Marine and Coastal

National Environmental Science Program

FINAL REPORT

Project 2.2

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Advancing national standards and best practices to monitor key marine values and pressures

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NESP Marine and Coastal Hub partners

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Executive summary

Ocean best practices are crucial for enhancing collaboration, efficiency, and data reliability in marine research and management. From 2015-2021, the NESP Marine Biodiversity Hub spearheaded the development and adoption of nine national standards for marine survey design and sampling (survey design, multibeam, autonomous underwater vehicles, demersal baited remote underwater video (BRUVs), pelagic BRUVs, towed imagery, grabs and box corers, sleds and trawls, remotely operated vehicles). These standards, collectively known as the NESP SOPs (Standard Operating Procedures), have been widely embraced by various stakeholders, including industry and international partners, and have enhanced data comparability and management efficiency at regional and national levels.

In 2022, the NESP Marine and Coastal Hub supported an expansion of these efforts through Project 2.2 (*Advancing national standards and best practices to monitor key marine values and pressures*). This project focused on maintaining and updating the suite of SOPs while also further expanding it to address additional national marine monitoring objectives.

The objectives of this final report are to

1. Describe the key achievements of NESP Project 2.2,
2. Provide an updated assessment of outcome and impact of the SOPs,
3. Identify challenges, and
4. Recommend future actions related to governance, maintenance and future best practices.

Our main achievement was the release of Version 3 of the SOPs (marine-sampling-field-manual.github.io), including three new SOPs:

- The **microplastics** SOP focuses on the identification and quantification of microplastics (1 µm - 5 mm) from water, sediment, biota, and air samples from marine and coastal environments. Ultimately, it aims to ensure microplastic sampling can occur accurately and comparably between NGOs, consultants, research and government institutions.

- The **knowledge, attitudes, practice (KAP) survey** SOP presents an approach for conducting face-to-face marine protected area knowledge, attitude and practice surveys with marine recreational users (fishing and non-fishing) at boat ramps and coastal access points. This data is explicitly designed to inform management reviews and provide essential pressure data to complement biodiversity surveys.

- The **benthic observation survey system (BOSS)** SOP demonstrates how a novel four-camera drop platform, with a wide combined field of view (~270o), can be used to collect benthic imagery that can be annotated for spatial modelling, predictive modelling, and ground truthing of robust habitat maps.

The new SOPs were supported by a workshop, revisions to older SOPs, website updates, and a framework for ocean best practices development. In addition, Indigenous partners shared their knowledge for the KAP and BOSS SOPs, thus laying the groundwork for future Indigenous partnerships and Indigenous-led projects using the SOPs.

The impact of the SOPs since their release in 2018 has been substantial, with strong uptake across diverse sectors including applied science, offshore industry, and academic research. Endorsement and utilization of the SOPs have been widespread, ranging from national agencies like Parks Australia to international bodies like the Global Ocean Observing System (GOOS), and they have contributed to improved marine monitoring both nationally and globally. Additionally, the framework developed for ocean best practices is anticipated to see wide adoption beyond Australia following its publication and endorsement by the Ocean Best Practices System.

Despite widespread adoption, barriers to the uptake of SOPs persist, including issues related to funding, awareness, training, content, and institutional support. These highlight the need for targeted efforts to enhance understanding and implementation, particularly among State and Territory marine park agencies and private consultancies. This report provides a clear list of recommendations, including nominating all SOPs for international endorsement, establishing governance mechanisms for ongoing oversight, securing funding for SOP development and infrastructure, and identifying future SOP development priorities to address emerging needs such as offshore renewable energy monitoring. These efforts will ensure the transparency, effectiveness, and long-term sustainability of marine sampling best practices in Australia and beyond.

Overall, the SOPs seem to have reached a critical momentum, whereby they are widely known and used. NESP Project 2.2 and its preceding project achieved the following outcomes:

- Contributed to an improved information flow from survey through to management decision for the task of assessing condition status of key natural values and pressures;
- Facilitated stronger and more general inferences about ecological processes, based on consistent sampling methodology;
- Aided in the cost-effective sampling of Australia’s marine environment, even when sampling is performed by different institutions at different times; and
- Provided a reference point for regulatory and management agencies responsible for monitoring the trend and status of communities and individual species.

1. Introduction

1.1 Background

Ocean practices refer to a wide variety of methods used to observe any metric related to the marine environment. Their intended purposes are equally as diverse. Some are general and can be applied to most environments, such as using open-water sensors to measure ocean conditions (Bittig et al. 2019). Others are more specialised, designed for specific projects or places, such as using 4-dimensional photogrammetry to map coral reefs (Gordon et al. 2023).

Theoretically, the number of ocean practices is unlimited, but functionally it is worthwhile to identify ocean best practices. These are methods that have "repeatedly produced superior results relative to other methodologies with the same objective; to be fully elevated to a best practice, a promising method will have been adopted and employed by multiple organizations" (Pearlman et al. 2019). Ocean best practices have many benefits including more collaborative opportunities, efficient use of time, improved systems operability, data comparability and interoperability, greater trust in data, streamlined regulatory approvals, and higher funding success (Pensieri et al. 2016, Rivest et al. 2016, Walker et al. 2021).

To that end, there has recently been concerted efforts to define, develop, and promote ocean best practices. At a global scale, the UNESCO Ocean Best Practices System (OBPS) includes a searchable and secure Repository that allows the submission and retrieval of all ocean practices (Hörstmann et al. 2021). At a national scale, the NESP Marine and Coastal Hub and its previous iterations have supported the development of a suite of Australian ocean best practices (hereafter referred to as standard operating procedures, SOPs). These SOPs help ensure that marine data are comparable with other areas and sectors, thus strengthening their value for managing at regional and national scales.

1.2 History of NESP Standard Operating Procedures (SOPs)

The NESP Marine Biodiversity Hub (2015-2021) delivered a project that developed and progressed the adoption of nine national standards for marine survey design and sampling. Ultimately, these standards ensure that information collected is comparable with other areas and sectors and provide a reference for management agencies to use for data collection requirements, thus strengthening the value of data for managing at regional and national scales.

The first version of the NESP SOPs was released in 2018, and the second version was released in 2020, comprising the following standards:

- Survey design
- Multibeam (led by AusSeabed in Version 2)
- Autonomous underwater vehicle
- Benthic baited remote underwater video
- Pelagic baited remote underwater video
- Towed imagery

- Benthic sleds and trawls
- Grabs and box corers
- Remotely operated vehicle (Version 2 only)

Collectively these methods were released as the Field Manuals for Marine Sampling to Monitor Australian Waters (Przeslawski et al. 2019b) and are colloquially known as the SOPs (standard operating procedures). The project was a success, with 136 individuals from 53 organisations contributing to the SOPs. The SOPs have been adopted at State, Commonwealth, and international levels by a range of users, including industry and in developing nations (Przeslawski et al. 2021).

Whilst these nine standards have been recognised to be critical for advancing capacity for a comprehensive assessment of Australia's marine estate, they represent a relatively small fraction of the total number of national standards required to meet national needs. At the conclusion of the previous Marine Biodiversity Hub project, numerous recommendations were put forward regarding maintenance, updates, and measuring uptake and impact (Przeslawski et al. 2019a, Przeslawski et al. 2019b), but there was no obvious mechanism to achieve these.

In 2022, the NESP Marine and Coastal Hub supported a follow-up 18-month project to implement some of the recommendations and to ensure the currency of the SOPs as related to national marine monitoring objectives for key values and pressures. One of the centrepieces of the project was the development of three new SOPs, all of which followed a best practice development process that was also finalised during the project, as well as several other key outputs and engagement activities described below in ‘Key Achievements’.

1.3 Objectives

The objectives of this final report are to

1. Describe the key achievements of NESP Project 2.2 (Advancing National standards and best practices to monitor key marine values and pressures),
2. Provide an updated assessment of outcome and impact,
3. Identify challenges, and
4. Recommend future actions related to governance, maintenance and future best practices.

2. Key Achievements

2.1 New SOPs

Research-users and NESP Marine and Coastal Hub scoping projects identified priorities for the development of additional SOPs in three key areas that require consistent national approaches. These were confirmed in a 2022 questionnaire and workshop (Przeslawski et al. 2023b) and are briefly described below.

2.1.1 Microplastics SOP

An increasing number of organisations are undertaking research, monitoring, and data collection on the presence of plastic contamination in the environment. This information is essential for establishing baseline data to support the establishment of indicators and targets for decision-making to mitigate plastic contamination. However, a recurring conclusion from reviews of marine and coastal plastic assessments is that the use of an array of different sampling approaches, preparation methods, and measurement units result in datasets that are inconsistent and seldom comparable. This is often compounded by a lack of effective quality assurance and control procedures. This data incompatibility was also underscored in a previous NESP Marine and Coastal Hub project (1.18, *Synthesis of current data on microplastics in South Eastern Australia*), together with the need to prioritize method harmonization as a pathway to improve data reproducibility and comparability.

Establishing national standards and best practices for marine microplastics addresses the pressing need for cost-effective, standardized approaches essential for reliable data integration and comparison. We developed a SOP for coastal and marine microplastic assessments in water, sediment, biota, and air that aim to facilitate reliable data comparisons across regions, and national and international collections by implementing reproducible and comprehensive guidelines. These cover all steps from sample collection, processing, laboratory procedures, and plastic characterisation. The SOP also focuses on ensuring consistent terminology and data reporting parameters. The SOP scope includes the identification and quantification of microplastics (1 µm - 5 mm), providing methods for collecting data that are findable, accessible, interoperable and reusable (FAIR Guiding Principles). Ultimately, it aims to ensure microplastic sampling can occur accurately and comparably between NGOs, consultants, research and government institutions.

2.1.2 Knowledge, Attitude, Practice (KAP) SOP

In Australia, there is an extensive and increasing network of marine protected areas including networks of no-take zones, sometimes within marine parks, with the objective of conserving marine biodiversity. Historically a large variety of methods have been used to measure and monitor their human dimensions. This lack of consistency has limited spatial and temporal comparability and prevented national-level insights. However, consistent and structured knowledge, attitude and practice (KAP) surveys of users within marine protected areas, including networks of no-take zones, can inform communication and management decisions and provide pressure information to complement biodiversity monitoring.

Here we present a SOP which outlines a robust method to conduct marine recreational user knowledge, attitude and practice surveys. The protocol has been developed through co-design and testing with Traditional Owners and Cultural Rangers on Wadandi and Wudjari Sea Country as well as through national workshops with social science researchers and marine park managers from around Australia. This SOP presents an approach for conducting face-to-face marine protected area knowledge, attitude and practice surveys with marine recreational users (fishing and non-fishing) at boat ramps and coastal access points. We outline seven sequential steps to planning, conducting, analysing and publishing results from a marine protected area recreational user knowledge, attitude and practice survey. The establishment of a consistent protocol facilitates temporal and spatial comparison, the

generation of insights beyond the scope of a single study and provides an excellent opportunity for Indigenous-led research on Sea Country. This data is explicitly designed to inform management reviews and provide essential pressure data to complement biodiversity surveys.

2.1.3 Drop Camera SOP (Benthic Observation Survey System – BOSS)

Mapping the extent and composition of benthic habitats can help inform the sustainable development of the oceans and maintain key ecosystem services through ecosystem-based fisheries, conservation and infrastructure management, and it can provide the basis for the assessment of cumulative anthropogenic and environmental impacts. The key to producing robust maps is adequate spatially balanced ground truthing information and validation.

Horizontally facing imaging platforms are primarily used to collect information on mobile fauna (i.e. stereo-BRUVs for fish assemblages), but such platforms and drop camera systems such as the Benthic Observation Survey System (BOSS), are highly amenable to cost-effective and spatially balanced survey designs. In the BOSS SOP we demonstrate how the novel four-camera BOSS platform with a wide combined field of view (~270°) can be used to collect benthic annotation suitable for spatial modelling, prediction and ground truthing of robust habitat maps. We also provide annotation, validation and modeling workflows in addition to a detailed field guide.

2.2 Stereo-BRUV Exemplar

The Baited Remote Underwater stereo-Videos (stereo-BRUV) platform is one of the most popular SOPs (see Section 3), widely used as a global standard by research institutions and management bodies to monitor fish and their habitats. It is important that users of stereo-BRUV collect, annotate, quality control, store and share their data in a consistent manner to ensure that data produced is of consistent quality and to enable temporal or large scale synthesis to occur to inform management and monitoring.

We created an SOP exemplar that included an open-access statistical package, including an accessible web application, field and annotation manuals, reusable functions with example data, and documentation that describes how to use them (globalarchivemanual.github.io/CheckEM). This package provides a stereo-BRUV exemplar workflow (Figure 1), from field manuals for stereo-video platforms to step-by-step video annotation guides for fish and benthos and R workflows for data checking and data analysis (Gibbons et al. 2023). In addition, we developed a R Shiny web application with user manual and demonstration video for an accessible workflow to perform quality control checks on stereo-video annotations (marine-ecology.shinyapps.io/CheckEM). It is hoped that our efforts to standardise the stereo-video workflow will streamline data collection, annotation and both quality assurance and quality control, thereby yielding data that will better meet the FAIR principles and increase collaboration between stereo-video users to make their data more ready for syntheses and environmental reporting.

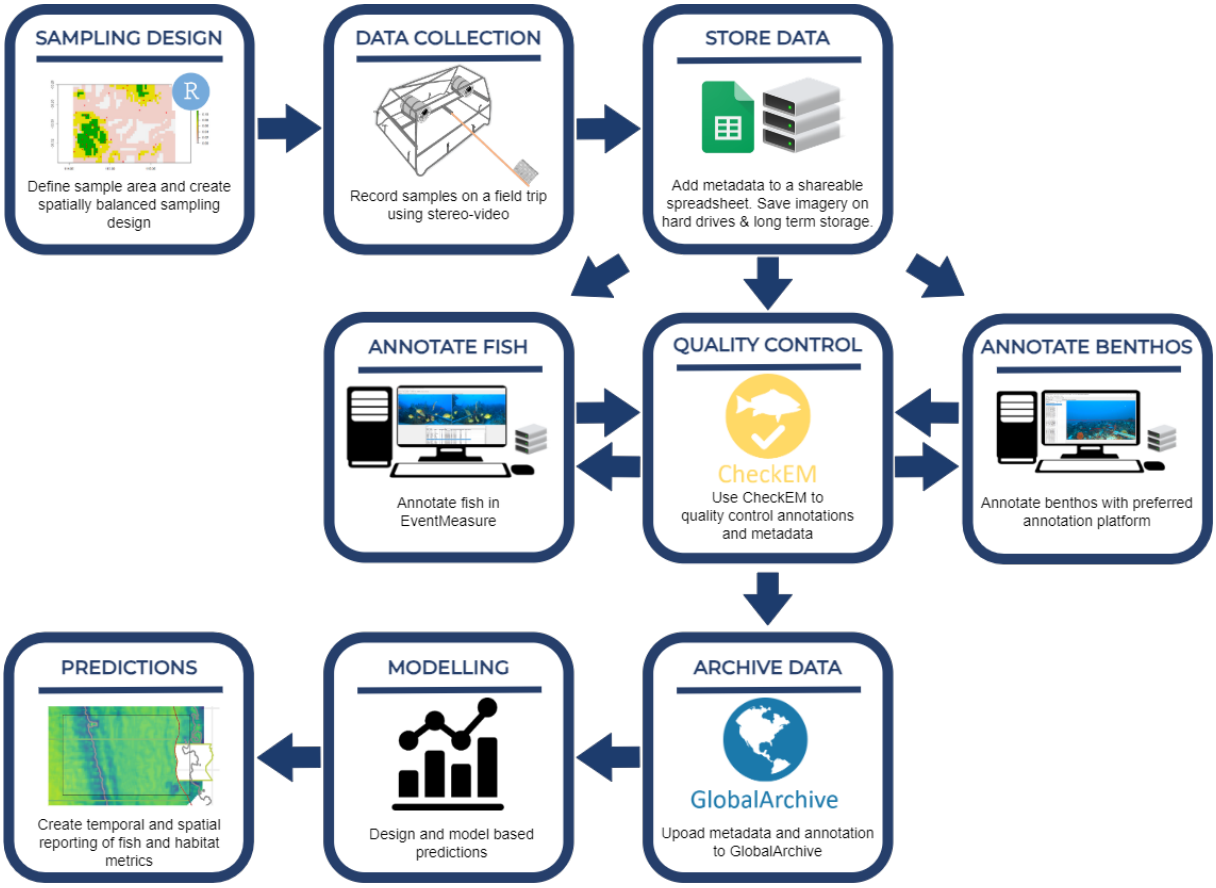

Figure 1 The stereo-video workflow, using CheckEM for quality control and GlobalArchive as a repository of image annotation data.

2.3 Version 3

Version 3 of the SOPs includes the three new SOPs described in Section 2.1, as well as revisions to most of previous SOPs (shown in green in 2024 column of Table 1). Most of these revisions included the addition of recent citations and updated data release sections. In addition, the introduction (Chapter 1) was revised to include the following:

- Addition of new universal protocol 'Indigenous leadership and collaboration' to highlight the role of Traditional Knowledge in marine science,
- Expansion of universal protocol 'Data discoverability and accessibility' to further highlight the importance of FAIR data,
- Updated universal protocol 'Permits' to direct users to AusSeabed,
- Description of ocean best practice development (see below),
- Inclusion of collaborators from new SOPs, and
- Revision of overall number of collaborators and agencies.

Table 1 Working groups responsible for the development of the marine sampling field manuals. Working group members are listed in a table at the end of this chapter as authors or collaborators. Green indicates activity on a given field manual during a new version, while grey indicates no development or changes.

Field Manual	Working Group Lead(s)	V1 (2018)	V2 (2020)	V3 (2024)
Survey design	Scott Foster			
Multibeam	Vanessa Lucieer, Kim Picard, Aero Leplastrier			
AUV	Jac Monk, Neville Barrett			
BRUV (benthic)	Tim Langlois, Joel Williams, Jac Monk			
BRUV (pelagic)	Phil Bouchet			
Towed imagery	Andrew Carroll			
Sled and trawl	Rachel Przeslawski			
Grab and box corer	Rachel Przeslawski			
ROV	Jac Monk			
Drop cam	Tim Langlois, Jac Monk			
KAP survey	Matt Navarro, Nicole Hamre			
Microplastics	Nina Wootton, Patrick Reis-Santos			

The SOP website was also updated to reflect Version 3 (https://marine-sampling-field-manual.github.io):

- Branding for NESP Marine and Coastal Hub,
- New and revised SOPs, and
- New homepage section on 'Related Guidelines and Best Practices'
- Updated 'Downloads' section to include the journal article on best practice development

2.4 Workshop & Questionnaire

At the start of NESP Project 2.2 there was a need to solicit input from the marine science community about their needs. As such, we coordinated a workshop and questionnaire to collect this information in September 2023. The aims of the online workshop and questionnaire *Advancing National Ocean Best Practices and Standards* were 1) to improve the uptake and applicability of the national marine standard operating procedures (SOPs) and other best practices across diverse users; and 2) to guide further actions on the development of future SOPs and how they are used.

The workshop had 46 attendees, while the questionnaire had 47 respondents, both predominantly represented by people from Australia. Importantly, there was consensus to continue the SOP program in the long-term, including the possible inclusion of methods, guides, and practices outside of NESP. Recommendations and challenges related to the

SOPs were identified from the workshop and are further described later in this report. Details about the questionnaire and workshop responses can be found in (Przeslawski et al. 2023b).

2.5 Ocean Best Practices Development

The project applied learnings from the NESP SOPs to develop a framework to create an ocean best practice, including three phases 1) scope and recruit, 2) develop and release, 3) revise and ratify (Figure 2). Each phase includes underlying steps that are supported by the Ocean Best Practices System (www.oceanbestpractices.org). This framework was published using the SOPs as a case study for developing best practices (Przeslawski et al. 2023a).

In particular, we note that the NESP SOPs differ from many other practices, which often only use the second phase (develop and release). We emphasised the value of the other phases to ensure a practice is truly a 'best practice'. These phases also have other benefits, including higher uptake of a practice stemming from a sense of shared ownership (from the scope and recruit phase) and currency and accuracy (from the revise and ratify phase). Although the process we describe may be challenging, it optimises the chance to develop a true best practice that is a) fit-for-purpose with a clearly defined scope; b) representative and inclusive of potential users; c) accurate and effective, reflecting emerging technologies and programs; and d) supported and adopted by users.

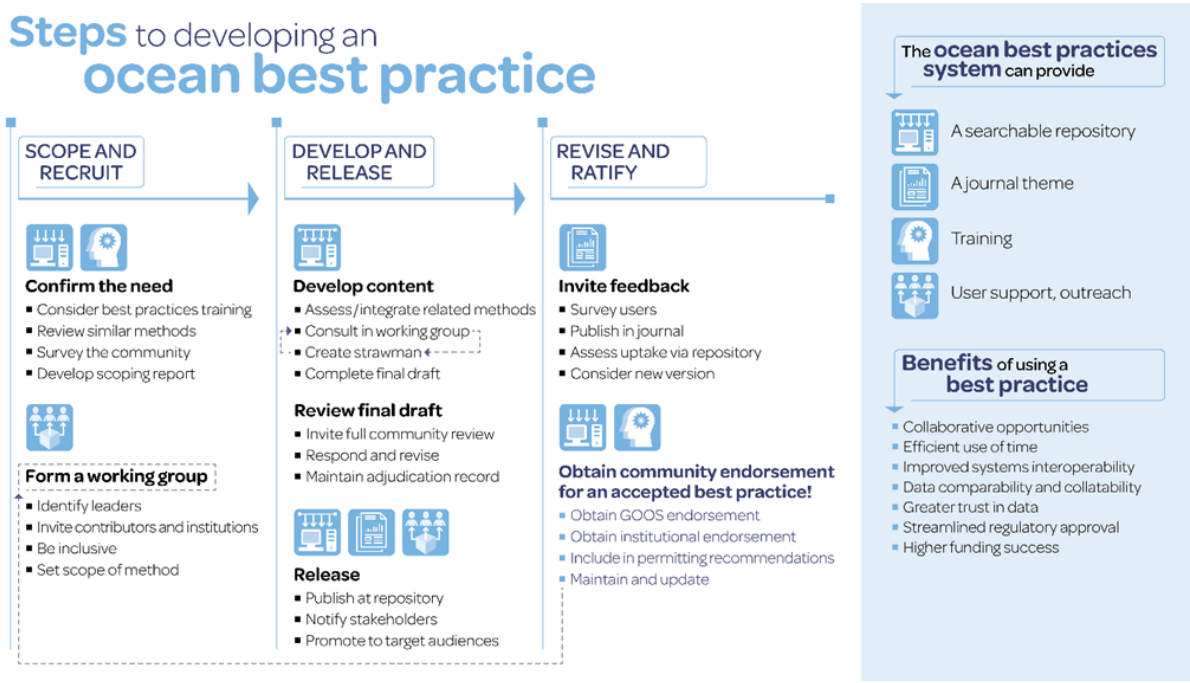

Figure 2 The three phases and associated steps required to develop an ocean best practice. Each step is linked to icons showing the relevant part of the Ocean Best Practices System that provides support.

2.6 Indigenous Partnership

This project benefited from active collaboration and input from Traditional Owners across Wadandi and Wudjari Countries in both the KAP and BOSS SOPs. This is recognised by the

co-authorship of Indigenous scientists, Cultural Rangers, Healthy Country Planners and Traditional Owners of these countries.

For these collaborations, we co-developed Research Collaboration Agreements, providing free, prior and informed consent (FPIC), that included testing and trialling both the KAP and BOSS SOPs on Country and collating feedback and input from collaborators via the Esperance Tjaltjraak Native Title Aboriginal Corporation, Undalup Association, and Karri Karrak Aboriginal Body Corporate (Figures 3, 4). These relationships and knowledge sharing have helped lay the groundwork for future Indigenous partnerships and Indigenous-led projects using the SOPs, particularly in Wadandi Country and Wudjari Country.

Figure 3 Dr Wayne Webb of the Undalup Association and Karri Karrak Aboriginal Body Corporate leading the development and implementation of the Knowledge Awareness and Practice (KAP) SOP on Wadandi Country, including the Geographe Marine Park.

Figure 4 Jeremy and Bubba-Lee of the Esperance Tjaltjraak Native Title Aboriginal Corporation deploying the BOSS Drop camera system on Wudjari Country, including the Eastern Recherche Marine Park.

3. Uptake and Impact

In this section, we briefly revisit the metrics from the 2019 report *Impact and Outcomes of Marine Sampling Best Practices* (Przeslawski et al. 2021) and provide a qualitative

assessment of the impact of the SOPs to date. Overall, there has been strong uptake of the SOPs since their release in 2018. Importantly this uptake has spanned diverse sectors: applied science, offshore industry and academic research.

Based on the metrics listed in Table 2 and responses from the workshop (Przeslawski et al. 2023b), highest uptake is among the multibeam, benthic BRUV and survey design SOPs (Figure 5). High uptake may be related to the number of co-authors, with the two most popular SOPs also having the most co-authors (Figure 5). This supports the notion that inclusive and comprehensive collaboration with multiple experts promotes use of the SOPs (Przeslawski et al. 2023a).

"The development of standardised protocols and a clear field sampling manual have proven to be a valuable resource throughout the project"

~ Marine Researcher, Centre for Environment, Fisheries and Aquaculture Science (United Kingdom)

Table 2 Outcomes related to the SOPs as determined in May 2024. The visitor count from Google Analytics encompasses the period from April 2019 to April 2024, inclusive.

Output	Source	Metric	Value
SOP journal paper (2019)	Google Scholar	Number of citations	18
	Scopus	Number of citations	11
Survey design legacy site paper (2017)	Google Scholar	Number of citations	47
	Scopus	Number of citations	25
Transect-based design paper (2020)	Google Scholar	Number of citations	29
	Scopus	Number of citations	17
Benthic BRUV paper	Scopus	Number of citations	109
Introduction (V2)	Google analytics	Number of visitors	665
Survey design manual (V2)	Google analytics	Number of visitors	2.8K
Multibeam manual (V2)	Google analytics	Number of visitors	4.3K
AUV manual (V2)	Google analytics	Number of visitors	955
Benthic BRUV manual (V2)	Google analytics	Number of visitors	3.3K
Pelagic BRUV manual (V2)	Google analytics	Number of visitors	1.0K
Towed imagery manual (V2)	Google analytics	Number of visitors	797
Grab / box corer manual (V2)	Google analytics	Number of visitors	519
Sled / trawl manual (V2)	Google analytics	Number of visitors	543
ROV manual (V2)	Google analytics	Number of visitors	918[1]

[1] *Google analytics was set up for the ROV manual in June 2023*

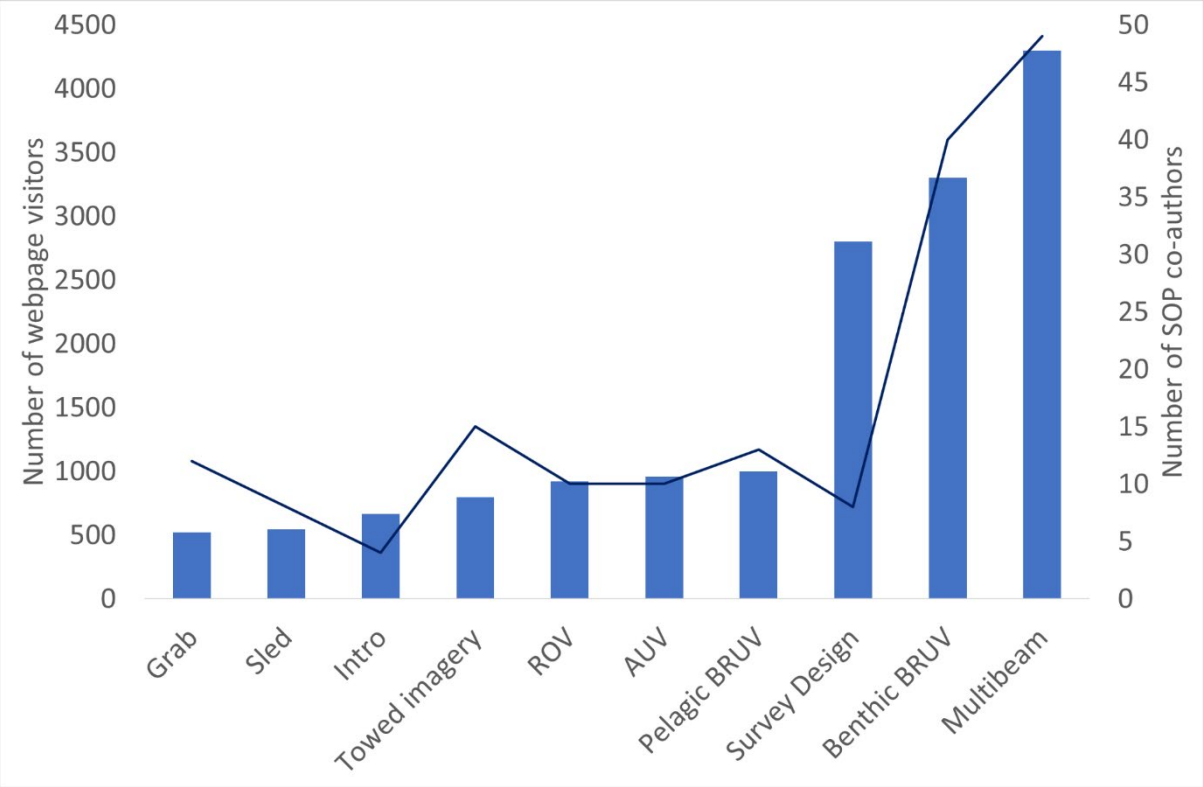

Figure 5 Number of visitors to each SOP webpage (bars) and number of co-authors (line). The ROV manual includes visitors from June 2023 - April 2024 while the others included visitors from April 2019 to April 2024.

Community endorsement of the SOPs remains high, as shown in the following ways:

- More than 228 contributors from 76 agencies contributed to the SOPs.
- Acceptance of the SOPs and their development as an endorsed project (National Best Practices in Marine Monitoring) in the United Nations Ocean Decade
- 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 (Hermes 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)
- The SOPs were cited in a statement about Australia's status as a world leader in marine monitoring in a report on offshore wind energy in Europe (Stephenson 2021).
- The SOPs are regularly applied to consultancy work, including environmental monitoring for offshore renewables (e.g. Grab and Box Corers, BRUV, Sampling Design SOPs).

"The 'SOPs are one of my bibles"

~ Marine Parks Manager, Parks Australia

At a national scale, the Australian SOPs have been used to ensure consistency in data acquisition and data quality such that data are interoperable at national scales. This allows scientists, managers and policymakers in Australia to 1) meet state and federal goals for integrated monitoring (e.g. National Marine Science Plan in (Smith et al. 2021), New South Wales Marine Integrated Monitoring Program (Aither 2022), 2) report on internationally agreed metrics at local to national scales (e.g. Essential Ocean Variables, Essential Biodiversity Variables in (Miloslavich et al. 2018, Muller-Karger et al. 2018)), and 3) adopt a best practice-based approach to monitoring the vast network of Australian Marine Parks that will ideally spread into many other applications that are comparatively unguided and unregulated regarding standards for data collection and management (e.g. naval mapping, offshore renewable energy development).

"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!"

~ Researcher, Sydney Water

At a global scale, the SOPs have contributed to the development, use, and maintenance of existing best practices (Przeslawski et al. 2023a). They have been promoted through the international UNESCO program Ocean Best Practices System. These international links help to ensure that the science we undertake in Australia can complement that undertaken elsewhere (Pearlman et al., 2021). This will contribute to improving our understanding of our global ocean and the changes it faces, which in turn will assist other ocean stakeholders in policy and management to make science-driven decisions.

The framework to develop an ocean best practice has been applied outside this project, including AusSeabed's Australian Sub-bottom Profiling Guidelines (McNeil et al. 2023). With the recent publication of the framework (Przeslawski et al. 2023a) and adoption by the Ocean Best Practices System, we anticipate this framework to also be widely adopted outside Australia.

"On the brink of a cruise…, I was informed by my team that we required an epibenthic dredge for the collection of biological samples. It was my responsibility to identify a suitable design and ensure the timely manufacture and delivery of the equipment. With sailing date looming and having no prior experience in dredge design and deployment, I frantically searched the internet for any guides that could assist me with the task at hand. Fortunately, I stumbled across the Field Manual for Benthic Sleds and Bottom Trawls…. These guides 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."

~ Instrument Technician, South African Environmental Observation Network

4. Challenges

4.1 Awareness and Adoption

Although the SOPs have been nationally and globally adopted, there are still barriers to uptake. These were identified by workshop participants as related to funding, awareness, training, content, and institutional support. Some of these barriers overlap; for example, funding is strongly linked to institutional support (Figure 6). Further details on barriers to uptake, as well as potential solutions can be found in the workshop report (Przeslawski et al. 2023b).

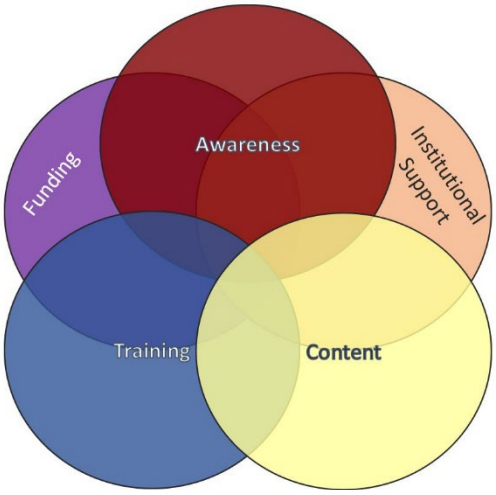

Figure 6 High-level barriers to uptake of the SOPs

There still seems limited uptake of these best practices from some State and Territory marine park agencies, as well as private consultancies and industry. There is an opportunity to better help them understand the rationale for adopting these marine sampling best practices, particularly regarding survey design.

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”. While the existing SOPS are very useful, they are not (nor should be) everything to everyone. They are still often too flexible to establish long-term monitoring programs to detect temporal change, and such long-term monitoring programs may therefore require more specific procedures within the context of a broader SOP or, conversely, a consolidated monitoring guide encompassing multiple marine sampling SOPs.

4.2 Long-term Support

To date, the SOPs have been wholly supported by projects and associated funding from NESP Marine and Coastal Hub, involved NESP partner agencies, and individual goodwill.

These projects lasted 3 years (Version 1-2) and 18 months (Version 3), and there are currently no plans for a similar SOP project in the immediate future.

Without high-level oversight, the strong momentum generated during the development and release of these best practices may fade. A previous recommendation suggested that the National Marine Science Committee take on the governance role of the SOPs, expanding beyond NESP and overseeing all Australian ocean best practices (Przeslawski et al. 2019b). As such, NESP 2.2 project members Rachel Przeslawski and Dave Souter presented to the National Marine Science Committee in February 2023 to propose that the NMSC consider taking the potential role of establishing an oversight committee for Australian ocean best practices (see recommendations below).

5. Recommendations

5.1 Endorsement

The NESP Marine and Coastal Hub has expended significant resources to create these SOPs, and communicating these efforts and their outcomes across Australia and the world is a considerable challenge. Potential users of the SOPs will also benefit from a transparent and unbiased endorsement process to identify best practices suited to their particular needs. Although the NESP SOPs have followed an internationally recognised process to develop best practices (Przeslawski et al. 2023a), only the BRUV SOP currently has international endorsement (Langlois et al. 2020) based on nomination to the Global Ocean Observing System (Hermes 2020).

In 2024, the Ocean Best Practices System released a process for recognised organisations or expert groups to register and express endorsements of practices (Bushnell and Pearlman 2024). These endorsements, and the evidence which supports them, percolate through a number of ocean data and information organisations to increase visibility and uptake of the endorsed practices.

Recommendation 1. NESP Marine and Coastal Hub via the NESP 2.2 project leader nominates all 12 SOPs for international endorsement by the Ocean Best Practices System.

5.2 Governance

After our presentation to the National Marine Science Committee in Feb 2023, there was support from some NMSC members that the Marine Environmental Baselines and Monitoring working group take on an oversight role for the SOPs and other ocean best practices in Australia. This could include identification of SOPs and best practices to be submitted to the Ocean Best Practices System for endorsement (see above), identification of new SOPs and best practices that are needed, identification of current SOPs that require revision, facilitation of discovery and uptake of best practices, and efforts to track uptake and impact.

Recommendation 2. The National Marine Science Committee annually reviews the need and capacity to develop new SOPs using the established ocean best practice development process.

Recommendation 3. The National Marine Science Committee undertakes a triennial review of existing SOPs to determine if updates are needed.

If the NMSC is unable to take on this responsibility, IMOS is a good alternative oversight institution due to their history with the SOP project and the Ocean Best Practices System, as well as their expertise in ocean observations and data management. Unfortunately, this option was not scoped in the current project, as the IMOS collaborator on this project shifted roles midway through the project and was not replaced.

Recommendation 4. If the National Marine Science Committee is unable to undertake Recommendations 2-3, IMOS should be approached.

5.3 Funding and Critical Infrastructure

Funding is required to develop new SOPs or to undertake major revisions to the existing SOPs. Financial support is also necessary to provide long-term support for the SOP website which is currently managed by only two UWA staff (Gibbons, Langlois).

Further, key components of the current information delivery pathway used by these SOPs do not have ongoing funding for development and support. For example, the GlobalArchive platform and workflows, including the CheckEM app, provide an essential service for the quality assurance and control and delivery of information key to assessment of protected areas and being actively employed for ORE and OWF assessments, in particular fish body-size information. There is currently no ongoing funding model for the development and support of Global Archive.

Recommendation 5. NESP Marine and Coastal Hub and its successors continue to fund discrete projects related to new SOPs or major revisions, as identified by the research community or the NMSC (see Recommendations 2 and 3).

Recommendation 6. NESP Marine and Coastal Hub and its successors continue to fund a project partner such that they can provide technical support and minor revisions to the SOP website and support for Global Archive.

5.4 Future SOPs and best practices

The SOPs play a key role in the monitoring, condition and management effectiveness evaluation of Australia's waters, including protected areas and existing and future infrastructure. NESP Project 2.3 highlighted the key role that SOPs play in enabling a knowledge transfer pathway to support decision making and management effectiveness evaluation (Hayes et al. 2024). The project also identified a list of potential natural value indicators for benthic ecosystem components and possible sub-components across the Australian Marine Parks, many of which have also been demonstrated to be useful for the assessment of existing or proposed offshore infrastructure. In addition to established indicators already covered by the existing suite of SOPs (e.g. demersal fish and invertebrate assemblages), the project identified the importance of body-size or vertical extent information for assessing the condition of these ecosystem components (Hayes et al. 2024). Future SOPs could support this need by providing best practices for traps and imagery from which body size or size class information of mobile and sessile invertebrates could be quantified.

Since the 2019 scoping report for new SOPs (Przeslawski et al. 2019a), several development zones for offshore renewable energy (ORE) have been declared in Australia. There is thus a renewed focus on environmental monitoring through marine biodiversity and habitat assessment (partly addressed by the existing SOPs), marine mammals (addressed through (DCCEEW 2024), and seabirds and some fish (not yet addressed by national SOPs). This information will help to inform ORE site selection, design and monitoring. It remains uncertain how all of these SOPs may combine to inform overall best practices for ORE environmental monitoring, however many of the existing SOP’s are already being employed by ORE projects (e.g. Multibeam, Grab, Survey Design, and benthic and pelagic BRUVs). In addition, industry is continuing to engage in discussions on a coordinated collaborative program to deliver environmental baselines for the offshore renewables industry in Australia. This will require consistent methods and best practices to improve the comparability and interoperability of data. NESP Project 3.3 has also compiled an inventory of best practice standards for monitoring offshore windfarms (OWFs), incorporating the SOPs alongside international experiences with OWFs and environmental monitoring. This project provided tailored advice for the development of best practices in OWF environmental monitoring in the Australian context.

Table 3 shows recommendations for future SOP development based on the information described in this report, including the NESP 2.2 workshop, ORE development, and indicators identified in NESP 2.3. Many of these SOPs will be useful for both management effectiveness evaluation of protected areas and informing the design and monitoring the impacts of offshore infrastructure.

Table 3 Future SOPs in need of development or major revision, for consideration by NESP Marine and Coastal Hub and the NMSC

Potential new or revised SOP	Type	Scope	Rationale
Seabird surveys	Sampling Target	Survey methods to assess abundance, diversity, flight path, and flight height of seabirds	Inform ORE assessments
Trap and pots	Sampling Platform	Survey methods to assess abundance by size class of mobile macroinvertebrates	Inform ORE assessments and protected area management
BRUV, ROV, Towed imagery, AUV (revisions)	Sampling Platform	Assess size or vertical extent of sessile invertebrates (colonies and individuals)	Inform ORE assessments and protected area management
Remote sensing and mapping	Sampling platform + sampling target	Aerial and satellite imagery of submerged aquatic vegetation and other key habitats (e.g. sea urchin barrens)	Inform coastal and protected area management
Recreational activity redistribution	Analyses	Predicting displaced effort from new developments/activities including ORE	Inform ORE assessments and protected area management
Cumulative impacts	Analyses		Inform various state priorities, identified by Sustainable Ocean Plan and State of Environment

Recommendation 7. As part of their annual review, the National Marine Science Committee or other identified oversight committee will first consider the potential SOPs listed in this report in Table 3.

6. Conclusions

The SOPs seem to have reached a critical momentum, whereby they are widely known and used. Overall, NESP Project 2.2 and its preceding project achieved the following outcomes:

- Contributed to an improved information flow from survey through to management decision for the task of assessing condition status of key natural values and pressures;
- Facilitated stronger and more general inferences about ecological processes, based on consistent sampling methodology;
- Aided in the cost-effective sampling of Australia's marine environment, even when sampling is performed by different institutions at different times; and
- Provided a reference point for regulatory and management agencies responsible for monitoring the trend and status of communities and individual species.

However, there are still concerns about long-term support and continued uptake of the SOPs. Ongoing funding and support will ensure that we get the maximum benefit out of the SOPs regarding national collectability and comparability of data to address the varied needs of government, industry, Traditional Owners, and researchers.

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