Marine Biodiversity Hub

National Environmental Science Programme

Impact and Outcomes of Marine Sampling Best Practices

Rachel Przeslawski[1], Scott Foster[2], Brooke Gibbons[3], Tim Langlois[3], Jacquomo Monk[4]

D2 - Standard operating procedures for survey design, condition assessment and trend detection

March 2021

Milestone 40 – Research Plan v6 (2020)

1. Geoscience Australia
2. CSIRO
3. University of Western Australia
4. University of Tasmania

Australian Government Geoscience Australia

CSIRO

THE UNIVERSITY OF WESTERN AUSTRALIA

UNIVERSITY of TASMANIA

IMAS INSTITUTE FOR MARINE & ANTARCTIC STUDIES

Enquiries should be addressed to:
Rachel Przeslawski
GPO Box 378
Canberra ACT 2601
rachel.przeslawski@ga.gov.au

Project Leader's Distribution List

Various	All contributors to the best practices
Parks Australia	
NOPSEMA	Christine Lamont
APPEA	Luke Earnshaw
GBRMPA	Mel Cowlishaw
GOOS	Nic Bax, Juliet Hermes

Preferred Citation

Przeslawski R, Foster S, Gibbons B, Langlois T, Monk J (2021). Impact and Outcomes of Marine Sampling Best Practices. Report to the National Environmental Science Program, Marine Biodiversity Hub. Geoscience Australia.

Copyright

Acknowledgement

This work was undertaken for the Marine Biodiversity Hub, a collaborative partnership supported through funding from the Australian Government's National Environmental Science Program (NESP). NESP Marine Biodiversity Hub partners include the University of Tasmania; CSIRO, Geoscience Australia, Australian Institute of Marine Science, Museums Victoria, Charles Darwin University, the University of Western Australia, Integrated Marine Observing System, NSW Office of Environment and Heritage, NSW Department of Primary Industries. This paper is published with the permission of the CEO, Geoscience Australia

Important Disclaimer

Contents

List of Figures

List of Tables

EXECUTIVE SUMMARY

In 2017, the NESP Marine Biodiversity Hub committed to developing field manuals for selected marine sampling platforms to ensure that data collected at different times and places across Australia are directly comparable. Ultimately, 136 individuals from 53 organisations contributed to the *Field Manuals for Marine Sampling in Australian Waters* released in 2018 (Version 1) and 2020 (Version 2). These field manuals are underpinned by a highly collaborative and iterative process, involving extensive community consultation and review and can thus be considered best practices.

In this report, we aim to compile the outcomes of these marine sampling best practices. These outcomes are then integrated into an impact assessment based on the CSIRO Impact Framework. Due to the short period in which the best practices have existed, impact cannot yet be fully assessed, but we lay the foundations to facilitate such an assessment in the future.

Overall, the marine sampling best practices are spreading nationally and internationally, as evidenced by uptake and adoption, including by industry (e.g. Woodside) and developing countries (e.g. St Lucia). Australia and the Unites States represent countries with the most downloads, and highest uptake seems to be for the survey design, benthic BRUV, pelagic BRUV, and multibeam manuals. In addition, the best practices have received community endorsement, with recommendations from key national and international organisations (e.g. Parks Australia, Global Ocean Observing System (for the BRUV manual), National Offshore Petroleum Safety and Environmental Management Authority).

We anticipate several social, economic, and environmental impacts of the best practices to be measurable in 5-10 years after the release of the best practices (i.e. after 2025). For any single survey, the impact of these best practices may be small, but there is much stronger impact when considering a national perspective, as combined multiple datasets from multiple surveys allow us to see the bigger spatial and temporal picture. In this case, standardised datasets can be combined without the fear of confounding between method-of-observation and ecological signal. Thus, a series of compatible surveys are needed before they can be usefully combined, and the true impact of these best practices will not be felt for years, or maybe even decades. Ultimately, the measures of outcome and impact described in this report will help strengthen the links between marine observing communities and policy-making communities by ensuring that timely and fit-for-purpose information is generated for evidence-based decisions.

1. INTRODUCTION

1.1 History of NESP marine sampling best practices

In 2017, the NESP Marine Biodiversity Hub committed to developing field manuals for selected marine sampling platforms to ensure that data collected at different times and places across Australia are directly comparable. Initially, this included sampling platforms that already had well-developed national protocols (baited remote underwater video (BRUV), autonomous underwater vehicle (AUV)). Other platforms were subsequently included, following consideration of responses from the marine science community to a questionnaire. The process of developing the first version of the field manuals is described in Przeslawski et al. (2019b) and included more than 70 individuals from over 30 organisations.

After the release of the first version in February 2018, feedback was solicited about the field manuals. All original chapters were updated in Version 2 with stakeholder feedback, corrections, and updates where applicable. The chapter 'Seafloor Mapping Field Manual for Multibeam Sonar' was substantially changed in Version 2 to amalgamate it with the *Australian Multibeam Guidelines* which were released in June 2018 by AusSeabed, a nationally seabed mapping coordination program. The unified multibeam manual in Version 2 addresses stakeholder concerns about maintaining two separate SOPs for multibeam sonar. In addition, a new manual on ROVs was developed for the Version 2 package. The ROV was chosen based on findings from a scoping report for new manuals (Przeslawski et al. 2019a). All major changes related to a given sampling platform are logged in a version control table at the end of the relevant manual.

These revisions were included in the development of Version 2 which was released in July 2020 as a GitHub webpage (https://marine-sampling-field-manual.github.io), representing contributions from 136 individuals from 53 organisations. There were several reasons for moving Version 2 to an online platform (see https://introduction-field-manual.github.io/updates-and-revisions), including the need for easy updates combined with suitable version control.

The field manuals are underpinned by a highly collaborative and iterative process (Figure 1), involving extensive community consultation and review. For this reason, they can be considered best practices (Pearlman et al. 2019).

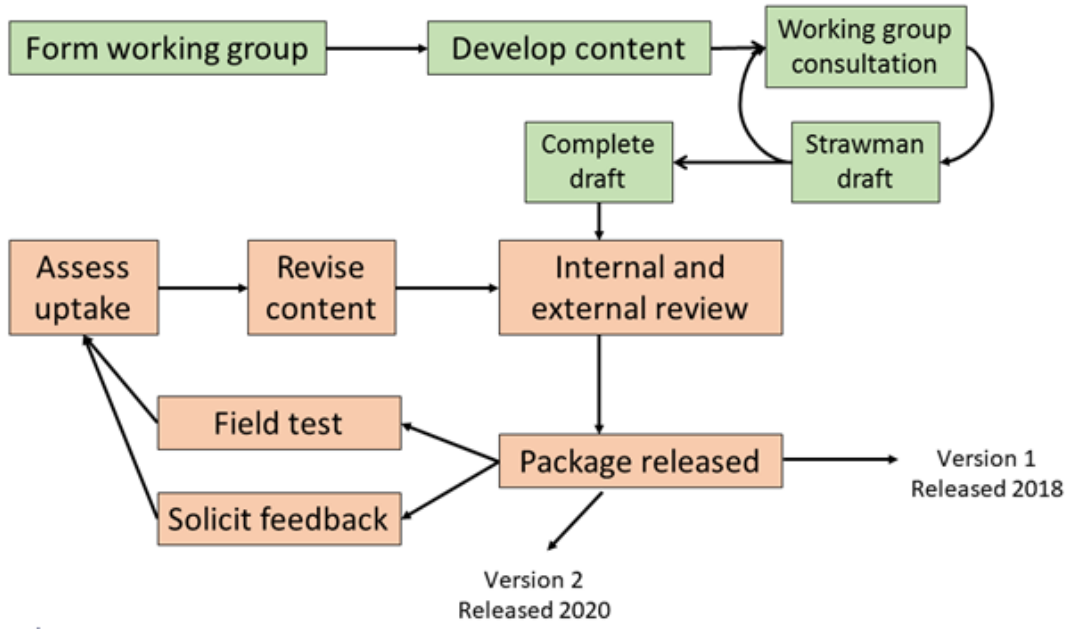

Figure 1 Development process of the NESP marine sampling best practices. Green represents steps confined to Version 1, while orange shows iterative steps to be taken in all future versions

1.2 Impact and outcomes

Measuring impact is becoming increasingly integral to scientific researchers and organisations, and there is a growing body of research investigating how best to increase (Fisher et al. 2020) and measure (Arsalan et al. 2020) research impact. For many projects, it is no longer sufficient to publish results in a scientific journal and move onto the next project. In order to secure support for future research, it is expected that researchers and organisations demonstrate social, economic, and/or environmental benefits of research (Sutton 2020).

The terms *impacts* and *outcomes* are often used interchangeably, and there isn't necessarily a hard boundary between them since outcomes can transform into impact over time. In this report, we adopt the definitions of CSIRO (2020):

- *Outcomes*: Also commonly called 'uptake', this refers to the intended or desired medium-term effects or change expected to be realised from successful delivery of research outputs (e.g. adoption of new techniques, process and behavioural changes, new products stemming from original outputs, licences/IP sold).
- *Impact*: An effect, change or benefit to the economy, environment or society beyond those contributions to academic knowledge. Impacts include wider economic, environmental and social impacts such as increased economic activity, productivity improvement, water savings, reduced emissions, improved health and wellbeing, etc.

Measuring outcomes and impacts can be challenging, due in part because there is no agreed definition of research impact (Johnson et al. 2020) but also because the impacts themselves are usually outside the researcher's capacity to quantify.

1.3 Objectives of this report

In this report, we aim to compile the outcomes of the *Field Manuals for Marine Sampling in Australian Waters,* hereafter called marine sampling best practices. These outcomes are then integrated into an impact assessment based on the CSIRO Impact Framework (CSIRO 2020). Due to the short period in which the best practices have existed, impact cannot yet be fully assessed, but we lay the foundations to facilitate such an assessment over the next five to ten years.

2. OUTCOMES

In this section, we quantify several quantitative and anecdotal outcomes related to engagement with the marine sampling best practices, including presumed and actual uptake.

2.1 Objective measures

Measures of outcomes are not necessarily straightforward. Citation indices are often used to assess research outcomes, but recent research has shown that they may not be a good indication of the uptake and influence of a publication, as uncited papers have recently been shown to have a universal and significant influence via social media platforms (Hou and Ye 2020). In the case of the marine sampling best practices, there simply has not yet been enough time for citations to come through. In addition, best practices may be less likely to be referred to in high-impact journals with limitations on space, with citations more likely to be made in cruise reports or other grey literature. For this reason, we also focus on webpage visitors and file downloads as an objective outcome measure. Analytics available through the GitHub website for version 2 and the Ocean Best Practices Repository (www.oceanbestpractices.org) greatly facilitate tracking such outcomes.

Based on the metrics listed in Table 1, highest uptake seems to be for the survey design, benthic BRUV, pelagic BRUV, and multibeam manuals.

Website analytics are available for Version 2, indicating that highest uptake of all the manuals from the GitHub website is from Australia (Figure 2) and from the Ocean Best Practices Repository is from the United States (Table 2).

Table 1 Outcomes related to the marine best sampling best practices as determined on 27 Oct 2020. Version 1 (V1) outcomes span a 2.5-year period, and version 2 (V2) outcomes span a 3-month period. Number of visitors shows the unique visits to a URL, but number of downloads may include repeat users. Not all metrics were available from each source.

Output	Source	Metric	Value
Journal paper (2019)	Google Scholar	Number of citations	4
	Scopus	Number of citations	3
Field manual package (V1)	Google Scholar	Number of citations	11
Survey design manual (V1)	Google Scholar	Number of citations	4
	OBP Repository[1]	Number of downloads	388
Survey design legacy site paper (2017)	Google Scholar	Number of citations	27
Transect-based design paper (2020)	Google Scholar	Number of citations	6
Multibeam manual (V1)	Google Scholar	Number of citations	3
	OBP Repository	Number of downloads	480
AUV manual (V1)	Google Scholar	Number of citations	5
	OBP Repository	Number of downloads	350

[1] OBP = Ocean Best Practices (www.oceanbestpractices.org)

Benthic BRUV manual (V1)	Google Scholar	Number of citations	13
	OBP Repository	Number of downloads	494
Pelagic BRUV manual (V1)	Google Scholar	Number of citations	9
	OBP Repository	Number of downloads	2025
Towed imagery manual (V1)	Google Scholar	Number of citations	2
	OBP Repository	Number of downloads	227
Grab / box corer manual (V1)	Google Scholar	Number of citations	2
	OBP Repository	Number of downloads	186
Sled / trawl manual (V1)	Google Scholar	Number of citations	1
	OBP Repository	Number of downloads	189
Field manual package (V2)	OBP Repository	Number of visitors	222
		Number of downloads	98
Survey design manual (V2)	Google analytics	Number of visitors	256
Multibeam manual (V2)	Google analytics	Number of visitors	303
AUV manual (V2)	Google analytics	Number of visitors	88
Benthic BRUV manual (V2)	Google analytics	Number of visitors	186
Pelagic BRUV manual (V2)	Google analytics	Number of visitors	84
Towed imagery manual (V2)	Google analytics	Number of visitors	64
Grab / box corer manual (V2)	Google analytics	Number of visitors	60
Sled / trawl manual (V2)	Google analytics	Number of visitors	81
ROV manual (V2)	Google analytics	Number of visitors	n/a[2]

[2] Google analytics had not been set up for the ROV manual prior to drafting this report

Figure 2 Demographics of unique visitors to the version 2 GitHub webpages for each marine sampling best practice as of October 2020.

Table 2 Demographics of unique visitors to the version 2 marine sampling best practice page in the OBP Repository as of October 2020.

Country	Views
United States	195
Romania	36
Spain	14
Australia	9
Cayman Islands	9
Netherlands	9
Canada	3
Brazil	2
Bahrain	1
Germany	1

In addition to the measurements of uptake mentioned above, another outcome has been community endorsement, as shown the following ways:

- A total of 136 individuals from 53 organisations contributed to the best practices.
- Parks Australia recommends the use of the marine sampling best practices as part of their process to approve scientific sampling in Australian Marine Parks.
- The Global Ocean Observing System (GOOS) endorsed the benthic BRUV best practice in September 2020 (Langlois et al. 2020) as one of the first such international endorsements (GOOS 2020).
- The National Offshore Petroleum Safety and Environmental Management Authority (NOPSEMA) encouraged titleholders to 'read and test applicability of the field manuals when planning relevant marine environmental studies' (NOPSEMA 2018).

2.2 Anecdotal measures

Anecdotal measures of outcome include knowledge of how the marine sampling best practices have been used and feedback from these users.

Based on discussions with colleagues and knowledge sharing at conferences and workshops, we have noted the following examples of the marine sampling best practices being applied since their release in 2018:

- All NESP Marine Hub surveys using the relevant sampling gear have applied the marine sampling best practices, including surveys to Lord Howe, Hunter, Beagle, Wessel, Coral Sea, Gascoyne, Southwest Corner, Huon, Arafura and Tasman Fracture Marine Parks.
- Woodside applied the BRUV and survey design best practices to a 2019 environmental assessment survey in Western Australia and will do so for future surveys, thereby facilitating generalizable population estimates to monitor fish.
- South Australia Department of Environment and Water applied the BRUV and survey design best practices to a 2020 study sampling within national and state marine parks near Kangaroo Island.

- RPS Group Consultants is applying several best practices including for grabs and box corers as part of their environmental assessment associated with an offshore windfarm off the coast of Victoria.
- New South Wales Department of Planning, Industry and Environment is applying several best practices, including spatially balanced designs, to their state monitoring programs.
- A principal researcher from Museums Victoria has applied the survey design best practice to an approved Marine National Facility voyage to the Cocos (Keeling) Islands territory, scheduled for 2022.
- A research scientist from the South Australian government included the grab and box corer best practices in a funding application to the Commonwealth Government's Community Grants Hub (Our Marine Parks) and subsequent survey plan.
- Sydney Water's Aquatic Ecology Lab has applied the grab and box corer manual to their Ocean Sediment Program.
- The CEFAS in the UK were trained in the benthic stereo BRUV best practice and applied this alongside the St Lucian Fisheries Department to assess marine parks (Mitchell et al. 2020).
- A researcher from the South African Environmental Observation Network applied the sled and trawl best practice in a survey to collect biological specimens.

Feedback from users has been positive and includes the following statements:

- Strong (2020) pointed to the survey design best practice as providing 'useful advice [to] greatly improve objectivity and efficiency by reducing the impact of spatial autocorrelation and improving the distribution of the observations along environmental gradients at the study site', as it relates to habitat mapping.
- RPS published an article on the best practices, affirming that they will 'provide guidance for research and monitoring programs across the nation' (https://www.rpsgroup.com/insights/shaping-a-new-standard-for-australian-marine-research/) and showing that their use of the best practices is an industry advantage.
- A researcher from the South African Environmental Observation Network wrote that the sled and trawl best practice '…not only gave me a detailed breakdown of dredge dimensions and deployment protocols, but even went so far as to describe sample preservation and post cruise data management. It definitely saved my fieldwork and I have since used them on numerous other cruises."
- A spatial modeler from the Commonwealth Government described the R package included in the survey design best practice as 'really cool'.
- A participant in the *Evolving and Sustaining Ocean Best Practices* international workshop praised the BRUV best practice, stating that before its development there 'wasn't really an established way of doing research applicable to developing countries'.
- A researcher from Sydney Water stated "It was so good to see that the field methods in the manuals were the same as what we follow and that such a massive resource is publicly available. It's so useful and has allowed us to confirm that we're using the most widely accepted method…., [and] the way you present it is much more user friendly!"
- A scientist at CEFAS discussed the application of the BRUV best practices in St Lucia: 'The use of BRUVs presents a relatively novel survey method for us…. The development of standardised protocols and a clear field sampling manual have

proven to be a valuable resource throughout the project. Within country capacity building and the development of a lasting legacy are important measures of the success of the CME Programme. Therefore, the data generated during the survey, along with training provided and equipment used, will support the Government of St Lucia to continue to better manage their marine resources.'

- A marine scientist has referred to the best practices as 'great products' in relation to his review of IMOS facilities.

See Table 3 for the full list of outcomes integrated in the CSIRO Impact Framework.

3. IMPACTS

As mentioned previously, it is too soon to appropriately assess the impacts of the marine sampling best practices. Impact is generally understood to be noticeable and measurable five to ten years after an output (CSIRO 2020, Johnson et al. 2020). We can, however, identify the social, economic, and environmental impacts that we anticipate the marine sampling best practices will have.

Table 3 lists the anticipated social, environmental, and economic benefit from the marine sampling best practices over the next ten years, described below in more detail:

- Environmental: The marine sampling best practices may reduce negative impacts on the marine environment by facilitating the adoption of efficient survey design and sampling methods that are less invasive or target fewer locations.

- Economic/Environmental: One of the biggest impacts of standardisation is when multiple datasets from multiple surveys are combined to look at a bigger spatial and/or temporal picture to develop regional or national management strategies for our marine estate. This saves time and money spent on multiple marine surveys, as well as allowing for bigger picture questions to be addressed.

- Economic/Environmental: The marine sampling best practices support the Australian Government's emerging efforts to develop ocean accounts so that we can make better decisions about how we manage our marine ecosystems and resources. The best practices, particularly regarding sampling design, will facilitate generalizable and repeatable survey results to develop spatial predictions of biodiversity, detect change over time and assess the effectiveness of management plans.

- Economic: By employing best practices, researchers can save time in planning and deploying gear, as well gain efficiencies through repeated use (re-use) of data. On marine surveys, time equates to cost, with many vessels costing tens of thousands dollars per day. For example, the recent use of the survey design and BRUV best practice for Woodside saved approximately three days of large ship and crew time (~$300,000).

- Social/Economic: Adoption of best practices by industry may improve social license to operate by reducing uncertainty associated with the impacts of these industries (e.g. petroleum, fisheries).

- Social: An active community of contributors and users of the marine sampling best practices can foster a collaborative culture among marine scientists.

- Social: Awareness of the marine environment by society will grow through effective reporting of ecosystem health (e.g. State of the Environment) which relies on robust and efficient collection and use of data.

- Social: Sustainable management of marine resources is perhaps the ultimate impact for the marine sampling best practices which would contribute to food security, employment, and social wellbeing. This will be the most challenging impact to measure.

Table 3: NESP Marine Sampling Best Practices – Impact Pathway

IMPACT STATEMENT: The NESP Marine Sampling best practices will facilitate the cost-effective collection of data to inform sustainable management of Australia's marine estate.

PARTICIPATION: The impact pathway includes funders and executives (to encourage uptake), researchers, technicians and vessel operators (to use best practices); and marine managers and policy-makers (to make decisions based on evidence acquired using best practices).

GA, CSIRO, UTAS, UWA plus other NESP partners	GA, CSIRO, UTAS, UWA, NESP, AusSeabed, plus over 45 other agencies (https://introduction-field-manual.github.io/collaborators)	GA, CSIRO, UTAS, UWA, NESP, AusSeabed, plus over 45 other agencies (https://introduction-field-manual.github.io/collaborators)	Parks Australia/DoEE, GA, CSIRO, UTAS, UWA, NESP, AusSeabed, NMSC, IMOS/AODN, APPEA, NOPSEMA, NSW-DPI and other state and territory governments, RPS and other private consultants, CEFAS, Woodside and other industry, IOC-IODE, GOOS	Industry; Government; Academia; General Public
	Years 2016-2020		Years 2018-2028	

INPUTS
What we invest

- **Funding**
- **Staff, including skilled specialists (marine science, statistics)**
- **Research Project Plan (NESP)**
- **Partnerships with stakeholders (university, government, industry)**
- **IT and office infrastructure**
- **Defined scope**
- **Co-designed program**
- **IP and copyright advice**
- **Communication Plan**

ACTIVITIES
What we do

- **Survey marine science community**
- **Review existing methods**
- **Form working groups to establish best practices**
- **Lead workshops to identify key challenges and recommendations (e.g. data discoverability)**
- **Engage with stakeholders to understand needs and limitations on method use**
- **Participate in international fora to link national efforts with global initiatives**

OUTPUTS
Our deliverables

- **Field manuals (pdf, Version 1 released in 2018)**
- **Field manuals (web-based, Version 2 released in 2020)**
- **Communication and outreach materials (e.g. articles, poster, video, flyer)**
- **Scientific journal paper**
- **Roadshows and conference presentations**

OUTCOMES
The uptake, adoption or consumption of our work

Short Term Outcomes

- **Uptake of field manuals and associated journal paper (e.g. downloads, citations)**
- **Increased coordination and collaboration among organisations and research groups to deliver accessible and collatable data**
- **Adoption of the best practices on collaborator and stakeholder surveys**
- **Capacity development and training (e.g. St Lucia and CEFAS)**
- **Community endorsement of best practices**
- **Identification of best practice gaps (i.e. new field manuals needed)**
- **Encouraging national-scale partnerships based on mutual methods for survey planning, data acquisition, and data discovery**

Medium Term Outcomes

- **Reduced costs of survey operations**
- **New knowledge of marine biodiversity and habitats which assist planning decision making**
- **Adoption of the best practices on surveys outside collaborative network**
- **Integrated ecosystem knowledge**

IMPACTS
Benefits to economy, environment, society

Economic

- **Support the Australian Government's emerging efforts to develop ocean accounts**
- **Fully realise the economic benefit from marine resources through more efficient & cost-effective survey planning, data acquisition and management**
- **Improved social licence to operate for offshore industries**

Environmental

- **Better-informed regional or national management strategies for our marine estate**
- **Improved knowledge of the marine environment**
- **Reduce negative impacts on the marine environment**

Social

- **Sustainable management of marine resources**
- **Collaborative culture among marine scientists**
- **Greater social awareness of the marine environment through reporting of ecosystem health**

4. CHALLENGES

Several challenges remain regarding the impact of the marine sampling best practices:

- Without high-level oversight, the strong momentum generated during the development and release of these best practices may fade. A governance and version control workflow has been developed, and Przeslawski et al. (2019b) suggested that the National Marine Science Committee could take on the role of Governance Committee (Figure 3). This has not been progressed to date.
- The period taken to measure impact (5-10 years) does not match with traditional funding cycles (3-5 years) (Johnson et al. 2020). This could cause a potential gap in support, during which these best practices suffer from lack of oversight and custodianship.
- There is still limited uptake of these best practices from some State and Territory marine park agencies. We still have an opportunity to better help them understand the rationale for adopting these marine sampling best practices, particularly regarding survey design. An opportunity exists to facilitate uptake by State agencies through the National Marine Baselines and Monitoring framework under the National Marine Science Plan.
- To a certain extent, the field manuals do not just specify a set of instructions for deploying gear. Rather, they represent a scientific approach for gathering information from the ocean. This is a very important distinction, especially as Australian marine science moves from the preliminary process of “discovery” towards a more formal and management-orientated process of “monitoring” (e.g. governance frameworks like MERI). This requires a culture shift. There are already signs of this message getting through, with a number of senior scientists understanding this need as evidenced with recent large surveys of Southern seamounts (Huon Marine Park), Ningaloo Marine Park, Elizabeth-Middleton reefs (Lord Howe Marine Park), and the upcoming Cocos-Keeling and Christmas Island surveys.

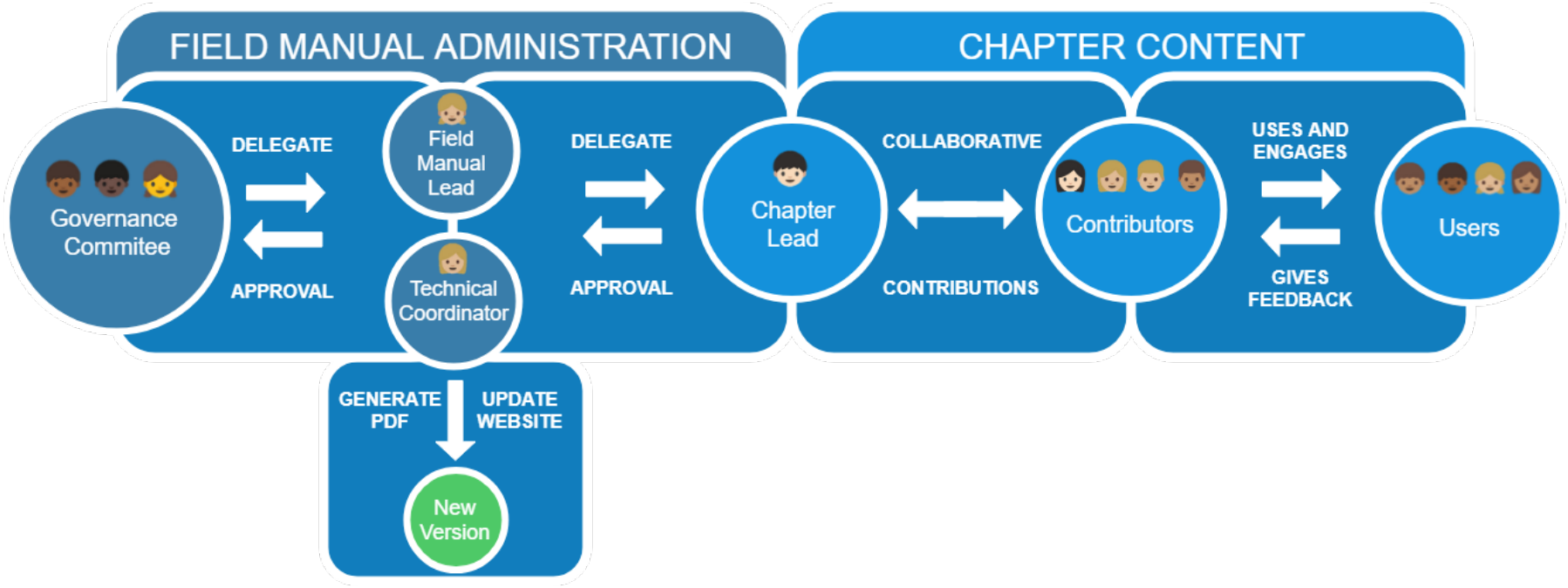

Figure 3 Workflow of version control and governance for the digital field manuals of Version 2 and future versions. The long-term Governance Committee has not yet been identified.

5. RECOMMENDATIONS & CONCLUSIONS

One of the key concerns relates to the future of the marine sampling best practices, particularly regarding their continued maintenance and assessment of impact. There is currently no governance framework nor associated support to maintain and update these resources. We recommend that a Best Practices Governance Sub-Committee is scoped and progressed through the National Marine Science Committee to include the marine sampling best practices, as well as other national standard operating procedures and best practices (e.g. Integrated Marine Observing System (IMOS)).

Our understanding of research impact is rapidly changing and measures to demonstrate impact still being developed (Williams 2020). In this context, this report provides a preliminary assessment of impact of the marine sampling best practices based on early uptake and feedback from practitioners. The metrics used here, while relatively simple, do point to strong uptake of best practices over the past two to three years. Importantly this uptake has spanned diverse sectors: applied science, offshore industry and academic research. With further use of the best practices, impact can be gauged further over the next five to ten years as related to social, economic and environmental benefits identified here, as well as additional unforeseen benefits that may occur (e.g. policy impacts in Reed et al. (2018)). These measures of outcome and impact vary in complexity and duration to detection (Figure 4), but ultimately will help strengthen the links between marine observing communities and policy-making communities by ensuring that timely and fit-for-purpose information is generated for evidence-based decisions.

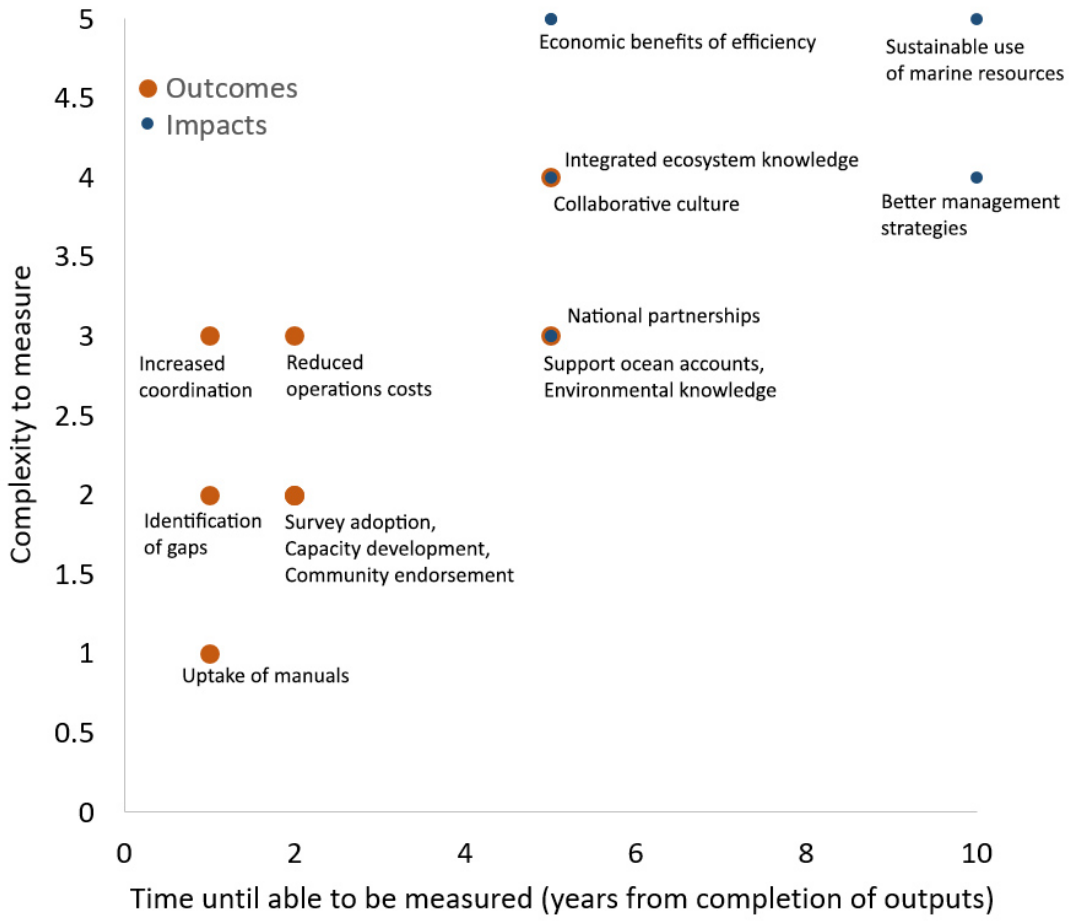

Figure 4 The complexity of measurements (1 = simple, 5 = complex) and time to measure for each outcome and impact in Table 3.

For any single marine survey, the impact of these best practices may be small, stemming from being able to demonstrate that the survey was performed using a robust scientific method and the inferences drawn from the resulting data are sound. There is much stronger impact when considering a national perspective, as combined multiple datasets from multiple surveys allow us to see the bigger spatial and temporal picture. In this case, and only if standardised, the datasets can be combined without the fear of confounding between method-of-observation and ecological signal. Thus, a series of compatible surveys are needed before they can be usefully combined, and the true impact of these best practices will not be felt for years, or maybe even decades.

REFERENCES

CSIRO. 2020. Impact Evaluation Guide.

Fisher, J. R. B., S. A. Wood, M. A. Bradford, and T. R. Kelsey. 2020. Improving scientific impact: How to practice science that influences environmental policy and management. Conservation Science and Practice 2:14.

GOOS. 2020. GOOS Best Practice Endorsement Process.7.

Hou, J. H., and J. T. Ye. 2020. Are uncited papers necessarily all nonimpact papers? A quantitative analysis. Scientometrics 124:1631-1662.

Johnson, M. T., L. J. Johnson, G. A. Bayliss-Brown, V. Danino, S. Day, I. Dunnett, J. Forster, I. Lorenzoni, K. Kennedy, G. Malin, K. Moore, P. M. Fuller, M. Walton, and T. J. Tolhurst. 2020. The Marine Knowledge Exchange Network: Insights from an Innovative Regional-to-National Scale Academic-Led Knowledge-to-Impact Network and Recommendations for Future Initiatives. Coastal Management 48:308-335.

Langlois, T., J. Goetze, T. Bond, J. Monk, et al. 2020. A field and video annotation guide for baited remote underwater stereo-video surveys of demersal fish assemblages. Methods in Ecology and Evolution 11: 1401-1409.

Mitchell, P. J., S. G. Bolam, H. Close, C. Garcia, J. Monk, and K. Alliji. 2020. Distribution of demersal fish assemblages along the west coast of St. Lucia: implications for planning no-take marine reserves. . Aquatic Conservation: Marine and Freshwater Ecosystems. Accepted.

NOPSEMA. 2018. Sharing knowledge about the marine environment. Page 27 The Regulator.

Pearlman, J., M. Bushnell, L. Coppola,et al. 2019. Evolving and Sustaining Ocean Best Practices and Standards for the Next Decade. Frontiers in Marine Science 6.

Przeslawski, R., L. Bodrossy, A. Carroll, A. J. Cheal, M. Depczynski, S. Foster, B. D. Hardesty, P. Hedge, J. Langlois Timothy, A. Lara-Lopez, A. Leplastrier, S. Mancini, K. Miller, J. Monk, M. Navarro, S. Nichol, S. Sagar, R. D. Stuart-Smith, J. Van de Kamp, and J. Williams. 2019a. Scoping of new field manuals for marine sampling in Australian waters. Geoscience Australia.

Przeslawski, R., S. Foster, J. Monk, N. Barrett, P. Bouchet, A. Carroll, T. Langlois, V. Lucieer, J. Williams, and N. Bax. 2019b. A Suite of Field Manuals for Marine Sampling to Monitor Australian Waters. Frontiers in Marine Science 6.

Reed, M. S., R. Bryce, and R. Machen. 2018. Pathways to policy impact: a new approach for planning and evidencing research impact. Evidence & Policy 14:431-458.

Strong, J. A. 2020. An error analysis of marine habitat mapping methods and prioritised work packages required to reduce errors and improve consistency. Estuarine, Coastal and Shelf Science 240:106684.

Sutton, E. 2020. The increasing significance of impact within the Research Excellence Framework (REF). Radiography 26:S17-S19.

Williams, K. 2020. Playing the fields: Theorizing research impact and its assessment. Research Evaluation 29:191-202.

www.nespmarine.edu.au

Contact:
Rachel Przeslawski
Geoscience Australia

Address | GPO Box 378 |Canberra ACT | 2601
email | rachel.przeslawski@ga.gov.au
tel | +61 2 6249 9101