WORKSHOP SUMMARY DOCUMENT

Abalone assessment and management: what have we learned, what are the gaps and where can we do better

Workshop Venue: Oaks on Collins, 480 Collins Street, Melbourne

7th and 8th March 2019

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Background

The workshop was called jointly by Fisheries Research & Development Corporation (FRDC) and the Abalone Council of Australia (ACA), with the following objectives:

- To consolidate and exchange information on the range of current and planned assessment and management approaches in Australian abalone fisheries
- To identify areas of common interest and determine the degree to which common approaches may be adopted across and within jurisdictions
- To determine where existing research outputs and future research could best be used by managers to improve outcomes and increase industry and the community's confidence in assessments
- To consider areas of common interest and prioritise future RD&E investment

The workshop agenda is provided as **Attachment 1** and a list of participants as **Attachment 2**. Managers and researchers represented all jurisdictions with abalone fisheries (New South Wales, South Australia, Tasmania, Victoria and Western Australia).

All presentations and accompanying discussion papers prepared for the workshop can be found on the ACA website – https://www.abalonecouncil.com.au/research-development/papers-from-workshop-7-8-march-2019/.

It was noted that this was the third in a recent series of meetings where abalone research priorities have been discussed. The first was in 2015 where the so-called 'Four Box' model was developed as a way of categorising the main fields of work and expenditure for abalone research; this structure was used in the presentation of FRDC research to the workshop (Table 1; Session 6). In 2017, a workshop was held to develop the 2018-2023 ACA RD&E Plan, and a number of projects dealing with assessment and management.

Table 1. The 'Four Box' model for collection and use of finer scale data in assessment and management decision making.

Data recording technology (all types)	Database & analytical tools	Indicators & performance measures	Harvest strategies/ management decisions
Support current & new methods used in jurisdictions	• Regional capability, methods and tools • Freely accessible and usable • Use inputs from variety of data loggers and traditional information sources • Re-package data into required space/time blocks • Calculate indicators and performance measures used in different jurisdictions		Support current & new methods used in jurisdictions: • Including current & evolving workshop approaches • Practical use of finer scale data in assessment and management

Opening remarks

The meeting was opened by Dean Lisson (ACA EO), who acknowledged the funding and other support provided by FRDC and the presence of managers, researchers and industry from each abalone jurisdiction. The newly appointed Chair of the ACA, Ian Cartwright, was introduced and acted as facilitator for the meeting.

Kaz Bartaska, ACA Board member and abalone processor provided a summary of observations and his expectations for the workshop and future research and management of abalone fisheries. He noted:

- The substantial decline in abalone production over the last few years, despite many millions of dollars for RD&E investment;
- It was not logical to continue to do the same thing and expect a different outcome;
- That consideration should be given to the use of KPIs to assess the benefits of RD&E;
- Variation between stakeholder views makes the achievement of consensus challenging; and
- Collaboration and consensus is essential to improve the current situation.

1. Status of Australian abalone stocks

Steve Mayfield (SARDI) provided a presentation on the status of stocks, based on the outcomes of the 2018 State of Australian Fish Stocks (SAFS) Reports. A total of 30 stocks were considered. Of those six were classified as 'negligible' or 'undefined'. Of the 24 abalone stocks assessed, 10 (42%) are classed as 'sustainable' with the balance classed as 'depleted' (12%) or 'depleting' (46%). These proportions of depleted and depleting stocks are much higher than for other species assessed under SAFS 2018.

Wild abalone production in Australia has fallen from around 5,300t to 2,800t in the last 20 years. This reflects fisheries management action to reduce TACs and industry action to reduce catches, both in response to declining stock levels and lower CPUE. Declines are attributed to a number of causes of which fishing mortality is but one; others include: habitat loss due to *Centrostephanus*, environmental change & marine heat waves, disease outbreak (AVG, *Perkinsus*), and reduced natural recruitment, all of which reduce productivity.

Dr Mayfield drew attention to the vulnerability of exploited abalone populations, which have demonstrated high susceptibility to overfishing and depletion both in Australia and in a number of fisheries overseas. Current low resilience leaves Australian abalone stocks highly exposed to external influences and there is a need to better match catch with productivity. Stock recovery from severe depletion has rarely been demonstrated and, where it has occurred, this has been after many years with little to no fishing.

Discussion points

- Given that SAFS operates at a high spatial scale (generally zones), the process potentially masks poor fine-scale performance and does not reflect the scale that abalone fisheries should be/are managed at.
- Declines in productivity from a range of sources means that the high catches taken in the past are unlikely to be achieved in the short to medium term, thus such catch levels are unlikely to provide realistic management targets/thresholds and should be used with caution.
- Environmental change has been one of the key factors impeding natural recruitment and productivity.
- In some fisheries, inadequate consideration has been given to other factors that likely contribute to declines in biomass, including illegal activities, MPAs and recreational and indigenous fishing.
- Use of appropriate legal minimum length (LMLs) is a key management measure to protect spawning biomass. However, it is vital to also set appropriate TACs.
- 'What we have been doing is not working' – Australian abalone fisheries need to look at new approaches. New Zealand and the transparency of data between divers provides a model in this regard.

2. Data and analysis

Craig Mundy (IMAS) provided a presentation on data and analyses. Commencing with clarification of terms commonly used (and, at times misunderstood) in abalone stock assessments.

It was noted that individual fishing events are independent of nearby fishing events and that CPUE from one dive does not infer similar CPUE on nearby (or distant) dives. Summary values of fleet level experience (e.g. mean catch) offer a proxy for 'abundance' across assessment areas. Similarly, results from FIS sites are not easily extrapolated to neighbouring sites, but where there is adequate coverage these FISs are considered representative of the fishing grounds.

A summary of data availability among States was provided. Catch and effort are the only comprehensive data sets across all jurisdictions and while there is some level of GPS and depth coverage in most jurisdictions, there is considerable variation in space and time.

CPUE-based indicators will need to continue to be used in abalone assessments and there is a need to account for the effects of factors other than relative abundance that can effect CPUE. e.g. diver experience, month, doubling up, and mixed species fishing. It is possible to account for the potentially confounding effects of these eternal factors on 'raw' CPUE and standardise CPUE using accepted statistical methods to standardise CPUE.

In summary, iindividual fishing events are not indicative of the fishery, but summary statistics of the fleet experience do offer a proxy for abundance. Spatial and temporal complexities are ignored in the current approach to calculating 'mean' values in CPUE trends, however, planned research will help address this issue. Catch LF, FIS, GPS data has variable coverage and time-series across jurisdictions, with catch and effort being the only variables common to all states with sufficient coverage in the context of a common approach to assessing stock status.

See also *Section X. Rapid talk session* of this summary record for further discussion of collection, analysis and use of data.

Discussion points

- Coverage and time series are important; in Tasmania there are enough logger data to support recommendations for management action, but with more data (commercial LF and recruitment plate data and expanded FIS) and further analysis there would be more confidence in the advice.
- Fishers can maintain CPUE in the face of declining biomass (hyper-stability) up to the point where severe depletion becomes apparent and management intervention is unlikely to recover stock abundance. It was acknowledged that when fishers are no longer able to adjust practices to maintain CPUE, this should be interpreted as a clear sign of depletion.
- Where there are issues with the various data sets/indicators, a weight of evidence approach is probably appropriate - whereby: (i) the majority of indicators point in the same direction provides confidence in results, conversely (ii) there are differences in indicators, driving the need for additional analysis/data collection. It is also possible to weight indicators, as is the case in Tasmania.
- There was a review of performance indicators at the initiation of the use of GPS loggers more than 10 years ago, but it is unclear how this has been picked up.
- Tasmania, CZ (SA) and NSW have mandated the use of loggers, but there is variable use elsewhere. The WZ industry advised that the availability of logger data prior to AVG was pivotal in supporting their recovery strategy.

- Noted that sections of the NZ industry are experimenting with open access to diver logger data; the general view is that this approach would not be acceptable at this time to most of the Australian industry.

Victoria Western Zone Abalone - Data collection, validation & collaboration

Craig Fox presented a case study based on the Victorian Western Zone (WZ). A summary history of the Victorian Western Zone (WZ) was provided. It was noted that industry-led data collection started in 2004/5, with all divers using GPS/ab measurers, which led to a recognition that overfishing was occurring and voluntary catch reductions were implemented. The outbreak of AVG decimated the zone leading to its closure in 2006.

The fishery re-opened in 2009, with a TAC of 42t set in order to facilitate recovery of the fishery. Management arrangements included fine-scale management by reef code, the use of GPS loggers and increasing size limits by 10mm to 130mm.

The use of real-time diver-driven data collection has led to close collaboration between divers, managers and researchers, improving transparency in the decision-making process. This data enables industry and researchers to make inter-annual comparisons of fishing pressure, CPUE/catch and average size. Confidential data are sent to the industry appointed researcher, Duncan Worthington, and are easily accessible by divers who can directly see the benefit from the system.

A description of the TACC-setting process was provided. Whereby, data validation and TACC setting is now an effective and collaborative process that includes (divers & FIS) data and qualitative discussion.

The benefits of collaboration between fisheries managers and industry was emphasised including sharing industry-collected data, building stronger relationships (e.g. taking fisheries managers diving) and data validation.

Discussion points

- WADA acknowledged the role of appropriate size limits as an effective tool for recovery.
- Understanding the status of stocks when they are no longer fished is challenging, there is a need to develop appropriate indictors of recovery.
- The WZ (Vic) is an example of where the conditions were right to facilitate recovery (sufficient remnant populations); in cases of very severe depletion such recovery may not be achievable.
- Recovery will be influenced by a combination of appropriate TAC and LML changes and ‘slow and steady’ approaches to management changes.
- Keith Sainsbury noted that in WZ (Vic) and NSW it appears recovery has occurred in two phases. The first phase resulted in a relatively quick response to reduced catch (decreased mortality) and biomass increase due to growth. The second phase will take longer and be dependent on increased successful recruitment from the larger biomass to improve productivity. This phase is dependent on successful recruitment. It is possible that even if low catches are maintained and increased recruitment does not occur as expected, declines may occur.
- Recovery has been patchy in other areas using similar approaches to those used in the WZ (Vic); e.g. 13 years of low catches in northeast Tasmania, where there is no recovery. In some cases, recovery can be quick, in others it can be patchy – this is likely influenced by external forces (water temperature, AVG etc.) that can undermine recovery efforts.
- There are a small number of fishers (n = 6) in WZ (Vic) and the level of cooperation and implementation of collaborative arrangements is likely to be more challenging in jurisdictions with greater numbers of divers.

- Small scale management, the implementation of catch targets, data sharing and access to data on a daily scale for each reef code are considered to be important and were pivotal to recovery in the WZ (Vic)
- Localised pressure exacerbates overfishing, driven by economic pressure from there being too many divers to access a limited/dwindling resource.
- There is the need for leadership in the sector at the diver level to instil a better example/standard for behaviour/stewardship.
- Abalone are a community-owned fishery/resource and the regulators have the power and responsibility to control how it is accessed and used. However, there are often political barriers to 'hard' fisheries management decisions that need to be overcome.
- Ways to demonstrate the economic benefits of spreading effort/modifying fishing should be developed to assist with 'selling' management measures to industry.
- Data sharing is the key driver to inform where we can go and this is needed in real time – it was acknowledged that there was a need to make a move to do this. This requires action to work out how we will we manage and use data.
- The use of lag indicators adds to delays in the implementation of management decisions and needs to be addressed; the Tasmanian 'recruitments plates' project provides one way forward in this area. WA is already using recruitment indicators to set TAC in the Perth Metropolitan Roe's abalone fishery, which allowed proactive management decisions to be made when stocks were affected by a marine heatwave.
- WA stated an intention to put forward a project that would see how the recovery strategy employed in the WZ (Vic) could be applied in WA (Augusta Sub-area Fishery), noting that such a project would be of value to other jurisdictions where severe depletion of abalone stocks had occurred (e.g. South Australian CZ).

3. Review of Harvest Strategies

Cathy Dichmont (CDC Consulting) provided a presentation on progress with the development and implementation of harvest strategies for abalone in Australia.

In the case of abalone, it was noted as surprising that there are disparate approaches to decision systems and harvest strategy (HS) frameworks between (and within) jurisdictions for the same or similar species. However, all states have made some progress towards implementing HSs with Tasmanian and Western Australia using HS, South Australia redeveloping a previous HS, and other jurisdictions in various stages of developing and testing HS.

The fundamental approaches behind each HS were presented, including indicators, and a number of conclusions drawn:

- Tensions exist between larger management scales and smaller population dynamics, and between short term and medium term changes.
- Where several indicators are used there is a need to determine how best to link and weight them in order to address conflicting/inconsistent data. There needs to be explicit definitions on what these datasets mean/represent (with explicit definitions documented). This will aid in the weighting approach, and agreement should facilitate discussion.
- There have been negative reviews of HSs resulting from: a lack of lead indicators, disputes over the value of FISs, reliance on lag indicators which are converted into moving averages (especially for declining stocks), and the use of indicators in combination that do not reflect stock size.

- All HSs still apply a weight of evidence approach to the final decision-making process reflecting scale issues and different interpretation of data value between sectors.
- Only WA (in a small region) directly includes environmental indicators in the HS yet environment issues (beyond AVG) are often mentioned as drivers of productivity.
- Few HSs are MSE tested and always singly (i.e. by jurisdiction not across jurisdiction), to date there has not been a comprehensive overview of all HSs and there appears to be little sharing between jurisdictions.
- The use of either a FIS or GPS/diver logger data as an absolute index of abundance remains controversial.
- The degree to which current HSs reflect unique aspects of abalone (smaller scale, overfishing risk, ecosystem changes) can be questioned and decisions are mostly left to a weight of evidence approach but with no guidance as to how to undertake this weight of evidence approach.

In order to resolve differences in opinion among different stakeholders on the value of certain indicators in whatever HS framework is selected, there is a need for cross-cutting research to robustly evaluate these opinions. In addition, it is recommended that relevant abalone scientists meet regularly to discuss HS development, data needs and implementation.

No cross-jurisdictional testing of past, present and future HSs has been undertaken and it is recommended to MSE test all strategies rather than singly, so as to achieve economies of scale and learning from each jurisdiction.

Environmental drivers and indicators are likely to become (even more) important and their role in HSs needs to be investigated, possibly through the use of a cross cutting technical group.

Discussion points

- It is important to define what is meant by, and what we want to achieve from, the weight of evidence approach. Namely, establishing explicit rules/guidelines and codifying the WOE approach, thus removing subjective aspects of interpretation. Note that the WZ (Vic) has an appendix to its HS that partially achieves this. Cathy Dichmont was tasked with preparing a short presentation on day two of the workshop on the application of weight of evidence approaches (see *Section X. Rapid talk* session of this summary record)
- It is important to have greater collaboration between researchers to avoid developments being done in isolation and to ensure sharing of knowledge. There may be some role for an abalone research committee to inform the ACA on research direction/developments and identify tactical and strategic needs.
- Need standardised and robust methods for FIS – this should be explored across states and when done should reduce much of the controversy surrounding FIS methodology and its use of FISs in fisheries assessments and TACC setting.
- Clear need to better integrate climate and environmental variability in HSs.

4. Stock enhancement

Lachlan Strain (DPIRDWA) provided a summary of stock enhancement methodologies for abalone fisheries, focusing on:

- *Stock Enhancement* – The ongoing release of cultured juveniles into wild population(s) to augment the natural supply of juveniles and optimize harvests by overcoming recruitment limitation; and

- *Restocking* – The release of cultured juveniles into wild population(s) to restore severely depleted spawning biomass to a level where it can once again provide regular, substantial yields.

Abalone restocking and stock enhancement has been conducted on varying scales around the world and there is considerable scientific literature available. Fisheries and aquaculture scientists and managers in Australia receive numerous inquiries regarding stock enhancement and/or restocking ranging from solid project proposals to random ideas. Increases in aquaculture production and subsequent availability of seed stock will help progress these activities.

While there are currently no abalone stock enhancement or restocking projects occurring within Australia, several large-scale experimental projects have been completed with promising results and conclusions. Despite the interest and pilot scale successes, none have progressed to commercialisation due to a range of roadblocks. These include:

- The lack of clear planning and strategic direction to provide the rationale for stock enhancement / restocking, including liaison between various sectors and regulatory agencies.
- The inability to translate research (funding >$2 million) into commercial scale operations, especially in WA where commercial stock enhancement and NSW where supplementary rebuilding of local populations were found to be viable.
- Abalone aquaculture has seen a rapid increase in commercial production both in Australia and worldwide with significant research into commercial production bottlenecks (focusing on greenlip, blacklip and hybrids). There is a need to develop culture protocols that support release of abalone into the wild, including consideration of genetic, biosecurity and disease protocols.
- Biosecurity/disease risks with potential for significant impacts to wild fishery, including AVG, *Vibrio* and *Perkinsus* need to be considered. Stringent biosecurity and disease protocols need to be imposed on hatchery production of seed stock with detailed risk assessments and potential mitigation strategies.

Other roadblocks are associated with the potentially prohibitive costs of set up depending on capital expenditure and quality, pricing and marketing issues.

A range of past and potential research projects were described and a range of recommendations provided. These were to:

- Develop strict national / state policies that deal with the complexities of abalone stock enhancement.
- Identify locations and pre-assess the viability of stock enhancement across Australia.
- Targeted research into specific locations where stock enhancement has the greatest potential to succeed.
- Develop fishing industry/aquaculture/government business models to deal with ownership and commercialisation.
- Stop the current *ad-hoc* approach.

Discussion points

- Previous experience with abalone fisheries has shown that not allowing stocks to become severely depleted is the most economic (and obvious) approach to safeguarding abalone stocks. However, in some places stocks may be so depleted as to make recovery impossible without enhancement (i.e. to overcome issues with low levels of natural recruitment).

- The beneficiaries of stock enhancement (property rights over enhanced stocks) is a key issue. It was generally considered that where existing abalone habitat is enhanced/recovered then access rights should stay with existing entitlement holders.
- Site selection was acknowledged as being critical to success, and needs to be informed by where the productive areas are/were and where there is suitable bottom & food availability.
- Establishing targets for stock rebuilding prior to undertaking these activities is essential.
- Genomic work indicates that paternal adaption is a limiting factor for the successful translocation of abalone. This then encourages sourcing brood stock from the 'recovery area' of interest. In recovery projects this is likely to be best achieved through using the closest fish to the restocking site.
- Stock enhancement might be seen as a means of not having to reduce catches, however stock enhancement does not compensate for inadequate fisheries management.
- There is a time lag involved – this is likely significant – i.e. in transitioning from start-up/restocking, to catching introduced abalone/stock recovery.
- Stock enhancement should not be seen as a means of delaying management action – rather it is a useful way to aid in the recovery of stocks.
- There would be value in a review of abalone enhancement projects to inform future developments and the policies governing them.

5. Dealing with *Centrostephanus*

Dean Lisson (Tasmania) briefly introduced this section, noting that in the interests of time, the report of the recent *Centrostephanus* workshop held in Tasmania was available from here. It was suggested that interested parties could contact Dean or Craig Mundy to find our more information if required.

Workshop participants noted that there was a need to develop a code of conduct on *Centrostephanus* harvesting and culling. Experience has generally shown that culling is the most effective means of controlling urchin numbers and promoting habitat recovery.

6. Comments on management

The facilitator, in noting the importance and rarity of having fishery managers from multiple abalone jurisdictions present, offered an opportunity for each jurisdiction to make comments on issues and experiences relating to abalone research and management.

Tasmania: A good HS process is in place using MCDA based on catch rates. The TAC setting process is broadly agreed upon by industry and management, and has resulted in substantial reductions aimed at addressing stock declines. There is a need to better incorporate spatial indicators into the HS. Size limits remain a major issue and while some work has been completed and action taken, the 'set and forget' mentality that can accompany the setting of size limits has meant that management/industry has not been reactive enough to changes.

South Australia: Management plans are in place with a strong regulatory framework and formalised HSs, which are integral to fisheries management decisions. There is a strong management–industry relationship, which aids in progressing issues (e.g. voluntary closures). This is in part due to good industry leadership. There is a need to tweak the current metrics used (e.g. moving from lagging to leading indicators), but there have been issues in decision-making. This needs to be improved through the regulatory system (so as not to be playing catch up). This also requires acceptance from industry in what the data/information/ assessment advice is saying – i.e. it reflects reality.

It was acknowledged that managers do not generally get together to talk with their counterparts (beyond specific issues). Representatives from **Western Australia** and **New South Wales** endorsed

the comments from Tasmania and SA – e.g. the value of adopting leading indicators, the importance of management-industry relations, the value of a well-articulated HSs. In addition, it was noted that particular attention should be focused on facilitating cross-jurisdictional discussions in order to leverage improvements and learn from the successes and challenges in other jurisdictions.

Discussion points

- There was acknowledgement of the importance of engaged and proactive industry working together with managers to ensure the sustainability of their fisheries. This engagement is evidenced through TAC processes, although the degree to which decisions adequately address declining resource status was questioned.
- Discussions noted the use of loggers as being of potential value for both industry and government, and the need for industry and management to progress data sharing arrangements around this data stream.
- Governance (decision making) on issues like TAC reductions or LML changes, needs to be improved across all sectors to ensure real/effective change that will result in the 'best' management of abalone resources; such change is best achieved when industry, researchers and managers are united on the need for, and means of addressing change.
- Acknowledgement that severe declines in biomass have occurred despite management changes and thus there is a need to retrospectively assess the outcomes of management decisions, how they were made (data used etc.) and how we may be able to learn from these and do better in the future.
- Ministers and their advisers are easily confused and a clear and unequivocal biological basis for making changes to management arrangements is required, including adequate data and analysis to justify change.
- There a lack of understanding of the fisheries management process/theory within industry and (especially) quota owners who do not fish. Reference was made to the Fishwell Consulting educational video series.
- There is a lack of succession planning by industry leaders and science, there are very few young researchers and managers and this should be addressed.

7. Past, present and future research

Chris Izzo (FRDC) provided an outline of the history of FRDC funded abalone-related research. In the last 17 years, some 80+ projects at a cost of approximately $18.5M have been implemented, including in area management-related research such as data collection, stock assessment & management, and stock enhancement. An Assessment & Management RD&E summary of past projects using a previously developed 'Four Box' framework was presented.

Overall, there appears to have been limited adoption and translation of research into management change, one exception being an increased emphasis on spatial assessment and management. In almost all cases getting industry and political agreement to substantial change, even where industry is heavily engaged, is usually a lengthy process. Where management is embedded within policy (as is the case for South Australia) changes need to be made through regulation, which can take 18 months.

Discussion points

- It was acknowledged that the development of future projects need to define clear pathways to adoption, which will be underpinned by manager/industry leadership and/or 'champions'.
- In the future research adoption will require greater collaboration between stakeholders and an increase in expertise. This may be achieved with project teams having all stakeholders

actively involved in projects to ensure that there is 'buy in' and that RD&E outputs are 'fit for purpose', and thus more readily adopted.

- There is a great deal of relevant abalone focused research done both in Australia and overseas that can inform abalone management; the abalone sector tends to be somewhat insular in this regard.
- The ACA should be able to develop a balanced portfolio of research investments, balancing tactical and strategic priorities and seeking cooperation and coordination between states. This lead to a broader discussion on the ACA project prioritisation process (see below).

Prioritisation of projects

The process of project prioritisation to be followed by the ACA, now that an IPA has been established, was discussed. While a formal process has yet to be developed, it is anticipated that the agreed upon process will centre around the ACA Board receiving proposals and then providing an opportunity for managers and researchers in all jurisdictions to provide comment. This process will aid in confirming the broad relevance/need for the proposed work, which will be included in Board considerations and recommendation of funding to the FRDC Board/Managing Director.

The ACA welcomes projects that align with the strategic priority areas and acknowledges the need for proponents to have clarity of the project approval process. The ACA will provide guidelines on the submission and approval of projects under the IPA.

8. Weight of evidence, harvest strategies and data

Weight of evidence and Harvest Strategies

Following day one discussions, Cathy Dichmont was requested to provide additional guidance on two issues:

i) Best practice associated with the weight of evidence (WOE) approach

ii) Inclusion of environmental information in a Harvest Strategy

It was noted that this guidance was preliminary in nature and provided to assist understanding of workshop participants during Day 2 of the workshop

Weight of evidence (WOE) approach

The following steps were suggested:

- Define purpose of weight of evidence approach, which should exclude use of the WOE to subvert the HS into a political process.
- Define indicators to be used and what they reflect – e.g. CPUE as a relative index of abundance.
- Define each indicator's strengths and weakness and how it should be interpreted, codifying it in some way so as ensure a standardised decision making processes.
- Develop assessment criteria, showing how the approach will address and weight different indices and strains of information.
- Define what approach is taken if indices are contradictory.
- Document the rationale for conclusions.

Inclusion of environmental information in a Harvest Strategy

There are two approaches to including environmental information into harvest strategies, either by including it into the standardisation of the affected indicator or use as an indicator in the HS. These

approaches are contingent on there being a good understanding of the causative link between the environment and some aspect of the biology/catchability of the species.

It is helpful to be transparent around definitions of regime shift, how one would recognise it, and what is done about it. However, a common situation is one where a continual productivity shift occurs, which is more difficult to handle using empirical models, which are not well parameterised to account for environmental impacts/factors. In model-based HS, the assessment can be run with recent recruitments.

Collection, analysis and use of data

The workshop noted that there was a wide disparity between the types of data, coverage and time series across Australian abalone jurisdictions. Craig Mundy provided an assessment of the range of data that might represent 'best practice' and presented the following:

Fishery Dependent Data

1. Logbook data for longevity (and as a backup)
2. GPS and depth data loggers (mandatory use)
3. Commercial catch length frequency – including:
    - Volume of data – sample from majority of catches sufficient
    - Spatial precision of data – e.g. block/reefcode/mapcode is sufficient

Fishery Independent Data

1. Recruit density and length frequency (abalone recruitment modules/collection plates will have a role here)
2. Emergent density and length frequency (collected via transect surveys)
3. Target key fishing grounds and a selection of marginal areas within high importance spatial assessment units.

Discussion points

- Some states are using VMS, which sends real time position information instead of GPS data contained in loggers and reported on download/transmission. It was noted that the former provides greater scope for compliance aspects and enables spatial management measures that might otherwise be unacceptable on the grounds of compliance. There was agreement that VMS is the preferred platform for the collection/report of positional data given this dual purpose
- The issue of additional data that could improve assessments was raised, e.g. environmental data sets that are measured in situ.

9. Future Projects

A number of projects were discussed during the workshop. These projects were:

9.1 Diver observation

Two approaches to formalising diver observation into management processes, including TAC setting, are under consideration:

i) A proposal from SA: *Incorporating industry based observations and information into the Abalone quota setting framework – 2018-130* for which a full FRDC application has been completed and had initial consideration by the ACA Board of Directors

ii) A proposal from Victoria: *Abalone diver observation collection, analysis and reporting system for improved management decision making – 2019-038* for which an EOI has been submitted to the FRDC and ACA Board of Directors

South Australian Proposal: Abalone fishers in SA have been using simple diver observation sheets, which have been fed into the quota setting framework on an informal basis. This project seeks to work closely with managers, industry and researchers, including a social scientist to establish, test, validate and refine a survey technology based on 'deckhand' software. Options for the inclusion of information from the survey in the abalone harvest strategy will be explored. The outcomes of the project aim to provide support to robust and defendable management decision making, reduce the risk of overfishing, empower industry divers to have stewardship of the fishery and provide a methodology that can be extended to other states.

Victorian Proposal: The proposal has been developed by industry (AIC) in consultation with VFA. The system will use a mobile device application whereby divers complete a simple survey. A set of standardised reports as well as the data file is provided to authorised persons. A trial of the system has been effectively run and used to inform discussions at stock assessment meetings. This project aims to develop a final I.T. solution that has the best fit across jurisdictions and achieve integration with existing platforms and data sources, where it makes sense to do so.

Discussion points

- These projects will assist in summarising and presenting diver data for more formal use by industry forums.
- While there was little concern about the differing technologies under the proposal, there is a need to considered commonality in the data being collected and deciding which indicators are of most value.
- To ensure diver observation is robust, verifiable and weighted (with other assessment information) such that it does not undermine the TAC setting process.
- It was not clear to some present how the data stream from these sorts of projects will be incorporated in HSs, and in particular, what the appetite is among managers to adopt the proposed approaches. Intellectual property, cost and confidentiality are other issues that will require resolution. This would need to be appropriately addressed during a project on this subject.
- There are different data needs among jurisdictions, largely due to jurisdictions being at different ends of the continuum on the use, collection and adoption of electronic and other data streams. There was discussion about bringing all sectors up to the same level in terms of data collection and use.
- Diver observation can assist in predictive capacity as it has the potential to inform researchers and managers on 'what is happening under the water', including with sub-adult stocks. However, it was acknowledged that this information needs to be used in combination with other data streams to ensure that robust decisions are made (e.g. using weight of evidence approaches).
- There was consensus agreement that the comprehensive adoption and use of digital (logger) data should be considered as 'standard' for effective abalone management.
- Issues remain with validating data streams from diver observation – one method maybe to use FIS at fixed 'indicator sites' over time.

In summary, there was widespread support for a project on formalising diver observation input into fisheries assessments, noting that South Australia had expressed a view that the objectives of such work should be used formally in the HS framework. Conversely, Victoria would see the information being used as a secondary/tertiary indicator. ACA to coordinate the submission of a project or projects in this area.

9.2 Management Strategy Evaluation (MSE) of harvest strategies

The workshop noted that there had been considerable discussion about the current range of harvest strategies and their various merits. Noting also the advice (from earlier presentations & discussions) that HSs should be tested before implementation. There was agreement to task Cathy Dichmont to provide a brief overview of the benefits of a project that would develop an MSE 'test bed' that could be used to test existing and potential harvest strategies.

In a brief presentation, the following outcomes that could be achieved from such a project were suggested:

- Optimise existing published HSs in a robust test framework (ability to maintain sustainability, time to rebuild stocks etc.)
- Contrast HS performance under a range of stock types (low, medium, high productivity)
- Provide guidance on what constitutes a best practice abalone HS
- Fast track HS development for states reviewing or without a HS
- Compare strategies to address conflicting indicators (weighting vs. sequential contrast)
- Provide advice on how best to include additional indicators such as environmental and/or GPS/logger based information

Discussion points

- HS evaluation is particularly pertinent given the broad application of empirical (rather than model) based HSs in Australia

The workshop suggested that an EOI be sought to develop an MSE 'test bed'

9.3 Coherence of indicators and proxies for density and biomass of exploitable abalone

Various indicators and proxies have been used from logbook, GPS loggers and FIS data to inform fisheries assessments and TAC setting. The workshop agreed that it wold be helpful to examine how well current indictors correlate with the status of stocks. Keith Sainsbury was asked to develop a framework for a project that would consider the degree to which different indicators and proxies are giving the same signals, what are the similarities and differences, including trends, point estimates and precision.

A brief presentation and outline of a project was provided. The project would focus on situations where all three kinds of data are available, noting that several jurisdictions have such situations for Greenlip and Blacklip.

Under the proposed project methods, indicator calculation that has been used across jurisdictions would be defined and replicated, with consideration given to:

- Project to span logbook, logger and FIS data
- Different calculation methods for the same kind of data give different indicators to compare
- Different kinds of FIS methodology give different indicators to compare
- Comparison of statistical coherence for a range of space scales
- Use of established statistical methods (e.g. from signal processing, time series, correlation analysis)
- Providing guidance on the calculation and interpretation of the different indicators and proxies

Replication of calculations done by the scientists in each jurisdiction who are familiar with the data sets and their current analysis would be completed and statistically tested by an independent scientist using an agreed methodology.

The workshop suggested that an EOI be sought that would use independent statistical testing to consider the degree to which different indicators and proxies used in fisheries assessments are giving the same signals on the status of available stocks

9.4 Best practice and policy on stock enhancement (including governance)

The workshop noted that here was considerable and continuing interest in stock enhancement where stocks were so depleted as to render recovery without intervention impossible.

The workshop suggested that an EOI be sought that would define best practice and policy in stock translocation (including governance)

9.5 Best practice in stock recovery

Western Australian industry representatives stated an intention to put forward a project that would see how the recovery strategy employed in the WZ (Vic) could be applied in the Augusta Fishery in WA; noting that such a project would be of value to other jurisdictions where severe depletion of abalone stocks had occurred.

9.6 Fishery Independent Survey (FIS) methodology

Victoria (CZ), noting the apparent variation in FIS methodology, including survey techniques and use of data in assessments, requested that consideration be given to a short study to review current practice and make recommendations on how best FISs could be standardised and used cost-effectively going forward.

Discussion points

- It was noted, that the WZ (SA) was currently undertaking a cost-benefit analysis of a range of FIS scenarios as part of FRDC project 2016-213 'Building economics into fisheries management decision making – to utilise a suite of SA case studies'.

10. Other issues

10.1 Capacity in the abalone sector

The workshop noted that there was a limited number of young people among the participants and there was a general view that it is important to encourage young fishers, managers and researchers to increase their capacity and leadership capabilities within the abalone fisheries. There are a number of ways this can be addressed, including by:

- Using the recently approved diver exchange programme (FRDC project 2018-109 'National Abalone Diver Exchange Program').
- Synthesising and adapting existing training material that inform fisheries management and use this to build capacity – e.g. Fishwell Consulting educational video series.
- Encouraging younger industry members to be engaged/involved with abalone management and research.

10.2 Future collaboration between managers, industry and researchers

It was agreed, that there was a requirement for ACA to host annual RD&E workshops to provide a forum for researchers and managers to meet. The ACA made a commitment to ensuring that such similar activities were facilitated in future. There is a similar need for managers and researchers to meet more often.

The ACA to host annual RD&E workshops to provide a forum for industry, researchers and managers to meet

10.3 Project application process

Researchers were unclear how research applications would be handled under the new Abalone IPA.

The ACA will provide guidelines on the submission and approval of projects under the IPA

11. General Comments/observations

On the topic of the human costs of abalone fishing/management

- There is a substantial human cost associated with fishing for and managing abalone fisheries. For example, divers face an increasing risk of shark attack (which may be offset by a real time shark warnings project from CSIRO). There are ongoing severe economic impacts on divers and quota holders from reduced TACs.
- In Tasmania, the problem of too many licenced divers seeking to earn an income from a drastically reduced TAC has created high levels of effort that exacerbate local depletions. Refer to the Tas Abalone Fishery case study in FRDC project 2017-159 'Retrospective assessment of ITQs to inform research needs and to improve their future design and performance'.

On the topic of exploring/adopting improved fishing targets/indicators

- There is the potential to build economic outcomes into an MSE and there is interest in doing so from industry. While some jurisdictions are tied to the MSY concept, MEY may be a more appropriate target. Noted that there is already a project that has been completed under the Seafood CRC (Klaas Hartmann, FRDC project 2009-714.30 'Economic management guidance for Australian abalone fisheries').
- Building on the successful outcomes of work on Greenlip in SA (and Tasmania), SARDI is continuing to look at the effects/benefits of fishing at different times of the year. Refer to FRDC project 2015-017 'Maximise yield or minimise risk in the Blacklip Abalone fishery: using biological data to direct harvest strategies'.
- Overall, there needs to be a more conservative approach to abalone management. However, it is unclear what being more conservative look like – in part this will require industry to work with their managers as opposed to clashing with them on TACs etc.
- There has been an inability in some cases to match catch to spatial area productivity and stick within agreed catch limits.
- There is a need for the inclusion of leading indicators; it has been repeatedly shown that current assessment and management processes have not been able to pick up the changes in abundance and react effectively in a timely fashion.
- Climate and other environmental change will impact abalone populations, including by changing the biological parameters of abalone, many of which are now some 30 years old; this has the potential to undermine current fisheries assessments. While there are instances where abalone exist in relatively high water temperatures (e.g. Northern NSW), it is likely that rapid temperature change is the primary cause of mortality events (i.e. marine 'heat waves').

On the topic of improving scientific input into the management process

- There may be some merit in the concept of an independent science panel to assist in deflating the angst in the decision making process. The consultative SAFS process among researchers has demonstrated value in such an approach.

- Having a single scientist in a stock assessment/TAC committee situation creates substantial pressure on that individual, especially in the face of stock declines. There may be value in having both an independent scientist and a conservationist present.

10 Summary of actions

Action	Responsibility
Research projects	
Formalising diver observation input into fisheries assessments	ACA to coordinate with WZ(SA) and EZ(Vic)
Management Strategy Evaluation (MSE) of harvest strategies	ACA to commission EOI
Coherence of indicators and proxies for density and biomass of exploitable abalone	ACA to commission EOI
Best practice and policy in stock enhancement (including governance)	ACA to commission EOI
Best practice in stock recovery	WA to submit EOI to ACA
Fishery Independent Survey (FIS) methodology	ACA to commission EOI
Other actions	
Explanation of differences between empirical Harvest Strategies and stock assessment informed Harvest Strategy (building on Cathy Dichmont presentation)	ACA
Ensure all relevant past and current projects and their outputs are available on the ACA website or similar media	FRDC/ACA
Define the decision-making (governance) process associated with the Abalone IPA including how RD&E priorities will be established, calls for research projects made, projects assessed etc.	ACA
Convene a regular – at least annual – meeting that includes industry, managers and researchers with the focus on information exchange and improving abalone research and management outcomes	ACA
Consideration of the establishment of a cross-jurisdictional technical reference group for abalone assessment	ACA/FRDC
Synthesise all the training material that informs fisheries management to support capacity building for managers and industry, including “master” classes on concepts and processes	FRDC
Identify past abalone research outputs (e.g. ABASIM, pre-recruit methods, data loggers) that have not been adopted and reasons for this	FRDC/ACA/ Researchers/ managers

Promote the Australasian Abalone Conference at Grand Chancellor 29-31 July 2019, and use opportunity to improve information sharing and adoption	All/ACA
HR resource for 1 day a week for next 3 months to assist with establishment of abalone IPA	FRDC to identify
ACA to meet with AFMF abalone directors	FRDC/ACA

11. Conclusions

Patrick Hone (FRDC) used the opportunity to summarise FRDC's views on workshop outcomes and future directions for RD&E for the abalone sector. These included:

What we know now:

- Abalone fisheries are extremely vulnerable to fishing and environmental change and ongoing declines (as shown by SAFS Reports) illustrate this.
- Abalone fisheries have the potential to have hyper-stable catches making CPUE a problematic indicator.
- There is a tension between larger management scales and smaller population dynamics.
- Only WA Roe's abalone has included climate change/environmental factors in their stock assessment/HS.
- Management decisions have been too slow to address the rate of change.
- There is probably a new regime shift in some fisheries whereby the habitat can no longer can support past levels of historical catch.
- There is no agreed national abalone management approach. Currently, there are >5 different approaches to assessing and managing what is essentially the same species.
- Stock sustainability is the priority with biomass as king; thus it is important to acknowledge/remember that TACs are not 'set and forget' and must be reviewed/varied to respond in a timely manner to changes in the fishery.
- Co-management should not result in the government not taking ultimate responsibility for the status of the stock.
- Industry has no agreed policy framework across abalone fisheries – e.g. HS, Economic, Social, Access, Digital (data ownership).

What we need to do:

- Create transparent fine scale spatial data, including catch, length frequency and in the future, pre-recruit indices.
- Collect more timely fisher-dependent data based on digital methods, to be provided daily.
- Create habitat maps – with productivity/yield overlay.
- Develop and test indicators that are predictive.
- Complete more timely assessments – based on recent data (monthly) – like a monthly financial statement.
- Undertake annual stock assessments based on last 12 months of data.

- Set TACs at spatially relevant scales.
- Provide fine scale tools to fishers to distribute effort/catch – daily published "heat" maps of prior fishing.

What FRDC would like:

- Acknowledgment that:
  - incremental improvements in doing things better will not work;
  - we need to do things differently.
- Agreement to a national approach – "it's the same abalone":
  - 5 Directors of fisheries agreement to a national approach;
  - 5 State – ACA agreement to a national approach;
  - One harvest strategy structure/template;
  - A national abalone digital strategy and data standards;
  - Compulsory diver GPS catch data and sizes;
  - Standardised stock assessments;
  - A national approach to FIS – for pre-recruits;
  - A national cloud-based database.

Dean Lisson concluded the workshop by thanking speakers and participants, acknowledging the value of having researchers, management and industry working together to improve the links between research and management action/outcomes.

He flagged the Australasian Abalone Convention in July, in Hobart, with a draft program to come out soon and encouraged attendance and support.

Ian Cartwright closed the workshop, thanking all attendees for their participation over the two days, with particular thanks to the presenters for their contributions.

AGENDA

Abalone assessment and management; what have we learned, what are the gaps and where can we do better

Venue: Oaks on Collins, 480 Collins Street, Melbourne

7-8 March 2019

Day 1

Presentation/session	**Presenter**
Introductory remarks and housekeeping	Chair
Stakeholders in the supply chain	Kaz Bartaska
1. Status of Australian abalone stocks	**Steve Mayfield**
Q and A session, including discussion of SAFS classifications	Participants
Rebuilding severely depleted abalone stocks (excluding stock enhancement)	Craig Fox
Q and A session	Participants
2. Review of data collection and analysis	**Craig Mundy**
Q and A session	Participants
3. Review of Harvest Strategies:	**Cathy Dichmont**
Q and A session	Participants
4. Stock enhancement	**Lachlan Strain**
Q and A session	Participants

Day 2

5. Dealing with *Centrostephanus*	**Dean Lisson**
Q and A session, including experiences from other states	Participants
6. Past, present and future research	
i) Past research investment and uptake	Chris Izzo
Q and A session, including extension and communication strategies	Participants
ii) Current research underway or just completed (FRDC/states	Chris Izzo, with state researcher contribution
Q and A session	Participants
iii) Future Research priorities including current applications	Chris Izzo, research

• Formalising diver observation and use in fisheries assessment (2 applications – SA and Vic). Short presentations by John Minehan and Jonas Woolford • *Perkinsus* (1 application – SA) • AVG detection (1 application) • Contribution and valuation of the abalone industry (1 application ACA) • Other non-FRDC research activities	proponents and participants
Identification of research gaps and process for ACA consideration of research proposals and their outputs/outcomes	Participants
Identification of research gaps and process for ACA consideration of research proposals and their outputs/outcomes (contd.)	Participants
Concluding remarks	Dean Lisson, Patrick Hone, Ian Cartwright

LIST OF PARTICIPANTS

Ian Cartwright	thalassa@bigpond.com
Chris Izzo	Christopher.izzo@frdc.com.au
Patrick Hone	Patrick.hone@frdc.com.au
Jonas Woolford	pres@abalonesa.com.au
Belinda McGrath-Steer	Belinda.mcgrath-steer@sa.gov.au
Joey McKibben	joeywmck@hotmail.com
Dean Lisson	deanlisson@tassie.net.au
John Minehan	John.minehan@gmail.com
Craig Fox	kkfox2@bigpond.com
Harry Peeters	wada@pipeline.com.au
Geoff Ellis	Geoffellis01@gmail.com
Allan Buck	Abuck6@bigpond.com
Bruce Mapstone	Bruce-mapstone@netspace.net.au
Dallas D'Silva	Dallas.dsilva@vfa.vic.gov.au
Tony Smith	smithadm@gmail.com
Lachlan Strain	Lachlan.strain@dpird.wa.gov.au
Rhiannon Jones	Rhiannon.jones@dpird.wa.gov.au
Malcolm Haddon	Malcolm.haddon@gmail.com
Craig Mundy	Craig.mundy@utas.edu.au
Jaime McAllister	Jaime.mcallister@utas.edu.au
Ben Stobart	Ben.stobart@sa.gov.au
Keith Sainsbury	ksainsbury@outlook.com
Cathy Dichmont	cathydichmont@gmail.com
Darvin Hansen	darvinh@tasmanianseafoods.com.au
Mark Webster	mark@seasult.com.au
Amelia Grant	Amelia.grant@vfa.vic.gov.au
Fiona McKinnon	Fiona.mckinnon@dpi.nsw.gov.au
Rowan Chick	Rowan.chick@dpi.nsw.gov.au
John Smythe	Abalone1@bigpond.com
Kaz Bartaska	kaz@kansom.com
Justin Bell	Justin.bell@vfa.vic.gov.au
Nathan Adams	Ntadams24@hotmail.com

Kerry Rowe	krowe@westnet.com.au
Matt Bradshaw	Matt.Bradshaw@dpipwe.tas.gov.au
Melinda Caspersz	Melinda.caspersz@abalonecouncil.com.au