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RESEARCH REPORT
Project 1.32a

An Inventory of Northern Australia's Seagrass Data

FINAL REPORT

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Cover images

Seagrass meadows in the Northern Territory. TropWATER, James Cook University.

Contents

Acknowledgements **1**

Executive summary **2**

1. Introduction **4**

2. Study approach and methods **6**

3. Results **8**

4. Discussion **27**

5. References **29**

List of figures

Figure 1. Spatial extent of seagrass data inventory. 7

Figure 2. Locations (dots) and areas (polygons) where seagrass information has been collected or could be collected from targeted seagrass projects or other marine research in the Northern Territory and northern Western Australia. 26

List of tables

Table 1. Survey locations, project name, date of survey, accessibility of data and seagrass information collected. TBA: to be advised following discussion with data custodian/s. 10

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Executive summary

Northern Australia has globally significant seagrass habitat that provide well-documented ecological services, including providing a food resource that underpins the survival of dugong and green sea turtles. Key to understanding, managing, mitigating risk and establishing monitoring of these habitats is reliable data on this resource. Recent National Environmental Science Program (NESP) projects have provided a synthesis of 35 years of seagrass data from the Great Barrier Reef (GBR) and a 40-year synthesis for Torres Strait and the Gulf of Carpentaria. However, seagrass data for the majority of Northern Territory waters and northern Western Australian waters were not included and remain disparate and not available in an easily accessible database. To begin addressing this, we have created an inventory of projects between Cape Arnhem (Northern Territory) and Ningaloo Reef (Western Australia), where seagrass data is available for inclusion in a synthesis or could be available with further evaluation. This inventory is the first stage in expanding the seagrass data synthesis to cover all of northern Australia. We identify knowledge gaps in the available seagrass data which will assist in designing seagrass mapping and monitoring priorities across northern Australia.

This inventory compiles projects that were undertaken from 1971 – 2022 that either have information on seagrass habitat or, with further evaluation, seagrass information that could be extracted. The inventory includes information on the location of the seagrass/project area, the data custodian and the date data were collected. It describes the spatial information available and key seagrass information collected (i.e., percent cover, species, above-ground biomass). It includes information on the availability of the data for public use or, if data is not publicly available, the potential for a pathway to make it available.

This inventory identifies at least 49 projects between Cape Arnhem and Ningaloo Reef that have collected seagrass data. Projects that have contributed to the approval processes for larger dredging campaigns, like the Pluto, Wheatstone, Gorgon and Cape Lambert Projects have been grouped together. These projects were part of a data-sharing agreement with the Western Australian Marine Science Institution Dredging Science Program. Individual projects and datasets that contribute to these larger projects will need to be ‘unpacked’ with further resources and consultation.

Of the 49 projects identified in this inventory, 19 are publicly available. For the projects with access constraints, 26 have the potential for negotiations to enable them to be included in a data synthesis, albeit with some caveats. The information included in some projects and datasets we have listed was not able to be confirmed within the timeframe and resources for this project and will require further investigation.

Most project data have spatial information and can be incorporated into a spatial synthesis similar to that for the GBR, Torres Strait and Gulf of Carpentaria. We also identified projects where seagrass habitat was not a target of the project, but additional seagrass information could be extracted to include in a future synthesis.

The inventory in this report provides a valuable resource to underpin:

- Creation of a seagrass data synthesis between Cape Arnhem (Northern Territory) and Ningaloo Reef (Western Australia).
- Identification of knowledge gaps to guide future mapping and monitoring efforts for northern Australia.
- Regional planning in northern Australia.

1. Introduction

Seagrass habitats provide well documented ecological services that include nutrient absorption, sediment stabilisation, and food and habitat for traditional, commercial and recreational fishing species (Hayes et al. 2020; Jänes et al. 2020; Bainbridge et al. 2018; Nordlund et al. 2016; Costanza et al. 2014). In northern Australia, seagrasses are a major marine ecosystem, with extensive meadows mapped across the region (Carter et al. 2022; Carter et al. 2021; Huisman et al. 2021; Roelofs et al. 2005; Green and Short 2003; Poiner et al. 1987). These seagrass habitats provide food for dugong (*Dugong dugon*) and green sea turtles (*Chelonia mydas*) (Scott et al. 2020; Hays et al. 2018; Scott et al. 2018; Tol et al. 2016; Kelkar et al. 2013; Marsh et al. 2011) and play a significant role in supporting sea country values for First Nations saltwater people (Statton et al. 2021; Butler et al. 2012; McNiven 2003; Bradley 1997).

Key to understanding, managing, mitigating risk, and monitoring seagrass habitats in northern Australia is reliable knowledge on where there have been surveys for seagrass, where seagrass was present, and what communities occur. Recent seagrass data projects include a 35-year synthesis of data from the Great Barrier Reef (GBR) (Carter et al. 2021) and a 40-year synthesis for Torres Strait and the Gulf of Carpentaria (Carter et al. 2022). Seagrass data for Northern Territory (NT) waters west of Cape Arnhem and northern Western Australia (WA) have not been collated in a systematic way across the region. Efforts to collate and inventory some seagrass information have been made for museum or herbarium collection records (i.e., Huisman & Sampey 2014) and for some major dredging campaigns (Jones and Twomey 2019), but overall seagrass data remains disparate, and much is held in databases that cannot be accessed by the public. The need for a more inclusive inventory and more reliable/verified information on seagrass in northern Australia was identified by a recent review of Australian marine and coastal wetlands (Brock et al. 2022).

Our objective for this report was to inventory seagrass data between Cape Arnhem (NT) and Ningaloo Reef (WA). Information on seagrass in the inventory includes:

- What data exists.
- Whether data is publicly available.
- Whether there are access constraints and if there are pathways to allow the data to be made public.
- The methods used to collect the data.
- Whether the data has the key attributes required for it to be incorporated into a spatial synthesis (e.g., latitude, longitude, seagrass presence/absence, seagrass species).

This inventory provides the basis for the creation of a spatial synthesis of seagrass data in this important region that will align with spatial syntheses for the GBR, Torres Strait and Gulf of Carpentaria (Carter et al. 2022, Carter et al. 2021) and underpins future mapping and monitoring activities.

2. Study approach and methods

The spatial scope of this inventory was coastal waters between Cape Arnhem (NT) and Ningaloo Reef (WA) (Figure 1). This is a complex coastline that includes large rivers, small estuaries, shallow embayments, coral reefs and islands (Sangha et al. 2019; Bryce et al. 2018; Wilson 2014).

We conducted a review of the literature and data portals such as the WA Department of Water and Environmental Regulation (DWER) Index of Marine Surveys for Assessments (IMSA) (https://biocollect.ala.org.au/imsa#max%3D20%26sort%3DdateCreatedSort) to identify data sets and potential data custodians. We worked with universities, government agencies, citizen science groups and industry to gather information on any surveys that may have collected seagrass information. Data custodians were contacted if possible and provided with a questionnaire to ensure information was collected in a standardised way. We asked data custodians to provide the following information for each data set:

- Location
- Name of project
- Data custodian
- Date range of data
- Is data publicly available?
- If data is not publicly available, are there pathways to accessibility?
- Data type
- Survey method/s
- Does data have spatial information?
- What seagrass information was collected?
- Is data suitable for inclusion into seagrass synthesis or is further work required to extract seagrass information?
- Comments and additional information

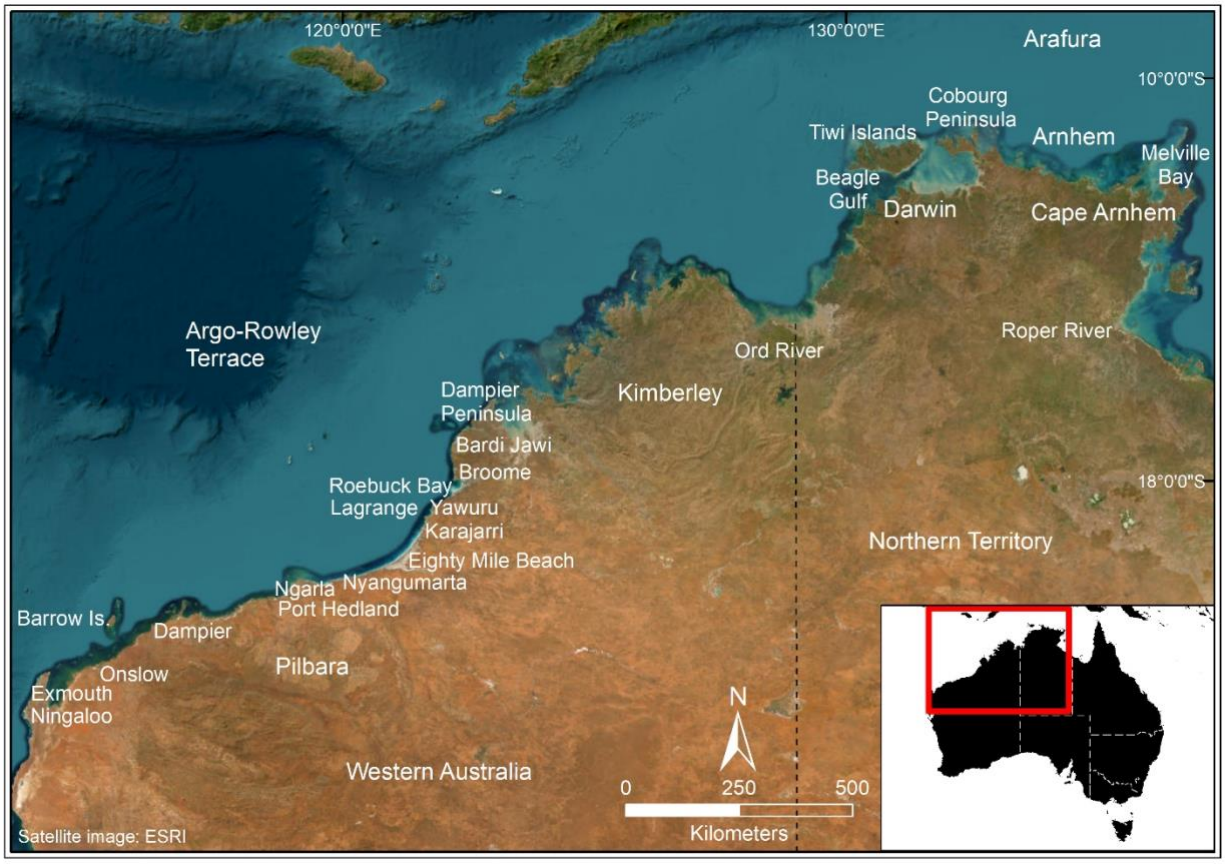

Figure 1. Spatial extent of seagrass data inventory.

3. Results

This inventory identified at least 49 projects that include or potentially include seagrass data between Cape Arnhem and Ningaloo Reef (Table 1; Figure 2). The information includes data collected from 1971 to 2022. Most of the data comes from WA, with many projects centred around large-scale dredging campaigns for oil and gas projects, e.g., Wheatstone, Gorgon, Pluto and Cape Lambert Projects.

Some data custodians we contacted have not responded. Some databases with seagrass information were hard to access or verify. For some projects, metadata statements were located on the IMSA data portal; however, the original report or data could not be located to determine whether seagrass information was collected as part of the project. We are confident that as a NT-WA data synthesis progresses that additional data will be identified.

Nineteen data sets in our inventory are publicly available. For the projects with access constraints, 26 have the potential to be released publicly with negotiated caveats. Data may be withheld for a range of reasons, including academic publication requirements, commercial in confidence for private and government bodies, and the need to protect information on traditional fishing and hunting grounds.

Data in the inventory came from six major sources:

- Industry projects related to dredging and port expansion.
- Region scale mapping by government departments including Commonwealth Scientific and Industrial Research Organisation (CSIRO), Western Australian Museum and Australian Institute of Marine Science (AIMS).
- Citizen science monitoring and observations.
- Traditional Indigenous Knowledge.
- Academic research projects.
- Incidental seagrass data collected during other surveys.

The data included in the inventory were collected using a variety of survey methods, including aerial surveys, walking and observing, SCUBA diving and freediving, video transects from towed cameras, sediment grabs, sediment cores, photographs, underwater still camera and video ‘drops’, trawl and net samples, drones, underwater unmanned and remotely operated vehicles.

Most project data inventoried have spatial information, primarily point data, so could be incorporated into a spatial synthesis similar to that for the GBR, Torres Strait and Gulf of Carpentaria (Carter et al. 2022; Carter et al. 2021). We include datasets where additional seagrass information may be available if further analysis is completed on the project data that would allow for inclusion in a future synthesis.

Table 1. Survey locations, project name, date of survey, accessibility of data and seagrass information collected. TBA: to be advised following discussion with data custodian/s.

Location	Name of project	Custodian	Date range of data	Is data publicly available?	If data not publicly available, is there a pathway to accessibility?	Data type	Survey method	Data has spatial information	Seagrass information collected	Suitable for inclusion into synthesis (Yes) or needs re-analysis (RA)	Comments & additional information
Northern Territory (Cape Arnhem to the NT/WA border)											
Northern Territory & Queensland	A survey of intertidal seagrass from Van Diemen Gulf to Castlereagh Bay, Northern Territory, and from Gove to Horn Island, Queensland	Queensland Department of Agriculture & Fisheries (DAF), Northern Territory Department of Environment, Parks and Water Security (DEPWS)	2004	Yes		Point Polygon	Helicopter	Yes	Presence / absence. % cover. Species composition.	Yes	datarequests.depws@nt.gov.au Roelofs et al. 2005
Northern Territory	Northern Australia Marine Biodiversity Survey (NAMBS)	DEPWS / Museum & Art Gallery Northern Territory (MAGNT)	2003 - 2005	Yes		Point	Walking Benthic trawls Sediment grabs	Yes	Presence / absence.	Yes	datarequests.depws@nt.gov.au Russell and Smit 2007
Northern Territory	DEPWS – One off survey	DEPWS	2000	Yes		Point, Polygon	Walking, Observation Sediment grabs Towed video, Helicopter	Yes	Presence / absence.	RA	datarequests.depws@nt.gov.au Unpublished Opportunistic sampling. Re-analyse to determine seagrass species composition
Beagle Gulf	Beagle Gulf Benthic Survey:	DEPWS / MAGNT	1993	Yes		Point	Sled-tows Samples	Yes	Presence / absence.	Yes	datarequests.depws@nt.gov.au

Location	Name of project	Custodian	Date range of data	Is data publicly available?	If data not publicly available, is there a pathway to accessibility?	Data type	Survey method	Data has spatial information	Seagrass information collected	Suitable for inclusion into synthesis (Yes) or needs re-analysis (RA)	Comments & additional information
	Characterisation of soft substrates								Species composition.		Smit et al. 2000
Darwin Harbour	International Petroleum Exploration (INPEX) – Various seagrass baseline & monitoring programs	INPEX	2010 - 2013	No	Yes	Point Polygon	Underwater video Drop-down camera	Yes	Presence / absence. % cover. Species composition. Shoot density. Seedbank.	Yes	Published in various reports Key publication is: Cardno 2014.
Darwin Harbour	DEPWS - Seagrass	DEPWS	2016	Yes – Request data		Point Images	Drop-down camera Still images	Yes	Presence / absence. % cover. Species composition.	Yes	datarequests.depws@nt.gov.au Unpublished
Darwin Harbour - Mindle Beach Casuarina Beach Fannie Bay	DEPWS – Seagrass-Watch	DEPWS / Seagrass-Watch	2011 - 2013	Yes – Request data		Point	Observation	Yes	Presence / absence. % cover. Species composition. Canopy height.	Yes	https://www.seagrasswatch.org/contact/ datarequests.depws@nt.gov.au Unpublished
Darwin Harbour / Bynoe Harbour	DEPWS - Seagrass	DEPWS	2011	Yes – Request data		Polygon	Helicopter	Yes	Presence / absence.	Yes	datarequests.depws@nt.gov.au Unpublished
Darwin Harbour	Middle Arm Port Development	Northern Territory Government (NTG)	2020 - ongoing	No	Yes	Point Polygon	Underwater video	Yes	Presence / absence. % cover.	RA	Re-analyse to determine seagrass species composition

Location	Name of project	Custodian	Date range of data	Is data publicly available?	If data not publicly available, is there a pathway to accessibility?	Data type	Survey method	Data has spatial information	Seagrass information collected	Suitable for inclusion into synthesis (Yes) or needs re-analysis (RA)	Comments & additional information
											Published in various reports
Darwin Harbour	Mandorah Marine Facility Development	Northern Territory Government (NTG)	2020 - ongoing	No	Yes	Point Polygon	Underwater video	Yes	Presence / absence. % cover.	RA	Re-analyse to determine seagrass species composition Published in various reports
Darwin Harbour	Sediment sampling program	DEPWS - Aquatic Health Unit	2012	Yes		Point	Sediment cores	Yes	Presence / absence.	RA	datarequests.depws@nt.gov.au Opportunistic sampling. Re-analyse to determine presence/absence of seagrass and identify if notes on seagrass species were kept
Darwin Harbour & Port Essington (Cobourg Peninsula)	MAGNT - various marine biological surveys	MAGNT	1982 - ongoing	No	Yes	Point	Various	Yes	Unknown.	RA	Further discussions with MAGNT
NT Herbarium	Specimen voucher records	NTG		Yes		Voucher records	Various, collected and within collection	yes	Presence / absence.	Yes	datarequests.depws@nt.gov.au https://nrmaps.nt.gov.au/nrmaps.html

Location	Name of project	Custodian	Date range of data	Is data publicly available?	If data not publicly available, is there a pathway to accessibility?	Data type	Survey method	Data has spatial information	Seagrass information collected	Suitable for inclusion into synthesis (Yes) or needs re-analysis (RA)	Comments & additional information
Bynoe Harbour	TBA	Kenbi Rangers / Northern Land Council (NLC)	2017 - ongoing	No	Yes	Point	Helicopter Drop-down camera	Yes	Presence / absence. % cover.	Yes	Contact Northern Land Council for data access
Bynoe Harbour / Indian Island	Indian Island intertidal Seagrass survey	NTG	2003	Yes		Point Polygon	Walking Snorkelling	Yes	Presence / absence % cover. Biomass (below & above-ground).	Yes	datarequests.depws@nt.gov.au Unpublished Biomass data needs working up
Tiwi Islands including Vernon Islands	Various documents that mention seagrass habitat around the islands	Tiwi Land Council, Tiwi Resources, Tiwi Islands Regions Natural Resource Management Strategy	TBA	TBA	TBA	TBA	TBA	TBA	Presence / absence. Species composition.	TBA	Various documents mention seagrass habitats occur around the islands but no comprehensive survey of seagrass has been completed – information is from Indigenous Knowledge and expert knowledge
Cobourg Peninsula	Cobourg Peninsula Ramsar Site Ecological Character Description	Department of Sustainability, Environment, Water, Population and Communities BMT WBM Pty Ltd	2011	No	TBA	Point Polygon	Observation	TBA	Presence / absence. Species composition.		Indigenous Knowledge and expert knowledge transferred to polygons AECOM (2010) also did some work, is

Location	Name of project	Custodian	Date range of data	Is data publicly available?	If data not publicly available, is there a pathway to accessibility?	Data type	Survey method	Data has spatial information	Seagrass information collected	Suitable for inclusion into synthesis (Yes) or needs re-analysis (RA)	Comments & additional information
											linked with BMT-WBM (2011) report.
Glibb River (Melville Bay), Port Bradshaw	Seagrass-Watch	Dhimurru Rangers / Seagrass-Watch	2008	Yes		Point	Observation	Yes	Presence / absence. % cover. Species composition. Canopy height.	Yes	One off survey https://www.seagrasswatch.org/contact/ McKenzie 2008
Melville Bay	Baseline maps	AIMS / Rio Tinto / Alcan Nabalco	1971 - ongoing	No	Yes	Point – Not confirmed	Underwater video	Yes	Presence / absence. Species composition.	TBA	Commercial in Confidence data URS 2003 Speare et al. 2008 https://apps.aims.gov.au/metadata/view/c7c21bd2-8ca4-49f4-98cb-1bebfe7f97d9
Bremer Island (Gulf of Carpentaria)	Baseline maps	DEPWS / CDU	2008	No	Yes	Point – Not confirmed	Underwater video	Yes	Presence / absence. Species composition.	Yes	datarequests.depws@nt.gov.au Unpublished report

Location	Name of project	Custodian	Date range of data	Is data publicly available?	If data not publicly available, is there a pathway to accessibility?	Data type	Survey method	Data has spatial information	Seagrass information collected	Suitable for inclusion into synthesis (Yes) or needs re-analysis (RA)	Comments & additional information
Port Bradshaw (Gulf of Carpentaria)	Port Bradshaw Benthic survey	DEPWS	1999	No	Yes	Point	Underwater video SCUBA	Yes	Presence / absence. Species composition.	RA	datarequests.depws@nt.gov.au Unpublished report
Western Australia (Ningaloo Reef to the WA/NT border)											
Exmouth Gulf	Seagrass communities in Exmouth Gulf, Western Australia: a preliminary survey	Australian Institute of Marine Science (AIMS)	1994	No	Yes	Point	Observation Self contained underwater breathing apparatus diving (SCUBA)	Yes	Presence / absence. % cover. Species composition. Biomass. Shoot Count.	Yes	adc@aims.gov.au
Exmouth Gulf	Biomass and productivity of seagrass communities in Exmouth Gulf, Western Australia	Australian Institute of Marine Science (AIMS)	1995	No	Yes	Point	Observation SCUBA	Yes	Presence / absence. % cover. Species composition. Growth.	Yes	adc@aims.gov.au

Location	Name of project	Custodian	Date range of data	Is data publicly available?	If data not publicly available, is there a pathway to accessibility?	Data type	Survey method	Data has spatial information	Seagrass information collected	Suitable for inclusion into synthesis (Yes) or needs re-analysis (RA)	Comments & additional information
Exmouth Gulf - Simpson Island Whalebone North Whalebone South Giralia Bay Gales Bay	FRDC project 1999/222: Developing techniques for enhancing prawn fisheries, with a focus on brown tiger prawns (*Penaeus esculentus*) in Exmouth Gulf & Impact of cyclones and aquatic macrophytes on recruitment and landings of tiger prawns *Penaeus esculentus* in Exmouth Gulf, Western Australia	Commonwealth Scientific and Industrial Research Organisation (CSIRO) / Western Australia Department of Primary Industries and Regional Development (DPIRD)	1999 - 2001	No	Yes	Point	SCUBA	Yes	Presence / absence. % cover. Species composition. Biomass (below & above-ground). Shoot density.	Yes	https://researchrepository.murdoch.edu.au/id/eprint/16673/1/techniques_for_enhancing_prawn_fisheries.pdf Loneragan et al. 2003 Loneragan et al. 2013 http://dx.doi.org/10.1016/j.ecss.2013.03.024
Exmouth Gulf	Continuation of FRDC 1999/222 project	DPIRD / CSIRO	2003, 2005, 2006	No	Yes	Point Polygon	Underwater video	Yes	Presence / absence. % cover. Species composition.	Yes	Loneragan et al. 2013 http://dx.doi.org/10.1016/j.ecss.2013.03.024
Exmouth Gulf	Assessing Nursery Ground Benthic Habitats of the Exmouth Gulf Prawn Managed Fishery	DPIRD	2016 - 2020	No	Yes - After 2023	Point	Underwater video Drop-down camera	Yes	Presence / absence. % cover. Species composition. Biomass.	Yes	Unpublished Contact DPIRD https://www.fish.wa.gov.au/Sustainability-and-Environment/Fisheries-Science/Stock-assessment-and-data-analysis/Pages/Maki

Location	Name of project	Custodian	Date range of data	Is data publicly available?	If data not publicly available, is there a pathway to accessibility?	Data type	Survey method	Data has spatial information	Seagrass information collected	Suitable for inclusion into synthesis (Yes) or needs re-analysis (RA)	Comments & additional information
											ng-a-data-request.aspx
Exmouth Gulf & Pilbara - South Muiron Island Bundegi Exmouth Gulf Thevenard Island Rosemary Island Bella	Western Australian Marine Science Institution (WAMSI): Dredging Science Node - Projects associated with Theme 5: Projects 5.2, 5.3, 5.4	CSIRO / Edith Cowan University (ECU) / Department of Biodiversity, Conservation and Attractions (DBCA) / WAMSI	2013 - 2015	Yes		Point	SCUBA Photographs Sample collections	Yes	Presence / absence. % cover. Species composition. Biomass (below & above-ground). Shoot density. Leaf length & width. Flowering. Seed bank. Stable isotope ratios.	Yes	https://data.csiro.au/collection/csiro:17632v4 McMahon et al. 2017. https://wamsi.org.au/project/5-2-seagrass-genetics/ Vanderklift et al. 2017a. https://wamsi.org.au/project/5-3-seagrass-natural-dynamics/ Vanderklift et al. 2017b. https://wamsi.org.au/research/programs/dredging/
Exmouth Gulf - South Muiron Island Bundegi Exmouth Gulf	Masters Project - TBA	ECU / DBCA	2021	No	Yes – After 2023	Point	SCUBA Photographs Sample collections	Yes	Presence / absence. % cover. Species composition.	Yes	Request data from Approver Kathryn McMahon

Location	Name of project	Custodian	Date range of data	Is data publicly available?	If data not publicly available, is there a pathway to accessibility?	Data type	Survey method	Data has spatial information	Seagrass information collected	Suitable for inclusion into synthesis (Yes) or needs re-analysis (RA)	Comments & additional information
Exmouth Gulf	Tracking dugong movements in the Exmouth Gulf	ABC / Artemis Media	2020	No	Yes	Point	Underwater video	Yes	No seagrass information collected	RA	Opportunistic underwater video footage of seagrass habitat while filming for dugong. Footage could be re-watched, georeferenced, and identified for any seagrass information christophe.cleguer@jcu.edu.au
Exmouth Gulf	Learmonth Pipeline Fabrication Facility	DWER / BMT	2019 - 2020	Yes		Point	Underwater video	Yes	Presence / absence. % cover. Species composition.	Yes	https://biocollect.ala.org.au/imsa/project/index/52a79fe5-d192-43d6-a4bf-962254a72487
Pilbara - Pilbara shelf	The Pilbara Marine Conservation Partnership – Environmental pressures: Regional Biodiversity – Pilbara Seabed Biodiversity Mapping & Characterisation	CSIRO	2012 - 2015	No	Yes	Point	Underwater video	Yes	Presence / absence. Biomass. % cover (via proportion of towed video).	Yes	Pitcher et al. 2016 https://nla.gov.au/nla.obj-318835631/view
Pilbara	Conserving critical seagrass habitat for dugong: an	ECU / DBCA	2017 - 2019	No	Yes	Point	SCUBA Photographs	Yes	Presence / absence. % cover.	Yes	McMahon et al. 2020 Said et al. 2020

Location	Name of project	Custodian	Date range of data	Is data publicly available?	If data not publicly available, is there a pathway to accessibility?	Data type	Survey method	Data has spatial information	Seagrass information collected	Suitable for inclusion into synthesis (Yes) or needs re-analysis (RA)	Comments & additional information
	integrated assessment across the Pilbara						Sample collections		Species composition. Biomass. Shoot density. Flowering. Seed bank. Genetic diversity.		k.mcmahon@ecu.edu.au
Pilbara - Onslo (Mangrove Island), Exmouth (Exmouth Gulf) & Karratha (Regnard Island)	Conserving critical seagrass habitat for dugong: an integrated assessment across the Pilbara & Assessing environmental drivers of dugong occurrence across the Pilbara through a novel integrated UAV-seagrass sampling approach	Murdoch University / DBCA / ECU	2018 - 2019	No	Yes	Point	Drop-down camera Underwater video Drone footage	Yes	Presence / absence. % cover. Species composition. Stable isotope ratios.	Yes	christophe.cleguer@jcu.edu.au

Location	Name of project	Custodian	Date range of data	Is data publicly available?	If data not publicly available, is there a pathway to accessibility?	Data type	Survey method	Data has spatial information	Seagrass information collected	Suitable for inclusion into synthesis (Yes) or needs re-analysis (RA)	Comments & additional information
Pilbara – Pluto, Cape Lambert, Wheatstone and Gorgon Project areas including inshore and offshore areas	Various baseline, monitoring, biodiversity projects as part of approval processes that both target seagrass habitats and don't target seagrass habitats. e.g. Seagrass Baseline Monitoring – Ashburton - 2012	Chevron / Woodside, Rio Tinto, Department of Water and Environment Regulation (DWER) & WA Index of Marine Surveys for Assessments (IMSA) / WAMSI / Western Australian Museum (WAM)	1998 - 2015	No	Yes	Point Polygon	Underwater video Drop-down camera Still images Sediment grab	Yes	Presence / absence. % cover. Species composition.	RA	Further investigation into many individual projects (>20) to identify and determine location of potential seagrass data Most metadata reports can be found at: https://biocollect.ala.org.au/imsa/home/index#max%3D30%26sort%3DdateCreatedSort
Onslow	Onslow Marine Support Base	Onslow Marine Support Base Pty Ltd / O2 Marine	2017	No	Yes	Point	Drop-down camera Video footage	Yes	Presence / absence. % cover. Species composition.	RA	A relatively large body of work from the area has been undertaken outside of this specific project (including Wheatstone project work) so further investigation into these projects is warranted https://biocollect.ala.org.au/imsa/project/index/65268235-adad-43ac-88d3-89337a85b3b7

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Pilbara; Mardie Coast	Mardie Project – Subtidal benthic communities and habitats	O2 Marine / Mardie Minerals Limited	2018 - 2019	No	Yes	Point Polygon	Underwater video Drop-down camera Snorkelling SCUBA	Yes	Presence / absence. % cover (limited). Species composition. Extent.	Yes	https://biocollect.ala.org.au/imsa/project/index/ff261cbf-2c60-4229-80d7-47433b545835
Dampier	Benthic Habitat Report Dampier Marine Service Facility	Worley Parsons / Dampier Port authority	2009	No	Yes	Point Polygon	Underwater video Drop-down camera	Yes	Presence / absence. % cover (limited). Species composition. Extent.	Yes	https://biocollect.ala.org.au/imsa/project/index/04a58f37-5f00-429c-9ee4-11c724127ca0
Port Hedland	Port Hedland Spoilbank Marina Benthic Communities and Habitat	Teal Solution / O2 Marine / DWER	2019	No	Yes	Point Polygon	Drop-down camera Side scan sonar	Yes	Presence / absence. % cover. Species composition. Extent.	Yes	https://biocollect.ala.org.au/imsa/project/index/195d3147-1004-452b-8541-f1e24e431d01
Eighty Mile Beach	Eighty Mile Beach - subtidal benthic communities and habitats	DBCA / Ngarla and Nyangumarta Traditional Owners	2019	TBA	TBA	Point Polygon	Underwater video Sidescan sonar	Yes	Presence / absence. Species composition. Extent. Other broad habitat	Yes	enquiries@dbca.wa.gov.au

Location	Name of project	Custodian	Date range of data	Is data publicly available?	If data not publicly available, is there a pathway to accessibility?	Data type	Survey method	Data has spatial information	Seagrass information collected	Suitable for inclusion into synthesis (Yes) or needs re-analysis (RA)	Comments & additional information
									community descriptions.		
Roebuck Bay	Yawuru Nagulagun / Roebuck Bay marine Park Subtidal Benthic Habitat mapping	DBCA / Yawuru	2018	No	Yes	Point Polygon	Underwater video Sidescan sonar	Yes	Presence / absence. Species composition. Extent. Other broad habitat community descriptions.	Yes	enquiries@dbca.wa.gov.au
Roebuck Bay - Town beach Demco Port Black Ledge	Seagrass-Watch / The Broome Community Seagrass Monitoring Project	Seagrass-Watch / Environs Kimberley	2006 - 2022	Yes		Point	Observations	Yes	Presence / absence. % cover. Species composition. Canopy height.	Yes	https://www.seagrasswatch.org/western-australia/ https://www.seagrasswatch.org/contact/
Roebuck Bay - Town beach	SeagrassSpotter	SeagrassSpotter	2018, 2020	Yes		Point	Photos	Yes	Presence / absence. Species composition.	Yes	https://seagrassspotter.org/map
La Grange, West Kimberley	La Grange Subtidal Benthic Habitat mapping	DBCA / Yawuru / Karajarri	2022	No	Yes	Point Polygon	Underwater video Sidescan sonar	Yes	Presence / absence. Species composition. Extent.	Yes	primehouse.reception@dwer.wa.gov.au

Location	Name of project	Custodian	Date range of data	Is data publicly available?	If data not publicly available, is there a pathway to accessibility?	Data type	Survey method	Data has spatial information	Seagrass information collected	Suitable for inclusion into synthesis (Yes) or needs re-analysis (RA)	Comments & additional information
									Other broad habitat community descriptions.		
North-western Australia North-west shelf Broome – Dampier land	Distribution and biogeography of seagrass species on the Northwest coast of Australia	University of Western Australia (UWA)	1984 - 1986	Yes		Point	Snorkel SCUBA Walking	Yes	Presence / absence. % cover (limited). Species composition. Depth.	Yes	doi.org/10.1016/0304-3770(87)90026-X
Kimberly Region - Gourdon Bay, Quondong - Coulomb Point, Perpendicular Head & Packer Island	WAMSI: Benthic habitat surveys of potential LNG hub locations in the Kimberley region	CSIRO / AIMS / WAMSI	2008	Yes		Point	Underwater video Sample collection	Yes	Presence / absence. % cover. Species composition.	Yes	https://data.pawsey.org.au/public/?path=/WA%20Node%20Ocean%20Data%20Network/WAMSI1/Node1/Kimberley_NDT_Benthic_habitat
Kimberly Region - Kimberley coast to the continental shelf edge	Diversity and distribution of marine benthic algae and seagrasses in the tropical Kimberley, Western Australia	WAM	2009 - 2014	No	Yes	Point	SCUBA Walking	Yes	Presence / absence. Species composition.	Yes	Further investigation into historical Huisman et al. research doi.org/10.18195/issn.0313-122x.85.2021.185-200

Location	Name of project	Custodian	Date range of data	Is data publicly available?	If data not publicly available, is there a pathway to accessibility?	Data type	Survey method	Data has spatial information	Seagrass information collected	Suitable for inclusion into synthesis (Yes) or needs re-analysis (RA)	Comments & additional information
Kimberley Region - South of Broome to the Western Australia-Northern Territory border	Kimberley marine biota. Historical data: marine plants	WAM	1880s - 2009	TBA	TBA	Point	Walking	Yes - limited	Presence / absence. Species composition.	Yes	A synthesis of shallow water (<30m) marine flora in the Kimberley region that are verified by specimens and lodged in herbarium collections doi.org/10.18195/issn.0313-122x.84.2014.045-067
Kimberly Region - Bardi Jawi Indigenous Protected Area (Cygnet Bay, One Arm Point, Jalan (Tallon Island) and Iwany (Sunday Island)	WAMSI: Project 2.2.4 - Benthic primary productivity: production and herbivory of seagrasses, macroalgae and microalgae.	ECU / CSIRO / UWA / WAMSI / Badi Jawi Rangers	2013 - 2015	Yes		Point	Observations Sample collection	Yes	Presence / absence. Biomass (above & below-ground). Growth rates. Shoot counts. Flowers. Stable isotopes.	Yes	https://data.pawsey.org.au/public/?path=/WA%20Node%20Ocean%20Data%20Network/WAMSI2/KMRP/2.2/2.2.4

Location	Name of project	Custodian	Date range of data	Is data publicly available?	If data not publicly available, is there a pathway to accessibility?	Data type	Survey method	Data has spatial information	Seagrass information collected	Suitable for inclusion into synthesis (Yes) or needs re-analysis (RA)	Comments & additional information
Kimberley Region - One Arm Point Sunday Island Tallon Island Montgomery Reef Roebuck Bay Ashmore Reef	Surviving the extreme – Seagrasses of the Kimberley	Gary Kendrick	TBA	Yes - Limited		Point	Observations Sample collection	Yes	Presence / absence. Species composition.	Yes	http://hdl.handle.net/102.100.100/86956?index=1
Dampier Peninsula - One Arm Point Chille Creek	Seagrass-Watch	Seagrass-Watch	2009 - 2013	Yes		Point	Observations	Yes	Presence / absence. % cover. Species composition. Canopy height.	Yes	Program suspended 2013 https://www.seagrasswatch.org/western-australia/ https://www.seagrasswatch.org/contact/

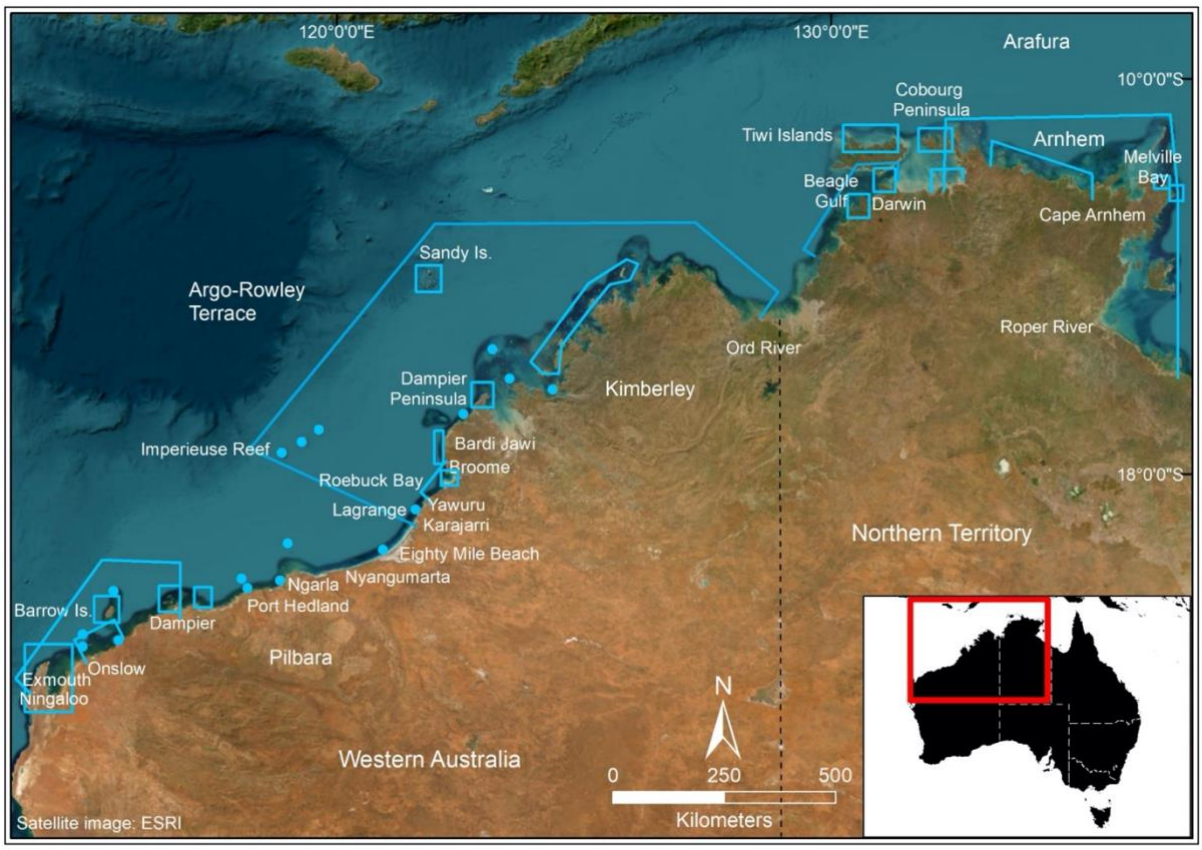


Figure 2. Locations (dots) and areas (polygons) where seagrass information has been collected or could be collected from targeted seagrass projects or other marine research in the Northern Territory and northern Western Australia.

4. Discussion

This project inventoried work on seagrass habitat between Cape Arnhem (NT) and Ningaloo Reef (WA). The inventory is the first stage in creating a spatial data synthesis similar to that for the GBR, Torres Strait and the Gulf of Carpentaria (Carter et al. 2022; Carter et al. 2021). We identify knowledge gaps in Australia's north to support the development of seagrass mapping and monitoring priorities across this remote region. This inventory and the spatial data synthesis we will develop from it will be key to advancing identified Indigenous research and monitoring priorities for Sea Country and for developing approaches for coordinated monitoring. It will assist research needs on priority threatened and migratory species, with a focus on turtles and dugongs.

The status of some datasets was not able to be confirmed within the time and resources for this project and will require additional negotiation and funding. For northern WA, there is seagrass data associated with approval processes for multiple major oil and gas dredging campaigns (Jones and Twomey 2019). The Western Australian Marine Science Institution (WAMSI) collated some of this data and it is stored at the Pawsey Supercomputing Centre (https://pawsey.org.au/) (Jones and Twomey 2019). However, authorisation and data access agreements are still required for access to this data (Jones and Twomey 2019). These individual projects and datasets that contributed to the larger projects will need to be 'unpacked' with further consultation.

We have included data in the inventory that extends back to the early-1970s, with a large temporal gap in data from then until the mid-1990s. The *Western Australian Museum Kimberley marine biota. Historical data: marine plants* project has seagrass information that extends back to the 1800s; however, for these early data sets the spatial accuracy required for a synthesis may not be available.

Since 1999, projects that have collected information on seagrass have more consistent metadata. For inclusion in a regional data synthesis, early data would need to be reviewed, validated and compared with original trip logs where possible, as was completed for the GBR, Torres Strait and Gulf of Carpentaria data syntheses (Carter et al. 2022; Carter et al. 2021). It is important in a published synthesis to ensure the information is reliable by only including point and polygon data where the original source can be located and where we are confident they represent a reliable interpretation of that data.

We excluded in this inventory published synthesised online data sets such as those compiled by the United Nations Environment World Conservation Monitoring Centre (https://data.unep-wcmc.org/datasets/7) and CSIRO's Coastal and Marine Resources Information System (https://data.csiro.au/collections/collection/CIcsiro:12640v1). Components of these datasets have insufficient metadata to reliably confirm and cross reference with the original data source or project. Where available we have sourced the original project data.

There are some projects that did not target seagrass but with additional funding, the data from these projects could be re-analysed and key seagrass information extracted to include in future data syntheses.

The inventory identifies information gaps. Much of the seagrass data is biased towards ports and specific dredging projects. In these areas there is good spatial information about seagrass with some temporal information. Outside of these data ‘hot spots’, most seagrass information is relatively old (>10 years), and surveys have not been repeated so there is no temporal information. It is important that the data is curated and lodged in an online database, as we have done for the GBR, Torres Strait and Gulf of Carpentaria. Previous experience has demonstrated that older data is not secure and, if not compiled and validated, can be lost.

5. References

AECOM 2010. Research of key knowledge gaps in the ecological character of the Cobourg Peninsula Ramsar site, Northern Territory: Aquatic Flora and Fauna and Physicochemical Assessment. Prepared for the Australian Government, Canberra.

Bainbridge, Z., Lewis, S., Bartley, R., Fabricius, K., Collier, C., Waterhouse, J., Garzon-Garcia, A., Robson, B., Burton, J., Wenger, A. and Brodie, J. 2018. Fine sediment and particulate organic matter: A review and case study on ridge-to-reef transport, transformations, fates, and impacts on marine ecosystems. Marine Pollution Bulletin, **135**: 1205-1220. doi.org/10.1016/j.marpolbul.2018.08.002

BMT WBM. 2011. Ecological Character Description for Cobourg Peninsula Ramsar Site. Prepared for the Australian Government, Canberra.

Bradley, J. J. 1997. Li-anthawirriyarra, people of the sea: Yanyuwa relations with their maritime environment. Charles Darwin University (Australia).

Brock, R. J., Rasmussen, J., Adame, M. F., Brown, C. J., Connolly, R. M. 2022. Identifying knowledge gaps and solutions for extent mapping of Australian marine and coastal wetlands, Project 1.5 Scoping study. Report to the National Environmental Science Program, Marine and Coastal Hub. Griffith University.

Bryce, M., Radford, B. and Fabricius, K. 2018. Soft coral and sea fan (Octocorallia) biodiversity and distribution from a multi-taxon survey (2009/2014) of the shallow tropical Kimberley, Western Australia. Records of the Western Australian Museum, **85**: 045-073, doi.org/10.18195/issn.0313-122x.85.2018.045-073

Butler, J. R., Tawake, A., Skewes, T., Tawake, L. and McGrath, V. 2012. Integrating traditional ecological knowledge and fisheries management in the Torres Strait, Australia: the catalytic role of turtles and dugong as cultural keystone species. Ecology And Society, **17**: 1-19. doi.org/10.5751/ES-05165-170434

Cardno 2014. Darwin Harbour – A Summary of the Ichtys LNG Nearshore Environmental Monitoring program.

Carter, A., McKenna, S., Rasheed, M., Taylor, H., van de Wetering, C., Chartrand, K., Reason, C., Collier, C., Shepherd, L., Mellors, J., McKenzie, L., Roelofs, A., Smit, N., Groom, R., Barrett, D., Evans, S., Pitcher, R., Murphy, N., Duke, N. C., Carlisle, M., David, M., Lui, S., Torres Strait Indigenous Rangers (led by Pearson, L., Laza, T., Bon, A.), and Coles, R. G. 2022. Four Decades of Seagrass Spatial Data from Torres Strait and Gulf of Carpentaria. Report to the National Environmental Science Program.

Carter, A., McKenna, S., Rasheed, M., Collier, C., McKenzie, L., Pitcher, R. and Coles, R. 2021. Synthesizing 35 years of seagrass spatial data from the Great Barrier Reef World Heritage Area, Queensland, Australia. Limnology & Oceanography Letters, 1-11. doi.org/10.1002/lol2.10193

Costanza, R., de Groot, R., Sutton, P., van der Ploeg, S., Anderson, S. J., Kubiszewski, I., Farber, S. and Turner, R. K. 2014. Changes in the global value of ecosystem services. Global Environmental Change, **26**: 152-158. doi.org/10.1016/j.gloenvcha.2014.04.002

Green, E. P. and Short, F. T. 2003. World Atlas of Seagrasses. University of California Press, United States of America.

Hayes, M. A., McClure, E. C., York, P. H., Jinks, K. I., Rasheed, M. A., Sheaves, M. and Connolly, R. M. 2020. The Differential Importance of Deep and Shallow Seagrass to Nekton Assemblages of the Great Barrier Reef. Diversity, **12**: 292. doi.org/10.3390/d12080292

Hays, G.C., Alcoverro, T., Christianen M.J.A., Duarte C.M., Hamann M., Macreadie P.I., Marsh H.D., Rasheed M.A., Thums M., Unsworth R.K.F., York P.H., Esteban N. 2018. New Tools to Identify the Location of Seagrass Meadows: Marine Grazers as Habitat Indicators. Frontiers in Marine Science, **5**: Article 9 doi.org/10.3389/fmars.2018.00009

Huisman, J. M., Dixon, R. R., Townsend, R. A. and Belton, G. 2021. Diversity and distribution of marine benthic algae and seagrasses in the tropical Kimberley, Western Australia. Records of the Western Australian Museum, **185**: 200. doi.org/10.18195/issn.0313-122x.85.2021.185-200

Jänes, H., Macreadie, P. I., Nicholson, E., Ierodiaconou, D., Reeves, S., Taylor, M. D. and Carnell, P. E. 2020. Stable isotopes infer the value of Australia's coastal vegetated ecosystems from fisheries. Fish And Fisheries, **21**: 80-90 doi.org/10.1111/faf.12416

Jones, R. and Twomey, L. 2019. Review and consolidation of environmental monitoring data collected by industry. Report of Theme 1 - Project 1 prepared for the Dredging Science Node, Western Australian Marine Science Institution, Perth, Western Australia, 18 pp.

Kelkar, N., Arthur, R., Marba, N. and Alcoverro, T. 2013. Green turtle herbivory dominates the fate of seagrass primary production in the Lakshadweep islands (Indian Ocean). Marine Ecolgoy Progress Series, **485**: 235-243. doi.org/10.3354/meps10406

Loneragan, N.R., Kangas, M., Haywood, M.D.E., Kenyon, R.A., Caputi, N. and Sporer, E. 2013. Impact of cyclones and aquatic macrophytes on recruitment and landings of tiger prawns *Penaeus esculentus* in Exmouth Gulf, Western Australia. Estuarine, Coastal Shelf Science **127**: 46-58 doi.org/10.1016/j.ecss.2013.03.024

Loneragan, N.R., Kenyon, R.A., Crocos, P.J., Ward, R.D., Lehnert, S., Haywood, M.D.E., Arnold, S., Barnard, R., Burford, M., Caputi, N., Kangas, M., Manson, F., McCulloch, R., Penn, J.W., Sellars, M., Grewe, P., Ye, Y., Harch, B., Bravington, M., Toscas, P. and Meadows, J. 2003. Developing techniques for enhancing prawn fisheries, with a focus on brown tiger prawns (*Penaeus esculentus*) in Exmouth Gulf. Final Report on FRDC Project 1999/222. CSIRO, Cleveland. pp.276.

Marsh, H., O'Shea, T. J. and Reynolds III, J. E. 2011. Ecology and Conservation of the Sirenia: Dugongs and Manatees. Cambridge University Press, Cambridge, United Kingdom. doi.org/10.1017/CBO9781139013277

McKenzie, L. J. 2008. Seagrass-Watch: Proceedings of a Workshop for Mapping and Monitoring Seagrass Habitats in North East Arnhem Land, Northern Territory, 18–20 October 2008. (Seagrass-Watch HQ, Cairns). 49pp.

McMahon, K., Hernawan, U., van Dijk, K., Waycott, M., Biffin, E., Evans, R. and Lavery, P. 2017 Genetic variability within seagrass of the north west of Western Australia. Report of Theme 5 - Project 5.2 prepared for the Dredging Science Node, Western Australian Marine Science Institution, Perth, Western Australia, 41pp.

McMahon, K., Said, N. and Lavery, P. 2020. Findings from the Pilbara Seagrass Monitoring Network. A report to the Department of Biodiversity Conservations and Attractions, WA.

Nordlund, L., Koch, E., Barbier, E. and Creed, J. 2016. Seagrass ecosystem services and their variability across genera and geographical regions. PLOS ONE, **11**: doi.org/10.1371/journal.pone.0163091

Pitcher, C.R., Miller, M., Morello, E., Fry, G., Strzelecki, J., McLeod, I., Slawinski, D., Ellis, N., Thomson, D., Bearham, D., Keesing, J., Donovan, A., Mortimer, N. Babcock, R., Fromont, J, Gomez, O., Hosie, A., Hara, A., Moore, G., Morrison, S., Kirkendale, L., Whisson, C., Richards, Z., Bryce, M., Marsh, L., Naughton, K., O'Loughlin, M., O'Hara, T., Boddington, D., Huisman, J. 2016. Environmental Pressures: Regional Biodiversity — Pilbara Seabed Biodiversity Mapping & Characterisation. Final report, CSIRO Oceans & Atmosphere, Published Brisbane, March 2016, 62 pages

Poiner, I. R., Staples, D. J. and Kenyon, R. 1987. Seagrass communities of the Gulf of Carpentaria, Australia. Australian Journal Of Marine And Freshwater Research, **38**: 121-131. doi.org/10.13140/RG.2.2.26732.56960

Roelofs, A. J., Coles, R. and Smit, N. 2005. A survey of intertidal seagrass from Van Diemen Gulf to Castlereagh Bay, Northern Territory, and from Gove to Horn Island, Queensland. Report to the National Oceans Office. Queensland Department of Primary Industries & Fisheries, Cairns, 27pp.

Russell, B. C. and Smit, N. 2007. Report of a Marine Biodiversity Survey of Inshore Soft Bottom Benthos of the SE Van Diemen Gulf and NW Arnhem Land between the Goulburn Islands and Castlereagh Bay, Northern Territory. Report to the Marine and Biodiversity Division, Department of the Environment, water, Herritage and the Arts and Parks Australia North. 292 pp.

Said, N., Cleguer, C., Hodgson, A., Lavery P., Lo, J.. Tyne, J. and McMahon, K. 2020. Assessing environmental drivers of dugong occurrence across the Pilbara through a novel integrated UAV-seagrass sampling approach. A report to the Department of Biodiversity Conservations and Attractions, WA.

Sangha, K.K., Stoeckl, N. Crossman, N. and Costanza, R. 2019. A state-wide economic assessment of coastal and marine ecosystem services to inform sustainable development policies in the Northern Territory, Australia. Marine Policy **107**: 103595 doi.org/10.1016/j.marpol.2019.103595 .

Scott, A. L., York, P. H., Duncan, C., Macreadie, P. I., Connolly, R. M., Ellis, M. T., Jarvis, J. C., Jinks, K. I., Marsh, H. and Rasheed, M. A. 2018. The role of herbivory in structuring tropical seagrass ecosystem service delivery. Frontiers in Plant Science, **9**: 1-10. doi.org/10.3389/fpls.2018.00127

Scott, A. L., York, P. H. and Rasheed, M. A. 2020. Green turtle (*Chelonia mydas*) grazing plot formation creates structural changes in a multi-species Great Barrier Reef seagrass meadow. Marine Environmental Research, 105183. doi.org/10.1016/j.marenvres.2020.105183

Smit, N., Billyard, R. and Ferns, L., 2000. Beagle Gulf Benthic Survey – Characterisation of soft substrates. Technical Report No. 66 (2000) Parks and Wildlife Commission of the Northern Territory.

Speare, P., Johansson, C., Depczynski, M. and Meekan, M. 2008. Marine Habitats of southern Melville Bay using towed video and aerial photography. Marine Health Monitoring Program (MHMP) Project No. 30. Australian Institue of Marine Science. Final Report prepared for Charles Darwin University / Alcan Gove Pty Ltd.

Statton, J., Sinclair, E.A, McNeair, S., Kendrick A., Kendrick., G.A. 2021. Assisting recovery of seagrass in Shark Bay, Gathaagudu. Final Report to the National Environmental Science Program, Marine Biodiversity Hub.

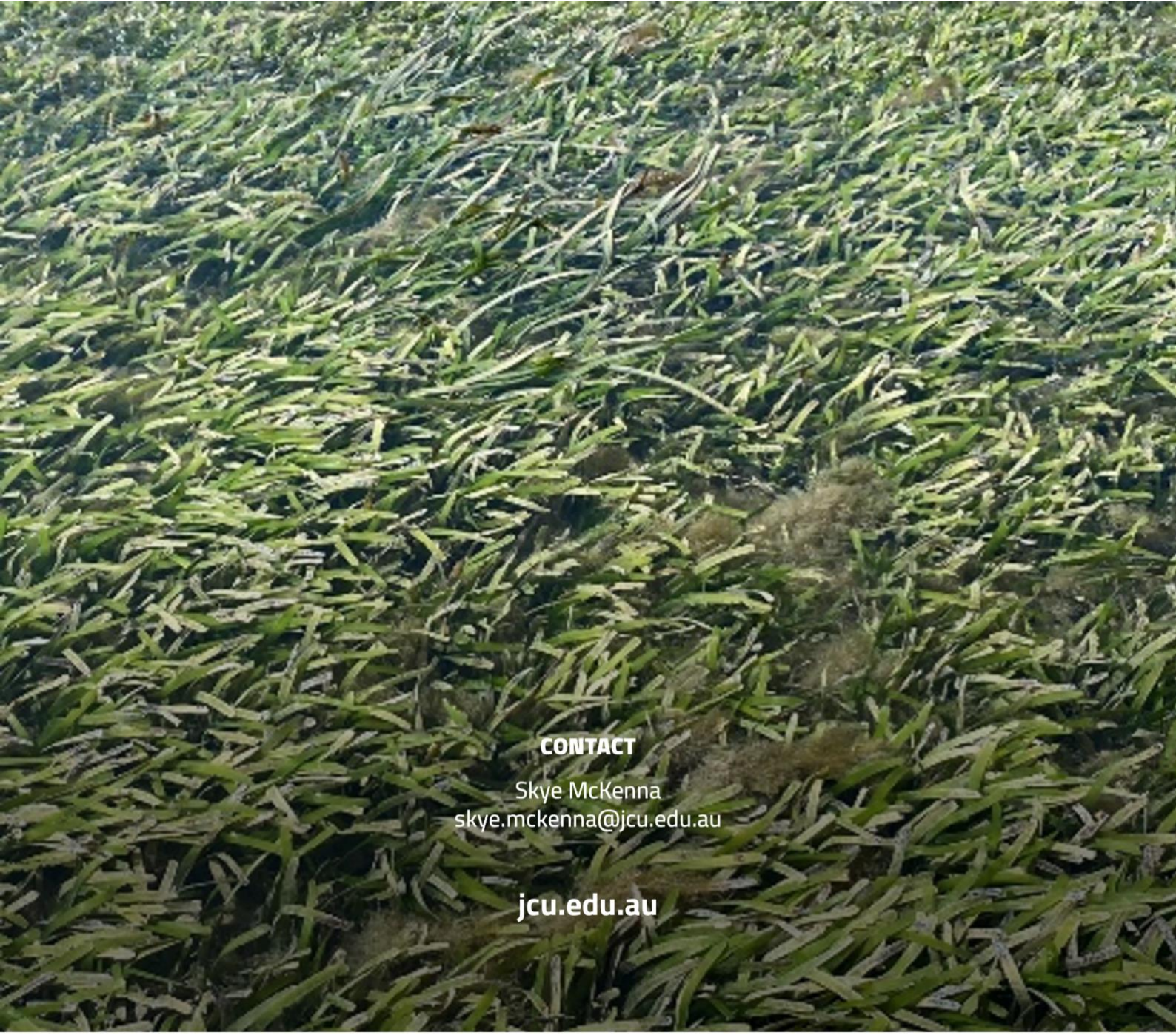
Tol, S. J., Coles, R. G. and Congdon, B. C. 2016. *Dugong dugon* feeding in tropical Australian seagrass meadows: implications for conservation planning. PeerJ, **4**: e2194. doi.org/10.7717/peerj.2194

URS 2003. Marine Habitats of Gove Peninsula and southern Melville Bay. Report prepared for Alcan Gove Pty Limited. Report Number R954 Ref: DK:M&C1798/PER. 7 Nov 2003.

Vanderklift, M., Bearham, D., Haywood, M., Lozano-Montes, H., McCallum, R., Mc Laughlin, J., McMahon, K., Mortimer, N. and Lavery, P. 2017a. Natural dynamics: understanding natural dynamics of seagrasses of the north west of Western Australia. Report of Theme 5 - Project 5.3 prepared for the Dredging Science Node, Western Australian Marine Science Institution, Perth, Western Australia, 55 pp.

Vanderklift, M., Bearham, D., Haywood, M., McCallum, R., McLaughlin, J., McMahon, K., Mortimer, N. and Lavery, P. 2017b. Recovery mechanisms: understanding mechanisms of seagrass recovery following disturbance. Report of Theme 5 - Project 5.4 prepared for the Dredging Science Node, Western Australian Marine Science Institution, Perth, Western Australia. 25pp.

Wilson, B. 2014. Kimberley marine biota. History and Environment. Records of the Western Australian Museum Supplement 84: 1–18. doi:10.18195/issn.0313-122x.84.2014.001-018



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