning and recruitment dynamics of species and the importance of biotic and abiotic factors (particular oceanic currents) in determining the movement of various life history stages.

8. What other information sets exist for your cross-jurisdictional species that could improve the quality of guidance for fishery management decisions (e.g., genetic, parasites, hard-part chemistry)?

Genetic and conventional tagging data for Snapper, Some conventional tagging information for mudCrabs. Conventional tagging data for many other species.

9. What are the priority species among those you have listed?

Mud Crab, Spanner Crab, Snapper, Grey Mackerel, Tropical Snapper, Sharks

10. Are issues likely to change in future given trends in human populations and/or climate change

Issues will remain the same in terms of trends in human population as these are already considered. The effect of future climate change on key issues may result in a more precautionary management approach but will also be affected by the magnitude of the climate change and its impact on fisheries resources.

11. What documentation exists within your jurisdiction relating to these questions, particularly in direct relation to management of cross-jurisdictional species?

There is a range of species specific information in stock assessments, ecological risk assessments and research reports although many of these do not directly address cross-jurisdictional issues and are related to local management.

Queensland (cont.)

	Stock	Status	Shared jurisdiction	Key management issues	Management measures	Is biological info collected by FQ (LTMP unless otherwise specified)
Barramundi (*Lates calcarifer*)	East coast	Sustainably fished		Commercial catches are stable and within historical levels. There is a good range of fish lengths and ages in several years of sampled populations. Studies of Barramundi in the Fitzroy catchment indicate harvest levels are below sustainable yield estimates.	Net fishery Seasonal closures	
Barramundi (*Lates calcarifer*)	Gulf	Sustainably Fished	NT	Commercial catches are within historical levels and catch rates have been steadily increasing since 1981. There is a good range of ranges of fish lengths and ages in several years of sampled populations.	Net fishery Seasonal closures	
Bugs–Balmain (*Ibacus chacei and I. brucei*)	East Coast	Uncertain		Two species were considered in the assessment but landings are dominated (80%) by *I. chacei*. Conservative minimum legal sizes allow spawning to occur before capture; however there is insufficient biological information to classify the sustainability status of Balmain Bugs.	Trawl Limited entry; individual tradeable effort; gear restrictions; permanent area closures; seasonal closures; daytime closures	No program in place; some opportunistic data from fishery observer program
Bugs–Moreton Bay (*Thenus australiensis and T. parindicus*)	East Coast	Uncertain		Two species were considered in this assessment. GBRMP closures act to protect Moreton Bay Bug biomass. Introduction of MLSs based on yield-per-recruit modelling and the use of square-mesh cod-ends has reduced the risk of overfishing small Bugs. More	Trawl Limited entry; individual tradeable effort; gear restrictions; permanent area closures; seasonal closures;	No program in place; some opportunistic data from fishery observer program

				information is available about Moreton Bay Bugs than Balmain Bugs; however their status is considered 'uncertain' due to the lack of a time series of recent length frequency data and the recent removal of the ban on harvesting berried females.	daytime closures	
Crab–Mud (*Scylla* spp.)	East Coast	Uncertain		A more reliable index of commercial effort would result in a more confident catch rate estimate and strengthen identified trends in the data. Improved recreational catch estimates would also provide more confidence in total harvest estimates. A credible indicator of abundance would reduce uncertainty in the assessment. Allowing the take of female Mud Crabs is being considered for the fishery and more information is required on the movement of female Mud Crabs.	MLS No female take Apparatus restrictions (C-50; R-4 pots) Limited entry Spatial closures	No current program; considering targetted logbook to get improved CPUE
Crab–Mud (*Scylla* spp.)	Gulf	Sustainably fished	NT	Improved recreational catch estimates, including at a regional level–allowing discrimination between the Gulf of Carpentaria and the east coast–would also provide more confidence in total harvest estimates and the stock status. Allowing the take of female Mud Crabs is being considered for the fishery and more information is required on the movement of female Mud Crabs.	MLS No female take Apparatus restrictions (C-50; R-4 pots) Limited entry Spatial closures	
Crab–Spanner (Ranina ranina)	East Coast	Not fully utilised		Operators are requesting the input control regarding the number of dillies permitted for use removed.	Limited entry Dillies (C-45 in Managed Area A; 30 in Managed Area B; R – 4 dillies, traps or pots) Quota	Fishery independent surveys (size)
Mackerel–Grey (*Scomberomorus*	East Coast	Uncertain		There is uncertainty in the assessment of current catch trends and stock status given the	TACC 250t Net fishery	

***semifasciatus*)**				commercial fishery fundamentally changed with the introduction of new conservative quota management arrangements on 1 July 2009. Only two years of routine biological data (length of fish caught in the fishery) were available which is insufficient to assess trends.	Small line fishery Limited entry	
Mackerel–Grey (*Scomberomorus semifasciatus*)	Gulf	Uncertain	NT, Commonwealth	Recent research indicates the possible existence of multiple localised adult sub-stocks of Grey Mackerel (meta populations) within the Gulf of Carpentaria. The Gulf of Carpentaria stock is managed as a whole and shared with Northern Territory.	Net fishery Small line fishery Limited entry offshore fishery Limited entry inshore fishery	
Mackerel–Spanish (*Scomberomorus commerson*)	East coast	Sustainably fished		At current fishing levels the fishery is considered sustainably fished. A new stock assessment is currently being completed, with outcomes expected to be publically available in late 2010. Preliminary results support the outcomes of the previous 2008 assessment.	SM and an L1, L2 or L3 symbol C&R up to 3 lines and 6 hooks Quota –SM symbol required. Entitlement under units issued is 544 022 kg, however current legislation requires a reduction in the value of an SM unit if specified catch triggers are reached1.	Fishery dependent data (length and age data collected annually)
Mackerel–Spanish (*Scomberomorus commerson*)	Gulf	Uncertain	NT, Commonwealth	Catch has declined but remains within historical harvest levels. Catch rates have increased slightly. A lack of data demonstrating temporal trends in length or age frequencies led the workshop expert panel to determine an 'uncertain' status. This species will be reviewed again in late 2010.	Limited entry line fishery Bycatch net fishery	Fishery dependent data (length and age data collected annually)
Mackerel–Spotted	East coast	Sustainably fished	NSW	Spotted Mackerel undertake a major seasonal migration along the east Queensland coast	Quota	Fishery dependent data (length and

(*Scomberomorus munroi*)				and appear to form a single stock. They spawn in northern Queensland waters between August and October then migrate south.		age data collected annually)
Sea Mullet **(*Mugil cephalus*)**	East coast	Sustainably fished	NSW	Stock is shared with New South Wales. Queensland's catches are stable and within historical levels. Sea Mullet was recently assessed by New South Wales as 'fully fished' due to a long history of stable landings and catch rates for estuary and ocean fisheries in both jurisdictions.	Commercial: N – mesh, haul (seine) and tunnel nets K – seine nets on ocean beaches L – hook and line Recreational – cast nets, small seine (bait) nets, hook and line	Fishery dependent data (length and age data collected annually)
Shark spp.	East coast			Determining the level of catch of individual species given the identification issues.	Quota – TACC 600t Max size Possession and no take limits for some spp. Commercial: N – mesh, haul (seine) and tunnel nets K – seine nets on ocean beaches L – hook and line Recreational – cast nets, small seine (bait) nets, hook and line	Length and species composition collected from fishery observer program on commercial boats
Shark spp.	Gulf			Determining the level of catch of individual species given the identification issues.	Net fishery Limited entry offshore fishery Limited entry inshore fishery	
Snapper **(*Pagrus auratus*)**	East coast	Overfished	NSW	The Snapper stock is shared with New South Wales and is considered 'overfished'. Stock assessment results indicate a high level of fishing pressure.	Line – L1, L2, L3 C&R - up to 3 lines and 6 hooks MLS – 35cm Commercial vessel max 20m	Fishery dependent data (length and age data collected annually); independent sampling for pre-

					In possession limit of 5 for recreational sector	recruit data
Snapper–Crimson (***Lutjanus erythropterus***)	East coast	Uncertain	NT	Lower landings reported since introduction of OS quota. Increased landings identified in 2008–09 are due to improved resolution of commercial logbooks and increased catch. Catch efficiency may be increasing with increasing availability of technology (sounders, GPS). Recreational catch estimates would be valuable. High discard mortality (60%) for these relatively long lived species.	RQ symbol Line fishery 3 lines with no more than 6 hooks Boat size and tender restrictions TACC – ITQs Min and max sizes R – in possession limits Spawning closures	
Snapper–Crimson (***Lutjanus erythropterus***)	Gulf	Uncertain	NT	Catches and catch rates have increased since 2001 however the total catch remains below the allocated commercial quota and well below the estimated sustainable yield estimates established in 1994 for Red Snappers in the Gulf of Carpentaria. The sustainable yield estimates are being revised and new monitoring and reference points are expected to be developed for Crimson Snapper in 2010. While the stock status for Crimson Snapper is likely to be sustainable at current harvest levels, it is defined as 'uncertain' until the species can be reassessed against new sustainable reference levels once established.	Quota (combined for Crimson, Saddletail Snapper and red/other emperor) Developmental fishery – semi-demersal fish otter trawl	
Snapper–Goldband (***Pristipomoides multidens***)	East Coast	Uncertain	NT	It is unknown if there is a single stock or separate stocks on the east coast. Some otoliths have been collected but have not been aged. This species is currently monitored as a key 'OS' species through the PMS.	RQ symbol Line fishery 3 lines with no more than 6 hooks Boat size and tender restrictions TACC – ITQs Min and max sizes R – in possession limits	

					Spawning closures	
Snapper–Hussar **(*Lutjanus adetii* and *L. vitta*)**	East Coast	Uncertain	NT	Commercial catches currently well below the long term average for this species group. Recreational catches currently estimated to be substantial and needs to be better quantified to determine stock status.	RQ symbol Line fishery 3 lines with no more than 6 hooks Boat size and tender restrictions TACC – ITQs Min and max sizes R – in possession limits Spawning closures	
Snapper–Rosy (*Pristipomoides filamentosus*)	East Coast	Uncertain	NT	Since quota was introduced in 2004 catch has declined significantly (60 t to <5 t). Recreational catch estimates for this species is not available (recorded as 'jobfish unspecified'). Limited biological information is available. This species is currently monitored as a key 'OS' species through the PMS.	RQ symbol Line fishery 3 lines with no more than 6 hooks Boat size and tender restrictions TACC – ITQs Min and max sizes R – in possession limits Spawning closures	
Snapper–Saddletail **(*Lutjanus malabaricus*)**	East Coast	Uncertain	NT	Since quota was introduced in 2004 catch has declined significantly (150 t to 50 t). Species specific recreational catch estimates would be valuable. Limited biological information available. This species is currently monitored as a key 'OS' species through the PMS.	RQ symbol Line fishery 3 lines with no more than 6 hooks Boat size and tender restrictions TACC – ITQs Min and max sizes R – in possession limits Spawning closures	
Snapper–Saddletail **(*Lutjanus malabaricus*)**	Gulf	Uncertain	NT	Catches have generally increased while catch rates have varied since 2005. The total catch however remains below the allocated commercial quota and well below the estimated sustainable yield estimates established in 1994 for Red Snappers in the	Quota (combined for Crimson, Saddletail Snapper and red/other emperor) Developmental fishery – semi-demersal fish otter trawl	

				Gulf of Carpentaria. The sustainable yield estimates are being revised and new monitoring and reference points are expected to be developed for Saddletail Snapper in 2010. While the stock status for Saddletail Snapper is likely to be sustainable at current harvest levels, it is defined as 'uncertain' until the species can be reassessed against new sustainable reference levels once established.		
Tailor (***Pomatomus saltatrix***)	East Coast	Sustainably Fished	NSW	The Tailor stock is shared with New South Wales and is considered 'sustainably fished'. Preliminary results of a recent stock assessment (2009) indicate that the combined Queensland–New South Wales total harvest of Tailor is below the estimated MSY and above 50% of virgin biomass.	Quota Commercial: N – mesh, haul (seine) and tunnel nets K – seine nets on ocean beaches L – hook and line Recreational – cast nets, small seine (bait) nets, hook and line	Fishery dependent data (length and age data collected annually)
Threadfin–King (***Polydactylus macrochir***)	East Coast	Uncertain	NT	No trend in commercial catches and catch rates. Highest catches occur in the Capricorn region. Recent research suggests king threadfin may have highly localised populations and may be under high fishing pressure in some areas. Sustainability reference points in the PMS are not monitored at a regional level so it is not possible to determine overall catch trends or stock status at this time.	Commercial: N – mesh, haul (seine) and tunnel nets K – seine nets on ocean beaches L – hook and line Recreational – cast nets, small seine (bait) nets, hook and line	No
Threadfin–King (***Polydactylus macrochir***)	Gulf	Uncertain	NT	Commercial catches and catch rates appear stable. However recent research suggests king threadfin may have highly localised populations and may be under high fishing pressure in some areas. Sustainability reference points in the PMS are not monitored	Net fishery N3 – inshore net	No

				at this spatial level so it is not possible to determine localised/regional catch trends or stock status at this time.		

South Australia

1. What is a cross-jurisdictional species?

A species which move between areas where several agencies are managing the potential impacts on the species

2. Which are the key cross-jurisdictional species in your jurisdiction?

- White Shark
- Dusky Whaler
- Shortfin mako
- Bronze whaler
- School Shark
- Thresher Shark
- Sevengill Shark
- Blue Shark
- Gummy Shark
- Murray Cod
- Southern Bluefin Tuna
- Mulloway
- Blue-eye Trevalla
- Snapper
- Callop
- Australian Salmon
- Samson fish
- King George Whiting
- Kingfish
- Australian Herring
- Sardine

- Blue whales
- Southern Right Whale
- Common dolphin
- Pinnipeds (Subantarctic fur seals, elephant seals, leopard seals)

- Petrels (e.g., Albatrosses, shearwaters)
- Penguins (e.g., little penguin)

3. Which jurisdictions do you share your species with (state, federal, sectoral)?

- Western Australia (e.g., Dusky Whaler, Australian Salmon)
- Victoria (e.g., Bronze Whaler, King George Whiting, Snapper)
- New South Whales (e.g., White Shark, Dusky Whaler)
- Tasmania (e.g., Sevengill Shark, Gummy Shark)
- Commonwealth (e.g., Shortfin Mako, White Shark, Dusky Whaler)
- Antarctic waters (e.g., pinnipeds, cetaceans)
- Queensland (e.g., Shortfin Mako, Dusky Whaler)
- Northern Territory (e.g., Dusky Whaler)

4. What are the key management issues with these species?

Current management issues include:

- The various and sometimes different legislation between States and agencies
- Difference in priorities and values of some species between States and agencies
- Environmental factors which can increase vulnerability of some species (e.g., drought for freshwater species, cod)

5. What are the management measures for these species?

This is a very broad question and a large range of input and output controls are currently in place in South Australia to manage cross-jurisdictional species. These include: quotas, min/max size limits, licenses and permits, spatial and temporal closures, complete protection, protection according to reproductive state, and gear limitations.

6. What are the challenges in establishing complementary management approaches between jurisdictions?

- Lack of communication between agencies
- Lack of knowledge of spatio-temporal dynamics of these species
- Lack of knowledge of the stock structure and mixing rate of these species

7. What are the key information gaps (in terms of movement) and how do they relate to potential future management measures?

- The connectivity between South Australia and Western Australia of Dusky Whaler populations
- Extent of movements of Bronze Whalers
- Extend of movements of adult Shortfin Makos
- Extend of mixing and fine-scale stock structure of Australian White Shark population
- Origin of King George Whiting and Snapper populations (i.e., the spawning areas of King George Whiting from Victoria and from the southeast stock of Snapper is unknown)

8. What other information sets exist for your cross-jurisdictional species that could improve the quality of guidance for fishery management decisions (e.g., genetic, parasites, hard-part chemistry)?

- Stock structure of Snapper populations between South Australia and Victoria. However, this work is outdated and was undertaken in the 1970s
- Otolith chemistry for King George Whiting and Snapper (although stock connectivity across jurisdiction was not investigated)
- Catch data and demographic data for many of the cross-jurisdictional species
- Genetic samples for Shortfin Mako, bronze, and Dusky Whalers

9. What are the priority species among those you have listed?

Taking into account their ecological importance, their vulnerability and the current level of knowledge of their population status, sharks have been identified as species of concern.

Additionally, the lack of understanding of the origin of King George Whiting and Snapper is also in need to be resolved.

10. Are issues likely to change in future given trends in human populations and/or climate change?

Fishing pressure is likely to intensify.

Extension of distribution range leading to additional species becoming cross-jurisdictional species and new jurisdictions becoming involved in the management of already existing cross-jurisdictional species.

11. What documentation exists within your jurisdiction relating to these questions?

There is extensive literature available on King George Whiting and Snapper in South Australia and Victoria (e.g., SARDI report series).

Gummy Shark and School Shark stock assessment have been undertaken through AFMA and the SharkRAG. Documentation such as reports and meeting minutes are available from AFMA.

Recently, outcomes from preliminary work on bronze and Dusky Whalers have been released through SARDI reports.

Tasmania

1. What is a cross-jurisdictional species?

A species where harvesting in one jurisdiction affects resources in another jurisdiction

2. Which are the key cross-jurisdictional species in your jurisdiction?

Rock Lobster, Giant Crab, Commercial Scallop, Blue Warehou, Australian Salmon

3. Which jurisdictions do you share your species with (state, federal, sectoral)?

Adjacent states (SA, Vic) and Commonwealth.

4. What are the key management issues with these species?

TACC/ catch management, managing regional differences in biology and fleet, uncertainty in stock size, recruitment variability.

5. What are the management measures for these species?

TAC, TAC, block caps, input controls, input controls

6. What are the challenges in establishing complementary management approaches between jurisdictions?

Different acts and thus management objectives, different performance measures, uncertainty about larval sources, SRR and targets for reproductive outputs.

7. What are the key information gaps (in terms of movement) and how do they relate to potential future management measures?

Larval movement in SRL, GC and Commercial Scallops, movement of GC between size limit zones, movement of Warehou between commonwealth and state

8. What other information sets exist for your cross-jurisdictional species that could improve the quality of guidance for fishery management decisions (e.g., genetic, parasites, hard-part chemistry)?

Ocean modelling, tag recapture

9. What are the priority species among those you have listed?

SRL, Commercial Scallops, GC, finfish

10. Are issues likely to change in future given trends in human populations and/or climate change.

Perhaps Climate Change on larval dispersal patterns?

11. What documentation exists within your jurisdiction relating to these questions?

Many different projects include information on spatial differences in these species.

Victoria

1. What is a cross-jurisdictional species?

Any species that is targeted or caught in significant quantities by any type of fishing in two or more State/Territory/Commonwealth jurisdictions.

2. Which are the key cross-jurisdictional species in your jurisdiction?

- Tunas (Southern Bluefin Tuna, Yellowfin, Bigeye, Albacore) - Vic/SA/Tas/NSW recreational catch; Commonwealth commercial catch:
- Pelagic Sharks (Shortfin Mako, Bronze Whaler) - Vic/SA/Tas/NSW recreational catch;
- Gummy/School Shark - Vic/SA/Tas/NSW recreational & commercial catches; Commonwealth commercial catch:
- Australian Salmon - Vic/SA/Tas/NSW recreational & commercial catches;
- Sardine - Vic/SA/Tas/NSW commercial catches; some Commonwealth commercial catch:
- Snapper - Vic recreational & commercial catches; some Commonwealth commercial catch:
- King George Whiting(?) - Vic/SA recreational & commercial catches;

3. Which jurisdictions do you share your species with (state, federal, sectoral)?

See above

4. What are the key management issues with these species?

Lack of regular, credible estimates of recreational catch to use in stock assessments or to facilitate resource sharing decision making (tunas, sharks, AustralianSalmon, Snapper, King George Whiting);

Understanding of stock structure and sources of recruitment (some tunas/sharks, Eastern Australian Salmon, Pilchard, King George Whiting)

5. What are the management measures for these species?

- Vic recreational fisheries - licence requirement (unless exempt); size/catch limits for all significant target species; equipment restrictions.
- Vic commercial fisheries - managed using input controls (limited entry licensing, equipment restrictions, closed seasons/areas) and size limits for key target species.
- Management of some fisheries (tunas, Gummy/School Shark, Pilchard, Snapper) partly defined by OCS agreements between Victoria and the Commonwealth.

6. What are the challenges in establishing complementary management approaches between jurisdictions?

- Coordination of research, fishery monitoring & stock assessment approaches across jurisdictions;
- Negotiation and agreement on fisheries resource sharing across sectors/jurisdictions;
- Negotiation and agreement on sharing of management costs across sectors/jurisdictions.

7. What are the key information gaps (in terms of movement) and how do they relate to potential future management measures?

Stock structure & degree of mixing between fish in waters adjacent to Victoria and fish in other state/Commonwealth jurisdictions (some tunas, pelagic sharks, Pilchards);

Sources of juvenile recruitment to/escapement from Victorian fisheries (Eastern Australian Salmon, King George Whiting)

8. What other information sets exist for your cross-jurisdictional species that could improve the quality of guidance for fishery management decisions (e.g., genetic, parasites, hard-part chemistry)?

Some genetic, tagging and otolith microchemistry data to inform stock structure and movement of some species. Much of these data are more than 10 years old.

9. What are the priority species among those you have listed?

Southern Bluefin Tuna, Shortfin Mako Shark, Snapper, King George Whiting, Eastern Australian Salmon, Pilchard.

10. Are issues likely to change in future given trends in human populations and/or climate change

Not sure what this means - for discussion at the workshop.

11. What documentation exists within your jurisdiction relating to these questions?

Not sure what this means - for discussion at the workshop.

Western Australia

1. What is a cross-jurisdictional species?

Not formally defined under WA legislation but, for the purposes of this workshop, is notionally taken to mean:

A species occupying an area administered under different Governments' management regimes (jurisdictions), for which the activities in one jurisdiction can directly or indirectly impact the status of the species in another jurisdiction

2. Which are the key cross-jurisdictional species in your jurisdiction?

- Elasmobranchs
- Gummy Shark (*Mustelus antarcticus*), WA, Comm;
- Dusky Whaler (*Carcharhinus obscurus*), WA, Comm, SA;
- Sandbar Shark (*Carcharhinus plumbeus*), WA, Comm;
- Blacktip Sharks (*C. limbatus* and *C. tilstoni*), WA, NT, Qld;
- [+ many others]

- Teleosts
- Snapper (*Pagrus auratus*), WA, Comm;
- Goldband Snapper (*Pristipomoides* spp., mainly *P. multidens*), WA, Comm, NT;
- Spanish Mackerel (*Scomberomorus commerson*), WA, NT, Qld;
- Grey Mackerel (*Scomberomorus semifasciatus*), WA, NT, Qld;
- Tropical Lutjanids (Red Snappers, Ruby Snapper), WA, NT, Qld, Comm;
- Pilchards (*Sardinops sagax*), WA, SA, Comm?;
- Australian Herring (*Arripis georgianus*)?, WA, SA;
- Australian Salmon (*Arripis truttaceus*), WA, SA, Vic?
- [NB Tuna spp, legislated single jurisdiction under OCS]

- Invertebrates
- Probably none relevant to this workshop

- TEPs
- White Shark (*Carcharodon carcharias*), WA, Comm, SA, Vic, NSW, Qld, Tas?;
- Australian Sealion (*Neophoca cinerea*), WA, Comm, SA;

3. Which jurisdictions do you share your species with (state, federal, sectoral)?

See above

4. What are the key management issues with these species?

- Differential commercial gillnet management arrangements (permitted input/output controls, mesh sizes, etc) for Gummy Sharks and uncertainty in exchange rates between jurisdictions/management zones.
- Recruitment of Dusky and Sandbar Sharks is particularly susceptible to mortality of older juvenile and adult sharks (by targeted fishing, bycatch, IUU, bait-bands, etc.).
- Uncertainty in Blacktip Shark catch species composition (hence uninformative CPUE) is an impediment to reliable assessment. Also limited information on exchange rates between WA, NT and Qld stocks.
- Assessing and managing the cumulative impacts of cross-sectoral and cross-jurisdictional exploitation of multiple demersal scalefish (teleost) species, including Snapper and tropical Lutjanids.
- Greater certainty about the stock status and interconnectivity of mackerel and Australian Herring, stock components between areas.
- A better understanding of inter-annual movements of Salmon and impacts of environmental conditions on movement and abundance.
- Forecasting pilchard movements to improve the management response to a future virus outbreak.
- Mitigation of White Shark mortality, particularly in demersal gillnet fisheries.
- Mitigation of Australian sealion mortality, particularly in demersal gillnet fisheries.
- Demersal scalefish species (including Snapper and some Lutjanids) improved understanding of stock dynamics and interconnectivity between areas.
- Long-term monitoring effects of climate change.

5. What are the management measures for these species?

Various but generally input controls (except for Snapper, Mackerels, pilchards). See State of the Fisheries and Aquatic Resources report 2009-10.

6. What are the challenges in establishing complementary management approaches between jurisdictions?

OCS and Joint Authorities assist in providing for the orderly management of key species (e.g. Rock Lobster, tuna) and fishing methods (e.g. trap and trawl). The challenge arises where the species move across State boundaries (e.g. some shark species, mackerels, Herring Salmon, pilchards) and between State - Commonwealth jurisdiction when different fishing methods managed by each jurisdiction impact on a single stock/species (e.g. Snapper).

7. What are the key information gaps (in terms of movement) and how do they relate to potential future management measures?

Linkages and exchange rates of Gummy Sharks between WA management zones and between WA and Comm –managed fisheries

Bycatch rates (or risk) of adult Dusky and Sandbar Sharks during natal migrations along WA west coast. Seasonal and intra-annual Dusky Whaler migrations to SA Gulfs and species-specific shark catches by the SA Marine Scalefish Fishery.

Abundance, fishing mortality, connectivity and exchange rates of Blacktip Sharks between WA, NT and Qld jurisdictions. Also, contemporary species-specific inshore-offshore movements as related to fine-scale catch distributions.

For a number of demersal scalefish species (including Snapper and some Lutjanids) that occur both inside and outside of the 200m isobath, information regarding stock structure and abundance outside the 200m jurisdictional boundary and movements between jurisdictions is necessary to underpin joint State/C'wealth harvest strategies.

For mackerel, Australian Herring, salmon and pilchards, additional information on the extent of fish movement around the coastline and across State boundaries would be useful. Also sources and transportation of Australian Herring recruitment.

Uncertainties in White Shark population structure, movements, catches, post-release mortality, abundance, etc. (See 2009 SEWPaC Issues Paper).

Uncertainty in gillnet (and other methods?) capture rates of Australian sealions.

8. What other information sets exist for your cross-jurisdictional species that could improve the quality of guidance for fishery management decisions (e.g., genetic, parasites, hard-part chemistry)?

Various, including: long-term catch and effort data series, age-specific fishing mortality rate estimates, life-history data, stock assessments, biological samples (genetic, hard-part samples), tag movement data.

Movement/exchange rates of Gummy, Dusky and Sandbar Sharks between management zones are currently under investigation (FRDC project 2010/03).

9. What are the priority species among those you have listed?

All of them (and others). See the Department of Fisheries' Research, Monitoring, Assessment and Development Plan 2010 – 2011 for descriptions of their relative risks/priorities.

NB the current acoustic telemetry infrastructure in Western Australia is most suited for providing information on wide-ranging continental shelf -associated species, including Gummy, Dusky, Sandbar and White Sharks, for which research is underway. Thus, this infrastructure is critical to the objectives of FRDC project 2010/03.

Demersal scalefish species information needs relate to depth stratified stock abundance/structure information and would seem to have limited applicability to current acoustic tracking resources.

10. Are issues likely to change in future given trends in human populations and/or climate change

Yes and due to the dynamic nature of the Department's management and research priority-setting processes.

11. What documentation exists within your jurisdiction relating to these questions?

Department of Fisheries. 2011. Research, Monitoring, Assessment and Development Plan 2010 – 2011. Fisheries Occasional Publication No. 88, 2011. Department of Fisheries, Perth, Western Australia.

Brayford, H. G. and Lyon, G. E. 1995. Offshore Constitutional Settlement 1995. Fisheries Management Paper no. 77. Department of Fisheries, Perth, Western Australia.

Fletcher, W. J and Santoro, K. (eds). 2010. State of the Fisheries and Aquatic Resources Report 2009/10. Department of Fisheries, Perth, Western Australia.

APPENDIX 6

FRDC Preliminary Research Proposal

(TasFRAB, SAFRAB, WAFRAB, VicFRAB, NSWFRAB, ComFRAB, QldFRAB, NTFRAB)

Application Reference: RB021

Project Title: Towards a National Strategy for Understanding Movements of Cross-Jurisdictional Species: aligning management needs with the goals of IMOS

Applicant: CSIRO

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Organisation: Fisheries Victoria Position: Section Leader Invertebrate Fisheries

Start Date: 01-Jul-2012 **End Date:** 30-Jun-2013

Project Budget

	Salary	Travel	Operating	Capital	Cash Contribution	FRDC Contribution	Applicant (In kind)	Other (In kind)	Project
12/13	$106,14	$25,000	$29,862	$0	$0	$161,002	$106,575	$40,000	$161,002
Totals	**$106,14**	**$25,000**	**$29,862**	**$0**	**$0**	**$161,002**	**$106,575**	**$40,000**	**$161,002**

Theme

Resource access and allocation

Objectives

1 Produce a detailed strategic research plan to address key information gaps for key species identified in FRDC 2010/235, including indications of optimal locations for receiver

Research Priorities for understanding movements of cross-jurisdictional species - June 2011

infrastructure .

2 Use existing data from IMOS infrastructure to evaluate questions including assessing not only the number of lines necessary but also the number of tags needed for each species.

3 On the basis of the objectives above, inform the strategic goals of IMOS and better align them with recognised fisheries management needs

Flow of Benefits

Name	Commercial	Recreational	Traditional
Commonwealth	5.00	5.00	0.00
NSW	5.00	5.00	0.00
NT	10.00	5.00	0.00
QLD	10.00	5.00	0.00
SA	5.00	5.00	0.00
TAS	5.00	5.00	0.00
VIC	10.00	5.00	0.00
WA	10.00	5.00	0.00

Need

Around Australia there are many species of sharks and finfish that range widely or undertake long-distance reproductive or foraging migrations. There is a need to better describe and understand these aspects of the ecology and biology of these species in order to more effectively manage them across both single and multiple jurisdictions. These species cross various jurisdictional boundaries (State and Commonwealth) and in this process are subject to a range of management regulations which may potentially be simplified or aligned to best meet the needs of an overall stock management approach. Given the nature of these highly mobile species it is beyond the capability of any single jurisdictional agency to carry out the required research to understand these species' movements and the implications for our understanding of stock dynamics and how these relate to management actions both within and among jurisdictions. Significant potential exists to address the key information gaps using the Australian Animal Tracking and Monitoring System (AATAMS) infrastructure. However outcomes of a recent cross-jurisdictional workshop (FRDC 2010/235) have made clear that there is not a full match between the highest management priorities in terms of information gaps/species, and the existing infrastructure of AATAMS' acoustic network. High management priorities (Gummy Shark, School Shark) did not match existing AATAMS infrastructure, while other species (salmon) fit infrastructure reasonably well but were lower priorities for management. In order to better align the needs of research for management and national infrastructure a clear set of strategic goals and methodologies are required.

Planned Outcomes and Benefits

The strategic vision developed by his project will position multiple management agencies to influence the placement of national acoustic tracking infrastructure in IMOS. In doing so it will harness an investment currently valued at $2.8M in acoustic receiver infrastructure, and an equivalent amount of investment in ongoing project support (tagging and receiver maintenance) by state and commonwealth agencies. This will help ensure that data from the tracking network most directly meets their needs for managing key cross jurisdictional species and maximise return on investments in active tagging and tracking projects.

Consultation

This proposal has been developed based on the outcomes of a workshop held in May 2011 of all Australian fisheries management jurisdictions to develop a consensus on the key high priority species for targeted movement research.

Other consultation includes discussion of the project objectives with representatives of FRABs in constituent jurisdictions with generally positive responses that this project will represent worthwhile investment if it can ensure IMOS investment meets fisheries needs. It was also noted that a clear path for information uptake by management must be demonstrated and this was a core goal of the proposal

Methods

A working group of PI and key jurisdictional representatives will convene to develop a detailed description of the management issues and options as they relate to the biology of high priority cross-jurisdictional species listed in FRDC 2010/235. This will be used to develop and document the management benefits potentially gained from a program of tagging and tracking these species. This would be used to further prioritise on the basis of benefit and risk.

A national strategy for tagging and tracking cross-jurisdictional species will be developed based on this information. The strategy will set out the objectives of the program from a management-outcome perspective and will place them in the context not only of the existing AATAMS acoustic receiver network but importantly will describe any further infrastructure needs that may be needed in order to achieve the long term goals for cross-jurisdictional species.

Analysis of selected existing data sets from AATAMS receiver networks will be undertaken using a range of statistical approaches combined with MSE modelling to ensure that planned tagging and receiver networks are fit-for-purpose in terms of ability to detect movements, and robust in terms of inferences made from tag detections, e.g. rate and direction of movement as well as the proportion of individuals taking part.

Results of strategic analysis for cross jurisdictional species and technical capacity of the acoustic tracking methods will be used to align and harmonise IMOS strategic goals and infrastructure with management needs, thus incorporating management outcomes in the AATAMS strategic framework.

Related Projects and Research Capacity

Collectively the applicants have extensive experience with fisheries research and management. They have worked in a range of fisheries and have used the proposed tracking technology to better understand the movements and life history of a range of fish and sharks from the NT to southern Tasmania. High level statistical expertise in the field of animal movement analysis has also been brought to the project.

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