Marine Biodiversity Hub

National Environmental Science Programme

Scoping report:

Comparative assessment of pelagic sampling platforms

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Project D2: Standard Operating Procedures (SOP) for survey design, condition assessment and trend detection

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Photograph: Pelagic BRUVS being deployed in French Polynesia. Credits: Manu San Felix, National Geographic Society (2014).

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GLOSSARY

AUV	Autonomous Underwater Vehicle
BRUV	Baited Remote Underwater Video
CMR	Commonwealth Marine Reserve
CPR	Continuous Plankton Recorder
DOV	Diver-Operated Video
eDNA	Deoxyribonucleic Acid
LIDAR	Light Detection and Ranging
MCA	Marine Commonwealth Area
OAWRS	Ocean Acoustics Waveguide Remote Sensing

1. BACKGROUND

Despite being the most voluminous of the planet's biomes, the pelagic ocean is chronically underexplored and drastically data-deficient [1]. Australia, for instance, boasts the third biggest ocean territory in the world (by surface area), yet knowledge of both benthic and pelagic biodiversity values and processes throughout this vast estate remains largely incomplete [2]. Monitoring activities are fundamental to bridging these knowledge gaps by generating the data necessary to assess, understand and document trends in natural communities throughout the country's Marine Commonwealth Area (MCA) [3], in response to both environmental pressures and spatial management measures.

In an era of unprecedented concern about global marine defaunation [4], increasingly modest conservation budgets are placing a strong emphasis on strategic resource allocation [5]. Faced with mounting pressures to build accountability, managers and policy advisors must now more than ever make investment decisions that are not only wise but also cost-effective [6]. This can be challenging given the smorgasbord of modern survey tools currently available, most of which differ widely in costs, capabilities, mobilisation constraints, resolution or sensitivity, and are evolving very rapidly without always being critically evaluated or compared. In recent years, novel technologies for sampling pelagic organisms and/or habitats such as drifting videography [7], environmental DNA [8], unmanned (airborne or waterborne) vehicles [9], or wireless sensor networks [10] (among many others) have emerged and have been gaining traction. They can supplement (or sometimes replace) more traditional and longer-established pelagic sampling approaches like midwater trawling [11], aerial and vessel-based visual transects [12-14], passive and active acoustics [15], electronic telemetry [16-18], or remote sensing [19, 20], yet protocols for choosing optimal combinations of methods for a given region, taxonomic/indicator group, or environment remain generally unavailable. Additionally, the few published studies that weigh up the merits and caveats of multiple sampling gears typically do not report explicit cost estimates, thereby undermining their potential to match research and management needs [21].

This scoping report provides the basic framework for a subsequent comparative synthesis report aimed at critically appraising a range of pelagic sampling platforms, particularly with respect to their suitability for supporting the long-term monitoring of the national Commonwealth Marine Reserve (CMR) network within the Australian marine estate. It is an output from the National Environmental Science Programme (NESP) expanded Project D2 ('Standard Operating Procedures for survey design, condition assessment and trend detection'), and is complemented by a similar report focused on benthic sampling techniques.

2. PROPOSED OUTLINE

Below is a provisional outline for the comparative assessment of pelagic marine sampling platforms:

Chapter 1: Introduction

- Background
- Scope
- Objectives

Chapter 2: Review of Platforms[1]

- Capture sampling (trawls, gillnets, longlines … but also CPR, light traps etc.)
- Still/video imagery (DOVs, AUVs, pelagic BRUVs, aerial photography, animal-borne imaging etc.)
- Acoustics (passive, active)
- Telemetry (satellite, acoustic)
- Molecular genomics (eDNA)
- Unmanned systems (drones, underwater vehicles, gliders)
- Remote sensing (e.g. ocean colour, but also megafauna such as whales etc.)
- Others platforms as identified through the literature review

Chapter 3: User perceptions of Platforms

- Delivery and analysis of an online questionnaire gauging the use of, and perceptions on, pelagic sampling platforms[2] within a broad cross-section of the scientific community
- Recommendations derived from analysis of user perspectives

Chapter 4: Comparison of Platforms

- Review of existing studies using multiple platforms & their findings[3], with an emphasis on ability to reliably detect known biogeographic patterns
- Case study using the Bremer Canyon Emerging Priorities Project as an example
- If possible (i.e. considering data quality, quantity, accessibility etc.), quantitative comparison of real datasets from multiple platforms[4]

[1] This list is indicative and will be refined (expanded) following completion of the literature review.
[2] Modelled against the online questionnaire on benthic sampling platforms undertaken by the Hub late 2016.
[3] Examples (identified through a preliminary search of the published literature) include [22-25].
[4] In a similar manner to [26] and subject to data availability. Suitable datasets will be identified via the literature search and the online questionnaire.

Chapter 5: Potential of Platforms for Monitoring

- Monitoring objectives
- Assessment of each class of platforms against the aforementioned objectives

Chapter 6: Development of a Support Tool to Facilitate Monitoring Decisions.

- Feasibility study for the development of a tool to assist managers in selecting appropriate monitoring techniques for a given goal, time horizon, budget etc. The tool could, for instance, be adapted from the Cost Effective Resource Allocator introduced by [27].
- Conditional on the above, development of the tool/app, e.g. in Excel spreadsheet or R Shiny format and presentation of illustrative examples.

Chapter 7: Conclusions and Recommendations

- Summary of main findings
- Guidelines for further research, particularly in the context of current knowledge gaps, monitoring needs, and likely future technological developments

3. PROPOSED METHODS

3.1 **Literature review** (proposed chapters 1, 2, 4 and 5)

Using both the Web of Science and Google Scholar search engines, the literature will be reviewed for existing descriptions, field tests, summaries, and comparative evaluations of pelagic sampling methods, from which a comprehensive list of known platforms and their characteristics will be compiled (Table 1, Table 2). Previous NERP/NESP Hub outputs will be targeted to ensure consistency and legacy value [3]. In particular, we will build upon [28]'s review on sampling techniques for mobile oceanic predators.

Table 1: Table template summarising the major types of pelagic sampling platforms and their acquisition targets. Ellipses indicate information to be included in the comparative assessment report.

	Method	**Data Type**	**Target**	**Coverage**	**Habitat**
Imagery	Pelagic BRUV	Abundance, size, diversity, community composition	Pelagics	Point counts (moored) or transects (drifting)	All
	Aerial photo	…	…	…	…
	Aerial video	…	…	…	…
	Animal-borne	…	…	…	…
Acoustics	OAWRS	…	…	…	…
	Passive	…	…	…	…
	Active	…	…	…	…
Direct sampling	Midwater trawl	…	…	…	…
	Gillnet	…	…	…	…
	Longline	…	…	…	…
	CPR	…	…	…	…
Remote sensing	Satellite imagery	…	…	…	…
	LIDAR	…	…	…	…
…	…	…	…	…	…

Table 2: Table template listing the advantages/disadvantages of key pelagic sampling platforms. Ellipses indicate information to be included in the comparative assessment report.

	Pelagic BRUVs	Aerial surveys	Direct capture	Telemetry	…
Non-destructive / invasive	X	X	…	…	…
Able to revisit same sites	X	X	X	…	…
Species-level identifications[5]	X	X	X	X	…
Genetic analysis possible	…	…	X	X	…
Costs (per day, per sample)	…	…	…	…	…
…	…	…	…	…	…

[5] Refers to identifications able to be made with unknown or cryptic species (i.e. well-known, distinctive species can be identified via imagery).

To identify potentially useful data and results incorporating multiple sampling platforms, the literature will also be searched using keyword combinations of various gear types. Any study in which two or more of the sampling platforms are deployed and associated data analysed will be short-listed for inclusion in a meta-analysis.

3.2 **User questionnaire** (proposed chapter 3)

An online questionnaire will be administered via the SurveyGizmo or Google Forms platform. All NESP researchers will be invited to contribute and additional respondents will be identified through selected directories, listserves, and chain referral within relevant academic, government, non-government, and industry organizations worldwide. For example, the University of Victoria's MARMAM or the University of Queensland's Spatial.Ecology email digests could be used as forums to reach a large part of the international scientific community. Likewise, the Australian Marine Science Association (AMSA) and the Australian Society for Fish Biology (ASFB) could help target Australian networks. Where possible, survey results will be analysed 'in real time' such that a summary map can be generated iteratively to identify where responses have been gathered and generate regionally-based incentive to solicit information from under-represented regions.

3.3 **Meta-analysis** (proposed chapters 4 and 5)

A qualitative (or quantitative, wherever possible) meta-analysis will be undertaken based on the number and quality of studies short-listed from the literature review. It seems unlikely that a quantitative analysis will be possible at a broad scale since preliminary work has shown high variation within a sampling platform type, as well as limited data available from multiple platforms within a particular survey. Rather, quantitative analyses may be done on particular studies and datasets from given surveys.

Based on the findings from the literature review, each pelagic sampling platform will also be assessed regarding its utility in measuring and monitoring trends in ecological indicators, as identified from published research and communication with Department of Environment.

3.4 **Decision support tool** (proposed chapter 6)

We will attempt to adapt the Cost Effective Resource Allocator put forward by [27] into a tool that can be used to select appropriate pelagic sampling platforms (or combinations thereof) for monitoring purposes. As the resource allocator explicitly considers costs and value benefits, a challenge will be to accurately quantify those for each pelagic gear. At minimum, a simple decision tree will be created to guide methodological choices based on budget brackets and summary information for each class of platforms.

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