Marine Biodiversity Hub

National Environmental Science Programme

Workshop report from the National BRUV Forum – Perth, 18-19 July 2017

Hosted by the NESP Marine Biodiversity Hub and Fisheries Western Australia

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Project D3 – Preparing for and implementing monitoring of CMRs and the status of marine biodiversity assets on the continental shelf

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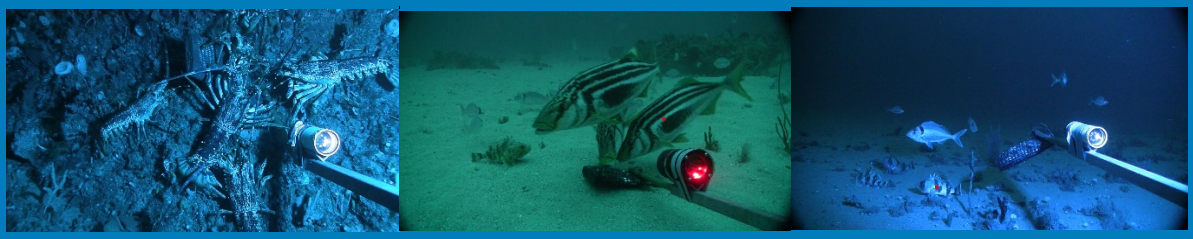
Milestone 4 - Research Plan v3, 2017



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Important Disclaimer

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EXECUTIVE SUMMARY

A two-day forum was held in Perth in July 2017 to establish a national working group to progress cooperation and collaboration between agencies and universities involved in BRUV-based research and monitoring programs. Such cooperation and collaboration is essential to ensure acquired data is suitable for national objectives, such as SOE reporting and monitoring of Australian Marine Parks. It is also essential for the establishment of shared data infrastructure, such as “Global Archive”, and adoption of standard operating protocols as widely as possible, allowing fullest integration of data and monitoring programs between State and Commonwealth agencies.

The forum reviewed current programs around Australia to familiarise participants with the widely varying adoption nationally, as well as the range of protocols currently in use. It identified major gaps in spatial coverage that needed filling as a high priority, including the Great Australian Bight, the Coral Sea, and northern waters from Darwin to the Gulf of Carpentaria. When reviewing protocols, it found that most agencies are adopting broadly similar protocols, and that some differences, such as bait types, are often unavoidable (but may not overly bias results). Some of the major differences related to the use of mono vs stereo, and use of subsets of species for length and/or abundance estimates.

Possible reporting metrics for State of the Environment (SOE) and similar programs were discussed, and it was agreed that many of the metrics recently developed/reviewed for UVC surveys by the NESP Marine Biodiversity Hub were also highly applicable to BRUV data. However, as many of these metrics involve biomass estimation, and estimates across the full set of species present, it was realised that many of the current programs do not have sufficient data across these measures to allow indicator metrics to be readily developed at national scales without revisiting the acquired video (and size is not possible from mono video, prohibiting biomass estimation).

A review of the extent of temporal datasets that may be of use for SOE reporting indicated that many jurisdictions were in an early stage of development, with few programs having data series in excess of three years. The notable exception being NSW MPAs, with a 7-year time series. Hence, BRUV programs are as yet a few years away from making a significant contribution to SOE assessment at national scales, but are likely to do so in the future, particularly as MPA networks and associated monitoring programs (State and Commonwealth) provide the spatial and management frameworks necessary to underpin sound SOE assessments.

1. ATTENDEES

Mike Travers	Fisheries, WA
Tom Holmes	WA Marine Science Program, Department of Biodiversity, Conservation and Attractions
Hamish Malcolm	NSW Department of Primary Industries
Dimitri Colella	SA Department for Environment and Water
Ariel Freidman	Grey Bits
Phil Bouchet	University of Western Australia
Markus Stower	Australian Institute of Marine Science
Leanne Currey	Australian Institute of Marine Science
Tim Langlois	University of Western Australia
Shane Penny	NT Department of Primary Industries and Resources
Neville Barrett	Institute for Marine and Antarctic Studies, University of Tasmania
Jacquomo Monk	Institute for Marine and Antarctic Studies, University of Tasmania
Euan Harvey	Curtin University
Mark Meekan	Australian Institute of Marine Science
Rachel Przeslawski	Geosciences Australia
Danny Brock	SA Department for Environment and Water
Charlie Huveneers	Flinders University, South Australia
Sasha Whitmarsh	Flinders University, South Australia
Daniel Ierodiaconou	Deakin University, Victoria - via Skype

2. CORE AGENDA

(1) An overview of the current major BRUV programs around Australia

(2) An indication of current gaps in spatial/temporal coverage and opportunities for improvement, including the new CMR network for offshore environments

(3) Evaluation of, and agreement on, core standard operating protocols to maximise the ability to share data for wider analysis, as well as innovative approaches and opportunities for additional analysis

(4) Development of a national facility to store/share BRUV video, scored data, and potentially further annotate data (e.g. Global archive). Current developments, ways forward and support such a national facility

(5) Approaches to using a national database to report into SOE and similar processes at regional to national scales using agreed reporting metrics. Are there sets of generic indicators, or is it more complicated than that?

(6) Scoping of a paper on the utility of a national BRUV-based program for quantitative reporting into SOE based on agreed metrics.

(7) Establishing a formal working group to represent the BRUV community in the national science space now that it has become a “mature” tool, including election of a Chairperson to coordinate the group in its initial few years.

3. INTRODUCTION/BACKGROUND

This workshop was initiated to establish a national working group to facilitate coordinated benthic BRUV-based inventory and monitoring studies. The overall aim is to form a group for ongoing cooperation and collaboration to ensure that BRUV-based research and monitoring programs are as well integrated across the State/Commonwealth/university space as possible, are integrated into other environmental monitoring (biological and physical) as well as delivering into adaptive management at regional to national scales. A central aim is addressing a key objective of the National Marine Science Plan by establishing a BRUV-based component of a nationally integrated ecosystem monitoring program through ensuring that agencies are working collaboratively to ensure individual programs are best positioned to integrate at broader, national scales. While BRUV-based monitoring is now a “mature” method, and there is progress towards adopting agreed standard operating protocols as widely as possible, there is still a range of issues to resolve with respect to fine-tuning protocols to suit regional needs and operating conditions, while allowing greatest opportunity to develop comparable datasets at the national scale. To be able to contribute to processes such as national SOE reporting, it is vital that monitoring datasets be as comparable as possible. Establishing a national forum will allow the necessary discussions to be held, and learnings shared across agencies. To facilitate sharing, tools such as Global Archive need to be developed/refined/supported and adopted, and a national forum is an ideal platform for raising awareness and uptake. Finally, to obtain support for BRUV programs on the national stage, including representing need for support for data infrastructure, establishing a national working group would play an important role in focussing representation via an elected Chair.

A core component of the Marine Biodiversity Hub’s role in facilitating this initial forum is also in ensuring the mechanisms are in place to adopt BRUV-based monitoring in the new AMP network, ranging from data infrastructure (e.g. Global Archive), standard operating protocols (with AMP-specific protocols being discussed by a related group, but ideally based on State-based approaches), integration with State-based programs, through to development of regional capability to support future AMP monitoring. Ideally the forum will be a significant opportunity to exchange ideas along these lines, and will continue through subsequent years to enhance cooperation.

4. STATE BY STATE BACKGROUND AND SUMMARY OF CURRENT SITUATION

4.1 Western Australia

WA Fisheries use, Mike Travers: Have been using (stereo) BRUVs since 2005, e.g. in the Kimberley area, with a lot of Indigenous engagement, including traditional owners. Much of that research has been from the research vessel "Naturaliste" with smaller vessels in support. Other work facilitated through fisheries includes studies at the Ngari Capes in the SW, and similar work with the SW Catchment Council, studies in the NW, monitoring the NW trap fishery, limited monitoring work in the Walpole region (South Coast), and some ongoing work around the Abrolhos Islands. No work has specifically focussed on Commonwealth waters, however, surveys around the Abrolhos Islands, and Browse Island are in proximity.

A major issue in the NW has been strong tides and associated visibility issues, so it requires use of a lot of small systems to maximise data acquisition during the limited tidal windows. Much of the research is aligned with MPA management objectives and add-ins with traditional key species interests, e.g. Christmas Island.

WA: Conservation, Tom Holmes: Essentially fairly new in this space but has been utilising stereo BRUVS in a series of survey in the SW Capes MPA for baselines, with occasional engagement elsewhere. One key consideration going forward at the workshop is to inform the Standard Operating Protocol (SOP) space for Indigenous communities, as BRUVS in some form may well be a tool that may suit Indigenous engagement in marine monitoring programs.

Much of the conservation based research has been undertaken in collaboration with research partners (including FWA above). Typically, most of their fish work is shallow water based, utilising UVC approaches or diver-held stereo video. However, in many of the new MPA's, particularly in tropical areas, BRUVS are increasingly being used, including the Kimberley region, The Pilbara, and Montebello Islands, typically in research partnerships. They are planning more work in the Kimberley, and may involve significant engagement with Indigenous groups, requiring development of SOPs that suit the interests of these groups.

Tim Langlois: Marine Futures undertook an extensive stereo BRUV program in WA matched with co-located MBES surveys over a wide geographical range in WA, including off Rottnest Island, Perth, the SW Capes, Esperance, Albany, and where possible, with contrasts in/out of sanctuary zones of MPAs. Additional programs were funded by the Coastal CRC, as well as with NRM groups, such as the SW Capes MPA baseline undertaken by Mark Wepsta. This encompassed approximately 15,000 hours of deployment, excluding work undertaken in WA by AIMS projects. Some additional projects include monitoring at the Abrolhos Islands, private data (keen naturalist) in Shark Bay, Bush Heritage studies at Shark Bay, WAMSI funded projects (700+Hours in the Perth metro region, and 600+ hours at Ningaloo, including some coverage in Commonwealth waters.

There are many other studies by the Oil and Gas industry and associated consultants that are mostly completely unknown. Ideally the Commonwealth could/should make this data of national interest to make it widely available.

4.2 Western Australia/NT/Queensland (AIMS based research)

Leanne Currey: AIMS research has been using a mix of single and stereo BRUV systems across tropical Australia and internationally. This has had a broad range of applications, including monitoring the effects of closures in the GBR, and mapping patterns of biodiversity, with over 4,200 deployments in the GBR alone. A recent development has been the FinPrint project, led by Michelle Heupel, utilising light-weight BRUVS to specifically record the distribution of elasmobranchs in the Pacific region with philanthropic funding from Paul G. Allen. This has currently involved approximately 25,000 deployments in Australia, Micronesia and throughout the Pacific region, but they are only recording elasmobranch species in the current analysis (due to the size and focus of the project). There are a few potential issues to explore here, with the logistics of using standard baits being impossible (i.e. pilchards are not available everywhere or able to be kept/shipped to remote and hot locations). This is something to consider with SOP development, as at times, it will be impossible to standardise around pilchards.

In western WA, AIMS research has focussed on projects for the oil and gas industries and their environmental effects/baselines. Much of this work is commercial in-confidence, although data may eventually be released after withholding times have lapsed. Much of this work involves repeat sampling through time as part of monitoring programs. In many cases the sampling is co-located with other data, including MBES, water quality, and other biological datasets. AIMS has pursued a regional coverage approach to expand knowledge throughout the region. Despite evolution of gear types, they have tried to keep the designs consistent, with some variation due to specific needs, such as the lightweight frames used by FinPrint.

4.3 New South Wales

Hamish Malcolm: NSW has undertaken a State-wide program of BRUV deployments since 2001, but the main focus has been from 2010 onwards, with a MPA-focus. These include Cape Byron, Solitary Islands, Port Stephens, Jervis Bay, Batemans Bay and Lord Howe Island. While this major program was setup with an MPA focus, it is now heading towards broader SOE reporting using the MPAs as a contrast with adjacent fished areas. Generally, the sampling is on reef, at depths between 25-50 m and compliments UVC-based monitoring at a number of the marine parks in shallower water (5-1-0 m). Typically, deployments are in winter, with 30 minute set times (determined by trials of a range of times) and with minimum separation of 200 m. The typical deployment design is 2-5 locations in each MPA, 2 sites per location, 4 drops per site. Much of the scored data is now in Global Archive, with some historical data missing, but it does include habitat data. Initial surveys were not stereo, and stereo has been undertaken only since 2011. Typically, the stereo is only used for size estimation on the focus

species. Currently there is new work being undertaken on sediment habitats, and an increasing focus on supporting research in AMPs. To date, the AMP work has included work in the Solitary Islands (e.g. Pimpernel Rock), and the Cod Grounds.

4.4 Victoria

Daniel Ierodiaconou: Currently there have been over 1000 BRUV deployments in Victoria, mostly using protocols developed by Euan Harvey (i.e. stereo, one hour deployments, pilchard baits), typically with most of the data now on Global Archive. Much of the focus has been on MPAs, within a range of student (PhD and Hons) projects. There is currently a project to also collate historical data from embayment studies, including research on seagrass, much of which is single video (from researchers including Greg Jenkins and Steve Swearer). It now appears that BRUV-based approaches may be incorporated into the MPA monitoring program administered by Parks Victoria, to extend the sampled depth range beyond the shallow reef systems historically sampled by UVC methods. New surveys may include locations like Point Addis, Port Phillip Bay (and heads), Bunnerong. Currently, MPA sampling in this new program has incorporated six parks, but with external reference sampling only at four of these. More are planned for 2017/18 with sampling strategies underpinned by MBES or bathymetric LIDAR to stratify sampling by depth, habitat and complexity. All locations are classified by habitat, and all have existing mapping data. Habitat classification from BRUV imagery is being undertaken via specific software and protocols developed by Tim Langlois and Jim Seager. Initial MPA sampling at the Point Addis MPA has recently been analysed by Jan Carey in a power analysis to determine the extent of replication needed to detect management trigger-level changes (as determined by control charts) and that will inform future sampling in that region and in general.

There is a program of undertaking spatially explicit sampling to better understand the fish assemblages of differing habitats, and that has included towed video (TV) to describe habitats and obtain area estimates of habitat patches (and how this area may influence BRUV-based observations), essentially providing complementarity by using both BRUV and TV methods.

In the future there are plans to fill in the gaps in current MPA coverage, and to integrate BRUV survey data with TV, UVC and mapping datasets, as well as evaluating the use of EDNA for understanding species diversity patterns.

4.5 South Australia

Danny Brock (DEWNR): There are 19 MPAs in SA, but very little budget for surveys, so a relatively limited survey program at this stage with BRUVS. Generally are attempting to focus on sanctuary zones (no-take areas) with a range of tools, including BRUVs, UVC, and habitat mapping for initial inventory and baselines. This has a focus on biodiversity patterns as well as focal groups and focal species. BRUV surveys (stereo), with standard SeaGIS frames, have been undertaken since 2009 on reefs at 10-20 m depth, in ten sanctuary zones, 60 sites, with 240 drops per year on average. Partnerships with university researchers also have been used to extend these studies (see next section). Some surveys have been nearby to AMPs so may

provide some background information on regional patterns. Currently there is a significant focus on the Encounter Bay MPa due to ease of access and likely higher pressures.

Current challenges involve video-processing, and ideally could be addressed via automation and citizen science in the future (a research priority). Need to develop suitable metrics and analytical techniques for change detection, as well as approaches for data management.

Sasha Whitmarsh (SA, Flinders Uni): Flinders University research has undertaken around 700 BRUV drops around the Gulf of St Vincent, primarily evaluating anthropogenic pressures and method development. Method development includes evaluation of multiple camera systems on BRUVS (e.g. forward and rear facing) to improve data density, as well as broader literature reviews to suggest how papers could be improved to allow for comparisons to be more easily made in the future.

4.6 Northern Territory

Shane Penny: The NT has a fairly restricted BRUV program that is primarily looking at trends in some key species, including golden snapper and jewfish. There are a range of protection zones for these species and monitoring programs focus on these. Portable frames are used for ease of transport and for working with indigenous marine rangers. Sampling is usually via monthly programs, sampling remote locations several times per year, and is strongly determined around tides. Key challenges are remoteness, tidal currents, turbidity, and bait issues. Typically, pilchard baits are lost very quickly (particularly to some sharks), requiring use of alternative baits (e.g. Squid) or a mix. Typically, a program involves around 12 drops per day in depths of 6-16 m.

4.7 Tasmania

Overall, BRUV deployments are relatively restricted in Tasmania, and have involved a range of studies from method evaluation and development (including habitat associations and BRUV vs TV vs AUV derived abundance and diversity data), AMP baseline surveys, MPA effectiveness evaluation, and broader biodiversity evaluation. BRUV programs were initiated by the CERF Marine Biodiversity Hub in SE Tasmania to evaluate the effectiveness of this approach to describing deep shelf reef fish assemblages and as a potential approach for AMP inventory and monitoring. This was expanded by the NESP Hub to assess spatially balanced survey designs for AMP inventory and monitoring in the Flinders AMP, and the Tasman Fracture AMP, and complimented by an Honours project to evaluate long-term protection responses in the Governor Island MPA in eastern Tasmania. Subsequently an FRDC study has focussed on evaluating the BRUV approach to informing knowledge on the biology of a range of commercial reef species on deep shelf reefs in eastern Tasmania. The total number of surveys is approximately 450 across all projects.

All surveys have been undertaken using standard SeaGIS stereo frames, using pilchard bait, one-hour soak times and a minimum separation of 200 m between drops. Length estimates have mostly been restricted to commercially targeted species, or bycatch species, with

abundance estimates based on MaxN, and other parameters such as time of first arrival also scored. All video scoring was completed using the SeaGIS software “EventMeasure” and has been uploaded into GlobalArchive. Habitat data for each drop is currently being scored and also added to Global Archive in this template to format text.

5. SPATIAL GAPS IN DATA COVERAGE

Discussion of major spatial gaps in coverage identified three broad regions as the most significant gaps to fill to inform patterns of biogeography.

There were: (1) Great Australian Bight, from the Nuyts Archipelago in SA, through to approximately 200 km, east of Esperance. This gap also aligns with a similar spatial gap in UVC coverage of the Australian coastline; (2) Wessel Islands in the NT through to the Gulf of Carpentaria. While there is a small amount of data from Groote Island and some shoals north of Darwin, the NT remains very under sampled, with a big data gap in general in the Gulf region; (3) Coral Sea. There is no known BRUV coverage in the Coral Sea at all.

Filling these spatial gaps should be a significant consideration for State and Commonwealth management agencies when planning science programs on a regional basis.

The other major gap is in deeper shelf waters where BRUVS are still an effective monitoring tool. With the exception of WA, there are few BRUV deployments at depths beyond 30 m (notable exceptions include some deep reef and AMP focussed work in Tasmania, and similar AMP focussed research in NSW in the Hunter AMP). The new AMP network may be a significant opportunity to address this gap given that where they are present on the shelf at all, most are in deeper cross shelf environments.

6. STANDARD OPERATING PROTOCOLS

Discussion on SOPs was not intended to come up with an agreed overall SOP, as this was being pursued separately by a working group facilitated by the Marine Biodiversity Hub in a project to develop an agreed SOP for AMP monitoring, and one that was ideally closely aligned with protocols used by major State-based monitoring programs. The main focus of the discussion was around exploring some of the differing approaches being used, the reasons behind that, and the extent that differences may influence our ability to analyse pooled datasets.

Some key points of discussion were:

(1) Approaches to length data and estimates, just using estimates from MaxN frames may not be the best approach to gain a good population estimation and AIMS were examining alternatives. It was suggested that perhaps more thought was needed on what metrics were needed from the video data, before SOPs were prescriptive for the types of video analysis used.

(2) Influence of visibility on biomass estimation were raised. Some discussion suggested that using visibility on models could account for this, however, in some empirical analysis undertaken (Euan) it rarely had an influence.

(3) Taxonomic sufficiency. As some species, particularly tropical ones, are difficult to differentiate from video at times, there was a question of how to deal with this? Do some groups lump genera when scoring video? Typically at UWA they remove groups that aren't identified to species completely from analysis, rather than go up to the genera level. The overall consensus was to score as finely as possible (i.e. species level at all times unless impossible) and then lump in subsequent analysis if necessary for particular metrics.

(4) Collecting covariate data. Current meters, including temperature, current velocity and direction have worked well with AIMS studies, particularly at whole of reef scales, and used as covariates in models.

(5) Biases in field of view. A number of factors can influence the FOV, that subsequently may alter the quantity of fish sighted. For rocks, kelp, etc. in the path between camera and bait, or obscuring the background, the only solution to date has been to treat this as a covariate in models. With differing camera systems there can be differing FOVs, e.g. between GoPros and older vs newer Handicam's. This is typically able to be addressed in the EventMeasure software by setting a standard FOV to score within, rather than scoring the full width of the camera system in use if it has wider than usual FOV. However, it may not be particularly significant with regard to number of extra fish sighted (Euan) although would make a good Honours project to explore this in depth.

(6) Minimum distance between deployments. Currently most practitioners use a minimum separation of 200 m between drops to minimise potential interactions, based on work by

Euan and others. Is there any extra learning that may inform this? Work in NSW on Grey Nurse Sharks suggests very little interaction at the 200m scale, and that where there are habitat boundaries (such as reef to sand), a gap as large as 200 m generally wouldn't be needed for the majority of reef associated species if that was the focus).

(7) Repeat sampling biases. It was noticed by AIMS researchers that in repeat sampling, there can be learning by resident fishes and sharks that are essentially being trained to return to the baits, or follow the boat. So sampling designs may need to account for that if repeated sampling is sufficiently regular through time to influence behaviour.

(8) Bait. In many locations (e.g. during FinPrint studies) there is a need to utilise local fish with high oil content similar to pilchards as pilchards are not available often, or similar pilchards species (e.g. in Indonesia) were not as effective. There is a possibility of trialling chook or bait pellets with added tuna oil as an alternative standard approach, and it was suggested that the differing research groups undertake local trials of the effectiveness of this alternative with a view to national standards in the future.

In South Australia there have been some policy issues with the use of "berley" due to restrictions on the use of berley in populated areas (potential shark attraction), hence use of pilchards in those situations is more acceptable. The overall bait attraction issue is one also experienced in other areas, including Lizard Island (potential Tiger shark attraction) where additional permitting is required. Similar problems have been encountered in Torres Strait with Trepang divers.

(9) Bait bag presentation. Potential for different bait bags and poles in shark areas, e.g. aluminium vs plastic poles, and bait bags in contact with the seabed to minimise shark interaction. However, part of the fish attraction is presentation of the bait (Euan) so needs to be visible. Some work in NSW in GNS areas has found metal cans are still effective, at least for GNS. A possible issue with some metal bait bags though, is that they may be swallowed whole, which is an issue with many sharks as they have no regurgitation mechanism. Adequate presentation can also influence dispersion of the bait plume and hence attraction, so thought needs to be given to orientation wherever possible. Also related to orientation is the behaviour of species, as some sharks are oriented in the current, hence 360degree cameras can pick up more information if the standard camera is not looking downstream of the bait plume.

(10) Habitat scoring. There have been a range of approaches to habitat scoring from BRUV video, ranging from none, to detailed metrics, and there is a need to refine our approaches to this nationally. At AIMS there is a newish scheme implemented 3 years ago. Substrate is categorical with estimates as percentage cover within the FOV. For example, cobble 30%, coral 30%, sand 40%. In many locations they also have TV and MBES data, but in analysis to date, the best model fits are from the FOV habitat data rather than other sources. Relief is also scored into categories, and the overall scheme varies within broad habitat categories, e.g. the inshore soft sediment scheme is different from the coral reef scheme.

Currently a new approach has been developed by Tim Langlois ay UWA for use with Global Archive, providing a visual ranking of relief from 0-5, biotic components using the CATAMI classification scheme for differing habitat classes using broad level habitat types, e.g. macroalgae, then canopy vs understorey. Can be scored at around 150 drops per day.

7. NATIONAL FACILITY FOR STORING IMAGERY AND POST-ANALYSIS DATA

Ariell Friedman and Tim Langlois gave a detailed overview of the current state of development of Global Archive, an online software tool that allows all BRUV post-scored data to be added and stored. The development of the tool has reached an advanced stage and is ready to enable upload of most datasets. In many cases, extensive datasets have already been added to this in a testing framework and it is anticipated that the majority of holdings nationally will be able to be added by the end of 2017. It is able to upload typical files generated via EventMeasure software, as well as incorporating additional information such as habitat data, bait type, data limitations (e.g. stereo vs mono), differing bait types, and the key information fields around locations, dates, depths etc. Further development of this tool will be undertaken throughout 2017/18 with additional funding from IMOS/EMII/AODN. Key issues still to resolve include data-sharing agreements and IP, restricted access (i.e. can valuable datasets be added despite IP restrictions, and kept secure). However, a significant test of this will be use of this database to support a range of national level analyses of BRUV data in later 2017 and early 2018.

There was some discussion around the possibility of adding all existing raw vide data to a national facility for archiving, and this will be explored further with IMOS/AODN/EMII as Global Archive evolves, and potentially has the capability to link with original files.

8. STATE OF ENVIRONMENT REPORTING: USEFUL INDICATORS/METRICS?

Discussion of potential indicator metrics for national and state-level SOE reporting started by reviewing a recent analysis in this space utilising long-term a set of major UVC-based monitoring programs. Stuart-Smith, RD, Edgar, GJ, Barrett, NS, et al. (2017). Assessing national biodiversity trends for rocky and coral reefs through the integration of citizen science and scientific monitoring programs", Bioscience, 67 (2) pp. 134-146. This analysis is also to be published as a more detailed technical report through the Marine Biodiversity Hub in 2017. The study explored a wide range of metrics applicable to BRUV analysis as well, with a set of recommendations around the most effective analyses, including B20, the biomass of fish greater than 20 cm as a metric for effects of fishing pressure, and trait-based approaches, such as community thermal affinity, to detect patterns associated with warming, or ecosystem shifts. It was agreed that the core metrics recommended in that paper should be explored as a starting point. However, as these metrics generally do require length data for each species, as well as abundance estimates for all species sighted, it may presently restrict the datasets available for use, as many do not record the full species diversity (e.g. FinPrint studies only record elasmobranchs) and many do not record lengths of all species sighted, rather they measure lengths on a limited set of targeted or indicator species. While this cannot readily be addressed at this stage (other than revisiting past footage if there are funding opportunities, and it is in stereo), there are alternative metrics that can be explored.

Some aspects that need further examination that are specific to BRUV deployments are things like behaviour towards BRUVS, and how individual species may be characterised and adjusted for. This is an area requiring more thought and research.

Time of arrival needs exploring further, as does time of MaxN, as both may be related to overall abundance. Likewise, time of first feeding may be important, particularly as this can be critical in attracting other species through behavioural interactions. An issue here though may be that it could be temperature related, with warmer temperatures leading to advanced timing.

If metrics are to be based on a set of target species, or vulnerable species, or trophic group, a working group may be necessary to review lists of potential species to ensure consistency at national levels. For species such as targeted species, the choice could be informed by examination of regional catch records (State and Commonwealth), in addition to BRUV records.

Dispersal traits may also be worth examining in an analysis, to examine potential local scale attraction to BRUVs, but also vulnerability to pressures through time.

It was generally agreed that the majority of correlative metrics used in the UVC paper were highly relevant to SOE-style analysis of BRUV data, including spatial distribution of population pressure, sea surface temperatures, nutrients, fishing access points etc, and these should be explored further and developed as a set that is available and applicable for BRUV-based analysis. As much of the UVC metrics for each site were determined for each specific site via GIS or similar approaches, a matching set of these variables would need to be developed for BRUV locations, as well as ideally, a way of updating this to match new deployment locations.

9. SCOPING A NATIONAL BRUV-BASED PROGRAM FOR QUANTITATIVE REPORTING INTO SOE BASED ON AGREED METRICS

A proposed outcome for Hub research in 2017 has been to develop a paper on BRUV-based analysis of temporal patterns to underpin potential future SOE reporting for fish assemblages around Australia.

Discussion initially centred around the group's knowledge of researchers in the field and their potential to contribute meaningful datasets (i.e. extensive coverage and temporal data, or the capability for future temporal data). Key partners would be DPAW in SA, Deakin Uni in Vic, IMAS in Tas, Marine Futures (WA), Curtin Uni (WA), AIMS (WA, NT, Qld), CSIRO (WA, Babcock), Fisheries WA, Conservation WA, NSW DPI.

However, for SOE reporting, typically temporal datasets are essential to determine the direction of change, as well as an assessment of the current state. In that sense temporal datasets are required and these are very restricted at present in Australia.

One of the most extensive is in NSW, with stereo surveys in the MPAs in a number of years beginning in 2010 (but not annually). There is a smaller dataset that goes back 15 years in some areas but it is mono data only, so has no length estimation.

In South Australia, there is a limited series of surveys across 2 years focussed around a subset of MPAs via DEWNR. Flinders Uni have a limited set of data in a few locations with up to 3 years of data (SA Water projects), and some locations with seasonal sampling.

In WA, there are some multi-year datasets buy no major program, some places have data up to 5 years (Kimberley), most less, e.g. Jurien (3 years in deep water), Canning Bioregion (2 years), Ngari Capes (2 replicates), Rottnest (3 years).

The AIMS data mostly has focussed on spatial replication rather than temporal, so there is very little available. There is some data associated with development projects (e.g. Scott Reef/Montarra) but these are subject to confidentiality agreements, and none span more than three years.

In the NT, current monitoring of fish protection areas is limited to approximately one year.

In Victoria, time series is restricted to Warrnambool, where there is a 3-year data series.

Overall, at this stage in time, any SOE analysis and reporting is going to be substantially restricted by the lack of long-term datasets from BRUV deployments, and a significant effort is needed to build these datasets at a representative set of locations around Australia. The new AMP network may act as one framework for facilitating this in cross-shelf waters, however, an alternative mechanism is needed if this to be expanded in nearshore waters.

Final discussions on this topic centred around resolving bottlenecks in data availability to Global Archive to facilitate subsequent analysis, with the most significant of these being a data-sharing agreement between agencies to allow access and use of this data. This is particularly the case for AIMS data as there are issues with respect to industry confidentiality agreements, but also that contributors do want to ensure that their data is used appropriately, and with consultation, and that authorships are discussed where data use meets typical accepted protocols for this (e.g. the Vancouver Protocol).

10. INDIGENOUS ENGAGEMENT

The final discussion of the workshop focussed on Indigenous engagement, recognising that BRUVs are a tool that may be readily adopted by Indigenous communities as part of monitoring programs and that development of protocols for use should account for this opportunity and interest. While ideally effort is needed to develop approaches that include SOPs that are applicable, in many cases, programs need to be tailored to the needs, interests and capability of the local communities, so not be overly prescriptive. Mike Travers flagged the importance of coordinating engagement with Indigenous communities to ensure there are not multiple groups undertaking programs in the same State/region, as this can lead to confusion in communities and result in an overall failure to develop meaningful and ongoing engagement.

11. ESTABLISHING A FORMAL WORKING GROUP TO REPRESENT THE BRUV COMMUNITY IN THE NATIONAL SCIENCE ARENA

While there is ongoing collaboration between many researchers and agencies using BRUVS for ongoing observations, and general agreed principles underlying many deployments and post processing (SOPs), it was recognised that there was a need to have an ongoing formal group that can both facilitate ongoing cooperation/collaboration, as well as represent the interests and needs of the BRUV community in national discussions, particularly with respect to larger initiatives such as IMOS/AODN/EMII that can provide support for necessary initiatives such as Global archive to allow data sharing/access and provide a safe and permanent repository for BRUV-based data. The group present now represent the initial working group members, representing a broad range of agencies across Australia. Additional representation is invited from others interested parties not in attendance (e.g. CSIRO). The working group elected Professor Euan Harvey as the current Chair of the group.

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