

COMMONWEALTH OF AUSTRALIA

**NEARSHORE MARINE HABITAT MAPPING OF THE NORFOLK
MARINE PARK**

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1 INTRODUCTION

1.1 Australian Marine Park Context

The Norfolk Marine Park (hereafter, 'the Park') is the most easterly of the Temperate East Marine Park Network, which contains eight Australian Marine Parks located between the NSW coast and Norfolk Island (**Figure 1**). Its waters encompass 188,444 km² of ocean and range in depth from 0 m at the Norfolk Island high tide mark to 5000 m off the edge of the Norfolk Ridge. Nepean and Phillip Islands, which sit 1 km and 6 km south of Norfolk Island, are also located within the boundaries of the Park. The Park is significant because it contains habitats, species, and ecological communities associated with the Norfolk Island Province. It includes two key ecological features – the Norfolk Ridge, and the Tasman Front and associated eddy field – both of which are valued for their high productivity, aggregations of marine life, biodiversity, and endemism.

The Park supports a range of species, including species listed as threatened, migratory, marine, or cetacean under the Environment Protection and Biodiversity Conservation (EPBC) Act (1999). Biologically Important Areas within the Park include breeding and foraging habitat for seabirds, marine turtles, and a migratory pathway for humpback whales.

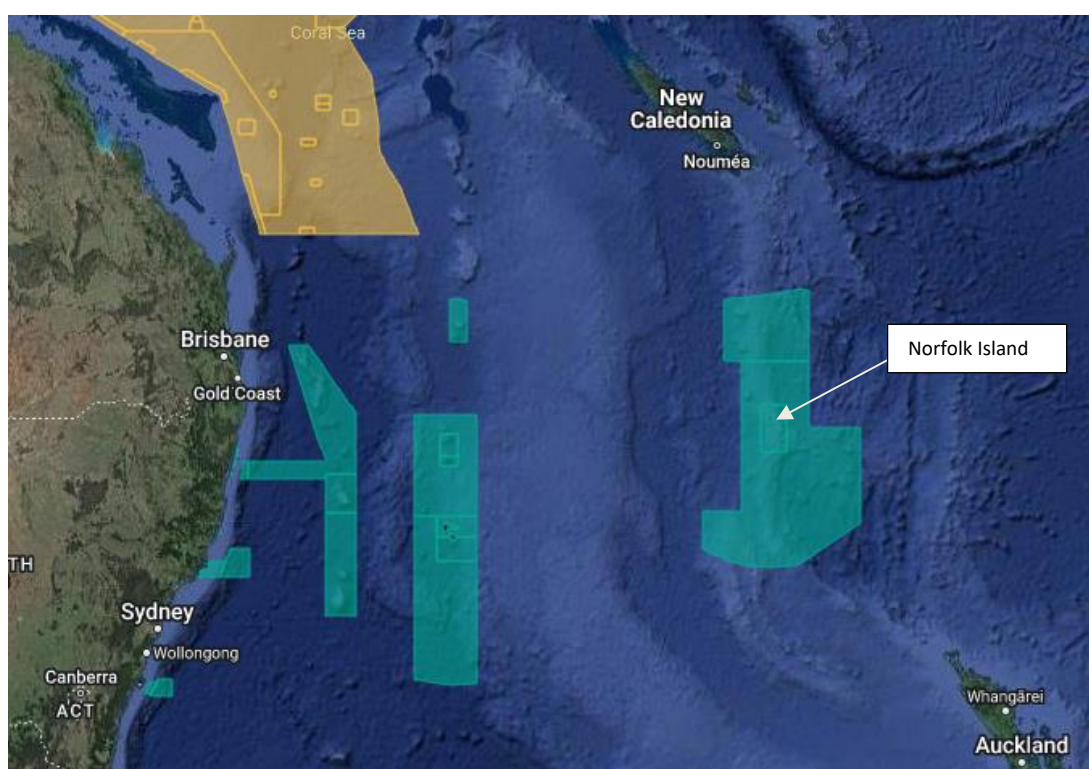


Figure 1: Temperate East Marine Park Network in eastern Australia. Green shading indicates included Marine Parks.

The Park contains three separate zones (**Figure 2**); a National Park Zone, a Habitat Protection Zone, and a Special Purpose Zone (Norfolk). Norfolk Island is located within the Special Purpose Zone (Norfolk), which is delineated by the area covered by a Memorandum of Understanding (MoU) with the Australian Fisheries Management Authority (AFMA) for the inshore fishery area, known locally as the “MoU Box”.

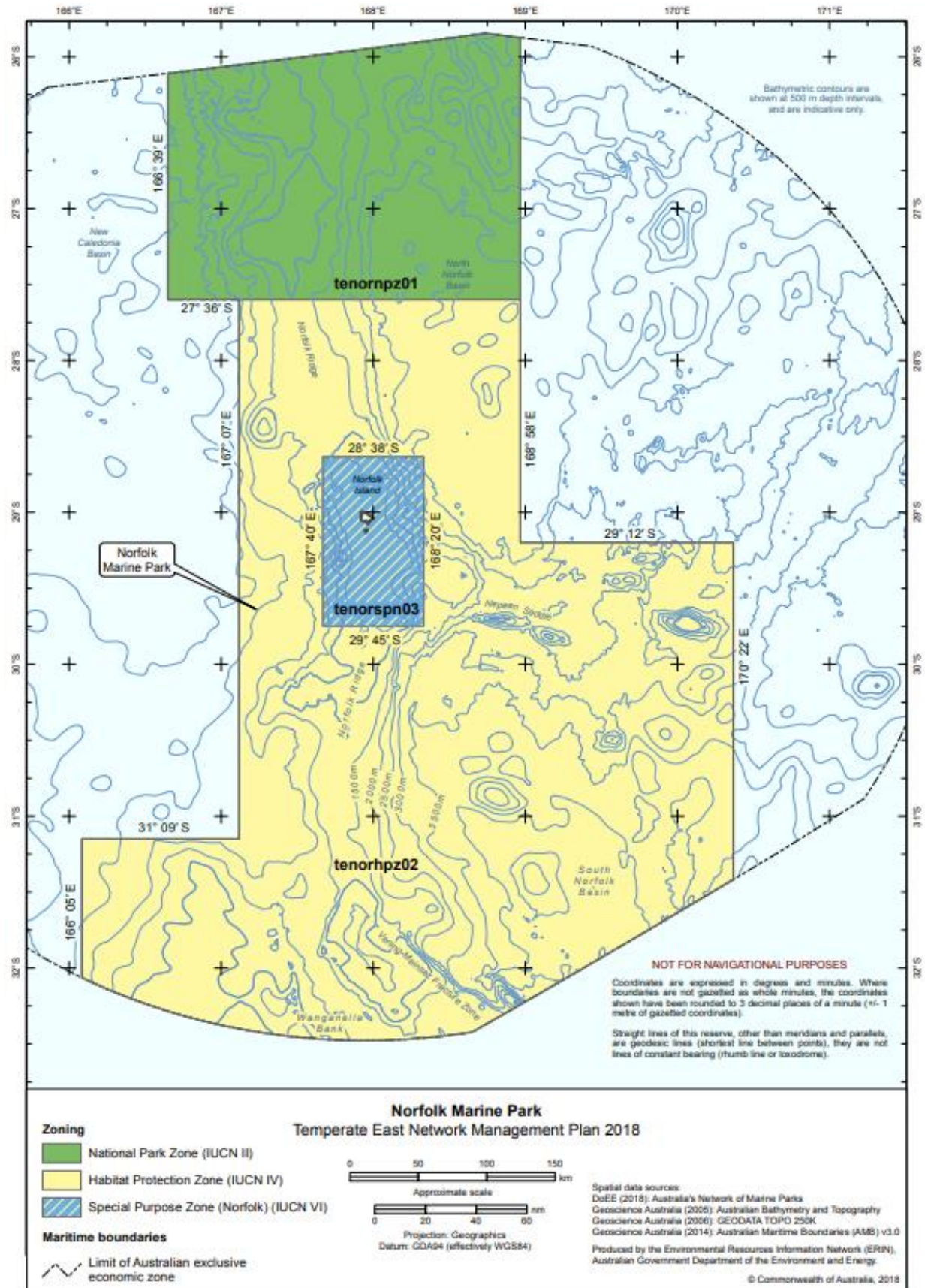


Figure 2: Zones of the Norfolk Marine Park.

1.2 Existing Knowledge

A comprehensive reference list and summary of the available information on the marine environment and species lists for Norfolk Island is contained in Appendix B of the Advisian report to the Commonwealth Government titled 'Marine and Terrestrial Ecology Assessment of the Kingston Pier Channel Construction' (Advisian 2021). A list of the marine flora of Norfolk Island was also published by Millar (1999), who recognised 236 species comprising "one of the more biogeographically diverse floras of the worlds oceanic islands". While no endemic flora were identified in this earlier study, 106 of the 41 Chlorophyta, 41 Phaeophyta, and 154 Rhodophyta species were found to be shared with the Great Barrier Reef, New South Wales Coastline, and Lord Howe Island. These locations are all linked via the East Australian Current (Jeffrey et al. 1990), which brings water ranging in temperature from 19°C to 26°C to Norfolk Island and facilitates the occurrence of marine algae at depths of 16 – 28 m at this location (Millar 1999).

A survey conducted in 1999 identified the coral assemblage around Norfolk, Phillip and Nepean Islands as one of the southern-most coral assemblages in the world and one of the few known examples of a transitional algae and coral assemblage, i.e., there is an unusual mix of tropical and temperate marine fauna and flora due to the alternating influence of warm and cool currents at the Islands (Kuster 2001). Kuster (2001) and Zann et al. (2001) concluded the reefs were not actively accreting and therefore are not true coral reefs. The slow growing encrusting coral characteristic of the ecosystem occurs as a thin veneer over the rocky substrate and appears to be growing at a similar rate as they are eroded and physically destroyed.

Kuster (2001), summarising the findings of a 1999 survey, found that the inshore benthic communities were dominated by relatively few species of subtropical hard corals co-existing with a high diversity of algae. The 57 species of scleractinian corals (27 genera in 11 families) comprises a unique association of tropical and temperate species of global biodiversity value. While he reported a moderately high species diversity, only six subtropical species accounted for almost 50% of the coral coverage. Most of the other species were uncommon or rare (Zann et al. 2001). The Norfolk Island region coral communities form part of a chain of reefs that may be essential in maintaining a supply of larvae dispersed from source reefs to the west, probably Lord Howe Island, Elizabeth and Middleton Reefs. Kuster (2001) further concluded that the domination of coral diversity by so few species together with the cool water temperatures generating conditions that are marginal for coral growth may make the coral communities vulnerable to disturbance.

Knowledge of coral assemblages within the Park has been further expanded in recent years, with a study on corals in Emily Bay and the Slaughter Bay Lagoon at Norfolk Island, including additional species lists, being prepared for Parks Australia by a consortium of Universities (Sydney Institute of Marine science, UNSW, James Cook and the University of Newcastle; Ainsworth et al. 2021). Overall, however, marine invertebrates remain poorly studied and the known list of sessile species is limited to one ascidian, one sponge and three anemone species (Advisian, 2021). Mobile invertebrates present within the Park include sea stars, sea cucumbers, brittle stars, and feather stars. White-tipped and black sea urchins are also common around the island. A summary of the turtle records of Norfolk Island has been published by Pendoley and Christian (2011).

Alongside the reference list and studies described above, other unpublished species lists for the Park included here in **Appendix A** are:

- A list of corals compiled by Dr Charlie Veron (1997)
- A list of fish species compiled by Jack Marges from research by Dr Malcolm Francis and Dr Jack Randall (1998)
- A list of algae, invertebrate, and fish species found in Ball Bay, Norfolk Island, by local divers Jack Marges and Karlene Christian (1995)

Despite these numerous resources, however, there is currently no habitat map available for the marine environment surrounding Norfolk Island, and the nearby Nepean and Phillip Islands. The data resulting from these aforementioned single-point-source marine surveys that were largely carried out by visiting experts have not, to-date, been captured in a single place or compiled into a single habitat map, nor has any of the expertise or gained knowledge been passed onto local community members. This lack of habitat mapping hinders ongoing monitoring of the local marine environment and leaves a large gap in the knowledge used for impact assessment of marine activities around the island. This project aimed to close this knowledge gap by using local community members to collect data for input into a high-level marine habitat map for the Norfolk Marine Park.

2 AIMS AND OBJECTIVES

The objective of this project was to create the first marine habitat map for the nearshore shallow water surrounding Norfolk, Nepean, and Phillip Islands in collaboration with Norfolk residents who could provide local knowledge input to the ground-truthing and mapping surveys. The long-term objective was to engage and educate the local community in monitoring the health of their marine environment.

This high-level habitat map will be used for planning purposes, development applications, and EPBC Act referrals within the nearshore waters of the Norfolk Marine Park, where no specific zoning for recreational and commercial activities currently exists. For example, there is an urgent need for ship anchoring zones and anchor exclusions zones to be identified, as well as locations for permanent moorings to be established, which currently do not exist at the island.

The map will also provide a basis for any ongoing citizen-science-driven marine habitat impact and condition assessments, and monitoring. The map can be further refined as more detailed information becomes available from subject matter experts in the future. The capture, collation, and storage of data by local residents as facilitated through this program will ensure that information is retained on the island for future reference and, by involving the community in the data collection process, it will give them ownership of any future zoning planning.

This project involved Norfolk Island residents collecting marine habitat data that was subsequently used to ground-truth habitat maps of the Park that were prepared using remote sensing techniques.

The project was conducted in six stages;

1. Creation of a high-level habitat map using satellite imagery and specialised algorithms to assign habitat type classifications (service provide by EOMAP Pty Ltd).
2. Public consultation with local fishermen, surfers, and divers at Norfolk Island to get feedback on the accuracy of the habitat classifications derived through remote sensing.
3. Ground-truthing of the derived maps using a team based at Norfolk Island.
4. Processing of the ground-truthed survey data to assess the accuracy of the habitat classification process..
5. Modification and remapping of the habitat types identified in the satellite-image derived map based on the ground truthing field data (by EOMAP).
6. Upload of a publicly available habitat map to be hosted on the Norfolk Island Flora and Fauna Society web page, including the provision of links to captured field images embedded in the map that can be easily viewed by the general public.

3 METHODS

3.1 Satellite Image Base Mapping

The remote sensing company, EOMAP, produced a Very High Resolution Benthic Habitat Mapping output that used satellite images to map the seabed within an ~70 km² Area of Interest around Norfolk, Phillip, and Nepean Islands at a 2 m spatial resolution (**Figure 3**). The Area of Interest was selected as it was deemed optically shallow, i.e. suitable for satellite-based mapping of bathymetry at 2 m resolution. The satellite imagery used was the Archived WorldView-2/3 (mosaic of 2018 dates). The maximum mapping depth was ~25 – 30 m with local variations.

The EOMAP algorithms used satellite images to analyse the main sea bottom albedo types and classified areas of seafloor based on reflectance as a function of texture and spectral characteristics. The seafloor classes were then linked to common major habitat types, including seagrass, corals, hardbottom substrate, and unconsolidated sediment.

The outputs included a Very High-Resolution (2 m) Benthic Habitat Map, seafloor habitat classification shapefile (ESRI polygon), metadata file (XML), and copy of the classified habitat area map (PDF).

3.2 LiDar data

Between 2015 and 2016, the Royal Australian Navy's Hydrographic Service used Laser Airborne Depth Sounder (LADS) to acquire bathymetric data in the vicinity of Norfolk, Phillip, and Nepean Islands for the purposes of improving nautical charting in the area for safe navigation of coastal and commercial shipping. These bathymetric data were used in this project, and are subject to the following Copyright Notice:

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Purpose and Conditions

1. *Supplied data may be used to assist with survey planning around Norfolk Island for the Australian Marine Parks seabed mapping project.*
2. *The following notice is to be included on any maps, diagrams or similar derived products containing AHO Material:*

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Figure 3: The Area of Interest (yellow) around Norfolk, Phillip and Nepean Islands identified by EOMAP estimated to be optically shallow, i.e., suitable for satellite-based mapping of bathymetry at 2 m resolution.

3.3 Satellite Image Ground-Truthing

3.3.1 Public Consultation

Project team members, K. Pendoley and M. Christian, gave a radio interview with Radio Norfolk Island on Friday 14 October, 2022, to promote and discuss this mapping project. K Pendoley then met with the Norfolk Island Flora and Fauna Society on 17 October 2022 and gave a presentation to the Society members and interested observers on the nearshore habitat mapping project. Attendees were invited to review the satellite-imagery derived maps and to provide the project team with feedback. Twenty individuals attended this meeting.

Another public consultation was held with Norfolk Island residents on 20 October 2022, when specific individuals with strong links to fishing, surfing, and diving were personally invited to a second presentation of the project and to review and comment on the satellite imagery derived maps. A total of 12 people visited over the 2-hour open-house period.

Additionally, K. Pendoley met with J. Marges on 20 October 2022 to review the maps and to collect notes on coral species lists compiled by Charlie Veron, as well as any available fish species lists.

3.3.2 Field Survey Timing and Location

The ground-truthing field survey dates and areas covered during the survey are shown in **Table 1**. The GPS locations of each ground-truthing sampling location is listed in **Appendix B**.

Table 1: Ground truthing survey days, dates, and geographic area covered.

Survey day	Survey date	Zone targeted
Day 1	14/10/2022	Norfolk Island: North coast
Day 2	15/10/2022	Norfolk Island: West coast
Day 3	16/10/2022	Norfolk Island: South coast
Day 4	18/10/2022	Phillip and Nepean Islands
Day 5	19/10/2022	Nepean Island and Ball Bay
Day 6	20/10/2022	Cascade/Steels Pt/Elephant Rock
Day 7	21/10/2022	Elephant Rock, filming for YouTube clip

3.3.3 Field Survey Methods

The equipment used to ground-truth the satellite-derived habitat map was designed to be cheap and simple to operate. Off-the-shelf components included a GoPro Hero 9 camera and waterproof housing (rated to 30 m), and a panel of LED dive lights (**Figure 4**). These were attached, facing directly downwards, to a locally manufactured dropper system comprising a metal pole with a vane arrangement at the top to prevent camera rotation. Following Day 1 of the survey, a second Go Pro Hero 9 was attached to the top of the pole and aimed horizontally to capture a landscape view of the seabed. The complete array was deployed using an electric fishing rod, with the line marked in 10 m segments to measure water column depth. At each sampling location, the fishing line was allowed to

run out freely until the dropper system reached the seabed and was then wound back to allow the system to hover ~ 1 m above the seabed while the boat drifted at the surface for 2 – 3 minutes.

The GoPro's were set to video mode and switched on immediately prior to deployment. The camera settings were 4k at 60 frames/sec on the down camera and 4k at 30 frames/sec on the side camera. Data was collected on micro-SD cards and downloaded daily.

Sampling locations were selected based on the EOMAP satellite habitat map, with the aim to ground truth benthic habitat at as many different depths across the identified habitat types as possible. Locations were surveyed along pseudo-transect lines, starting with the sites in shallow water near the coast and extending to those offshore into waters up to 40 m depth. Sampling locations were labelled and identified using waypoint numbers on the boat depth sounder. The associated latitude and longitude for each waypoint was downloaded from the sounder following each survey day.

A whiteboard slate was used on-board the vessel to note the following information for each sampling location prior to camera deployment:

- Date and time (day:month:year, 24 hour clock)
- Geographic location (site)
- Waypoint number (wpt)
- Depth (m)
- Seabed description from depth sounder output
- Notes on the location

A brief video of the whiteboard slate was collected immediately prior to the camera being deployed overboard at each sampling location (**Figure 5**).

3.3.4 Data Processing

The videos were downloaded to a hard drive daily. They were sorted by waypoint and selected images representative of each site (~ 5 per site) extracted for use in a publicly accessible map. The full-length videos from each site were also edited down to short clips suitable for uploading to a web site.

Each of the full-length video clips was viewed by a qualified marine biologist who assigned a habitat type to each individual waypoint site. This was then compared to the habitat classification derived from the satellite imagery mapping. The satellite habitat map was then annotated with the ground truthed information, specifically sites that differed from the satellite map were identified and labelled with the actual seabed type.

3.4 Map Hosting and Access

Each of the representative images and edited videos were linked to the Survey site Waypoint (GPS location). This relationship data was then stored within a JSON file. JSON (JavaScript Object Notation) is an open standard file format for sharing data that uses human-readable text to store and transmit data. All JSON linked images and videos were then uploaded to the Norfolk Flora and Fauna website. An annotated satellite habitat map was then built using the Google Maps JavaScript (JS) Application

Programming Interface (API), the JSON file was used to create each waypoint location and link the corresponding videos and images to that location. The annotated satellite habitat map was uploaded to the Norfolk Island Flora and Fauna website.

As part of the data processing, a 2 minute video of the project was produced by Eye Design Films for upload to YouTube. The link can be found on the Norfolk Island Flora and Fauna website.



Figure 4: Survey equipment for marine habitat ground-truthing, including camera and LED light array (top) and electric fishing rod (bottom).

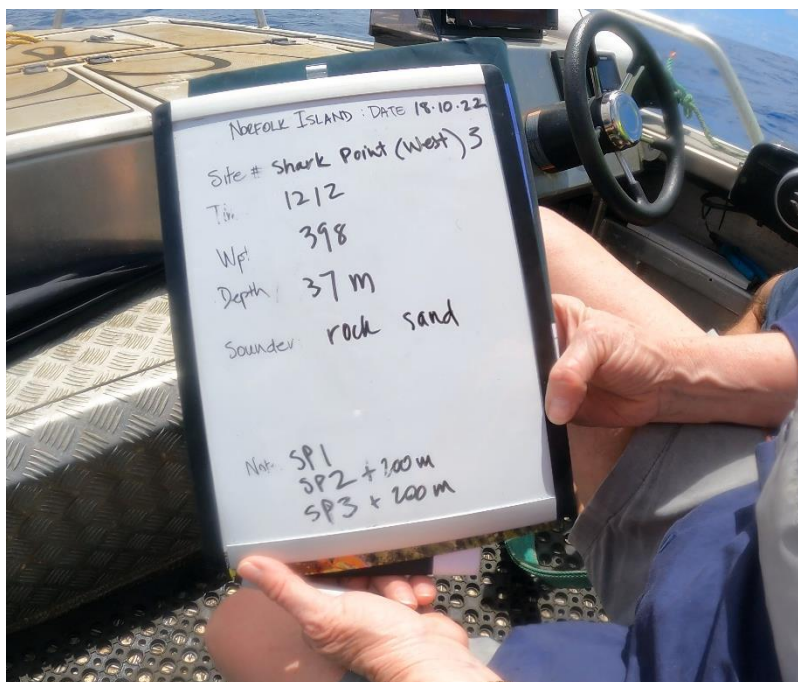


Figure 5: Metadata collected at each sampling location within Norfolk Marine Park.

4 RESULTS AND DISCUSSION

4.1 Satellite Habitat Map Classifications

The satellite image-derived habitat maps produced by EOMAP are shown in **Figure 6** and **Figure 7**. The two most geographically extensive habitat types identified were

1. Hardbottom / rock – partly covered with coral and macroalgae
2. Unconsolidated sediment (sand /gravel, uncovered)

The automated classification also included areas dominated by coral, seagrass, or rock with macroalgae or uncovered rock.

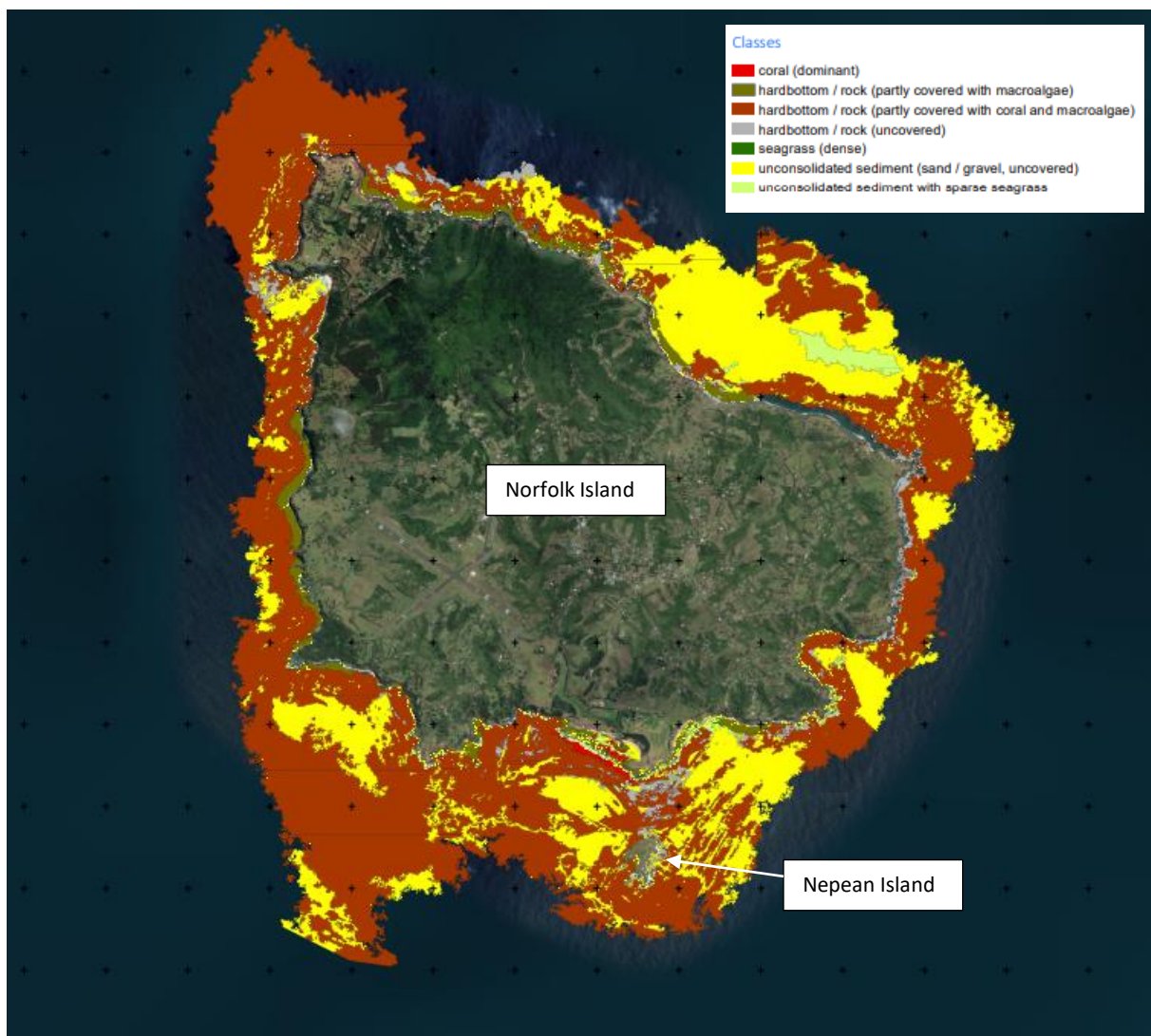


Figure 6: Satellite-image derived marine habitat classifications surrounding Norfolk and Nepean Islands.

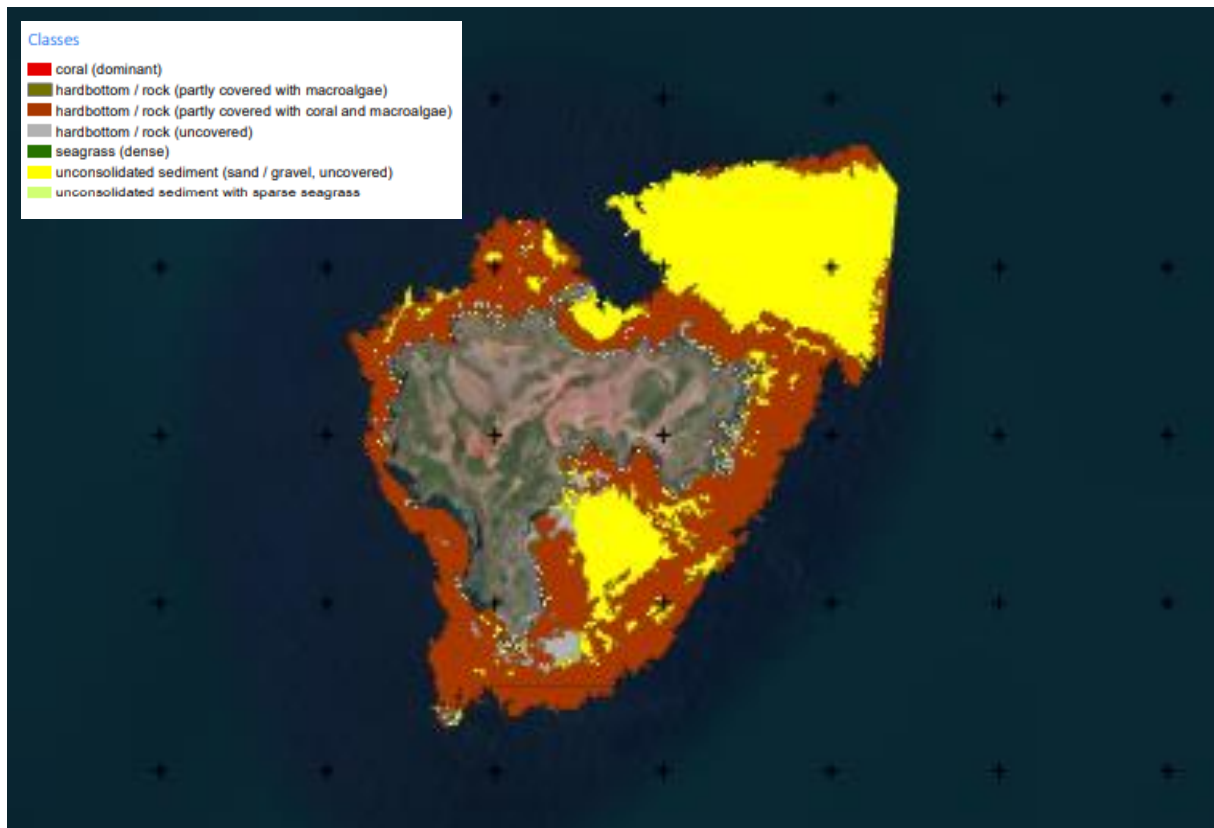


Figure 7: Satellite image derived marine habitat classifications surrounding Phillip Island.

4.2 LiDar Data

The Lidar map for the nearshore waters is shown in **Figure 8**. These data were used together with the satellite-derived habitat map (**Section 4.1**) to select the sampling locations for the ground-truthing survey conducted in October 2022.

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4.3 Ground Truthing Survey

Seabed video data from a total of 169 sampling sites was collected during the ground-truthing field survey. The complete data set is listed in **Appendix B** and metadata collected for each of the sites includes:

- Date,
- Time,
- Latitude and longitude,
- Waypoint number,
- Satellite map classification, and
- Ground-truthed habitat classification



Figure 8: LiDar bathymetry map for Norfolk, Nepean, and Phillip Islands.

4.4 Habitat Classifications Following the Ground-Truthing Survey

With the exception of seagrass habitat, the first set of habitat classifications derived from the satellite imagery (see **Appendix C**) were largely consistent with the ground-truthed data. Seagrass has never been found at Norfolk Island, and this was confirmed by Jack Marges (*pers. comm.*, 20 October 2022). The areas identified as seagrass (sparse or dense) from the satellite imagery were inspected in the field and found to be bare sand comprising white and black sediments (**Figure 9**).

Black sea urchins were extremely common on a combination of hard bare rock, coral, and macroalgae habitat, and in some cases were present in very high densities (~10 urchins/m²; **Figure 10**). White sea urchins were less common and found primarily on hard rock macroalgae habitat (**Figure 11**).

Nearshore, the seabed was characterised by hard bottom rock which was either bare uncovered rock (**Figure 12**), covered with coral (**Figure 13** and **Figure 14**), coral and macroalgae (**Figure 15** and **Figure 16**), or with macroalgae and little to no coral (**Figure 17**). Coral and macroalgae were present on exposed rock ledges and reef tops, on spur and groove formations, and on rocky outcrops emergent from sandy seabed habitat (**Figure 18** to **Figure 20**).

4.5 Revised Habitat Maps

Following the confirmation that seagrass does not occur in the Park, the data collected during the ground-truthing survey described in **Section 4.3** and **Appendix B** was resubmitted to the habitat mapping company, EOMAP, for input into the original satellite image habitat mapping model. These field data were used to retrain the model and the satellite images were subsequently remapped and habitat classifications refined using this information; producing the final habitat map. In addition to 'Seagrass' no longer being listed as a habitat type within the Park, the habitat category "Hardbottom / rock (uncovered, partly colonized by urchins)" was incorporated into the revised map following the observation of urchin barrens across sampling sites. The final maps are presented in **Figure 21** to **Figure 24**.

4.6 Map Hosting and Access

The results from this project are all publicly available through the Norfolk Island Flora and Fauna Society website (<https://norfolkislandfloraandfauna.net>), under the Norfolk Island marine habitat mapping project web page, which can be found [here](#). The project information collated on the website includes:

1. Final habitat maps
2. Interactive map Google Earth map (<https://norfolkislandfloraandfauna.net/marine/habitat-mapping/>) with links to representative images and video clips for each 168 survey sampling locations and can be easily explored by the public,).
3. LiDar bathymetry map (<https://norfolkislandfloraandfauna.net/marine/habitat-mapping/lidar-map-of-seabed/>),

A short You Tube video of the ground-truthing survey can be accessed on the Flora and Fauna site and on YouTube

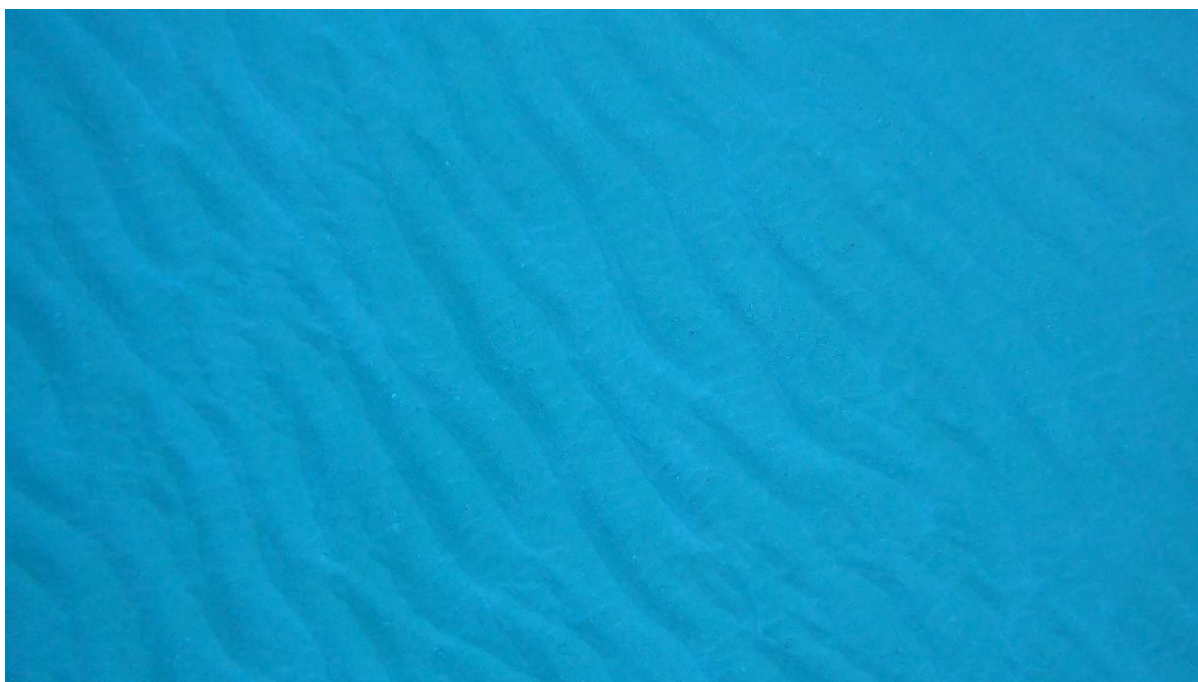


Figure 9: Unconsolidated sediment (US) at Site 335 (frame 126).

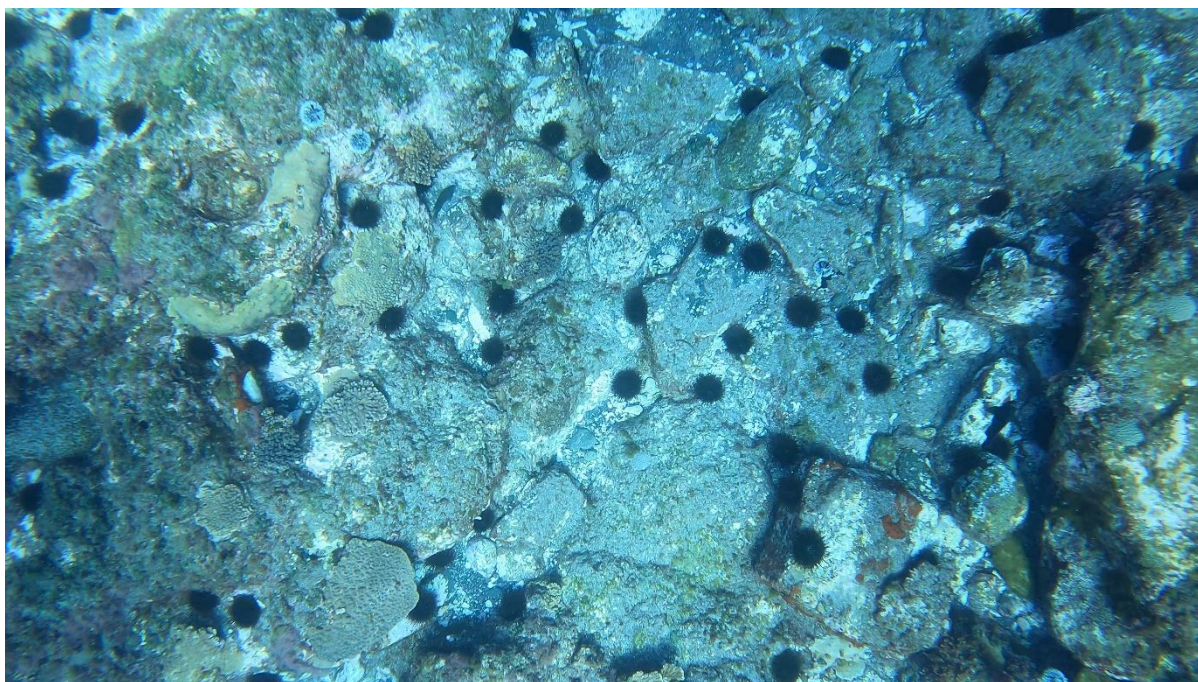


Figure 10: Bare rock with high-density black urchin barren at Site 383 (frame 54).



Figure 11: Macroalgae and high-density white urchins at Site 403 (frame 74).

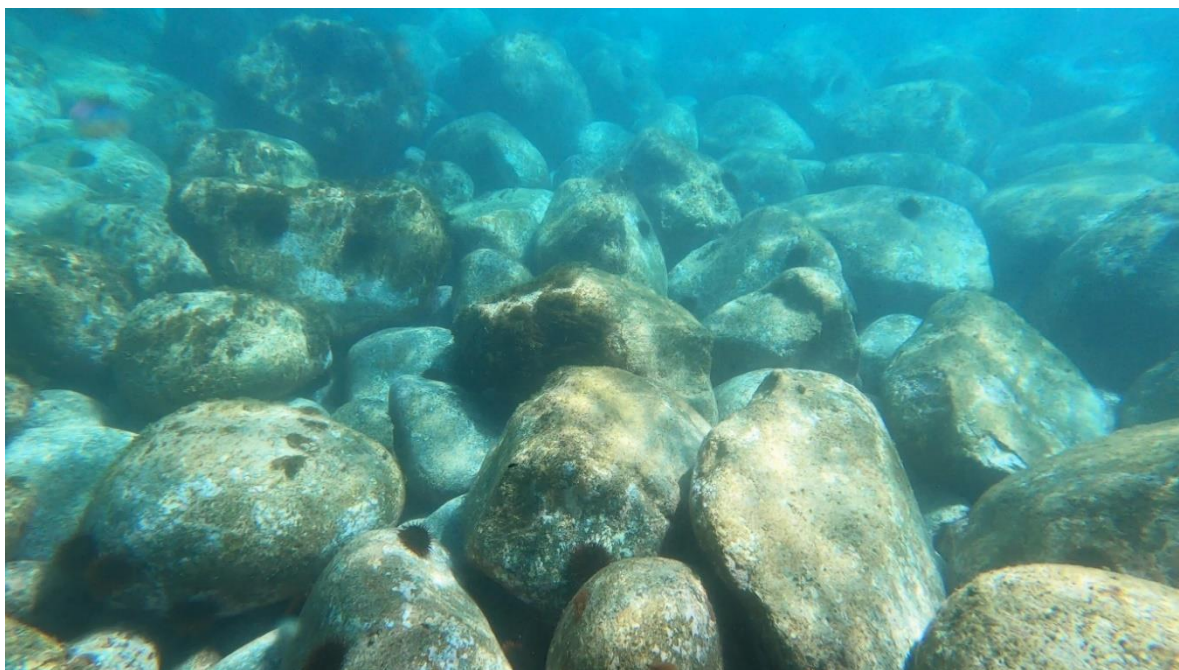


Figure 12: Bare rock at Site 426 (frame 49).



Figure 13: Coral at Site 435 (frame 360).



Figure 14: Coral at Site 332 (frame 25).



Figure 15: Hard Bottom Rock + Macro Algae (HBR + MA) at Site 441 (frame 41).



Figure 16: Hard Bottom Rock + Macro Algae (HBR + MA) at Site 429 (frame 8).



Figure 17: Sand and Sand veneered rock and Macroalgae (HBR + MA) at Site 365 (frame 84).



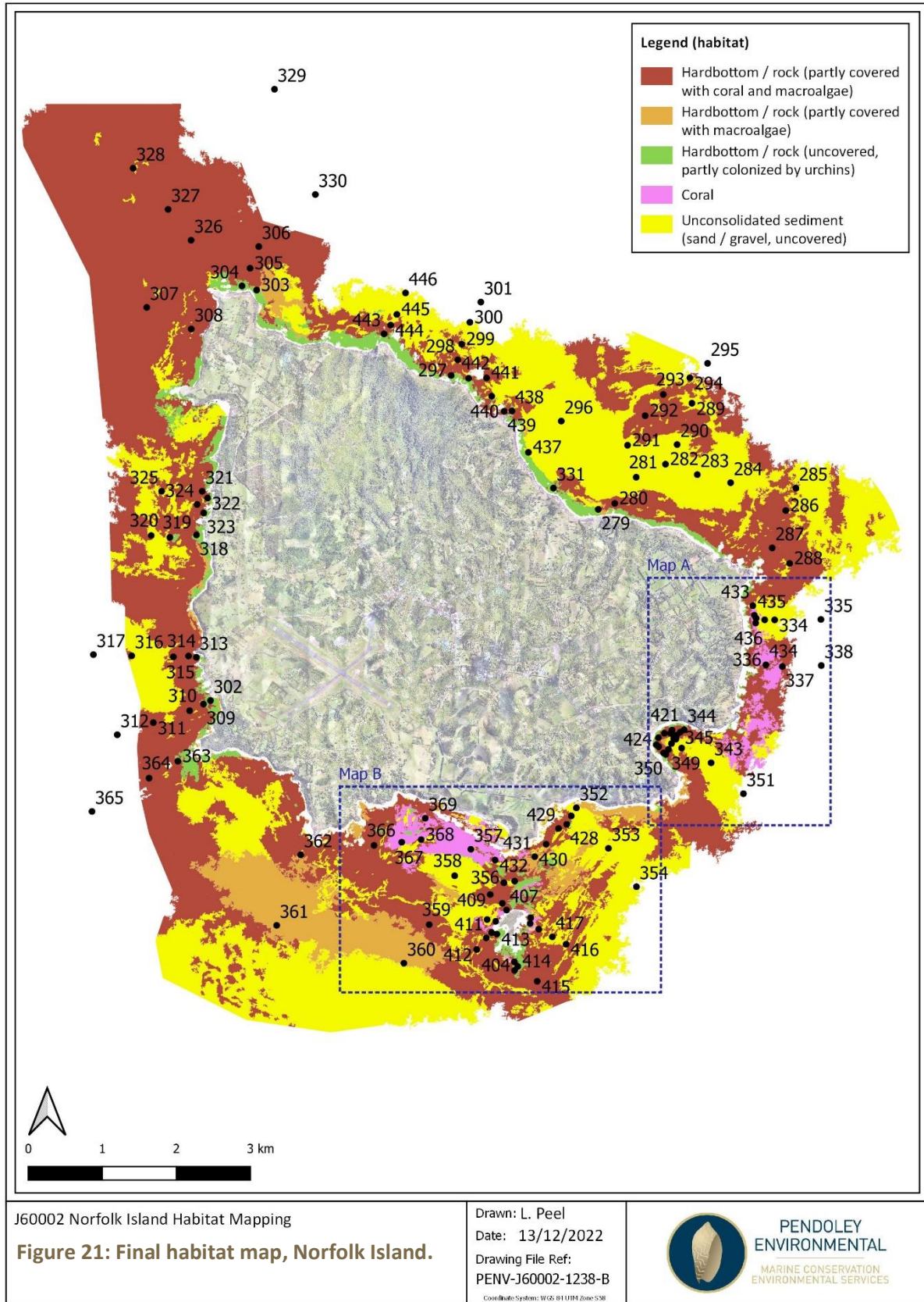
Figure 18: Hard Bottom Rock + Coral and Macroalgae (HBR + C + MA) at Site 362 (frame 58).

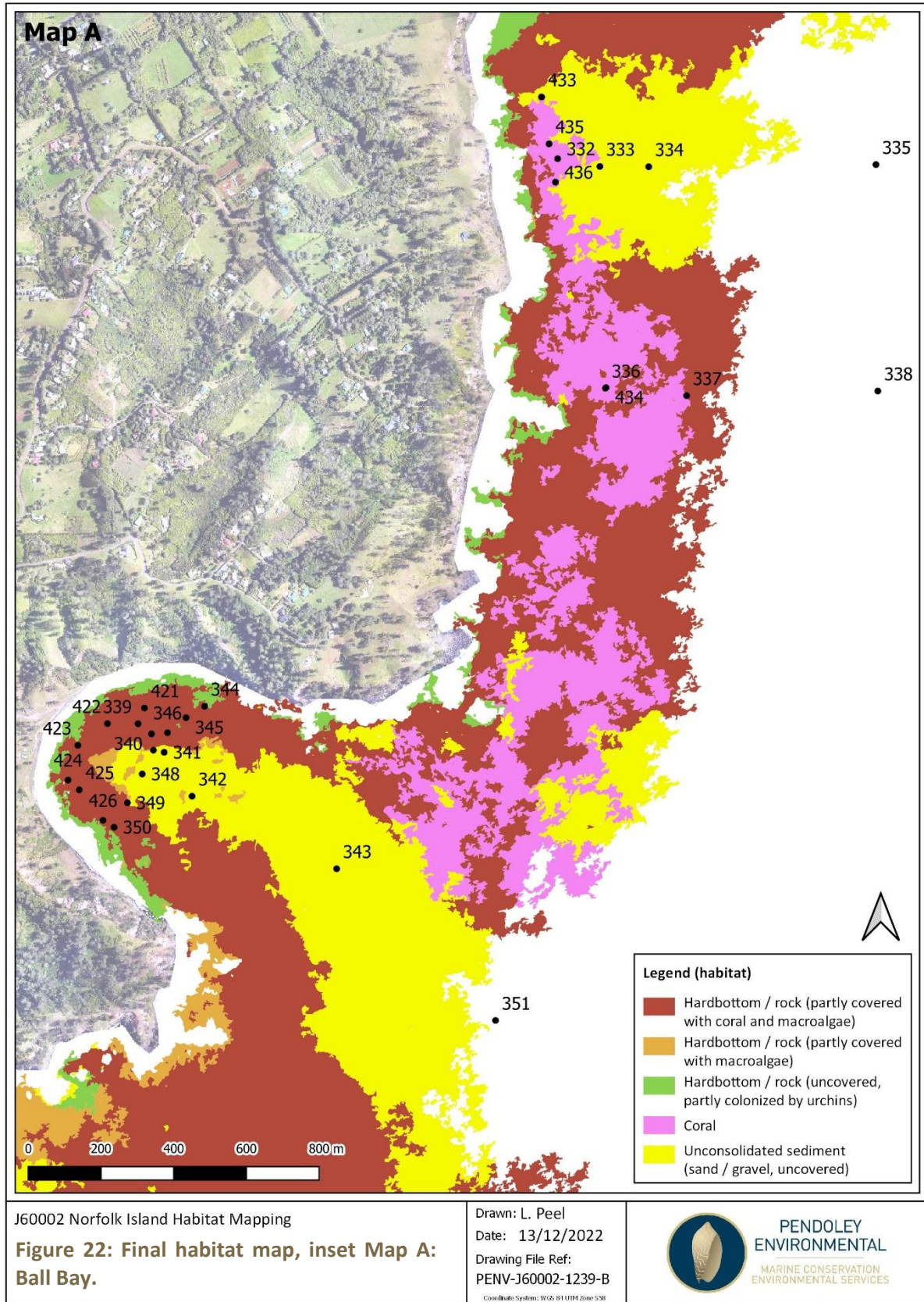


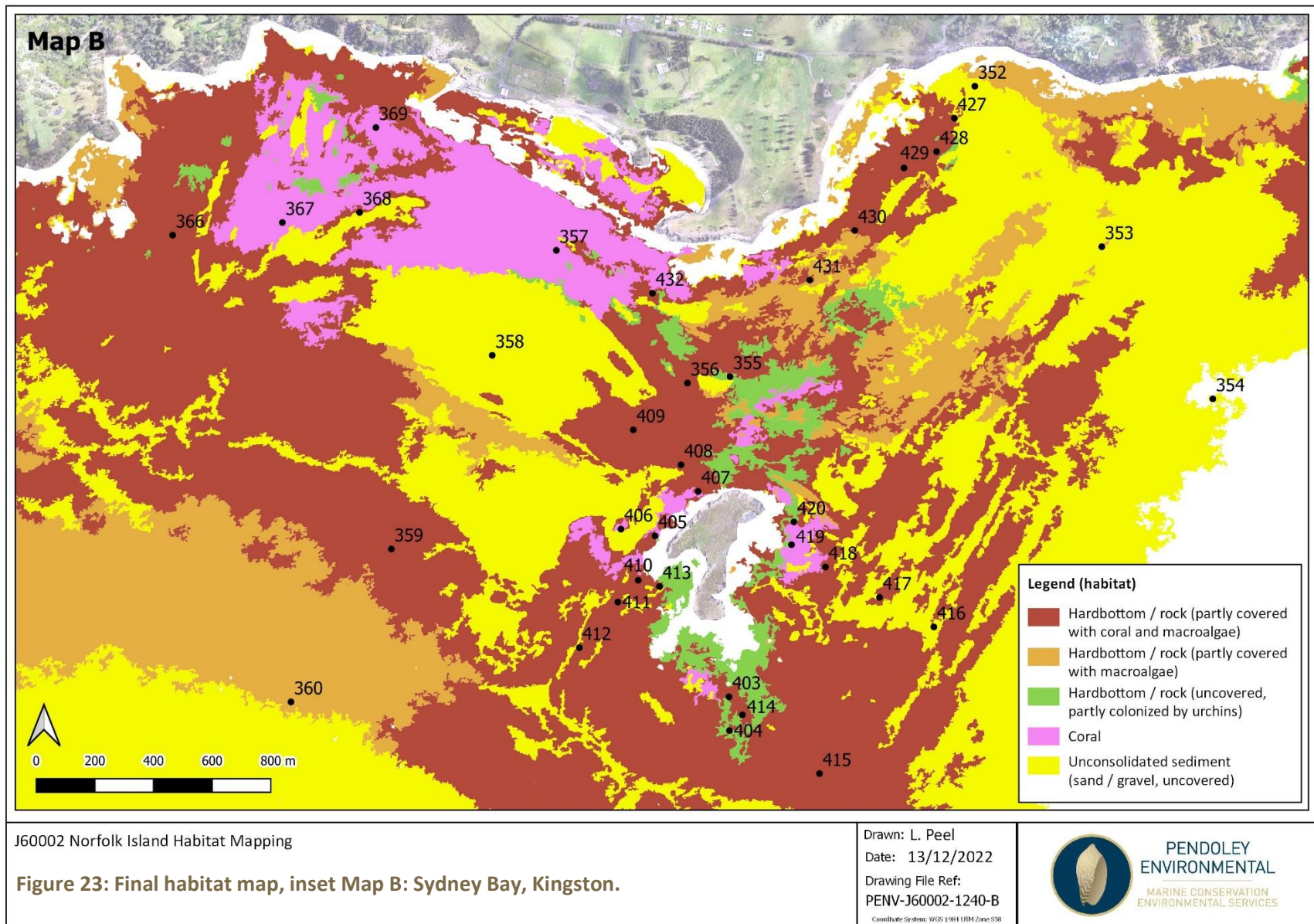
Figure 19: Hard Bottom Rock + Coral and Macroalgae (HBR + C + MA) at Site 377 (frame 50).

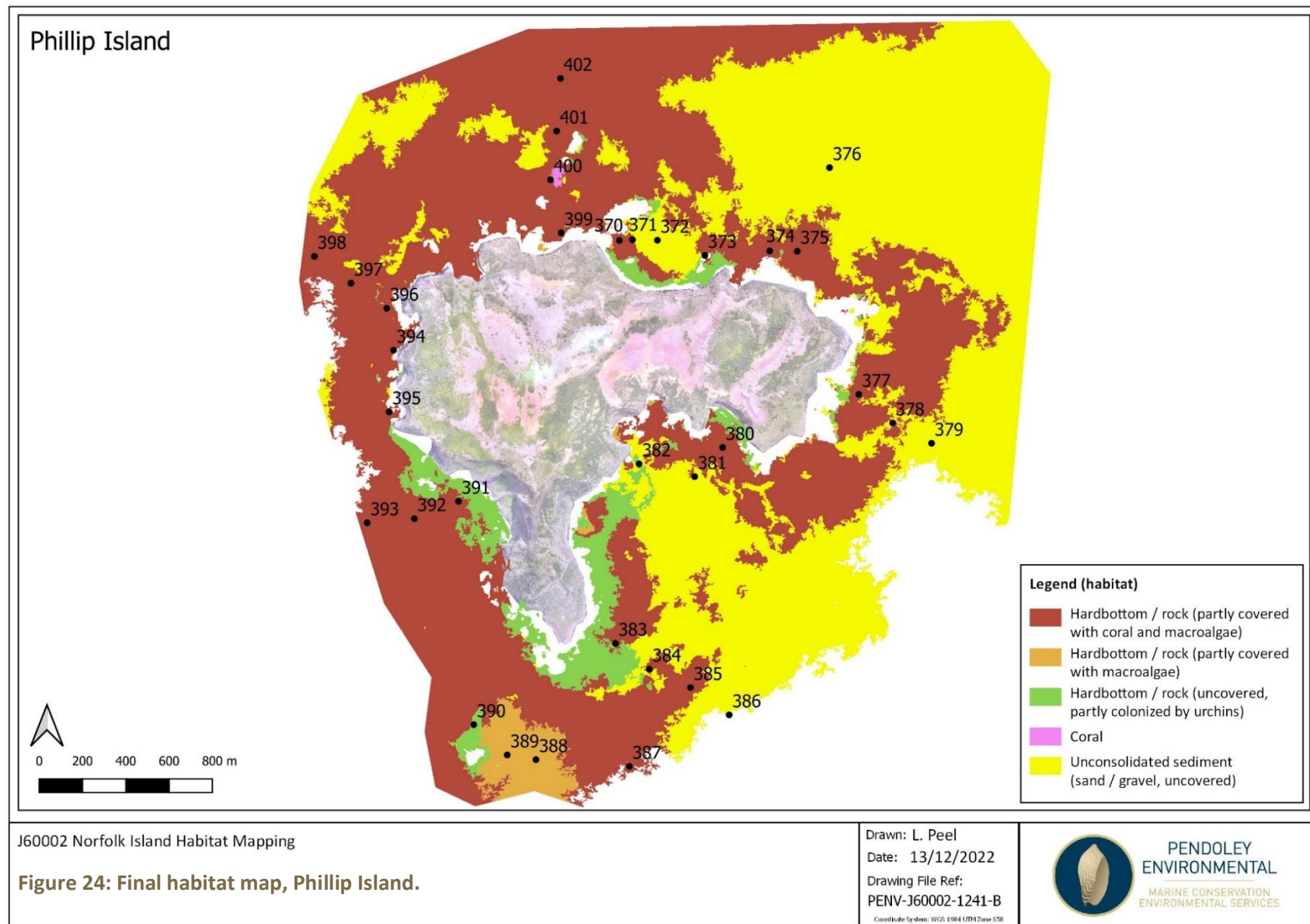


Figure 20: Coral and macroalgae on rocky outcrops in sandy seabed habitat at Site 359 (frame 64).









5 SUMMARY

In collaboration with Norfolk Island residents, a simple and affordable drop-camera system was used to ground-truth the marine habitat classifications derived from satellite imagery of the ecosystems surrounding Norfolk, Nepean, and Phillip Islands within Norfolk Marine Park. This resulted in the first marine habitat map being prepared for the Park, which can be used to inform future management, planning, development, and zoning decisions in a manner that serves to conserve the endemic and threatened species and ecosystem biodiversity of the region.

The conservation value of the Norfolk Island marine ecosystem, and Park more broadly, remains important for several reasons. Not only is it the eastern most coral reef system in Australia but the relatively cooler waters surrounding Norfolk, Nepean, and Phillip Islands may provide a refuge for local species as sea water temperature rise because of climate change. Additionally, the remote location of the Park will likely provide some protection to local flora and fauna from anthropogenic disturbances that occur more frequently in coastal mainland waters, including disease spread and pollution events. Lastly, it is important to recognise that the eastward-moving, warm core eddies that break away from the southward flowing East Australian Current remain a pathway for immigration of all marine species between the Great Barrier Reef, New South Wales coastline, Lord Howe Island, and the Park; both natural and invasive. The connectivity of these sites highlights the potential for the Park act as a buffer to larger-scale impacts, by providing a possible refuge to species with distributions spanning two or more of these regions in eastern Australia.

6 RECOMMENDATIONS

1. Conduct a follow-up ground-truthing survey to confirm the revised habitat classifications following the retraining of the EOMAP model using the October 2022 ground-truthing data.
2. Conduct seasonal surveys within the Norfolk Marine Park to assess if there is any variation in:
 - Macroalgae diversity, distribution, and density; and,
 - Sea urchin distribution and density.
3. Identify and install permanent benthic monitoring stations markers for any future monitoring surveys.
4. Identify and chart ship and vessel anchoring areas within Norfolk Marine Park, alongside locations where permanent moorings could be installed.
5. Require any future surveys of marine habitat structure and composition within the Norfolk Marine Park to be made aware of this map at the proposal stage, and use it as a baseline reference during surveys to ensure new data both complements and build on the existing database.

7 ACKNOWLEDGEMENTS

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- Dr Kellie Pendoley, Perth based Pendoley Environmental, Principal Scientist, BSc (Environmental Science), MSc Chemical Oceanography, PhD Biology; Project Manager and grant manager, data processing and analysis and reporting.
- Ms Margaret Christian, on-island Project Manager and support.
- Mr Robert Ryan, on island technical support, survey equipment manufacturer, data management support.
- Mr Mitchell Graham, on-island vessel owner and operator, skippered boat for all field surveys.
- Mr Luca Fox, on-island technical support, data processing.
- Mr Peter Pendoley, Perth based marine biologist (MSc), data processing and habitat classification analysis.
- Dr Matthew and Dr BJ Landau, Rutgers University New Jersey, marine biologists (PhD), data processing and habitat classification analysis.
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- Ms Bronte Moore (BSc, MSc) / Dr Lauren Peel (BSc, PhD), Perth-based Pendoley Environmental, Environmental/Marine Scientist, GIS mapping support.

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Appendix A: Unpublished species lists from Norfolk Island.

		Copyright 1997					
		Compiled by Dr J.E.N. Veron					
		Not Harvested					
		Nepean					
		Little of Capt					
		Boats					
		No Harvest					
Genus	Species	28 Nov 97	29 Nov 97	29 Nov 97	2 Dec 97	Comments	
Pocillopora	denticornis	X	X	X	X	Very common everywhere	
Montipora	mollis	X	X	X	X	Common only in Emily Bay (EB)	
	cf. turkensis	X	X	X	X	Prob new sp., common EB	
	cf. acquiheterulata			X	X	Prob new sp., common EB	
	cf. densa			X	X	Prob new sp., uncommon	
	cf. turgescens			X		Uncertain	
	sp. l					Uncertain	
Acropora	glauca	X	X	X	X	Very common everywhere	
	sulphurensis	X		X	X	Common where present	
	chabera			X		Common EB	
	cheerfulensis			X	X	Common only EB	
Astropora	explanata		X			Only one colony seen, bright green	
Porites	hercensis	X	X	X	X	Common everywhere	
Alveopora	sp.	X	X	X	X	Forms big massive colonies, common	
Goniopora	lobata	X	X		X	Uncertain	
	norfolkensis	X	X			Uncertain	
Psammocora	superficialis	X				Rare	
Coccoloba	columna	X	X	X	X	Uncertain	

Figure A1: Page 1 of 2 of Charlie Veron's coral list from Norfolk Island (1997).

<i>Echinophylla</i>	<i>aspera</i>	X	X	X	X	Uncommon but forms very big colonies
<i>Scolymia</i>	<i>australis</i>	X	X	X	X	Uncommon, very distinctive
<i>Acanthaster</i>	<i>hillei</i>	X	X	X	X	Uncommon, very large corallites
	<i>howeianki</i>	X	X		X	Common
	<i>lordhowensis</i>	X	X		X	Very common, many colour morphs
<i>Hydnophora</i>	<i>pilosa</i>	X				Uncommon, except EB
<i>Corallaster</i>	<i>frutiles</i>	X	X		X	Very common
	<i>australensis</i>	X	X		X	Very common
<i>Momaster</i>	<i>curta</i>	X	X		X	Very common
<i>Cylindaster</i>	<i>serotilis</i>		X		X	Common EB
<i>Plectaster</i>	<i>versipora</i>	X	X		X	Common, grey or green
<i>Euphyllia</i>	<i>osceola</i>	X	X		X	Incredible!
<i>Turbinaria</i>	<i>frondens</i>	X	X		X	Common
	<i>radicis</i>		X		X	Uncommon
	<i>petraea</i>		X			Rare
	<i>psautia</i>		X		X	Uncommon

Figure A2: Page 2 of 2 of Charlie Veron's coral list from Norfolk Island (1997).



List of Norfolk Island fish species



The following is a list of known fish species from the waters around Norfolk Island. To a large extent the list is based on research conducted by Dr Malcolm Francis and Dr Jack Randall. It has been compiled by Jack Marges of Bounty Divers and any errors and omissions are entirely his responsibility. Common names, where indicated, are those traditionally used on Norfolk Island.

LAMNIDAE sharks

Carcharodon carcharias white pointer

TRIAKIDAE gummy sharks

Mustelus lenticulatus gummy shark

CARCHARHINIDAE whaler sharks

Carcharhinus amblyrhynchos bronze whaler

Carcharhinus galapagensis galapagos shark

Carcharhinus plumbeus sandbar shark

Galeocerdo cuvier tiger shark

TORPIDIDAE electric rays

Torpedo maclelleni electric ray

SPHYRNIIDAE hammerheads

Sphyrna zygaena

DASYATIDAE stingrays

Taeniura meyeni bullray

UROLOPHIDAE stingarees

Urolophus sp

MYLIOBATIDAE eagle rays

Myliobatis tenuicaudata eagle ray

Figure A3: Page 1 of 14 of the list of fish species compiled by Jack Marges from research by Dr Malcolm Francis and Dr Jack Randall (1998).

MUREANIDAE morays

Anarchias sp

Echidna nebulosa - 1

Enchelycore ramosus mosaic moray - 2

Gymnothorax annasona lord howe moray - 3

Gymnothorax chilospilus

Gymnothorax eurostus abbott's moray - 5

Gymnothorax nubilus

Gymnothorax obesus - 4

Gymnothorax porphyreus

OPHICHTHIDAE snake eels

Leiuranus semicinctus dash eel - 2

Leiuranus versicolor dot-dash eel - 3

Muraenichthys australis

Muraenichthys nicholsae

Myrichthys maculosis dot eel - 1

CONGRIDAE conger eels

Conger wilsoni conger eel

CLUPEIDAE herrings

Spratelloides delicatulus

CHANIDAE milkfishes

Chanos chanos

GONORYNCHIDAE beaked salmons

Gonorynchus greyi beaked salmon

PLOTOSIDAE catfish

Plotosus lineatus lined catfish

Figure A4: Page 2 of 14 of the list of fish species compiled by Jack Marges from research by Dr Malcolm Francis and Dr Jack Randall (1998).

SYNODONTIDAE lizard fishes

Saurida gracilis

Synodus dermatogenus

Synodus doaki - 2

Synodus similis - 3

Synodus variegatus - 1

Trachinocephalus myops

MORIDAE beardies

Lotella phycis beardy

BYTHITIDAE eusk eels

Dermatopsis macodon

ANTENNARIIDAE anglerfishes

Histrio histrio sargassum angler

Antennarius pictus

GOBIESOCIDAE clingfishes

Alabes parvulus

Lepadichthys frenatus

HEMIRAMPHIDAE garfishes

Euleptorhamphus viridis

Hyperhamphus australis

BELONIDAE longtoms

Ablennes hians

Platybelone argulus

BERYCIDAE nannagais

Centroberyx affinis nannagai

HOLOCENTRIDAE squirefishes

Myripristis berndti

Figure A5: Page 3 of 14 of the list of fish species compiled by Jack Marges from research by Dr Malcolm Francis and Dr Jack Randall (1998).

AULOSTOMIDAE trumpetfishes

Autostomus chinensis painted flutemouth

FISTULARIIDAE cornetfish

Fistularia commersonii smooth cornetfish

SYGNATHIDAE pipefishes

Halicampus boothae pipefish

SCORPAENIDAE scorpionfishes

Ablabys taenianotus - 2

Dendrochirus zebra - 1

Pterois volantis lion fish

Scorpaena cookii bucket - 3

Scorpaenodes guamensis

Scorpaenodus scaber

SERRANIDAE groupers

Acanthistius cinctus toughcord

Aulacocephalus temmincki gold ribbon groper

Capredon krasnyukovae ?

Epinephelus cyanopodus

Epinephelus daemlii habuka

Epinephelus fasciatus red snapper

Epinephelus nierra wirenetting cod

Epinephelus octofasciatus

Epinephelus rivulatus red snapper

Pseudanthias pictilis

Pseudanthias squamipinnis orange fairy basslet

Trachypoma macracanthus toadstool groper

Figure A6: Page 4 of 14 of the list of fish species compiled by Jack Marges from research by Dr Malcolm Francis and Dr Jack Randall (1998).

Plesiopidae longfins

Plesiops insularis

Kuhliidae flagtails

Kuhlia mugil 5 bar flagtail

Priacanthidae bigeyes

Heteropriacanthus cruentatus

Apogonidae cardinal fishes

Apogon crassiceps

Apogon doederleini bigeye

Apogon kullopterus

Apogon norfolcensis

Apogon sp B

Archamia leai

Echeneidae remoras

Echeneis naucrates

Remora remora

Carangidae trevallies

Alectis ciliaris (4/96) lagoon

Carangoides orthogrammus

Caranx melampygus home ofie

Caranx sexfasciatus

Decapterus muroadsi

Flagatis bipinnulata

Pseudocaranx dentex ofie

Seriola dumerili

Seriola hippus samson fish

Seriola lalandi kingfish

Figure A7: Page 5 of 14 of the list of fish species compiled by Jack Marges from research by Dr Malcolm Francis and Dr Jack Randall (1998).

Seriola rivoliana amalco jack

Trachinotus bailloni

Trachinotus blochii snub nosed dart

Trachurus novaezelandiae

ARRIPIDAE australian salmon

Arripis trutta kawahai

Arripis ? ester

LUTJANIDAE snappers

Lutjanus fulvus blacktail snapper

Lutjanus kasmira 4 lined snapper

Paracaesio xanthurus southern fuselier

CAESIONIDAE fuseliers

Pterocaesio digramma

Pterocaesio trilineata

HAEMULIDAE sweetlips

Plectorhinchus gibbosus

SPARIDAE sea breams

Pagrus auratus bream

LETHRINIDAE emperors

Gnathodentex aureolineatus gold spot bream

Gymnochranius euanus

Lethrinus miniatus trumpeter

MULLIDAE goatfishes

Mulloidichthys flavolineatus yellow lined goatfish - 2

Mulloidichthys vanicolensis gold striped goatfish - 4

Parupeneus ciliatus - 1

Parupeneus multifasciatus

Figure A8: Page 6 of 14 of the list of fish species compiled by Jack Marges from research by Dr Malcolm Francis and Dr Jack Randall (1998).

Parupeneus pleurostigma

Parupeneus spilurus

Upeneichthys lineatus

Upeneus francisi - 5

MONODACTYLIDAE silver batfishes

Monodactylus argenteus

PEMPHETIDIDAE sweepers

Parapriacanthus ransonnetti bullets

pempheris analis bronze bullseye

GIRELLIDAE blackfishes

Girella cyanea blue nanwi

KYPHOSIDAE drummers

Kyphosus bigibbus

Kyphosus cinerascens

Kyphosus sydneyanus stinken

Kyphosus vaigiensis

MICROCANTHIDAE stripeys

Atypichthys latus tweed trousers

Microcanthus strigatus

SCORPIDIDAE sweeps

Bathystathus cultratus

Labracoglossa nitida

Scorpis lineolatus ?

Scorpis violaceus blue nanwi

EPHIPPIDIDAE batfishes

Platax teira batfish

Figure A9: Page 7 of 14 of the list of fish species compiled by Jack Marges from research by Dr Malcolm Francis and Dr Jack Randall (1998).

CHAETODONTIDAE butterfly fishes

Amphichaetodon howensis

Chaetodon auriga threadfin

Chaetodon citrinellus lemon b'fish

Chaetodon flavirostris dusky

Chaetodon lineolatus

Chaetodon lanula raceoon

Chaetodon mellannotus black backed

Chaetodon mertensii

Chaetodon pelewensis

Chaetodon piebeius blue spot

Chaetodon tricinctus 3 banded

Chaetodon speculum lagoon (2) 1/98

Chaetodon trifascialis

Chaetodon trifasciatus

Chaetodon unimaculatus 6/96 cemetery

Chaetodon vagabundus

Forcipiger flavissimus long nosed

Heniochus monoceros bannerfish

POMACANTHIDAE angel fishes

Centropyge hispidus

Centropyge tibicen

Chaetodontoplus conspicillatus

PENTACEROTIDAE boarfishes

Evistias acutirostris

POMACENTRIDAE damsels

Abudefduf sexfasciatus sergeant major

Figure A10: Page 8 of 14 of the list of fish species compiled by Jack Marges from research by Dr Malcolm Francis and Dr Jack Randall (1998).

Abudefduf sordidus white aauti
Abudefduf vaigiensis
Abudefduf whiteleyi sergeant major
Amphiprion lateronotus clown fish
Chromis flavomaculata
Chromis funea scissor tail
Chromis hypsilepis sailor's piss
Chromis vanderbiltii
Chrysiptera glauca
Chrysiptera notialis
Neoglyphidodon polyactanthus aauti
Parma alboscapularis
Parma polylepis aauti
Plectroglyphidodon dickii
Plectroglyphidodon johnstonianus
Pomacentrus pavo
Stegastes fasciolatus
Stegastes gascoynei
Teixeirichthys sp
CIRRHITIDAE hawkfishes
Cirrhitus splendens splendid hawkfish
Paracirrhites arcatus
paracirrhites fosteri foster's hawkfish
CHIRONEMIDAE kelpfishes
Chironemus microlepis
APLODACTYLIDAE sea carp
Aplodactylus etheridgii stiddy

Figure A11: Page 9 of 14 of the list of fish species compiled by Jack Marges from research by Dr Malcolm Francis and Dr Jack Randall (1998).

CHEILODACTYLIDAE morwongs

Cheilodactylus ephippium tamanian trumpeter

Cheilodactylus vestitus teraki

Nemadactylus macropterus

MUGILIDAE mullets

Mugil cephalus

Myxus elongatus

Valamugil sehei

SPHYREANIDAE barracudas

Sphyræna acutipinnis

Sphyræna barracuda ?

LABRIDAE wrasses

Anampses elegans elegant wrasse

Bodianus axillaris s 4/97 swiss

Bodianus perditio

Bodianus unimaculatus

Cheilio inermis cigar fish

Coris aygula 6/96 cemetery

Coris bulbifrons double header

Coris picta comb wrasse

Coris sandageri sanddagger

Cymolutes praetextatus

Gomphosus varius bird wrasse

Halichoeres margaritaceus

Halichoerus trimaculatus

Labroides dimidiatus cleaner wrasse

Labroides bicolor LO 12/4/98 bicolor cleaner

Figure A12: Page 10 of 14 of the list of fish species compiled by Jack Marges from research by Dr Malcolm Francis and Dr Jack Randall (1998).

Notolabrus inscriptus inscribed wrasse

Novaculichthys taeniourus

Pseudojuloides elongatus

Pseudolabrus luculentus

Stethojulis bandanensis

Stethojulis maculatus

Suezichthys arcuatus

Thalassoma amblycephalum

Thalassoma hardwicke

Thalassoma jensen

Thalassoma lunare moon wrasse

Thalassoma lutescens sleepy dolly

Thalassoma purpuraceum po'ov

Thalassoma tribulatum po'ov

SCARIDAE parrot fishes

Scarus ghobban parrot fish

Scarus rivulatus

CREMNIIDAE sand divers

Lymnichthys fasciatus

TRIPTERYGIIDAE threefins

Enneapterygius rufopileus

Enneapterygius sp

Norfolkia squamiceps

CLINIDAE weedfishes

Heteroclinus roseus

BLENNIIDAE blennies

Cirripectes alboapicalis

Figure A13: Page 11 of 14 of the list of fish species compiled by Jack Marges from research by Dr Malcolm Francis and Dr Jack Randall (1998).

Cirripectes castaneus

Entomacrodus ninafaoensis

Entomacrodus striatus

Istiblennius dussumieri

Istiblennius edentulus

Istiblennius lineatus

Parablennius serratolineatus

Plagiotremes tapeinosoma

CALLIONYMIDAE stinkfishes

Callionymus calcaratus

Diplogrammus goramensis stinkfish

GOBBIIDAE gobies

Bathygobius aeolosoma

Callogobius sp

Eviota prasina

Eviota smaragdus

Eviota sp

Priolepis semidoliatus

Valenciennaea strigata 7/96 lagoon

Vanderhorstia sp

MACRODESMIDAE dart gobies

Pteroleotris evides 9/96 fishbowl

ACANTHURIDAE surgeon fishes

Acanthurus dussumieri ringtail surgeonfish

Acanthurus nigrofuscus

Acanthurus triostegus convict surgeon

Naso annulatus

Figure A14: Page 12 of 14 of the list of fish species compiled by Jack Marges from research by Dr Malcolm Francis and Dr Jack Randall (1998).

Naso unicornis unicorn fish

Prionurus maculatus

Zebrasoma scopas

ZANZLIDAE moorish idols

Zanclus cornutus moorish idol

SCOMBRIDAE tunas

Sarda australis bonito

BOTHIDAE flounders

Bothus mancus left hand flounder

Bothus pantherinus

PLEURONECTIDAE right eye flounders

Peltorhamphus latus

SOLEIDAE soles

Aseraggodes bahamondei sole

BALLISTIDAE triggerfishes

Rhinecanthus rectangulus

Sufflamen fraenatus

MONACANTHIDAE leatherjackets

Brachaluteres taylori ?

Cantheschenia longipinnis

Pervagor alternans

Pervagor janthinosoma

OSTRACHIDAE boxfishes

Lactoria diaphana cowfish

Ostracion cubicus boxfish

TETRAODONTIDAE puffers

Canthigaster callisterna clown toby

Figure A15: Page 13 of 14 of the list of fish species compiled by Jack Marges from research by Dr Malcolm Francis and Dr Jack Randall (1998).

Torquigener altipinnis

DIODONTIDAE porcupine fishes

Diodon hystrix porcupine fish

Jack Marges, Norfolk Island, 1998

Figure A16: Page 14 of 14 of the list of fish species compiled by Jack Marges from research by Dr Malcolm Francis and Dr Jack Randall (1998).

APPENDIX B

INVERTABRAE AND ALGAE

Algae : Red coralline algae (rhodophytes)

Numerous species of both encrusting and erect species were noted

Green (chlorophyte) algae

Numerous species were noted including :

- *Caulerpa racemosa*
- *Codium spongiosa*
- *Padina* sp

Porifera (sponges)

Reddish brown 'ball' sponge

Echinodermata

Urchins - *Triplonectes gratilla*

- *Heliocidaris tuberculata*
- *Echinometra mathaei*

Starfish - one species of blue/grey species was found (common)

Ascidians

Lissoclinum bistratum

Cnidaria (Coelenterata)

Corals (scleractinian)

- *Polillopora damicornis* (?)
- *Acanthastrea lordhowensis*
- *Acropora hyacinthus*
- *Porites lichen* (?)
- *Goniastrea australensis*

Corals (non - scleractinian)

- one species of brown soft coral

Anemones

- Giant green anemone
- Pinkish white anemone
- "ball" tentacle anemone

Figure A17: Page 1 of 3 of the list of marine species observed in Ball Bay, Norfolk Island, compiled by Jack Marges and Karlene Christian (1995).

Mollusca

Gastropoda

- *Nerita albicilla*
- *Hinea braziliana*

Opisthobranchs

- small orange coloured specie

Platyhelminthes (flatworms)

- small green body with fluorescent blue spots

Annelida

- orange tubeworm (*vermetus* sp)

Arthropoda

- 2 species of crab

Figure A18: Page 2 of 3 of the list of marine species observed in Ball Bay, Norfolk Island, compiled by Jack Marges and Karlene Christian (1995).

APPENDIX C

FISH SPECIES NOTED DURING THE CONDUCT OF THE SURVEYS IN BALL BAY (common Norfolk names in brackets).

Muraenidae (Moray eels)

- *Gymnothorax eurostus* (Abbott's moray)

Pomacentridae (damsel fish)

- *Chrysiptera notialis*
- *Parma polylepis* (artui)
- *Neoglyphidodon polyacanthus* (artui)
- *Chromis hepselepis* (sailors piss)

Labridae (wrasses)

- *Thellosoma purpurium* (po'ov)
- *Notalabrus inscriptus*
- *Coris sandageri*
- *Pseudolabrus luculentus*
- *Thellosoma futescens*
- *Stethojulus maculatus*
- *Stethojulus bandenensis*
- *Novaculichthys taniourus*
- *Coris bulbifrons* (double header)

Aplodactylidae

- *Aplodactylus etheridii* (stiddy)

Macrocanthidae

- *Atypichthys latus* (tweed trousers)

Scorpididae

- *Scorpis violaceus* (nanwi)

Blennidae

- *Parablennius serotiniata*
- *Plagiotremus tapeinosoma* (sabretooth blenny)

Apogonidae (Cardinals)

- *Apogon norfolkensis* (bigeye)

Serranidae

- *Acanthistius cinctus* (toughcord)

Cheilodactylidae

- *Cheilodactyles ephippium* (tasmanian trumpeter)

Figure A19: Page 3 of 3 of the list of marine species observed in Ball Bay, Norfolk Island, compiled by Jack Marges and Karlene Christian (1995).

Appendix B: October 2022 Survey results and metadata.

Table B1: Marine habitat classification data derived from satellite imagery (EOMAP; 2021) and collected at sampling locations (Wpt) within the Norfolk Marine Park (2022).
HBR – C + MA = hardbottom_rock (partly covered with coral and macroalgae); HBR – MA = hardbottom_rock (partly covered with macroalgae); HBR – U = hardbottom rock (uncovered); US = unconsolidated sediment (sand _ gravel, uncovered); US – SS = unconsolidated sediment with sparse seagrass; OM = off habitat map.

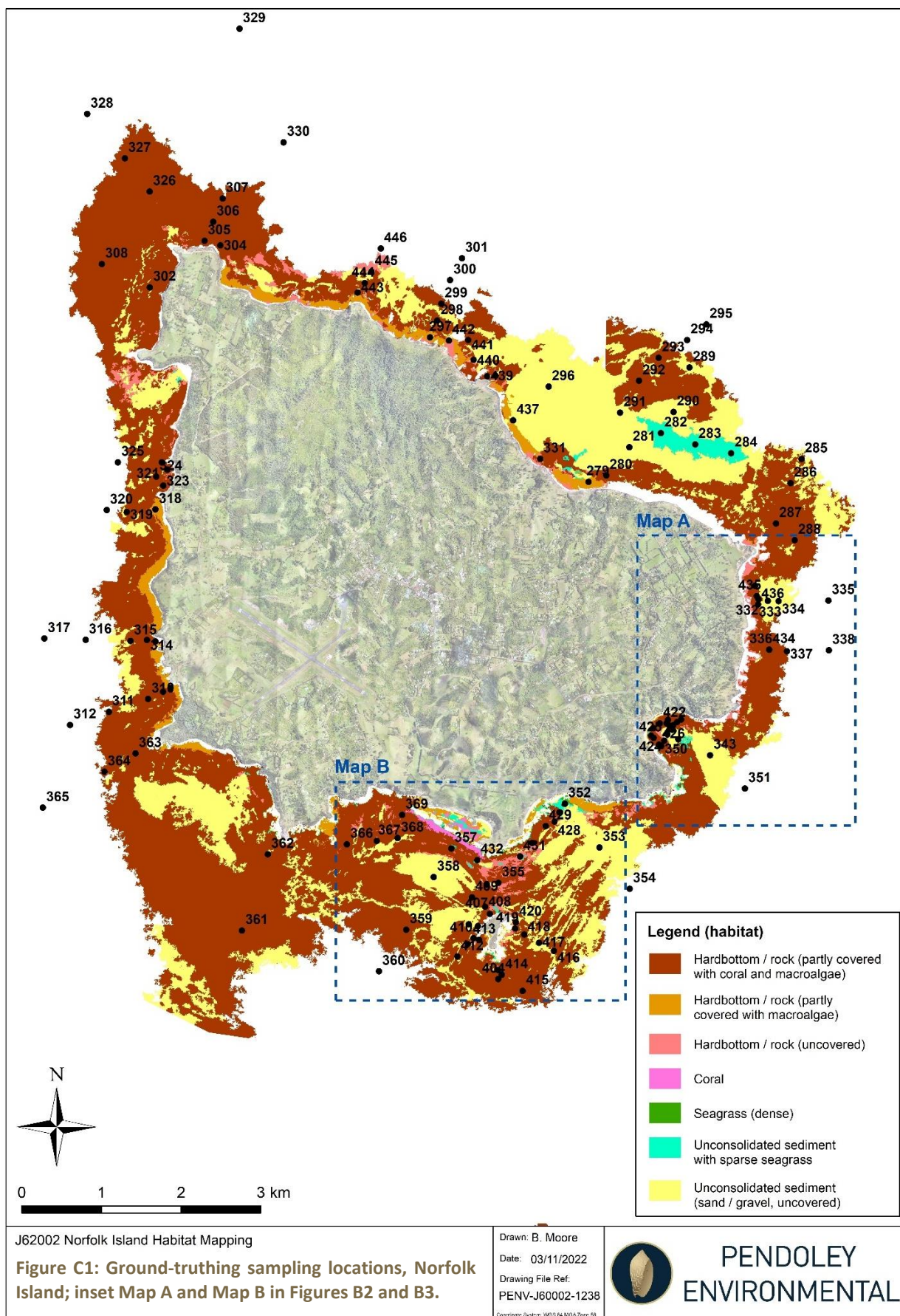
Area	Wpt #	Latitude	Longitude	Class_name eomap 2021	Depth (m)	Ground-truthed habitat (2022)	Notes on videos
Cascade Bay to Steels Pt	279	-29.021124	167.974589	hardbottom_rock (partly covered with macroalgae)	6.1	-	no video, slate only
Cascade Bay to Steels Pt	280	-29.020344	167.976851	hardbottom_rock (partly covered with coral and macroalgae)	11	HBR - C + MA	hard corals
Cascade Bay to Steels Pt	281	-29.017088	167.979735	unconsolidated sediment (sand _ gravel, uncovered)	25	US	Sand/gravel black and white
Cascade Bay to Steels Pt	282	-29.01541	167.983755	unconsolidated sediment with sparse seagrass	12	US	Sand/gravel, strong ridging, shell hatch broken off red sponge
Cascade Bay to Steels Pt	283	-29.016584	167.988199	unconsolidated sediment with sparse seagrass	29	US	sand/gravel turbid lot of detritus
Cascade Bay to Steels Pt	284	-29.017467	167.992850	unconsolidated sediment with sparse seagrass	35	US	sand/gravel, large sandy ridges
Cascade Bay to Steels Pt	285	-29.017924	168.001917	hardbottom_rock (partly covered with coral and macroalgae)	31	HBR - C + MA	coral lots of cup corals and sea anemone, calcareous green algae
Cascade Bay to Steels Pt	286	-29.02069	168.000601	hardbottom_rock (partly covered with coral and macroalgae)	26	HBR - C + MA	Close ups of algae, lot of cup corals and anemone
Cascade Bay to Steels Pt	287	-29.025285	167.998844	hardbottom_rock (partly covered with coral and macroalgae)	20	HBR - C + MA	encrusting coral, white urchin, encrusting sponges
Cascade Bay to Steels Pt	288	-29.027122	168.001322	hardbottom_rock (partly covered with coral and macroalgae)	24	HBR - C + MA	Lots of coral rubble, coral, zooanthids and sponges
Cascade Bay to Steels Pt	289	-29.007898	167.987208	unconsolidated sediment (sand _ gravel, uncovered)	32	US	Sandy with coral rubble
Cascade Bay to Steels Pt	290	-29.012982	167.985297	unconsolidated sediment (sand _ gravel, uncovered)	32	US	sand gravel coral rubble, scattered Dictyopteris sp - a brown MA with midrib,
Cascade Bay to Steels Pt	291	-29.013218	167.978428	unconsolidated sediment (sand _ gravel, uncovered)	28	US	Sandy, gravel, black and white sand gravel coral rubble some MA, dead intact shells and shell hatch
Cascade Bay to Steels Pt	292	-29.009561	167.980763	hardbottom_rock (partly covered with coral and macroalgae)	26	HBR - C + MA	Lot of MA and coral rubble
Cascade Bay to Steels Pt	293	-29.006912	167.983197	hardbottom_rock (partly covered with coral and macroalgae)	29	HBR - C + MA	Lots of young plate coral, anemone
Cascade Bay to Steels Pt	294	-29.004808	167.986829	off habitat map	34	HBR - C + MA	Sea Whips' see 1:12; lots of sand accretion, old reef with sponges, green MA
Cascade Bay to Steels Pt	295	-29.002987	167.989236	off habitat map	36	HBR - C + MA	Sea Whips', lots of sand, reef edge sponge and coral rubble
Cascade Bay to Steels Pt	296	-29.010475	167.969145	unconsolidated sediment (sand _ gravel, uncovered)	23	US	Complex sand riffles, nothing living here
Bird Rock transect	297	-29.005249	167.953723	hardbottom_rock (partly covered with macroalgae)	6	HBR - C + MA	Yellow Moray seen, lots of black gravel and coral rubble, black urchin
Bird Rock transect	298	-29.003334	167.954588	hardbottom_rock (partly covered with coral and macroalgae)	17	HBR - C + MA	rocky outcrops with sand between, cup corals tube worms? Red algae, sponges
Bird Rock transect	299	-29.001402	167.955066	hardbottom_rock (partly covered with coral and macroalgae)	29	US	with MA covered rocky outcrops, tyre on seabed??
Bird Rock transect	300	-28.998714	167.956129	off habitat map	33	US	black and white sand an gravel and coral rubble
Bird Rock transect	301	-28.996215	167.957581	off habitat map	35	US	white sand and gravel, coral rubble
Headstone Pt	302	-29.000377	167.917507	hardbottom_rock (partly covered with macroalgae)	8.5	HBR - Un	lots of black sea urchins, fine turfing algae, some encrusting coral, reef front?
Black Bank, Pt Howe	303	-29.045609	167.921455	hardbottom_rock (partly covered with macroalgae)	19	HBR - Un	Lot of coral rubble and remnants, Black gravel,
Black Bank, Pt Howe	304	-28.995434	167.926448	hardbottom_rock (partly covered with coral and macroalgae)	11 to 15	HBR - C + MA	black gravel and lot of coral rubble, one back urchin
Black Bank, Pt Howe	305	-28.994969	167.924402	hardbottom_rock (partly covered with coral and macroalgae)	22	HBR - C + MA	lots of corals and anemones, coral rubble and sand off edge of rocks
Black Bank, Pt Howe	306	-28.992793	167.925457	hardbottom_rock (partly covered with coral and macroalgae)	29	HBR - C + MA	Looks like strong current here, sand veneer over rock, black gravel , scattered coral and algae, bivalve shell piles
West of Pt Vincent	307	-28.990121	167.926593	hardbottom_rock (partly covered with coral and macroalgae)	19	HBR - C + MA	Nice lighting; few good fish shots; ca 7 sec wave length, reef top Halimeda green algae (calcareous) sponges
Sth Pt Vincent	308	-28.997878	167.911261	hardbottom_rock (partly covered with coral and macroalgae)	10	C	coral and patches of algae on hard bottom, occasional urchin
Headstone Pt	309	-29.046059	167.920500	hardbottom_rock (partly covered with coral and macroalgae)	16	HBR - C + MA	Curious Jacks, white urchins, rocky rubbly between high relief rock with coral and algae see side camera
Headstone Pt	310	-29.046910	167.918598	hardbottom_rock (partly covered with coral and macroalgae)	20	HBR - C + MA	Schooling fish, spur and groove, coral rubble and white sand in grooves
Headstone Pt	311	-29.048470	167.913595	hardbottom_rock (partly covered with coral and macroalgae)	24	C	Nice plate coral, bright yellow encrusting coral seen -see 2:04, high density coral mosaic
Headstone Pt	312	-29.050061	167.908638	off habitat map	34	US	Some rocky platforms present supporting MA and corals
Sewage outfall	313	-29.040377	167.919355	hardbottom_rock (partly covered with coral and macroalgae)	7.5	HBR - C + MA	Lot of Black Urchin; not much MA, mainly bare rock and urchins
Sewage outfall	314	-29.040243	167.918255	hardbottom_rock (partly covered with coral and macroalgae)	15	C	Mature plate coral, ahermatypic coral, white urchin
Sewage outfall	315	-29.040393	167.916155	hardbottom_rock (partly covered with coral and macroalgae)	25	HBR - C + MA	ca 30% sand between rocky outcrops covered in coral and algae and anemones, black sea stars
Sewage outfall	316	-29.040393	167.910369	off habitat map	32	HBR - C + MA	Sand accretion present, rocky outcrops covered in coral and algae in sandy seabed
Sewage outfall	317	-29.040361	167.905051	off habitat map	38	US	Sandy
Sth of Puppies Pt transect	318	-29.025459	167.918940	hardbottom_rock (partly covered with macroalgae)	6	HBR - Un	Lot of bare boulders and Black urchin; corals and MA

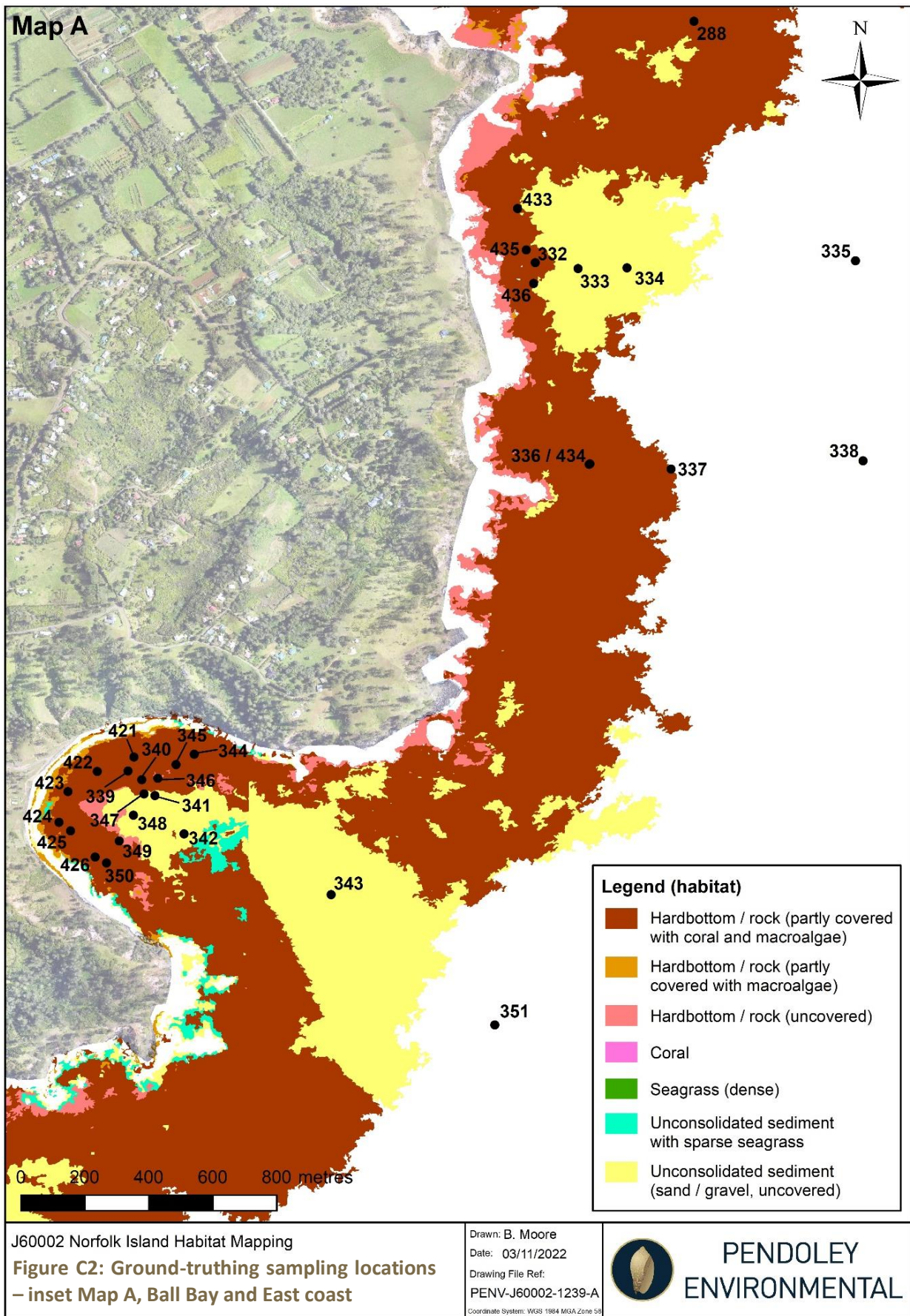
Area	Wpt #	Latitude	Longitude	Class_name eomap 2021	Depth (m)	Ground-truthed habitat (2022)	Notes on videos
Sth of Puppies Pt transect	319	-29.025837	167.915263	hardbottom_rock (partly covered with coral and macroalgae)	7	HBR - C + MA	White Urchin, schooling fish, massive sponges
Sth of Puppies Pt transect	320	-29.025672	167.912667	off habitat map	30	US	HBR - C + MA present in sandy seabed
Jacobs Rock transect west	321	-29.020131	167.919589	hardbottom_rock (partly covered with coral and macroalgae)	9	HBR - C + MA	encrusting coral, turfing algae and lots of black urchins, some white
Jacobs Rock transect west	322	-29.020927	167.920355	hardbottom_rock (partly covered with coral and macroalgae)	7.5	HBR - C + MA	Boulders, encrusting coral, MA, lots of Black Urchins some white present
Jacobs Rock transect west	323	-29.022755	167.919869	hardbottom_rock (partly covered with coral and macroalgae)	6.5	HBR - C + MA	boulders, encrusting coral, dense Black Urchin some white urchins, no MA
Jacobs Rock	324	-29.021747	167.918931	hardbottom_rock (partly covered with coral and macroalgae)	16	C	rock with coral surrounded by sand patches spur and groove, transect parallel to shore heading south', nice wrasse cameo, see 2:00 down
Jacobs rock	325	-29.020241	167.913956	off habitat map	29	HBR - C + MA	Spur and Groove Formation, coral and algae on rocky outcrops in sand, brown starfish
Pt Vincent NW transect	326	-28.989553	167.917183	hardbottom_rock (partly covered with coral and macroalgae)	19.5	HBR - C + MA	Down326 only 46 sec long: Side326 2':19": lot of white urchin, encrusting coral, turfing algae
Pt Vincent NW transect	327	-28.985863	167.913893	hardbottom_rock (partly covered with coral and macroalgae)	20	HBR - MA	Down327 only32 sec long: Side326 2':31": lot of white urchin, small fish, rubble, turfing algae, encrusting coral
Pt Vincent NW transect	328	-28.980951	167.908908	off habitat map	21	HBR - C + MA	Lots of small fish, Black tip shark, seems relatively diverse, red algae, white urchins
N Pt Howe offshore	329	-28.970898	167.928233	off habitat map	32	HBR - C + MA	sand patches and veneering ; Curious juvenile shark following <i>Down Camera</i> up; lot of small reef fish
NE Pt Howe offshore	330	-28.983608	167.934263	off habitat map	31	US	All sand
Cascade Cockpit	331	-29.018665	167.968297	hardbottom_rock (partly covered with macroalgae)	5.5	HBR - MA	Lot of Black Urchin; Many rounded boulders, very little turfing algae
Steels Pt Sth	332	-29.033907	167.996861	hardbottom_rock (partly covered with coral and macroalgae)	11.5	C	Nice low relief plate coral, dense coral, high coral diversity and abundance
Steels Pt Sth	333	-29.034073	167.99806	unconsolidated sediment (sand _ gravel, uncovered)	24	US	With rocky outcrops covered in coral and MA; appears relatively turbid
Steels Pt Sth	334	-29.034049	167.999439	unconsolidated sediment (sand _ gravel, uncovered)	28	US	Just bare sand
Steels Pt Sth	335	-29.033852	168.005856	off habitat map	35	US	Just bare sand
Two Chimneys transect	336	-29.039573	167.998375	hardbottom_rock (partly covered with coral and macroalgae)	18.5	HBR - C + MA	Lot of small fish white urchins
Two Chimneys transect	337	-29.039707	168.000673	hardbottom_rock (partly covered with coral and macroalgae)	31	HBR - C + MA	Benthic algae rooted in sand, sparse and small -Phaeophytes <i>Sargassum</i> maybe <i>Ecklonia</i> , rubbly bottom
Two Chimneys transect	338	-29.039471	168.006072	off habitat map	37	US	Just sand
Ball Bay E - W transect	339	-29.048194	167.985414	hardbottom_rock (partly covered with coral and macroalgae)	5.5	HBR - C + MA	Lot of Black Urchin; high relief rock and large boulders
Ball Bay E - W transect	340	-29.048438	167.985801	hardbottom_rock (partly covered with coral and macroalgae)	7	HBR - C + MA	coral MA black and white urchins
Ball Bay E - W transect	341	-29.048887	167.986171	unconsolidated sediment (sand _ gravel, uncovered)	14	US	Sparse but healthy looking dense Macroalga attached to rubble fragments
Ball Bay E - W transect	342	-29.049959	167.986991	unconsolidated sediment (sand _ gravel, uncovered)	14.5	US	Just sand
Ball Bay E - W transect	343	-29.051669	167.991128	unconsolidated sediment (sand _ gravel, uncovered)	26	US	Just sand
Ball Bay N - S transect	344	-29.047721	167.987280	hardbottom_rock (partly covered with coral and macroalgae)	5	HBR - C + MA	MA is fairly well developed; encrusting coral, lots of black urchin
Ball Bay N - S transect	345	-29.048013	167.986766	hardbottom_rock (partly covered with coral and macroalgae)	6.7	HBR - C + MA	MA is fairly well developed; lots of black urchin, some white Urchin
Sns	346	-29.048399	167.986252	hardbottom_rock (partly covered with coral and macroalgae)	9.5	HBR - C + MA	MA is fairly well developed; lots of black urchin, some white Urchin
Ball Bay N - S transect	347	-29.048840	167.985865	unconsolidated sediment (sand _ gravel, uncovered)	13.5	US	rocky outcrops in sandy area, MA relatively dense, some rock seen on <i>Side Camera</i>
Ball Bay N - S transect	348	-29.049439	167.985567	unconsolidated sediment (sand _ gravel, uncovered)	12	US	white sand with little no MA patches
Ball Bay N - S transect	349	-29.050164	167.985170	hardbottom_rock (uncovered)	9.5	HBR - C + MA	Bigger fish, coral and MA
Ball Bay N - S transect	350	-29.050778	167.984810	hardbottom_rock (partly covered with coral and macroalgae)	4.6	HBR - C + MA	(videos only 37 secs) Lot of black urchins, MA and coral 50/50
Ball Bay offshore	351	-29.055333	167.995725	off habitat map	38	US	bare white sand
Bloody Bridge	352	-29.057570	167.972597	unconsolidated sediment (sand _ gravel, uncovered)	3.4	US	Some rock, looks turbulent, white sand
Bloody Bridge	353	-29.062408	167.977185	unconsolidated sediment (sand _ gravel, uncovered)	20	US	Some low relief and heavily sedimented rock 'finger -like' projections present, sparse algae
Bloody Bridge	354	-29.067001	167.981205	off habitat map	33	US	Low density 'rooted' MA in white sand
Pt Hunter S	355	-29.066694	167.964286	hardbottom_rock (partly covered with coral and macroalgae)	13	HBR - MA	(<i>Side cam</i> footage 6 secs long) Lots of sand too, low relief flat rocks/ white sand patches , very sparse turfing algae
Pt Hunter S	356	-29.066922	167.962799	hardbottom_rock (partly covered with coral and macroalgae)	6	HBR - C + MA	Lot of small fish; lots of rocky outcrops, white urchins, lots of black urchins
Salt House transect	357	-29.062943	167.958094	hardbottom_rock (partly covered with coral and macroalgae)	9	HBR - C + MA	Nice, coral, MA and lots of black urchins
Salt House transect	358	-29.066221	167.955940	unconsolidated sediment (sand _ gravel, uncovered)	16.5	US	Quite turbulent, Great <i>Sidecam</i> shots of sand movement, bare white sand
Salt House transect	359	-29.072255	167.952578	hardbottom_rock (partly covered with coral and macroalgae)	28	HBR - MA	Sea stars present - several of which seem to be regenerating arms. White urchins, rock outcrop in sand
Salt House transect	360	-29.077037	167.949198	off habitat map	35	HBR - MA	Dense stands of Reds and Brown algae; lot of sand here, little coral
Pt Ross transect	361	-29.072815	167.931415	hardbottom_rock (partly covered with coral and macroalgae)	35	HBR - C + MA	stands of Reds, Greens and Brown algae; Relatively high diversity of algae, low relief rock, corals, sea whip
Pt Ross transect	362	-29.064133	167.934506	hardbottom_rock (partly covered with coral and macroalgae)	25	HBR - C + MA	Healthy and densely spaced coral, white urchin
Johnny stone transect	363	-29.053103	167.917138	hardbottom_rock (partly covered with coral and macroalgae)	11	HBR - C + MA	Large Black Urchin population; lot of denuded substrate, white urchins holding stones. Urchin barren
Johnny stone transect	364	-29.055254	167.913199	hardbottom_rock (partly covered with coral and macroalgae)	28	HBR - C + MA	Channels cut through this fore - reef

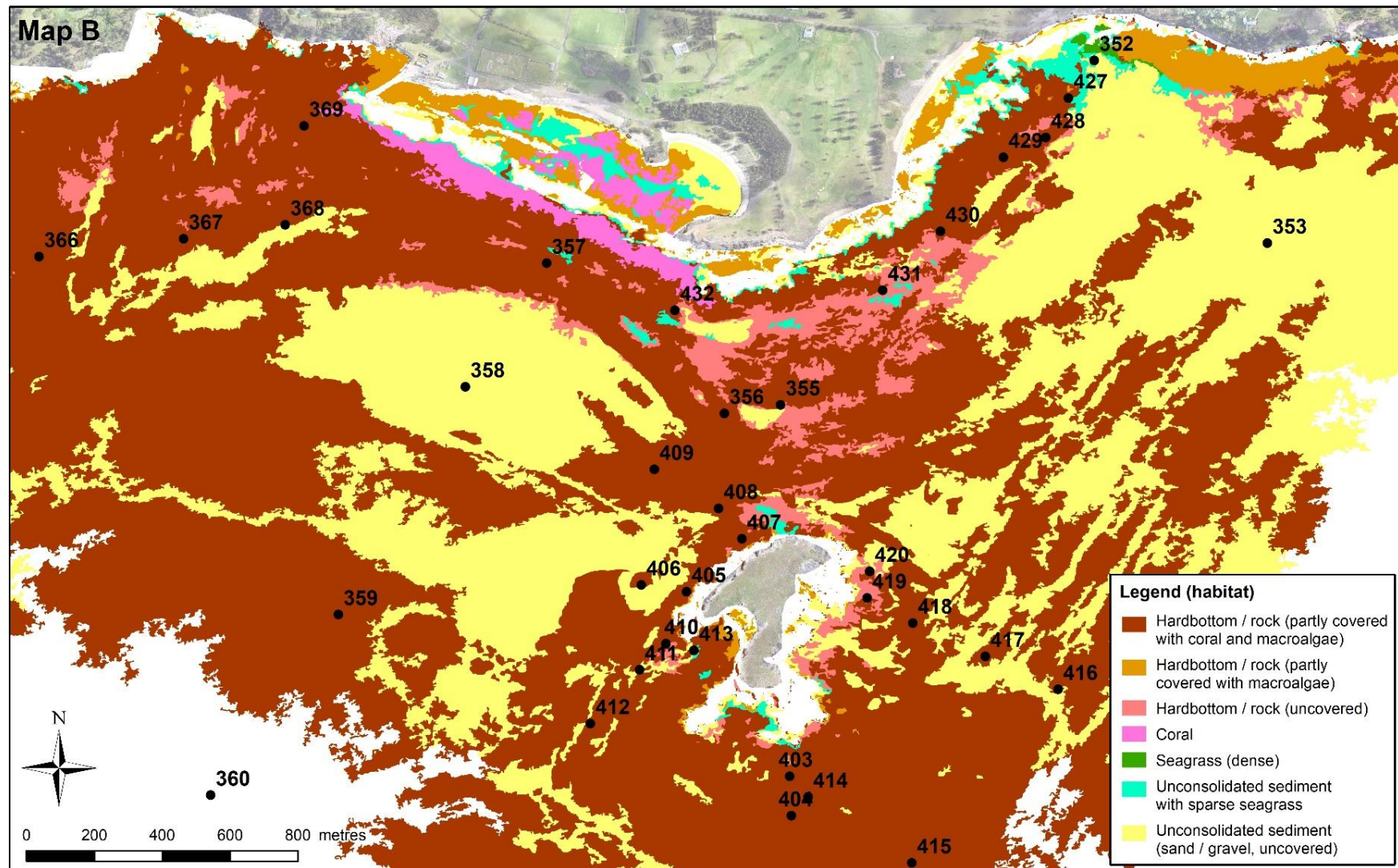
Area	Wpt #	Latitude	Longitude	Class_name eomap 2021	Depth (m)	Ground-truthed habitat (2022)	Notes on videos
Johnny stone transect	365	-29.059485	167.905393	off habitat map	42	US	good cover of algae
Bumboras to jetty transect	366	-29.06277	167.944646	hardbottom_rock (partly covered with coral and macroalgae)	9	HBR - C + MA	Some black urchins
Bumboras to jetty transect	367	-29.062297	167.948477	hardbottom_rock (partly covered with coral and macroalgae)		HBR - C + MA	(No Sidecam file), dive site used by Mitch and Jack
Bumboras to jetty transect	368	-29.061927	167.951172	unconsolidated sediment (sand _ gravel, uncovered)	16	US	(No Sidecam file) Some smaller rocks in bare white sand, scattered algae covered low relief rock platform and small boulders
Bumboras to jetty transect	369	-29.059304	167.951668	hardbottom_rock (partly covered with coral and macroalgae)	6	HBR - MA	(No Sidecam file) Lot of Sailors eyes i.e. <i>Valonia sp.</i> at the Jetty
Phillip Is	370	-29.114645	167.953272	hardbottom_rock (partly covered with coral and macroalgae)		HBR - C + MA	coral and algae on rocky ledges, lots of black urchins, green MA
Phillip Is	371	-29.114605	167.953894	hardbottom_rock (partly covered with coral and macroalgae)	9	HBR - C + MA	MA (see <i>Downcam</i> file at 43") NB bifurcated distal edge of frond; this is in sand, coral
Phillip Is	372	-29.114598	167.955075	unconsolidated sediment (sand _ gravel, uncovered)	17.5	US	bare white sand, interesting wave patterns
Phillip Is, Sail rock	373	-29.115180	167.957346	hardbottom_rock (partly covered with coral and macroalgae)	12	HBR - C + MA	Relatively large coral well developed; lots of small fish, sea anemone, little MA
Phillip Is Sth east end	374	-29.114928	167.960420	hardbottom_rock (partly covered with coral and macroalgae)	13	HBR - C + MA	See <i>Downcam</i> @19", or <i>Frame 117</i> , for good shot of camera array, coral and anemones, little MA, no side
Phillip Is Sth east end	375	-29.114912	167.961727	hardbottom_rock (partly covered with coral and macroalgae)	19.5	HBR - C + MA	No <i>Sidecam</i> file found, coral, anemones, some MA
Phillip Is Sth east end	376	-29.111393	167.96316	unconsolidated sediment (sand _ gravel, uncovered)	37.8	US	Just sand; no <i>Sidecam</i> file found, some emergent rock patches
Phillip Is East	377	-29.120810	167.964818	hardbottom_rock (partly covered with coral and macroalgae)	6.8	HBR - C + MA	Seems pristine. Great lighting, some nice fish shots, more MA, coral
PIE1 + 200m	378	-29.121968	167.966459	hardbottom_rock (partly covered with coral and macroalgae)		US	Lots of rubble; Ref file "Down378-2"; Side378 has <i>Downcam</i> in view , low density MA on rubble rock
PIE2 + 200m	379	-29.122771	167.968333	off habitat map	41	US	bare white sand,
Spin Bay transect	380	-29.123165	167.958419	hardbottom_rock (partly covered with coral and macroalgae)	6	HBR - C + MA	Lot of Black Urchin, more coral than MA
Spin Bay transect	381	-29.124409	167.957130	unconsolidated sediment (sand _ gravel, uncovered)	16.5	HBR - C + MA	REF File "Down381 - 2"; Rock ledges abutting sand coral red MA, anemones
Spin Bay transect	382	-29.123936	167.954471	hardbottom_rock (partly covered with coral and macroalgae)	12.5	HBR - C + MA	1 sp. Red algae abundant; green MA, low density coral, lots of black urchin
Jacky Jacky N - S transect	383	-29.131440	167.953561	hardbottom_rock (partly covered with coral and macroalgae)	8.5	HBR - C + MA	very high density black urchins, urchin barren, scattered corals, area appears denuded
Jacky Jacky N - S transect	384	-29.132479	167.955201	unconsolidated sediment (sand _ gravel, uncovered)	16	HBR - C + MA	coral, white urchins and black urchins zooanthids
Jacky Jacky N - S transect	385	-29.133203	167.957184	hardbottom_rock (partly covered with coral and macroalgae)	32	HBR - C + MA	Sand patches black and white sand stripes. Fore reef, green turtle with head under rock
Jacky Jacky N - S transect	386	-29.134298	167.959050	off habitat map	37.5	US	Some low emergent rock formations heavily accreted with sand, MA
Jacky Jacky E - W transect	387	-29.136549	167.954372	off habitat map	24.5	HBR - C + MA	Lots of small fish, red MA, rock outcrops with steep edges, black urchins, low density coral
Jacky Jacky E - W transect	388	-29.136368	167.949928	off habitat map	22	HBR - C + MA	Red algae; some closeups of <i>Halimeda sp.</i> black trepang
Near south rock	389	-29.136203	167.948558	off habitat map	40	US	rock platform heavily accreted with sand; rubble, low density coral and MA, a few ' whip coral' seen
Near south rock	390	-29.134975	167.946936	hardbottom_rock (partly covered with coral and macroalgae)	6	HBR - C + MA	Sea star; <i>Halimeda sp.</i> <i>Padina sp.</i> high density black urchins
Coyne Cove	391	-29.125684	167.945944	hardbottom_rock (partly covered with coral and macroalgae)	7	HBR - MA	Lot of Black urchin and MA, urchin barren
Coyne Cove	392	-29.126456	167.943871	off habitat map	24	HBR - C + MA	rocky seabed, heavily accreted with sand, MA and Coral low density, sea stars, sand patches
Coyne Cove	393	-29.126676	167.941636	off habitat map	34	HBR - C + MA	Relatively dense MA density and diversity; nb this includes greens, corals and sand patches, anemones, starfish
West end 1	394	-29.119456	167.942681	hardbottom_rock (partly covered with coral and macroalgae)	16	HBR - C + MA	coral, white urchins
West end 2	395	-29.122031	167.942546	hardbottom_rock (partly covered with coral and macroalgae)	13	HBR - Un	A pile of boulders with sparse surviving coral observed, black urchin
Shark Point west	396	-29.117716	167.942312	hardbottom_rock (partly covered with coral and macroalgae)	4.5	HBR - Un	Largely fractured bare rock with some black urchin observed; see <i>sFrame0051</i> for KP 'action'
Shark Point west	397	-29.116708	167.940581	hardbottom_rock (partly covered with coral and macroalgae)	24	HBR - C + MA	Fish plentiful, see <i>sFrame0066</i> ; Juvenile shark seen in <i>Downcam</i> , white urchins zooanthids
Shark Point west	398	-29.115629	167.938815	off habitat map	37	US	Lot of sand accretion on flat rocky seabed, lot of MA, Shark in <i>Downcam</i> @ 2:13
Stool east transect	399	-29.114393	167.950496	hardbottom_rock (partly covered with coral and macroalgae)	5	HBR - C + MA	very high density Black urchin, hard coral, anemones, red MA
Stool east transect	400	-29.112188	167.949928	hardbottom_rock (partly covered with coral and macroalgae)	14.5	HBR - C + MA	high density coral, red and green MA
Stool east transect	401	-29.110156	167.950163	hardbottom_rock (partly covered with coral and macroalgae)	21	HBR - C + MA	Fish, coral MA sea star, zooanthids, massive soft coral
SE3 + 200m	402	-29.107959	167.950280	off map	26	HBR - C + MA	Lot of calcareous red MA, some green and corals
Nepean, Mary Hamilton reef	403	-29.076541	167.964530	hardbottom_rock (partly covered with coral and macroalgae)	10	HBR - C + MA	wpt checked ; high density white urchin, blue sea stars
Nepean, Mary Hamilton reef	404	-29.077581	167.964575	hardbottom_rock (partly covered with coral and macroalgae)	17	HBR - C + MA	Black sea stars, nice coral, white urchins, soft corals anemone zooanthids
Nepean The Crack	405	-29.071649	167.961799	hardbottom_rock (partly covered with coral and macroalgae)	11	HBR - C + MA	Fish, black urchins, corals with white edges (new growth to be colonised by zooxanthellae)
Nepean The Crack	406	-29.071468	167.960600	hardbottom_rock (partly covered with coral and macroalgae)	16	HBR - C + MA	Beautiful fish corals MA , white urchins, coral sponge
Nepean NW	407	-29.070247	167.963268	hardbottom_rock (partly covered with coral and macroalgae)	5	HBR - C + MA	Black Urchin, high density white Urchin, Sea star, sand patches, turfing green algae
Nepean NW	408	-29.069443	167.962646	hardbottom_rock (partly covered with coral and macroalgae)	16	HBR - C + MA	rocky patches in sandy seabed, white urchin, low density coral, some green MA
Nepean NW	409	-29.068403	167.960943	hardbottom_rock (partly covered with coral and macroalgae)	17	HBR - C + MA	rocky patches in sandy seabed, white urchin, low density coral, some green MA
Nepean SW	410	-29.073027	167.961249	hardbottom_rock (partly covered with coral and macroalgae)	7	HBR - C + MA	lots of White Urchin, schooling fish, Sandy patches, low relief

Area	Wpt #	Latitude	Longitude	Class_name eomap 2021	Depth (m)	Ground-truthed habitat (2022)	Notes on videos
Nepean SW	411	-29.073713	167.960555	hardbottom_rock (partly covered with coral and macroalgae)		HBR - C + MA	Some schooling fish, sandy patches, high density white urchins, corals, MA
Nepean SW	412	-29.075146	167.959248	hardbottom_rock (partly covered with coral and macroalgae)	18	HBR - C + MA	Well developed sand channel, white urchins, nice coral turfing MA,
Nepean Back Bay	413	-29.073201	167.961997	unconsolidated sediment with sparse seagrass	5	HBR - MA	Some Black Urchin, high relief rock structure, low density coral, high density turfing green MA
Nepean SE1	414	-29.077084	167.965017	hardbottom_rock (partly covered with coral and macroalgae)	13.5	HBR - C + MA	white urchin, Black Urchin; Lot denuded rock
Nepean SE2	415	-29.078833	167.967766	hardbottom_rock (partly covered with coral and macroalgae)	16	HBR - MA	MA on expose rock in sandy habitat , some scattered coral
NE1	416	-29.074233	167.971641	hardbottom_rock (partly covered with coral and macroalgae)	24	US	Parallel 'fingers' of emergent rock with coral and MA on it in sandy habitat, nice cluster of catfish
NE1 - 200m	417	-29.073366	167.969713	hardbottom_rock (partly covered with coral and macroalgae)	21	HBR - C + MA	low profile rocky outcrops in sandy seabed, coral and MA on rock
NE2 - 200m	418	-29.072476	167.967793	hardbottom_rock (partly covered with coral and macroalgae)	14	HBR - C + MA	coral and MA, white urchin, zooanthids
NE3 - 100m	419	-29.071814	167.966585	hardbottom_rock (partly covered with coral and macroalgae)	10	HBR - C + MA	camouflaged White Urchins, low profile rocky with turfing algae and spares coral
Nepean E	420	-29.071113	167.966648	hardbottom_rock (uncovered)	13	HBR - C + MA	Small shark, rocky outcrops with coral and MA in sandy seabed, fish
Ball Bay	421	-29.047800	167.985585	hardbottom_rock (partly covered with coral and macroalgae)	3.5	HBR - MA	boulders with turfing MA, low density corals
Ball Bay	422	-29.048210	167.984549	hardbottom_rock (partly covered with coral and macroalgae)	3.5	HBR - MA	A lot of boulders and rubble; some encrusting corals, Black Urchins
Ball Bay	423	-29.048769	167.983728	hardbottom_rock (partly covered with coral and macroalgae)	2.5	HBR - UN	A lot of boulders and rubble; Black Urchin
Ball Bay	424	-29.049636	167.983476	hardbottom_rock (partly covered with coral and macroalgae)	2.5	HBR - MA	Black Urchin population is dense; MA is mostly green and dominated by a Codium sp, some low density corals
Ball Bay	425	-29.049872	167.983800	hardbottom_rock (partly covered with coral and macroalgae)	4	HBR - C + MA	Black Urchin present
Ball Bay groyne location	426	-29.050613	167.984494	hardbottom_rock (partly covered with coral and macroalgae)	4	HBR - C + MA	Black Urchin Present, green MA and sparse corals
Cemetery Bay	427	-29.058571	167.971912	hardbottom_rock (partly covered with coral and macroalgae)	6	HBR - MA	high density Black Urchin, MA fairly well developed
Cemetery Bay	428	-29.059611	167.971317	hardbottom_rock (partly covered with coral and macroalgae)	4	HBR - MA	MA appears as close cropped turf, Black Urchin all confined to deepest parts
Cemetery Bay	429	-29.060139	167.97019	hardbottom_rock (partly covered with coral and macroalgae)	4	HBR - MA	Turf; relatively high primary productivity???
Cemetery Bay	430	-29.062100	167.968523	hardbottom_rock (partly covered with coral and macroalgae)	6	HBR - MA	Lot of Black Urchin - many in sandy pockets, white urchins
Windmill	431	-29.063660	167.966991	hardbottom_rock (uncovered)	6	HBR - MA	Lot of Black Urchin - many in sandy pockets, white urchins , rocky outcrops in sandy seabed
Point Hunter lone pine	432	-29.064188	167.961492	hardbottom_rock (partly covered with coral and macroalgae)	8	HBR - MA	But drifts onto HBR - UN, Black Urchin abundant, white urchins
Steel Pt Sth drift start	433	-29.032386	167.996365	hardbottom_rock (partly covered with coral and macroalgae)	8		no footage, down or size.
Two chimneys coral site	434	-29.039558	167.998393	hardbottom_rock (partly covered with coral and macroalgae)	17.5	HBR - C + MA	Edge of fore reef is sandy, high profile rock in sandy seabed, high density coral and little MA, white and black urchins
Steels Pt drift	435	-29.033545	167.996608	hardbottom_rock (partly covered with coral and macroalgae)		coral	Some Black Urchin, corals high density
Steels Pt drift end	436	-29.034490	167.996816	hardbottom_rock (partly covered with coral and macroalgae)	12.5		no footage
Cave	437	-29.014385	167.964701	unconsolidated sediment (sand _ gravel, uncovered)	5	US	Sandy, rocky outcrops
Archway	438	-29.009388	167.962277	unconsolidated sediment (sand _ gravel, uncovered)	11	HBR - MA	Covers a transition btw flat turfy reef and sand, high density black urchins
Archway	439	-29.009458	167.961204	hardbottom_rock (partly covered with coral and macroalgae)	5	HBR - C + MA	Lot of Black Urchin barren, corals with little MA, rock cobble
	440	-29.007653	167.959419	hardbottom_rock (partly covered with coral and macroalgae)		corals	Some nice footage, coral is well developed
Bird rock East	441	-29.005438	167.958635	hardbottom_rock (partly covered with coral and macroalgae)	7	HBR - MA	Good productivity i.e. a lot of MA, lots of black urchins, red and green MA, spares corals
Elephant rock	442	-29.005541	167.956156	hardbottom_rock (partly covered with macroalgae)	5.9	HBR - C + MA	Black Urchin grazing well depicted here
Captain Cook transect	443	-29.000385	167.944268	hardbottom_rock (partly covered with coral and macroalgae)	8	HBR - MA	Lot of Coral rubble here, Side cam pointing down
Captain Cook transect	444	-28.999297	167.945151	unconsolidated sediment (sand _ gravel, uncovered)	15	US	see 00:51 Down cam, lot of rubble here, depauperate
Captain Cook transect	445	-28.997973	167.945980	hardbottom_rock (uncovered)	26	US	Some algae secured in sand, rocky rubble and gravel, small sting ray.
Captain Cook transect	446	-28.995332	167.947107	off habitat map	31	US	sea whips, bowl - shaped emergent coral

Appendix C: Original satellite-derived habitat classification maps prior to ground-truthing survey and retraining of EOMAP model.







J60002 Norfolk Island Habitat Mapping

Figure C3: Ground-truthing sampling locations – inset Map B, Kingston and Nepean Island.

Drawn: B. Moore
Date: 03/11/2022

Drawing File Ref:
PENJ-J60002-1240-A

Coordinate System: WGS 1984 UTM Zone 58



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