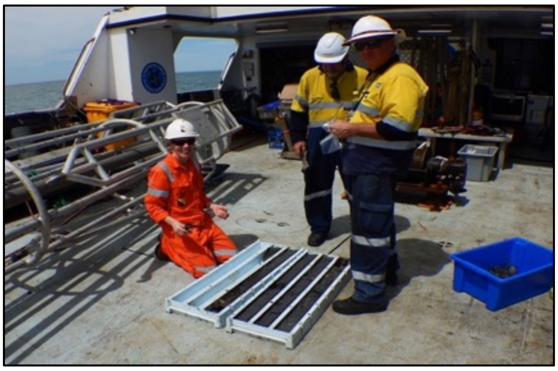
Referral Report No. 2

PROPOSAL SETTING & EXISTING ENVIRONMENT DESCRIPTIONS

Boskalis Cambridge Gulf Marine Sand Proposal
Western Australia



Prepared for Boskalis Australia Pty Ltd by EcoStrategic Consultants

For submission to:
- Western Australia Department of Water & Environmental Regulation
- Western Australia Environmental Protection Authority

In support of Project Referral under Section 38 of the Western Australia *Environmental Protection Act*

AUGUST 2024

Boskalis

ecostrategic CONSULTANTS

CONTENTS

ACRONYMS

ACH	Aboriginal Cultural Heritage.
ACHMP	Aboriginal Cultural Heritage Management Plan
ACHIS	Aboriginal Cultural Heritage Inquiry System
AIMS	Australian Institute of Marine Science
BAC	Balanggarra Aboriginal Corporation
BCH	Benthic communities & habitats
BIA	Biologically Important Area (for various marine species as defined by DCCEEW)
BKA	Boskalis Australia Pty Ltd
CG	Cambridge Gulf
CSIRO	Commonwealth Scientific & Industrial Research Organization
DBCA	WA Department of Biodiversity, Conservation & Attractions
DCCEEW	Commonwealth Department of Climate Change, Energy, the Environment & Water
DEM	Digital Elevation Model
DES	Digital Earth Australia (Geoscience Australia)
DEMIRS	WA Department of Energy, Mines, Industry Regulation & Safety
DHI	Danish Hydraulics Institute
DPLH	WA Department of Planning, Lands & Heritage
DSM	Digital Surface Model
EGS	Environmental Group Site Details (required by DEMIRS under WA Mining Act)
EMP	Environmental Management Plan
EMS	Environmental Management System (required by DEMIRS under Mining Act)
EOPCMP	Environmental Outcomes, Performance Criteria & Monitoring Plan (required by DEMIRS under Mining Act)
EPA	WA Environmental Protection Authority
EP Act	WA Environmental Protection Act
EPBC Act	Commonwealth *Environment Protection & Biodiversity Conservation Act*
EQMF	Environmental Quality Management Framework (in relation to marine environmental quality)
EQO	Environmental Quality Objective (in relation to marine environmental quality)
ERA	Environmental Risk Assessment (required by DEMIRS under Mining Act)
GHG	Greenhouse gas
HAT	Highest Astronomical Tide
HD	Hydrodynamics
IMP-MDRP	Introduced Marine Pests - Monitoring, Detection & Response Plan
IPA	Indigenous Protected Area
JBG	Joseph Bonaparte Gulf
KS	King Shoals
LAT	Lowest Astronomical Tide
LAU	Local Assessment Unit (for the impact assessments presented in this report)
LiDAR	Light Detection & Ranging
LPM	Littoral Processes Mode
MAFRL	Marine & Freshwater Research Laboratory (Murdoch University)
MBES	Multi-bean Echo Sounder.
MCP	Mijing Conservation Park
MEQ	Marine environmental quality
MG Corporation	Yawoorroong Miriuwung Gajerrong Yirrgeb Noong Dawang Aboriginal Corporation
MMF	Marine mega-fauna (large marine animals such as cetaceans, dugong, turtles, crocodiles, sharks etc)
MNES	Matters of National Environmental Significance (under Commonwealth EPBC Act)
MoU	Memorandum of Understanding

MSL	Mean Sea Level
NWQMS	National Water Quality Management Strategy
PCS	Port & Coastal Solutions (www.portandcoastalsolutions.com)
PSD	Particle Size Distribution (of sediments)
REF	Relevant Environmental Factor
SBP	Sub-bottom Profiler
SEM	Scanning Electron Microscope
SSS	Side-scan sonar
STM	Sediment Transport Model
SWM	Spectral Wave Model
TO	Traditional Owner
WA	Western Australia (State of)

REFERRAL DOCUMENTS

Report Citation: Boskalis Australia (BKA) (2024b), Cambridge Gulf Marine Sand Proposal - WA EP Act s38 - Referral Report No. 2: *Proposal Setting & Existing Environment Descriptions.*

This report is part of a larger set of documents submitted as part of Boskalis Australia's project Referral under section 38 of the Western Australia (WA) *Environmental Protection Act* (EP Act), as listed below.

Documents submitted as part of this Referral package (August 2024):	
Short Title	**Full citation**
EPA Form: *Referral of a Proposal under s38 of EP Act.*	EPA Form (2024): Referral of a Proposal under s38 of EP Act - Boskalis Cambridge Gulf Marine Sand Proposal.
EPA Template: *Project Content Document.*	EPA Template (2024): Project Content Document - Boskalis Cambridge Gulf Marine Sand Proposal.
Referral Report No. 1: *Regulatory Framework.*	Boskalis Australia (BKA) (2024a), Cambridge Gulf Marine Sand Proposal - WA EP Act s38 Referral Report No. 1: *Environmental Regulatory Framework.*
Referral Report No. 2: *Setting & Existing Environment Descriptions.*	Boskalis Australia (BKA) (2024b), Cambridge Gulf Marine Sand Proposal - WA EP Act s38 Referral Report No. 2: *Proposal Setting & Existing Environment Descriptions.* Annexes include: – Sand resource assessment report - Boskalis. – BCH mapping methods statement - MScience – Coastal LiDAR report - Sensorem. – Sediment contamination assessment report. – eDNA report - University of Canberra. – Turtle nesting report - EcoStrategic / DBCA.
Referral Report No. 3: *Traditional Owner Matters.*	Boskalis Australia (BKA) (2024c), Cambridge Gulf Marine Sand Proposal - WA EP Act s38 Referral Report No. 3: *Traditional Owners, Native Title & Aboriginal Cultural Heritage*. Annexes include: – Letters of support from the two TO groups.
Referral Report No. 4: *Impact Assessments.*	Boskalis Australia (BKA) (2024d), Cambridge Gulf Marine Sand Proposal - WA EP Act s38 *Referral Report No. 4: Impact Assessments of Key Environmental Factors.*
Referral Report No. 5: *Metcocean & Sediment Dynamics.*	Port & Coastal Solutions (PCS) (2024a), Cambridge Gulf Marine Sand Proposal - WA EP Act s38 Referral Report No. 5: *Metcocean & Sediment Dynamics - System Understanding, Conceptual Model & Initial Modelling.* – Annex 1: PCS (2024b) Supplementary Technical Note. – Annex 2: PCS (2024c) Factual Data Report.
Referral Report No. 6: *Consultation Report.*	Boskalis Australia (BKA) (2024e), Cambridge Gulf Marine Sand Proposal - WA EP Act s38 Referral Report No. 6: *Stakeholder Engagement & Consultation.*
Referral Report No. 7: *Commonwealth Matters.*	Boskalis Australia (BKA) (2024f), Cambridge Gulf Marine Sand Proposal - WA EP Act s38 Referral Report No. 7: *Commonwealth Protected Matters.*
Documents still being developed (to be submitted later).	
Referral Report No. 8: *Metcocean & Sediment Dynamics Full Modelling.*	Port & Coastal Solutions (PCS) (2024d), Cambridge Gulf Marine Sand Proposal - WA EP Act s38 Referral Report No. 8: *Hydrodynamic, Coastal Processes & Sediment Plume Modelling.*
Referral Report No. 9: *IMSA Package.*	Boskalis Australia (BKA) (2024g), Cambridge Gulf Marine Sand Proposal - WA EP Act s38 Referral Report No. 9: *IMSA Metadata Package Statement.*

FURTHER INFORMATION

Peter Boere
Director
Boskalis Australia Pty Ltd
Suited 1.3 / 9 Havelock St, West Perth 6005
Mobile 041 9987 158
peter.boere@boskalis.com

Steve Raaymakers
Lead Report Author / Consultant to Boskalis
EcoStrategic Consultants
PO Box 968, Edge Hill, Cairns 4870
Mobile 040 9909 422
steve@eco-strategic.com

PROJECT LOCATION

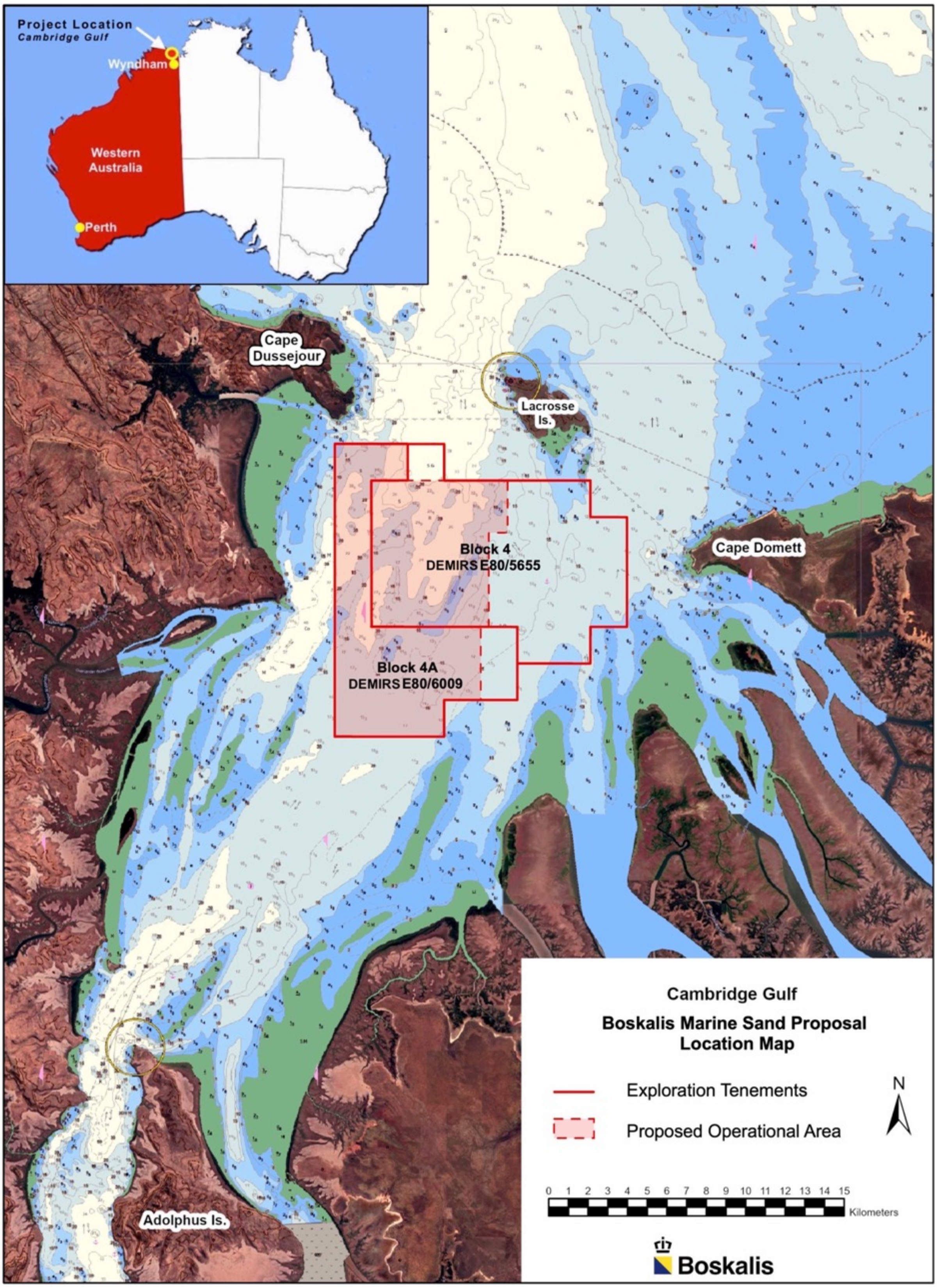


FIGURE 1: *Location of the proposal in Cambridge Gulf near Wyndham in the northeast of Western Australia.*

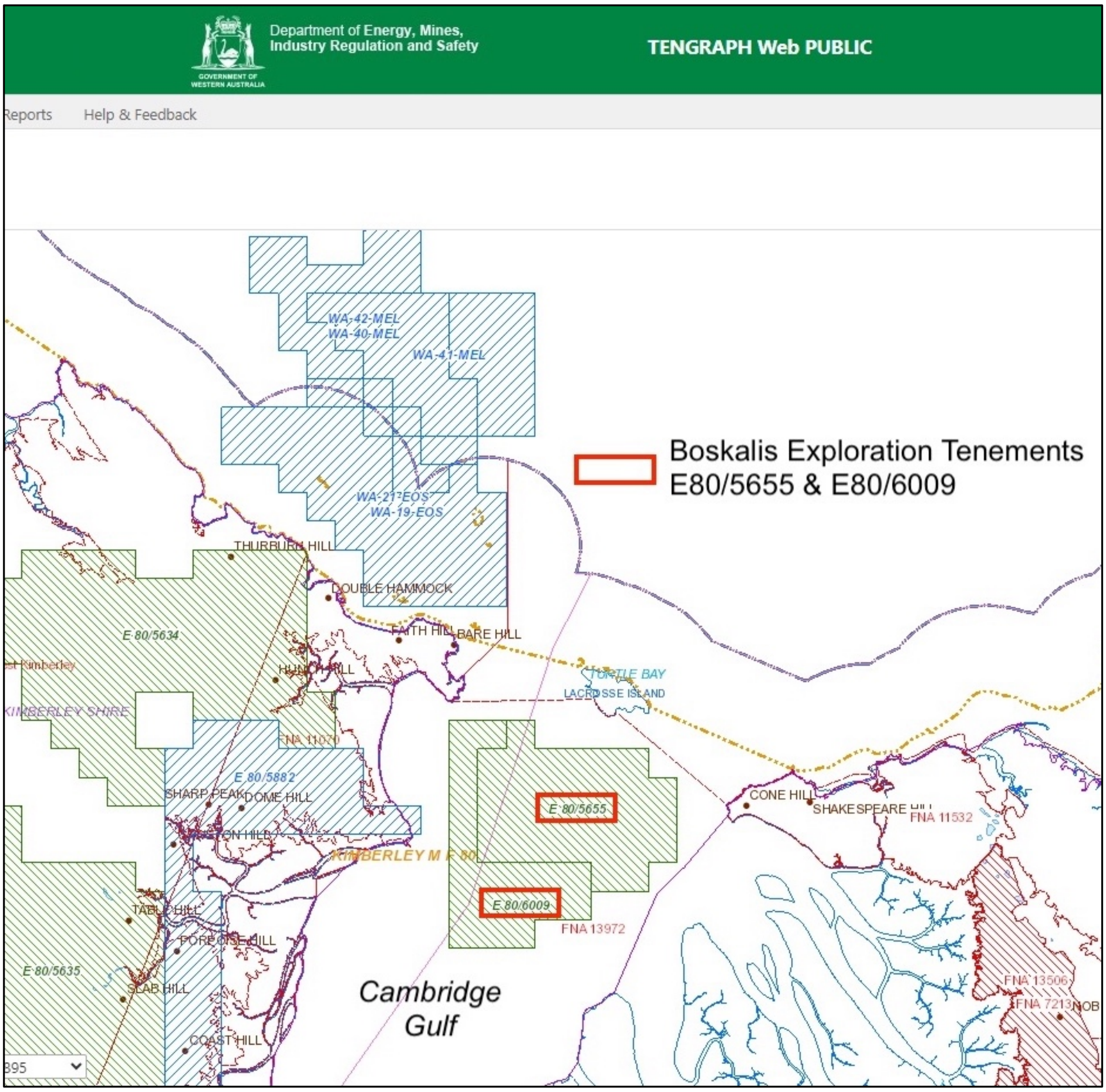


FIGURE 2: *DEMIRS Tengraph map of BKA's two exploration tenements in Cambridge Gulf.*

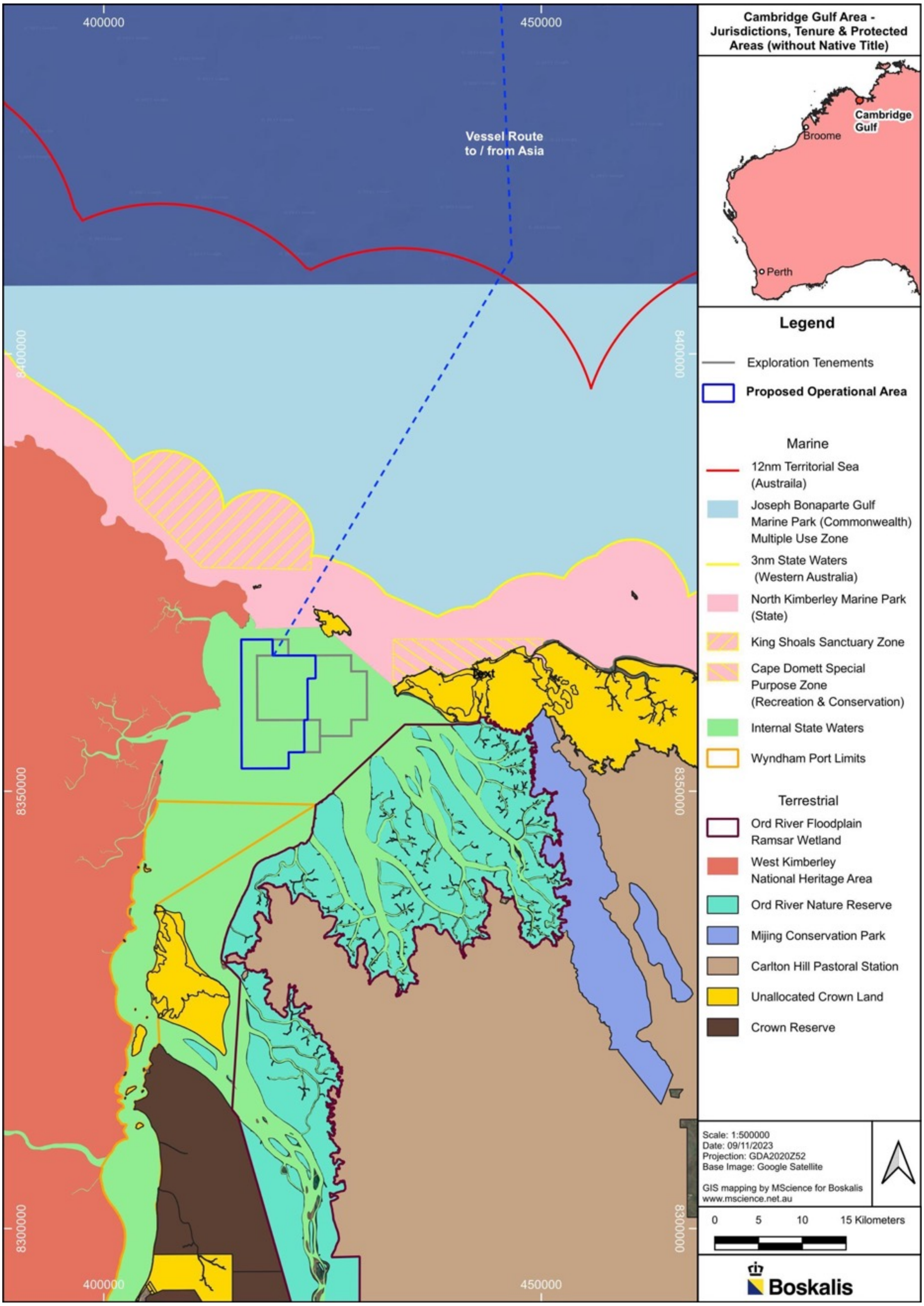


FIGURE 3: *Jurisdictions & tenure in the vicinity of the proposed operational area and the indicative route for the Sand Production Vessel (SPV) to/from Asia.*

ACKNOWLEDGEMENTS

The primary author of this report, Steve Raaymakers of EcoStrategic Consultants, is very much appreciative of the contributions of the following people and parties to the development of both this report and related reports that support Boskalis Australia's (BKA's) environmental assessment of the Cambridge Gulf (CG) marine sand proposal:

- Alkwin Landewee, Director for Boskalis Asia, Peter Boere, General Manager of BKA and Jaap Verdoorn, Operations Manager for Boskalis Asia, for their steadfast and tireless support for all of the work that underpins this report.
- Dr Stella Kortekaas, Antoon Hendriks and Sarah Sangster from Boskalis for, respectively, undertaking sand resource assessment in CG, advising on hydro- and sediment-dynamics issues and advising on environmental protection measures.
- Claire Thomas and Dennis de Boere from Boskalis for undertaking hydrographic surveys in CG in February - March 2024.
- Dr Paul Erftemeijer for assisting with field sampling in CG in July 2023 and assisting with data analysis and interpretation, undertaking expert review of other reports, undertaking literature search and review of the environment of CG, substantially drafting the sections of this report on mangroves, fishes and water quality, and providing a review of underwater noise.
- Brae Price for assisting with planning and field sampling in CG in July-August 2023 and data analysis and interpretation, and undertaking most of the GIS mapping presented in this report and related reports.
- Kirk Rumball for assisting with planning and field sampling in CG in July-August 2023 and data analysis and interpretation.
- Dr Helen Penrose for leading the dry-season Marine Mega-fauna (MMF) survey in CG in July 2023.
- Mia Macintyre and Jasmin Hunt for undertaking the wet-season MMF survey in CG in February 2024.
- Jason Dickie for undertaking aerial drone video and photographic surveys in CG in July 2023.
- Fred Turley and Anthony Wu from Sensorem Pty Ltd in Perth for undertaking aerial drone video, photographic and LiDAR surveys in CG in July 2023, and other staff at Sensorem who supported data analysis and reporting.
- Martin Holbrook for assisting with field sampling in CG in February 2024.
- Dr Alejandro Trujillo-Gonzalez from the University of Canberra, National Environmental DNA Reference Centre, for undertaking eDNA sampling in CG in February 2024 and undertaking the eDNA analysis and reporting.
- Dr Shona Menzies of Benthic Australia Pty Ltd for identification and analysis of all benthic samples from both the dry- and wet-season environmental surveys.
- Iain Posnett and Matt Frapple of MScience Marine Research in Perth for developing the benthic communities and habitat map for CG and related analysis and GIS mapping, and expert advice on various issues.
- Dr Andrew Symonds and staff from Port & Coastal Solutions (PCS) for undertaking analysis, assessment and reporting on hydrodynamics, sediment dynamics, coastal processes and related numerical modelling (see Referral Report No. 5).
- The Marine & Freshwater Research Laboratories at Murdoch University in Perth for supplying various survey gear and undertaking water quality analysis.
- ALS laboratories in Perth and Brisbane for chemical analysis of seabed sediment samples from CG, and Microanalysis laboratories in Perth for physical analysis of seabed and suspended sediment samples from CG.
- The management and crew of the survey vessel *Strait Shooter* from Carpentaria Marine in Weipa, for providing the platform for the sand exploration and environmental reconnaissance survey in CG in March 2023.
- The management and crew of the survey vessels *Kuri Pearl 2* and *Jetfire* from Terra-Firma Offshore in Exmouth, chartered through Quest Maritime, for providing the platform for the dry-season environmental survey in CG in July-August 2023.
- The management and crew of the survey vessels *Warrego* and *Utikka Rose* from Gun Marine Services in Exmouth, for providing the platform for the wet-season environmental survey in CG in February-March 2024.
- Mark Douglas from Wyndham and various technical staff from Boskalis for deployments, retrievals and servicing of in-situ oceanographic and water quality instruments in CG (ongoing).

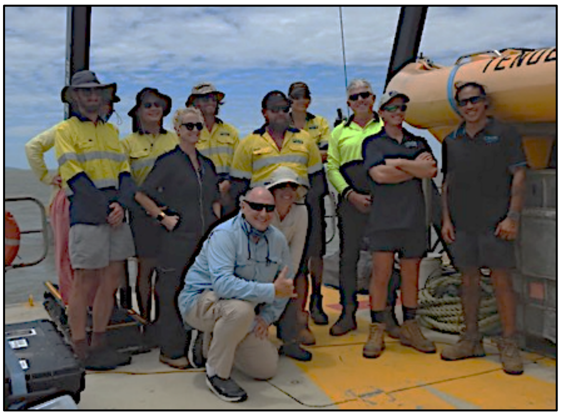


FIGURE 3: *BKA's environmental survey teams.* Left: *Dry-season Jul-Aug 2023.* Right: *Wet-season Feb-Mar 2024.*

MV Strait Shooter - Sand exploration survey Mar 2023.

MV Stormraker - Deploy and service in-situ instruments (ongoing).

MV Kuri Pearl 2 - Dry-season environmental survey Jul-Aug 2023.

Jet Fire - Dry-season environmental survey Jul-Aug 2023.

MV Warrego - Wet-season environmental survey Feb-Mar 2024.

Utikka Rose - Wet-season environmental survey Feb-Mar 2024.

FIGURE 4: *Vessels used by BKA for the various surveys and studies in CG.*

EXECUTIVE SUMMARY

1. This report supports Boskalis Australia's (BKA's) referral of its Cambridge Gulf (CG) marine sand proposal under section 38 of the WA *Environmental Protection Act* (EP Act), by describing the proposal setting and existing environmental conditions, resources and values within the defined Local Assessment Unit (LAU) for the CG area, as outlined in section 2.

2. This report was used to inform the assessment of potential impacts of the proposal as presented in Referral Report No. 4 - *Impact Assessments* (BKA 2024d), by identifying and describing the Key Environmental Factors (KEFs) that are found within the LAU that could potentially be impacted by the proposal, in accordance with WA EPA Guidelines for each KEF. The KEFs are:

   a) Benthic communities and habitats (BCH).
   b) Coastal processes.
   c) Marine environmental quality (MEQ).
   d) Marine fauna.
   e) Air quality; and
   f) Social surroundings.

3. Land-based and freshwater-based Environmental Factors are not relevant to the proposal as it does not involve land-based facilities or operations – the proposal is a 100% marine, vessel-based operation. Greenhouse gas emissions are not a relevant Environmental Factor as the proposal will only emit ~16% of the EPA's trigger of 100,000 tonnes of CO2e per year.

4. In addition to describing the KEFs, the report also describes the seabed sand resource in CG, which is the subject of BKA's proposal (section 5), and the Protected Areas that are present in the general area around CG (section 12).

5. The environmental descriptions presented in the report are based on a comprehensive suite of data from both pre-existing studies, reports and papers and new studies and data collection campaigns undertaken or commissioned by BKA, as outlined in section 3. The studies undertaken and the methods used to describe each KEF are presented in each KEF section.

6. The summary findings of the report are as follows:

   a) Sand resource (section 5): There is a minimum volume of 300 million m^3 of sand in the proposed operational area, derived from ongoing terrestrial sources in the catchment. This is a small proportion of the total sand resource present in CG overall. The seabed sand-forms comprise highly-dynamic sand-waves with vertical heights ranging from 1 to 8 m and horizontal wavelengths of between 50 and 200 m. Repeat hydrographic surveys measured horizontal migration of the sand waves over distances of up to 10 m in just 27-days over a lunar tidal cycle, from SSW to NNW.

   b) BCH (section 6): Extreme environmental conditions in CG including an 8 m tidal range, strong tidal currents >2 m/s, very high suspended sediment loads and turbidity, constantly moving seabed substrates, a permanently aphotic benthic zone and major pulses of freshwater and terrestrial sediment inputs during the wet season, significantly inhibit colonization by and survival of benthic biota. Coral, seagrass, macroalgae, sponge-bed or similar significant primary producer communities are not present in the LAU. The sand substrate within the proposed operational area is largely devoid of benthic biota, with the few examples of biota found in grab samples from that area mainly being small amphipods, isopods and brachyurans. The most significant benthic community in the LAU is a narrow band of mangroves found around most of the coast of CG, with a total area of 350 km^2, backed by extensive, barren mudflats and salt-flats.

   c) Coastal processes (section 7): Coastal processes in CG are driven by the tidally-dominated hydrodynamic system, with inputs of terrestrial sediments from the catchment, including large pulses during the wet season. The most important coastal environmental values that are dependent on coastal processes are the mangrove communities and several turtle nesting areas, mainly seaward beaches outside CG that are more linked to external coastal processes.

   d) MEQ (section 8): The waters of CG appear to be free of chemical contaminants, with no significant sources of pollution along the immediate coastline or in the broader catchment. The area has normal sea temperature, salinity and pH, with expected variation between the dry- and wet-seasons. The area has relatively low chlorophyll-*a* concentrations, in both the dry- and wet-seasons, extremely high suspended solids and turbidity levels; and very low (zero or near zero) benthic light levels, throughout the year. The main environmental value linked to MEQ is ecosystem health, while lack of human habitation and activity in CG reduces the relevance of MEQ values that are linked to human use.

e) Marine fauna (section 9): The most significant marine fauna resources and values in the LAU include a small population of Snubfin Dolphins (*Orcaella heinshoni*), with a breeding, calving, feeding and resting Biologically Important Area (BIA) declared over the area, and significant Flatback Turtle (*Natator depressus*) nesting beach at Cape Domett, outside of CG, lesser nesting sites in the area, and an inter-nesting buffer BIA for Flatbacks declared over the area.

f) Air quality (section 10): There is no urban, industrial or other development on the coast or in the immediate catchment of CG that could be potential sources of air pollution. Dry-season bush fires affect air quality through smoke, ash and particulate matter but these are a natural occurrence.

g) Social surroundings (section 11): The social surroundings of CG are strongly influenced by the fact that the area is completely uninhabited, with no road access and no built facilities or infrastructure at all. The area has high aesthetic values in the form of wild, untouched, natural scenery including rugged limestone cliffs along parts of the coast. No non-Aboriginal cultural heritage values including historic shipwrecks were identified in the proposed operational area. Consultation with the two relevant TO groups and comprehensive marine surveys have not identified underwater Aboriginal cultural heritage within the proposed operational area. There are significant Aboriginal cultural heritage sites on Lacrosse Island and on the adjacent mainland centred on Cape Domett, which will not be impacted in any way by the proposal. Commercial ships that transit to and from the Port of Wyndham are the main existing economic activity in CG, and the coasts and inlets around CG are used for recreational fishing.

h) Protected areas (section 12): There are five protected areas in the general vicinity of CG, as follows:

- The State North Kimberley Marine Park which starts at the seaward entrance to CG along the territorial sea baseline and extends out to the 3 nm limit of State coastal waters.
- The Commonwealth Joseph Bonaparte Gulf Marine Park located seaward of the State Marine Park.
- The State Ord River Nature Reserve which covers the Ord River Floodplain Ramsar Wetland on the eastern side of CG.
- The State Mijing Conservation Park located 20 km inland from the east coast of CG.
- The Balanggarra Indigenous Protected Area (BIPA) which commences 10 km inland from the western coast of CG.

1. BACKGROUND & PURPOSE OF THIS REPORT

1.1 Brief Description of the Proposal

Brief summary only - pls refer Proposal Content Document for details.

1. Boskalis Australia Pty Ltd (BKA) is assessing the feasibility of developing a marine sand sourcing operation in Cambridge Gulf (CG) near Wyndham in the northeast of Western Australia (WA) (Figure 1). The sand in CG is derived from natural terrestrial sources via river inputs. The sand would be exported to Asian markets for use in construction projects. In proposing CG, BKA has screened alternatives as outlined in Referral Report No. 4 - *Impact Assessments* (BKA 2024d).

2. The proposal is subject to the WA *Mining Act* including the comprehensive environmental assessment and management framework under that Act. BKA currently holds two exploration tenements in CG, E80/5655 (Block 4) and E80/6009 (Block 4A) (Figures 1 to 3). Based on sand distribution, the proposed operational area where BKA proposes to apply for a mining tenement is the western part of Block 4 and all of Block 4A (Figure 1 & 2). Key facts relating to the proposal include:

   a) Project lifespan: Up to 15 years from commencement of operations.

   b) Zero coastal or land-based development: The proposal does not involve the construction and operation of any shore-based facilities and does not involve the alteration of the coastline in any way. It will be a 100% vessel-based operation.

   c) Marine area: The proposed operational area is located in the central part of the main body of CG where there is a significant seabed sand resource, covering an area of ~100 km^2 as shown on Figures 1 and 2. Water depths within the area average -25 m MSL. The seabed within and around the proposed operational area comprises highly-dynamic sand-waves with very little biota and no significant benthic communities, due to the constantly moving substrate, strong tidal currents (>2 m/s), constantly high suspended sediments and permanent lack of benthic light.

   d) Single vessel: The proposed operation will involve a Sand Production Vessel (SPV) based generally on the design of a large Trailer Suction Hopper Dredger (TSHD) (Figure 4). It will be an internationally-registered vessel subject to all relevant regulatory requirements of the International Maritime Organization (IMO) and the Australian Maritime Safety Authority (AMSA). While design is conceptual, indicative specifications are Length Overall (LoA) of ~350 m, draft of ~19 m, sand capacity 75K m^3 to 125K m^3 and crew of ~25. There will be no refuelling or waste discharges in CG.

   e) Zero activity in CG for 86% of time: The SPV will self-load sand in CG for one to two days every two weeks. It will then sail to the sand delivery port in Asia and return to CG two weeks later to repeat the cycle. This means that the SPV will only operate in CG for 52 days per year, or 14% of the time. There will be zero operational activity in CG for 86% of the time during the project's lifespan of up to 15 years.

   f) Sand volumes: Exploration surveys indicate that there is a minimum of 300 million m^3 of sand in the proposed operational area and likely several times more. There are several orders of magnitude higher volumes of sand throughout CG overall. It is proposed to export up to 70 million m^3 of sand. This is a maximum of only 23% of the minimum volume of 300 million m^3 of sand estimated to occur in the proposed operational area, and a much smaller % of the volume of sand that occurs throughout CG overall.

   g) Low footprint each loading cycle: During each one- to two-day sand loading cycle, the SPV will work over an area of ~0.5 km^2 within the proposed operational area, with a draghead width of ~6 m. The SPV will remove a layer of approximately 30 cm of sand from the seabed during each loading cycle.

   h) End of project seabed condition: At the end of the 15-year project timeframe, if the proposed 70 million m^3 of sand is exported, the area within the proposed operational area will be on average <1m deeper than the pre-project seabed. It will still comprise sand with similar seabed morphology, dynamics and habitat features as before sand sourcing.

   i) No significant environmental impacts: Overall, due to the above factors and other factors as assessed in Referral Report No. 4 - *Impact Assessments* (BKA 2024d) and Referral Report No. 5 - *Metocean & Sediment Dynamics* (PCS 2024a), and with the implementation of best-practice impact avoidance, prevention, minimization, mitigation, management and monitoring measures, the proposal is unlikely to cause significant environmental impacts. If the proposal proceeds, BKA will seek to support research and monitoring initiatives to improve environmental protection and biodiversity conservation in the area, in cooperation with relevant stakeholders including TOs (see BKA 2024d).

   j) Economic benefits & TO support: The proposal will generate a range of economic benefits, including payment of State royalties, payment of voluntary royalties to TO groups, up to 40-50 local jobs, service contracts and business opportunities with priority focus on TOs, and support for local Indigenous Ranger groups and community development. Both TO groups in the area, Balanggarra and Miriuwung-Gajerrong, have issued letters of support for the proposal (see Referral Report No. 3 - *Traditional Owner Matters*, BKA 2024c).

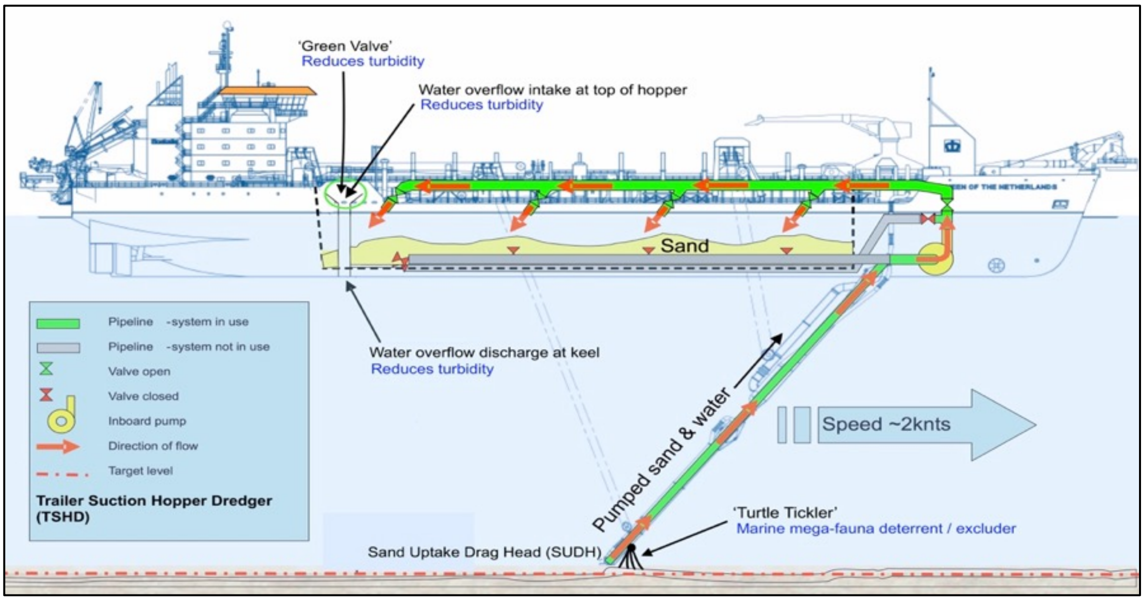


FIGURE 1.1: *The proposed operation will involve a single Sand Production Vessel (SPV) based generally on the design of a large Trailer Suction Hopper Dredger (TSHD) shown here – but designed and built specifically for the proposal.*

1.2 Purpose of this Report

1. To support its feasibility assessment BKA has undertaken a wide range of environmental, engineering, economic and other studies since 2018. These studies find that the proposal is feasible and viable and unlikely to cause significant environmental impacts, as defined under the WA *Environmental Protection Act* (EP Act) and the Commonwealth *Environmental Protection & Biodiversity Conservation Act* (EPBC Act) and other relevant State and Commonwealth legislation. The findings of these studies in terms of State (WA) impact assessments are presented in Referral Report No. 4 (BKA 2024d).

2. Despite the low likelihood of significant environmental impacts, as a responsible company with stringent environmental and social policies, BKA has committed to self-referring the proposal to the WA Environmental Protection Authority (EPA) under section 38 of the EP Act, and to the Commonwealth under Part 7 of the EPBC Act, for their determination of what further environmental assessments might be required, if any. If it is determined that assessment is required under both Acts, BKA will seek a joint process under the WA environmental assessment system, which is accredited by the Commonwealth.

3. As outlined in section 1.1 the proposal is subject to the comprehensive environmental assessment and management framework under the WA *Mining Act*, and relevant applications are also being made to the WA Department of Energy, Mines, Industry Regulation & Safety (DEMIRS).

4. The purpose of this report is to support BKA's self-referral under section 38 of the EP Act, by describing the proposal setting and existing environmental resources and values in and around CG, as per the Local Assessment Unit (LAU) in section 2.

5. The description of the existing environmental resources and values in this report is organized around the Environmental Factors described in the EPA's *Statement of Environmental Principles, Factors & Objectives* (EPA 2016a). Table 1.1 shows the EPA's Environmental Factors and associated Objectives, and identifies those that are relevant to the BKA proposal – referred to hereafter as Key Environmental Factors (KEFs). There are six KEFs as follows:

    a) Benthic communities & habitats (BCH).
    b) Coastal processes.
    c) Marine environmental quality (MEQ).
    d) Marine fauna.
    e) Air quality.
    f) Social surroundings.

6. The EPA's Environmental Factors relating to land and inland waters are not relevant as the proposal is a 100% vessel-based marine operation with no land-based components.

7. The descriptions of the KEFs in this report are based on a very comprehensive suite of data, as generally described in section 3, expanded where relevant under each KEF, and detailed in Annex 1 of Referral Report No. 4 (BKA 2024d). The description of the KEFs in this report is designed to under-pin and inform the impact assessments for each KEF in Referral Report No. 4 (BKA 2024d).

TABLE 1.1: *The EPA's 14 Environmental Factors and associated Objectives and their relevance to the BKA proposal*

Theme	Environmental Factor	Objective	EPA Guidance	Relevant to BKA Proposal?
Sea	Benthic Communities & Habitats (BCH).	To protect benthic communities and habitats so that biological diversity and ecological integrity are maintained.	2016, Environmental Factor Guideline - Benthic Communities & Habitats. 2016, Technical Guidance - Protection of Benthic Communities & Habitats. 2021, Technical Guidance - Environmental Impact Assessment of Marine Dredging Proposals.	Yes – described in section 6.
	Coastal Processes.	To maintain the geophysical processes that shape coastal morphology so that the environmental values of the coast are protected.	2016, Environmental Factor Guideline - Coastal Processes.	Yes – described in section 7.
	Marine Environmental Quality (MEQ).	To maintain the quality of water, sediment and biota so that environmental values are protected.	2016, Environmental Factor Guideline - Marine Environmental Quality. 2016, Technical Guidance - Protecting the Quality of Western Australia's Marine Environment.	Yes – described in section 8.
	Marine Fauna.	To protect marine fauna so that biological diversity and ecological integrity are maintained.	2016, Environmental Factor Guideline - Marine Fauna.	Yes – described in section 9.
Land	Flora and Vegetation.	To protect flora and vegetation so that biological diversity and ecological integrity are maintained.	N/a - no land-based components.	No - the proposal is a 100% vessel-based marine operation.
	Landforms.	To maintain the variety and integrity of significant physical landforms so that environmental values are protected.	"	"
	Subterranean Fauna.	To protect subterranean fauna so that biological diversity and ecological integrity are maintained.	"	"
	Terrestrial Environmental Quality.	To maintain the quality of land and soils so that environmental values are protected.	"	"
	Terrestrial Fauna.	To protect terrestrial fauna so that biological diversity and ecological integrity are maintained.	"	"
Water	Inland Waters.	To maintain the hydrological regimes and quality of groundwater and surface water so that environmental values are protected.	N/a - no impacts on inland waters.	No – the proposal is a 100% vessel-based marine operation.
Air	Air Quality.	To maintain air quality and minimise emissions so that environmental values are protected.	2020, Environmental Factor Guideline - Air Quality.	Yes – described in section 10.

Theme	Environmental Factor	Objective	EPA Guidance	Relevant to BKA Proposal?
	GHG Emissions.	To minimise the risk of environmental harm associated with climate change by reducing greenhouse gas emissions as far as practicable.	2023, Environmental Factor Guideline - Greenhouse Gas Emissions.	Not relevant as does not reach EPA's trigger. Addressed in Referral Report *No. 4 - Impact Assessments.*
People	Social Surroundings.	To protect social surroundings from significant harm.	2016, Environmental Factor Guideline - Social Surroundings. 2023, Interim Technical Guidance, EIA of Social Surroundings - Aboriginal cultural heritage.	Yes – described in section 11.
	Human Health.	To protect human health from significant harm.	N/a	No – the area is uninhabited and vessel crew will work under maritime safety system.

2. LOCAL ASSESSMENT UNIT

1. The WA EPA *Technical Guidance on the Protection of Benthic Communities and Habitats* (EPA 2016b) requires that a spatially-defined Local Assessment Unit (LAU) should be determined within which potential impacts are assessed.

2. The determination of the LAU boundaries should be specific to the location and should be configured to cover the full area within which impacts might occur from the proposal. This should take into account aspects of the local marine environment such as coastal geomorphology, bathymetry, hydrodynamics, the presence of islands and reefs, biological attributes including the distribution of habitat and community types and ecological connectivity of the area. Jurisdictional and administrative factors such as State coastal waters and marine reserve boundaries should also be taken into account.

3. The Technical Guidance states that while LAU boundaries should be site-specific, marine LAUs in WA would typically be approximately 50 km^2 (e.g. a rectangular area defined by a 10 km stretch of coastline extending 5 km offshore or to the 3 nm limit of State Waters).

4. Figure 2.1 shows the LAU used by BKA for the CG proposal, overlain on the Benthic Habitat Map for CG. The LAU covers a marine area of over 2,800 km^2, very significantly larger than the 50 km^2 reference stated by the EPA. This does not in any way imply potential for impacts throughout the area, but reflects BKA's conservatively precautionary approach to assessment, ensuring that all relevant environmental resources and values of the general area are included.

5. As shown on Figure 2.1 the LAU is centred on the proposed operational area and includes:

   - all coastal and marine areas within the main body of CG,
   - all of the coasts of Adolphus Island at the southern end of the main body of CG,
   - all of the coasts of Lacrosse Island at the entrance to CG,
   - the complex of mangrove-lined inlets and on the eastern side of CG known as the False Mouths of the Ord and part of the Ord River Floodplain Ramsar Wetland,
   - the three mangrove-lined rivers on the western side of CG, from north to south the Helby, Lyne and Thompson Rivers,
   - seaward to include the part of the State North Kimberley Marine Park located just offshore from CG,
   - east along the coastline outside of CG to include the beaches east of Cape Domett; and
   - west along the coastline outside of CG to include the beaches west of Cape Dussejour.

6. While the requirement to define a LAU is stated in the EPA guidance on benthic communities and habitats, BKA has used this LAU for the description of all KEFs.

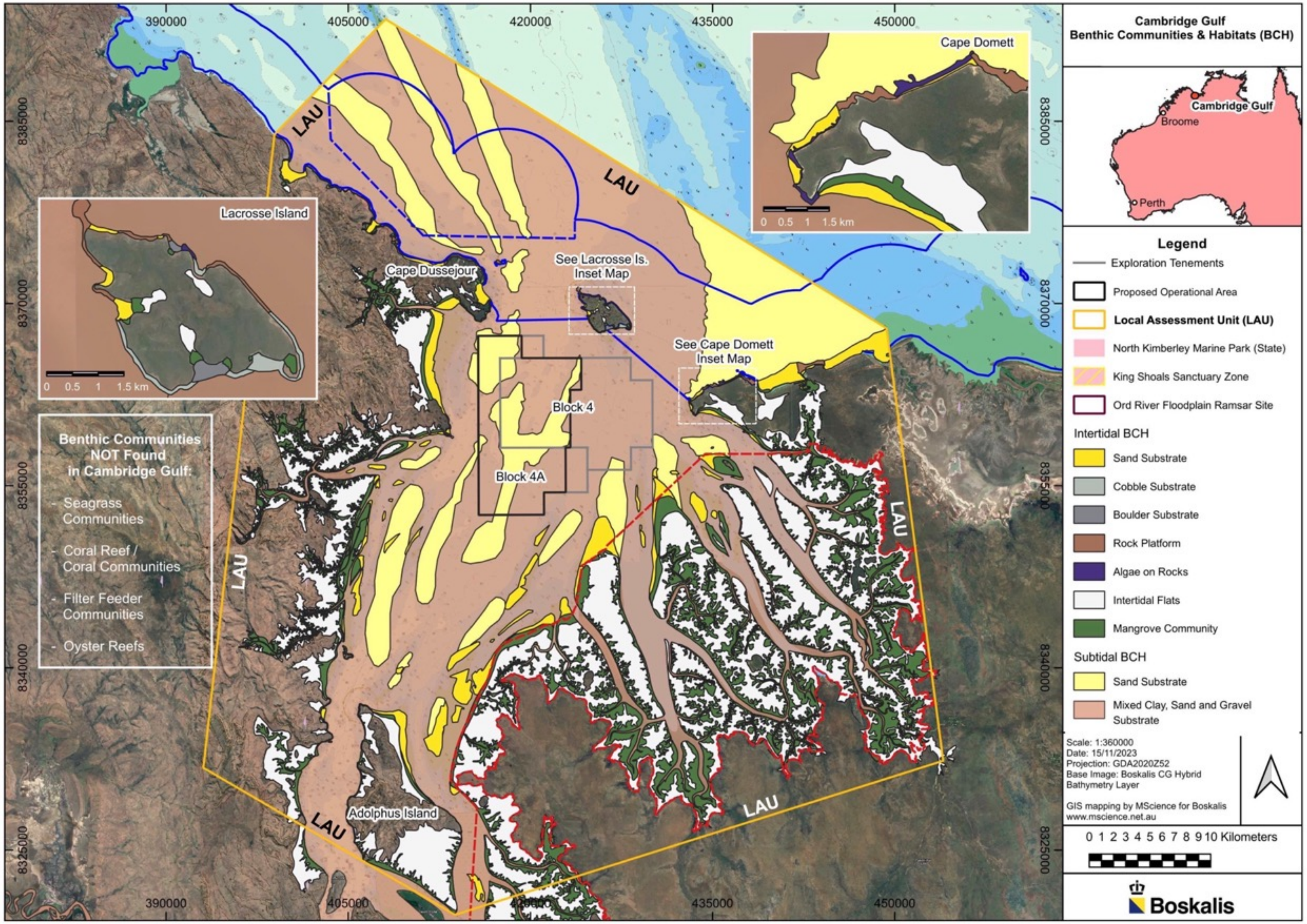


FIGURE 2.1: *The Local Assessment Unit (LAU) used by BKA for the CG proposal, overlain on the Benthic Habitat Map for CG.*

3. STUDIES & DATASETS USED TO INFORM THE KEF DESCRIPTIONS

1. BKA has sought to achieve as much scientific certainty as possible by supporting and informing the KEF descriptions presented in this report with a comprehensive suite of data. This includes sourcing and using a wide range of pre-existing data from external sources and previous studies of the area; and BKA-collected data. The latter includes surveys and sampling that BKA commissioned or has undertaken directly, including in both the dry- and wet-seasons, and ongoing data collection, as follows:

   a) Sand exploration survey February - March 2023. This included the following within Block 4 (E80/5655) (Figures 1 & 2):

      – Side-scan sonar and sub-bottom profiler surveys.
      – Vibro-core sampling of the seabed sediments at 35 sites.
      – Grab sampling of the seabed sediments at 35 sites, both to asses sediment types and qualitative assessment of benthic biota.
      – Drop camera deployment at 17 sites to assess benthic communities and habitats and assess water clarity / turbidity.
      – Secchi disc readings at 17 sites to assess water clarity / turbidity.
      – Observing for marine-mega fauna (MMF) for two hours per day over nine days, plus incidental observations.
      – Nine days of observations of general environmental conditions.

   b) Dry season environmental survey July - August 2023. This included the following throughout CG and offshore:

      – Replicate (mostly 3) benthic grab samples at 105 sites in CG, 27 sites at King Shoals (KS) and several sites offshore, for qualitative and quantitative assessment of benthic biota, and visual descriptions of benthic sediment types.
      – Drop camera deployments at 90 sites in CG, 27 sites at King Shoals (KS) and several sites offshore, for photographic record.
      – Grab samples of sediments at 21 sites in Block 4 for contamination assessment according to NAGD (2009).
      – Vertical water quality profiles at 53 sites in CG, 20 sites at KS and 30 sites offshore.
      – Midwater total suspended solids (TSS) and chlorophyll sampling at 31 sites in CG, three sites at KS and 20 sites offshore.
      – Aerial drone high resolution video and photogrammetry surveys of key intertidal habitats around CG at low tide.
      – Aerial drone surveys of all beaches and coastal sand areas around CG that could be turtle nesting areas.
      – Eight days of dedicated vessel-based MMF surveys covering >800 km of transects.
      – Twenty days of incidental MMF observations.
      – Twenty days of observations of general environmental conditions.

   a) Wet season environmental survey February - March 2024. This included the following throughout CG:

      – High resolution hydrographic survey of the proposed operational area and 1 km buffer, including repeat surveys over a lunar tidal cycle to assess seabed dynamics and changes to seabed morphology.
      – Replicate (mostly 3) benthic grab samples at 26 sites in CG and 14 sites at KS, for qualitative and quantitative assessment of benthic biota, plus photographic record and visual descriptions of benthic sediment types.
      – Vertical water quality profiles each hour over 13-hour spring tidal cycle at each of three sites in, north and south of the proposed operational area. This included Niskin suspended solids sampling at midwater and near-seabed, and co-deployment of YSI multi-sonde and Aquadopp ADCP for current speed and direction.
      – Aerial drone high resolution video and photogrammetry surveys of key intertidal habitats around CG at low tide.
      – Aerial drone high resolution (2 cm) LiDAR and photogrammetry surveys of the four main turtle nesting beaches in CG area at low tide.
      – eDNA sampling targeting Sawfish and River Sharks at 20 sites in the proposed operational area and up rivers and inlets on west and east coasts of CG.
      – Nine days of dedicated vessel-based MMF surveys covering >800 km of transects.
      – Twenty days of incidental MMF observations.
      – Twenty days of observations of general environmental conditions.

   b) Ongoing in-situ oceanographic and water quality monitoring since June 2023. This includes:

      – In-situ seabed ADCPs / AWACS at 10 sites throughout CG deployed for various periods depending on the site, up to 90 days plus at some sites to give full range of hydrodynamic conditions.
      – In-situ seabed light meters and multi-sonde sensors at eight sites throughout CG, to collect long-term near-seabed light (PAR /DLI), turbidity, temperature, salinity and pH data (ongoing).

2. The main studies and datasets used to support the KEF descriptions presented in this report are detailed further in Annex 1 of Referral Report No. 4 (BKA 2024d). Annex 1 of Referral Report No. 4 also includes maps showing the distribution of data collection points for the various datasets. Figure 3.1 below shows one example – which is a very small component of the much larger suite of datasets and maps presented in Annex 1 of Referral Report No. 4.

3. Further details of all relevant data relating to hydrodynamics, sediment dynamics and coastal process assessments undertaken by Port & Coastal Solutions (PCS) for BKA are contained in PCS (2024c) - *Factual Data Report* (an annex to Referral Report No. 5).

4. Referral Report No. 9 - *IMSA Metadata Package Statement* (BKA 2024g) presents all relevant metadata details in accordance with the EPA's Index of Marine Surveys for Assessments (IMSA) guidelines.

5. Some key features of the datasets used include:

   a) Some of the datasets provide data extending back over many years or decades, which assists in determining seasonal, inter-seasonal and longer-term patterns and trends. These include but are not limited to.

      - meteorological data dating back to the 1950s,
      - river level and discharge data dating back to the 1960s,
      - tidal data dating back to the 1980s,
      - satellite imagery dating back to the 1980s and used to assess coastal changes and derive total suspended matter correlations, to assess long-term trends in suspended matter / turbidity; and
      - suspended sediments, turbidity and other physical water quality data collected in CG by the Australian Institute of Marine Science (AIMS) from 1999 through 2004.

   b) Some of the BKA-collected datasets provide data that had never been collected in CG previously. In addition to informing the KEF descriptions in this report, they also inform general scientific knowledge and understanding of CG and will help to improve environmental protection and biodiversity conservation in the area. All data collected by BKA can be made freely-available to relevant parties, in addition to submitting via IMSA. Such 'new' data includes:

      - the first known benthic grab sampling in CG and at KS,
      - the first known seabed sediment contamination sampling in CG,
      - the first known aerial drone surveys of inter-tidal habitats and turtle nesting areas in and near CG,
      - the first known high resolution aerial drone LiDAR and photogrammetry surveys of the four main turtle nesting beaches in the CG area, providing a powerful baseline for future monitoring; and
      - the first known marine eDNA sampling in CG.

6. To support assessment of potential impacts on Aboriginal cultural heritage, BKA has undertaken what may be the most intensive and comprehensive survey for underwater Aboriginal cultural heritage ever undertaken anywhere in Australia to date. This included comprehensive seabed surveys throughout CG and engaging with the two TO groups on this issue. See Referral Report No. 3 - *Traditional Owners, Native Title & Aboriginal Cultural Heritage* (BKA 2024c).

7. Overall, the REF descriptions presented in this report are supported and informed by a very comprehensive suite of a wide-range of relevant data, which strengthens the reliability and degree of certainty of the environmental descriptions and assessments.

8. As outlined above, BKA also has an ongoing data collection program in place in CG, including in-situ seabed mounted oceanographic and water quality monitoring instruments.

9. Should the proposal be approved and proceed, BKA proposes to also implement a comprehensive environmental and biodiversity research and monitoring program, in consultation and cooperation with TOs and other relevant stakeholders such as DWER, DBCA and DPIRD Fisheries, as described in Referral Report No. 4 (BKA 2024d). This would provide data to further assist environmental protection and biodiversity conservation in the area.

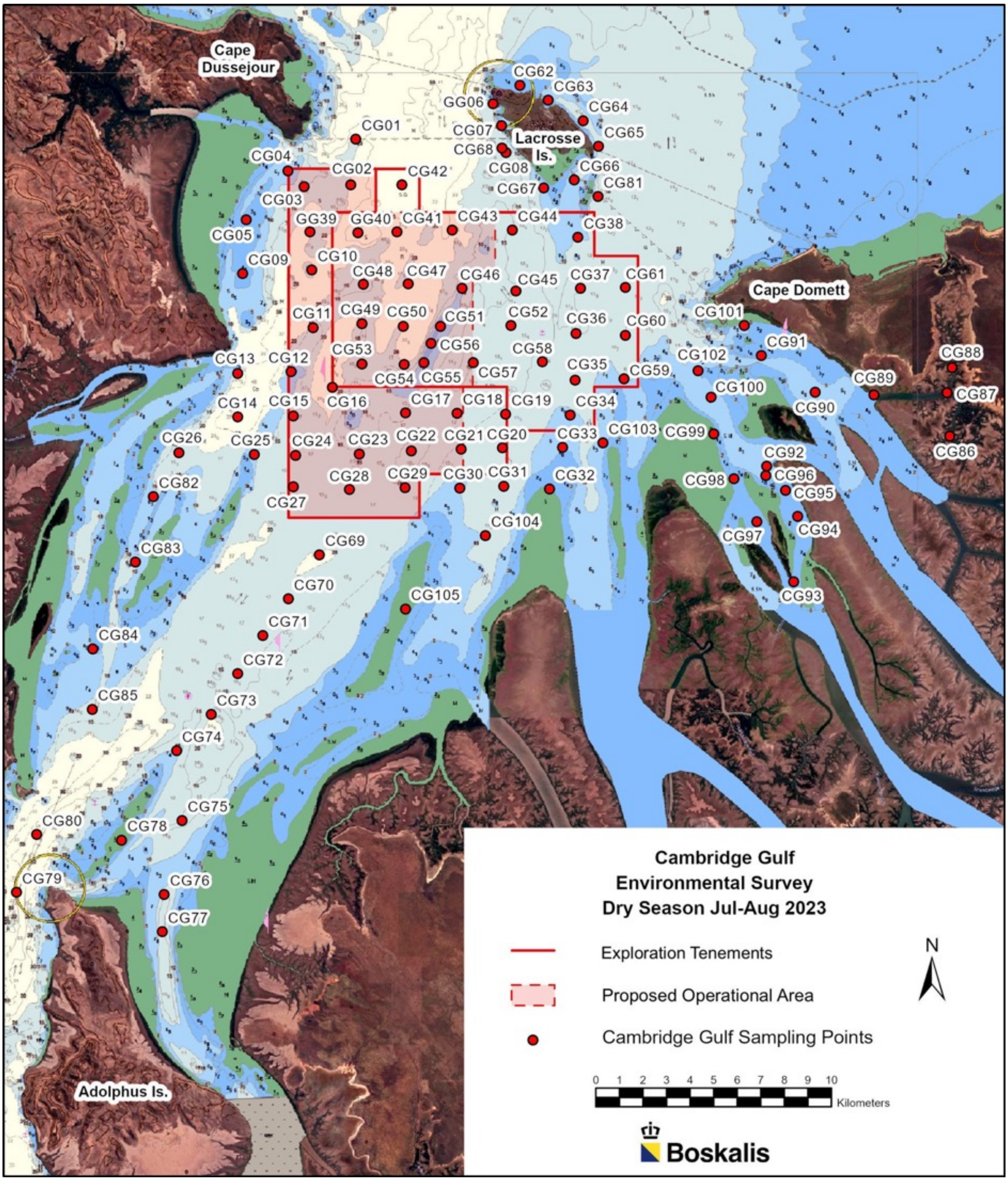


FIGURE 3.1: *One example of a* *map showing the distribution of data collection points in CG. This example is a very small component of the much larger suite of datasets and maps referenced in the following sections of this report, and described in detail in Annex 1 of Referral Report No. 4 (BKA 2024d).*

4. OVERALL SETTING OF CAMBRIDGE GULF

1. Cambridge Gulf (CG) is a large, highly dynamic and highly turbid embayment located on the tropical northeast coast of Western Australia (WA) (Figure 1). Geographically, CG is centered on 14º 52.00' S and 128º 16.00' E, facing northwards and seawards to the larger Joseph Bonaparte Gulf. The seaward mouth of CG is bounded to the west by Cape Dussejour and to the east by Cape Domett, with Lacrosse Island located centrally, dividing the mouth into a West Entrance and an East Entrance. The main body of CG extends ~40 km from its seaward mouth upstream to Adolphus Island, with the widest point being ~20 km (Figures 4.1 & 4.2). The mean water depth is approximately 12 m LAT (Wolanski et al 2004).

2. There is a complex system of estuarine inlets located on the east side of CG, just inshore from Cape Domett, lined with relatively narrow bands of fringing mangroves and backed by tidal mudflats and salt-flats, known as the 'False Mouths of the Ord River'. This area includes the Ord River Floodplain Ramsar Wetland (Figures 2, 2.1, 4.1 & 4.2) (see section 12.3).

3. At Adolphus Island CG splits into West Arm, which extends for another 80 km upstream to the small port town of Wyndham, and East Arm, which is the true lower reach of the Ord River (Figures 4.1 & 4.2).

4. CG has a macrotidal environment with semi-diurnal tides and a spring tidal range of 8 m. The large tidal range causes high current velocities, which BKA has measured to exceed 1.5 m/s (3 knots) (PCS 2024a), and the Australian Hydrographic Office (AHO) marks 3 to 4 knots (1.54 to 2.06 m/s) in West Entrance and in the centre of CG on chart AUS32 (see section 6.4.2). This causes very high natural turbidity from constant suspension of sediments with every change of the tide, and permanent aphotic conditions at the seabed.

5. The region has a hot, semi-arid climate. The annual average maximum temperature is 35.6 °C (measured at Wyndham), one of the highest in Australia. The annual average rainfall is 500 mm with the majority of this occurring in the wet season November to March. CG is within the tropical cyclone zone and is regularly hit by severe category cyclones.

6. Five main rivers discharge into CG, the Durack, Forrest, King, Ord and Pentecost, along with a number of smaller tributaries. The total catchment area for CG is approximately 87,000 km^2 with 62% of this being the Ord River catchment (DataWA 2023). Apart from the Ord, which has two dams and significant areas of irrigated agriculture, all of the other rivers are still 'wild', with very little clearing of natural vegetation or development.

7. Except for the Ord River, which has an overall length of 650 km, all of the rivers are quite small, but can have very high, acute, short-term flows during the tropical wet season. The wet season river discharges can vary by orders of magnitude year to year. There is also significant daily variability in river flows, with very high flows following tropical cyclones only lasting a matter of days (Wolanksi et al 2001).

8. The rivers all discharge sediment into CG. Over time, this has formed multiple small deltas and tidal flats. The supply of sediment varies significantly due to the high variability in river discharges. Peaks in sediment supply occur in the wet season, with limited sediment supply during the dry season (PCS 2024a). The rivers supply a combination of sand and fine-grained silt and clay. The sediment deposited in CG is subject to regular reworking by the strong tidal currents, resulting in well-sorted sands being present in the main channels (which BKA is assessing as a resource – the subject of this report) (PCS 2024a).

9. The coastline and hinterland around the main body of CG are completely uninhabited with no road access at all, and no built facilities or infrastructure, except for a small Aid to Navigation (light and RACON) on the peak of Lacrosse Island.

10. The closest town to the main body of CG is Wyndham located ~80 km upstream, with a small but important port and a population of 941 at the last national census in 2021(www.abs.gov.au) (Figure 4.1). The port receives diesel fuel to supply the mining industry in the East Kimberly region, fertilizer to supply farms throughout the Ord River irrigation area, and exports mined ores, live-cattle and agricultural produce. It also acts as a service port for small cruise ships that tour the Kimberley coast. Ships that serve the Port of Wyndham transit through CG both to enter and depart the port (see section 11.3 for further details on the port). The larger town of Kununurra is located 75 km west-south-west of Wyndham, with a population of 4,515 at the last national census in 2021 (www.abs.gov.au) (Figure 4.1).

11. The coast and hinterland on the western side of CG are Native Title lands of the Balanggarra peoples, and the coast and hinterland on the eastern side of CG are Native Title lands of the Mirriuwung-Gajerrong peoples. There is no Native Title over marine waters within CG (see Referral Report No. 3 - *Traditional Owner Matters*) (BKA 2024c).

12. Jurisdictionally, Cambridge Gulf is located wholly within the State Internal Waters of WA (landward of the Territorial Sea Baseline). To seaward is the State North Kimberly Marine Park, which extends from the Territorial Sea Baseline seaward to the 3 nm State limit, beyond which is the Commonwealth Joseph Bonaparte Gulf Marine Park (Figures 3 & 4.3). The local Government for the area is the Shire of Wyndham & East Kimberley (SWEK), with its main office in Kununurra.

13. Figures 4.4 to 4.9 depict some of the main geographical features of CG as marked on Figure 4.2. Section 11 on Social Surroundings includes further details on the overall setting of CG.

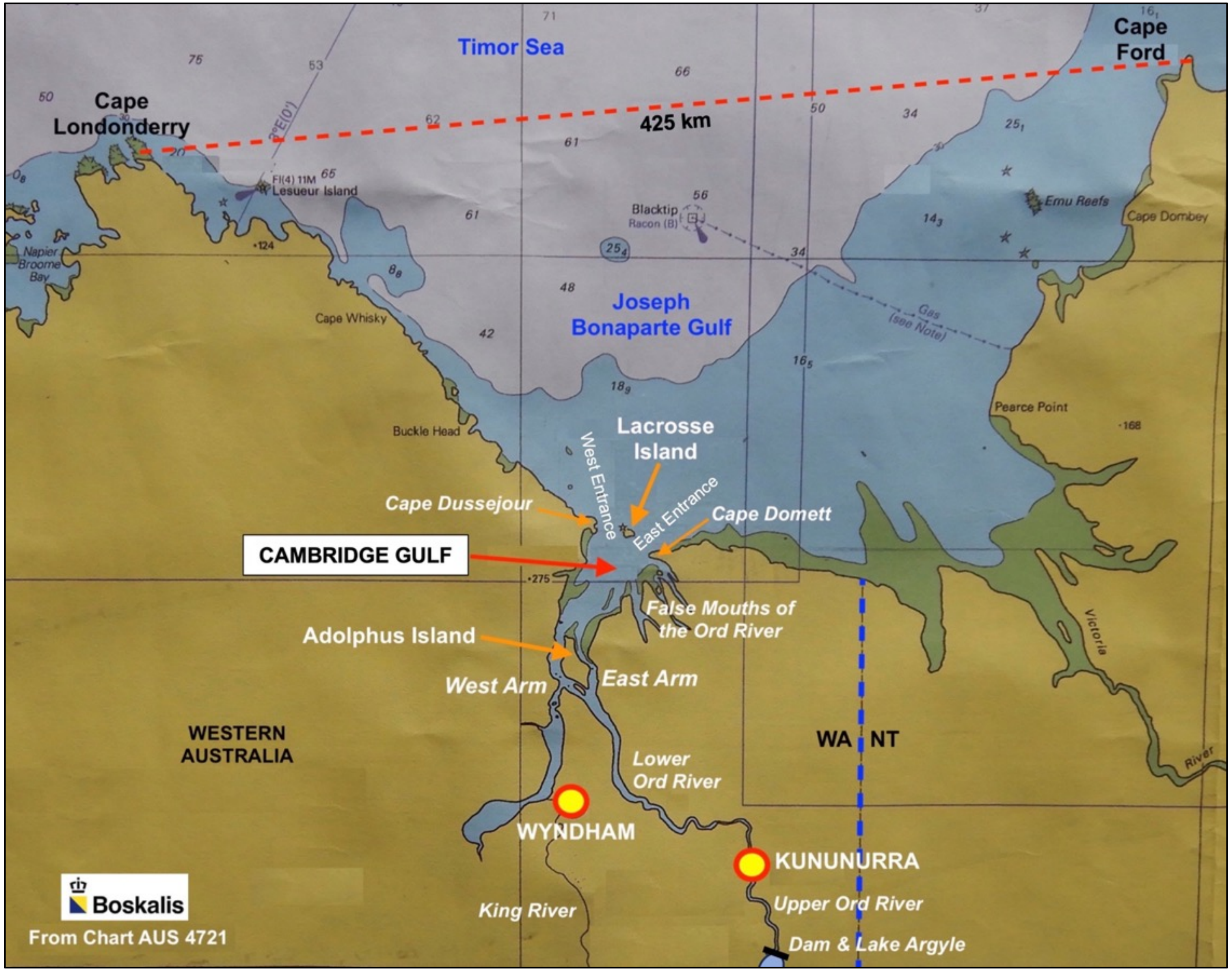


FIGURE 4.1: *Some of the main features in the CG region referred to in this report (extract from chart AUS4721).*

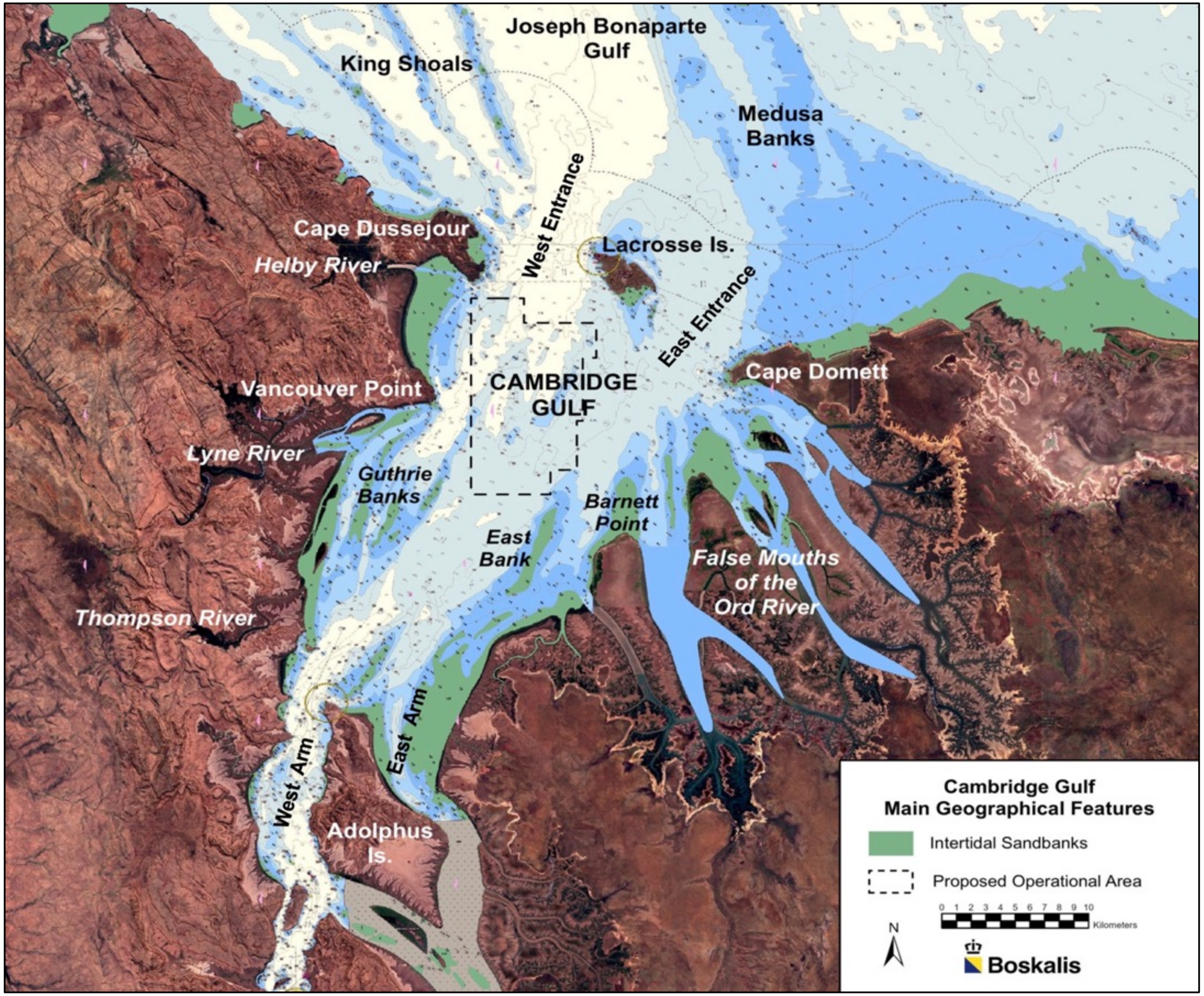


FIGURE 4.2: *The main geographical features around CG.*

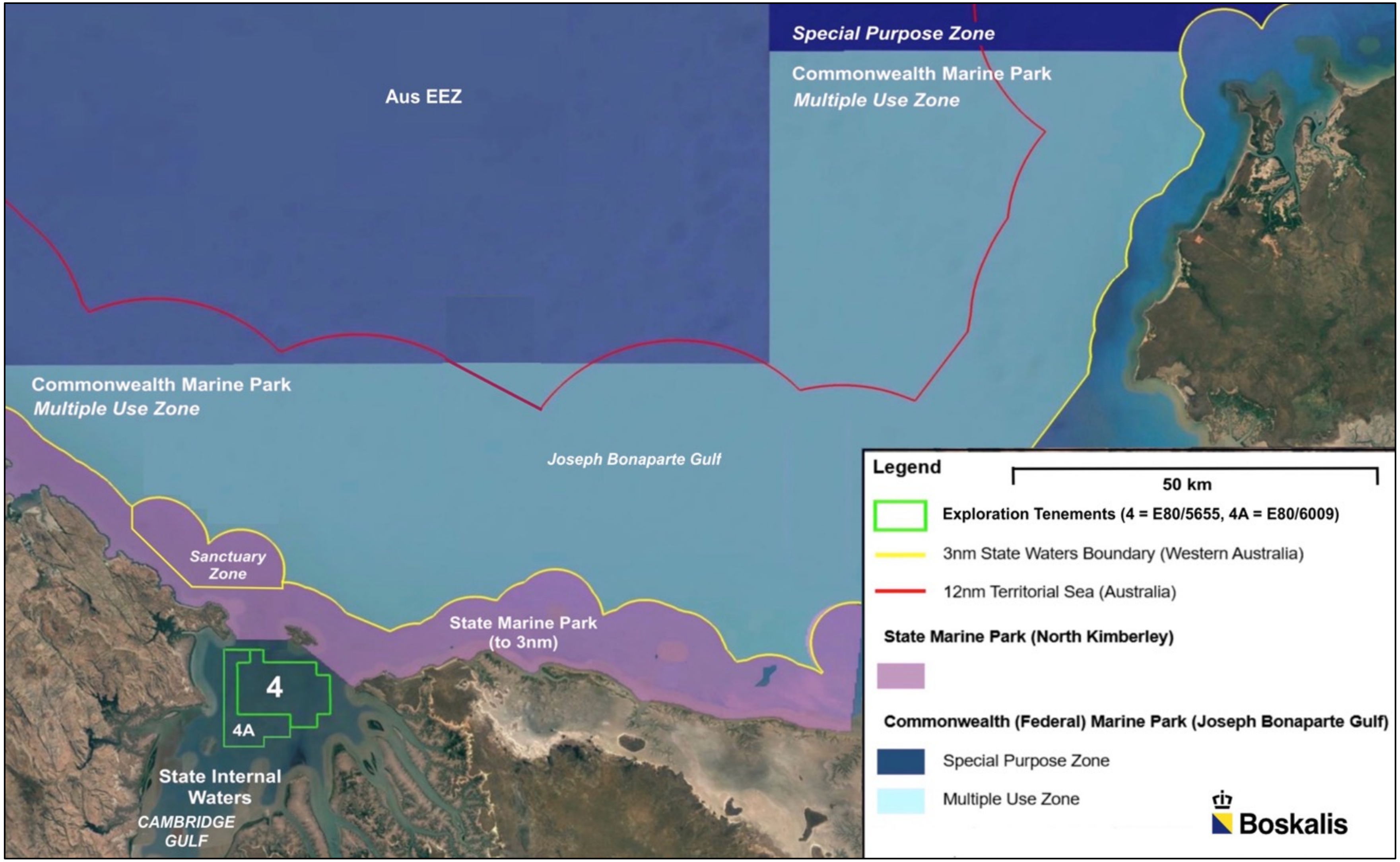


FIGURE 4.3: *Marine jurisdictions in and around CG.*

FIGURE 4.4: *Typical coast of CG looking north towards the seaward entrance, with rocky, sparsely vegetated hills and extensive salt- and mud-flats along the coast, fringed to seaward by mangroves (image: Tourism WA).*

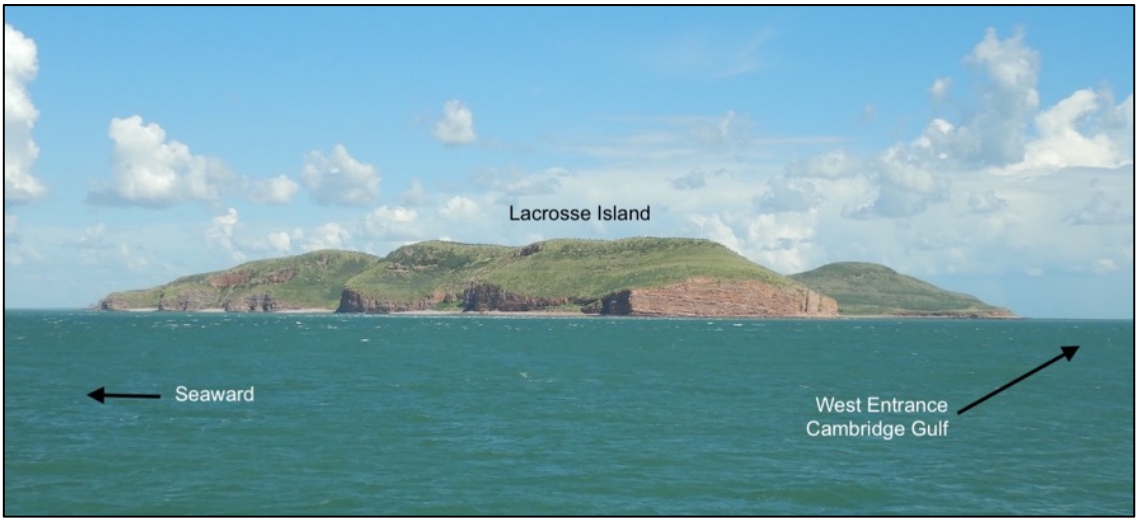


FIGURE 4.5: *Seaward side of Lacrosse Island which is located in the centre of the entrance to CG. This view is from the west when entering CG through West Entrance (image: Raaymakers).*

FIGURE 4.6: *Southern side of Lacrosse Island viewed from within CG (image: Raaymakers).*

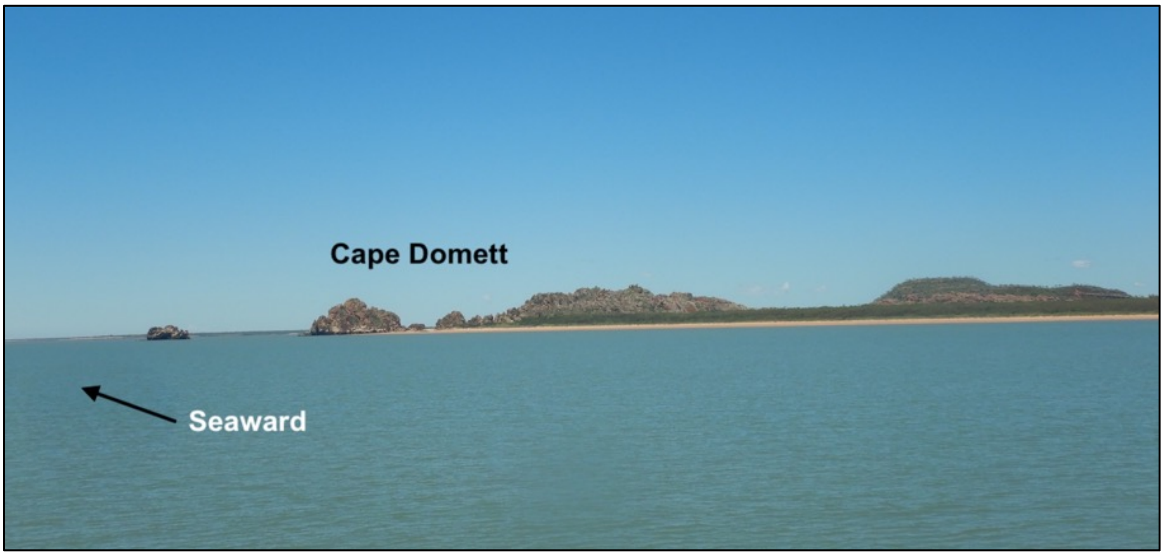


FIGURE 4.7: *Cape Domett on the eastern entrance of CG (image: Raaymakers)*

FIGURE 4.8: *Cape Dussejour on the western entrance of CG (image: Raaymakers).*

FIGURE 4.9: *One of the many tidal inlets that make up the 'False Mouths of the Ord River' on the eastern side of CG. The narrow band of mangroves backed by mud- and salt-flats is typical of most of the coastline of CG (image: BKA).*

5. DESCIPTION OF SAND RESOURCE IN CAMBRIDGE GULF

1. BKA is seeking to source marine sand from Cambridge Gulf (CG) for export to Asia, where demand for sand for construction and development is extremely high. Areas of seabed sand in CG were first identified by British Admiralty explorer Captain Philip King, who produced one of the first known maritime charts of area in 1826. Sandy seabed areas are clearly marked on his chart (Figure 5.1).

2. The Australian Estuarine, Coastal and Marine (ECM) National Habitat Map Series, developed by the Commonwealth Government since 2007 (Mount et al 2007) (Mount & Bricher 2008), shows significant sand areas in CG. This has been used by BKA's consultants in developing the Benthic Habitat Map for CG, as presented in Figure 2.1 in section 2 above. This depicts the sand areas in CG in yellow.

3. The sand in CG is derived from natural terrestrial sources in the catchment, where sandstone cliffs and rocky hills are eroded by the heavy wet season rains. The resulting sediment is carried into CG by the multiple rivers that drain the catchment, as described briefly in section 7 below on coastal processes. Figure 5.2 show the typical sand sources in the catchment, Figure 5.3 shows a simplified schematic of sand transport into CG, and Figure 5.4 shows seabed grab samples collected in CG that returned sand, showing that the upstream samples were predominantly sand and indicating the upstream catchment sources of the sand in CG.

4. Referral Report No. 5 - *Metcocean & Sediment Dynamics (PCS 2024a & b)* contains a more detailed assessment of sediment characteristics and dynamics in CG. The work by PCS (2024a & b) includes assessment of particle size distribution using a laser particle sizer, and the minerology / elemental characteristics using a scanning electron microscope (SEM-Feature analysis), of both seabed- and suspended-sediments, which indicates the upstream source of sand in CG.

5. As outlined in section 1, BKA holds two sand exploration tenements in CG issued by the WA Department of Energy, Mines and Industry Regulation and Safety (DEMIRS) under the WA *Mining Act*. These are referred to by BKA as Block 4 (DEMIRS E80/5655) and Block 4A (DEMIRS E80/6009) (Figure 5.5).

6. In order to assess the sand resource within Block 4, BKA undertook sand exploration surveys in February - March 2023. This was undertaken in accordance with BKA's Program of Work under E80/5655 as approved DEMIRS under the WA *Mining Act*, and included the following:

    a) Side-scan sonar (SSS) and sub-bottom profiler (SBP) transects (Figure 5.6).

    b) Vibro-core sampling of the seabed sediments at 35 sites (Figures 5.7 & 5.8).

    c) Grab sampling of the seabed sediments at 35 sites using a Smith-McIntyre Grab (Figure 5.7).

7. Sand exploration was not undertaken in Block 4A, as exploration tenement E80/6009 had not been issued at the time.

8. The study found that there is very little sand in the eastern half of Block 4 and significant sand throughout the western half of Block 4, with the sand appearing to extend west of the Block. Examples of the sand found in this area are shown in Figure 5.9.

9. Based on the findings, BKA applied for Block 4A and the corresponding exploration tenement E80/6009 was issued by DEMIRS in July 2024. BKA also revised the proposed operational area for sand sourcing to exclude the eastern half of Block 4, and include the western half of Block 4 only, plus all of Block 4A (Figure 5.5).

10. At an appropriate time BKA will apply to DEMIRS to convert the two Exploration Tenements to a Mining Tenement, excluding the eastern half of Block 4 due to the lack of sand in that area, and covering the proposed operational area only, subject to the outcome of the EP Act referral process. The proposed operational area covers an area of ~100 km^2, located slightly west of the centre of the main body of CG (Figure 5.4). The area of sand within the proposed operational area is estimated to be 75.3 km^2 (see below).

11. In February-March 2024, as part of the wet-season environment survey, BKA undertook high resolution multibeam echo-sounder (MBES) surveys of the proposed operational area plus a 1 km buffer around the area (Figure 5.10), to provide data to support environmental impact assessment of the proposed sand sourcing operation. This included mapping benthic communities and habitats in the proposed operational area, and assessment seabed dynamics to inform assessment of potential impacts of the proposal on coastal processes.

12. The MBES results show that the seabed in the proposed operational area mainly comprises highly mobile sand waves, formed and constantly moved by the prevailing strong tidal currents. The sand waves have vertical heights ranging from 1 to 8 m and horizontal wavelengths of between 50 and 200 m (Figures 5.10, 5.11 & 5.12) (see Referral Report No. 5 - PCS 2024b).

13. Repeat MBES surveys of two Target Areas in the proposed operational area over a month-long lunar tidal cycle in February-March 2024, measured horizontal migration of the seabed sand-forms by up to 10 m over just 27 days, showing that they are highly dynamic and constantly moving (Figures 5.10, 5.11 & 5.12) (see Referral Report No. 5).

14. BKA used the findings from the February-March 2023 sand exploration survey and the outputs of the February-March 2024 MBES surveys, to estimate the minimum volume of sand that is likely to be present in the proposed operational area. The sand assessment report is contained in Annex 1, and in summary it finds that:

    a) The areal extent of seabed that is covered by sand in the proposed operational area is approximately 75.3 km^2, calculated in QGIS.

    b) The thickness of the sand was estimated using the vibro-cores and SBP data from Block 4. However, the maximum penetration of the vibro-cores was 5.7 m and the SBP data did not penetrate sand beyond approx. 5.5 m. This means that in places where the thickness of the sand layer is more than 5.5 to 5.7 m, the base is not visible in the geophysical data and could not be reached by the vibro-core.

    c) Most sand is present in a few large sand dunes, which run parallel to the tidal-current direction from SSW to NNE. The greatest thickness of sand is found on top of the dunes, where the base of the sand is beyond the limits of detection by SBP or vibro-cores (5.5 to 5.7 m).

    d) The maximum thickness of the sand in Block 4 may be up to approximately 15 m on top of the dunes. Towards the troughs of the dunes the thickness reduces rapidly. However, the maximum thickness is a rough estimate because the base of the sand cannot be determined from the available data. For the volume calculations, the average thickness of sand recovered in the vibro-cores was used.

    e) The average thickness of sand in all vibro-cores taken in the area where sand is present in Block 4, is approximately 4 m, where a maximum of 6 m thickness was taken for the cores in which the base of sand was not recovered. Based on the cross sections, this is likely a conservative under-estimate. A similar average thickness was assumed in Block 4A – where exploration sampling has not yet been undertaken, but where the MBES survey undertaken for EIA purposes indicates a similar pattern.

    f) Volume of sand = area of sand x average thickness of sand, therefore 75.3 km^2 x 4 m = 301,200,000 m^3

    g) In conclusion:

        – *A minimum volume of 300 million m^3 of sand is likely to be present in the proposed operational area.*

        – *This is a small proportion of the total sand resource present in CG, as indicated on Figure 6.1 in section 2.*

15. As outlined in section 1.1, subject to environmental assessment, BKA will apply to source up 70 million m^3 of sand. This represents a maximum of 23% of the minimum volume of sand (300 million m^3) that is assessed to be present in the proposed operational area. It is a much smaller % of the total amount of sand that is present in CG overall, and which is subject to ongoing inputs from catchment sources.

FIGURE 5.1: *One of the first-known Maritime Charts of CG by British explorer Captain Philip King, who produced this chart in 1826. Sand areas are clearly marked on his chart, as underlined or circled in red, with the original text annotated with larger font to be readable (UK Hydrographical Office of the Admiralty, Chart 1049, 1826).*

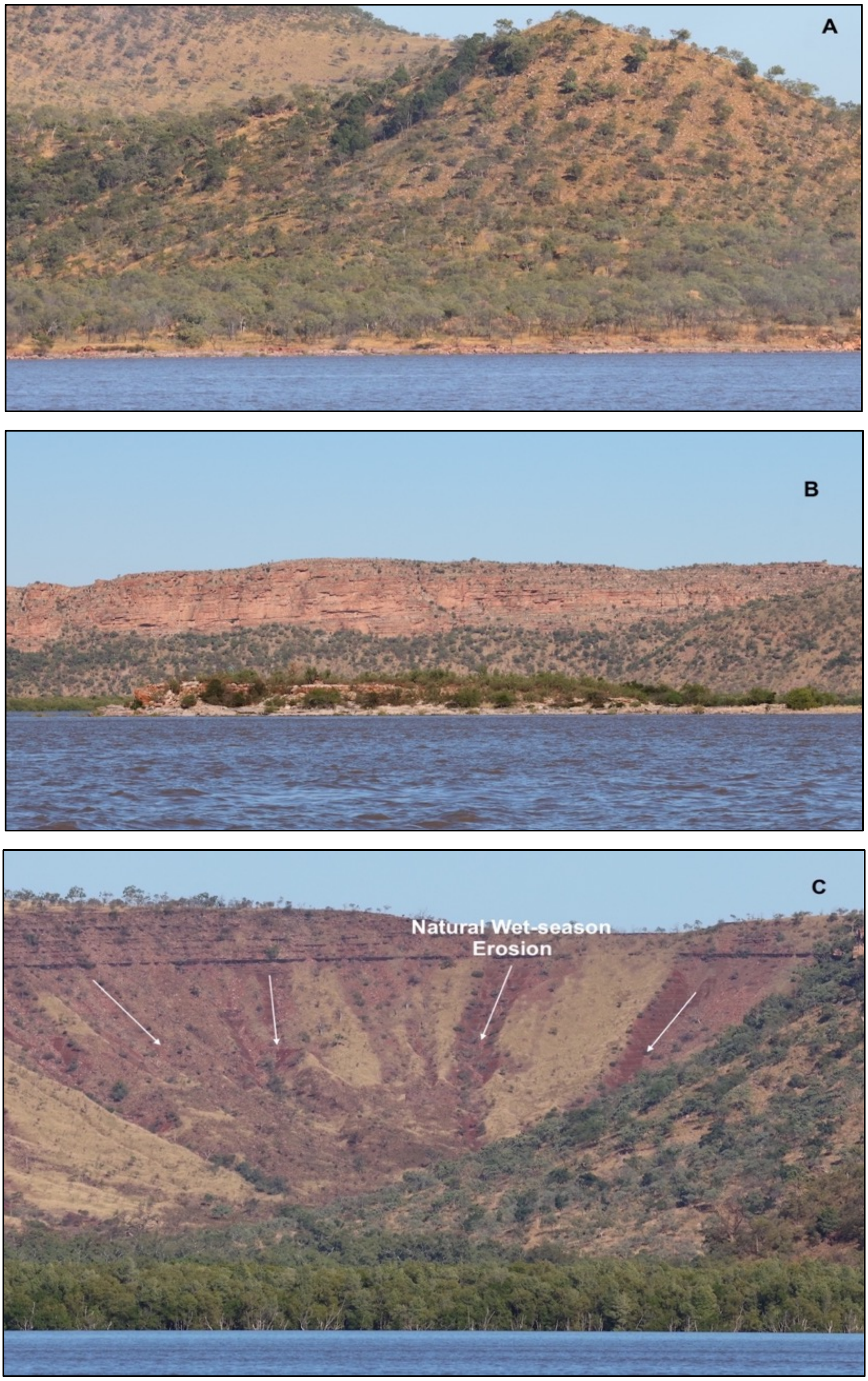


FIGURE 5.2 A, B & C: *Much of coastline of CG, especially on the western side and upstream (south) past Wyndham, is backed by sandstone cliffs and rocky hills. The sand in CG is derived from these features, which are eroded by the heavy wet season rains. The resulting sediment is caried into CG by the multiple rivers that drain the catchment. An example of the high levels of erosion is clear in image C - on the west coast near Adolphus Island (images: Raaymakers)*

FIGURE 5.3: *Indicative sand-supply routes from erosion in the surrounding catchments into CG.*

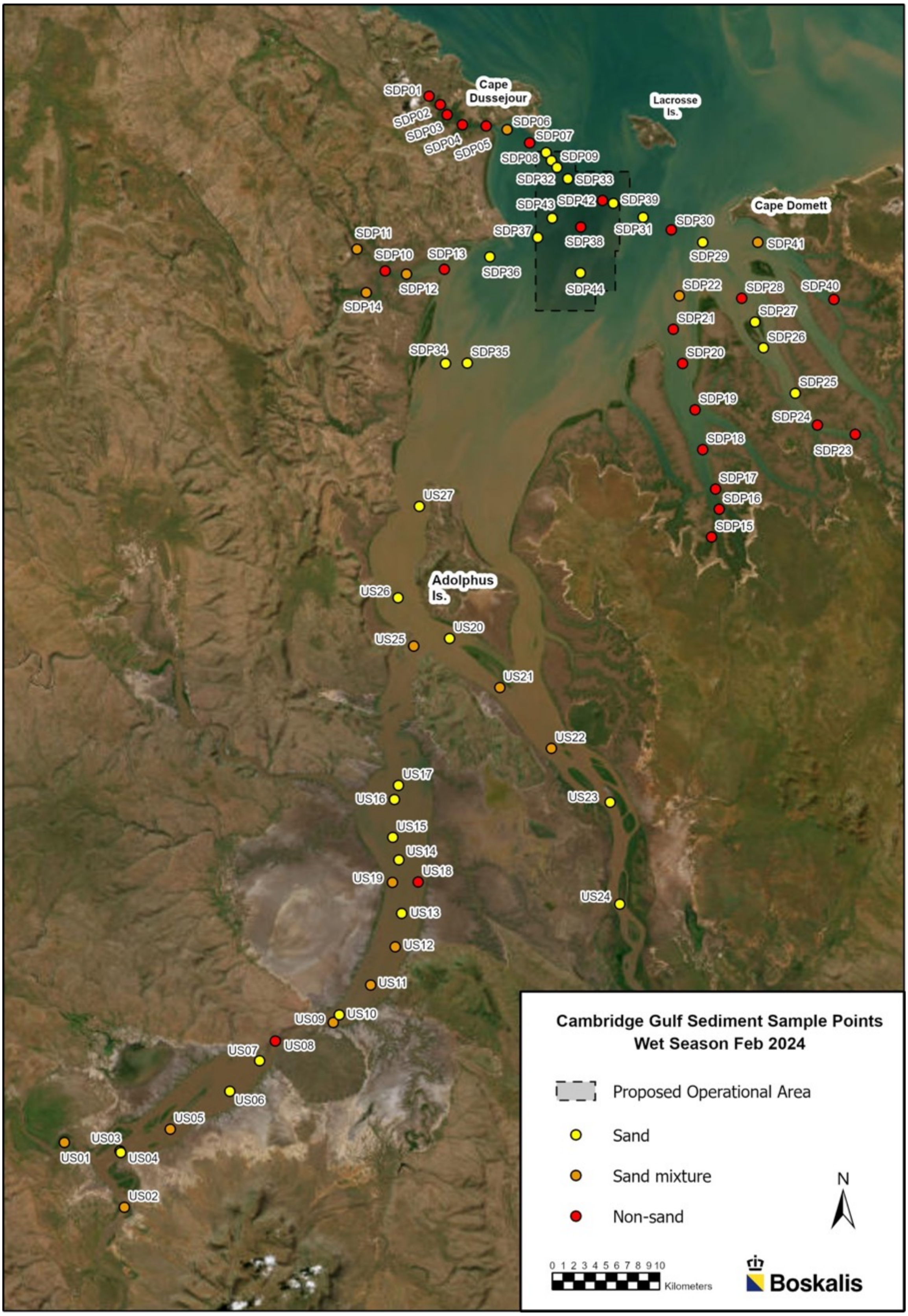


FIGURE 5.4: *Seabed sediment grab samples in CG indicating those that returned sand, showing that the upstream samples were predominantly sand and indicating the upstream catchment sources of the sand in CG.*

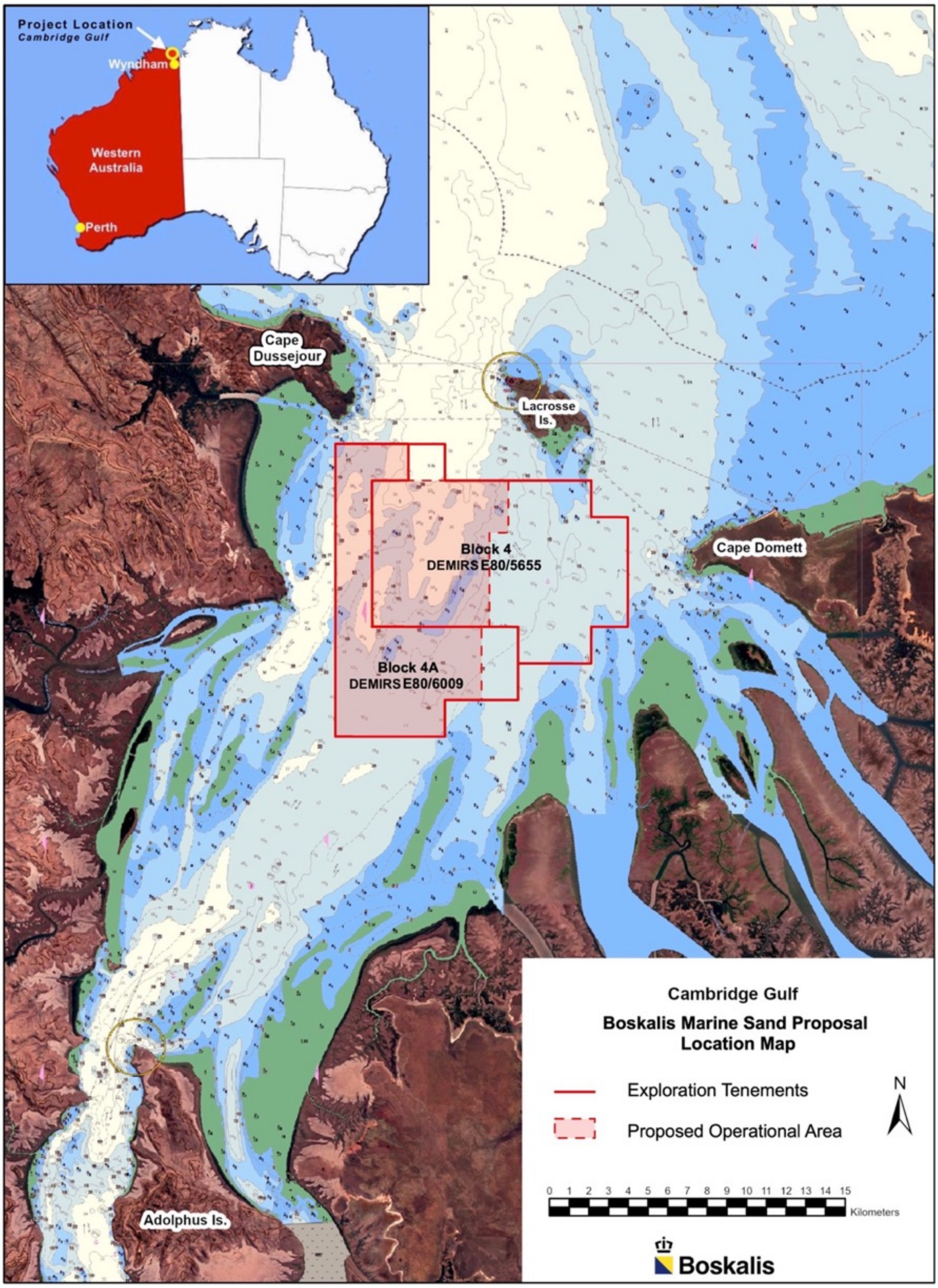


FIGURE 5.5: *BKA's two Exploration Tenements and the Proposed Operational Area for sand-sourcing in CG. Based on a lack of sand in the eastern half of Block 4 this has been excluded from the proposed operational area.*

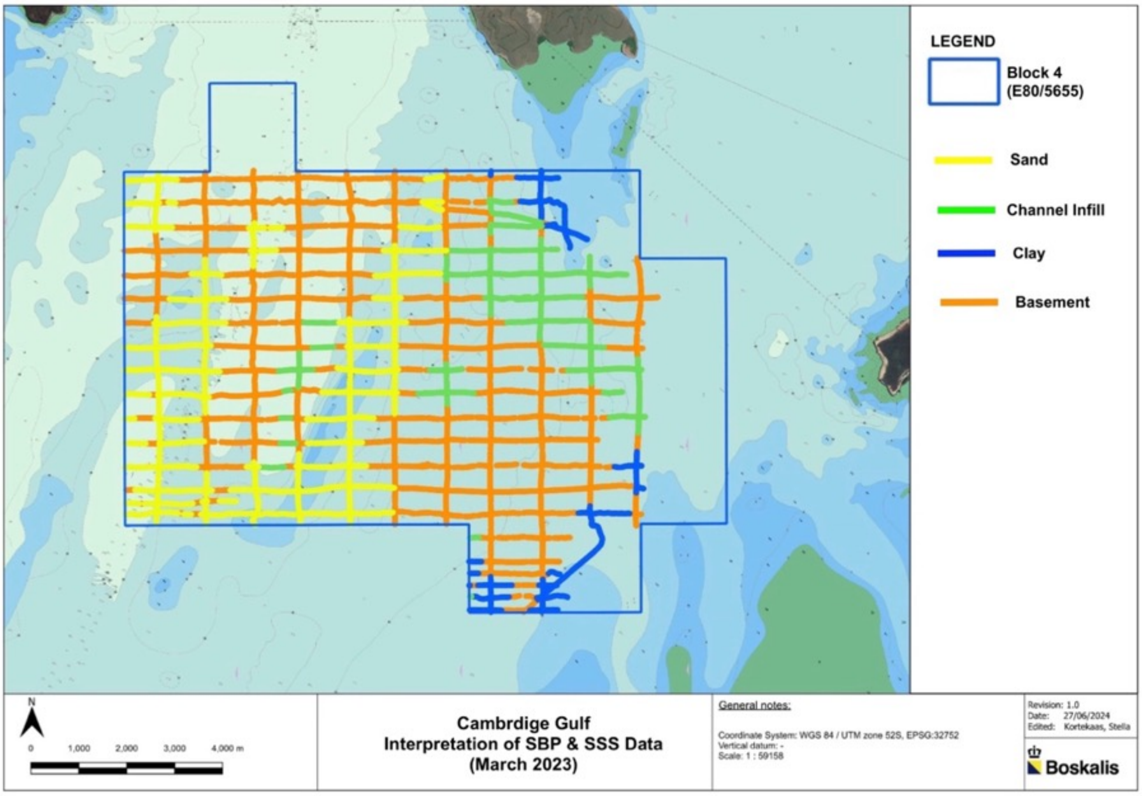


FIGURE 5.6: *Sub-bottom profiler (SBP) and Side-scan Sonar (SSS) transects undertaken in Block 4 (Exploration Tenement E80/5655) as part of the Sand Exploration Survey in Feb-March 2023. Sand areas are marked in yellow in the western part of the block.*

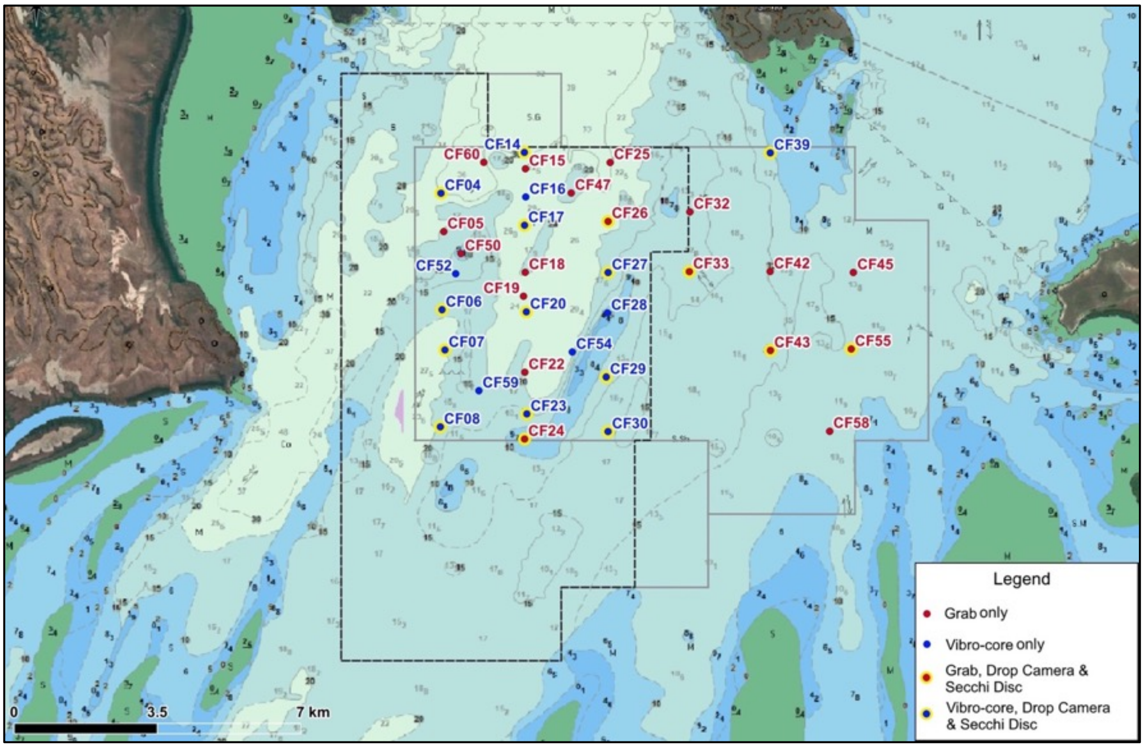


FIGURE 5.7: *Locations of vibro-core and grab sampling in Block 4 (Exploration Tenement E80/5655) during the Sand Exploration Survey in March 2023. Also shows drop camera and Secchi disc sampling sites that were undertaken for initial environmental reconnaissance of the area.*

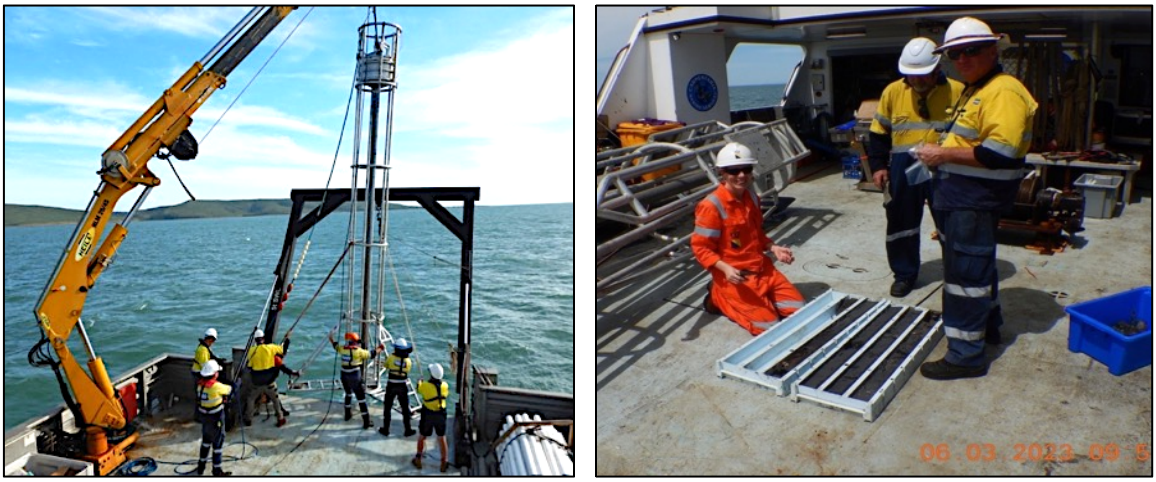


FIGURE 5.8: *Vibro-core sampling in Block 4 during the Sand Exploration Survey in March 2023 (images: Raaymakers).*

FIGURE 5.9: *Examples of the sand found in Block 4 using a Smith-McIntyre Grab during the environmental survey in Jul-Aug 2023. Note the coppery-brown colour is similar to the source rocks in the catchment shown in Figure 5.2 (images: Raaymakers).*

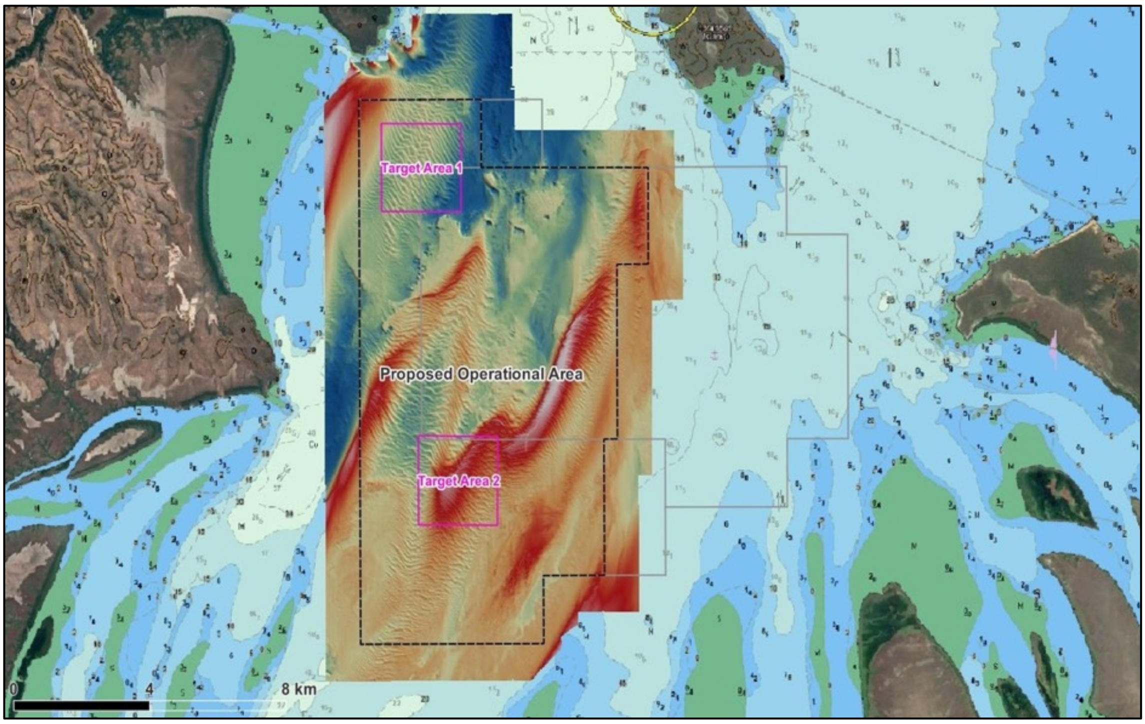


FIGURE 5.10: *High resolution Multi-beam Echo Sounder (MBES) survey of the proposed operational area and 1 km buffer showing the seabed sand-forms in this area. Red indicates higher (shallower) bathymetry and thicker (deeper) bodies of sand.*

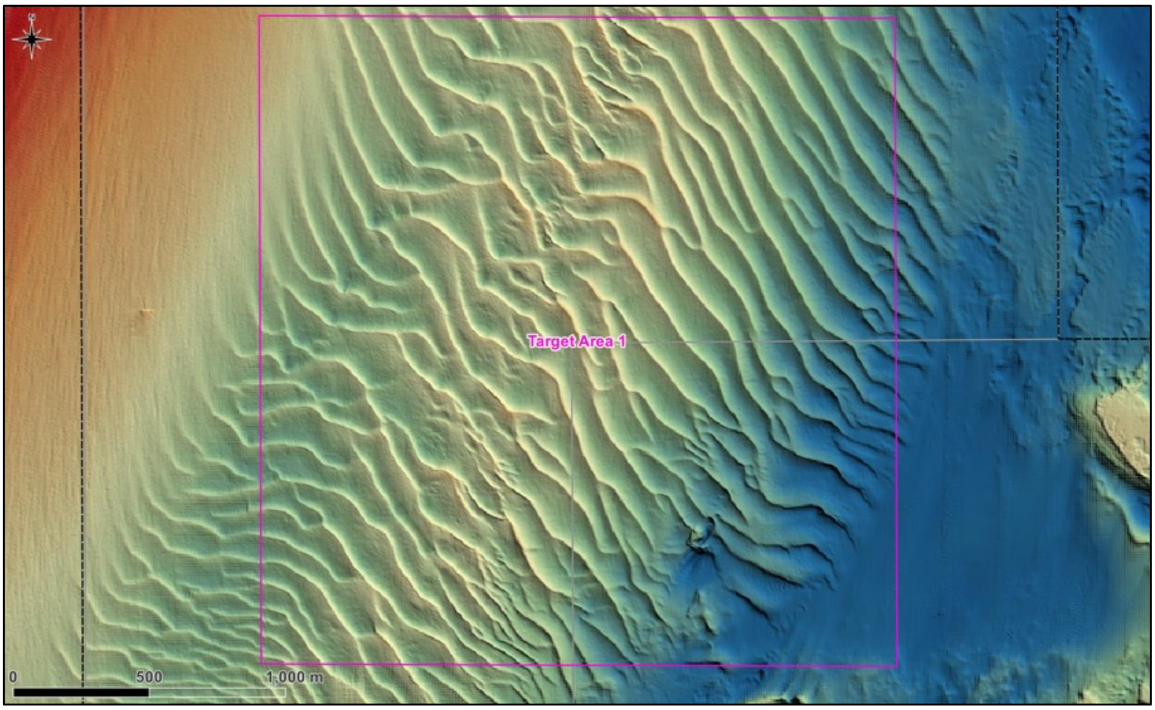


FIGURE 5.11: *Digital elevation model generated from the high-resolution MBES of Target Area 1 in the proposed operational area showing the seabed sand waves. The sand waves have vertical heights ranging from 1 to 8 m and horizontal wavelengths of between 50 and 200 m.*

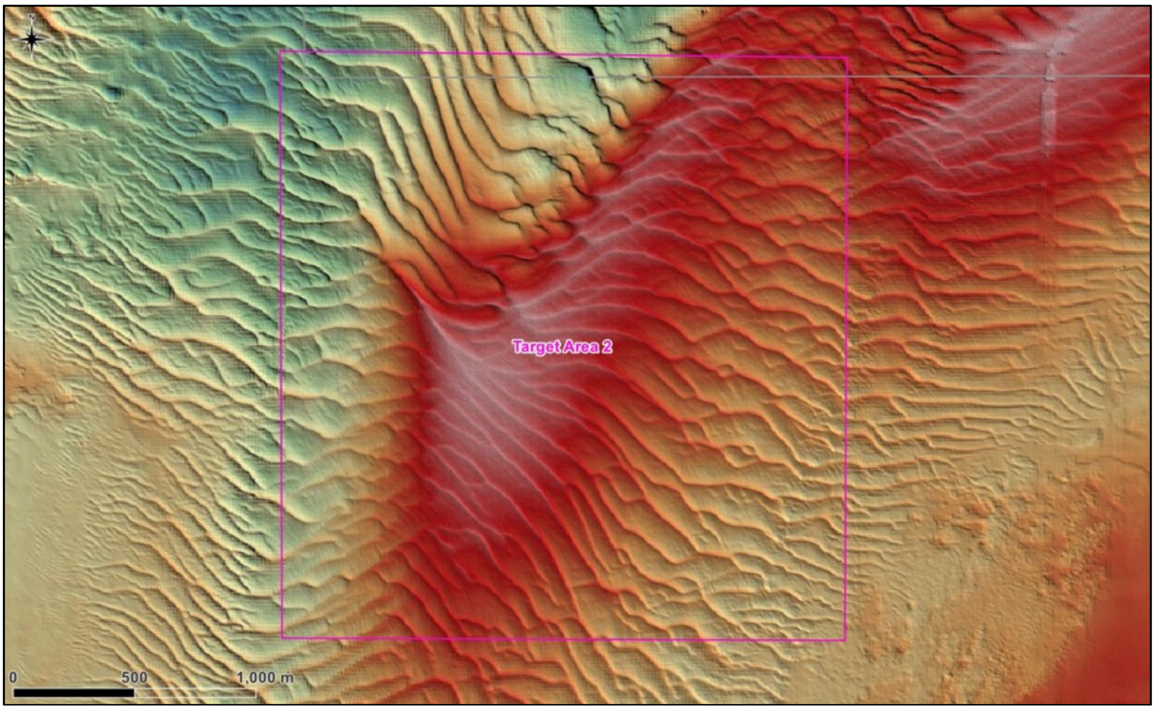


FIGURE 5.12: *As per Figure 5.11 but for Target Area 2. Red indicates higher (shallower) bathymetry.*

6. BENTHIC COMMUNITIES & HABITATS

6.1 Relevant EPA Guidance

1. The EPA has published three guidance documents relating to benthic communities and habitats (BCH) as follows;

   - EPA (2016a), *Environmental Factor Guideline - Benthic Communities & Habitats.*
   - EPA (2016b), *Technical Guidance - Protection of Benthic Communities & Habitats.*
   - EPA (2021c), *Technical Guidance - Environmental Impact Assessment of Marine Dredging Proposals.*

2. The Objective of the Environmental Factor Guideline is:

   - *To protect benthic communities and habitats so that biological diversity and ecological integrity are maintained*. Ecological integrity is defined as the *composition, structure, function and processes of ecosystems, and the natural variation of these elements*.

3. The Environmental Factor Guideline defines benthic communities as:

   - *biological communities that live in or on the seabed* and benthic habitats as the *seabed substrates that benthic communities grow on or in*.

4. The 2016 Technical Guidance highlights the importance of benthic primary producer communities including but not limited to:

   - *coral reefs,*
   - *algal-dominated biogenic reefs,*
   - *algal-dominated rocky reefs,*
   - *seagrass meadows,*
   - *mangrove forests*,
     algal mats; and
   - *salt marshes growing on intertidal sand/mud flats.*

6.2 Eight Benthic Assessment Steps from EPA 2016 Technical Guidance

1. The 2016 Technical Guidance sets out eight steps that should be followed in presenting information about the distribution and spatial extent of BCH in the LAU and for assessing potential impacts. These eight steps are addressed in Table 6.1.

2. The impact assessment steps are addressed in detail in Referral Report No. 4 - *Impact Assessments* (BKA 2024d).

TABLE 6.1: *How the eight steps in EPA 2016 Technical Guidance - Protection of BCH, have been addressed.*

The impact assessment steps are addressed in detail in Referral Report No. 4 - *Impact Assessments* (BKA 2024d).

Step	Assessment
1. What is the LAU?	Refer section 2 and Figure 2.1.
2. What is there now? What is the current area of each benthic community type and associated habitat within the LAU?	Areas have been calculated on GIS as per the MScience Method Statement in Annex 2, and as per the Benthic Habitat Map (Figure 2.1 in section 2): – Coral, seagrass, sponge communities, macro-algae communities etc: Zero km^2 – Mangroves: 350 km^2 – Intertidal salt- & mud-flats: 602.24 km^2 – Rocky shores & rock platforms (some with turf algae on rocks): 5.1 km^2 – Intertidal Cobble & Boulder Substrate: 0.57 km^2 – Intertidal Sand Substrate: 73.03 km^2 – Subtidal Sand Substrate: 356.35 km^2 – Subtidal mixed Clay, Silt, Sand & Gravel Substrate: 1,462.56 km^2 – Subtidal rocky Seabed: 3.51 km^2
3. Do any of the benthic communities have any particular tenure or conservation, ecological or social values that should be considered?	The King Shoals sand bank habitat is within a Sanctuary Zone of the North Kimberley Marine Park (State). Mangroves and salt- and mud-flat habitat on the eastern side of CG (known as the False Mouths of the Ord) are part of the Ord River Floodplain Ramsar wetland, which is protected as the State-designated Ord River Nature Reserve. Neither of these areas will be directly or indirectly affected by the proposal (see Referral Report No. 4 - *Impact Assessments*).
4. What area of each community and habitat was originally present in the LAU? (Ibaseline).	The same as listed against Step 2 as there has been no previous development in CG.
5. What % of the original area of each benthic community and its habitat is present now?	100% as there has been no previous development in CG.
6. How much more will be impacted and lost if this proposal was implemented?	There will be temporary impacts from the removal of an average of <1m depth of sand from within the proposed operational area of up to 75.3 km^2 over up to 15 years, with each two-day sand loading cycle every two-weeks covering approx. 0.5 km^2. As outlined in section 5 horizontal sand migration into and through the area is very rapid under the influence of tidal currents, and seabed morphology will restore rapidly (within weeks to months) under natural sand dynamics. As outlined in section 6.4.4 the sand grab samples from within the proposed operational area returned no biota or only a few small individual organisms (amphipods, isopods small crabs etc) after sieving to 500 microns. This is most likely due to the lack of benthic light and constant movement and reworking of the sand under the influence of strong tidal currents, which inhibits colonization and survival. The sand areas do not host any significant benthic communities. As outlined in section 6.4.4, within the proposed operational area there are gullies between the sand-waves where the seabed sediment comprises mixed gravel, sand and clay, with small hydroids and other small encrusting and motile benthic organisms attached to small rocks. These areas will not be targeted as they do not contain sand. The area of sand is approx. 75 km^2 and these other areas approx. 25 km^2 of the proposed operational area No other benthic areas will be impacted or lost.
7. How much would be lost in total if the proposal proceeds?	As per 6.
8. What will be the consequences for biological diversity and ecological integrity if the proposal proceeds?	There will be no significant or measurable permanent or irreversible changes to biological diversity and ecological integrity of benthic communities in or near CG.

6.3 Methods Used to Describe Benthic Communities & Habitats

6.3.1 Methods overview

1. A wide range of methods were used to assess, describe and map BCH in the LAU. These included:

    a) Initial literature search and review of existing data and previous studies relating to BCH in CG.

    b) Review of existing hydrographic charts and topographic maps of CG.

    c) Review and application of low-water and high-water satellite imagery to assess distribution and extent of key intertidal habitats (true colour images from Sentinel-2 / European Space Agency).

    d) Aerial drone high-resolution video, photography and photogrammetry surveys of key intertidal habitats at low tide.

    e) Sub-bottom Profiler (SBP) surveys within Block 4.

    f) Multi-beam Echo-sounder (MBES) surveys within the proposed operational area.

    g) Benthic drop camera surveys throughout CG and at King Shoals (KS) just seaward of CG, which is a Sanctuary Zone of the State North Kimberley Marine Park, and thus a high priority for assessment.

    h) Benthic biota grab sampling throughout CG and at KS.

    i) Benthic sediment grab sampling throughout CG and at KS.

    j) Review and application of the Global Mangrove Watch mangrove extent mapping tool to inform assessment of the distribution, extent and changes in mangrove cover in CG since1996.

    k) Review and application of the Australian *National Intertidal-Subtidal Benthic (NISB) Habitat Classification Scheme* (Mount et al 2007) and the related Australian *Estuarine, Coastal and Marine (ECM) National Habitat Map Series* (Mount & Bricher 2008).

    l) Review and application of processed Landsat satellite imagery of CG from Digital Earth Australia (DEA), a program of Geoscience Australia, including for:

        – Mangrove canopy cover.
        – High and low tide and intertidal extents.
        – Maximum extent of geomorphic sand bank units.

2. Methods k) and j) were undertaken by MScience Marine Research for BKA – see their methods statement in Annex 2.

3. Relevant outputs from the above methods were used to develop a BCH map and supporting maps for the LAU. The BCH map is shown as Figure 2.1 in section 2 and is repeated as Figure 6.34 in section 6.4.1 below for ease of reference when reading that section. The supporting maps are listed below. These maps were developed by MScience Marine Research for BKA – see their methods statement in Annex 2. The supporting BCU maps are:

    a) Examples of the following community and habitat types around CG:
        – Mangroves.
        – Damaged mangroves.
        – Intertidal mud- and salt-flats.
        – Intertidal rock platform
        – Intertidal cobble and boulder.
        – Intertidal sand.

    b) Jurisdictions and tenure map (Figure 3 above).

4. Further details on each of these methods are presented in sections 6.3.2 to 6.3.13 below.

6.3.2 Literature search & review

1. In accordance with standard procedure for commencing any environmental study, the first step was to undertake a search for existing reports, papers, studies and data of the area, using Google, Google Scholar and academic search engines, searching the research directories and web sites of relevant institutions such the Australian Institute of Marine Science (AIMS), the Commonwealth Scientific and Industrial Research Organization (CSIRO) and the Western Australian Marine

Science Institute (WAMSI), and searching government directories such as the National Marine Biodiversity Hub, the Atlas of Living Australia, the National Conservation Values Atlas, the Digital Atlas of Australia and DEA.

2. While very useful reports, papers and datasets were obtained relating to geology, sediments, hydrodynamics and coastal processes, and some on water quality, as cited in section 7 on coastal processes and section 8 on marine environmental quality, almost none were found relating to BCH. This reflects the lack of previous studies on BCH in CG.

3. A number of useful references on mangroves in CG were identified, obtained and reviewed, as cited in section 6.3.12 and 6.4.5. The main ones are:

   - Bunting, P., et. al., (2022). Global Mangrove Extent Change 1996–2020: *Global Mangrove Watch Version 3.0. Remote Sensing 2022*, 14, 3657. https://doi.org/10.3390/rs14153657
   - Cresswell, I.D. & Semeniuk, V., (2011). Mangroves of the Kimberley Coast: ecological patterns in a tropical ria coast setting. Journal of the Royal Society of Western Australia 94.
   - Gehrke, P., (2009). Ecological Patterns and Processes in the Lower Ord River and Estuary. CSIRO Water for a Healthy Country Flagship Report Series, Technical Report.
   - Hale, J., (2008). Ecological Character Description of the Ord River Floodplain Ramsar Site, Report to the Department of Environment and Conservation, Perth, Western Australia.
   - Semeniuk, V., (2000). Impacts of hydrological alteration of the Ord River on mangroves in Cambridge Gulf, Lower Ord River region. *In Ord River Scientific Panel Report to the Water and Rivers Commission. Recommendations for estimation of interim ecological water requirements for the Ord River*. Waters and Rivers Commission, Perth.
   - Thom, B.J., et. Al., (1975). Mangrove ecology and deltaic-estuarine geomorphology: Cambridge Gulf-Ord River, Western Australia. Journal of Ecology 63(1).

4. Several reports, papers and datasets relating to Joseph Bonaparte Gulf and the broader region of Northern WA were also identified, obtained and reviewed, although not directly relevant to the area within CG. These include, *inter alia:*

   - Commonwealth of Australia, (2012). Marine bioregional plan for the North-west Marine Region.
   - Galaiduk, R., et al., (2018). An eco-narrative of Joseph Bonaparte Gulf Marine Park: North-west marine region. Report to the National Environmental Science Program, Marine Biodiversity Hub.
   - McMahon, K., et al., (2017). Seagrasses of the north west of Western Australia: biogeography and considerations for dredging-related research. Report of Theme 5 - Project 5.1.2 prepared for the Dredging Science Node, Western Australian Marine Science Institution, Perth, Western Australia.
   - Przeslawski, R., et al., (2011). Seabed Habitats and Hazards of the Joseph Bonaparte Gulf and Timor Sea, Northern Australia. Geoscience Australia.

5. Relevant references are cited in the sections below and the full reference citations are provided in the References section.

6. The lack of pre-existing reports, papers and data on BCH in CG highlights the fact that the studies undertaken by BKA, as presented in this report, provide data that had never been collected in CG previously. In addition to informing the KEF descriptions in this report, they also inform general scientific knowledge, and will help to improve environmental management in the area. All data collected by BKA can be made freely-available to relevant parties, in addition to submitting via IMSA.

6.3.3 Review of marine (hydrographic) charts

1. Marine charts (also called hydrographic, nautical, navigation and admiralty charts) that are designed to support voyage planning and safety of navigation, which comply with the standards of the International Hydrographic Organization (IHO), are a useful resource for identifying the general presence of some of the main BCH in an area. They include internationally-standardized symbols and letters to depict intertidal and subtidal substrate (habitat) types, and certain benthic community types, including mangroves and coral reefs, as shown on Figure 6.1.

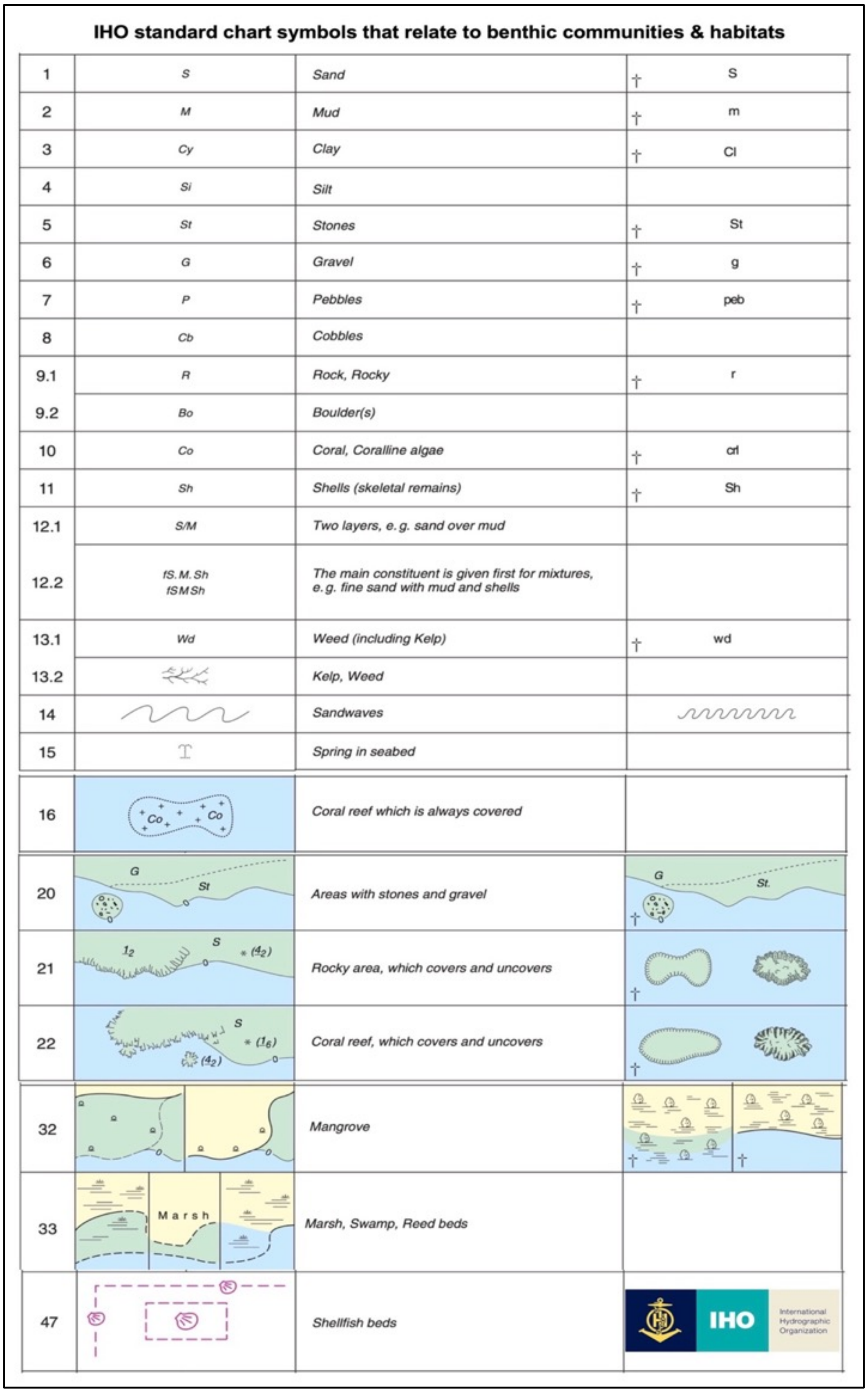
2. Review of the relevant official marine chart for the area is therefore a useful first step when identifying what BCH might be present in the area, and can be used as a tool to inform the targeting of more detailed site surveys. The reliability of the depiction of such features on marine charts depends on the availability of relevant data from others sources, as the charting authority usually only collects hydrographic data to allow the charting of bathymetry.

3. The charting authority for the CG area is the Australian Hydrographic Office (AHO). The official charts for the area are:

- AUS 32 - Cambridge Gulf (Figure 6.2).
- AUS 726 - Approaches to Cambridge Gulf.
- AUS 318 – Pelican Island to Penguin Shoal (includes inset of CG).

4. With the global shift from paper to electronic charts, AUS 32 and 726 have been discontinued in paper version, however chart data for the same areas are available digitally, and was obtained by BKA for this proposal.

5. The marine chart for CG was used to inform the targeting of more detailed site surveys and as a base-map and starting point for the BCH map developed by MScience for BKA (Figure 6.34).



IHO standard chart symbols that relate to benthic communities & habitats

1	S	Sand	† S
2	M	Mud	† m
3	Cy	Clay	† Cl
4	Si	Silt	
5	St	Stones	† St
6	G	Gravel	† g
7	P	Pebbles	† peb
8	Cb	Cobbles	
9.1	R	Rock, Rocky	† r
9.2	Bo	Boulder(s)	
10	Co	Coral, Coralline algae	† crl
11	Sh	Shells (skeletal remains)	† Sh
12.1	S/M	Two layers, e.g. sand over mud	
12.2	fS.M.Sh fSMSh	The main constituent is given first for mixtures, e.g. fine sand with mud and shells	
13.1	Wd	Weed (including Kelp)	† wd
13.2		Kelp, Weed	
14		Sandwaves	
15		Spring in seabed	
16	Co Co	Coral reef which is always covered	
20	G St	Areas with stones and gravel	G St. †
21	1_2 S (4_2)	Rocky area, which covers and uncovers	†
22	S (1_6) (4_2)	Coral reef, which covers and uncovers	†
32		Mangrove	† †
33	Marsh	Marsh, Swamp, Reed beds	
47		Shellfish beds	IHO International Hydrographic Organization

FIGURE 6.1: *International Hydrographic Organization (IHO) standard chart symbols that relate to BCH.*

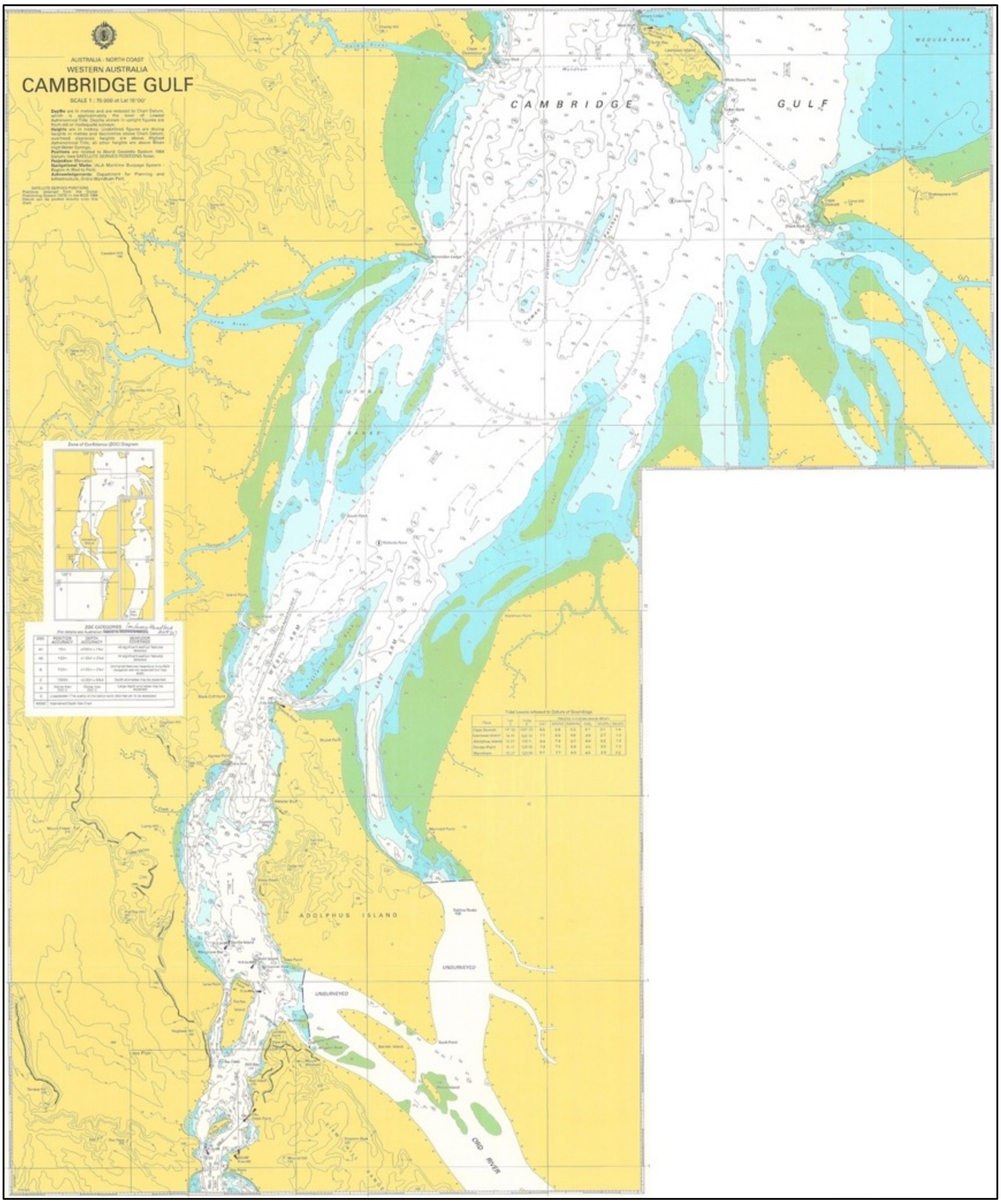


FIGURE 6.2: *Chart AUS 32 - Cambridge Gulf (source: AHO Tiff).*

6.3.4 Review of land (topographic) maps

1. While topographic maps are designed for land-based purposes, in coastal areas they map the coastline and islands and show mangroves, wetlands, saline flats, foreshore flats, intertidal flats and reefs, rocks and shoals (Figures 6.3 & 6.4). As with marine charts, reviewing the topographic maps for the area is a useful first step when identifying what BCH might be present in the area, and to inform the targeting of more detailed site surveys.

2. There are four official digital topographic maps that cover the CG area, produced by Geoscience Australia under the Australian Digital Topographic Map Series (AUSTopo), at two scales as follows:

    a) 1:250,000 scale (1 cm = 2.5km): D5210 - *Medusa Banks* and D5214 - *Cambridge Gulf.*
    b) 1:100,000 scale (1 cm = 1 km): D4568 - *Medusa* and D4567 - *Wyndham*.

3. The maps are available as GeoPDFs and GIS layers, and were used to inform the BCH mapping in CG.

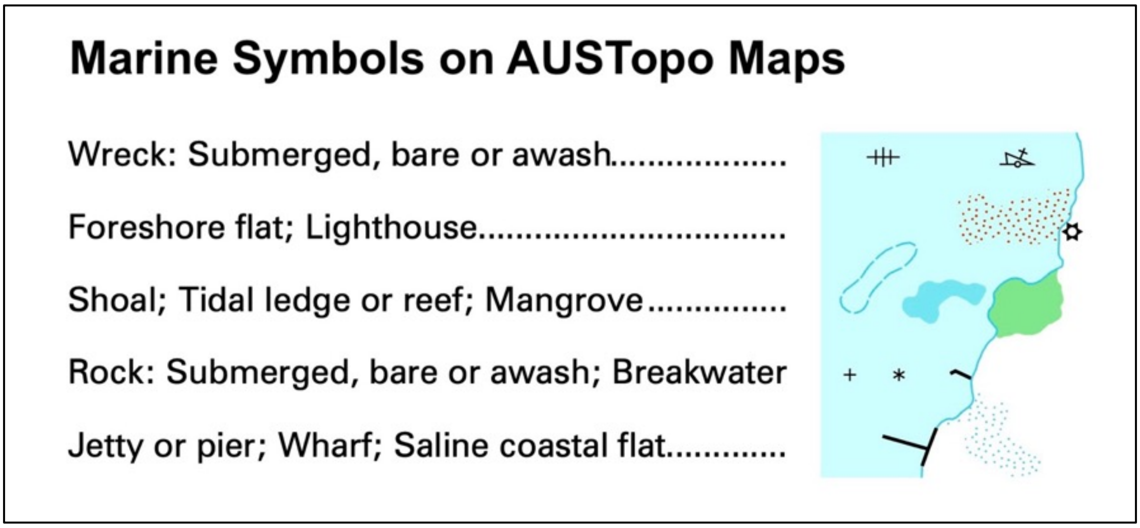


FIGURE 6.3: *Marine symbols used on AUSTopo maps (source: Geoscience Australia).*

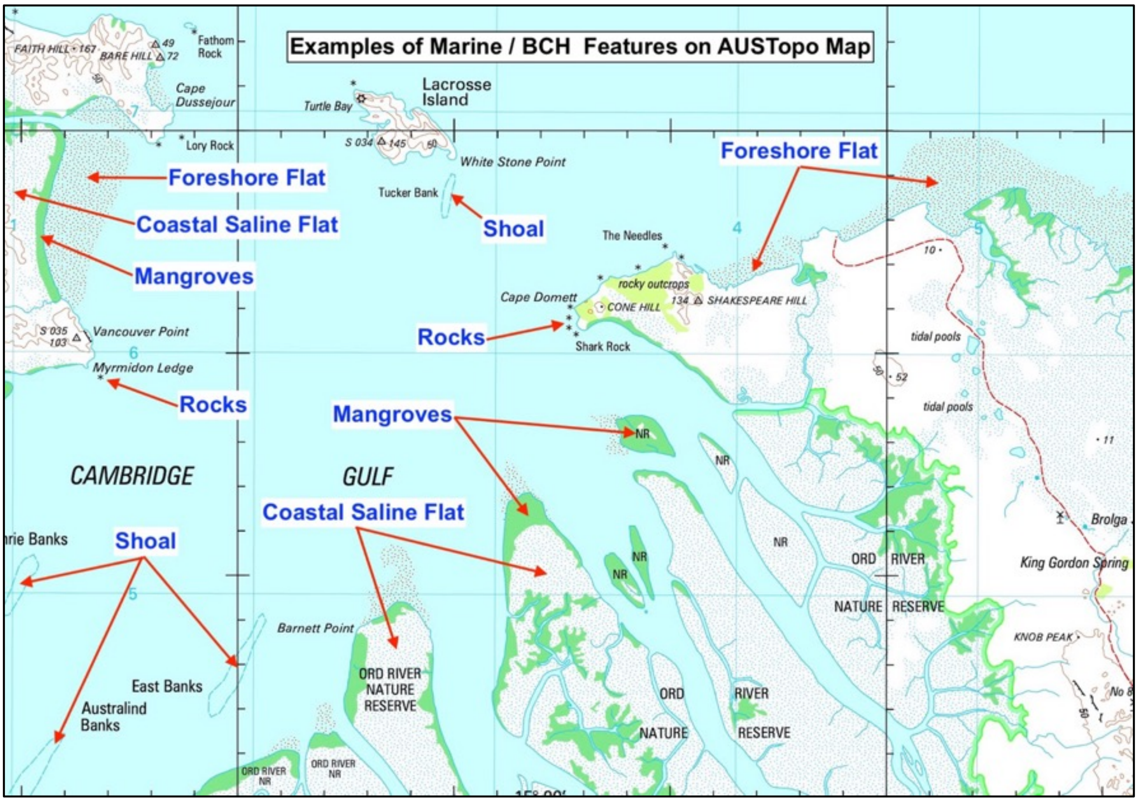


FIGURE 6.4: *Examples of marine / BCH features on an extract of AUSTopo map D5210, based on the symbols shown in Figure 6.3. While topographic maps are designed for land-based use – they also provide useful information to support BCH mapping – especially for intertidal BCH (source: Geoscience Australia).*

6.3.5 Low- and high-tide satellite imagery

1. In order to assist in determining the locations and extent of intertidal benthic habitats in CG, true colour Sentinel-2 satellite images were sourced for high- and low-tides (Figure 6.5). Comparisons were made between the images to reveal the seaward extent of inter-tidal habitats. It should be noted that suitable images could not be found on dates with peak spring tides due to cloud cover – so the differences in intertidal habitat extent on the images in Figure 6.5 are not the maximum that can occur, noting that CG has a peak spring tidal range of ~8 m. The tidal difference between these images is 6.13 m. These images were used to determine target areas for the aerial drone surveys described in section 6.3.6, and to inform development of the BCH map (Figure 6.34 in section 6.4.1). They are also useful in relation to assessing coastal processes.

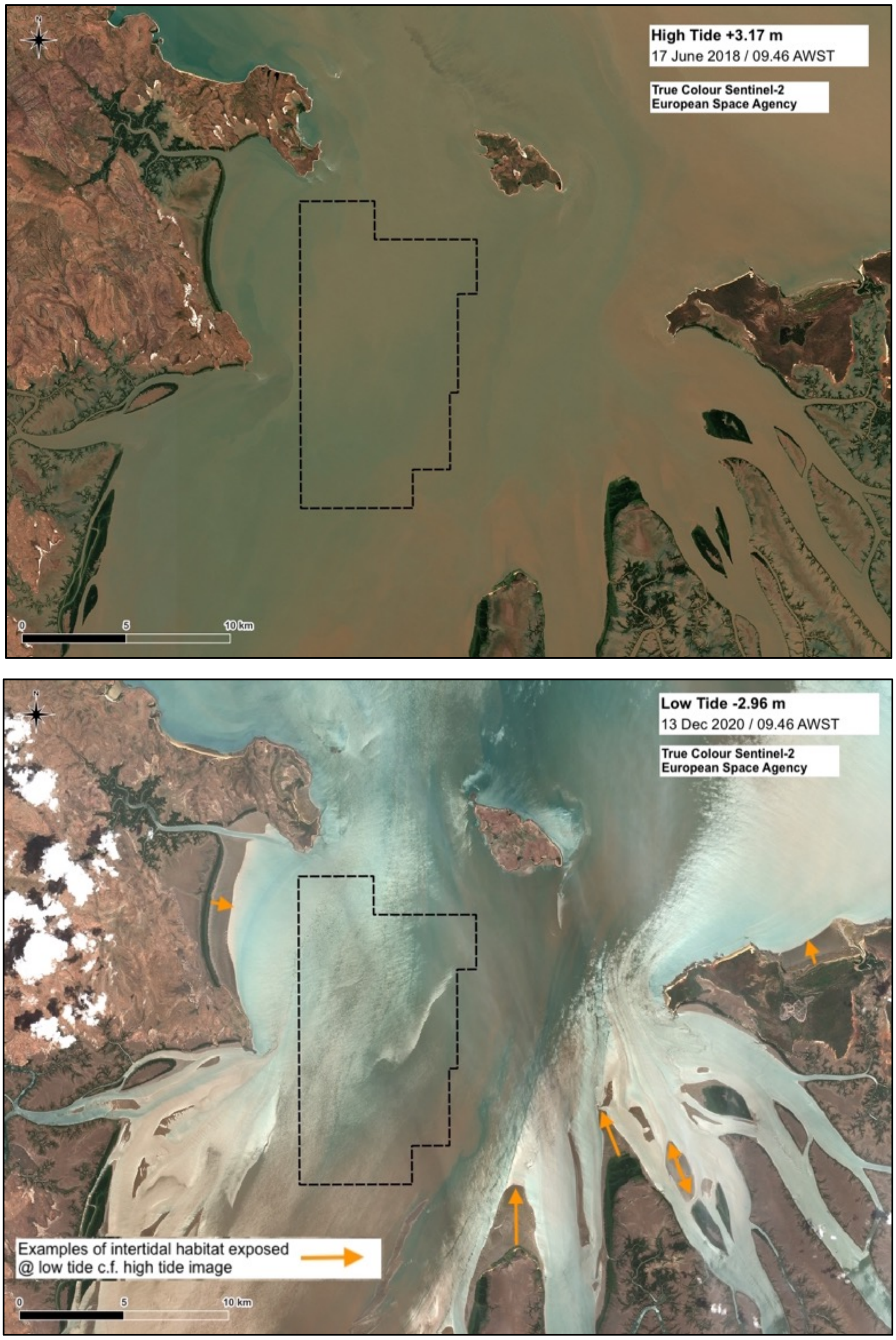


FIGURE 6.5: *High- and low-tide satellite images used to support assessment of intertidal BCH.*

6.3.6 Aerial drone surveys

1. Because of the extreme safety risk of crocodile attack in CG, ground-based intertidal BCH surveys were not preferred and aerial drone surveys were used, not only because they are safer, but also because they can cover larger areas more quickly.

2. During both the dry-season environmental survey in July 2023 and the wet-season environmental survey in February 2024, aerial drones were used to record high resolution video and photographic imagery of the key intertidal habitats in CG at low tide. Two main intertidal habitats were surveyed; intertidal rock substrate and intertidal sandflat / mudflat substrate. Both broadscale oblique imagery and fine scale vertical imagery were taken at each area – with the latter images overlapping to allow stitching to create orthomosaics. Several types of drones were used, with the main one being a DJI Mavic 3 CINE with a Hasselblad video camera (5.1K @ 50fps) and a Hasselblad 4/3 CMOS stills camera, effective pixels 20 MP.

3. There are only a few areas in the main body of CG that have stable intertidal rock substrate, these being rocky points and intertidal rock platforms at the following sites (Figure 6.7):

   a) Cape Domett on the east,
   b) Cape Dussejour on the west,
   c) Parts of the coast and especially the northern side of Lacrosse Island,
   d) Bream Ledge at the northwest tip of Lacrosse Island,
   e) Vancouver Point / Myrmidon Ledge on the western side of CG,
   f) Ina Island on the western side of CG south of the Thompson River; and
   g) Nicholl's Point on the northern tip of Adolphus Island.

4. There are also inter-tidal rock platforms that run along part of the seaward edge of the 3 km long beach to the west of Cape Dussejour (Turtle Beach West) (Figure 6.9), and along part of the seaward edge of the 1.9 km long beach to the east of Cape Domett (Cape Domett Seaward Beach).

5. Because stable rock substrate is the habitat type that is most suitable for sessile benthos such as corals, sponges, oysters, other bivalves, macroalgae and other algae, and because these are considered to be high-priority benthic primary producers (EPA 2016b), these areas were systematically videoed and photographed by drone at low ride. High resolution orthomosaic images were also created for most of these sites. These sites were also inspected by vessel at low-tide and overlapping planar view high resolution photographs taken of each area.

6. As outlined in sections 6.4.3 and 6.4.7 below, detailed analysis of the drone imagery did not identify any significant benthic biota at any of these sites, with a band of barnacles being present at the high-tide line of some of the rock platforms, and patches of turf algae and red-algae also being present on some of the rock platforms.

7. There are expansive areas of intertidal sandflats and mudflats along the coast and adjacent to the coast in CG, which are the substrate type most likely to support seagrass in CG. These areas were therefore also targeted by the drone surveys, especially in the summer wet-season (February 2024), when the vegetative stage of seagrass is most likely to be visible. The areas of intertidal flats surveyed were at the following sites, listed anti-clockwise from the northwest (Figure 6.5):

   a) Hummock Bay and Turtle Beach West on the coast outside of CG, to the west of Cape Dussejour,
   b) Cape Dussejour,
   c) Western Sandflat immediately south of Cape Dussejour,
   d) Ina Island near the mouth of the Thompson River on the western side of CG,
   e) the coast southwest of Nicholls Point on Adolphus Island,
   f) East Bank to the west of Barnett Point,
   g) Barnett Point,
   h) Cape Domett; and
   i) south Coast of Lacrosse Island.

8. Ground-based (walking) surveys were also undertaken at low-tide at Eastern Sandflats off the False Mouths of the Ord River as a ground-truthing check (with crocodile watch and extraction vessel immediately alongside the sand bank) (Figure 6.7).

9. As outlined in sections 6.4.3 and 6.4.9 below, detailed analysis of the drone imagery and the observations during the ground surveys did not identify any evidence of seagrass or other significant benthic communities anywhere in CG.

10. Figure 6.8 shows recovery of the drone after completion of a survey. Figures 6.9 and 6.10 show three examples of drone imagery of the intertidal rock substrates that were surveyed. Figures 6.11 to 6.13 show some examples of drone imagery of the intertidal sandflats / mudflats that were surveyed. Figures 6.14 and 6.15 show two examples of the orthomosaics. These figures are to illustrate methods - results are presented in section 6.4.

11. Annex 10 contains a technical report from Sensorem on their aerial drone surveys for BKA, which in addition to inter-tidal habitat surveys also included LiDAR to assist assessment of coastal processes (see section 7). All of the raw drone video and photographic imagery can be provided directly to relevant regulatory agencies if required, as well as submitted to IMSA.

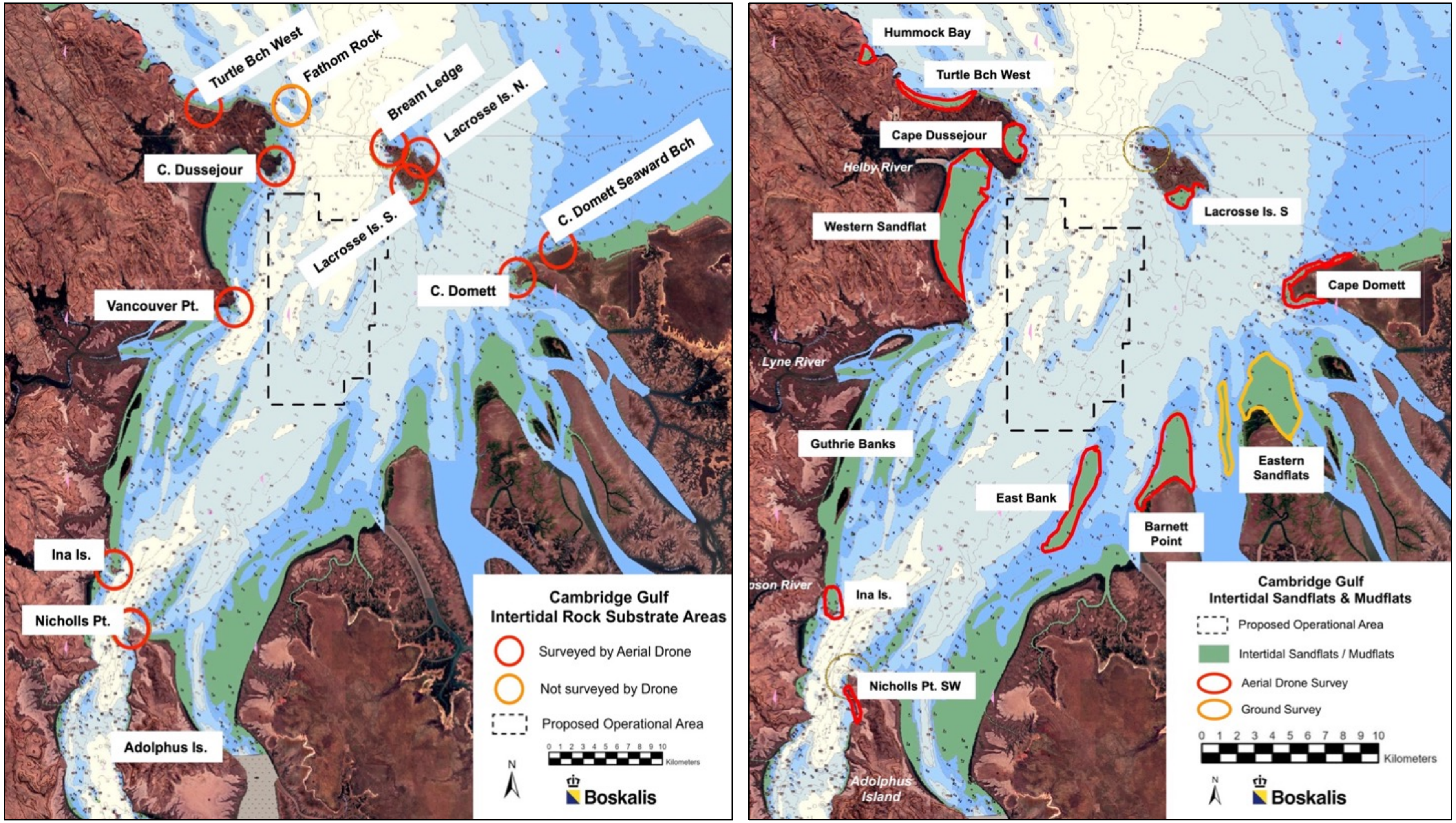


FIGURE 6.7: Aerial Drone Surveys.

LEFT: ***Intertidal rock substrate*** *areas targeted to assess for corals, sponges, oysters / other bivalves, macroalgae and other algae and any other benthic biota.*

RIGHT: ***Intertidal sandflat / mudflat*** *areas targeted to assess for seagrass and any other intertidal benthic biota.*

FIGURE 6.8: *Recovering the drone on the bow of the survey vessel after completion of a survey. BKA's proposed operational area is within the waters of CG stretching from the vessel towards the west coast of CG in the background.*

FIGURE 6.9: *An example of oblique aerial drone imagery of one of the intertidal rock substrate areas that were surveyed. Any indications of benthos were investigated in detail by the drone. Fine-scale vertical images were also taken. This is the rock platform that runs parallel to Turtle Beach West as marked on Figure 6.7 – Left.*

FIGURE 6.10: *An example of oblique aerial drone imagery of one of the intertidal rock substrate areas that were surveyed. Any indications of benthos were investigated in detail by the drone. Fine-scale vertical images were also taken (see Figure 41 below). This site is Vancouver Point / Myrmidon Ledge as marked on Figure 6.7 – Left. Lacrosse Island can be seen on the horizon, centre.*

FIGURE 6.11: *An example of oblique aerial drone imagery of one of the intertidal sandflats that were surveyed. Any indications of seagrass or other benthos such as colouration, were investigated in detail by the drone (the dark material in the lower left is organic matter from decaying mangrove leaves etc). Fine-scale vertical images were also taken. This site is the sandflats in the small bay immediately north of Cape Dussejour, as marked on Figure 6.7 – Right.*

FIGURE 6.12: *An example of oblique aerial drone imagery of intertidal mudflats. Any indications of seagrass or other benthos such as colouration, were investigated in detail by the drone. Fine-scale vertical images were also taken. This site is 'Nicholls Point SW' as marked on Figure 6.7 – Right.*

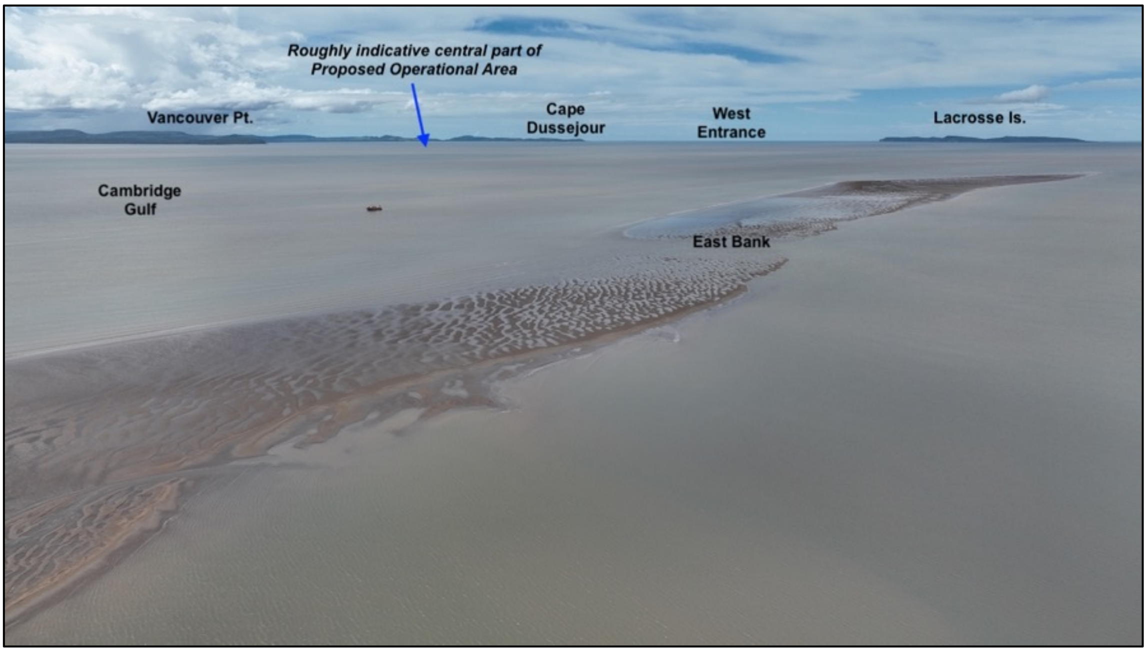


FIGURE 6.13: *An example of oblique aerial drone imagery of intertidal sandflats. Any indications of seagrass or other benthos such as colouration, were investigated in detail by the drone. Fine-scale vertical images were also taken. This site is 'East Bank' as marked on Figure 6.7 – Right. Lacrosse Island can be seen at top right and Cape Dussejour at top centre-left.*

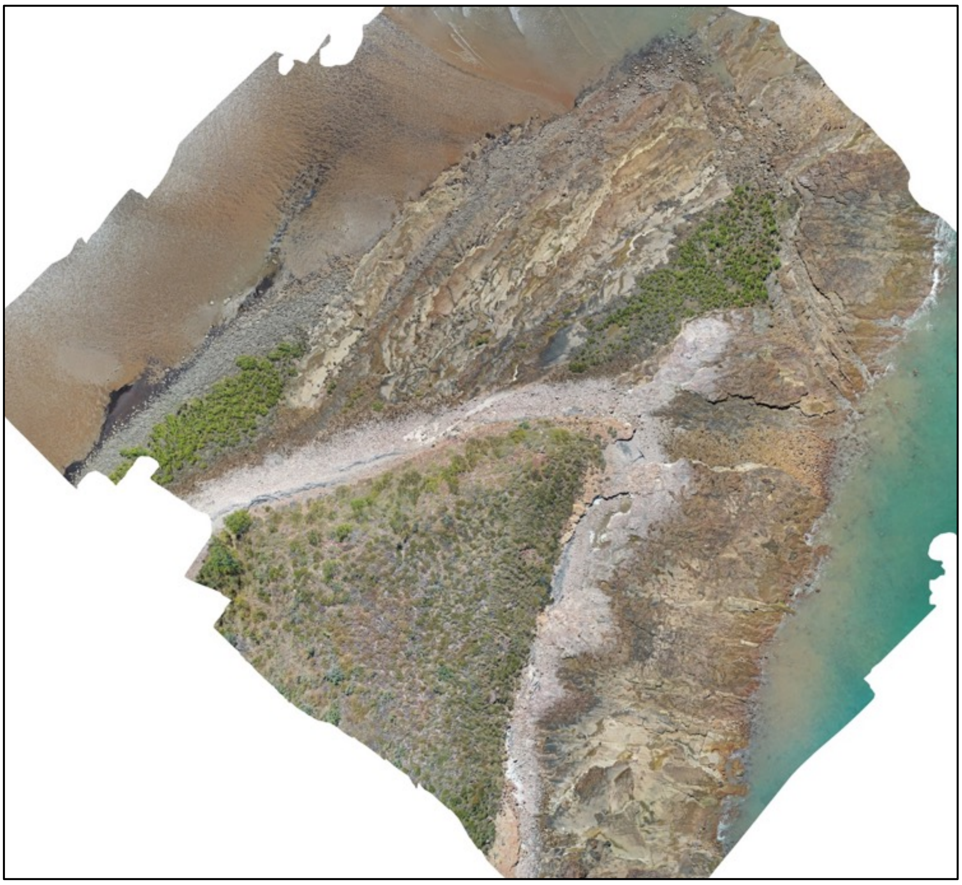


FIGURE 6.14: *An example of an orthomosaic of an intertidal rocky substrate site, created from the fine-scale vertical imagery. The original images are extremely high-resolution allowing zooming-in to assess details in the cm range. This site is Cape Dussejour as marked on Figure 6.7.*

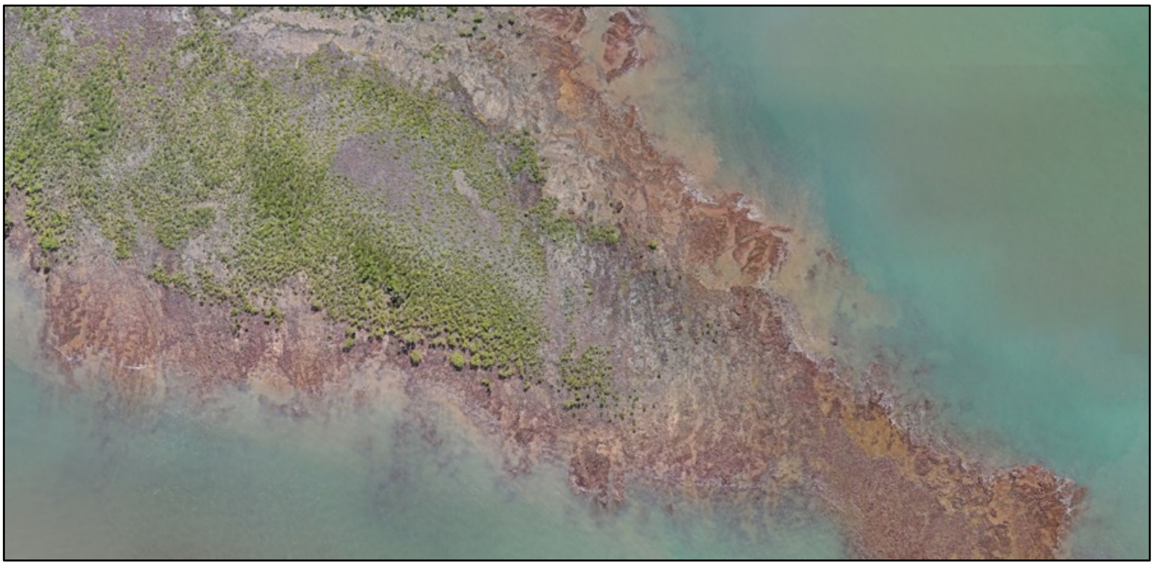


FIGURE 6.15: *An example of an orthomosaic of an intertidal rocky substrate site, created from the fine-scale vertical imagery. The original images are extremely high-resolution allowing zooming-in to assess details in the cm range. This site is Vancouver Point / Myrmidon Ledge as marked on Figure 6.7 – Left.*

6.3.7 SBP surveys

1. As outlined in section 5 and shown on Figure 5.6, BKA undertook Sub-bottom Profiler (SBP) surveys in Block 4 during the sand exploration survey in February-March 2023. While the primary purpose was to inform the sand resource assessment, because sand is a benthic substrate, the SBP results also informed development of the BCH map.

6.3.8 MBES surveys

1. As outlined in section 5 and shown on Figures 5.10 to 5.12 in that section, BKA undertook Multi-beam Echo-sounder (MBES) surveys in the proposed operational area and a 1 km buffer around the area, during the wet season environmental survey in February-March 2024. The high resolution MBES outputs, including development of a Digital Terrain Model (DTM), provide a very detailed picture of the composition, morphology and dynamics of the benthic habitat across the entire proposed operational area.

2. The repeat MBES surveys in the two target areas as described in section 5 and shown on Figures 5.10 to 5.12, inform the assessment of seabed sand dynamics within the proposed operational area, which in turn informs the assessment of coastal processes (refer section 7 below).

3. The MBES outputs also inform BKA's underwater Aboriginal cultural heritage survey as outlined in Referral Report No. 3 - *Traditional Owner Matters* (BKA 2024c).

6.3.9 Benthic drop-camera surveys

1. Standard methods for assessing and mapping BCH include using SCUBA diving to run video transects on the seabed and other dive-based methods. Environmental conditions and safety risks make diving non-workable in CG, including strong tidal currents, extremely high turbidity and low visibility (near blackout at the seabed), and the threat of crocodile and shark attack. As an alternative to SCUBA-based BCH survey, a drop-camera was used in an attempt to provide imagery of BCH.

2. During the sand exploration survey in March 2023, the opportunity was taken to carry out some general environmental reconnaissance, including deploying a drop camera with video running, to the seabed at 17 sites in Block 4, as shown on Figure 6.16 (sites CF04, 06, 07, 08, 14, 17, 20, 23, 24, 26, 27, 29, 30, 39, 33, 43 and 55). The average depth to the seabed at the time of sampling was around 25 m (noting that CG has a peak spring tidal range of ~ 8 m).

3. The results were the same for every drop – the video showed reasonably clear water for less than the first two meters down the water column, rapidly darkening to greenish then brownish and then dark brown to, at many sites, almost black for a few meters above the seabed. The videos did not return any imagery of the benthic environment at any of the sampling sites, due to the complete lack of benthic light. It appears that there is a permanent aphotic zone at and above the seabed in Block 4, caused by the permanent suspension of sediment by the strong tidal currents.

4. Screenshots of the video imagery from the surface to the seabed from three of the sampling sites (CF17, 20 and 23) are shown in Figure 6.17. Similar screenshots of the video imagery for all 17 sites are presented in Annex 3. The raw videos for all sites are archived and can be made available to regulatory agencies if required.

5. During the dry-season environmental survey in July-August 2023, the drop-camera sampling was extended beyond Block 4 to cover a much larger area. This included 90 sites throughout CG and 27 sites at King Shoals (KS) outside of CG (a Sanctuary Zone of the State North Kimberly Marine Park) (Figure 6.18). The results were identical to the March 2023 survey; 100% of the 117 sites showed a blacked-out aphotic zone at the seabed, except for a single site at KS (KS06), which was only 6 m deep (most sites were between 15 and 25 m deep). A glimpse of the seabed was possible – indicating that it comprised shell grit / gravel (Figure 6.19). Apart from being shallow, site KS06 was also the furthest to seaward of all sites – being ~12 km seaward of the entrance to CG, with less turbid (but still turbid) water.

6. Because the results from the Jul-Aug 2023 survey were the same as for the March 2023 survey, as shown in Figure 6.17 and Annex 3, similar screen-shots from the videos taken in Jul-Aug 2023 are not included in this report, for reasons of economy. The raw videos for all sites are archived and can be made available to regulatory agencies if required.

7. When the first several drop camera videos showed blacked-out conditions near the seabed, consideration was given to the possibility that the camera was not functioning properly, although the videos clearly showed a rapid decrease in water clarity as the camera was lowered, and an increase in water clarity as it was retrieved back to the surface, with normal footage above water. Never-the-less, to check, two alternate cameras were trialed, and both returned exactly the same results. A drop camera was also deployed to the seabed at several sites at a control location ~50 km offshore where water clarity is higher than in CG, and all returned clear imagery at the seabed.

8. Given that benthic biota requires light to survive, the aphotic seabed conditions throughout CG as recorded by the 134 camera drops undertaken in March 2023 and July-August 2023, indicate that there is unlikely to be any significant benthic communities in CG, or even at KS. This was confirmed by the grab sampling as described in section 6.3.10 below.

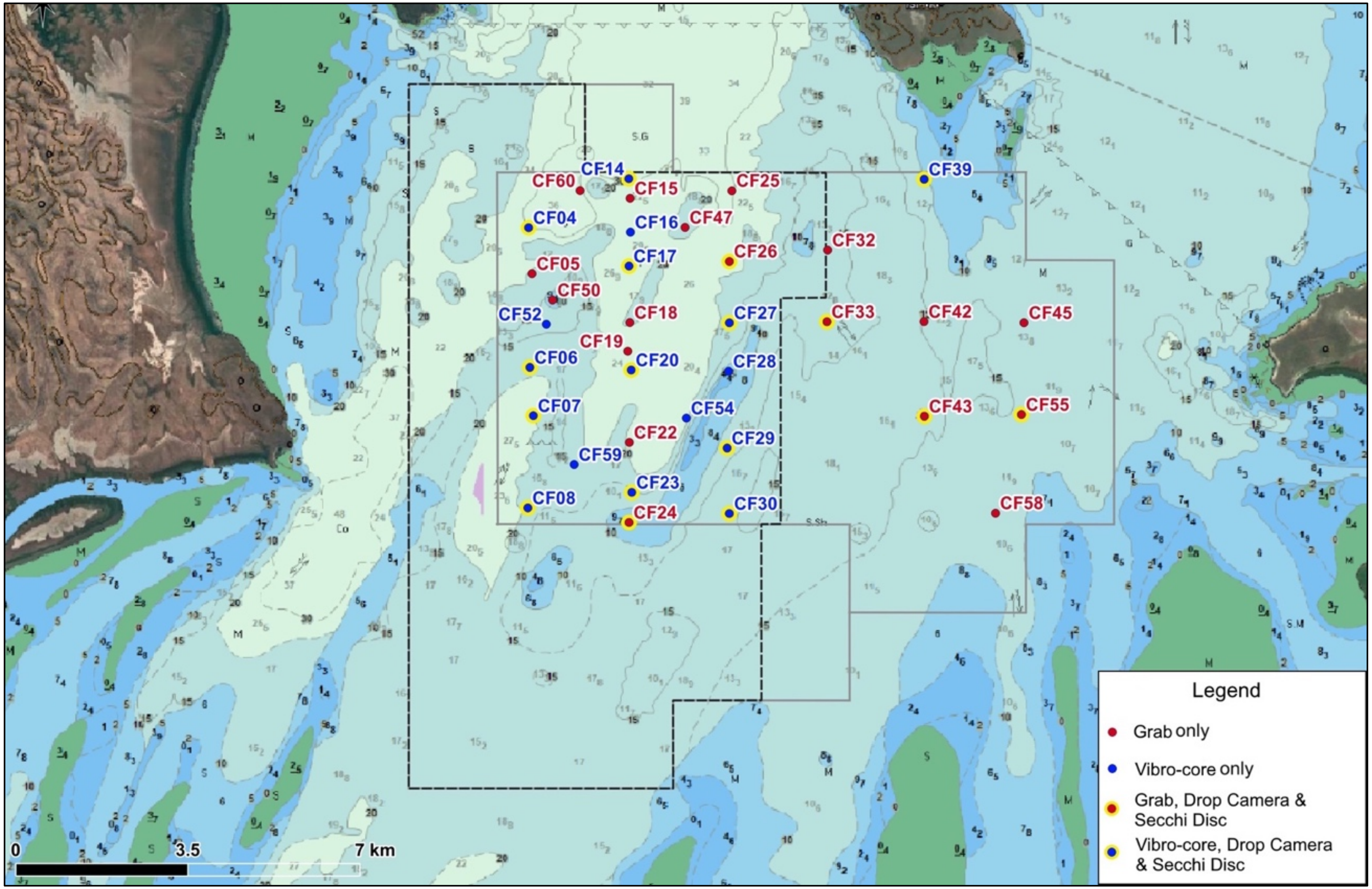


FIGURE 6.16: *The 17 sites (ringed in yellow) where a drop camera was deployed in March 2023.*

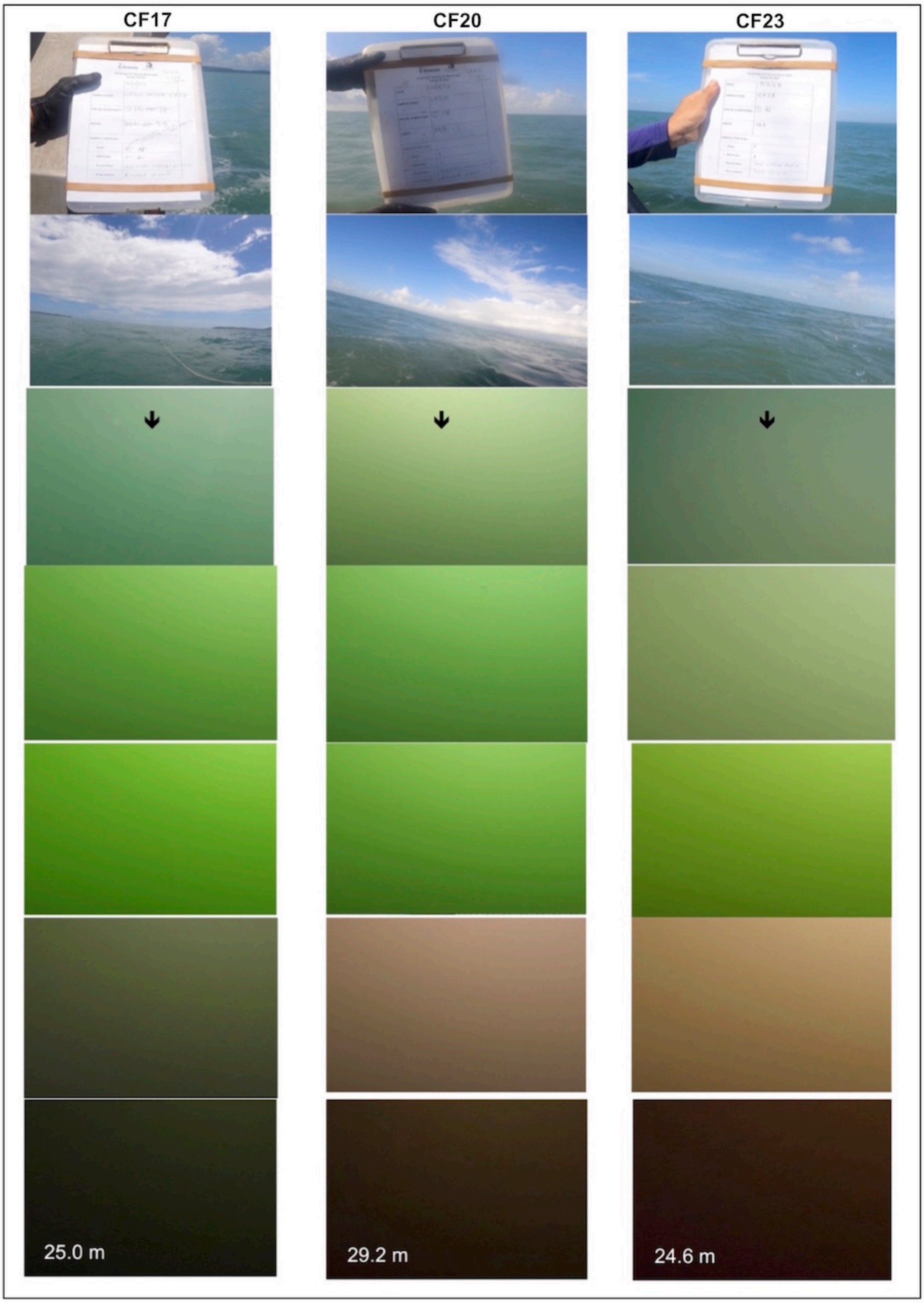


FIGURE 6.17: *Screenshots of the video imagery from the surface to the seabed from three of the March 2023 sampling sites. The complete set for all 17 sites is contained in Annex 3. All except one of the 134 camera drops undertaken in March 2023 and July-August 2023 returned the same result as shown here, with an aphotic zone near the seabed.*

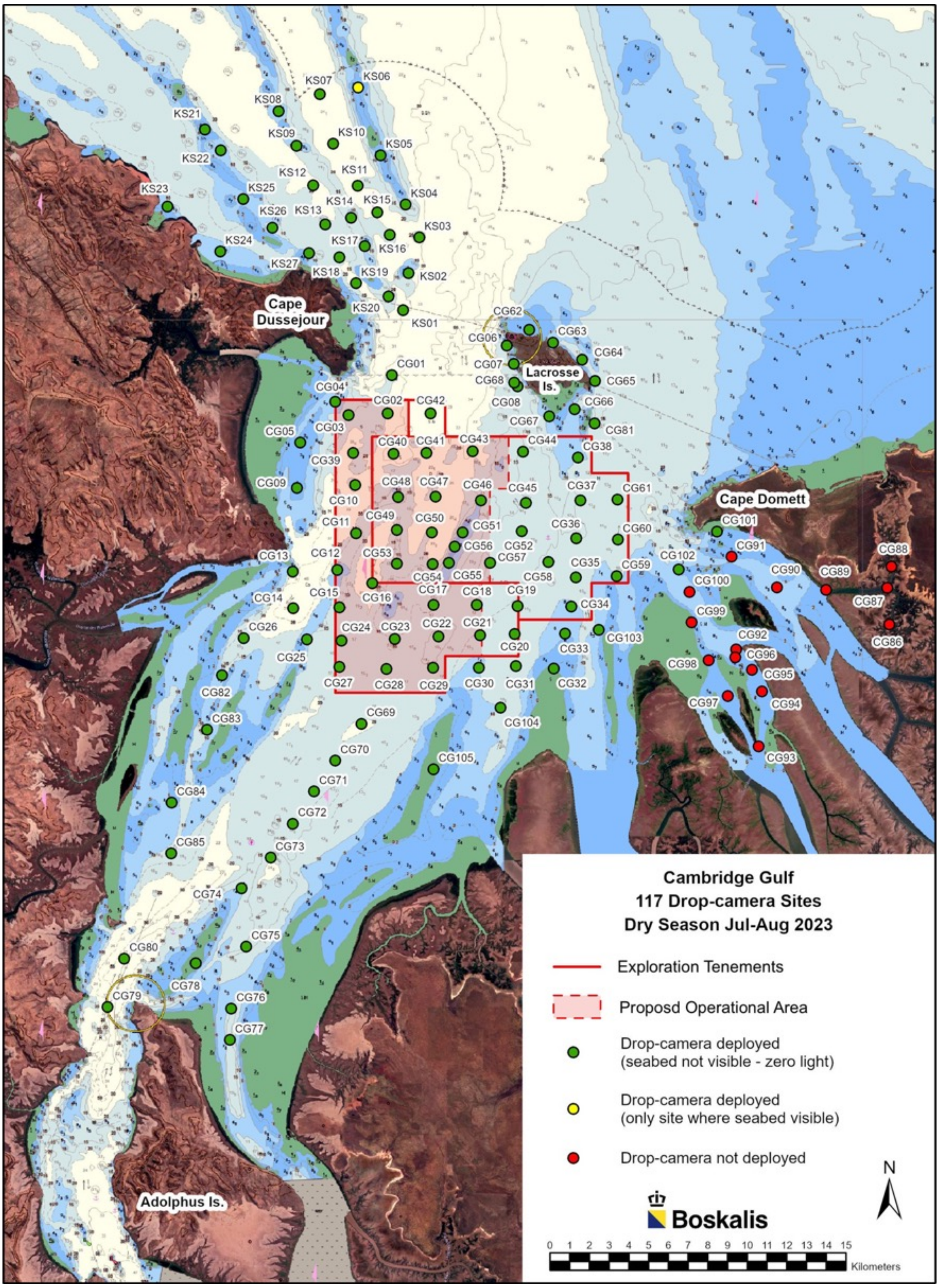


FIGURE 6.18: *The 117 sites where a drop camera was deployed throughout CG and KS during the dry-season environmental survey. These are addition to the 17 sites in Block 4 where a drop camera was deployed in March 2023. Site KS06 (top of map) was the only site out of the total of 134 drop camera sites that returned a glimpse of the seabed. See Figure 6.19. The drop camera was not deployed at the 'red' sites as there was near-zero visibility even near the surface, and tidal currents were strong at the time. Benthic grabs at the 'red' sites returned mainly clay and gravel.*

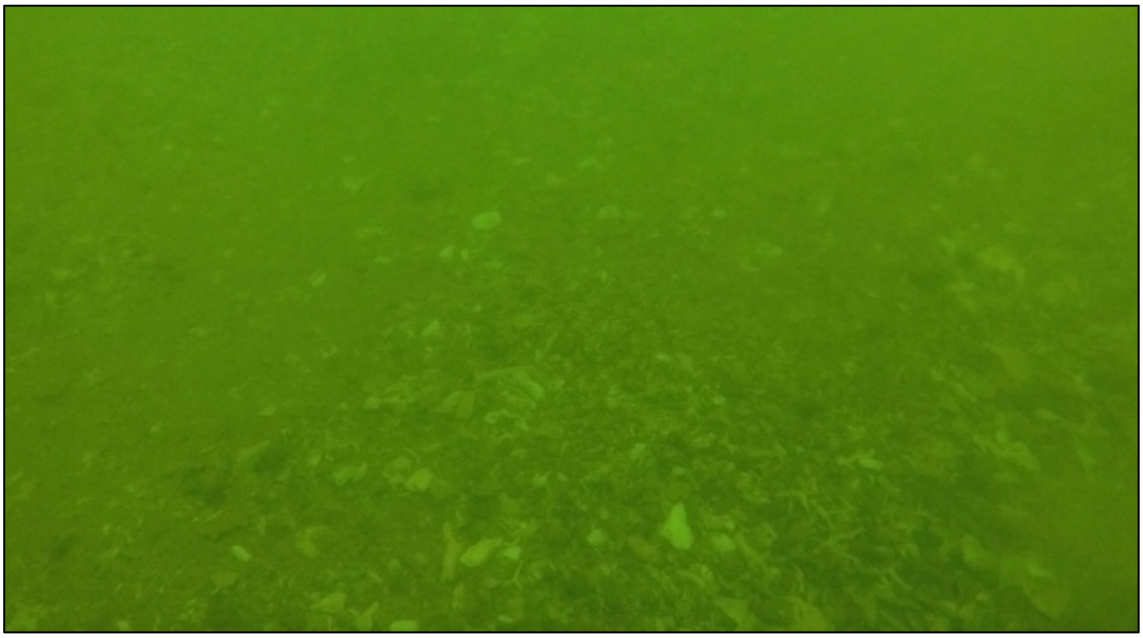


FIGURE 6.19: *Near-seabed screenshot from the video at site KS06 in July 2023 – showing shell-grit / gravel. This was the only site out of 134 drop camera sites throughout CG and KS that returned a glimpse of the seabed. It was only 6 m deep (most sites were between 15 and 25+ m deep). It was also the furthest to seaward of all sites – being ~12 km seaward of the entrance to CG, with less turbid (but still turbid) water.*

6.3.10 Benthic biota grab sampling

1. In accordance with standard methods for assessing BCH, benthic grab sampling with a five-litre Smith-McIntyre grab (Figure 6.20) and a Van Veen Grab was undertaken during the sand exploration survey in March 2023, the dry-season environmental survey in July-August 2023 and the wet-season environmental survey in February 2024.

Benthic grab methods during sand exploration survey March 2023:

1. The grab sampling in March 2023 was for initial environmental reconnaissance purposes, to assess for potential presence of significant macro-benthic species such as corals, seagrass etc in the proposed operational area, which could be cause to not proceed further with the proposal. The was an initial qualitative assessment and duplicate grabs were taken at each of 18 sites within Block 4, as shown on Figure 6.16 above (sites CF05, 15, 18, 19, 22, 24, 25, 26, 32, 33, 42, 43, 45, 47, 50, 55, 58 and 60). At some sites seabed conditions or strong tidal currents prevented duplicate grabs, and only one was taken, as listed in Table 3. At site CG22 three grabs were deployed until a successful sample collection was achieved, due to lack of sediment in the initial two grabs.

2. The contents of each grab were placed in a bin, inspected for any obvious macro-biota, sieved to 6 mm and searched further for macro-biota. Any biota found was recorded and photographed, and returned to the sea. As this was a qualitative reconnaissance survey, sieving to the 500 microns for smaller biota was not undertaken, and biota was not preserved and sent to a laboratory for detailed assessment (in any case very little biota was found, as outlined in section 6.4.4 below).

3. The nature of the seabed sediment, which constitutes the benthic habitat, was also recorded (clay, sand, shell-grit, gravel, rock etc – and mixtures of these), along with water depth at the site at the time, as indicated by the vessel's depth sounder (noting the 8 m peak tidal range in CG), plus the date, time and GPS mark.

4. Each step in the process for each grab was photographed with date/time stamp, with an accompanying data board to allow identification of which site the photographs relate to. The steps that were photographed were raw sample in bin, raw sample in sieve pre-sieving, remnants of the sample post-sieving, and any biota found in the sample. Figure 6.21 shows two examples of a photographic series of grab sampling. The full set of photographs for all 18 sites is archived, and can be provided to regulatory agencies if required and submitted via IMSA.

5. No significant macro-benthic species such as corals, seagrass etc were found at any site, and BKA therefore continued with further studies to develop the proposal.

TABLE 6.1: *Specifications for each benthic grab site sampled in March 2023 (listed chronologically by date sampled)*

Sequential No.	Site No.*	No. of Grabs	Date (March 2023)	Depth (m)	Lat (S)	Long (E)
1	**CF 05**	4	08	26.7	-14.802884	128.239787
2	**CF 24**	2	11	13.0	-14.849631	128.258248
3	**CF 25**	2	11	35.5	-14.787391	128.277704
4	**CF 26**	2	11	26.4	-14.800257	128.277285
5	**CF 43**	2	12	21.0	-14.829729	128.314288
6	**CF 33**	2	12	17.4	-14.811771	128.295700
7	**CF 58**	1	12	15.0	-14.847911	128.327597
8	**CF 32**	1	12	21.2	-14.798093	128.295846
9	**CF 42**	1	12	22.8	-14.811634	128.314057
10	**CF 45**	1	12	18.0	-14.811849	128.332952
11	**CF 55**	1	13	21.0	-14.829231	128.332544
12	**CF 22**	3	13	25.5	-14.834683	128.258748
13	**CF 47**	2	13	23.0	-14.793946	128.268928
14	**CF 18**	1	13	26.5	-14.811809	128.258467
15	**CF 15**	2	14	33.0	-14.788320	128.258547
16	**CF 60**	2	14	40.2	-14.787422	128.249214
17	**CF 50**	2	14	17.5	-14.807819	128.243905
18	**CF 19**	2	14	28.0	-14.817258	128.258370
		32				

*NOTE: CF is used as the site prefix code as it was supposed to be 'CG' for Cambridge Gulf but a keyboard error inserted 'F' instead of 'G'. As CF was then in place for all prepared data forms and templates, it was adhered to in order to avoid having to change all forms and templates. What is important is to know is the coordinates for each site, and to reference the sites correctly and consistently.

FIGURE 6.20: *The five-litre Smith-McIntyre grab used for the benthic sampling in CG.*

Site CF50 - Grab 1 **Site CF24 - Grab 2**

Step 1 - Bin: *Grab sample placed in bin & inspected for macro-biota.*

Step 2 - Pre-sieve: *Grab sample placed in 6 mm sieve & sieved.*

Step 3 - Post-sieve: *Post-sieved material inspected for biota.*

FIGURE 6.21: *Two examples of the photographic record of each step in the grab sampling procedure. The full set of photographs for all 18 sites sampled in March 2023 is archived, and can be provided to regulatory agencies if required.*

Benthic grab methods for dry-season environmental survey July-August 2023:

1. During the dry-season environmental survey a more comprehensive, quantitative approach to benthic grab sampling was applied. In order to provide broad representation of different benthic habitats, a total of 105 sites were sampled throughout CG, including in and around the proposed operational area, two parallel transects running south towards Adolphus Island, around all sides of Lacrosse Island, and up the tidal inlets on the eastern side of CG, known as 'The False Mouths of the Order River' (part of the Ord River Floodplain Ramsar wetland). An additional 27 sites were sampled at King Shoals (KS), located outside of CG (a Sanctuary Zone of the State North Kimberly Marine Park).

2. This totals 132 benthic grab sampling sites, in addition to the 18 reconnaissance sites sampled in March 2023. The July-August 2023 sites are shown on Figure 6.18 in section 6.3.9 above. The site prefix codes are 'CG' for Cambridge Gulf and 'KS' for King Shoals.

3. Because this survey involved taking benthic biota for identification and counting, a licence (Instrument of Exemption) to take benthic biota was obtained from the WA Department of Primary Industries and Regional Development (DPIRD), under the WA *Fish Resources Management Act* (Exemption No. 251137723). Because the sampling at KS was in the Marine Park, a licence to take fauna from that area was obtained from the WA Department of Biodiversity Conservation and Attractions (DBCA) under the WA *Conservation and Land Management Act* (Licence No. BA27000873).

4. To provide replication, triplicate grabs were taken at each site, except at a few sites where seabed conditions or strong tidal currents only allowed two or one grab to be taken, as listed in Annex 4.

5. Once the grab was retrieved, the sample was placed in a plastic bin and inspected for any obvious biota, which was photographed, removed and placed in ethanol in labelled sample containers. The sample was then sieved with a 500-micron sieve and the remaining material was inspected for biota, including using forceps and chopsticks to sort through the sediment and collect any biota. A pipette was also used to collect smaller biota. For courser sediments like shell-grit and gravel, after initial sieving and biota assessment, the retained sediment was returned to a bin of seawater with the water ~0.5 to 1 cm above the sediment surface, and shaken gently. This 'floats off' any small organisms that might not have been detected amongst the sieved sediment.

6. Two marine biologists inspected each sample. In some samples the sediment type required pre-sieving using a 3 mm or even 6 mm sieve, followed by the 500-micron sieve. Some samples contained gravel, pebbles or small rock and could not be sieved – but were inspected thoroughly, and where useful, subject to the 'float-off' check described above.

7. Any biota that was found at any stage of the process were removed, photographed and placed in ethanol in labelled sample containers. The biota samples were air-freighted to Benthic Australia Pty Ltd in Gladstone, Queensland, for taxanomic identification, counting and diversity analysis. Some organisms were too small to photograph clearly and were identified later by Benthic Australia.

8. As with the March 2023 grab sampling, the nature of the seabed sediment, which constitutes the benthic habitat, was also recorded (clay, sand, shell-grit, gravel, rock etc – and mixtures of these), along with water depth at the site at the time, plus the date, time and GPS mark.

9. For quality control and sample chain of custody (CoC), each step in the process for each grab was photographed with date/time stamp, with an accompanying data board to allow identification of the site the photographs relate to. Figures 6.23 to 6.31 show examples of methods used and each step in the process, as described above. The full set of photographs for all 132 sites is archived, and can be provided to regulatory agencies if required.

10. The specifications for each dry-season grab site are presented in Annex 4. The results are presented in section 6.4.4.

Benthic grab methods for wet-season environmental survey February 2024:

1. The benthic grab methods for the wet-season environmental survey were exactly the same as for the dry-season survey as described above. However, given the very low biota returns in the dry season, a lack of ephemeral / seasonal species, and the fact that environmental conditions in CG are less hospitable in the wet season, including significant freshwater and sediment inputs from wet season rains in the catchment, the number of sampling sites was reduced. There was also a safety imperative relating to the tropical cyclone season to complete all work on site as expeditiously as possible. The wet-season sites focussed on the high priority areas in and around the proposed operational area in CG (27 sites), and in the Marine Park at King Shoals (14 sites), giving a total of 41 sites, with triplicate grabs at all sites (Figure 6.22).

2. The wet season sampling site prefix code for the sites within CG is 'WS' for 'Wet Season', and at KS it is 'WSKS' for 'Wet Season - King Shoals'. The specifications for each dry-season benthic biota grab site are presented in Annex 5. The wet season sampling was undertaken under the same DPIRD and DBCA licences that applied to the dry-season survey. The results of the benthic sampling are presented in section 6.4.4 below.

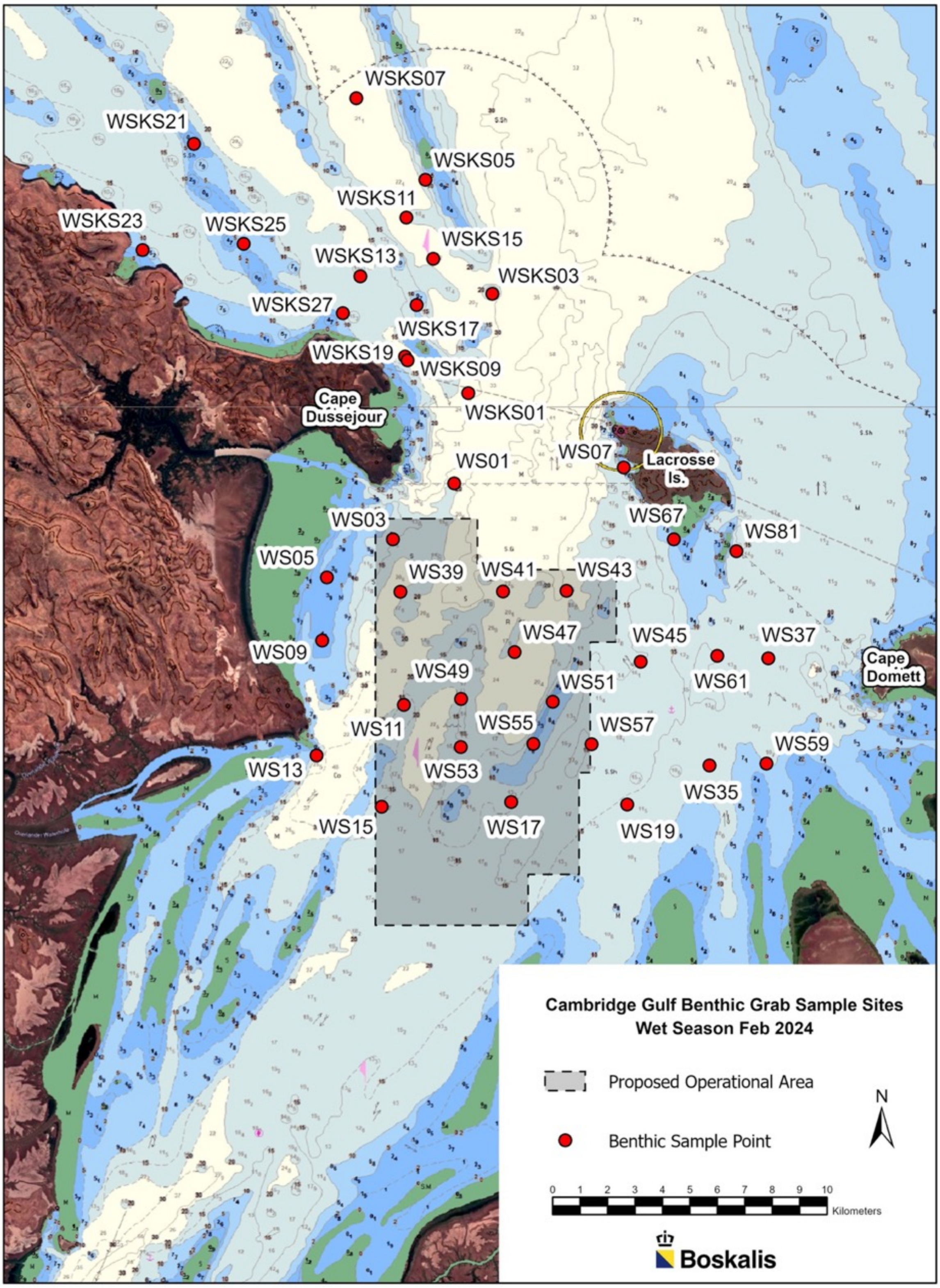


FIGURE 6.22: *Wet season (February 2024) benthic biota grab sites.*

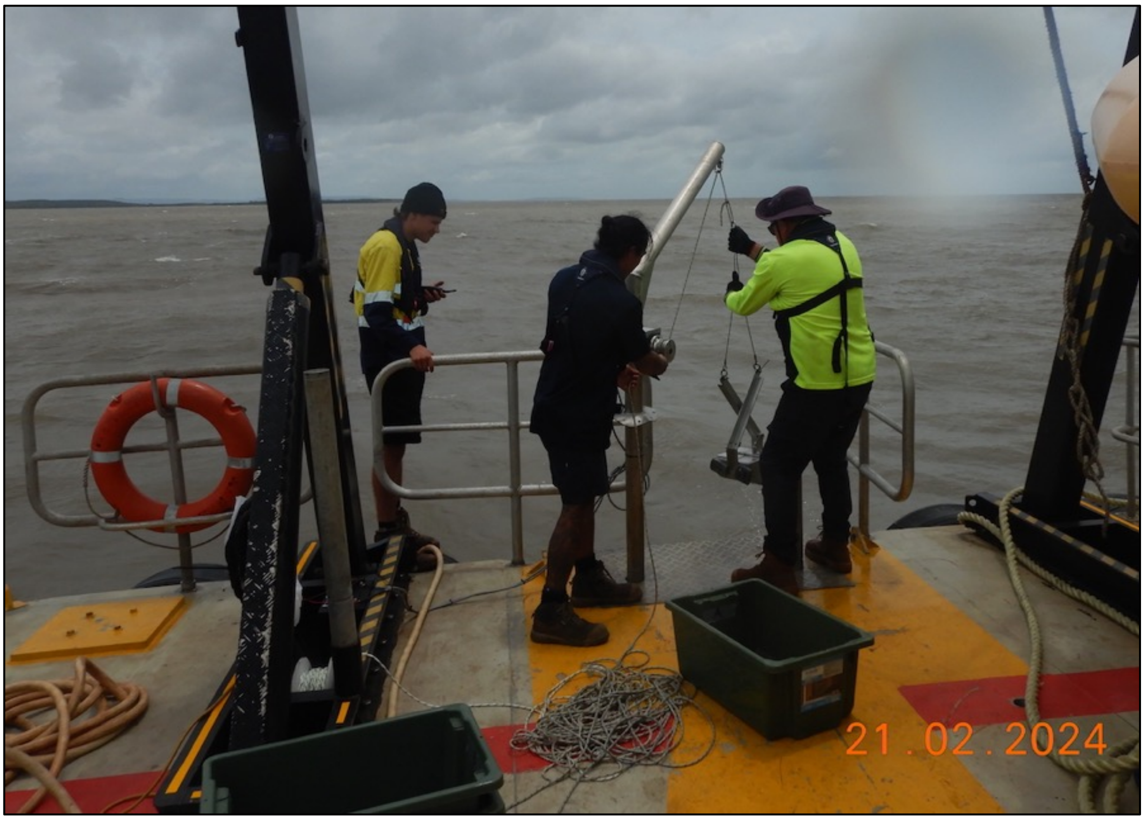


FIGURE 6.23: *Grabs were deployed and recovered by electric or hydraulic winch depending on the vessel.*

FIGURE 6.24: *A data board was photographed with the grab before each deployment, to provide a complete date-time stamped photographic record of all steps in each grab cycle.*

Site CG12 - Grab A | **Site CG20 - Grab A**

Step 1 - Bin: *Grab sample placed in bin & inspected for macro-biota.*

Step 2 - Pre-sieve: *Grab sample placed in 500 micron sieve & sieved.*

Step 3 - Post-sieve : *Post-sieved material inspected for biota.*

FIGURE 6.25: *Two examples of the photographic record of the grab sampling procedure used for both the dry- and wet-season sampling. Note the sample on the left is the typical sand that is found throughout CG, which typically left very little material after sieving, as per the lower left image. The sample on the right is clay/shell grit, which typically left a larger volume of material after sieving, as per the lower right image.*

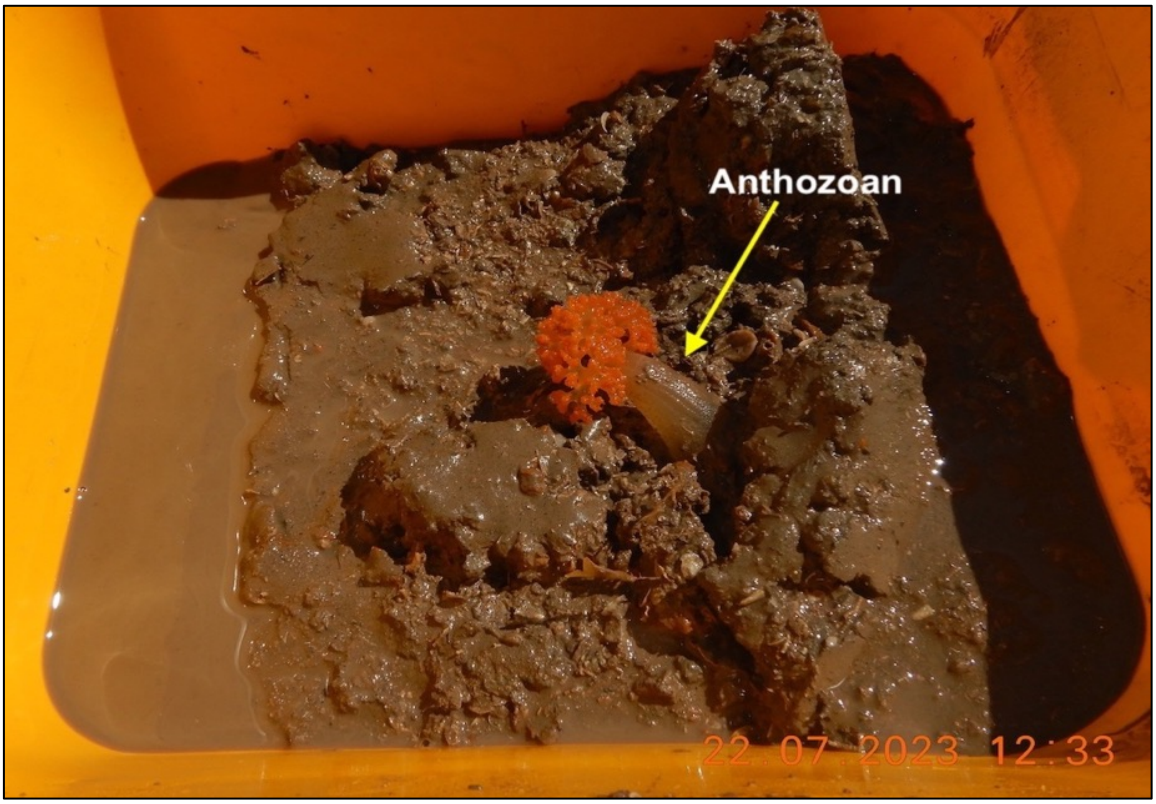


FIGURE 6.27: *Once the grab was retrieved, the sample was placed in a plastic bin and inspected for any obvious biota, as per this example. Any biota was photographed, recorded, removed from the sample before sieving and placed in ethanol in labelled sample containers.*

FIGURE 6.28: *In some samples the sediment type, especially samples where the gab returned a full five-liters of sand, required pre-sieving using a 3 mm or even 6 mm sieve, followed by the 500-micron sieve.*

FIGURE 6.29: *Post-sieved material was sorted and inspected in detail in-situ in the sieve, using chop-sticks and forceps to remove any biota found, as well as pipettes for very small biota. Samples were assessed by two people.*

FIGURE 6.30: *For courser sediments like shell-grit and gravel, after initial sieving and biota assessment, the sieve and retained sediment was returned to a bin of seawater with the water ~0.5 to 1 cm above the sediment surface, then gently shaken. This 'floated off' any small organisms that might have been missed visually amongst the sieved sediment.*

FIGURE 6.31: *Any biota that was found were removed, recorded, photographed and placed in ethanol in labelled sample containers. The biota samples were air-freighted to Benthic Australia for taxanomic identification, counting and diversity analysis.*

6.3.11 Benthic sediment grab sampling

1. In addition to the benthic biota grabs described in section 6.3.10, benthic sediment grabs were also collected. The primary purpose was to provide seabed sediment samples for Particle Size Distribution (PSD) analysis using a laser particle sizer, and for minerology / elemental feature analysis using a scanning electronic microscope (SEM). This was to provide information to assess the distribution of different sediment types in CG and upstream of CG towards potential sediment source areas. This in-turn supports the assessment of sediment dynamics and coastal processes, as outlined in section 7 below.

2. Because seabed sediment constitutes the benthic substrate (habitat), the sediment sampling also provided data to assist ground-truthing of the subtidal habitat mapping. Additionally, while the sediment grab samples were not sieved for biota assessment as outlined in section 6.3.10 (as the integrity of the samples had to be maintained for PSD and SEM analysis), they were inspected for any visible macro-benthos such as seagrass, algae, coral and other invertebrates.

3. A total of 72 sediment grabs were collected during the wet season survey in February 2024, extending from the Pentecost River upstream of Wyndham, into the Lower Ord River and downstream to CG, plus up the tidal inlets of the False Mouths of the Ord River, and out to KS, as shown on Figure 6.33.

4. A single grab was collected at each site. As with the benthic biota sampling, for quality control and sample chain of custody (CoC), each step in the sampling process was photographed with a data board, from pre-deployment of the grab, to sample in bin, to bagged and labelled sample, as shown on Figure 6.32.

5. As outlined in section 5 and shown on Figure 5.7 in that section, 35 sediment grabs were also collected during the July 2023 sand exploration survey. In addition, seabed sediment type was also recorded for all 656 benthic biota grabs collected during both the dry- and wet-season environmental surveys. These campaigns combined constitute a total of 763 sediment grab samples ranging from the headwaters of CG to offshore from CG at KS, and up the False Mouths of the Ord River. This provides a comprehensive dataset on seabed sediments, and supplementary sampling of macro-benthos.

FIGURE 6.32: *Sediment grabs. For quality control and sample chain of custody, each step of the process was photographed. This site (US06 – see Figure 6.33) is in the headwaters of CG (Pentecost River). All samples in that area were sand / sand-mix, with the same characteristics as the sand in CG, as per top right image. This indicates the upstream source of the sand in CG.*

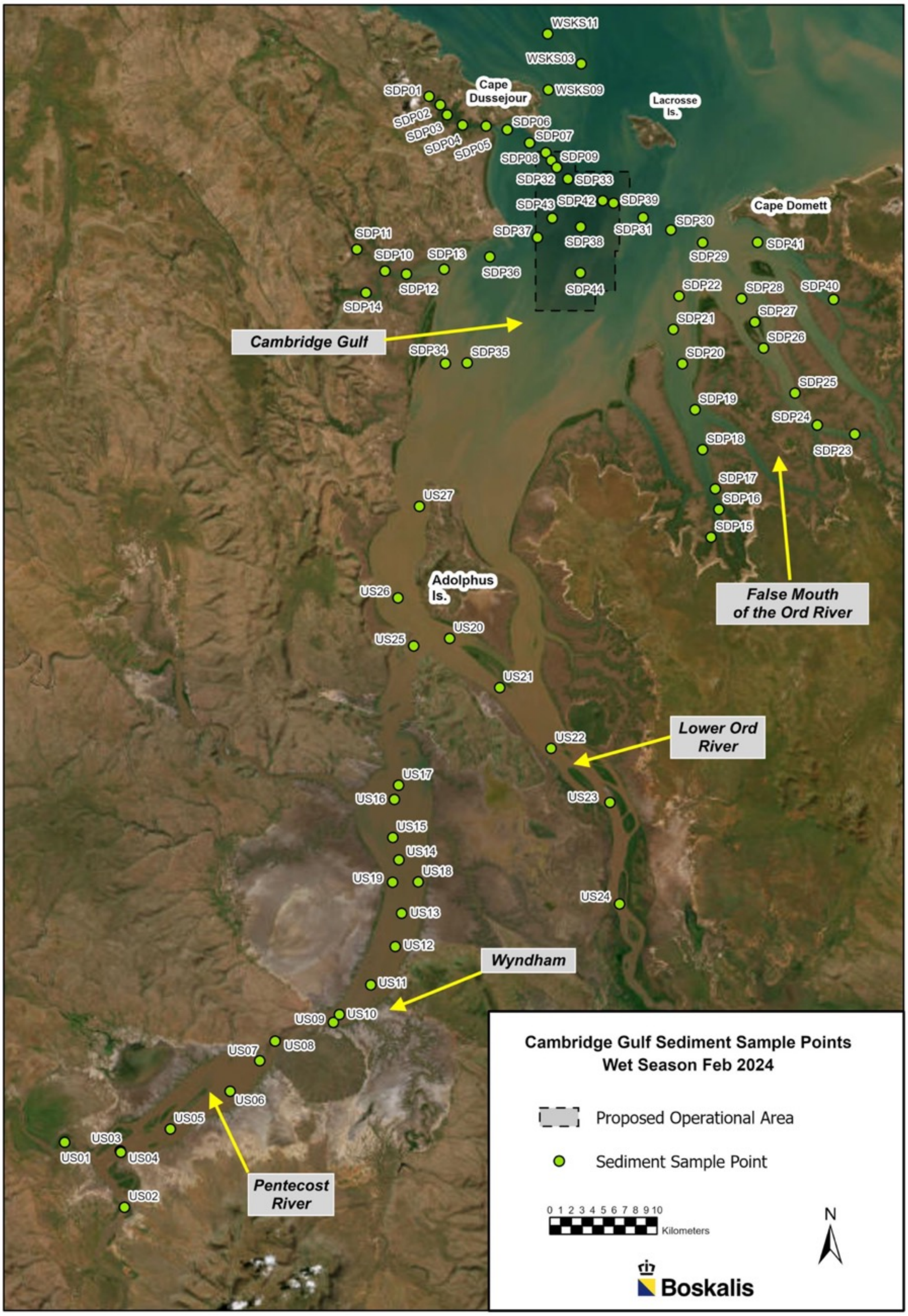


FIGURE 6.33: *Seabed sediment grabs collected at 72 sites during the wet season environmental survey in Feb 2024.*

6.3.12 Mangrove mapping

1. Several methods were used to assess, describe and map the mangroves within the LAU, with the results described in section 6.4.6 below. Methods used included:

    a) Review of pre-existing reports, papers and studies on mangroves in CG, as listed in section 6.3.2 above.

    b) Review and application of the relevant digital hydrographic charts and AUSTopo topographic maps for the area, as described in sections 6.3.3 and 6.3.4 above. The topographic maps represent mangrove areas accurately, as shown on Figure 6.4, and the GIS layers are available from Geoscience Australia.

    c) Review and application of processed Landsat satellite imagery of CG from Digital Earth Australia (DEA), a program of Geoscience Australia, including for mangrove canopy cover.

    d) Use of mangrove-related layers from the NISB Habitat Classification Scheme and ECM National Habitat Map Series.

    e) Review and application of *Global Mangrove Watch Version 3* Global Mangrove Extent Change 1996–2020 (Bunting, et. al., 2022) to assess changes in mangrove cover in CG over time.

    f) Use of aerial drone video and photography of a representative range of mangrove community types around the coast of CG, and investigation of areas of apparent natural dynamics, erosion and damage.

    g) Boast-based surveys and photography of the seaward face of mangroves in the following areas:

        – around the coast of CG, including well upstream of the three rivers on the western side (Helby, Lyne and Thompson Rivers); and

        – well upstream several of the tidal inlets that make up the False Mouths of the Ord River (part of the Order River Floodplain Ramsar Wetland), including investigation of areas of apparent natural dynamics, erosion and damage.

2. Ground-based surveys were not undertaken due to the extreme risk of crocodile attack in CG.

6.3.13 Development of BCH map

1. The MScience method was based on the NISB Habitat Classification Scheme and ECM National Habitat Map Series, supported where relevant by the results of the various benthic assessment methods described in sections 6.3 1 to 6.3.12 above, as described in their methods statement in Annex 2.

6.4 Description of Benthic Communities & Habitats

6.4.1 Overall BCH map

1. The overall BCH map for the LAU is presented in Figure 6.3.4 for reference in the following sections, which describe each of the different BCH types shown on the map. Sub-maps for each BCH type are included where relevant in the following sections.

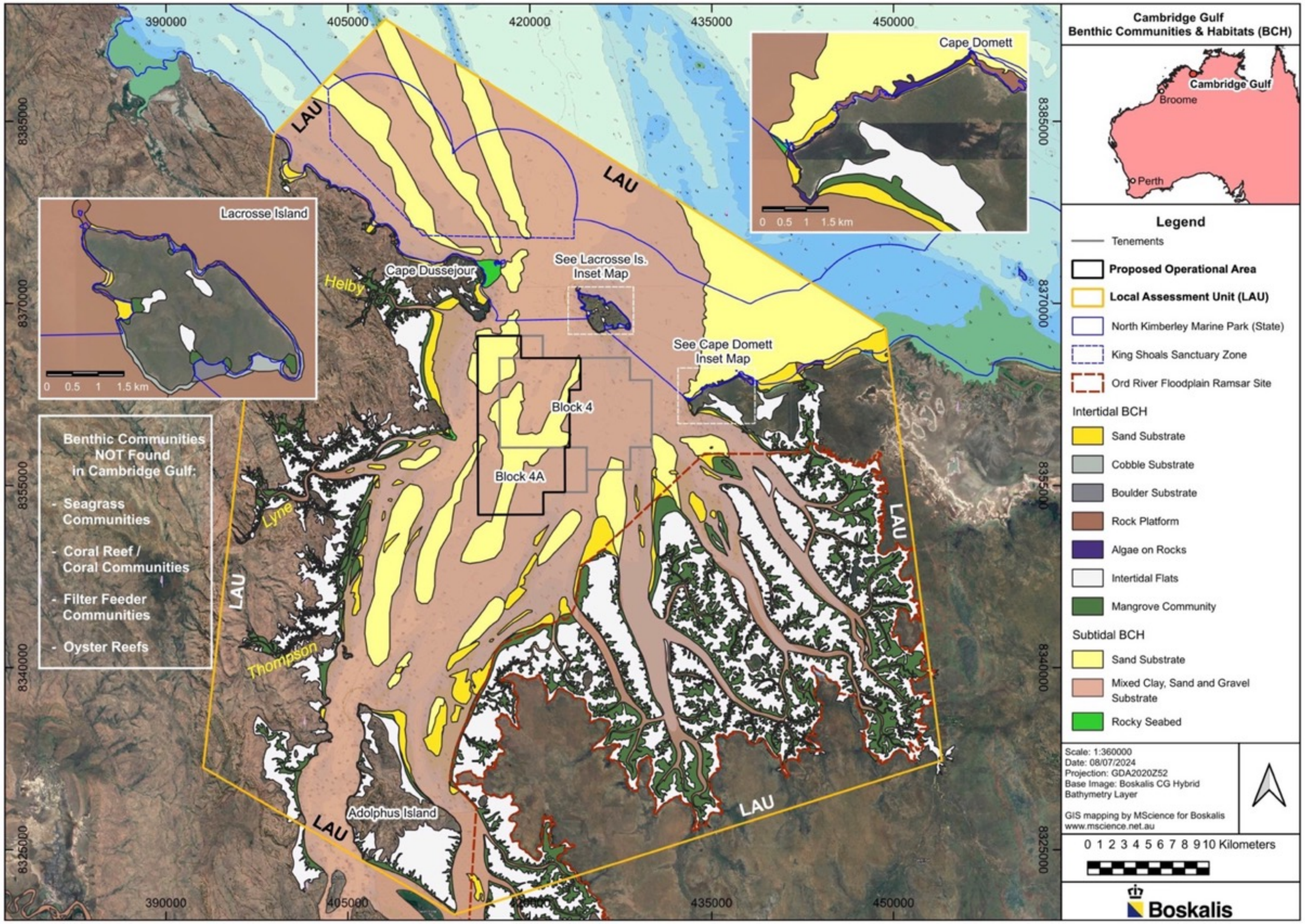


FIGURE 6.34: *Benthic Communities & Habitat Map for CG.*

6.4.2 Marine environmental conditions in CG that affect BCH

1. The marine environmental conditions in CG are extreme and are not conducive to colonization and survival of benthic organisms, which inhibits the development of significant benthic communities apart from mangroves. Inhibiting conditions are primarily driven by the peak spring tidal range of 8 m, which creates extremely strong tidal currents, which in turn drive other inhibiting environmental conditions as described below.

2. The nature of the seabed substrate in CG is also a significant inhibiting factor for benthos. The seabed substrate almost entirely comprises highly mobile sand and mixtures of clay, silt, sand, gravel and/or shell-grit. These substrates are unstable and are constantly moved by the strong tidal currents, and are therefore not suitable for settlement and colonization by sessile benthos, such as corals, sponges, sessile bivalves and oysters, and macro-algae. Sessile benthos requires stable, hard, rocky substrate.

3. Stable substrate is limited to very small areas at a few locations, these being at Cape Dussejour, Vancouver Point / Myrmidon Ledge and Ina Island on the western side of CG, Nicholls Point at the northern end of Adolphus Island, Cape Domett at the eastern entrance to CG, and around the coast and especially on the northern side of Lacrosse Island (Figures 6.7 & 6.34).

4. The tidal current velocities in CG have been measured by BKA in excess of 1.5 m/s (3 knots) (see Referral Report No. 5, PCS 2024a, b &c). The hydrographic chart for CG (AUS32) (Figure 6.2), indicates that currents can be up to 4 knots (2.06 m/s). The strongest currents of 3-4 knots as marked on the chart occur in West Entrance between Lacrosse Island and Cape Dussejour, and in the centre of CG (within BKA's proposed operational area) (Figure 6.35). These are very strong current velocities which have the following effects in terms of inhibiting benthos:

   a) Constantly moving benthic substrate: The strong currents, which change direction from flood to ebb tide every six hours, constantly shift and move the mobile seabed substrates, making it impossible for sessile benthos to settle, attach and persist. As outlined in section 5, multi-beam echo-sounder (MBES) surveys showed that the seabed in the proposed operational area mainly comprises highly mobile sand waves, with vertical heights ranging from 1 to 8 m, and horizontal wavelengths of between 50 and 200 m. The MBES surveys measured horizontal migration of the seabed sand waves by up to 10 m over just 27 days (a lunar tidal cycle), showing that they are highly dynamic and constantly moving. This is not a benthic substrate that is amenable to benthic biota.

   b) Total lack of benthic light: The strong tidal currents constantly stir up the finer fractions of the sediments and keep them in permanent suspension, especially near the seabed where there is a permanent aphotic layer, as outlined in section 6.3.9 and illustrated by the drop camera video screen shots in Annex 3. There is a total of 134 drop camera videos that all show the same result through CG and at KS, which can be made available to environmental regulators if required. As outlined in section 8 on Marine Environmental Quality, BKA has deployed a network of in-situ, data-logging seabed light meters that measure photosynthetically available radiation (PAR), with co-mounted turbidity meters, at key locations throughout CG and at KS. These instruments will remain in place into 2025 to provide a long-term dataset. To date these instruments consistently measure zero to almost zero benthic light under all tidal conditions, consistent with the drop camera videos. This is not a benthic light regime that is amenable to benthic biota.

   c) High suspended sediment concentrations & turbidity: Related to lack of light at the seabed are consistently high suspended sediment concentrations and associated high turbidity through the water column in CG. As outlined in section 8, some of the highest turbidity levels in Australia have been measured in CG, and the area is referred to by the Traditional Owners as 'Brown Water Country'. The consistently high suspended sediment concentrations and turbidity are caused by the strong tidal currents constantly suspending the benthic sediments.

16. Other environmental factors that inhibit benthic biota and communities in CG include:

   a) Increased suspended sediment & turbidity from catchment inputs: During the wet-season, suspended sediment concentrations and turbidity are elevated further due to inputs of sediments from the catchments via heavy wet-season rains and floods, often associated with tropical low-pressure systems and cyclones.

   b) Wet-season freshwater inputs: There can be significantly increased freshwater inputs to CG during the wet season, which is also a major inhibiter of marine benthic biota. Freshwater pulses into marine areas can kill-off species such as seagrass and corals (McKenzie et. al., 2011) (Lough et. al, 2015).

   c) Exposure of intertidal habitats at low tide: The 8 m tidal range in CG also inhibits intertidal benthos, as large areas of intertidal benthic substrate are exposed to the atmosphere and the sun at low tide, every tidal cycle. The extent of exposure is less at neap tide and greater at spring tide, with each occurring twice a month. Figure 6.5 in section 6.3.4 above provide an indication of the extent of such exposure.

17. Section 8 provides a more detailed description of marine environmental conditions in CG. Overall, given the marine environmental conditions described above, it is clear that CG does not provide an environment that is hospitable to benthic biota and communities.

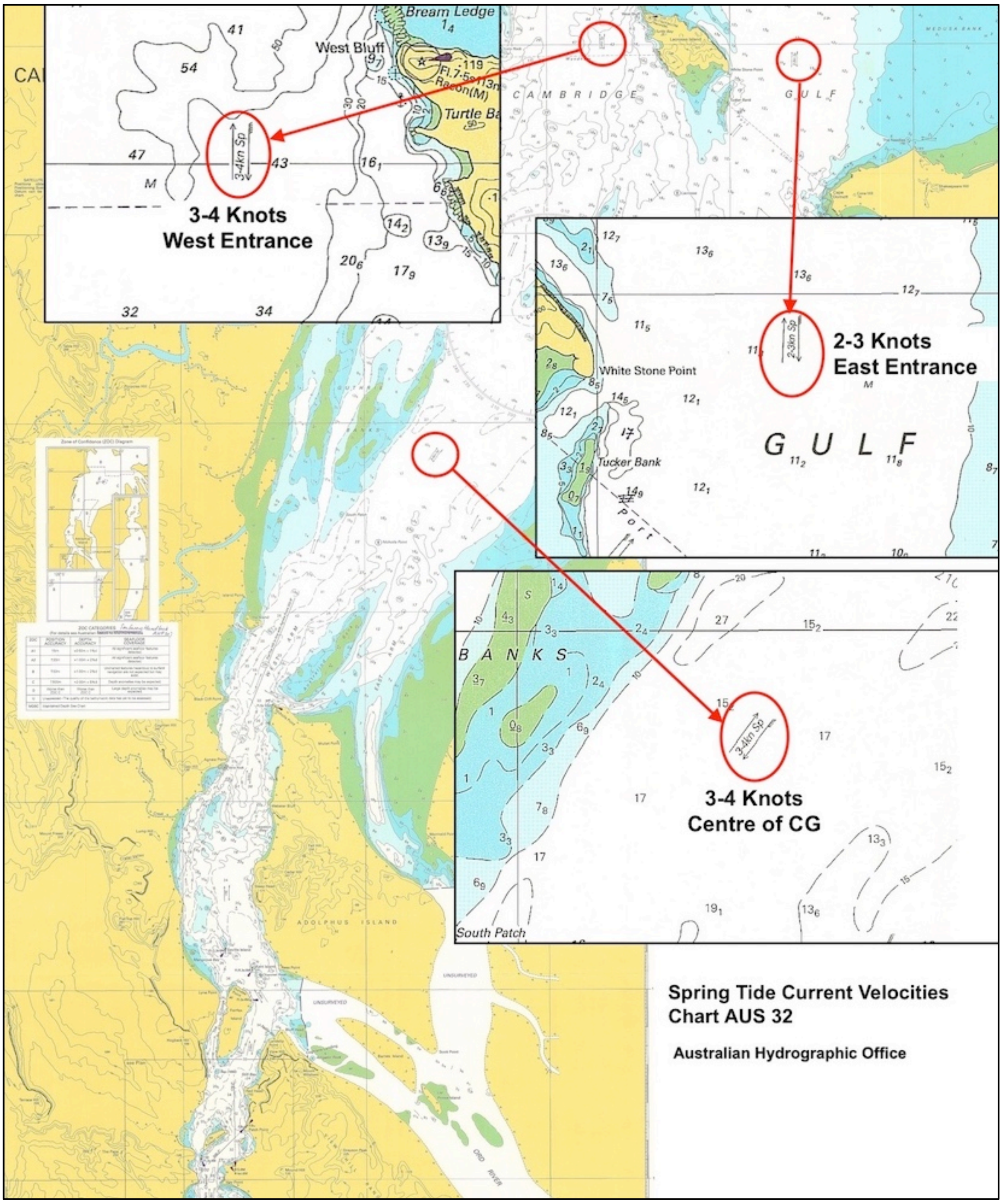


FIGURE 6.35: *Chart AUS 32 showing current velocities at three locations in CG.*

6.4.3 Lack of seagrass, coral, sponge, macroalgae & other primary producer communities

1. Due to the extreme environmental conditions as outlined in section 6.4.2 and detailed in section 5, CG does not host significant primary producer communities in the form of seagrass beds, coral reefs, sponge beds, macroalgae communities etc. No previous reports of the presence of any of these communities in CG could be identified through literature search.

2. A survey of intertidal seagrasses along the East Kimberley coast by Walker et al. (1996) as part of the WA Museum's strategic biological surveys of the entire Kimberley coast did not record any seagrasses or evidence of drift material at any of the sites surveyed. Galaiduk et al. (2018) state that Joseph Bonaparte Gulf, immediately offshore from CG (with less turbid waters); '. . . *is not expected to be a major area for dugong, given the lack of seagrass.'* McMahon et al. (2017) assessed seagrasses across the north of WA from Shark Bay to the NT border, and identified the Bonaparte/Cambridge IMCRA Bioregion, which includes CG, as not having any seagrass species (IMCRA = Commonwealth *Integrated Marine and Coastal Regionalisation of Australia*).

3. As shown on Figure 6.7 in section 6.3.6, aerial drone surveys and some ground surveys were undertaken at low tide over the main intertidal areas in CG that provide habitat that is most likely to support seagrasses, corals, sponge beds, macroalgae etc, and no evidence was found. Apart from mangroves, the most significant intertidal benthic biota identified were some bands of barnacles along the upper tide-line and some patches of filamentous / turf algae on rock platforms on the seaward coasts of Cape Dussejour, Lacrosse Island and Cape Domett, outside of CG (see sections 6.10 to 6.13 for the detailed results and images).

4. As outlined in sections 6.3.10 and 6.3.11 above, a total of 483 benthic biota grabs and 107 benthic sediment grabs were collected throughout all parts of CG in both the dry- and wet-season, and no evidence of seagrasses, corals, sponge beds, macroalgae etc, was found. A very small number (single digits across all grab samples) of small sponges and small anthozoans (corals and relatives) were collected from the grab samples, as reported in section 6.4.4 below. Figure 6.35 shows two examples of these.

5. Consultations were held with a commercial barramundi fisherman who is based in Wyndham, who has operated in CG for over 20 years, with the local Traditional Owners (TOs) and with District staff of WA DBCA, who patrol and undertake surveys of the area with the TOs. All advised that there are no seagrasses or corals in CG. The District DBCA staff advised that you need to travel ~50 km westwards along the coast outside of CG before marine environmental conditions start to become suitable for corals.

6. The most significant primary producer community in CG is the narrow band of mangroves that is found along most of the coast around CG, as described in section 6.8.

7. Given the lack of significant primary producer communities in CG, there is no potential for the BKA proposal to cause impacts on such communities. This was a key factor for BKA in selecting CG in the alternatives screening process (see Referral Report No. 4 - *Impact Assessments*).

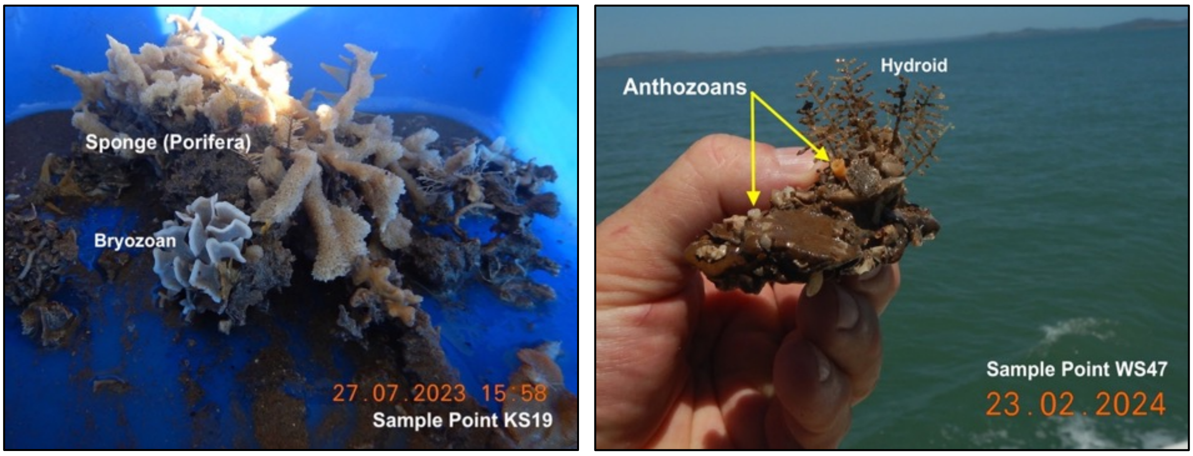


FIGURE 6.36: *Examples of the few small sponges (left) and anthozoans (corals and relatives) (right) that were collected from the benthic grabs. Note that the image on the left is from site KS19 near Cape Dussejour where there is hard, stable rock seabed and returned the most biota of all sites. This is not typical of sand areas inside CG (images: Raaymakers).*

6.4.4 Benthic biota grab results

6.4.4.1 Number & spread of sampling points & number of grabs

1. The locations of the dry-season sampling points are shown on Figure 6.18 above and the locations of the wet-season sampling points are shown on Figure 6.22 above.

2. The dry-season sampling point specifications are presented in Annex 4 and the wet-season sampling point specifications are presented in Annex 5, including the number of grabs per sampling point (mostly three), biota returns per grab, sediment type per grab and coordinates for each sampling point.

3. The raw data from the benthic biota identification and counting, as undertaken by Benthic Australia, are archived and can be submitted to regulatory authorities if required.

4. Some key-data from Annexes 4 and 5 are presented in Table 6.2 at the end of this section. Table 6.2 shows that:

    a) There were 132 sampling points in CG and at KS during the dry-season survey.

    b) There were 41 sampling points in CG and at KS during the wet-season survey.

    c) There was a total of 173 sampling points in CG and at KS for both surveys combined.

    d) There were 360 grab samples in CG and at KS during the dry-season survey.

    e) There were 123 grab samples in CG and at KS during the wet-season survey.

    f) There was a total of 483 grab samples in CG and at KS for both surveys combined.

5. Additionally, as outlined in section 6.310, 32 benthic biota grabs were collected from 18 sites within Block 4 (Exploration Tenement E80/5655) during the initial environmental reconnaissance survey in March 2023, giving a total of 483 + 32 = 515 benthic biota grabs collected throughout CG and KS, and up the False Mouths of the Ord River.

6. Additionally, as outlined in section 6.3.1, a total of 763 sediment grab samples were collected ranging from the headwaters of CG to offshore from CG at KS, and up the False Mouths of the Ord River, and while not sieved for smaller biota, these were all inspected for macro-biota, such as seagrass, algae, corals etc.

7. This gives 515 benthic biota grabs plus 763 sediment grabs = a total of **1,278** benthic grab samples overall.

8. This constitutes a comprehensive and representative benthic sampling campaign, covering all of the main subtidal benthic habitat types, including upstream to the Pentecost River, within the proposed operational area, throughout other parts of CG, up the tidal inlets of the False Mouths of the Ord River on the eastern side of CG (part of the Ord River Floodplain Ramsar wetland), and offshore from CG at KS (within a Sanctuary Zone of the State North Kimberly Marine Park), in both the dry and wet-seasons.

6.4.4.2 Type of benthic organisms found

1. The types of benthic organisms found in the LAU was influenced by the types of benthic substrates (habitats). Rock seabed, which provides hard stable substrate, supported the highest diversity of taxa and the highest abundance of organisms, although still at low values (see paragraph 6 below). The diversity and abundance of benthic biota found in the grab samples decreased with decreasing coarseness of the substrate, from areas dominated by small rocks to areas dominated by gravel and/or shell-grit substrate, often mixed with clay and/or sand, to sand areas and then clay areas having the least biota.

2. The most common benthic organisms found were small hydroids attached to small rocks, with associated encrusting small sponges, bryozoans, small anthozoans and small motile organisms such as brittle stars (Ophiuroidea), amongst others, as shown on Figures 6.3.7 and 6.3.8. This biota was typically found in non-sand areas where the substrate comprised gravel/ small rocks. Such areas included most of the eastern side of CG, around parts of Lacrosse Island and the non-sand areas in the deeper gullies between the sand ridges in the proposed operational area and at King Shoals.

3. Areas with substrate dominated by gravel and/or shell-grit substrate, often mixed with clay and/or sand, returned a variety of organisms including small polychaetes, hydroids, other small coelenterates, bryozoans, small sponges etc, with some examples shown on Figure 6.3.9. These were in very low numbers, often a single individual or a few individuals (single digits) per grab (see discussion of abundance below). Such substrate is present through most of CG outside of sand areas.

4. In sand areas, including within the proposed operational area, most grabs returned no biota, as shown on Figure 6.40. In the few cases where biota was found in sand samples, it typically comprised very small numbers of small crustaceans such as amphipods, isopods and small crabs (see also the specific discussion of the proposed operational area below).

5. Areas with clay-dominated substrate mostly did not return any biota (unless mixed with gravel) (Figure 6.41). Clay-dominated substrates are found in much of the eastern side of CG, up the tidal inlets of the False Mouths of the Ord River and around Lacrosse Island.

6. There is an area of rock seabed between Cape Dussejour and Fathom Rock on the western side of CG. At this location dry-season sampling point KS19 and wet-season sampling point WSKS19 returned the highest abundance and diversity of benthic organisms of all sampling points (although still low values). This is because the rock seabed at this location is one of the very few sites in CG that has stable, hard substrate, which sessile benthic biota can attach to. Figure 6.42 shows an example of the biota found in one of the grabs from sampling point WSKS19 at the rock-seabed site. This included small hydroids, other small cnidarians, bryozoans, small sponges etc. This area is discussed further under 'abundance' below.

7. All visible organisms found in the grab samples were photographed with sample location data as they were collected on the vessel. The full set of images is archived and can be provided to regulators if required. Many organisms were too small to photograph on the vessel (small amphipods, worms etc) and were identified later in the laboratory, to lowest taxanomic level (see also discussion of diversity below and the maps and graphs in Annexes 6 & 7).

FIGURE 6.37: *The most common benthic biota was found in non-sand areas and typically comprised pebbles and small rocks as per the top image, encrusted with hydrozoans, small sponges etc. The bottom image is the largest rock that was returned in a grab with such biota attached.*

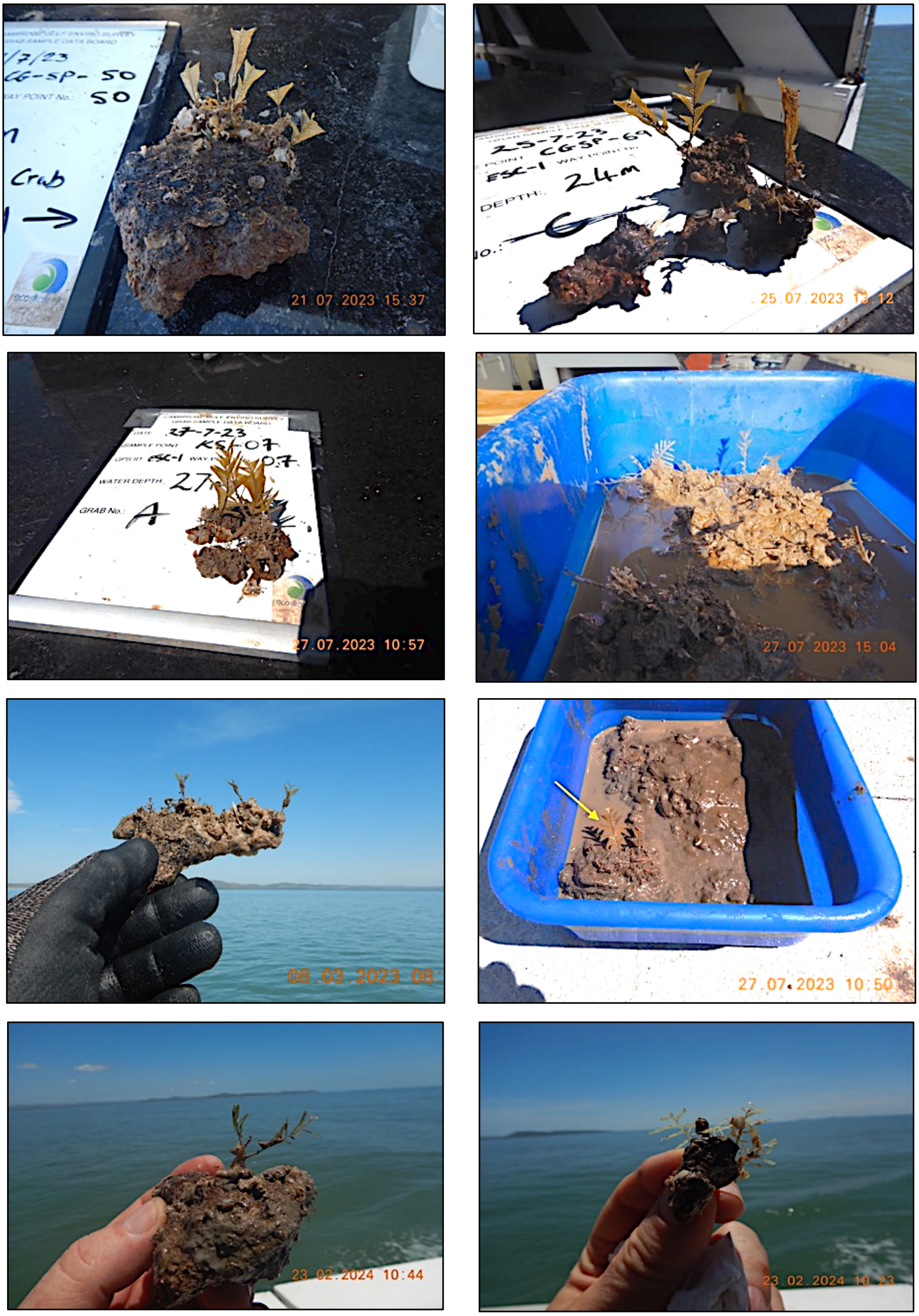


FIGURE 6.38: *Additional examples of small rocks encrusted with hydroids etc, which were the most common benthic biota found throughout CG, in non-sand areas.*

Unidentified branching coraliaform

Bryozoan & Sponge

Polychaete Worm

Echinoid

Brittle Star

Polychaete Worm

Unidentified at King Shoals (outside CG)

Small red coral at King Shoals (outside CG)

FIGURE 6.39: *Examples of some the other types of benthic organisms found in the grabs - all in single digit numbers across all 172 sampling points combined = very low abundance. Many organisms were too small to photograph on the vessel (small amphipods, worms etc) and were identified later in the laboratory.*

FIGURE 6.40: *An example of a grab sample of sand from within the proposed operational area. Top is pre-sieve and bottom is post-sieving to 500 microns, which was then searched for biota. Most sand samples did not contain biota, as constant movement of the sand under tidal currents prevents colonization. Compare this with Figure 6.42.*

FIGURE 6.41: *Areas with clay-dominated substrate mostly did not return any biota (unless mixed with gravel). Compare this with Figure 6.42.*

FIGURE 6.42: *Example of benthic biota found on the rocky seabed substrate at sites KS19 (dry season) and WSKS19 (west season), between Cape Dussejour and Fathom Rock on the western side of the western entrance to CG. This site returned the highest abundance and diversity of benthic biota of all sampling points (although still low values). Compare this with Figures 6.40 & 6.41.*

6.4.4.3 Presence / absence of benthic biota

1. As outlined above, the dry-season sampling point specifications are presented in Annex 4 and the wet-season sampling point specifications are presented in Annex 5, and some key-data from these Annexes are presented in Table 6.2 at the end of this section. Of note from Table 6.2 in relation to presence / absence of benthic biota is that:

   a) Biota was found at 47% of the total number of sampling points.

   b) Biota was not found at 53% of the total number of sampling points.

   c) Biota was found in 34% of the total number of grabs that were collected.

   d) Biota was not found in 66% of the total number of grabs that were collected.

2. This is indicative of the very low presence of benthic biota in CG, which is limited by the inhospitable environmental conditions described in section 6.4.2.

3. For both surveys combined, a lower percentage of sampling points returned biota in CG (45%) than at KS (59%), and a higher percentage of grabs returned biota in CG (34%) than at KS (33%).

6.4.4.5 Abundance of organisms

1. It should be noted that for those sampling points that returned biota, the number of individual organisms per sampling point was very low. Combining the grabs at each sampling point for all sampling points for both surveys, the following statistics are derived on abundance of organisms per sampling point.

   a) N-1 (total number) of sampling points = 173.

   b) N-2 (total number) of organisms identified = 1,142.

   c) Mean number organisms per sampling point = 1,142 / 173 = 6.6.

   d) Mode (most common) number of organisms per sampling point = 0.

   e) Range of number of organisms per sampling point = from 0 to a maximum of 239 at KS19 in the dry season survey (interestingly the next highest value was 108 at WSKS19 in the same locality as KS19 in the wet-season survey – see discussion below).

2. These are very low numbers for (mostly) three times five-liter replicate grabs combined (= a 15-liter combined grab sample per sampling point). Most (53%) of the sampling points had zero organisms, while most of those that had biota were in very low numbers. Additionally, most (66%) of the individual grab samples had zero biota.

3. Figures 6.43 to 6.47 graph the number of organisms per sampling point for, in order, the dry-season survey in CG, the dry-season survey at KS, the wet-season survey in CG and the wet-season survey at KS. The graphs show the following distribution of abundance categories for organisms per sample point:

Abundance Category	No. of Sampling Points	Abundance Category	No. of Sampling Points
0:	95	61 to 70:	1
1 to 10:	52	71 to 80:	0
11 to 20:	12	81 to 90:	0
21 to 30:	5	91 to 100:	1
31 to 40:	0	101 to 110:	1
41 to 50:	4	111 to 250:	1
51 to 60:	0		

4. This data shows that most sampling points (95) had zero organisms, followed by 52 sampling points with 1 to 10 organisms, then 12 sampling points with 11 to 20 organisms.

5. There were only 5 sampling points with 41 to 50 organisms. The higher categories of 61 to 70, 101 to 110 and 111 to 250 organisms had only one sampling point each, while the remaining categories had none.

6. These are very low numbers considering that organism sizes, which range from microns to millimeters to a few centimeters at most (depending on organism type), and relative to other inshore tropical marine ecosystems, where benthic grabs can return many hundreds or more individual organisms (author pers. obs. 1987 - 2024).

7. This further indicates the very low abundance of benthic biota in CG, which is limited by the inhospitable environmental conditions described in section 6.4.2.

8. It is noteworthy that the two sample points with the highest number of organisms, two orders of magnitude higher than most other sampling points, were KS19 in the dry-season with 232 organisms from three grabs combined, and WSKS19 in the wet-season with 108 organisms from three grabs combined. Both are in the same immediate locale, hence the same number (19). Sampling point WSKS19 was a wet-season repeat of KS19. All wet-season sampling points were placed as close as possible to equivalent previous dry-season sampling points, although strong currents, vessel movement and normal GPS error did not allow a perfect match, most would be within approximately 30 m.

9. As shown on Figures 6.18 and 6.22, sampling points WS19 and KSWS19 are located between Cape Dussejour and Fathom Rock near the western entrance to CG. As outlined under *Types of organisms* above, at this location there is rock seabed extending from the Cape to the Rock (Fathom Rock is a seaward extension of Cape Dussejour). The benthic grabs in this area returned much higher biota counts with a higher diversity of taxa than other areas because the rock seabed at this location is one of the very few sites in CG that has stable, hard substrate, which sessile benthic biota can settle on and attach to (Figure 6.42).

10. Abundance of organisms per sampling point are shown for the dry-season survey on Figure 6.48 and for the west-season survey on Figure 6.49.

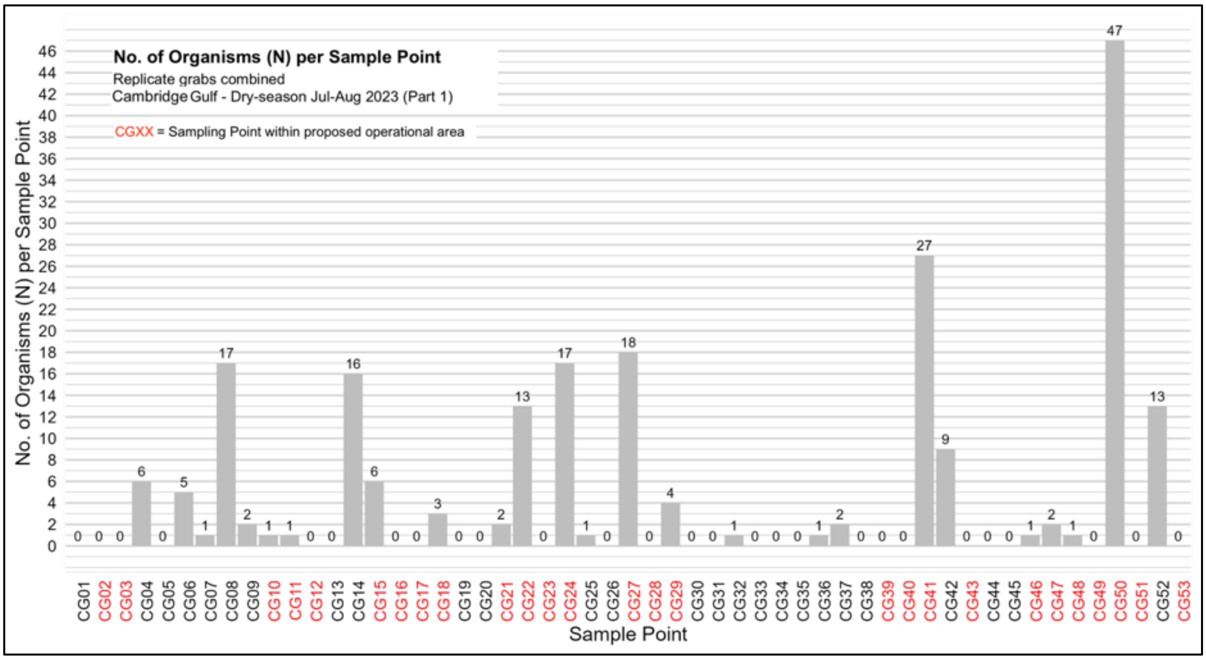


FIGURE 6.43: *No. of organisms per Sample Point (replicate grabs combined) – Cambridge Gulf dry-season survey Jul-Aug 2023 (Part 1 - CG01 to CG53). Red = Sample Point within proposed operational area.*

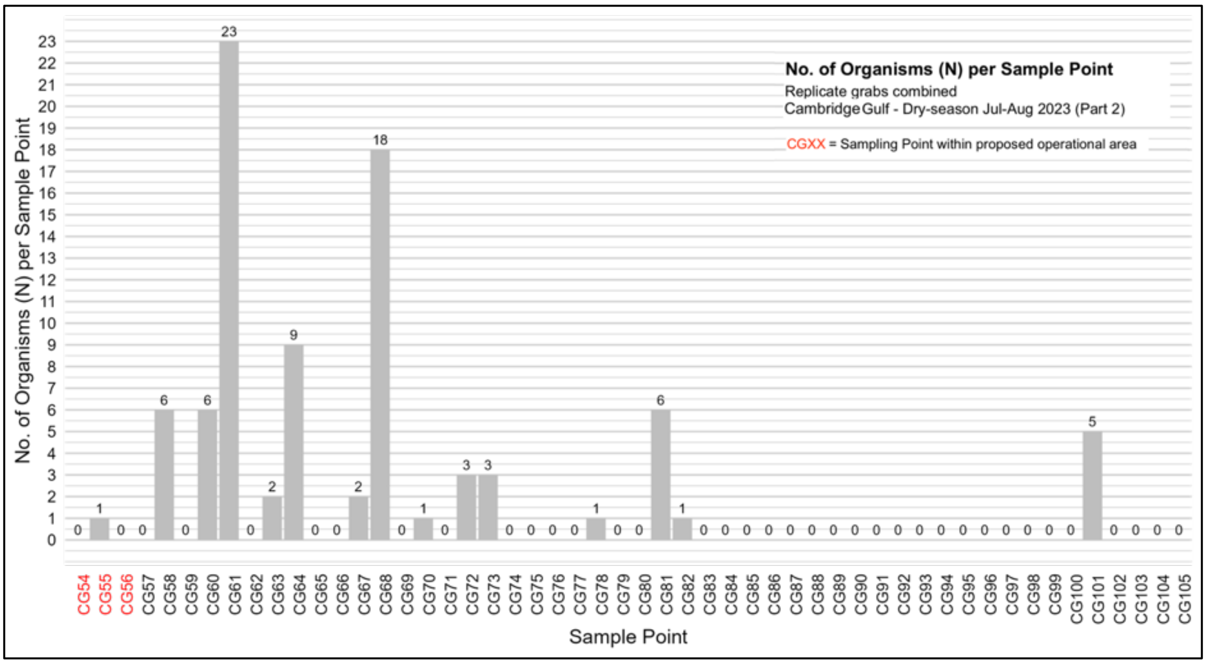


FIGURE 6.44: *No. of organisms per Sample Point (replicate grabs combined) – Cambridge Gulf dry-season survey Jul-Aug 2023 (Part 2 – CG54 to CG105). Red = Sample Point within proposed operational area.*

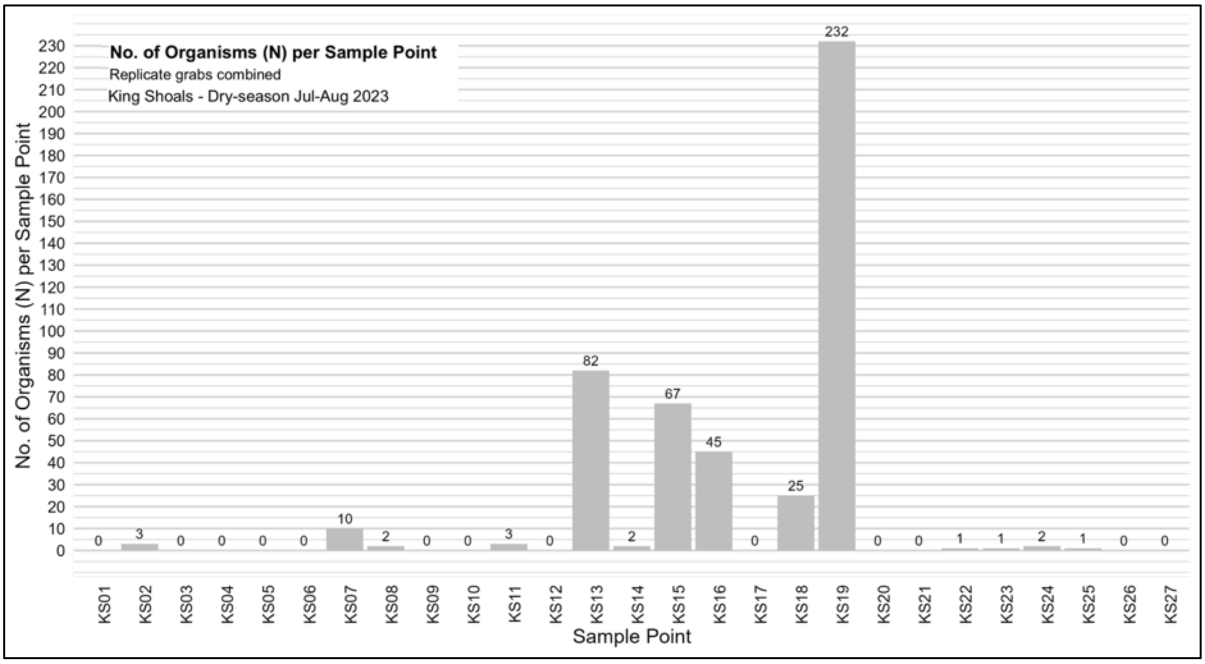


FIGURE 6.45: *No. of organisms per Sample Point (replicate grabs combined) – King Shoals dry-season survey Jul-Aug 2023.*

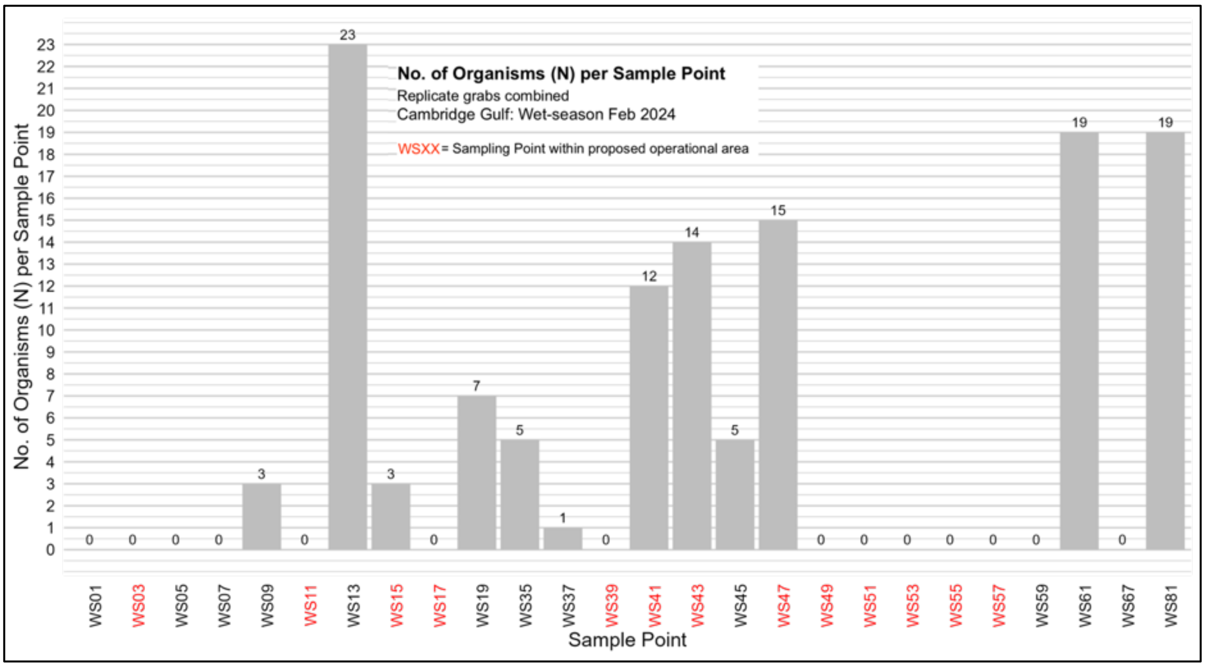


FIGURE 6.46: *No. of organisms per Sample Point (replicate grabs combined) – Cambridge Gulf wet-season survey Feb 2024. Red = Sample Point within proposed operational*

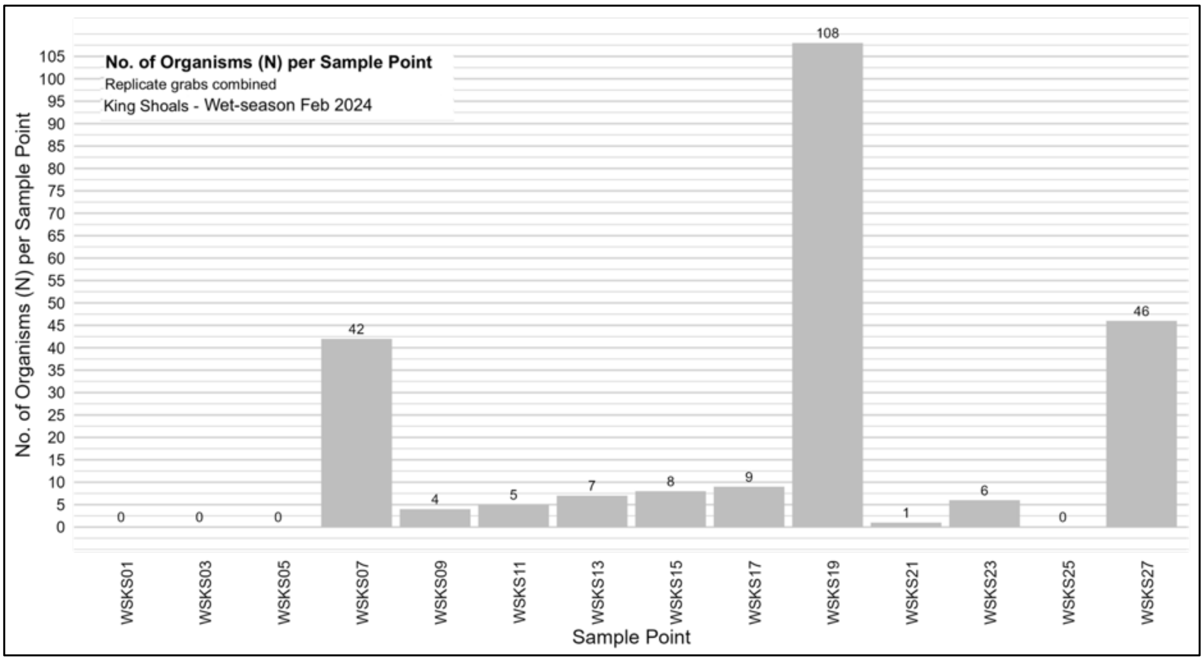


FIGURE 6.47: *No. of organisms per Sample Point (replicate grabs combined) – King Shoals wet-season survey Feb 2024.*

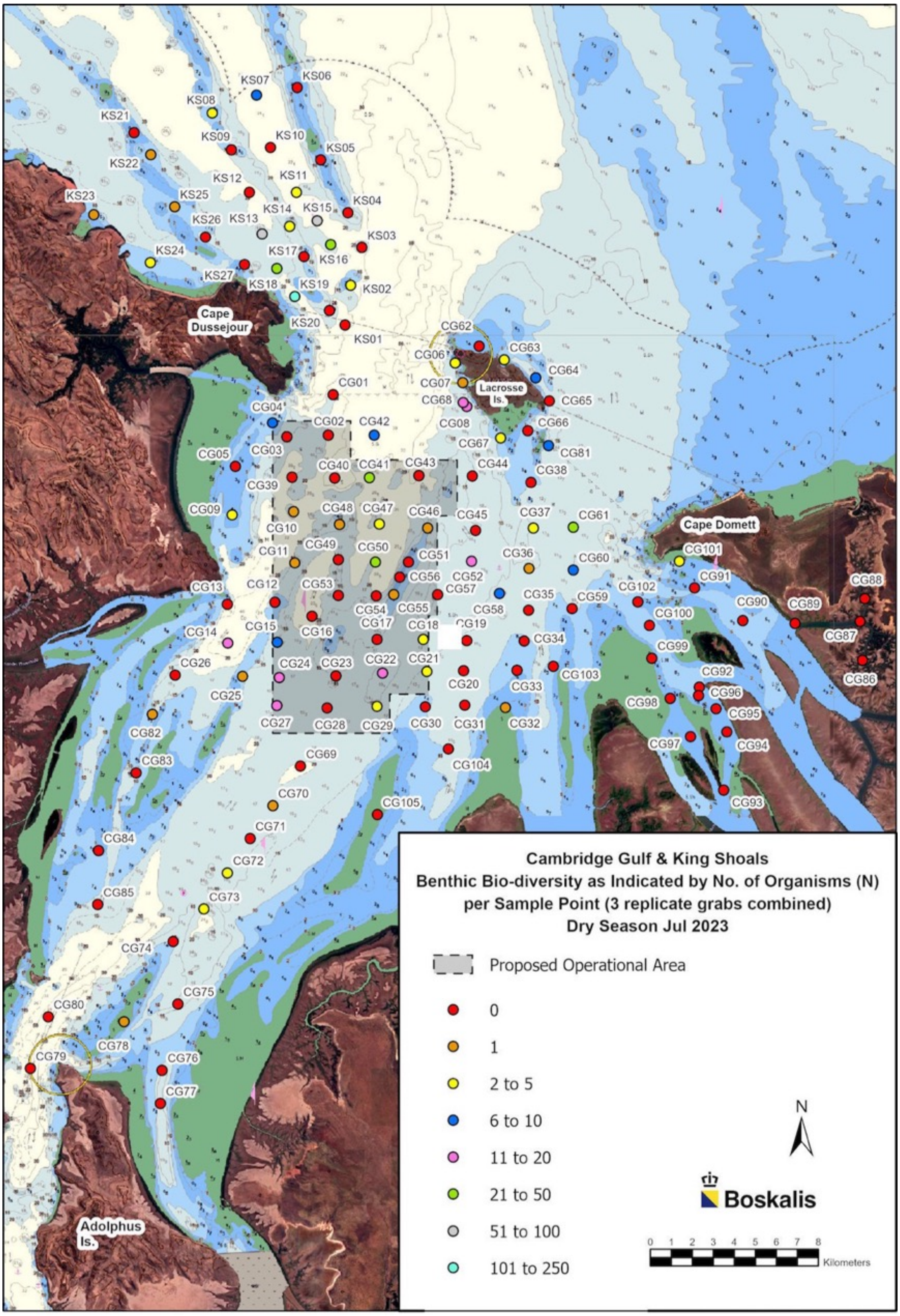


FIGURE 6.48: *No. of organisms per Sample Point (replicate grabs combined) – dry-season survey Jul-Aug 2023. Note the very low values of most abundance categories.*

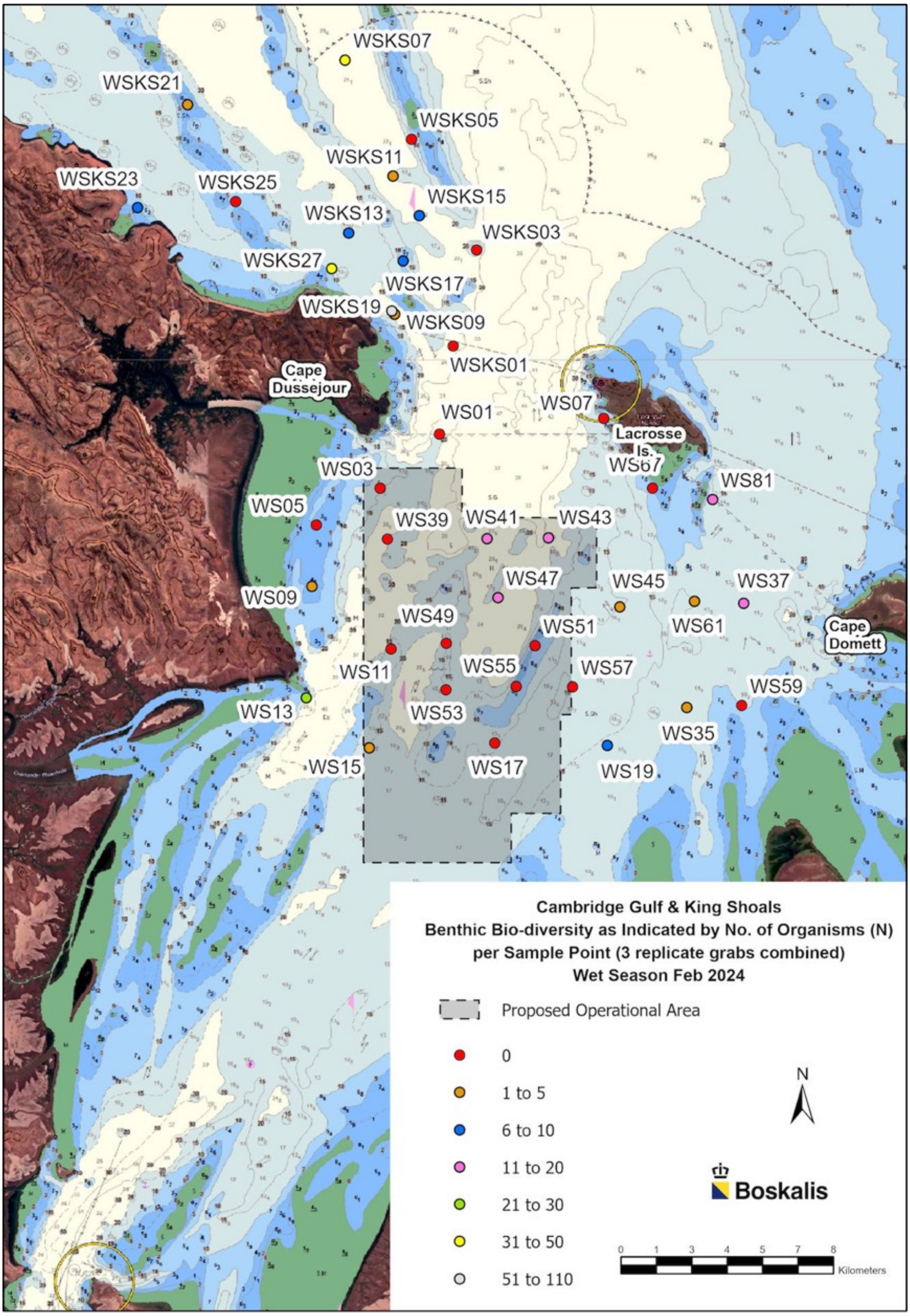


FIGURE 6.49: *No. of organisms per Sample Point (replicate grabs combined) –wet-season survey Feb 2024. Note the very low values of most abundance categories.*

6.4.4.7 Diversity of organisms

1. As outlined above all benthic biota samples were sent to Benthic Australia Pty Ltd for identification to the lowest taxanomic level possible (species level was not possible for many samples). Organisms were identified from 11 phyla and 24 orders/classes as follows (in alphabetical order starting with phyla with orders/classes indented):

- Annelida.
  - Polychaeta.
- Bryozoa.
- Chordata.
  - Tunicata.
    - Ascidiacea.
- Cnidaria.
  - Anthozoa.
  - Hydrozoa.
  - Zoanthazoa.
- Crustacea.
  - Amphipoda.
  - Anomura.
  - Brachyura.
  - Caridea.
  - Decapoda.
  - Isopoda.
  - Penaeoidea.
  - Pycnogonida.
  - Stomatopoda
  - Tanaidacea.
  - Thalassinidae.
- Echinodermata.
  - Crinoidea.
  - Echinoidae.
  - Holothuroidea.
  - Ophiuroidea.
- Heterokontophyta.
  - Phaeophyceae.
- Mollusca.
  - Bivalvia.
  - Gastropoda.
- Nemertea.
- Platyhelminthes.
- Porifera.

2. The majority of organisms found were hydrozoans as described in sub-section 6.4.4.2 above, followed by small custraceans such as amphipods, isopods and small crabs, small sponges (Porifera) and non-sessile bivalves.

3. Diversity indices (S) based on the number of taxa per sampling point were calculated for all sampling points. Figures 6.50 to 6.54 graph the number of taxa per sampling point for, in order, the dry-season survey in CG, the dry-season survey at KS, the wet-season survey in CG and the wet-season survey at KS. The graphs show the following number of taxa per sampling point:

No. of Taxa (S)	No. of Sampling Points
0:	95
1:	18
2 to 5:	30
6 to 10:	11
11 to 20:	11
21 to 50:	7

4. This data shows that most sampling points (95) had zero taxa (no biota), followed by 30 sampling points with two to five taxa, then 18 sampling points with only one taxon, 11 sampling points with six to 10 taxa, 11 sampling points with 11 to 20 taxa, followed by seven sampling points with 21 to 50 taxa. The sites with higher diversity equate to the sites with higher abundance, as discussed in section 6.4.4.6.

5. These are low numbers relative to other inshore tropical marine ecosystems, where benthic grabs can return many tens and sometimes hundreds of taxa per benthic grab (author pers. obs. 1987 - 2024).

6. Additional data and mapping of benthic biota diversity patterns are presented in Annexes 6 and 7, which contain maps showing the presence/absence of each main taxa type per sampling point, in the dry- and wet-seasons respectively. Additionally, Annexes 8 and 9 contain graphs showing the number of each main taxa type per sampling point, in the dry- and wet-seasons respectively.

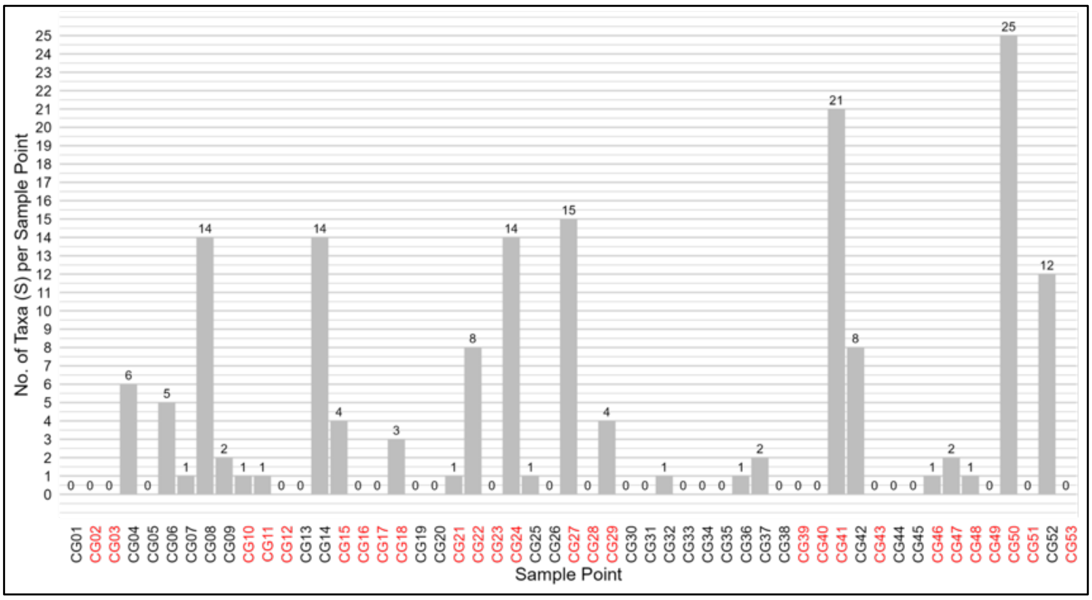


FIGURE 6.50: *No. of taxa per Sample Point (replicate grabs combined) – Cambridge Gulf dry-season survey Jul-Aug 2023 (Part 1 - CG01 to CG53). Red = Sample Point within proposed operational area.*

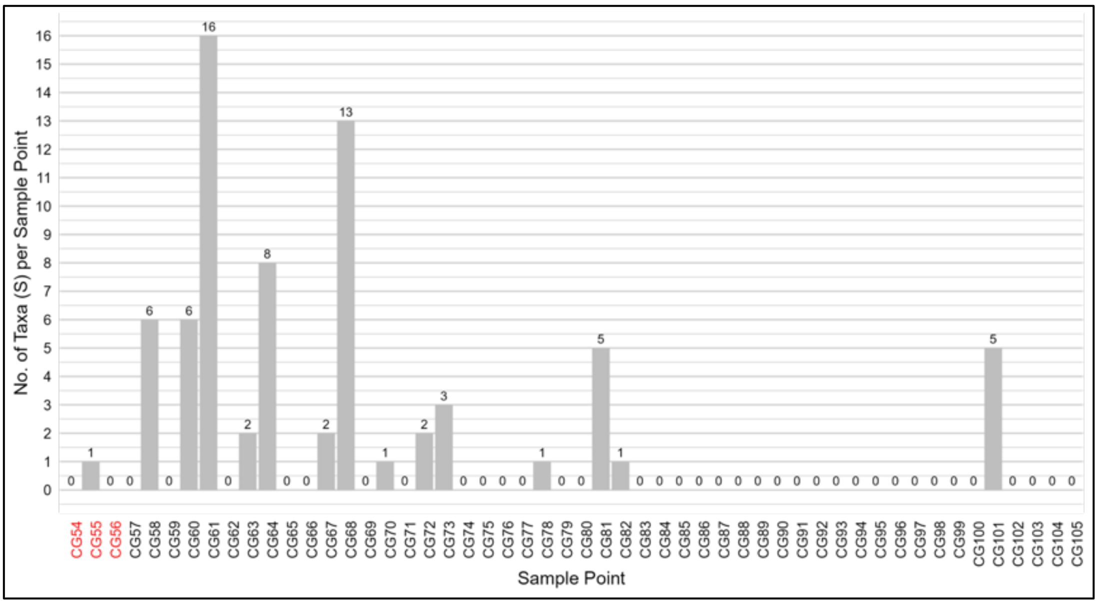


FIGURE 6.51: *No. of taxa per Sample Point (replicate grabs combined) – Cambridge Gulf dry-season survey Jul-Aug 2023 (Part 2 – CG54 to CG105). Red = Sample Point within proposed operational area.*

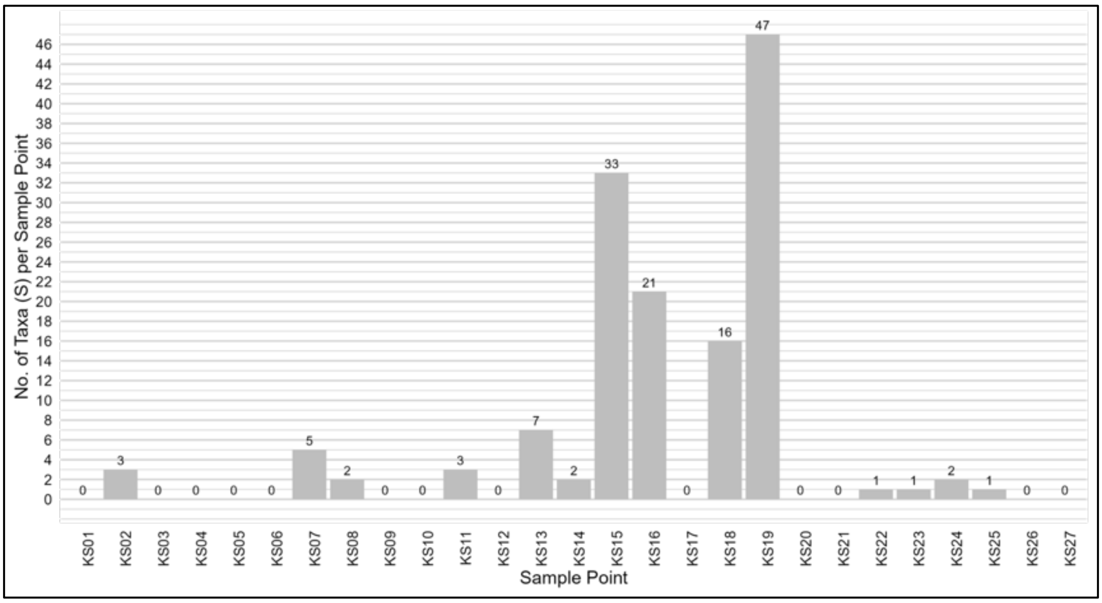


FIGURE 6.52: *No. of taxa per Sample Point (replicate grabs combined) – King Shoals dry-season survey Jul-Aug 2023.*

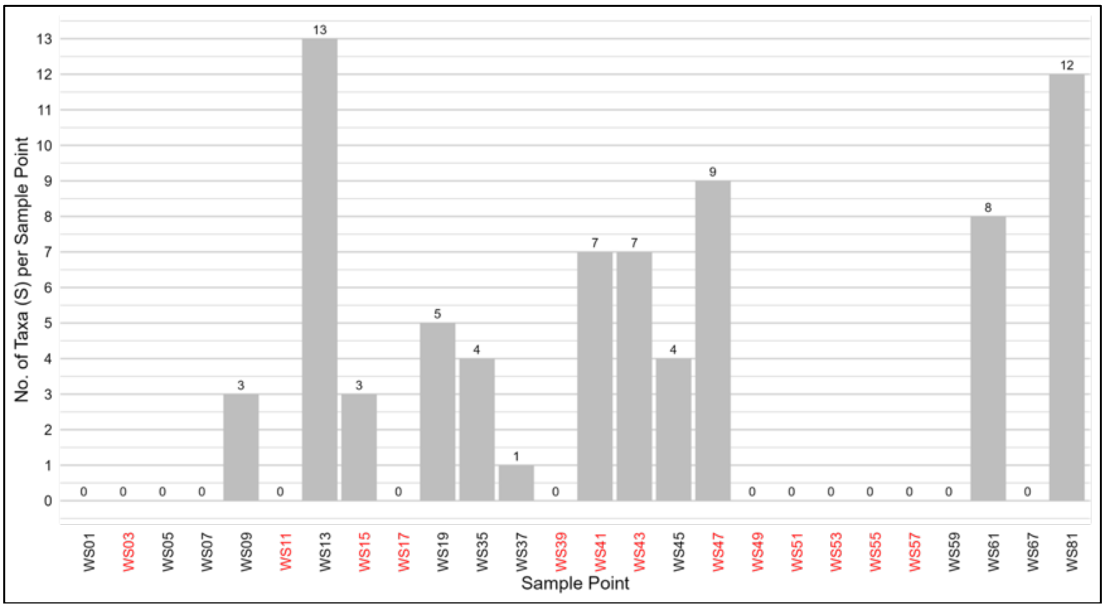


FIGURE 6.53: *No. of taxa per Sample Point (replicate grabs combined) – Cambridge Gulf wet-season survey Feb 2024.*
Red = Sample Point within proposed operational

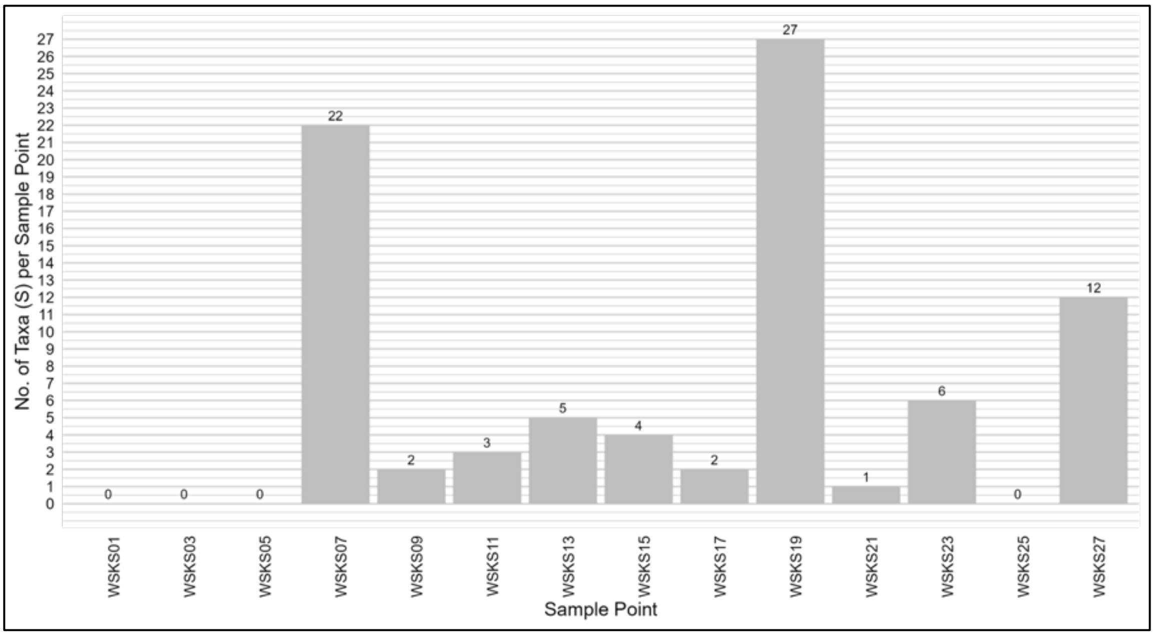


FIGURE 6.54: *No. of taxa per Sample Point (replicate grabs combined) – King Shoals wet-season survey Feb 2024.*

6.4.4.8 Benthic biota in proposed operational area

1. The proposed operational area is a priority focus when assessing the benthic grab sampling results. The sampling points colored red on the X axis of Figures 6.37 to 6.41 and 6.50 to 6.53 above are located in the proposed operational area. The following statistics apply with regard to sampling points in the proposed operational area (POA), for both surveys combined:

   - Number of grabs collected in POA: 132
   - Number of sampling points in POA: 44.
   - Number of sampling points in POA where biota was found: 21
   - Number of sampling points in POA where biota was not found: 23
   - Percentage of sampling points in POA where biota was found: 48%
   - Percentage of sampling points in POA where biota was not found: 52%
   - Total number of organisms found: 188
   - Mean number organisms per sampling point = 188 / 44 = 4.3

2. The mean number of organisms per sampling point of 4.3 is lower than the mean for CG overall, which was 6.6 as outlined in sub-section 6.4.4.5 above.

3. In sand areas, including within the proposed operational area, most grabs returned no biota, as shown on Figure 6.40 above and with another example in Figure 6.55 below. This is most likely because the constant movement of the sand under tidal currents prevents colonization, and there is no hard, stable substrate. In cases where biota was found in sand samples, they typically comprised very small numbers of small crustaceans such as amphipods, isopods and small crabs.

4. The proposed operational area is not comprised entirely of sand, about 25% of the seabed in this area is mixed small rocks, gravel, sand and clay (the deeper 'gullies' between the seabed sand waves). These areas contain the hydroid-dominated benthos that is typical of most non-sand areas in CG, as described in sub-section 6.4.4.2 above.

Pre-sieve

Post-sieve (500 microns)

FIGURE 6.55: *Further example of lack of significant benthos in sand areas. This sample is from site WS49 in the centre of the proposed operational area, and is typical of sand samples from throughout this area and CG overall.*

TABLE 6.2: *Key-data on benthic biota sampling points from Annexes 4 and 5.*

Refer Annexes 4 & 5 for supporting raw data.

Number of sampling points:

	Cambridge Gulf (CG)	King Shoals (KS)	CG & KS combined
Dry-season survey:	105	27	**132**
Wet-season survey:	27	14	**41**
Both surveys combined:	132	41	**173**

Number of sampling points that returned biota:

	CG	KS	CG & KS combined
Dry-season survey:	46	14	**60**
Wet-season survey:	13	10	**60**
Both surveys combined:	59	59	**83**

Percentage of sampling points that returned biota:

	CG	KS	CG & KS combined
Dry-season survey:	44%	52%	**32%**
Wet-season survey:	48%	71%	**56%**
Both surveys combined:	45%	59%	**48%**

Number of grab samples:

Three replicate grabs were taken at most sample points, with less at a few sites due to site conditions (rocky substrate and/or strong currents) as listed in Annexes 4 and 5.
The resulting number of grab samples were:

	CG	KS	CG & KS combined
Dry-season survey:	281	79	**360**
Wet-season survey:	81	42	123
Both surveys combined:	362	121	**483**

Number of grab samples that returned biota:

	CG	KS	CG & KS combined
Dry-season survey:	94	23	**117**
Wet-season survey:	13	10	**23**
Both surveys combined:	107	33	**140**

Percentage of grab samples that returned biota:

	CG	KS	CG & KS combined
Dry-season survey:	33%	29%	**32%**
Wet-season survey:	36%	40%	**37%**
Both surveys combined:	34%	33%	**34%**

6.4.5 Description of Mangroves

Importance of mangroves

1. The EPA's *Technical Guidance for Protection of Benthic Communities and Habitats* (EPA, 2016b) defines mangroves as a benthic community - as they grow on inter-tidal substrates. They are an important primary producer community, provide breeding, nursery and feeding habitat for a wide range of marine species, including crocodiles, numerous fish species, mud crabs, prawns (refer section 9 on marine fauna), and for a range of bird species, fruit bats (*Pteroptus spp*) and other animals.

2. Mangroves also act as filters for nutrients and sediments, reducing erosion and maintain water quality, provide protection of the coast from storms and cyclones, and act as an important carbon sink ('blue carbon) (Hutchison et al., 2014; Fries et al., 2020).

3. Mangroves are protected in WA in accordance with section 16(j) of the *Environmental Protection Act* and potential impacts from proposed developments should be assessed and managed in accordance with the *Technical Guidance* (EPA, 2016).

Mangroves in CG

1. Mangroves are the most significant benthic community in CG, comprising a relatively thin band along most of the coastline, backed by extensive mudflats and sandflats to landward. The mangrove-fringed coast includes the banks of the Helby, Lyne and Thompson Rivers on the western side of CG, and the shores of the deltaic network of tidal inlets that form the False Mouths of the Ord River on the eastern side of CG (part of the Ord River Floodplain Ramsar wetland). These mangroves cover a total area of ~350 km^2 within the LAU, as shown on Figure 6.56.

2. Fifteen species of mangrove trees and plants have been identified in CG as listed in Table 1 at the end of this section. The Apple Mangrove (*Sonneratia alba),* Stilt Mangrove *(Rhizophora stylosa),* Grey Mangrove *(Avicennia marina)* and Orange Mangroves (*Bruguiera spp*) are the most common, depending on the location, zone and community structure in the specific location.

3. Many mangrove areas globally have marked zonation, with the various mangrove species growing in distinct bands starting at the seaward face and moving to landward, with each successive band broadly aligned parallel to the seaward face. The main factors that contribute to this zonation are frequency of inundation by tidal waters, sediment type and salinity, drainage, plant interactions and animal interactions (Johnstone, 1990). In CG most mangrove stands exhibit the following general zonation from the seaward face to landward (Semeniuk et al., 1978; Cresswell and Semeniuk, 2011).

   a) *Sonneratia alba* or *Avicennia marina* or mix of both,
   b) *Avicennia marina* or *Avicennia marina* and *Bruguiera parviflora*,
   c) *Rhizophora stylosa*,
   d) *Ceriops tagal*, and
   e) *Avicennia marina.*

4. Nevertheless, multiple interactions between the various environmental conditions and locally variable sediment types, slope and geomorphology can create considerable complexity to this otherwise simplified zonation pattern (Figure 6.57). In many areas the Stilt Mangrove (*Rhizophora stylosa*) forms the seaward zone, especially at sites up the tidal inlets of the False Mouths of the Ord (Figure 6.58).

5. The up to 8 m tidal range is a significant influence on community structure and function of mangroves in CG (Figure 6.59)

6. Because the overall band of mangroves in CG is relatively narrow in most areas – from 10 to 50 metres wide, there is limited scope for the development of distinct zonation (Figures 6.60 & 6.61). However, there are some areas where the mangrove band extends more deeply to landward, and zonation is distinct (Figure 6.62).

7. Figure 6.63 shows some typical aerial views of mangroves in CG with map locators, and Figures 6.64 and 6.65 show some typical planar views with map locators.

Mangroves dynamics in CG

1. The mangroves in CG and especially on the eastern coastline and in the Ramsar area appear to be highly dynamic, with numerous areas of significant natural erosion and undercutting of mangroves (Figures 6.66 & 6.67). These natural erosion areas mainly face to the north-west and may therefore be impacted by north westerly winds and waves. They may be less sheltered from cyclone impacts than other parts of CG.

2. Previous studies have assessed historical changes in the extent of mangrove communities in CG. Studies by Jennings (1975) and Thom et al. (1975) report a net gain of mangroves in CG over 20 years from 1955 to 1975, based on comparisons of aerial photographs. A more recent comparison of satellite imagery taken 24 years apart (1996-2020) demonstrated an estimated net reduction in mangrove area in CG of 9,077 ha, as shown on Figure 6.68 (Global Mangrove Watch, 2020; Bunting et al., 2022). This scale of loss (especially if caused by cyclones) is not unprecedented. Paling et al. (2008) reported the loss of 5,700 ha of mangroves from Exmouth (WA) following a single cyclone in 1999 (TC Vance), followed by significant recovery in the subsequent decade.

Impact of the Ord River dam on mangroves

1. Construction of the Ord River Dam has also affected mangrove distribution and extent in the Lower Ord River upstream from CG. Studies by Semeniuk (2000) and Wolanski et al. (2001 and 2004) estimated a major accumulation of sediment of about 20 million m^3 in the estuarine sections of the Lower Ord River over a 30-year period after the Ord River Dam was completed in 1971. This sedimentation caused a 50% decrease in cross-sectional areas of the estuary over the same period, which resulted in an increase in the extent of mangroves in the Ord River estuary.

Proximity of the proposal to mangroves

1. As shown on Figure 6.56, the closest distance between the proposed operational area and mangroves is ~4 km, between the north-west corner of the operational area and the mouth of the Helby River on the north-west coast of CG. Most mangrove areas are >10 km from the outer boundaries of the operational area. The proposal is a 100% marine-based operation and does not involve any construction or operation of shore-based infrastructure, facilities or activities. Potential impacts on mangroves are assessed in Referral Report No. 4 – *Impact Assessments* (BKA 2024d).

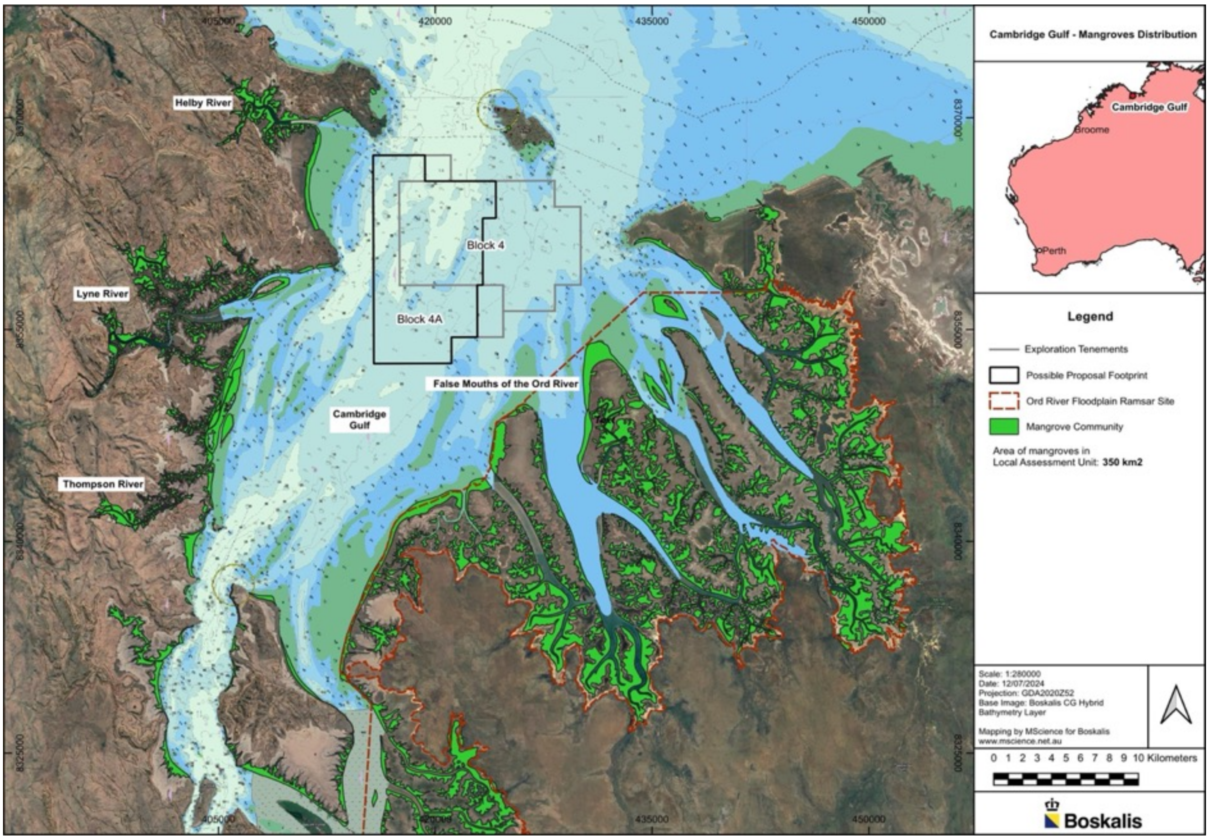


FIGURE 6.56: *Mangrove distribution in CG – a narrow band fringing most of the coast. Total canopy cover = 350 km^2.*

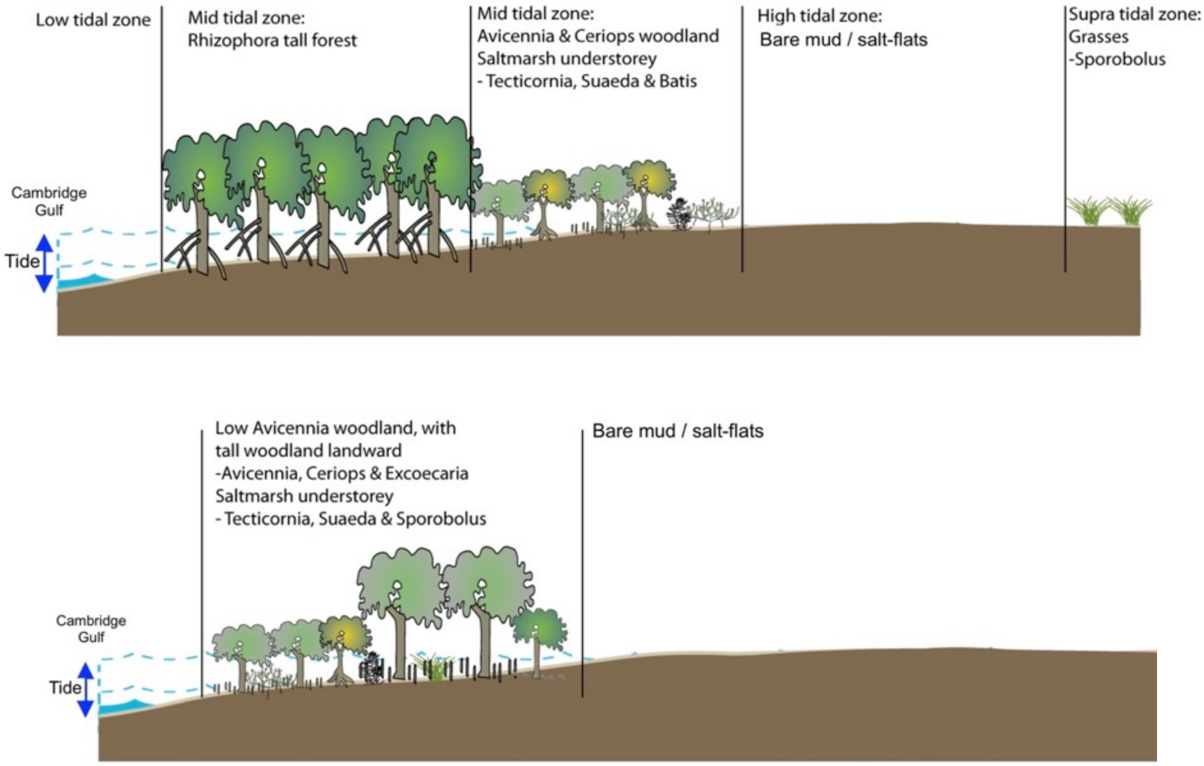


FIGURE 6.57: *Two variations of mangrove zonation in CG. Adapted from Hale (2008).*

FIGURE 6.58: *In many areas the Stilt Mangrove (Rhizophora stylosa) forms the seaward zone, especially at sites up the tidal inlets of the False Mouths of the Ord (image: Raaymakers Feb 2024)*

HIGH TIDE **LOW TIDE**

FIGURE 6.59: *The up to 8 m tidal range is a significant influence on community structure and function of mangroves in CG (images: Raaymakers Feb 2024).*

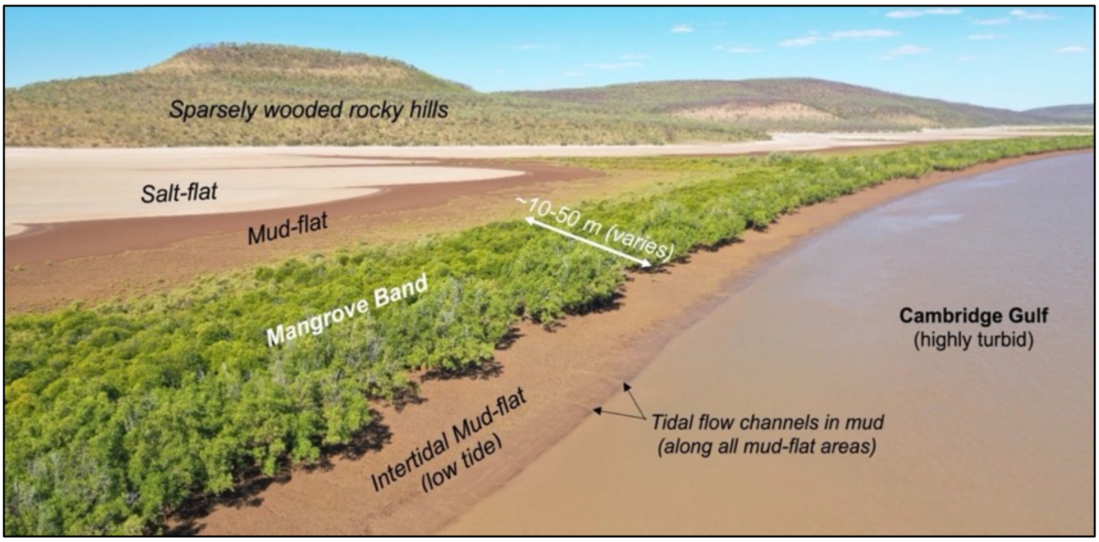


FIGURE 6.60: *The typical coastal environment that lines the majority of the coastline within CG. This shows the relatively narrow band of mangroves that constitute the most significant benthic community in CG.*

FIGURE 6.61: *The narrow bands of mangrove that line the inlets in the Ramsar wetland on the eastern side of CG.*

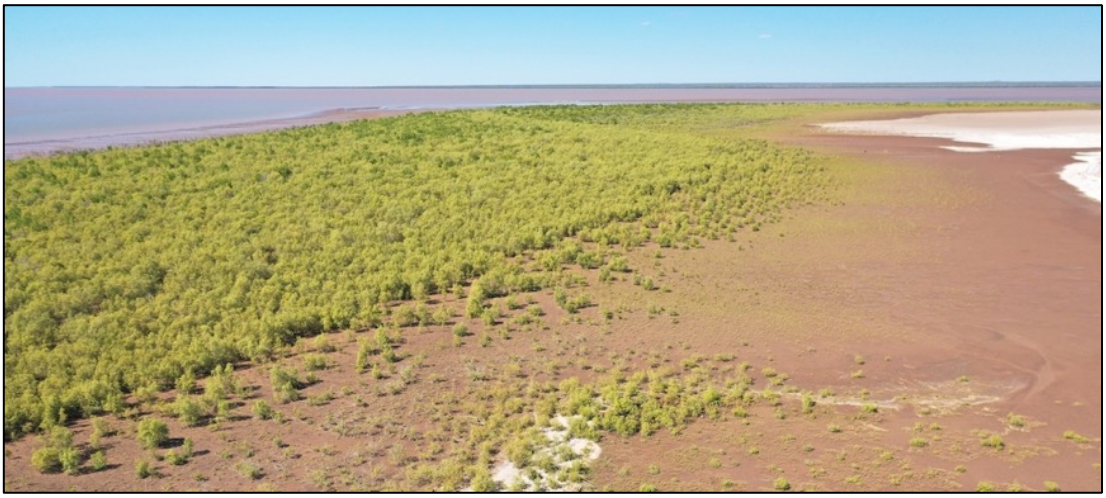


FIGURE 6.62: *In some areas of CG the mangrove bands are wider – this is Barnett Point looking north.*

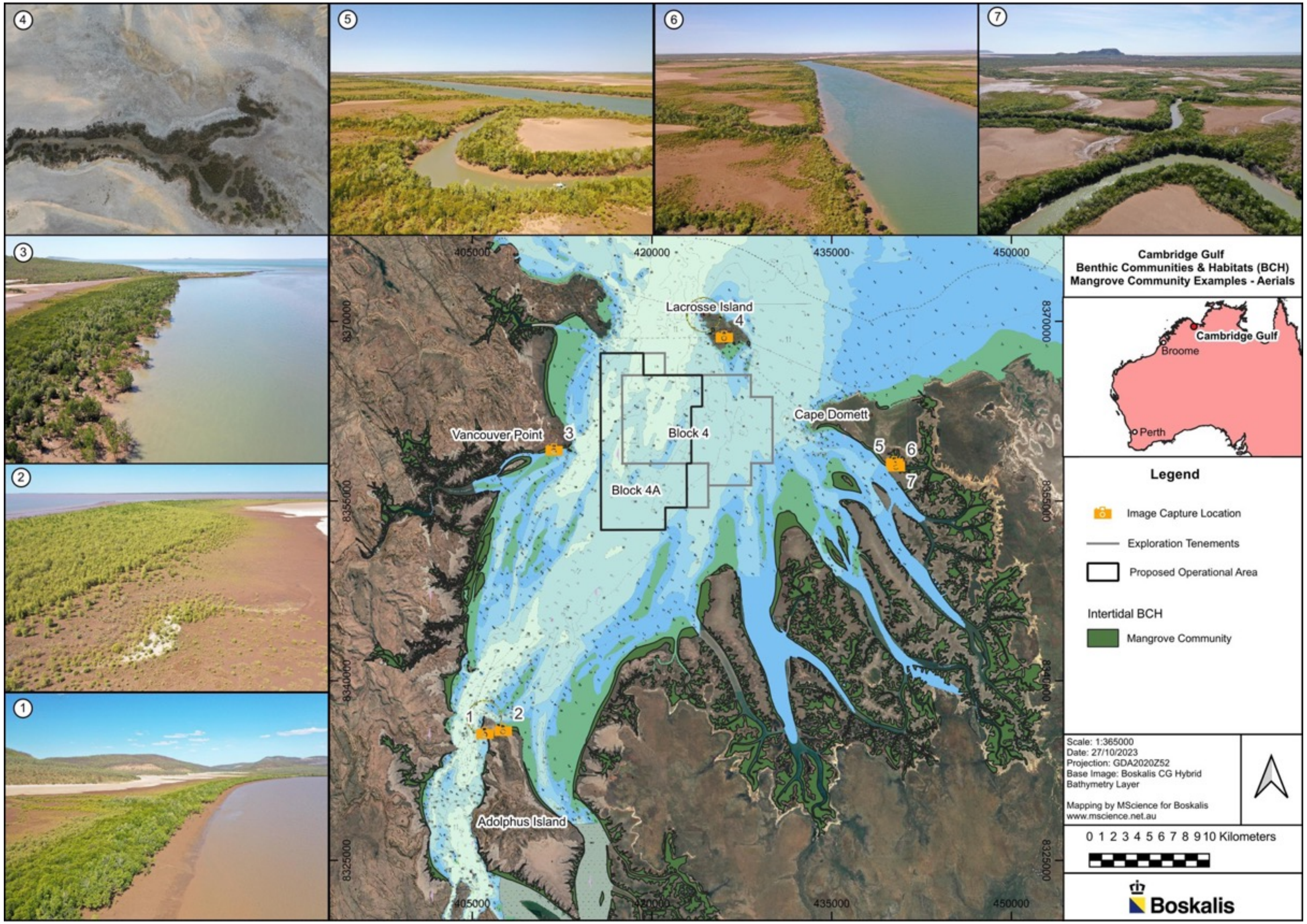


FIGURE 6.63: *Some aerial views of typical mangrove communities around CG.*

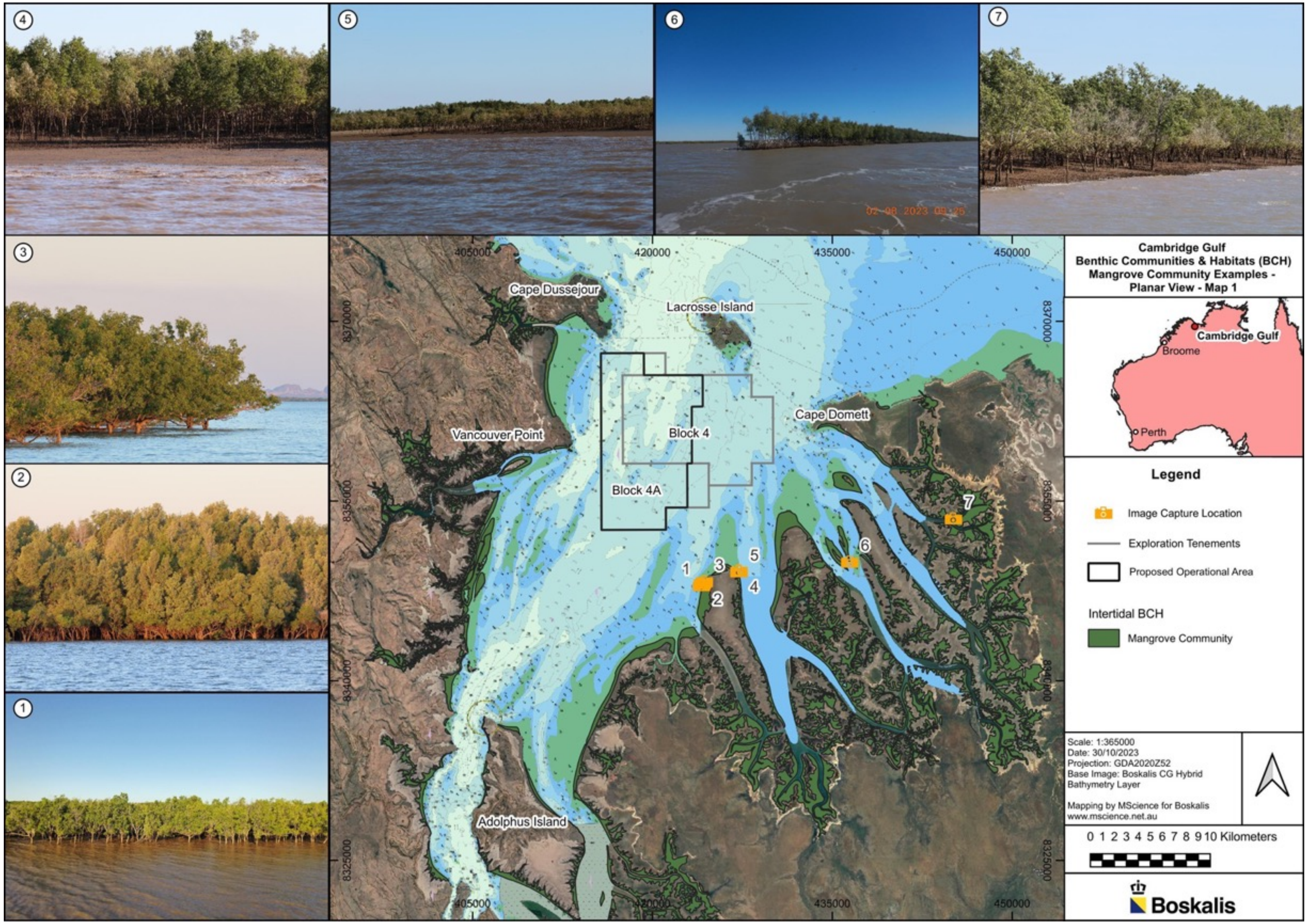


FIGURE 6.64: *Some planar views of typical mangrove communities around CG.*

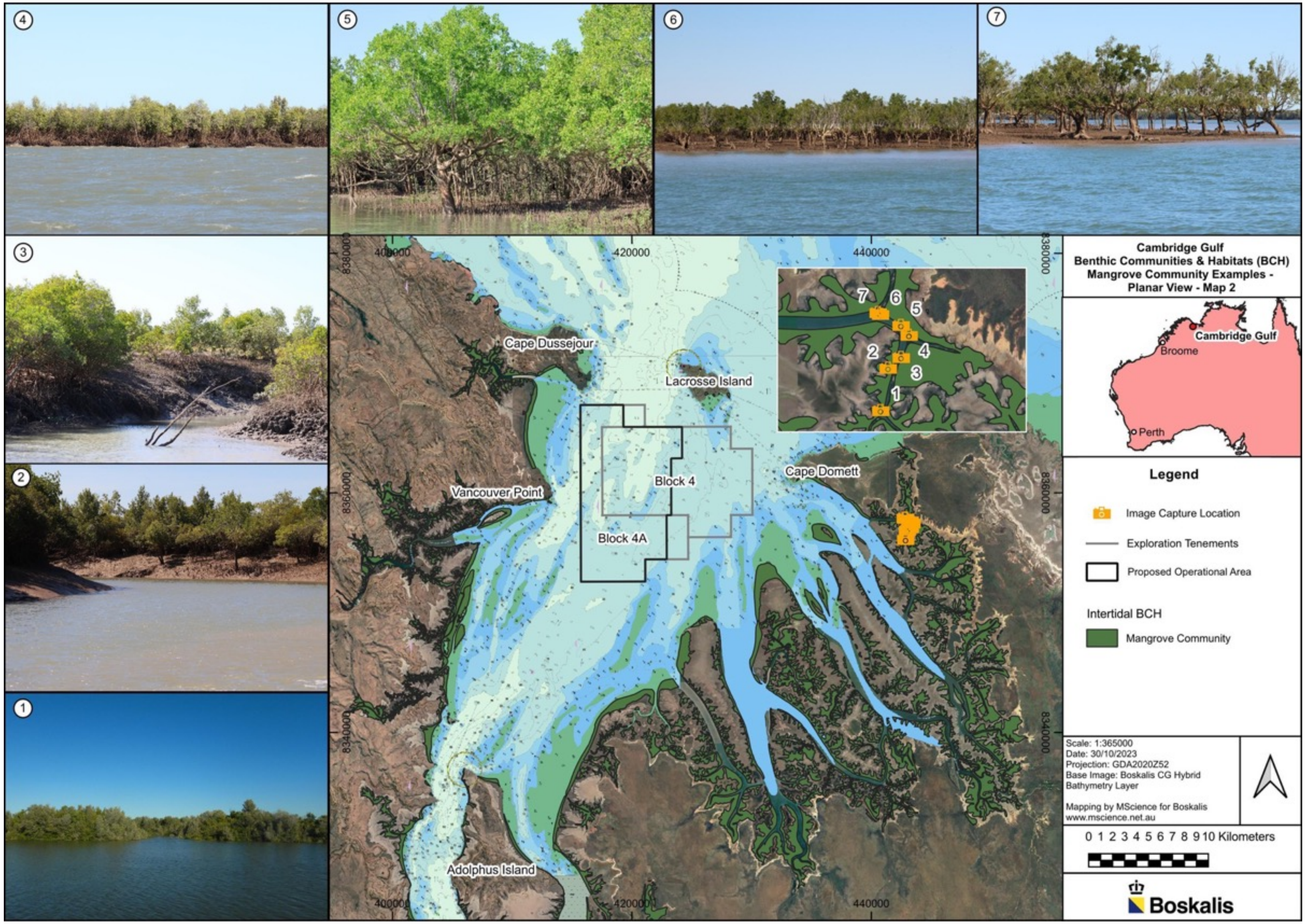


FIGURE 6.65: *Some planar views of typical mangrove communities around CG.*

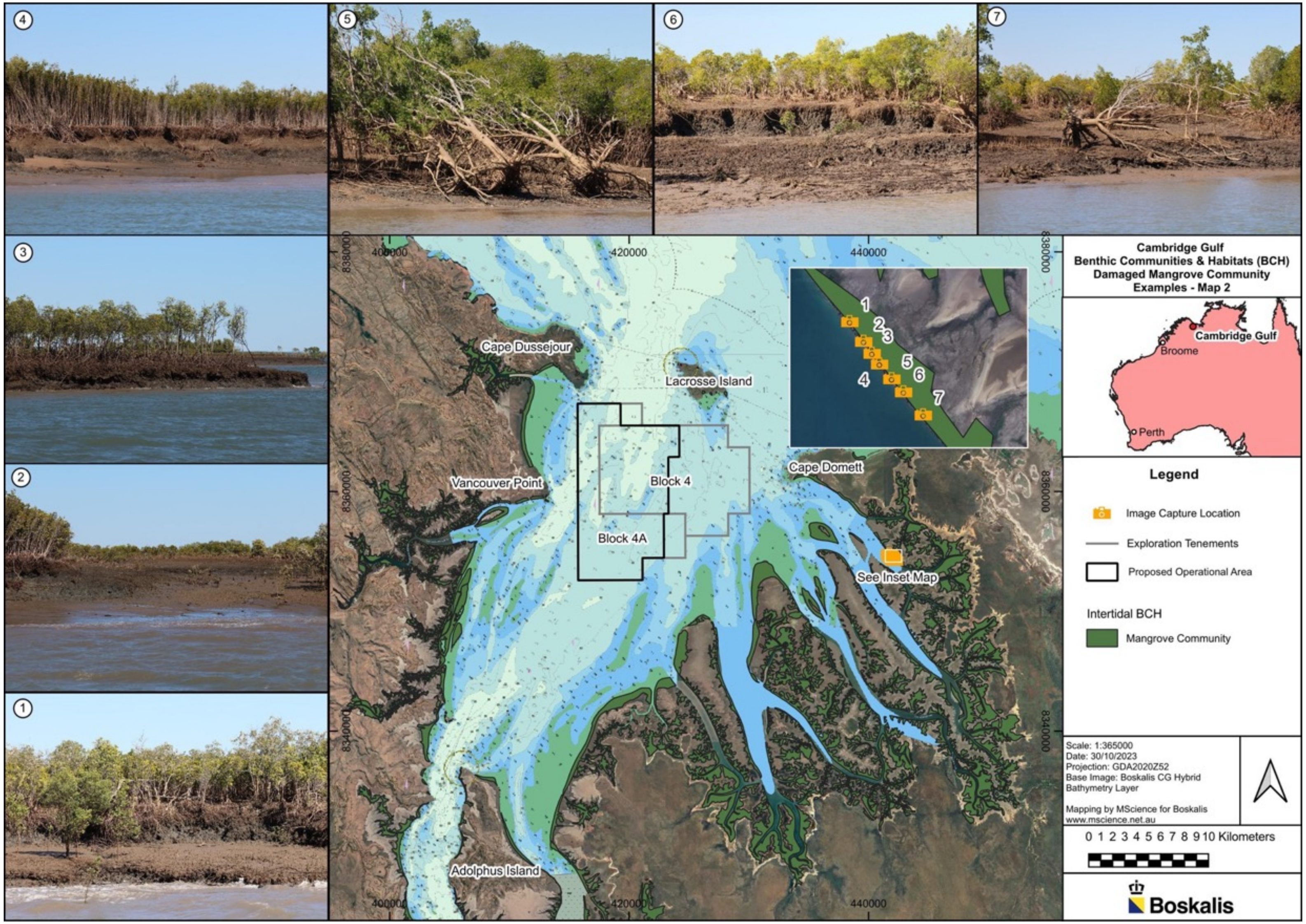


FIGURE 6.66: *Some examples of natural mangrove damage and erosion around CG.*

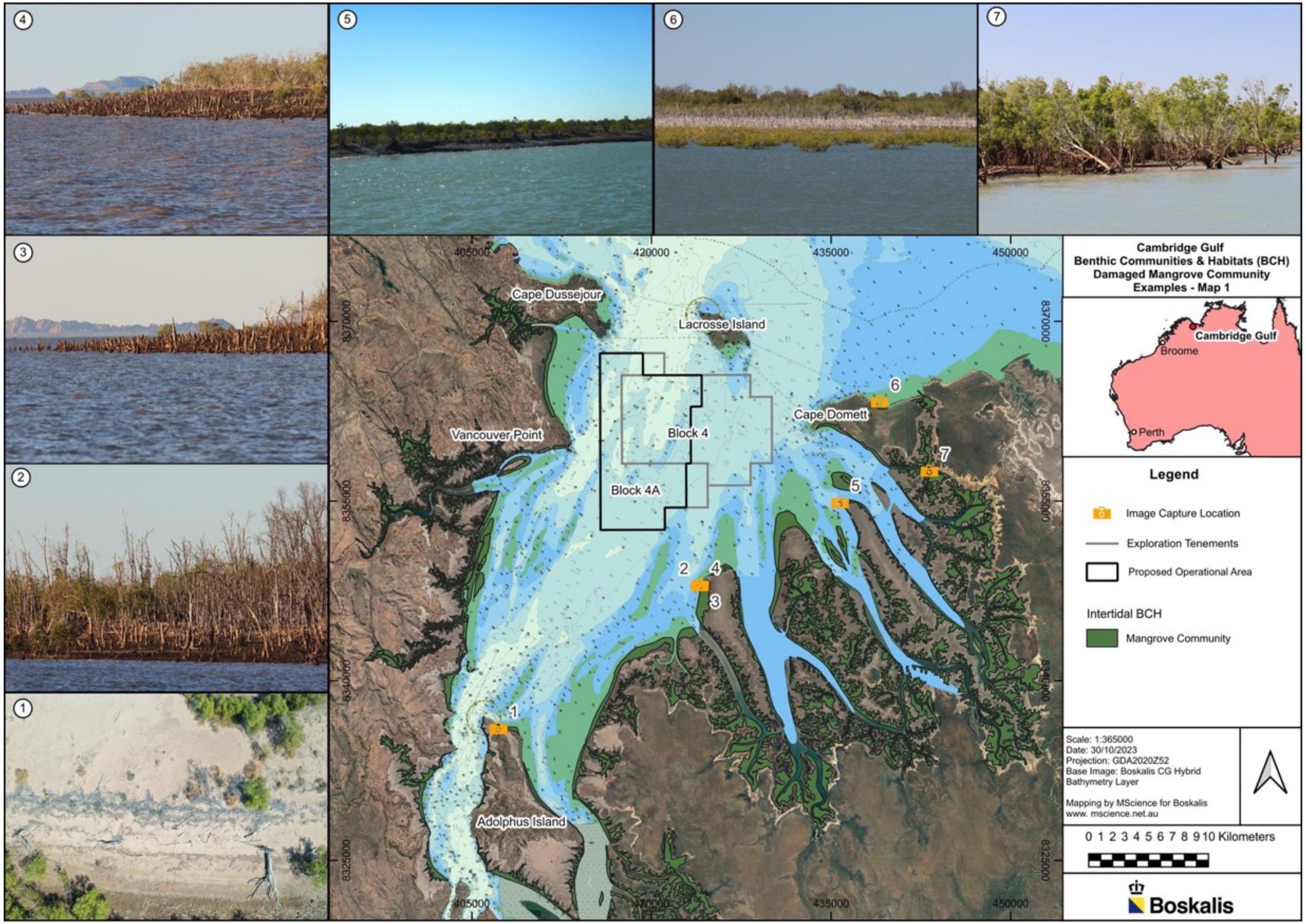


FIGURE 6.67: *Some examples of natural mangrove damage and erosion around CG.*

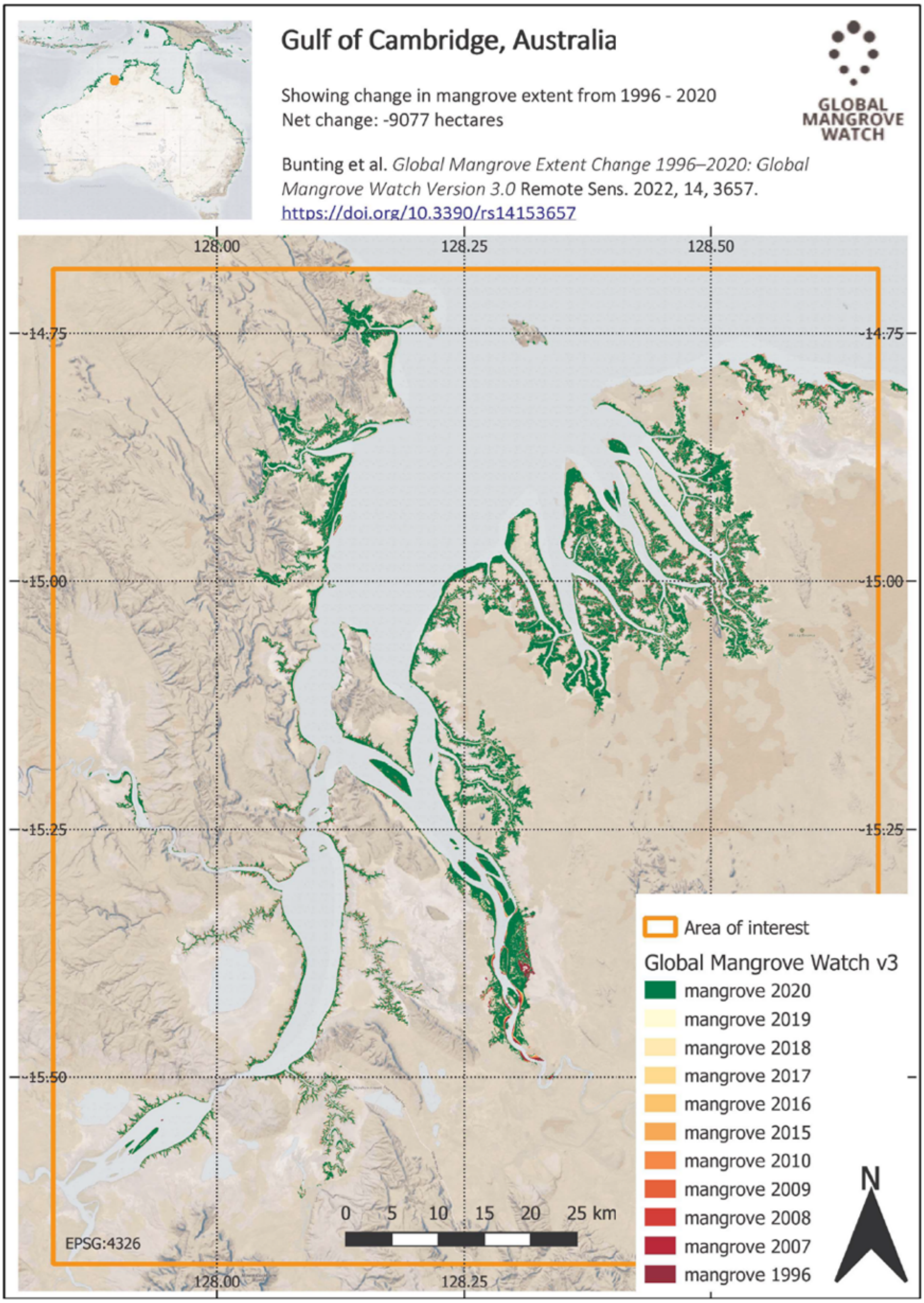


FIGURE 6.68: *Changes in mangrove extent in CG 1996 to 2020 (Global Mangrove Watch).*

TABLE 6.5: *Mangrove species recorded from the Cambridge Gulf region (Johnstone, 1990).*

Species			Description
1		Sea Holly *Acanthus ebracteatus*	A low viny herb (1-2m) growing under canopy patches where it forms thickets and scrambles over adjacent vegetation (Duke, 2006). In Cambridge Gulf, this species is only known from King River (Johnstone, 1990).
2		Southern Club Mangrove *Aegialitis annulata*	A low shrubby mangrove (up to 2m) with a knobbly, secondarily thickened stem base, that typically occupies exposed, often rocky sites subject to wave exposure and tidal action (Duke, 2006).
3		Black Mangrove *Aegiceras corniculatum*	A widely distributed 'true' mangrove shrub/small tree (up to 5m) with sweet-scented white flowers and distinctly curved horn-like fruits, generally occurs more upriver as dense sub-canopy, frontal hedges bordering estuarine margins (Duke, 2006).
4		Grey Mangrove *Avicennia marina*	Possibly the most widely distributed species of all mangroves (often up to 10 m, occasionally up to 30 m tall). This is a typical pioneering species that displays a wide tolerance to temperature, salinity, tidal inundation and substrate types (Duke, 2006). These features allow it to become established in sites where no other mangrove can survive. It's dense networks of pneumatophores and cable roots play a key role in trapping and stabilisation of sediments and prevention of soil erosion.
5		Rib-fruited Orange Mangrove *Bruguiera exaristata*	A common tree (up to 25 m tall) of the upper (high) intertidal mangrove zone, easy to recognise by its buttressed trunk, knee-like pneumatophores and cigar-like propagules. This species can also be found in tidal backwaters and as stunted stands bordering salt pans and sandy beaches (Duke, 2006).
6		Small-flowered Orange Mangrove *Bruguiera parviflora*	This mangrove tree species (up to 25 m tall) occurs as monotypic forests of inner mangrove fringe stands, typically forming dense forests of slender (straight and tall) trees with high branching (Duke, 2006). The trees have buttresses at the base of the trunk and knee roots. The flowers of this relatively small-leaved mangrove are visited by small insects including butterflies which appear best suited to triggering the explosive pollen release.
7		Kapok Mangrove *Camptostemon schultzii*	A soft-wooded evergreen tree species (up to 30 m tall) with silvery leaves, clusters of small flowers and fluted stem base buttresses (sometimes multi-stemmed). This species, a relative of the durian, is usually found in the high intertidal zone of mangrove habitat (Duke, 2006).
8		Spurred Mangrove *Ceriops tagal*	A common, widely distributed constituent of mangrove forests in the high-mid intertidal, sometimes forming dense thickets. This species often grows as broad monotypic stands across gently sloping tidal areas surrounding estuarine deltas of sheltered coastlines, including in parts of Cambridge Gulf (Duke, 2006). It occurs as either a shrub or tree (<25 m tall, often shorter) and can be recognised by its typical erect ovate leaves, ribbed/grooved propagules and stocky buttresses at the stem base.
9		Milky Mangrove *Excoecaria agallocha*	A mangrove-associate tree species (up to 15 m tall) that occurs in the high-mid intertidal of estuarine mangrove areas. This species is conspicuously dioecious, with separate male and female trees. Trees of this species are also notable during the dry season when they sometimes shed and replace their leaves turning bright red and orange before they fall (Duke, 2006).
10		White-flowered Black Mangrove *Lumnitzera racemosa*	A mangrove-associate species (up to 15 m tall) that often occurs along upland mangrove margins of relatively arid areas where they border relatively open high intertidal margins and exposed salt pans (Duke, 2006). In wetter areas, this species can form diminutive forest stands of slender trees in association with various other mangrove species. Its white flowers attract a range of faunal visitors (esp. insects) (Duke, 2006).

Species			Description
11		Myrtle Mangrove *Osbornia octodonta*	A mangrove-associated shrub or small tree (up to 5 m tall) that rarely forms monotypic stands but is typically found in association with other species, occurring as back beach stands bordering the highwater margin or as under-canopy shrub within exposed *Rhizophora* forests (Duke, 2006). The species is commonly found on sandy beaches where there is beach rock.
12		Reef Barrier Mangrove *Pemphis acidula*	An evergreen mangrove shrub to small tree (up to 7 m tall) with white flowers that is usually found in the high intertidal on coral reef ramparts, clinging to weathering limestone outcrops or along low-lying corally-sandy beach zones (Duke, 2006).
13		Stilt Mangrove *Rhizophora stylosa*	A widespread mangrove tree species (up to 30 m tall) typical of Australia's northern coastline. This species is tolerant of a wide range of exposure conditions allowing it to occupy both muddy downstream estuarine reaches as well as sandy, rocky and coral rampant intertidal areas (Duke, 2006). It often forms monotypic stands of either columnar tall trees or as dense and impenetrable thickets, depending on climatic and sediment conditions, but can also be found associated with various other downstream estuarine mangrove species (Duke, 2006). Johnstone (1990) reports that this species is lacking from the inner estuary of Cambridge Gulf.
14		Apple Mangrove *Sonneratia alba*	One of the most widely distributed of mangrove species (up to 20 m tall), found mostly at lower tidal contours within frontal stands of downstream lower estuarine reaches (Duke, 2006). It is very common in Cambridge Gulf. This species is commonly associated with other mangrove species (notably *Rhizophora stylosa, Aegiceras corniculatum* and *Avicennia marina*) and can grow in a range of sediment types from sand, gravel or soft river muds. It's dense networks of pneumatophores and cable roots play a key role in sediment trapping and stabilisation and the prevention of soil erosion.
15		Cedar Mangrove *Xylocarpus moluccensis*	A small to medium-sized deciduous tree (up to 15 m tall) with a relatively sparse canopy that sheds its leaves every year (usually somewhere between July and October). This species is commonly found in middle reaches at the mid- to upper tidal limit of most river estuaries, often mixed with other mangrove species (Duke, 2006). Surrounding the stem base are conical woody pneumatophores. This species is commonly found in a variety of substrates from soft oozy mud to sand and coarse gravel (Duke, 2006).

6.4.6 Description of Intertidal Mud-flats & Salt-flats

1. Most of the mangrove areas in CG are backed by extensive mud-flats and salt-flats. Both areas are combined as ‘intertidal flats’ shown in white on the BCH map (Figure 6.34 in section 6.4.1). They cover a combined area of 602.5 km^2 in the LAU.

2. These areas are inundated by seawater on spring high tides and partially dry out and are exposed to the sun on spring low tides. The mud-flat band has a brown colour and typically backs the landward edge of the mangroves. The mud-flats merge landward into the salt-flat areas which have lighter brown to whitish colouration. Figure 6.60 in section 6.4.5 above shows the mud-flat and salt-flat bands backing the seaward mangrove band. Figure 6.69 below shows an example of dendritic drainage lines on a salt-flat in CG, where the flooding tide pushes in to inundate the flat and the ebbing tide drains back to the sea.

3. The salt-flat areas have slightly higher elevation and less frequent tidal inundation than the mud-flat areas. This allows sufficient time between tidal inundations for solar evaporation of the last tidal inundation to create the surface layers of salt, hence the whiter colouration.

4. This habitat is hypersaline especially during the dry season, with vast areas of bare substrate and only limited patches of vegetation cover, mainly comprising low, salt-tolerant grasses and succulents (samphire) around the edges and on slightly higher parts of the flats (Figure 6.70).

5. The intertidal flats can also be inundated by freshwater and brackish water during wet season runoff events (Figure 6.71), when they provide habitat for shore birds and wading birds (Hale 2008).

6. Figure 6.72 shows some examples of intertidal flats around CG with map locations.

7. The BKA proposal is a 100% marine-based operation and does not involve any construction or operation of shore-based infrastructure, facilities or activities on intertidal flat areas. Potential impacts on these areas are assessed in Referral Report No. 4 – *Impact Assessments* (BKA 2024d).

FIGURE 6.69: *Example of dendritic drainage lines on a salt-flat in CG where the flooding tide pushes in to inundate the flat and the ebbing tide drains back to the sea. This is on the west coast of Adolphus Island.*

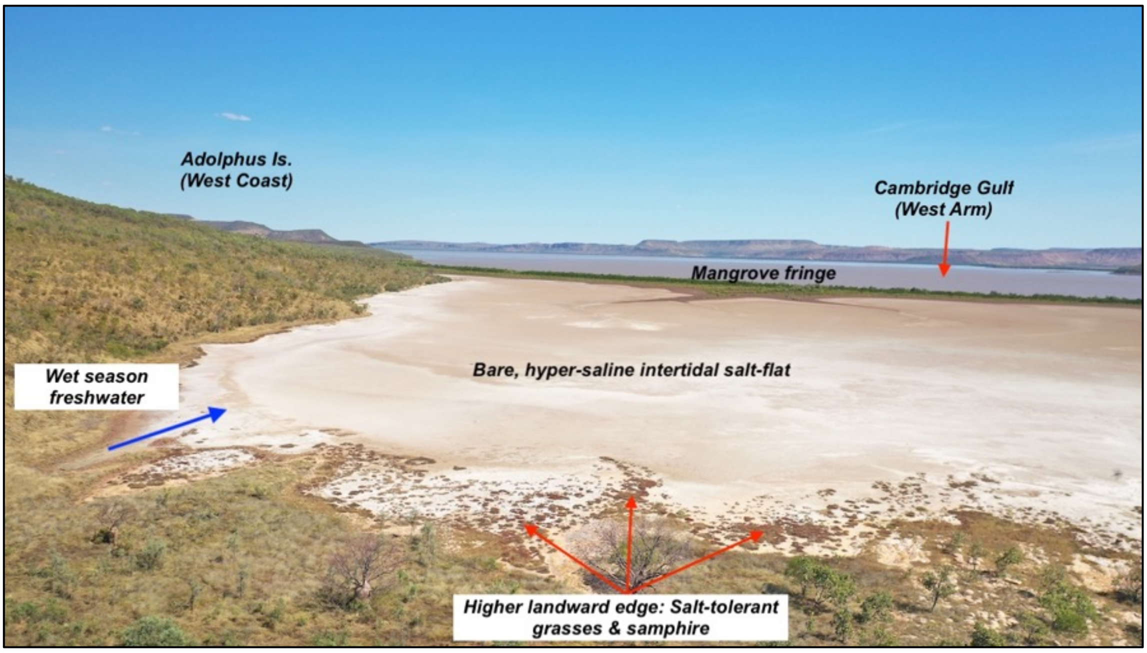


FIGURE 6.70: *Example of typical intertidal salt-flat CG. This is on the west coast of Adolphus Island.*

FIGURE 6.71: *The intertidal flats of CG can be inundated by freshwater and brackish water during major wet season runoff events. The normally whitish salt-flats appear brown due to an overlay of sediment-laden flood waters, which contribute alluvial sediments to the system. This is one of the tidal inlets that comprise the False Mouths of the Ord, on the eastern aside of CG (source: NW Regional Hub).*

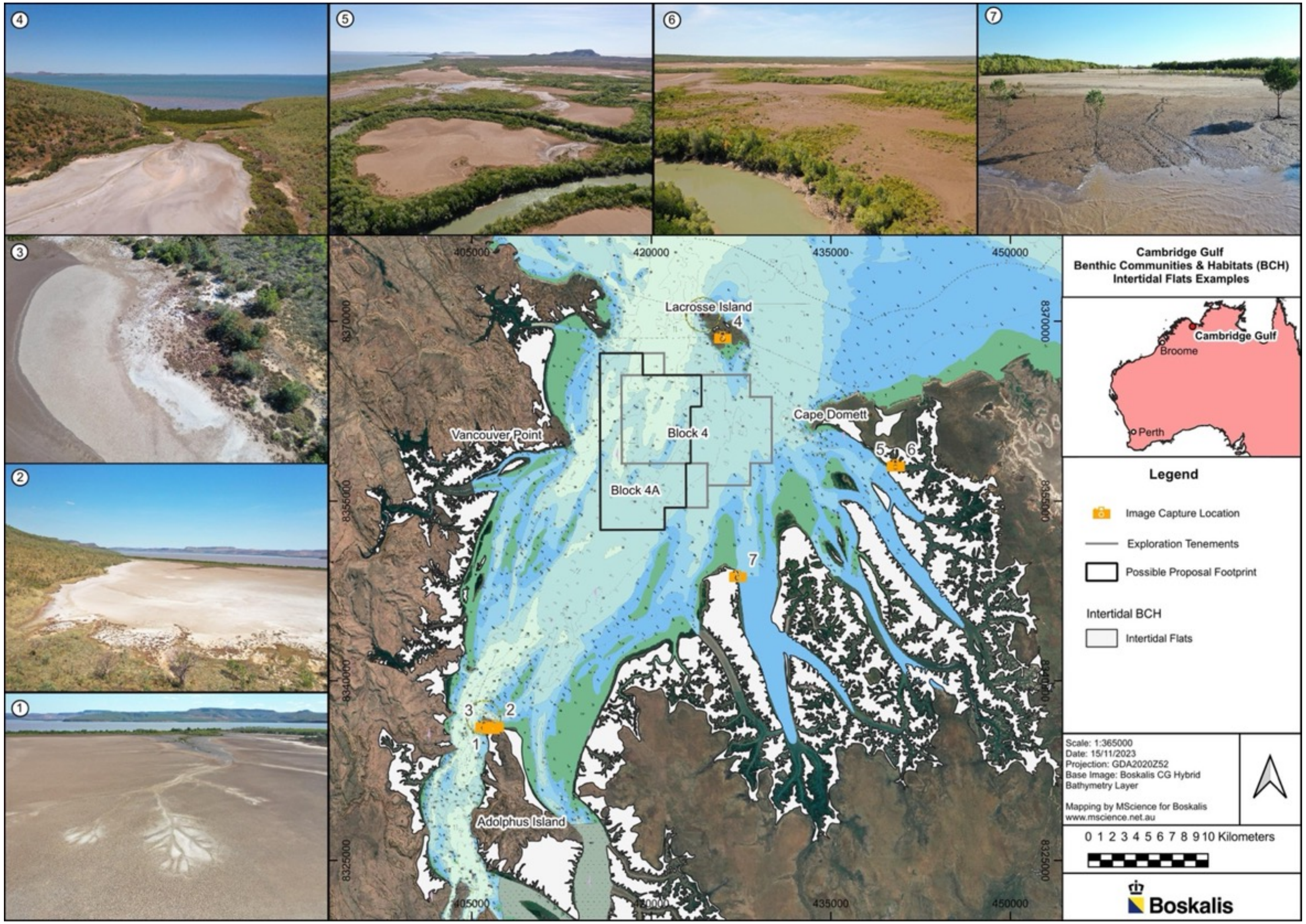


FIGURE 6.72: *Some examples of intertidal flats around CG.*

6.4.7 Description of Intertidal Rocky Shores & Rock Platforms

1. As outlined in section 6.3.6 there are a few areas in the main body of CG that have stable intertidal rock substrate, these being rocky points and intertidal rock platforms at the following sites (Figure 6.73). Their combined area is ~5.1 km^2.

    a) Cape Domett on the east,
    b) Cape Dussejour on the west,
    c) Parts of the coast and especially the northern side of Lacrosse Island,
    d) Bream Ledge at the northwest tip of Lacrosse Island,
    e) Vancouver Point / Myrmidon Ledge on the western side of CG,
    f) Ina Island on the western side of CG south of the Thompson River; and
    g) Nicholl's Point on the northern tip of Adolphus Island.

2. There are also inter-tidal rock platforms that run along part of the seaward edge of the 3 km long beach to the west of Cape Dussejour (Turtle Beach West), and along part of the seaward edge of the 1.9 km long beach to the east of Cape Domett (Cape Domett Seaward Beach) (refer Figure 6.9 in section 6.3.6).

3. Because stable rock substrate is the habitat type that is most suitable for sessile benthos such as corals, sponges, oysters, other sessile bivalves, macroalgae and other algae, and because these are considered to be high-priority benthic primary producers (EPA 2016b), these areas were systematically videoed and photographed by drone at low ride as described in section 6.4.6. High resolution orthomosaic images were also created for most of these sites (refer Figures 6.14 & 6.15 in section 6.3.6). These sites were also inspected by vessel at low-tide and overlapping planar view high resolution photographs taken of each area.

4. Detailed analysis of the drone imagery, orthomosaic images and vessel-based photography did not identify any significant benthic biota at any of these sites.

5. Bands of barnacles were present at the high-tide line of some of the rock platforms on the seaward (northern) side of Cape Domett, Lacrosse Island and Cape Dussejour, outside of CG.

6. Patches of green turf algae and/or red-algae were present on some of the rock platforms on the seaward (northern) side of Cape Domett, Lacrosse Island and Cape Dussejour, and on the rock platforms the run parallel with Cape Domett Seaward Beach and Turtle Beach West, west of Cape Dussejour, outside of CG.

7. Figures 6.74 and 6.75 show examples of the intertidal rocky shores and rock platforms. Figures 6.76 & 6.7 7 show examples of the intertidal rock platforms with barnacles, green turf algae and/or red algae. Figure 6.78 shows an example of the use high resolution orthomosaic imagery for assessment of intertidal rocky shore habitats (and other coastal resources. Figure 6.79 shows map locations of some examples of the intertidal rocky shores and rock platforms. Figure 6.80 shows map locations of some examples of the intertidal rocky shores and rock platforms with barnacles, green turf algae and/or red algae.

8. All of these areas are located outside of CG on seaward-facing northern shores, and the proposal will not impact on these areas as assessed in Referral Report No. 4 - *Impact Assessments* (BKA 2024d).

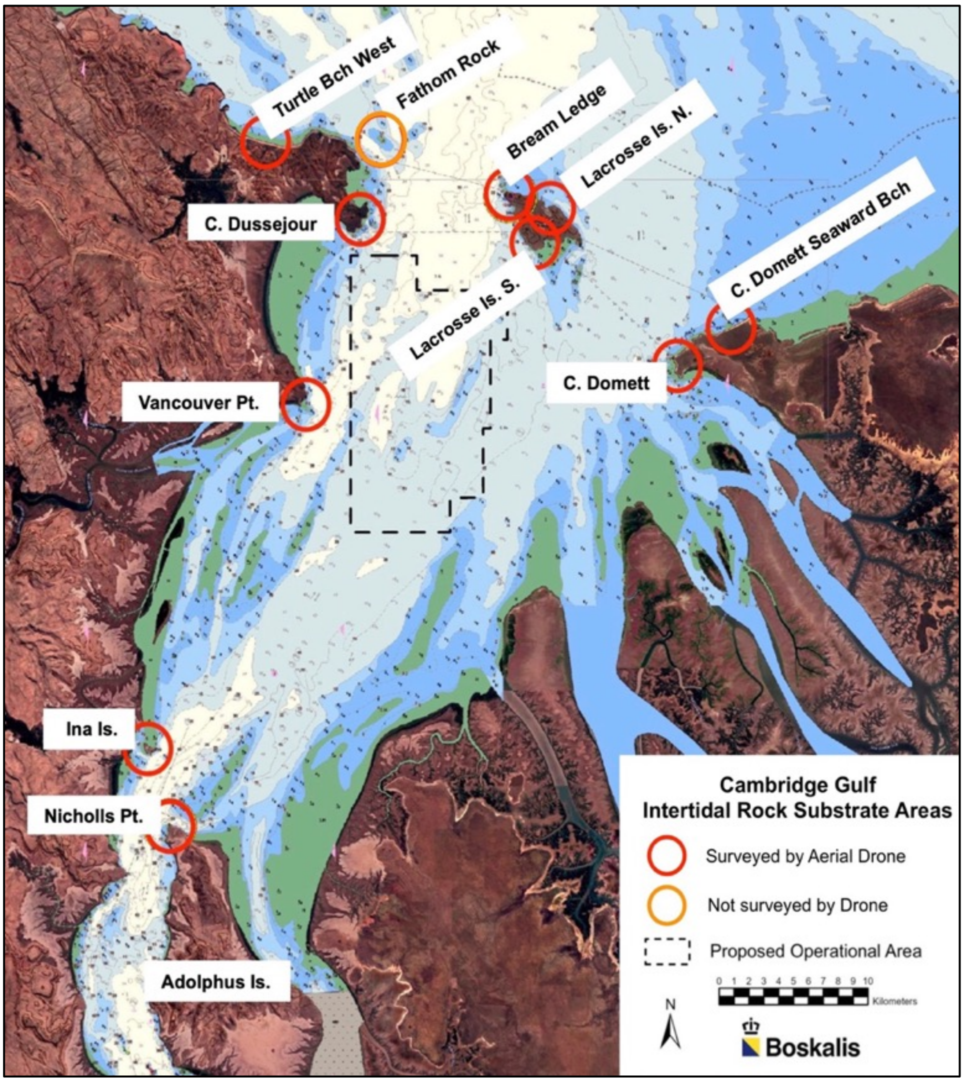


FIGURE 6.73: *Location of intertidal rocky shore and rock platforms in CG.*

FIGURE 6.74: *Example of intertidal rocky shore at Cape Dussejour outside the western entrance to CG (BKA).*

FIGURE 6.75: *Example of intertidal rocky shore at low tide – this is Vancouver Point on the western side of CG (BKA).*

FIGURE 6.76: *Example of intertidal rock platform on the seaward coast of Cape Domett, with a thin layer of green filamentous turf algae (BKA).*

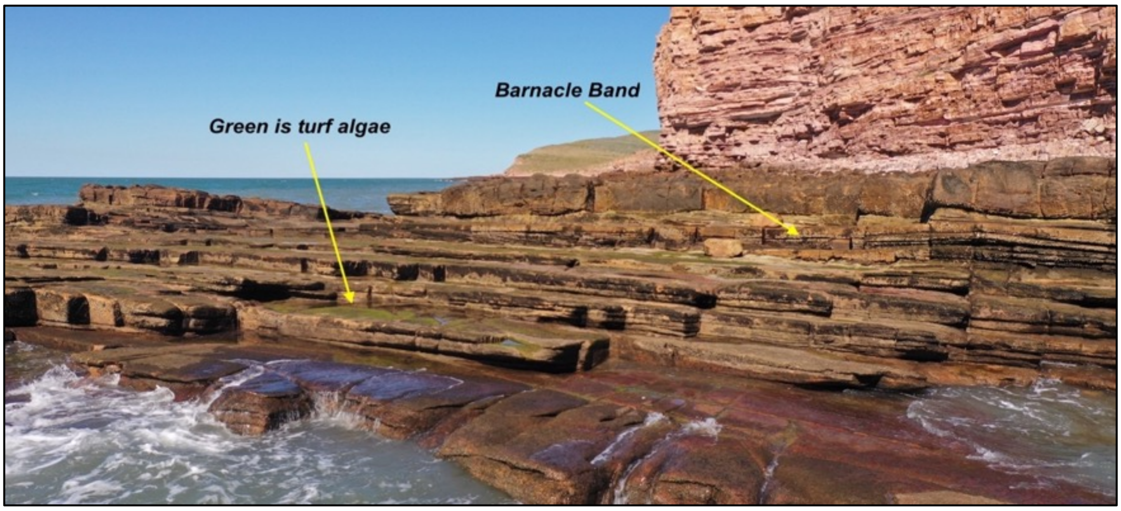


FIGURE 6.77: *Example of intertidal rock platform on the northern coast of Lacrosse Island, with a thin layer of green filamentous turf algae and band of barnacles (BKA).*

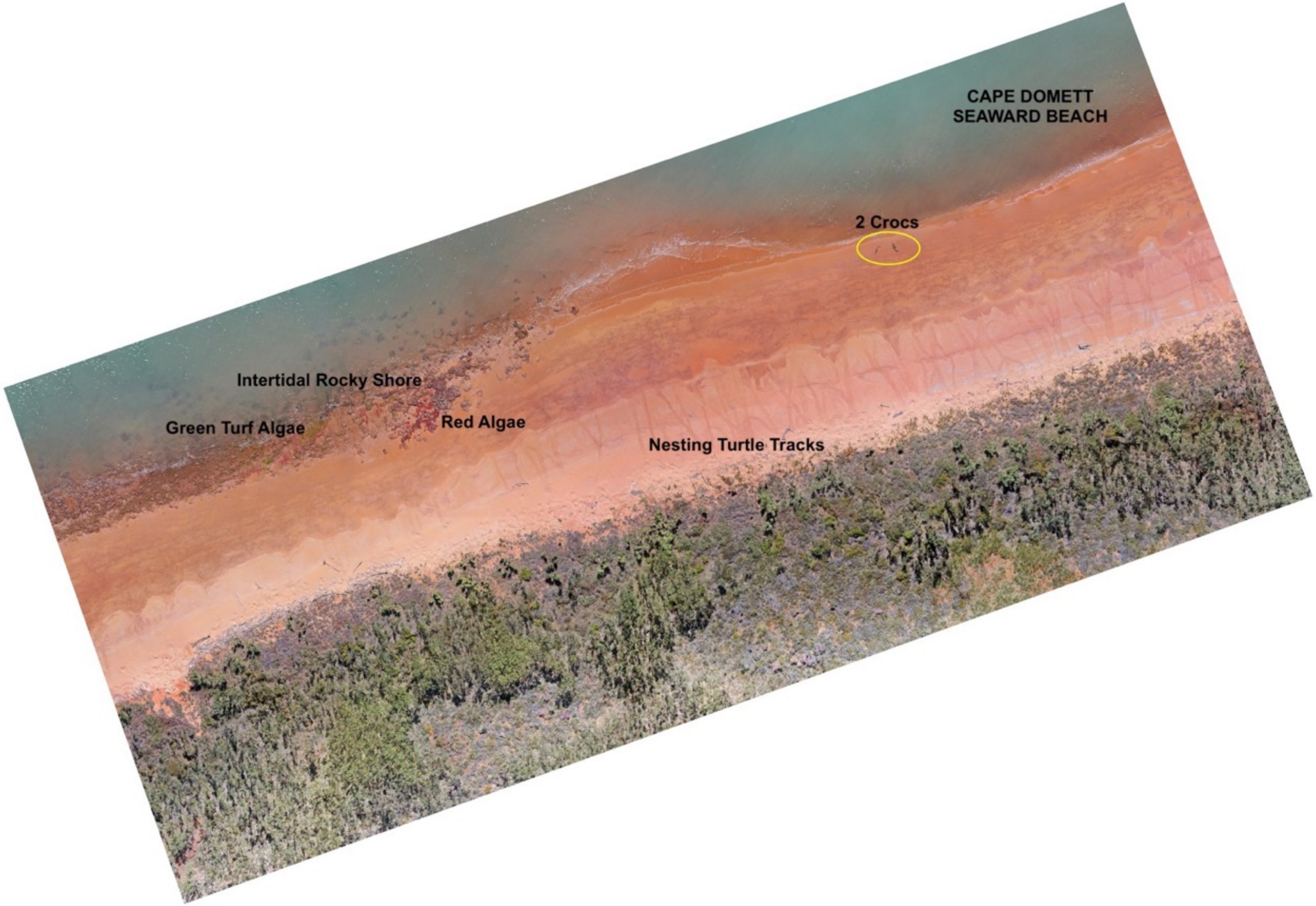


FIGURE 6.78: *Example of the use high resolution orthomosaic imagery for assessment of intertidal rocky shore habitats (left) and other coastal resources (BKA).*

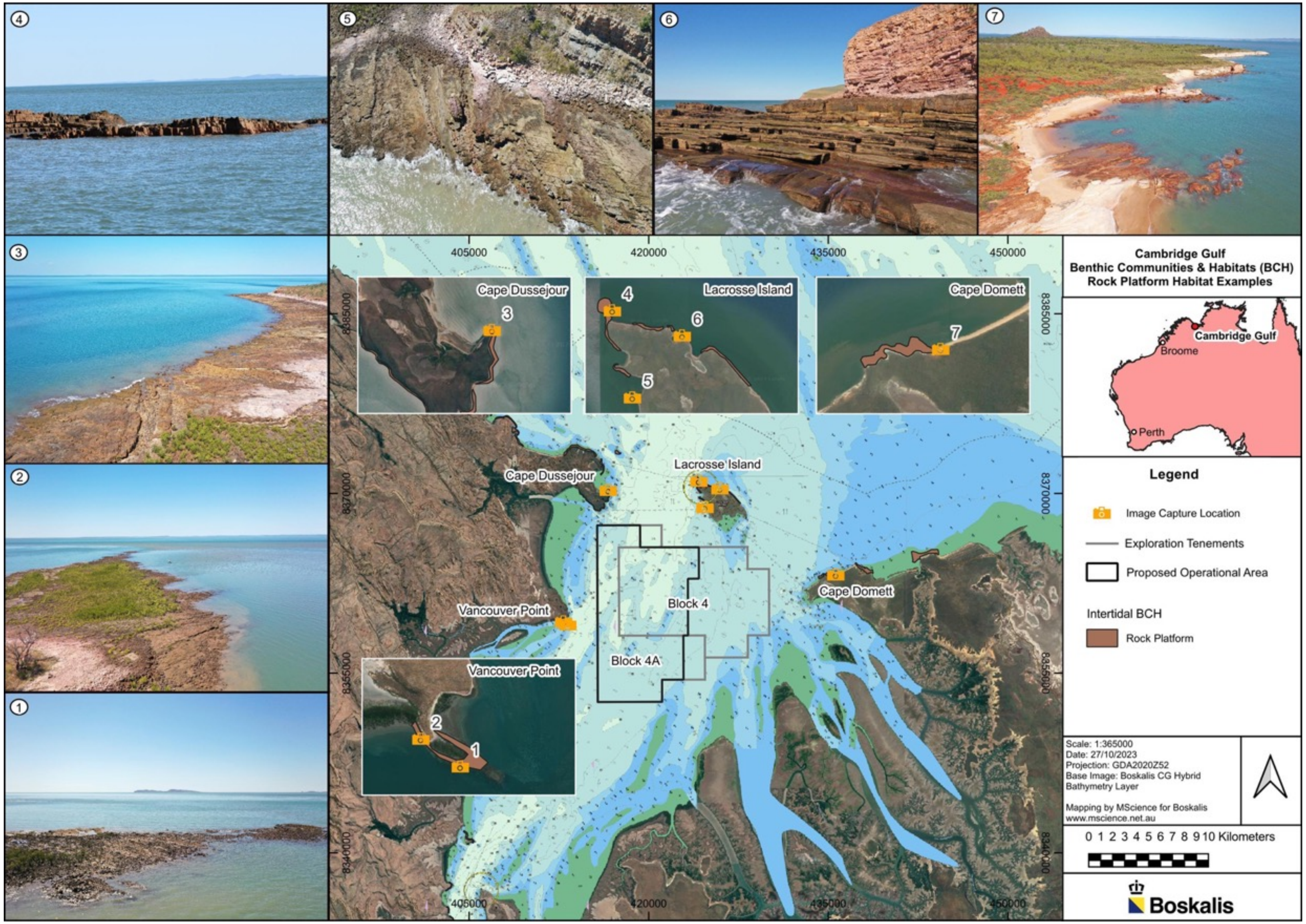


FIGURE 6.79: *Examples of intertidal rocky shores & rock platforms around CG.*

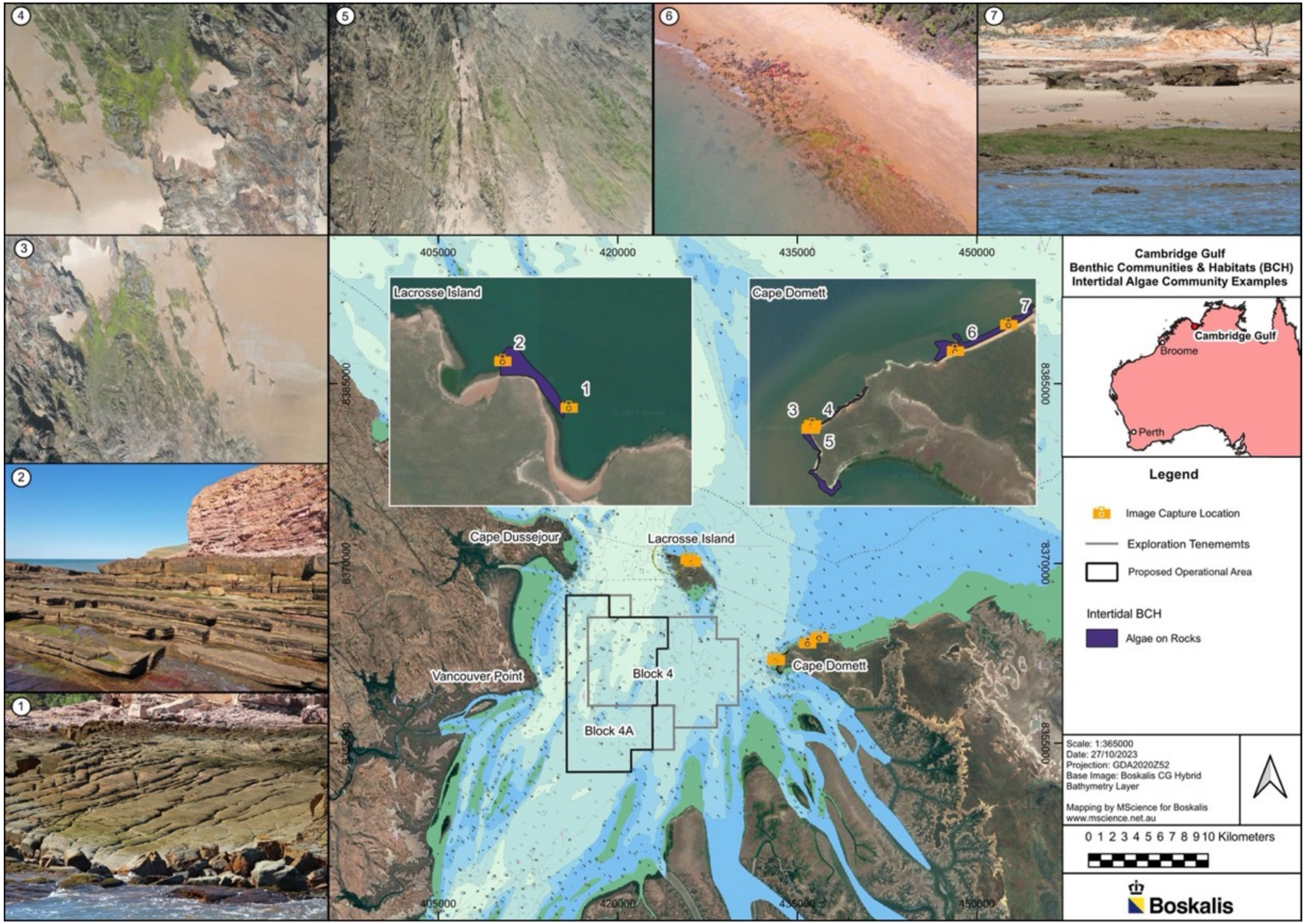


FIGURE 6.80: *Examples of intertidal rocky shores & rock platforms with algae cover.*

6.4.8 Description of Intertidal Cobble & Boulder Substrate

1. There is intertidal cobble and/or boulder beach substrate along parts of the southern coast and at the eastern tip of Lacrosse Island, and also at Nicholls Point on the northern tip of Adolphus Island.

2. Figures 6.81 and 6.82 show examples of this habitat type on the eastern tip of Lacrosse Island and the northern tip of Adolphus Island, respectively. Figure 6.83 shows map locations of additional examples around Lacrosse Island.

3. No evidence of benthic communities or biota was observed on these areas by high-res aerial drone photo and video surveys at low tide, with habitat suitability limited by the extreme environmental conditions of the area.

4. The proposal will not impact on these areas as assessed in Referral Report No. 4 - *Impact Assessments* (BKA 2024d).

FIGURE 6.81: *Example of intertidal cobble beach substrate at eastern tip of Lacrosse Island at low tide.*

FIGURE 6.82: *Example of intertidal boulder beach substrate at northern tip of Adolphus Island at low tide.*

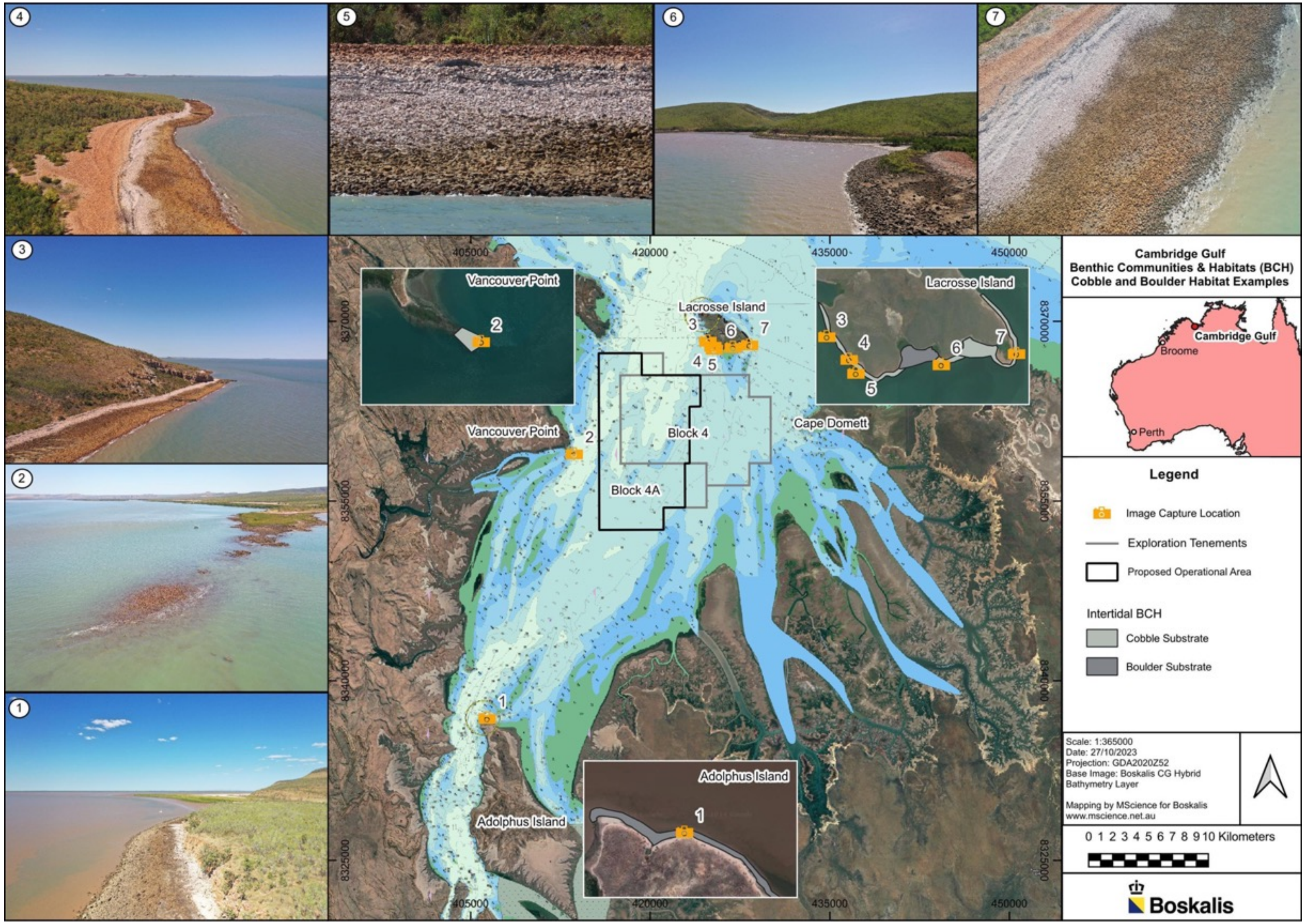


FIGURE 6.83: *Examples of intertidal cobble and boulder habitat around CG.*

6.4.9 Description of Intertidal Sand Substrate

2. There are expansive areas of intertidal sandflats along the coast and adjacent to the coast in CG, which are the substrate most likely to support seagrass. The following intertidal sandflat areas were targeted by the drone surveys (Figure 6.84):

    a) Hummock Bay and Turtle Beach West on the coast outside of CG, to the west of Cape Dussejour,
    b) Cape Dussejour,
    c) Western Sandflat immediately south of Cape Dussejour,
    d) Ina Island near the mouth of the Thompson River on the western side of CG,
    e) the coast southwest of Nicholls Point on Adolphus Island,
    f) East Bank to the west of Barnett Point,
    g) Barnett Point,
    h) Cape Domett; and
    i) south Coast of Lacrosse Island.

3. Ground-based (walking) surveys were also undertaken at low-tide at Eastern Sandflats off the False Mouths of the Ord River as a ground-truthing check (Figure 6.85).

4. Detailed analysis of the drone imagery and the observations during the ground surveys did not identify any evidence of seagrass or other benthos on these intertidal banks. Habitat suitability is limited by the highly dynamic nature of the sand substrate and the extreme environmental conditions of the area, with strong tidal currents and high natural turbidity

5. Figures 6.85 to 6.87 show examples intertidal sand substrate areas in CG, and Figure 6.88 shows some map locations.

6. The proposal will not impact on these areas as assessed in Referral Report No. 4 - *Impact Assessments* (BKA 2024d).

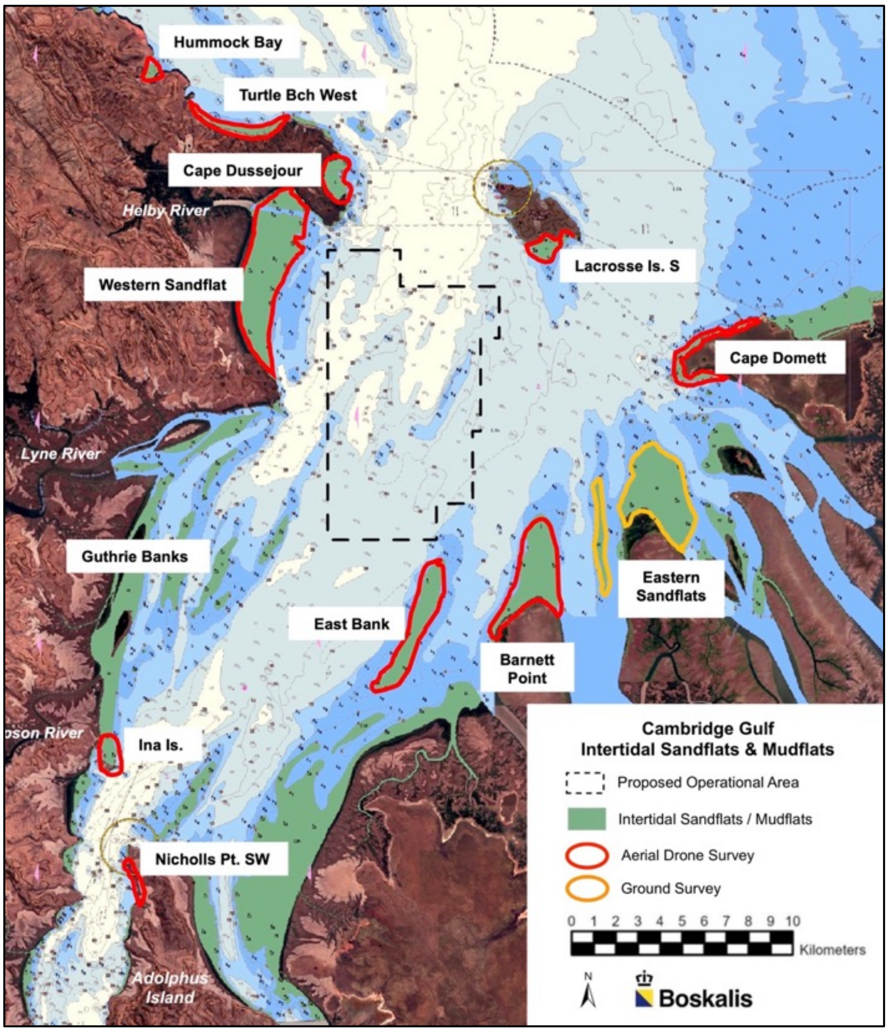


FIGURE 6.84: *Location of intertidal sand substrates in CG that were surveyed for seagrasses and other benthos.*

FIGURE 6.85: *Ground-based (walking) survey of Eastern Sandflat off the False Mouths of the Ord. Looking west towards Lacrosse Island.*

FIGURE 6.86: *Example of intertidal sand habitat in CG. This is East Bank on the eastern side of CG, on the western side of Barnett Point.*

FIGURE 6.87 A & B: *Examples of intertidal sand habitats on the west coast off CG south of Cape Dussejour.*

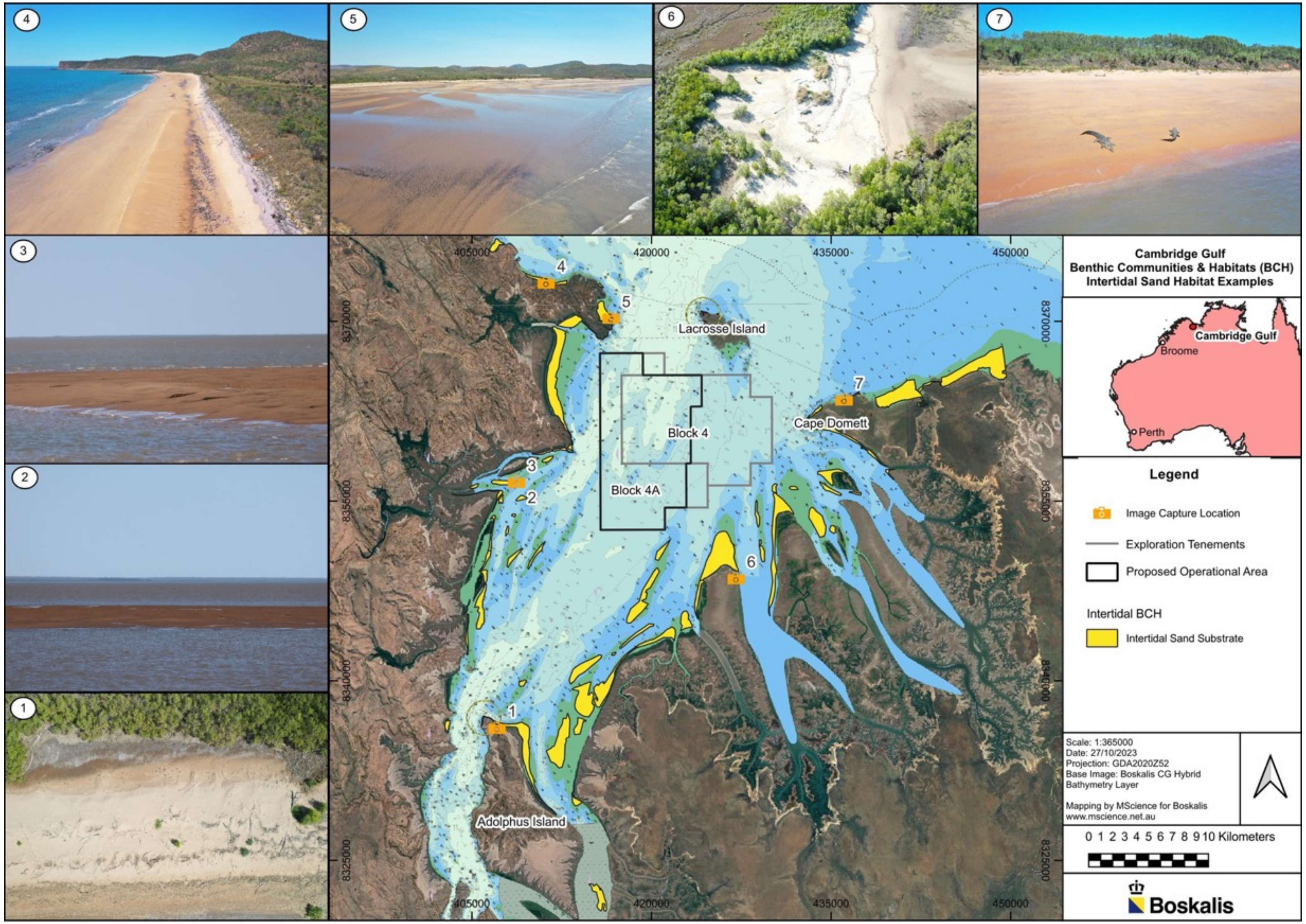


FIGURE 6.88: *Examples of intertidal sand habitat around CG.*

6.4.10 Description of Subtidal Sand Substrate

1. In addition to the subtidal sand-substrate in the proposed operational area as summarized in section 6.4.9, there are also extensive areas of subtidal sand-substrate at the following locations throughout the LAU, as shown on the BCH map (Figure 6.34 in section 6.4.1):

    - King Shoals seaward of the western entrance to CG,
    - most of the seabed to seaward north / northeast of Cape Dommet,
    - subtidal sand areas around the intertidal Guthrie Banks, south of the mouth of the Lyne River,
    - subtidal extensions of the intertidal Eastern Sandbanks and Barnett Point Sandbar, off the 'False Mouths of the Ord,
    - subtidal extensions of East Bank on the western side of Barnett Point; and
    - off the mouth of the Helby River.

2. As with the sand substrate in the proposed operational area as summarized in section 5, benthic grab sampling as described in sections 6.3.10 (benthic grab methods) and 6.4.4 (benthic grab results), found very little benthic biota, with most benthic grabs from these areas with sieving to 500 microns returning no biota at all. This is most likely due to the lack of light at the seabed and constant movement and reworking of the sand under the influence of strong tidal currents, which inhibits colonization and survival of benthic organisms on and in this substrate.

6.4.11 Description of Subtidal Mixed Clay, Silt, Sand & Gravel Substrate

1. As shown on the BCH map (Figure 6.34 in section 6.4.1), subtidal seabed areas throughout the LAU that do not comprise sand substrate appear to mostly comprise clay, silt or gravel or various mixtures of these, sometimes with sand in the mix. This includes the deeper gullies between the sand ridges in the proposed operational area and at King Shoals.

2. As outlined in section 6.4.4 (benthic grab results), benthic grab sampling indicates that these areas support a slightly higher abundance and diversity of very small benthic invertebrates than the sand areas, mainly small hydroids, bryozoans, sponges etc as described in section 6.4.4. However, abundance and diversity are very low, again due to the extreme environmental conditions including strong tidal currents, lack of light at the seabed and the unstable / mobile nature of the substrate.

6.4.12 Description of Subtidal Rocky Seabed

1. As shown on the BCH map (Figure 6.34 in section 6.4.1), there is a small area of rocky seabed habitat between Cape Dussejour and Fathom Rock near the western entrance to CG. As outlined in section 6.4.4 (benthic grab results) benthic grab sampling indicates that this area supports a higher abundance and diversity of benthic organisms than other parts of CG, as the rocky seabed provides a better substrate for attachment of these organisms than the predominant mobile sediment areas.

7. COASTAL PROCESSES

7.1 Relevant EPA Guidance

1. The EPA has published one guidance document relating to coastal processes - EPA 2016, *Environmental Factor Guideline - Coastal Processes*.

2. The Environmental Factor Guideline defines coastal processes as:

   . . . *any action of natural forces on the coastal environment.*

3. The Guideline recognizes that coastal environments are naturally dynamic, with their morphology at any point in time being determined by the interaction between their structure and innate mobility (e.g. from relatively immobile hard rocky cliffs to mobile, unconsolidated sand) and the intensity and degree of exposure to key geophysical and environmental processes (e.g. wind strength and wave height, current speed and direction).

4. The Objective of the Guideline is:

   – *To maintain the geophysical processes that shape coastal morphology so that the environmental values of the coast are protected*.

5. This objective recognises the fundamental link between the geophysical processes which shape the coastal environment and the environmental values that they support. These uses include the maintenance of ecosystem values, landforms, amenity, recreation, tourism, commercial, urban and industrial use.

6. Therefore, in assessing potential impacts of the proposal on coastal processes, BKA focused on whether the proposed removal of up to 70 million m^3 of sand from within the main body of CG will potentially alter sediment transport and supply pattern and the natural coastal erosion and accretion patterns in CG. BKA has also focused on whether any such change might alter the significant coastal ecosystems and values that the coastal environment supports. The most significant coastal ecosystems and values in CG that are influenced by coastal processes are described in section 7.3.

7. The Guideline describes considerations that should be taken into account when assessing the potential impacts of proposals on coastal processes, including *inter alia*:

   – predicting potential changes to coastal processes using analyses and modelling to a standard consistent with recognised published guidance; and

   – predicting potential changes to coastal processes in the context of the latest climate change projections.

8. BKA has commissioned detailed coastal process analysis and modelling by Port & Coastal Solutions (PCS), supported by a comprehensive suite of field data from both BKA's own field data collection campaign and external sources (see section 3 above and Annex 1.2 in Referral Report 4 - *Impact Assessments*). BKA required PCS to apply recognised published guidance to the analysis and modelling and include consideration of climate change implications (see Referral Report No. 5 - *Metcocean & Sediment Dynamics* (PCS 2024a & b).

9. The Guideline recommends independent peer review of coastal process modelling and predicted impacts. BKA engaged independent peer review of the modelling work for sequential stages, including review of the data collection and modelling design (terms of reference) and of the data analysis and modelling reports from PCS. The peer review reports are attached to Referral Report No. 4 (PCS 2024a & b).

7.2 Methods Used to Describe Coastal Processes

1. The methods used to describe coastal processes are detailed in Referral Report No. 5 - *Metcocean & Sediment Dynamics* (PCS 2024a) and it's supporting *Supplementary Technical Note* (PCS 2024b) and *Factual Data Report* (PCS 2024c). These are not repeated in detail here for reasons of economy. In summary the following methods were used:

   a) Existing data: Review, analysis and application of relevant pre-existing studies, reports, papers and data, including *inter alia*:

      – Coleman & Wright (1978), *Sedimentation in an Arid Macrotidal Alluvial River System: Ord River, Western Australia.*

- Australian Institute of Marine Science (AIMS), *Ord River & Cambridge Gulf Hydrodynamics & Sediment Movement Study.* Included nine sites in CG and data collection over multiple campaigns in 2000 - 2002.

- WA Department of Transport (DoT), *Port of Wyndham Tide Gauge data.*

- Australian Hydrographic Office (AHO), *Cambridge Gulf Tide Model.*

- Bureau of Meteorology (BoM), *Meteorological data.*

- Integrated Marine Observing System (IMOS), *Offshore oceanographic data.*

- Collaboration for Australian Weather & Climate Research (CAWCR) (CSIRO & BoM), *CAWCR Wave & Wind Hindcast Model.*

- University of WA (Bentley 2018), *Cape Domett Meteorological Data.*

- WA Department of Water & Environmental Regulation (DWER), *Stream Gauge Monitoring data for rivers that discharge into CG.*

- Geoscience Australia, *LiDAR and Landsat satellite imagery.*

- U.S. Geological Survey, *Satellite imagery.*

b) New data: Collection of new data in CG by BKA and its consultants, including *inter alia*:

- In-situ oceanographic instruments: A network of in-situ data-logging seabed-mounted ADCPs at 10 sites throughout CG and at King Shoals – collecting data on current speed and direction, water levels (tides) and waves (various sites since June 2023 and ongoing) (these also have co-mounted benthic light and multi-parameter sondes for turbidity, temperature, salinity and pH data, to inform marine environmental quality as outlined in section 8 below.

- Vertical water quality profiles: Sampled at multiple sites throughout CG under a range of conditions, including:
  - Niskin water samplers for suspended sediment sampling and PSD and elemental analysis of suspended sediments, to inform assessment of sediment transport patterns.
  - Co-deployment of multi-sonde water quality probe to provide coincident turbidity, temperature, salinity, pH and chlorophyll data.
  - In wet season the above profiles with co-deployment of Aquadopp ADCP to provide coincident current speed and direction data, every hour over 13-hour spring tidal cycle at three representative sites.

- Sub-bottom profiler (SBP): Surveys within Block 4 (exploration tenement E80/5655).

- Vibro-cores: Seabed sediment vibro-core sampling within Block 4.

- Grab samples: Seabed sediment grab sampling throughout CG and upstream rivers and inlets, for PSD and elemental analysis.

- Multibeam echosounder (MBES): Surveys of the proposed operational area and 1 km buffer, including repeat surveys over one-month over lunar tidal cycle.

- LiDAR and photogrammetry: Aerial drone LiDAR and photogrammetry at four priority turtle nesting beaches (Annex 10 contains a technical report from Sensorem on their aerial drone surveys for BKA).

c) System understanding & conceptual model: Development of a system understanding and conceptual model of dynamics in CG, using relevant data from a) and b) above (PCS 2024a).

d) Modelling: Set up and running of Danish Hydraulics Institute (DHI) MIKE modelling suite three-dimensional models on hydrodynamics, spectral waves, sediment transport and beach processes / littoral drift, using relevant data from a) and b) above (PCS 2024a). (NOTE: PCS continues to run the models further refine, calibrate and validate them as additional field data comes in from BKA's ongoing data collection program in CG, and a supplementary modelling report will be available in late 2024).

2. See Referral Report No. 5 - *Metcocean & Sediment Dynamics* (PCS 2024a) and it's supporting *Supplementary Technical Note* (PCS 2024b) and *Factual Data Report* (PCS 2024c) for details, including maps showing the spatial distribution of the various data collection instruments and details of their temporal deployments.

7.3. Description of Coastal Processes

1. A detailed system understanding and description of coastal processes, including the hydrodynamics and sediment dynamics that drive coastal processes in CG, is presented in Referral Report No. 5 (PCS 2024a & b). These are not repeated in detail here for reasons of economy, and a summary only is presented below.

2. A conceptual model for sediment transport and coastal processes in CG has been developed by PCS (2024a), as shown in Figure 7.1.

3. The description of benthic communities and habitats in section 6 above informs the description of the environmental values that are formed and influenced by coastal processes, as most of the benthic communities and habitats are coastal. These descriptions are not repeated in detail here for reasons of economy. Some of the main features are summarized below.

4. The main influencing factors on coastal processes in CG are as follows:

    a) The underlying geology and geomorphology of the coast and seabed.

    b) The input of sediments from the surrounding catchment via the various rivers that drain the catchment into CG (see below).

    c) The prevailing meteorology, including a dry season from May to October with very little rainfall and prevailing easterly winds, a wet season from November to May with sometimes extreme rainfall and very high terrestrial runoff, more westerly but variable winds, frequent tropical squalls and occasional tropical cyclones.

    d) The prevailing hydrodynamics, with CG being primarily a tidally-driven system with a large tidal range of 8 m and measured tidal currents of up to 4 knots (2.06 m/s), plus the effects of waves, including influences from the larger Joseph Bonaparte Gulf offshore from CG.

5. There are five main rivers that discharge sediments into the upstream parts of CG, upstream of Adolphus Island. These are the Durack, Forrest, King, Ord and Pentecost, along with a number of smaller tributaries. The small Helby, Lyne and Thompson Rivers are located on the west coast of the main body of CG. The total catchment area for CG is approximately 87,000 km^2 with 62% of this being the Ord River catchment (DataWA 2023).

6. Except for the Ord River, which has an overall length of 650 km, all of the rivers are quite small, but can have very high, acute, short-term flows during the tropical wet season. The wet season river discharges can vary by orders of magnitude year to year. There is also significant daily variability in river flows, with very high flows following tropical cyclones only lasting a matter of days (Wolanksi et al 2001). As outlined above the rivers all discharge sediment into CG. The supply of sediment varies significantly due to the high variability in river discharges. Peaks in sediment supply occur in the wet season, with limited sediment supply during the dry season (PCS 2024a & b).

7. The rivers supply a combination of sand and fine-grained silt and clay. The sediment deposited in CG is subject to regular reworking by the strong tidal currents, resulting in well-sorted sand which, over time is deposited to form extensive intertidal and subtidal sandbanks. The most significant intertidal sandbanks are described in section 6.4.9 above. The most significant subtidal sandbanks include the area within the proposed operational area, which are proposed to be sourced and exported, and are assessed to be highly dynamic, as described in section 5.

8. The building of two dams on the Ord River, one near Kununurra and one for the Ord River Irrigation Scheme, has interrupted the supply of sediment to CG from that source, but is also causing significant build-up of sediment in the lower Ord just south of Adolphus Island, due to the lack of wet-season flushing since building of the dams (Wolanksi et al 2001) (PCS 2024a).

7.4. Key Environmental Values Linked to Coastal Processes

1. As outlined in section 7.1 the objective of the EPA Environmental Factor Guideline for Coastal Processes is:

    – *To maintain the geophysical processes that shape coastal morphology so that the environmental values of the coast are protected.*

2. It is therefore necessary to identify the main environmental values of the coast in CC that are dependent on and influenced by coastal processes.

3. Of most relevance to the BKA sand sourcing proposal are those coastal areas that are comprised of more mobile substrates, that may potentially be affected by any changes to sediment dynamics from the proposed sourcing of up to 70 million m^3 of

sand over 15 years. Consistent with the EPA guidelines, the most significant coastal ecosystems and environmental values in CG that are influenced by coastal processes, and which could potentially be impacted by changes in coastal processes, are assessed to be the following:

a) Mangroves (Figures 7.2 to 7.4): The mangrove communities around the entire coast of CG, as described in section 6.4.5 above, can potentially be affected by changes in coastal processes because they grow on intertidal sediments. However, as outlined in section 6.4.5, the mangroves in CG are naturally highly dynamic and undergo expansions and retractions over time. There are numerous areas of significant natural erosion and undercutting, especially on the eastern coastline and in the Ramsar area, and shown on Figure 7.4. These natural erosion areas mainly face to the north-west and may therefore be impacted by north westerly winds and waves. They may also be less sheltered from cyclone impacts than other parts of CG

b) Ramsar Wetland (Figure 7.2): The tidal inlets and channels that form the so-called 'False Mouths of the Ord' on the eastern side of CG can potentially be affected by changes in coastal processes because they are formed by intertidal sediments. This area is part of the Ord River Floodplain Ramsar Wetland and is protected as part of the State-designated Ord River Nature Reserve. The main habitats that are linked to coastal processes in this area are mangroves as described in section 6.4.5 above and intertidal mud- and salt-flats as described in section 6.4.6 above, and the various biota that depend on these habitats.

c) Flatback Turtle nesting beaches / sites: Because beaches are comprised of sand, they can potentially be affected by changes in coastal processes. The key sites are as follows, as shown on Figures 7.2 and 7.5:

- 1. Cape Domett Seaward Beach (Length = 1.9 km) – the main nesting beach,
- 1A. Cape Domett Small Beach (Length = 0.4 km),
- 2. Turtle Bay on NW side of Lacrosse Island (Length = 0.3 km),
- 3. Turtle Beach West (Length = 3 km) west of Cape Dussejour; and
- 4. Barnett Point within CG.

4. The beaches are all located on seaward coasts outside of CG while Barnett Point is located within CG with no beach. At Barnett Point the nesting occurs on sand ridges (cheniers) that are protected behind mangroves.

5. Further details on turtle nesting in CG are presented in section 9 – Marine Fauna, and in particular sub-section 9.5 on Flatback Turtles, below.

6. The impact assessments in Referral Report No. 4 focus on whether the BKA sand-sourcing proposal is likely to cause changes to coastal processes, that in turn might cause impacts on these main coastal ecosystems and values in CG.

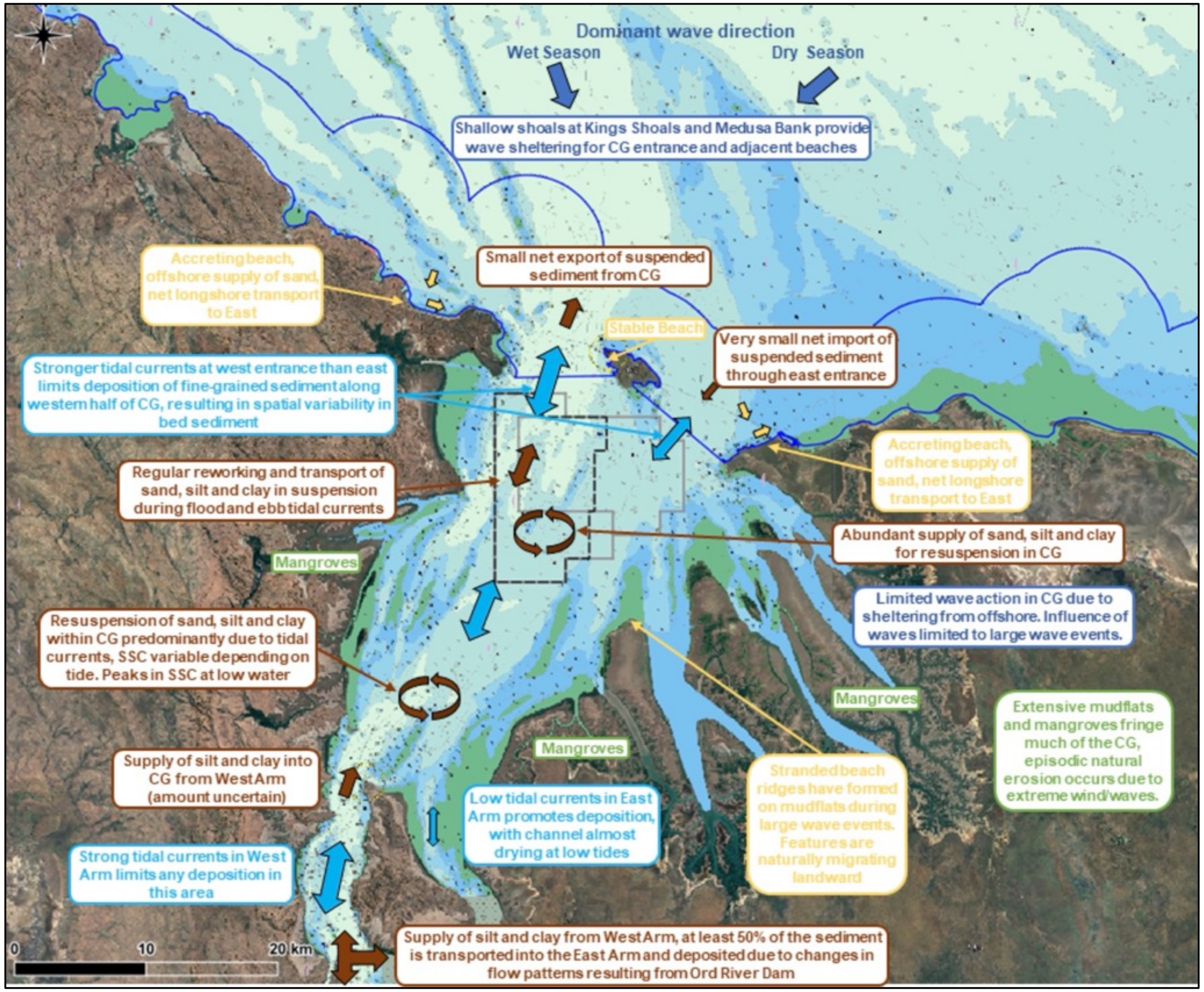


FIGURE 7.1: *A conceptual sediment transport and coastal processes system understanding for CG.* (*Note: text and arrows in dark blue relate to waves, pale blue relates to tidal currents, brown relates to sediment transport, yellow relates to beach changes and local sand supply and green relates to mangroves) (see Referral Report No. 5 - PCS 2024a).*

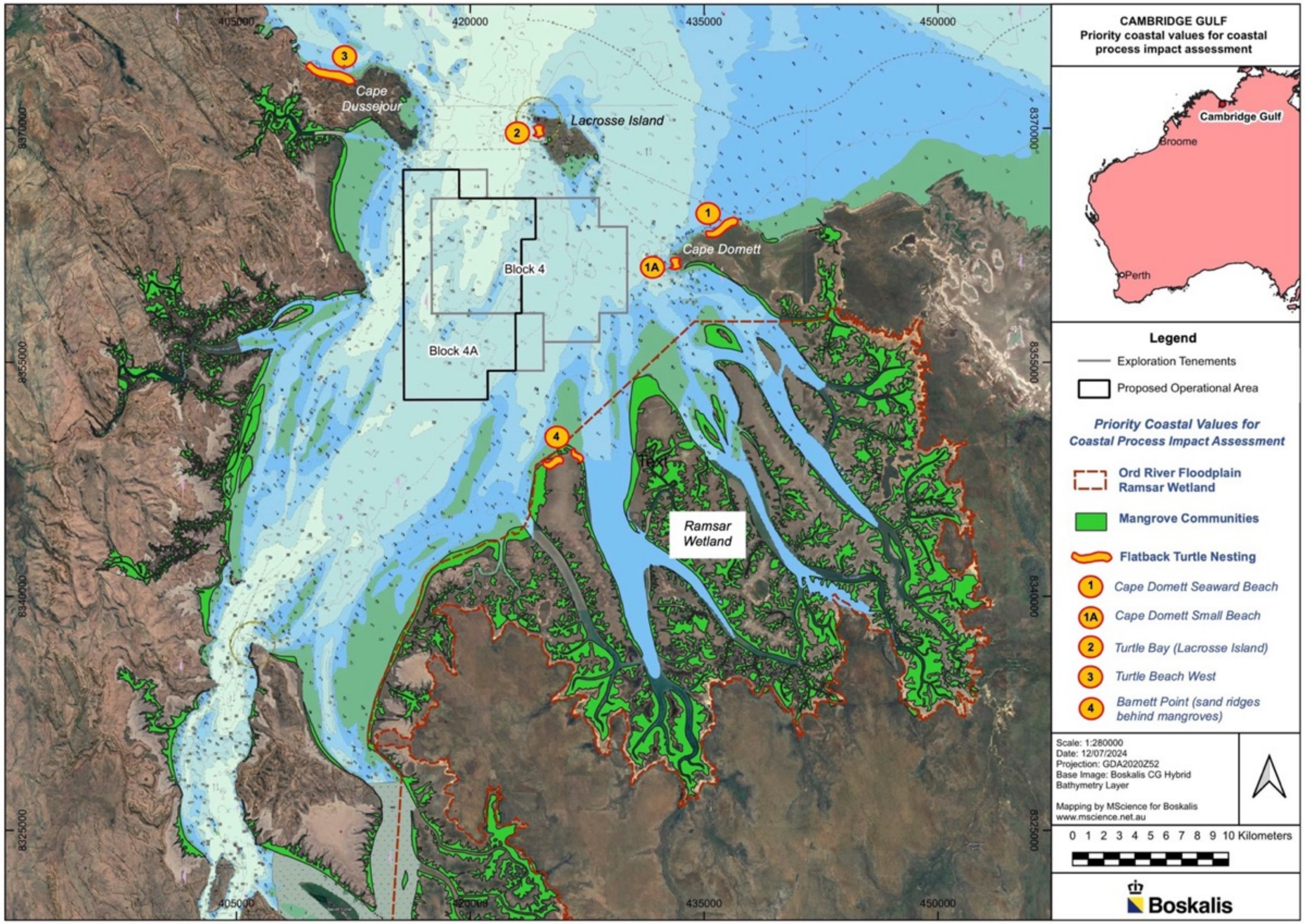


FIGURE 7.2: *The most significant coastal ecosystems and values in CG that are formed and influenced by coastal processes comprise the the mangroves around the coast of CG, including the mangrove-lined inlets in the Ord River Floodplain Ramsar Wetland; and five Flatback Turtle nesting sites.*

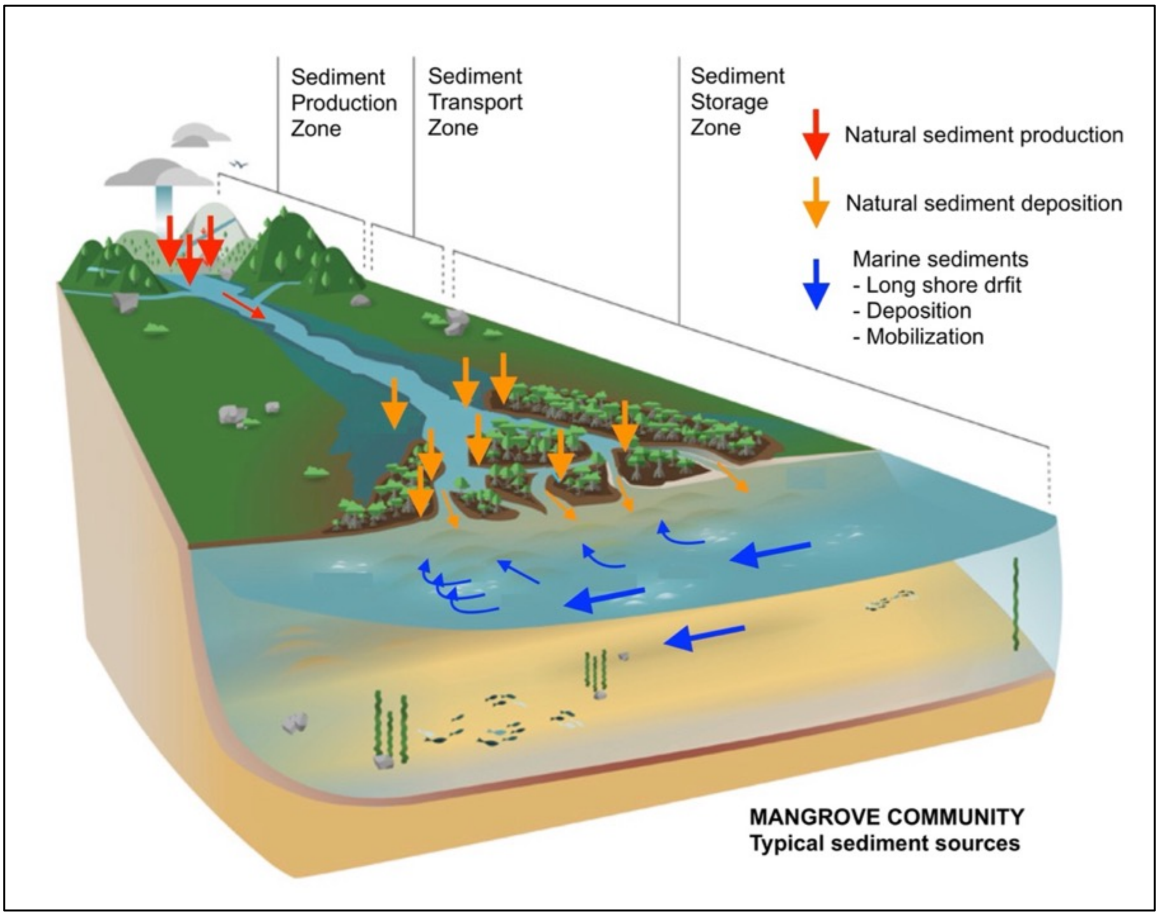


FIGURE 7.3*: Most sediments in mangrove communities come from landward catchment sources, although seaward sources from long-shore drift and local deposition and mobilization can also contribute. It is the latter sediment source that is relevant to the BKA proposal, as the proposal does not include any facilities or activities in the catchment, and only involves the proposed extraction of sand from within the centre of CG, which is seaward of all mangroves in CG (adapted from Anthony et al 2020).*

FIGURE 7.4: *Examples of natural dynamics of mangroves in CG under the influence of sediment dynamics, waves and wind, including cyclones. Assessment of potential impacts of proposals needs to consider the context of natural dynamics (mages: Raaymakers July 2023 & Feb 2024).*

1. Cape Domett Seaward Beach (midpoint looking west)

1. Cape Domett Seaward Beach (midpoint looking east)

1A. Cape Domett Small Beach (looking to Lacrosse Island)

2. Turtle Bay (NW side of Lacrosse Island)

3. Turtle Beach West (looking west from Cape Dussejour)

4. Barnett Point (from east side)

FIGURE 7.5: *The five main Flatback Turtle nesting sites in the CG area, which are formed and influenced by coastal processes. The top two images are both of Cape Domett Seaward Beach. At Barnett Point (bottom right) there is no beach and the turtles nest on sand ridges (cheniers) behind the mangroves.*

8. MARINE ENVIRONMENTAL QUALITY

8.1 Relevant EPA Guidance

1. The EPA has published two guidance documents relating to marine environmental quality (MEQ):

   – EPA 2016, *Environmental Factor Guideline - Marine Environmental Quality.*
   – EPA 2016, *Technical Guidance - Protecting the Quality of Western Australia's Marine Environment.*

2. The Environmental Factor Guideline defines MEQ as:

   – *. . . the level of contaminants in water, sediments or biota or to changes in the physical or chemical properties of waters and sediments relative to a natural state*. It does not include noise pollution, which is dealt with separately under the marine fauna factor.

3. The Objective of the Guideline is:

   – *To maintain the quality of water, sediment and biota so that environmental values are protected.*

4. In further explanation of the Objective:

   – *Environmental value* is defined under the *EP Act* as a *beneficial use or an ecosystem health condition*.

   – *Beneficial uses* are uses of the environment which are conducive to public benefit, safety or health or to aesthetic enjoyment. *Ecosystem health condition* is the condition of the environment itself and is measured in terms of ecological structure, function or processes. Both types of environmental values can be affected by emissions, degradation of the environment, or by loss or damage to natural habitats.

5. A set of five environmental values that require protection from the effects of pollution, waste discharges and deposits in marine environments have been agreed through the National Water Quality Management Strategy (NWQMS), with associated Environmental Quality Objectives (EQOs). The five environmental values that the EPA generally expects to be protected throughout WA's coastal waters are:

   – ecosystem health
   – fishing and aquaculture
   – recreation and aesthetics
   – industrial water supply
   – cultural and spiritual.

6. The description of marine environmental quality for CG includes descriptions of each of these environmental values in the context of CG in section 8.4.

7. The *Technical Guidance - Protecting the Quality of Western Australia's Marine Environment* outlines an Environmental Quality Management Framework (EQMF) for protecting and maintaining MEQ in WA, based on the approach outlined in the NWQMS. This includes a recommendation for the proponent to develop an Environmental Quality Management Plan (EQMP) which protects the EQOs for each of the five environmental values stipulated by EPA.

8. The EQMP approach is addressed in Referral Report No. 4 - *Impact Assessments*, noting that the BKA sand-sourcing proposed does not involve the discharge of wastes, pollutants or contaminants.

8.2 Methods Used to Describe Marine Environmental Quality

1. The methods used to describe MEQ were as follows:

   a) Existing data: Review, analysis and application of relevant pre-existing studies, reports, papers and data, including *inter alia*:

      – Australian Institute of Marine Science (AIMS), *Ord River & Cambridge Gulf Hydrodynamics & Sediment Movement Study.* Included nine physical water quality sites in CG and data collection over multiple campaigns in 2000 - 2002.

      – CSIRO (2003), *The Response of the Lower Ord River and Estuary to Management of Catchment Flows and Sediment and Nutrient Loads.*

- CSIRO (2003), *The Response of the Lower Ord River and Estuary to Management of Catchment Flows and Sediment and Nutrient Loads.*

- WA Department of Environment & Conservation (Hale 2008), *Ecological Character Description of the Ord River Floodplain Ramsar Site.*

b) New data: Collection of new data in CG by BKA and its consultants, including *inter alia*:

- Secchi disk: Deployment of a Secchi disk at 17 sites in Block 4 (exploration tenement E80/5655) during the preliminary environmental reconnaissance survey in March 2023, to provide initial data on water clarity in CG (Figures 8.1 & 8.2).

- Drop camera: Deployment of a drop camera at 17 sites in Block 4 during the preliminary environmental reconnaissance survey in March 2023, and at 90 sites in CG, 27 sites at KS and multiple sites offshore in July-August 2023. The primary purpose was benthic habitat assessment but the videos also provide data on water clarity (see section 6.3.9 and Annex 3).

- In-situ benthic light meters & multi-sondes: A network of eight in-situ data-logging seabed-mounted light meters and multi-parameter sondes including turbidity, temperature, salinity and pH (various sites since June 2023 and ongoing into 2025 to provide seasonal and inter-seasonal data over two years) (Figures 8.3 & 8.4).

- Sediment contamination assessment: Testing seabed sand samples from 21 sites within the proposed operational area for potential contamination according to the National Assessment Guidelines for Dredging (NAGD) (Commonwealth 2009) (Figure 8.5).

- Vertical water quality profiles:

  - Dry-season vertical water quality profiles at 53 sites throughout CG, 20 sites at KS and 30 sites offshore under a range of tidal conditions, using a multi-sonde water quality probe to provide coincident turbidity, temperature, salinity, pH and chlorophyll data (Figures 8.6 & 8.7).

  - Dry-season Niskin water sampling at 31 sites in CG, three sites at KS and 20 sites offshore (co-incident with some of the vertical water quality profile sites listed above), for total suspended sediments (TSS) and chlorophyll-a analysis (the former to allow deduction of TSS-turbidity correlation) (Figures 8.6 & 8.7).

  - Wet-season similar vertical water quality profiles as per the two points above, but at three fixed representative sites in CG, with sampling every hour over 13-hour spring tidal cycle, with a co-mounted Aquadopp ADCP to provide coincident current speed and direction data (Figures 8.8 to 8.10).

c) Suspended sediment & turbidity assessment: Commissioning PCS, as part of their broader hydrodynamics and sediment dynamics modelling work for BKA, to *inter alia* (refer PCS 2024a for details)*:*

- Assess all available data (both from previous studies and collected by BKA) on suspended solids concentrations (SSC) and turbidity in CG, including analysing and describing spatial and temporal patterns in these parameters under the influence of different tide and wind conditions and seasonal factors such as wet-season runoff.

- Analysis of Sentinel-2 satellite imagery to provide satellite-derived SSC spatial maps. In addition, metocean conditions prior to and at the time the images were captured and analysed to provide additional context to the images.

- Running the DHI MIKE Sediment Transport Model to model SSC in the CG region under various tidal and seasonal conditions, and comparing modelled SSC and satellite-derived SCC under these conditions.

2. The description of MEQ in the next section is based on the findings of these methods.

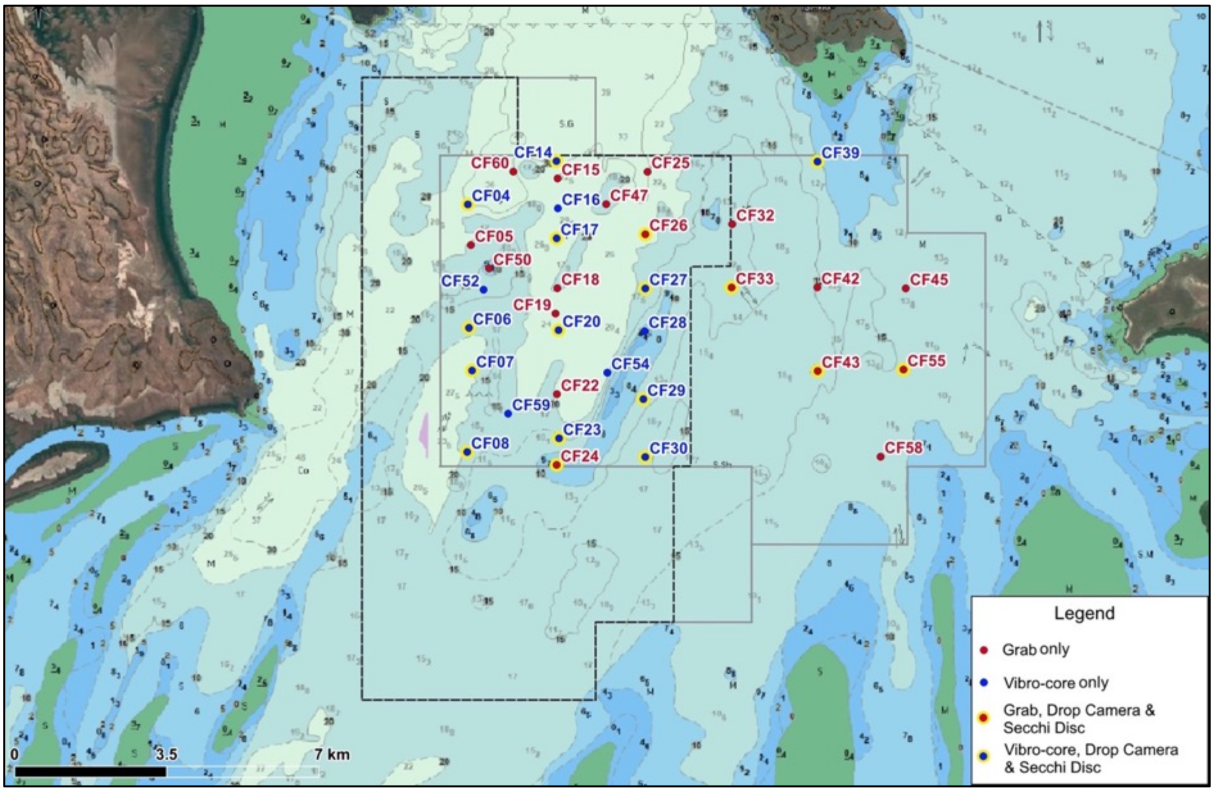


FIGURE 8.1: *The 17 sites (ringed in yellow) in Block 4 (exploration tenement E80/5655) where Secchi disc readings were taken during the preliminary environmental reconnaissance survey in March 2023.*

FIGURE 8.2: *The Secchi disc used. Note the heavy shackle to drop the disc vertically in strong tidal currents.*

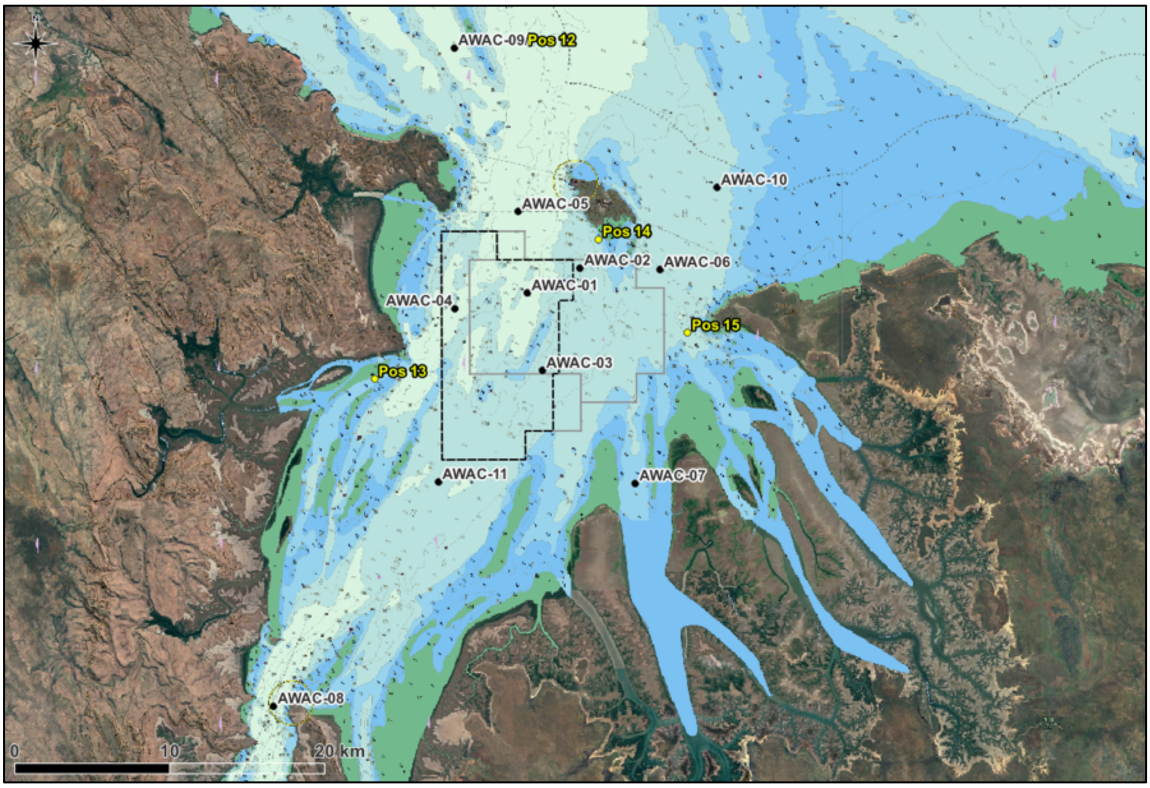


FIGURE 8.3: *The Locations of BKA's in-situ, data-logging, seabed-mounted instruments in CG. 'AWAC' = site with AWAC / ADCP and co-mounted light meters and multi-sondes. 'Pos' = sites with light meters and multi-sondes only. Deployments at various sites commenced in June 2023 and will continue into 2025 to provide 2-years of data.*

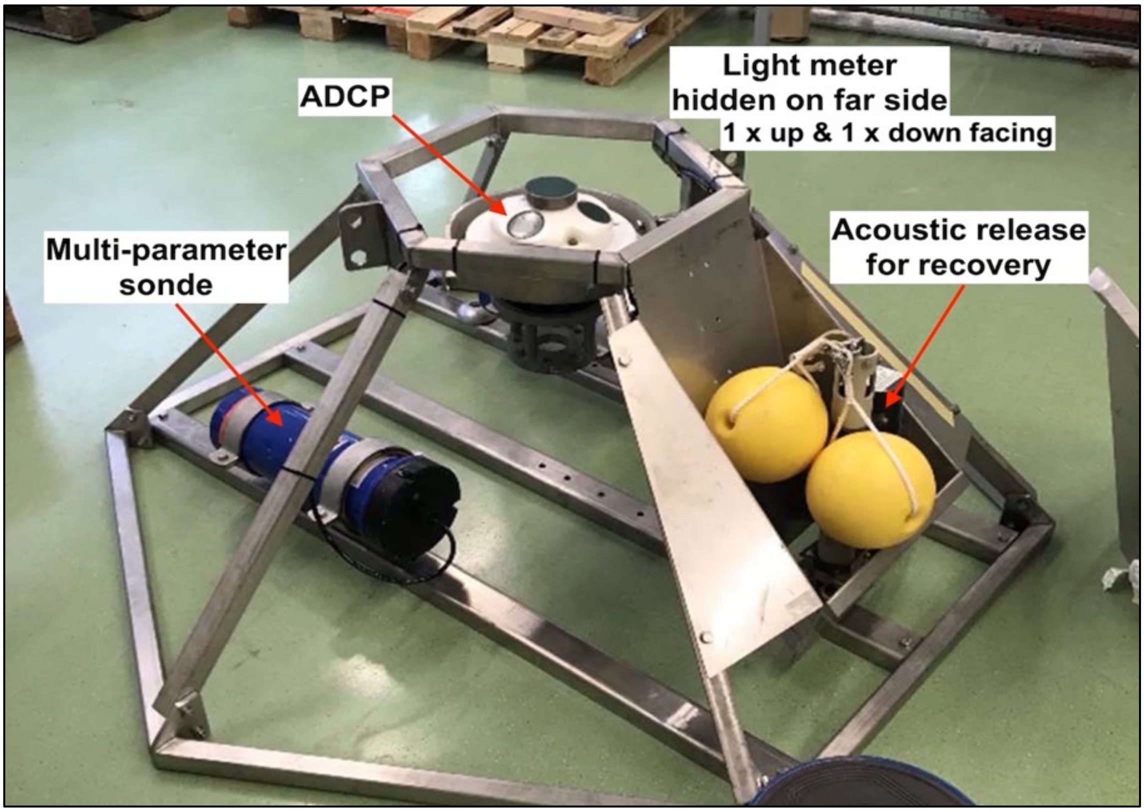


FIGURE 8.4: *Example of seabed frame with co-mounted ADCP, light meter and multi-parameter sonde (turbidity, temperature, salinity and pH). The frames without the ADCPs and with the latter instruments only are the same.*

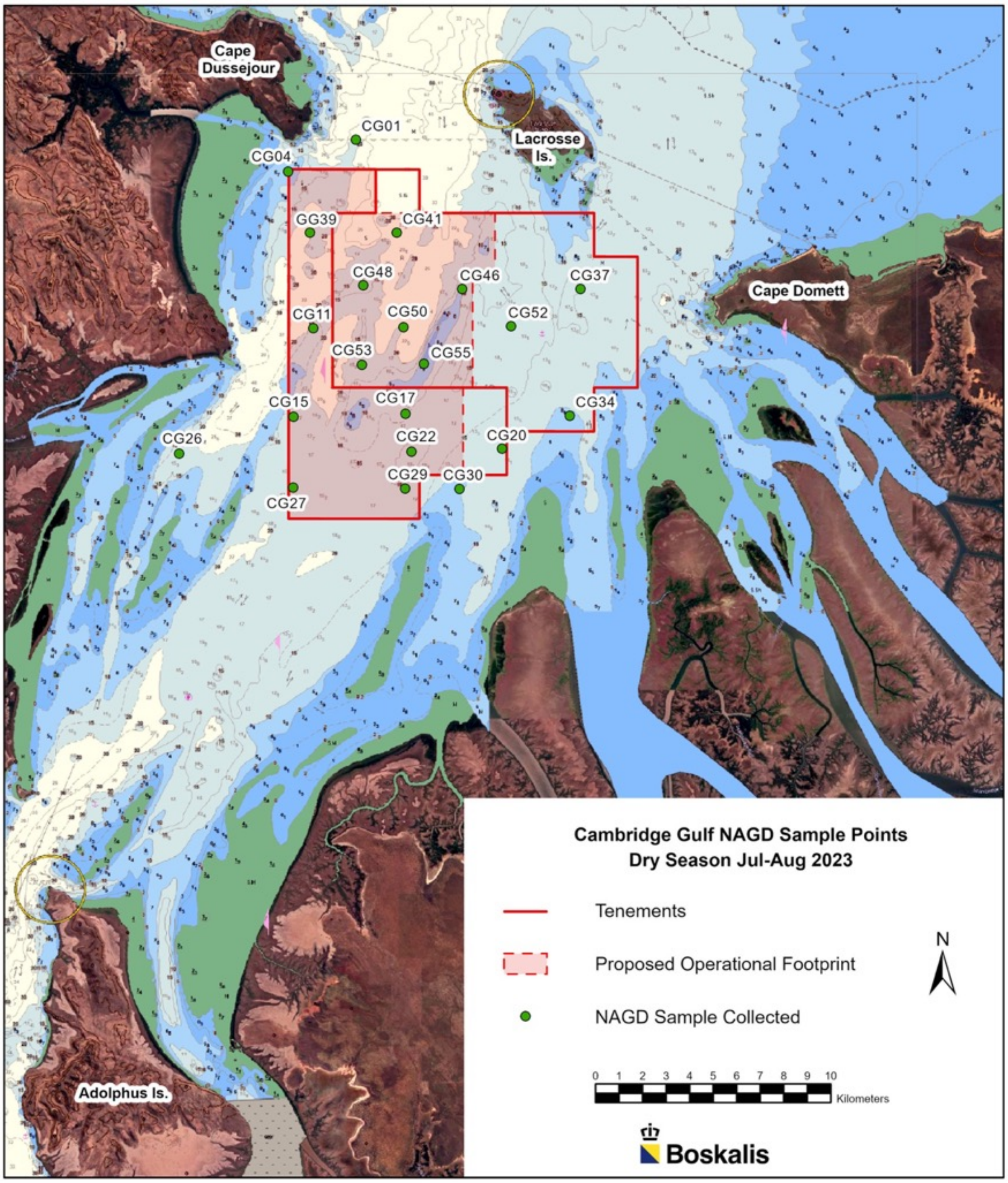


FIGURE 8.5: *Locations of sediment sampling sites for assessment against NAGD 2009 – dry-season July 2023.*

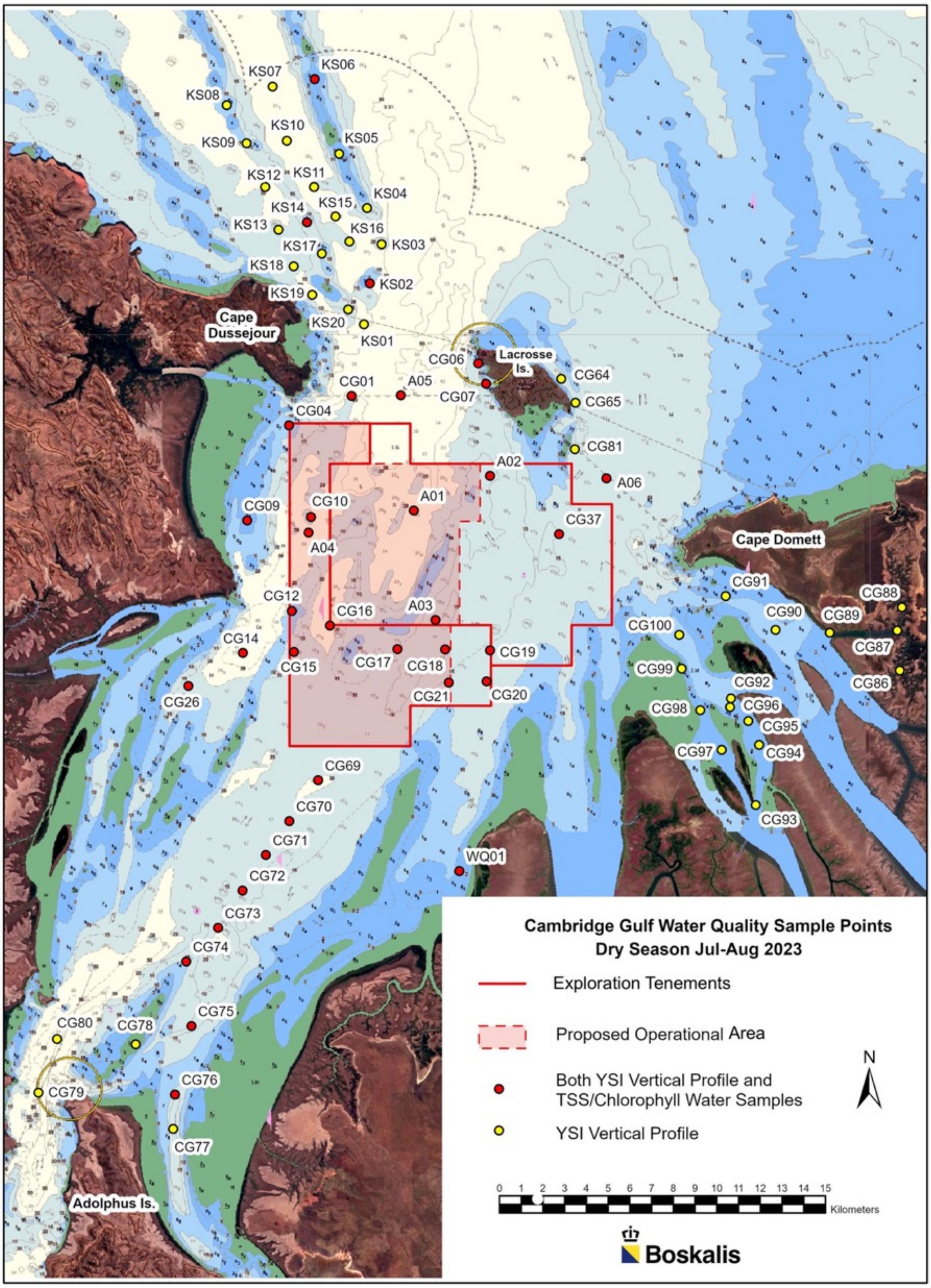


FIGURE 8.6: *Locations of Vertical Water Quality Profile sites in CG and at King Shoals dry-season July 2023.*

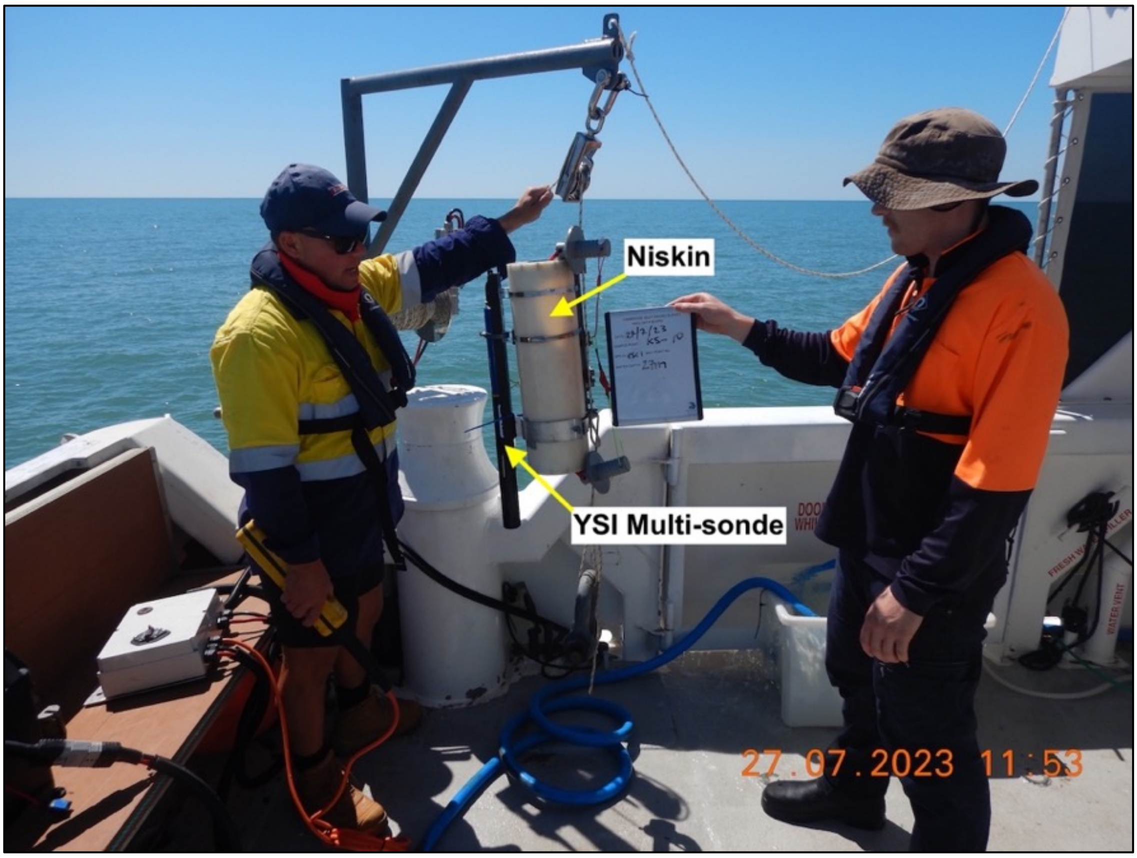


FIGURE 8.7: *Equipment set-up for Vertical Water Quality Profiles in CG and KS dry-season July 2023.*

FIGURE 8.8: *Equipment set-up for Vertical Water Quality Profile sites in CG wet season Feb 2024 (Niskin not shown)*

FIGURE 8.9: *Equipment set-up for Vertical Water Quality Profile sites in CG wet season Feb 2024, with near-sabed Niskin shown. A second Niskin was fitted to the line at the mid-water point as the rig was lowered to the seabed.*

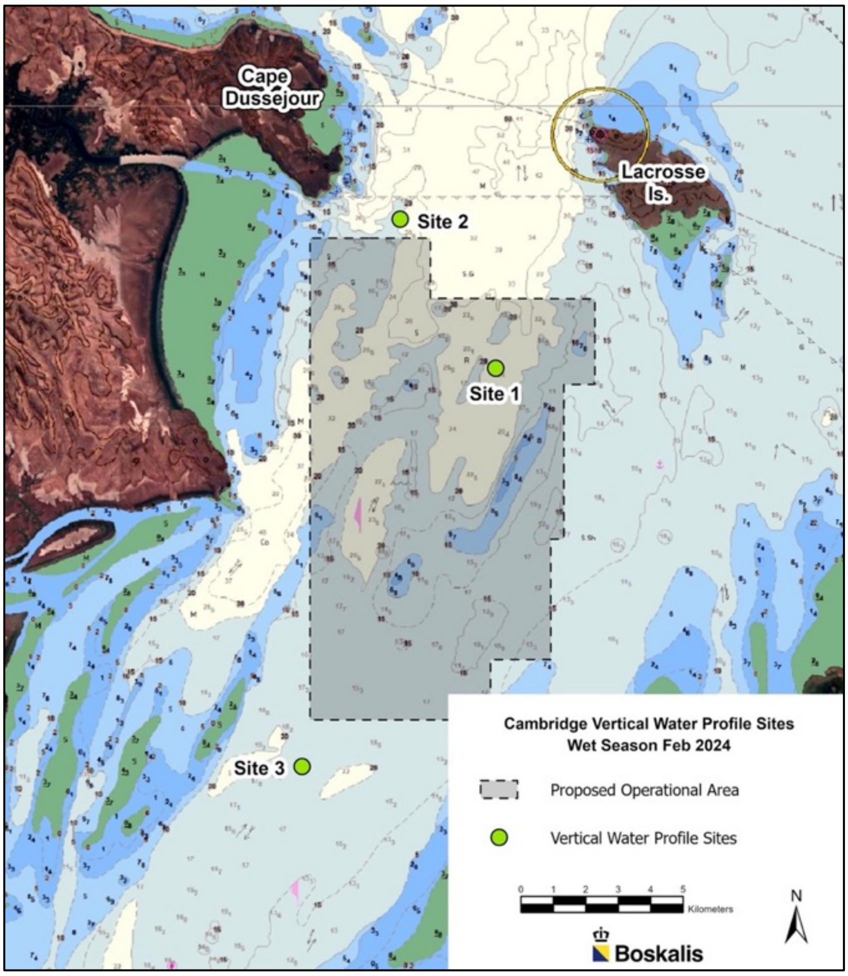


FIGURE 8.10: *Locations of Vertical Water Quality Profile sites in CG wet season Feb 2024.*

8.3 Description of Marine Environmental Quality

1. The main features of MEQ in CG are presented below. Referral Report No. 5 - *Metcocean & Sediment Dynamics* (PCS 2024a) and the supporting *Supplementary Technical Note* (PCS 2024b) and *Factual Data Report* (PCS 2024c) contain detailed analysis and presentation of suspended solids, turbidity and benthic light data in CG – and should be referred to.

8.3.1 Basic water quality parameters

1. The monitoring in CG by BKA between June 2023 through June 2024 measured the basic water quality parameters of TSS, turbidity, sea temperature, salinity, pH and chlorophyll-a, as presented in Table 8.1 (see Referral Report No. 5 and supporting reports for detailed data). In-situ (near-seabed) monitoring of turbidity, temperature, salinity and pH, plus benthic light, at several sites is ongoing and is planned to continue into 2025 to provide two-years of seasonal and inter-seasonal data, and will allow ongoing updates to this data.

2. Table 8.1 shows that TSS and turbidity in CG are extremely high (see further discussion in section 8.3.2 below), sea temperature, salinity and pH are generally within the normal ranges found in inshore tropical marine waters in northern Australia, and chlorophyll-a is quite low relative to other inshore tropical marine waters in northern Australia.

TABLE 8.1: *Minimum, maximum and mean values recorded for basic water quality parameters from BKA's sampling and monitoring in CG June 2023 to end June 2024*

NOTE: The seabed in-situ sensors remain in CG into 2025 to provide ongoing inter-seasonal data.

	Vertical Water Profiles						Seabed In-situ Sensors					
	Dry-season			Wet-season			Dry-season			Wet-season		
Parameters	Min	Max	Mean	Min	Max	Mean	Min	Max	Mean	Min	Max	Mean
TSS (mg/L):	6.0	220	52.7	12.0	155.6	54.7	N/a	N/a	N/a	N/a	N/a	N/a
Turbidity (NTU):	2.8	114.9	29.5	5.0	55.6	17.2	0.3	282.8	51.9	1.4	596.9	67.8
Sea Temp (°C):	23.0	24.4	23.9	30.9	31.3	31.1	24.5	30.0	27.6	28.0	32.9	30.2
Salinity (PSU):	29.5	32.9	31.7	27.4	32.4	30.6	21.3	34.1	29.5	7.5	34.5	28.2
pH:	Not Measured			8.6	8.7	8.6	8.3	8.6	8.5	8.0	8.6	8.4
Chlorophyll-a:	0.29 μg/L	1.26 μg/L	0.6 μg/L	0.04 RFU	0.47 RFU	0.07 RFU	N/a	N/a	N/a	N/a	N/a	N/a

TSS = Total Suspended Solids.
mg/L = Milligrams per litre.
NTU = Nephelometric Turbidity Unit.
PSU = Practical Salinity Unit.
pH = Potential of Hydrogen (concentration of hydrogen ions which is a measure of acidity / alkalinity).
μg/L = Micrograms per litre.
RFU = Relative Fluorescence Units.

Note for TSS:
- Dry-season data are based on suspended sediments filtered from Niskin water samples, taken from midwater at 53 sites spread throughout CG at random stages of the tide, = 53 samples.
- Wet season data are based on suspended sediments filtered from Niskin water samples, taken from midwater and near seabed every hour over 13 hours over a spring tidal cycle from low to high to low tide, at three fixed sites in CG, = 78 samples.
- These differences in sampling approaches between the seasons should be taken into account when assessing seasonal differences.

Note for Vertical Profile Turbidity, Temp, Salinity, pH and Chlorophyll-a.
- Dry-season data are based on near-continuous sampling by a YSI multi-sonde probe, lowered down the water column from surface to seabed, at 53 sites spread throughout CG at random stages of the tide, = 53 profiles (one at each of the 53 sites).
- Wet season data are based on near-continuous sampling by the same YSI multi-sonde probe, lowered down the water column from surface to seabed, every hour over 13 hours over a spring tidal cycle from low to high to low tide, at three fixed sites in CG, = 78 profiles.
- These differences in sampling approaches should be taken into account when assessing seasonal differences.
- The values for turbidity from the seabed in-situ sensors may be more suitable for comparing seasonal differences.

8.3.2 Suspended solids & turbidity

1. The mean water depth in CG is approximately 12 m LAT with a macrotidal environment with semi-diurnal tides and a spring tidal range of 8 m. The large tidal range causes high current velocities. BKA has measured currents >1.5 m/s (3 knots) (PCS 2024a), and the Australian Hydrographic Office (AHO) marks 3 to 4 knots (1.54 to 2.06 m/s) in West Entrance and in the centre of CG on chart AUS32 (see section 6.4.2). These strong currents cause very high natural turbidity from constant suspension of sediments with every change of the tide, and permanent aphotic conditions at the seabed, as described in section 6.3.9.

2. As outlined in section 8.31 TSS and thus suspended sediment concentrations (SSC) and turbidity levels in CG are extremely high naturally. BKA's various water quality sampling campaigns in CG from June 2023 to end June 2024, including vertical water quality profiles and in-situ sensors at the seabed, have measured the following key values for total suspended solids (TSS) and turbidity (see Referral Report No. 5 (PCS 2025a, b & c) for details):

    a) TSS concentration:
        - Dry-season mean TSS in the mid-water column of 57.2 mg/L and a peak value of more than 220 mg/L.
        - Wet-season mean TSS in the mid-water column of 54.7 mg/L and a peak value of 155.6 mg/L.

    b) Turbidity in the water column:
        - Dry-season mean turbidity in the water column of 29.5 NTU and a peak value of 114.9 NTU.
        - Wet-season mean turbidity in the water column of 17.2 NTU and a peak value of 55.6 NTU.

    c) Turbidity near the seabed:
        - Dry-season mean turbidity near the seabed of 51.9 NTU and a peak value of 282.8 NTU.
        - Wet-season mean turbidity near the seabed of 67.8 NTU and a peak value of 596.9 NTU.

3. Time series monitoring by the Australian Institute of Marine Science (AIMS) between 1999 and 2004 at various depths in the water column at multiple sites under a range of conditions in CG, measured peaks in SSC ranging from around 75 mg/L in the proposed operational area, to 5,000 mg/L in West and East Arms either side of Adolphus Island, south of the main body of CG (AIMS 2007, in Referral Report No. 5 (PCS 2024a, b & c)).

4. All of the above are extremely high values and range from one to four orders of magnitude higher than for similar tropical marine environments in northern Australia, as outlined in section 9 below on Marine Environmental Quality.

5. Based on data from both the dry-season environmental survey in July-August 2023 and the wet-season environmental survey in February-March 2024, BKA has derived turbidity / total suspended solids (TSS) correlations as follows (see Referral Report No. 5 (PCS 2024a, b & c)):

    a) Dry-season turbidity / TSS correlation: 1 NTU = 1.72 mg/L.
    b) Wet-season turbidity / TSS correlation: 1 NTU = 2.77 mg/L.

6. As outlined in section 8.2, as a further measure of water clarity / turbidity, during the sand exploration survey in March 2023 BKA's consultants took Secchi disc readings at 17 sites in the proposed operational area, recording the following values:

    a) a maximum (clearest) Secchi depth of 0.82 m,
    b) a minimum (most turbid) Secchi depth of 0.15 m; and
    c) a mean Secchi depth of 0.40 m.

7. This compares to:

    a) a Secchi range of 1.5 to 5.5.m for King Bay near Dampier (SKM 2003),
    b) a mean Secchi of 2.28 m for Darwin Harbour and Van Diemen Gulf (Blondeau et al 2017),
    c) a median Secchi of 1.4 m for Tonwsville enclosed coastal waters; and
    d) a median Secchi of 2.5 for Townsville open coastal waters (Dry Tropics Partnership 2021).

8. This shows that water clarity in CG is an order of magnitude lower than other tropical coastal marine environments in northern Australia. The TOs of the area refer to CH as 'Brown Water Country' (Figures 8.11 to 8.13).

9. Up to June 2024 PCS assessed all available data on SSC and turbidity in CG, including analysing and describing spatial and temporal patterns in these parameters under the influence of different tide and wind conditions, and seasonal factors such as wet-season runoff. The findings are reported in in Referral Report No. 5 (PCS 2024a, b & c), and are not repeated here for reasons of economy. Overall, as would be expected, the analysis showed that SSC varies over each tidal cycle, with lower SSC around high water due to offshore waters with low SSC being imported into CG, and higher SSC around low water due to upstream waters from the West and East Arms with very high SSC flowing into CG (Figure 8.13). The analysis also

showed that SSC increase due to large waves and high river discharge, but the surface water SSC during these events was not significantly higher than during large spring tides.

7. To better understand the spatial variability in SSC and thus turbidity in the CG region, and how this is affected by the metocean conditions, Sentinel-2 satellite imagery was sourced from Copernicus (2023) and processed by PCS to provide satellite-derived SSC spatial maps. In addition, metocean conditions prior to and at the time the images were captured, were analysed to provide additional context to the images. Two examples of satellite-derived SSC distribution for the CG area are presented in Figure 8.14 for spring tide conditions and Figure 8.15 for neap tide conditions. These show the naturally high SSC in the area. Further satellite images and full analysis are contained in PCS (2024a).

8. Figures 8.14 and 8.15 show SSC values of 50 mg/l over extensive areas – again these are very extremely high values compared to many similar tropical marine environments in northern Australia. It is important to note that in high SSC environments such as CG, the satellite-derived SSC will typically provide an indication of SSC in the upper water column and can only determine the SSC up to a certain concentration threshold (as values above that will cause the same light-blocking of the water column, as sensed by the satellite). For CG that value is around 50 mg/L. This means that in the areas with 50 mg/l shown on Figures 8.13 and 8.14, the actual SSC could be higher and possibly much higher than 50 mg/l.

9. As part of modelling work for the BKA proposal, PCS has applied the DHI MIKE Sediment Transport Model (STM) which is designed specifically for sediment transport studies in coastal and estuarine environments with fine-grained and sand sized sediment, and for dredging studies. This included modelling SSC in the CG region under various tidal and seasonal conditions, and comparing modelled SSC and satellite-derived SCC under these conditions. Figure 8.16 shows two examples of modelled versus satellite derived SSC distributions. Further comparative images and full analysis are contained in PCS (2024a). Comparison between the modelled and satellite-derived SSCs for comparable tidal states shows similar spatial patterns and magnitudes, which provides confidence that the MIKE STM model is able to simulate the sediment transport processes that result in sediment being suspended in CG.

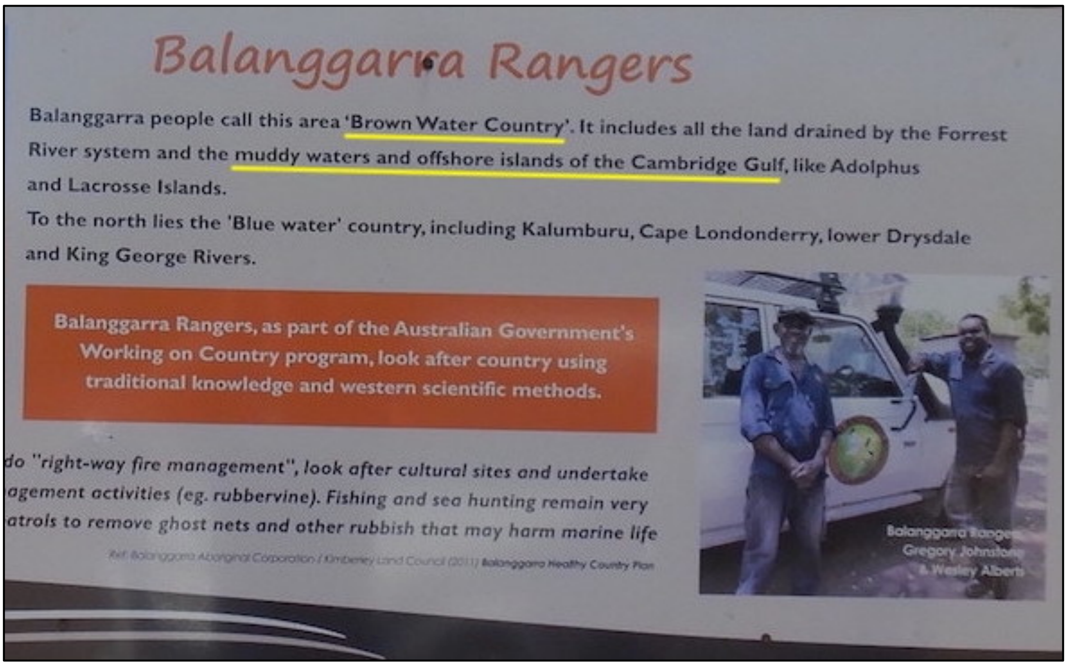


FIGURE 8.11: *An interpretive sign by the Balanggarra Indigenous Rangers at the Port of Wyndham public jetty, with reference to the area as 'Brown Water Country' and the 'muddy waters' of Cambridge Gulf.*

FIGURE 8.12: *Examples of suspended sediment concentrations and turbidity levels in CG, as shown in photographs taken during BKA's environmental survey work. The bottom-right image is at Wyndham (images: Raaymakers).*

FIGURE 8.13: *Example of a tidal-front of water from upstream CG with higher suspended sediment concentrations and turbidity levels moving seaward through outer CG with the outgoing (ebb) tide (images: Raaymakers).*

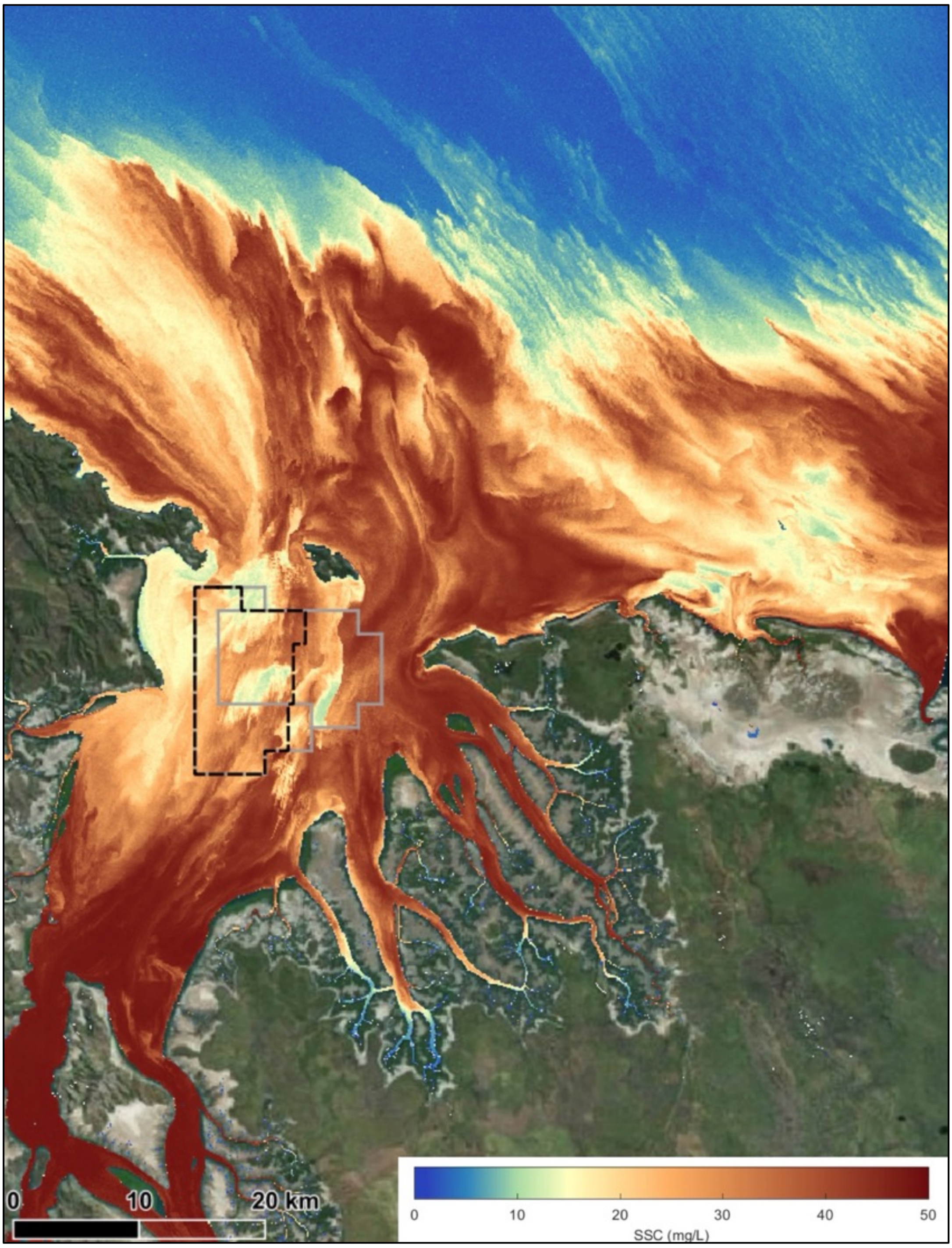


FIGURE 8.14: *Satellite-derived SSC for Sentinel 2 image captured on 12/05/2023 at neap tidal conditions just after the end of the wet season (PCS 2024a).*

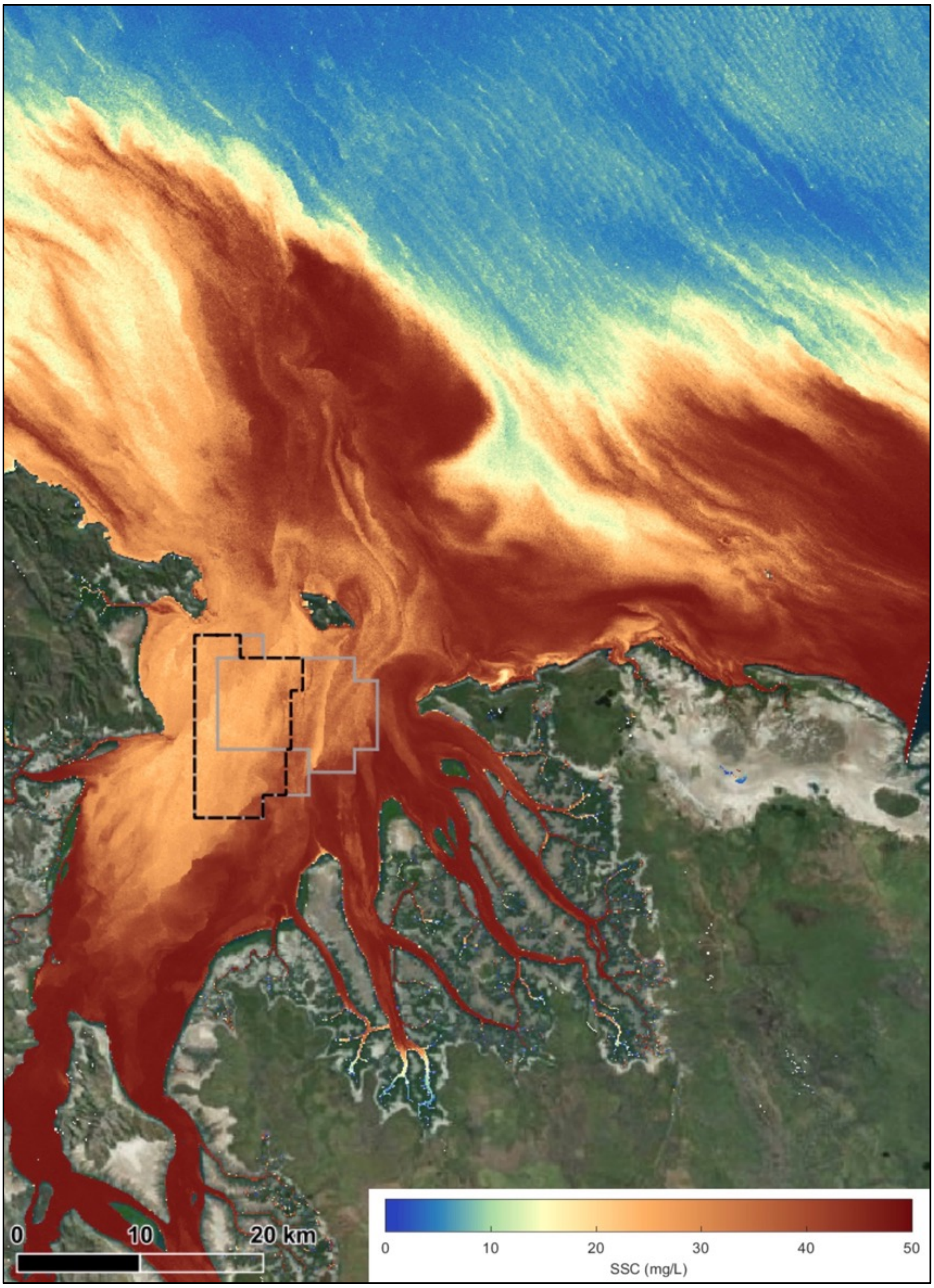


FIGURE 8.15: *Satellite-derived SSC for Sentinel 2 image captured on 22/05/2023 at spring tidal conditions just after the end of the wet season with an H_s of 0.8 m and a 10-knot easterly wind (PCS 2024a).*

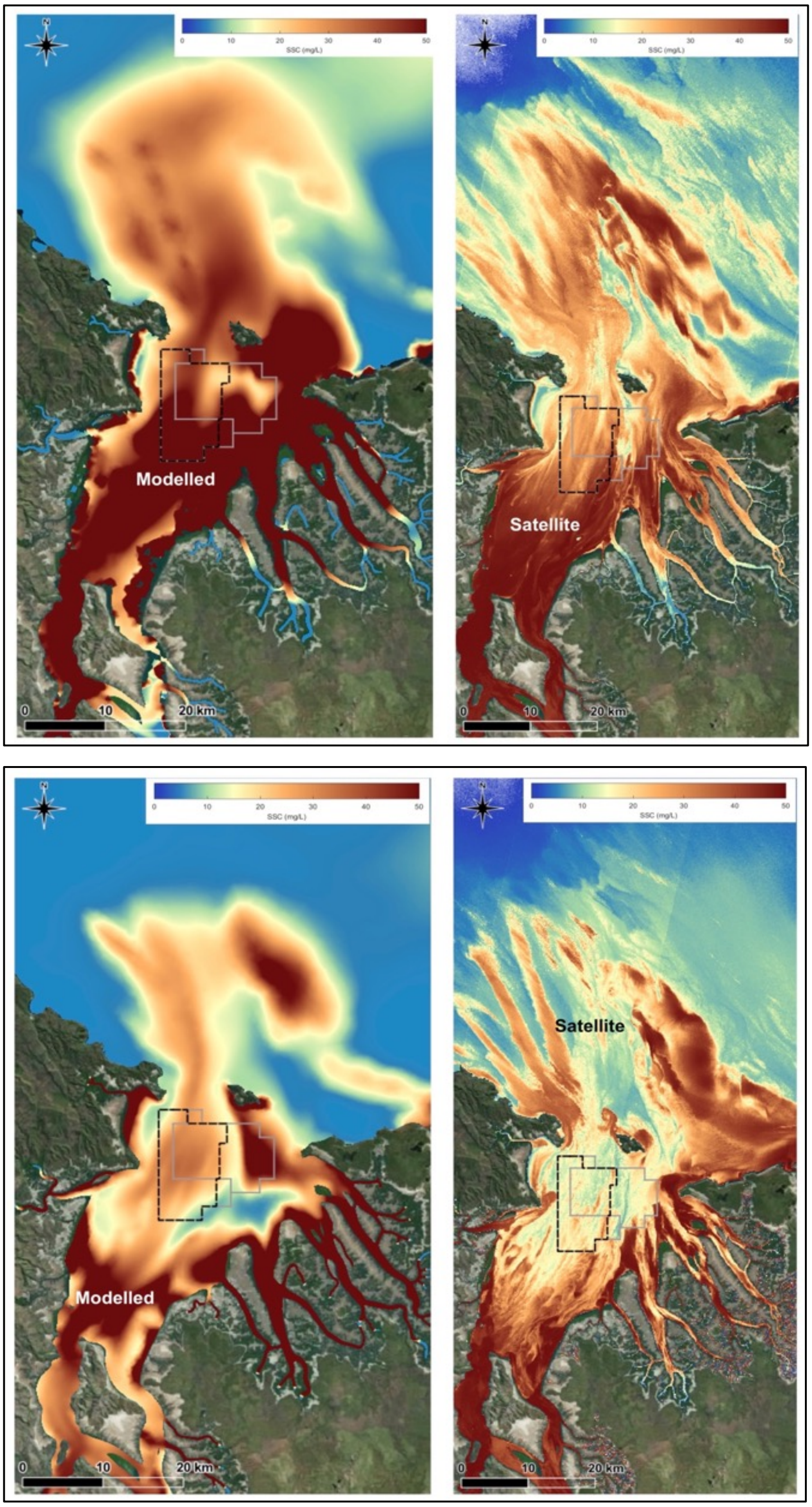


FIGURE 8.16: *From PCS 2024a.*

Top: *Modelled SSC in the CG region at the end of the ebb stage of the tide during a spring tide (left) and satellite image showing SSC during comparable spring tide conditions (right).*

Bottom: *Modelled SSC in the CG region at the end of the flood stage of the tide during a spring tide (left) and satellite image showing SSC during comparable spring tide conditions (right).*

8.3.3 Benthic light

1. As outlined in section 6.3.9 on drop camera deployments and shown in the images in Annex 3, there is a permanent aphotic zone near the seabed throughout CG, due to the constant suspension of fine silts and sediments by the strong tidal currents. Monitoring by BKA through 2023 and 2024 has consistently measured almost zero benthic light throughout CG and at King Shoals in both the dry-season and wet-season.

2. The available benthic light data to June 2024 was analysed by PCS (see Figure 8.3 in section 8.2 for instrument locations). The data at all of the available sites showed very low benthic irradiance, with virtually no light at all sites, and with most sites (except the shallowest two at Pos-13 and Pos-14, both -13 m MSL) showing no temporal pattern in the benthic irradiance, as would be expected due to variations in ambient light between day and night. In addition, at all sites except the shallowest two (Pos-13 and Pos-14) the upward and downward facing sensors did not show a consistent difference (i.e. the upward facing sensor always having higher values, as would be expected if there is light at the seabed, as it faces up to the sun). This further indicate that there was no light near the seabed.

3. Two example plots from the measurements at sites AWAC-04 (depth of 28.5 m MSL) and AWAC- 11 (depth of 22.3 m MSL) are shown on Figures 8.17 and 8.18. Full analysis of benthic light data to date is contained in PCS (2024b) and PCS (2024c) (annexes to Referral Report No. 5).

4. Benthic light monitoring at several sites on Figure 8.3 is ongoing and the 'Pos' sites are currently planned to continue into 2025 to provide two-years of seasonal and inter-seasonal data.

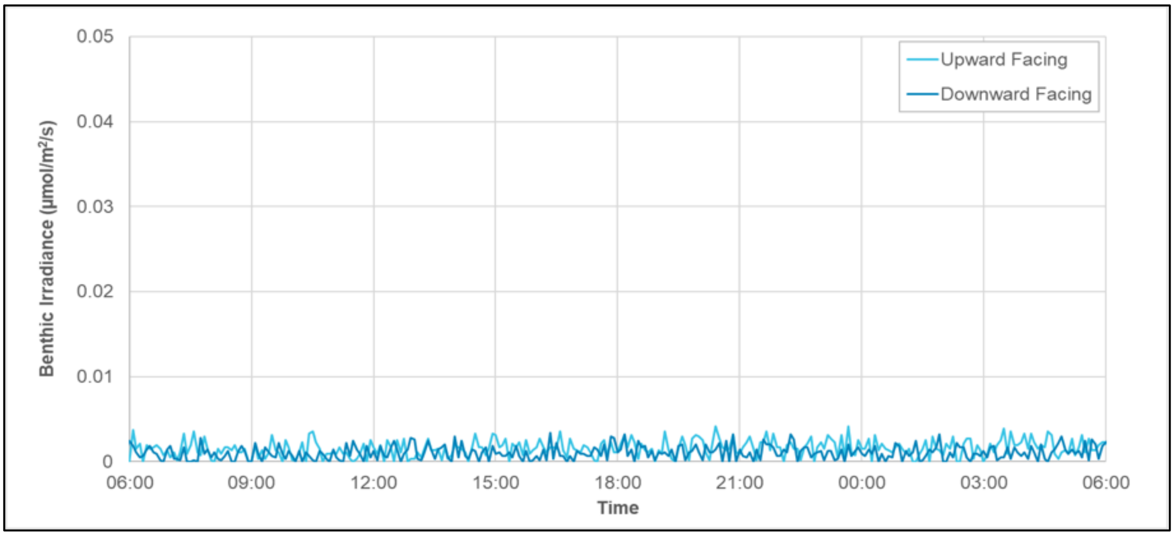


FIGURE 8.17: *Time series of instantaneous benthic light at AWAC-04 from 07/09 to 08/09/2023 (from PCS 2024b).*

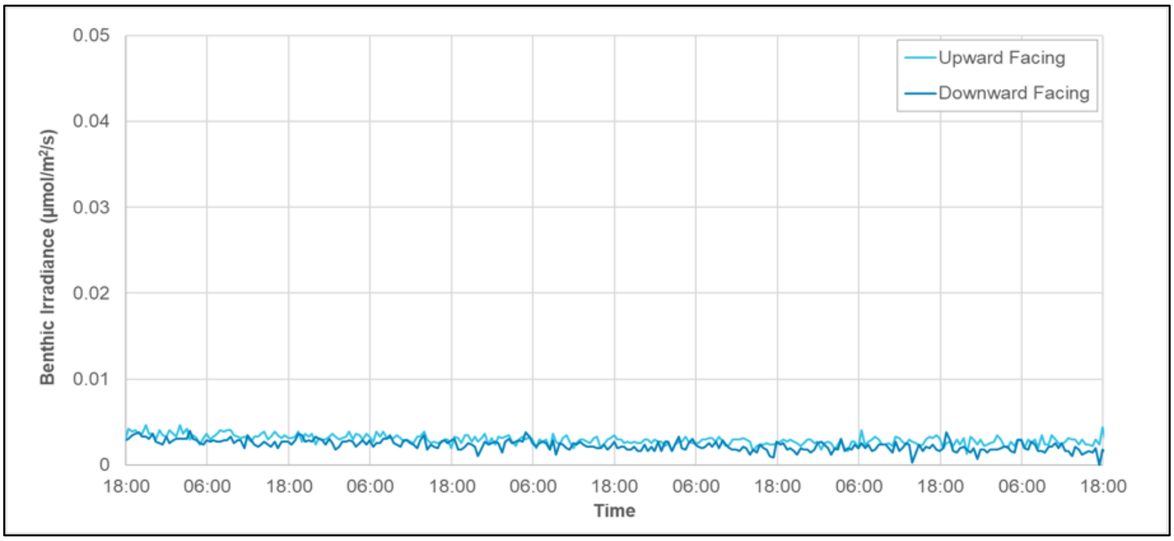


FIGURE 8.18: *Time series of instantaneous benthic light at AWAC-11 from 02/03 to 09/03/2024 (from PCS 2024b).*

8.3.4 Chemical pollution & contamination

1. There is no urban, industrial or other development on the coast or in the immediate catchment of CG that could be potential sources of contaminant inputs to the receiving marine environment.

2. Currently, the only potential source of marine pollution within CG itself, is the ships that transit through CG when entering and departing the Port of Wyndham. Over the three-financial year period 2019/20 to 2022/23 there was an average of 1.3 commercial ship transits per week through CG (CGL 2024). These included small cruise ships, bulk carriers, petroleum tankers and general cargo ships.

3. All such ships that enter Australian ports must comply with the *International Convention for the Prevention of Pollution form Ships* (MARPOL) and the implementing Australian law - the Commonwealth *Protection of the Sea (Prevention of Pollution from Ships) Act* and related Marine Orders (administered by AMSA). Assuming that they comply, these ships should not cause negative impacts on MEQ in the CG area.

4. In the wider catchment, including upstream of Adolphus Island, five main rivers discharge into CG, the Durack, Forrest, King, Ord and Pentecost, along with a number of smaller tributaries. The rivers all discharge sediment into CG. Apart from the Ord, which has two dams and significant areas of irrigated agriculture, all of the other rivers are still 'wild', with very little clearing of natural vegetation or development. Therefore, there are limited potential sources of contaminant inputs to the receiving marine environment in CG from those rivers.

5. There is potential for inputs of chemical contamination to the receiving marine environment in GG via the Ord River from the Ord River Irrigation Scheme area, where chemical pesticides and fertilizers are used on farms. However, such contaminants are mainly carried attached to sediments, and as outlined above the two dams on the Ord have interrupted sediment flow into CG, likely significantly reducing the potential for contaminants to be carried into CG via the Ord River.

6. Robson et al (2008) (CSIRO) report on regular, ongoing water quality monitoring undertaken by the WA Government in the Lower Ord (below the dams) and also undertook additional measurements of nutrient concentrations and other water and sediment quality parameters in 2006 and 2007. They did not report contamination in the system. They also reported that any dissolved inorganic nutrients entering the Lower Ord from potential upstream sources would be rapidly taken up by algae, while organic nutrients would be broken down by bacteria, both of which are abundant in the system, and thus nutrients are unlikely to reach downstream areas (including CG).

7. To assess for potential contamination of sediments in CG, in July 2023 BKA collected sediment samples from 21 sites within and around the proposed operational area, for analysis according to the Australian National Assessment Guidelines for Dredging (NAGD) (Commonwealth 2009) (Figure 8.5 above). Testing was undertaken by ALS NATA accredited laboratory for organic compounds (various hydrocarbons, organochlorine pesticides, dioxins, organotin compounds etc) and a suite of metals (including arsenic and mercury). All parameters for all samples returned below the NAGD screening levels or below limits of detection, indicating that the sediments are free of contamination. The analysis results are presented in Annex 10).

8.3.5 Overall summary of MEQ in CG

1. Overall, the receiving environment in CG in terms of MEQ can be summarized as:

    a) free of chemical contaminants and pollutants, with no significant sources of potential contamination along the immediate coastline or in the broader catchment,

    b) normal sea temperature, salinity and pH, with expected variation between the dry- and wet-seasons,

    c) relatively low chlorophyll *a* concerntrations, in both the dry- and wet-seasons,

    d) extremely high SSC and turbidity levels; and

    e) very low (zero or near zero) benthic light levels, throughout the year.

8.4 Key Environmental Values Linked to Marine Environmental Quality

1. The five environmental values that are linked to MEQ as outlined in the EPA technical guidance are described for CG in Table 8.2. This shows that the main environmental value is ecosystem health, while the other four are not so relevant or not relevant at all, given the situation in CG, as indicated in Table 8.2.

2. The potential impacts of the BKA sand-sourcing proposal on MEQ and on each of the associated environmental values are assessed in Referral Report No. 4 - *Impacts Assessments* (BKA 2024d).

TABLE 8.2: *The five environmental values that are linked to MEQ and their relevance in CG.*

Environmental Value linked to MEQ	Relevance & situation in Cambridge Gulf
1. Ecosystem health:	Overall, it is assessed that the existing (baseline) MEQ of CG is in a natural condition and free of contaminants and pollutants, while suspended sediment concentrations and turbidity levels are naturally very high and chlorophyll levels are relatively low. The health of the biological communities that are present in CG, and especially the mangrove communities around the coast of CG and the marine species that they support, are dependent on the maintenance of this natural, uncontaminated condition.
2. Fishing & aquaculture:	Small private vessels from Wyndham and Kununurra use CG for recreational fishing along the coast and up the inlets of CG. One commercial gillnet fisherman is sometimes active in CG, targeting Barramundi (*Lates calcarifer*) and Threadfin Salmon (*Eleutheronema tetradactylum*). He also works the adjacent coast outside CG. Three commercial gillnet fishermen based in Broome located over 1,000 km by sea to the west are licenced to fish in CG but currently do not. The mangroves around the coast of CG are important habitat for mud crabs (*Scylla spp*). There are three commercial crab fishermen licenced to fish CG. Two are based in Broome and are not currently active in CG, and one is based in Port Headland and their licence is for sale. The mangroves around the coast of CG are important nursery areas for Banana prawns (*Penaeus indicus* and *P. merguiensis)*, although the adults are trawled in waters over 50 to 100 km offshore from CG. Both the recreational and commercial fishing sectors depend on the maintenance of the natural, uncontaminated condition of MEQ of CG to ensure the health of fish, crab and prawn stocks. There is currently no aquaculture in CG and no proposals to develop aquaculture in the foreseeable future. The extreme environmental conditions of CG including strong tidal currents and naturally very high turbidity most likely make aquaculture non-viable in CG.
3. Recreation and aesthetics:	The only recreational activity in CG is recreational fishing as addressed against point 2 above. There is no swimming or water sports in CG as the area is uninhabited by humans and due to the presence of crocodiles, river sharks, stinging jellyfish, strong tidal currents and naturally very high turbidity levels. While the surrounding coast and landward backdrop of CG have high aesthetic value due to the rugged natural beauty of the area, the aesthetic value of the marine environment is very low due to naturally very high turbidity levels – the local TO groups refer to the area as 'Brown Water Country'.
4. Industrial water supply:	There is currently no industry that requires water supply in CG and no proposals to develop any such industry in the foreseeable future.
5. Cultural and spiritual:	There are significant land-based Aboriginal cultural heritage sites on the eastern side of CG and on Lacrosse Island – which are not affected by MEQ. BKA has consulted with the TO groups about marine-based cultural heritage and undertook an extremely comprehensive survey for potential underwater Aboriginal cultural heritage, and found no indications of such (see Referral Report No. 2 - *Traditional Owners, Native Title & Aboriginal Cultural Heritage*). As outlined above the local TO groups refer to the area as 'Brown Water Country' due to the naturally very high turbidity levels.

9. MARINE FAUNA

9.1 Relevant EPA Guidance

1. The EPA has published one guidance document relating to marine fauna - EPA 2016, *Environmental Factor Guideline - Marine Fauna*. The Guideline defines marine fauna as:

   – *Animals that live in the ocean or rely on the ocean for all or part of their lives.*

2. This definition is extremely broad and includes animals ranging in size from microscopic zooplankton to the blue whale. While benthic animals that are attached to the seabed such as corals, sponges etc are also marine fauna, they are typically considered under the environmental factor of *Benthic Communities and Habitats*, as presented in section 6. Therefore, for the purposes of this assessment, marine fauna includes all marine animals that are not attached to the seabed.

3. The Objective for marine fauna is:

   – *To protect marine fauna so that biological diversity and ecological integrity are maintained.*

4. In the context of this objective e*cological integrity* is the composition, structure, function and processes of ecosystems, and the natural variation of these elements. This acknowledges the importance of protecting marine fauna for their ecological roles. The EPA also recognises the iconic nature of many marine animals including traditional aboriginal cultural usage. The larger species can be seen by many as indicators of the 'health' of the marine environment.

5. The guideline requires impact assessments to consider both *direct* and *indirect* impacts on marine fauna, as well as links to potential impacts on *critical habitats* upon which the fauna are dependent, and temporal / seasonal patterns and *key ecological windows*, such as breeding, spawning, feeding or migration periods.

6. The guideline states that the EPA is focussed on 'significant' impacts to marine fauna, and lists some examples of what can be considered as 'significant', as follows:

   a) harm to individuals and/or declines in the population or the range of species protected under state legislation,
   b) reductions in populations of species of local and regional importance,
   c) impacts to species or groups of species that fulfil critical ecological functions within the ecosystem,
   d) loss or impact to critical marine fauna habitat, including habitats such as nesting beaches, nursery areas, sea lion haul out areas, specific foraging or breeding areas, and fish spawning aggregation areas
   e) reduction in species diversity in an area, which may be due to factors such as migration or range contraction resulting from a decline in the quality of the local environment
   f) introduction and/or spread of invasive marine species or diseases.

7. BKA has addressed these points in the impact assessments in Referral Report No. 4 - *Impact Assessments* (BKA 2024d).

9.2 Methods Used to Describe Marine Fauna

9.2.1 Methods overview

1. A wide range of methods were used to assess and describe marine fauna in the LAU. These included:

   a) Literature search: Initial literature search and review was undertaken of existing data and previous studies relating to marine fauna in CG.

   b) Marine mega-fauna (MMF) surveys: Dedicated, systematic vessel-based marine mega-fauna (MMF) surveys over nine-days each were undertaken in both the dry- and wet-seasons. These targeted larger (mega) marine fauna including dugong, snubfin, humpback and other dolphins, marine turtles, crocodiles, seasnakes, sharks and rays and significant fish sightings, plus any other sightings.

   c) Incidental observations: All team members and vessel-crew for all three survey trips to CG were briefed on incidental marine fauna observation protocols, and all personnel were asked to maintain watch for marine fauna when undertaking their day-to-day work and recording all incidental observations made.

   d) Drone surveys of turtle nesting: Targeted aerial drone video and photography surveys were carried out at all (17) supra-tidal sand areas in CG that could potentially host turtle nesting, during the dry-season survey in late July 2023, near to peak Flatback Turtle nesting season. Five out of the 17 sand locations surveyed were identified as having turtle nesting, and drone surveys of these specific areas were repeated in the wet-season survey in February 2024, to assess any nesting in the 'off-season'.

e) Other drone surveys: The video and photo-imagery from all other drone surveys carried out in CG, for example for intertidal habitat assessment, provided valuable aerial views of key areas, and were also assessed for signs of marine fauna.

f) DBCA Cape Domett turtle nesting data: DBCA has been undertaking annual monitoring of Flatback Turtle nesting at Cape Domett Seaward Beach since 2012 and DBCA provided BKA with access to the data to analyse and inform its assessment (see report in Annex 12).

g) eDNA sampling: eDNA sampling was undertaken of water and seabed sediments throughout CG and up inlets and rivers for evidence of sawfish and river sharks.

h) Fish observations: During survey trips to CG the research vessel's echo-sounder / fish finder was kept turned on and the crew on watch observed this and reported any significant observations. Incidental observations of fish activity were made by all team members during all other survey work.

i) Consultation: Consultations were held with commercial and recreational fishing interests, including the Western Australian Fisheries Industry Council (WACIF), Northern Prawn Fishery Industry (NPFI), Recfishwest, and local commercial and recreational fishermen, DPIRD Fisheries staff, district staff of DBCA and local TOs on their views on marine fauna, including fish species, in CG.

2. Consideration was given to demersal trawling in CG and especially in the proposed operational area to assess potential demersal fish populations. However, the undulating seabed with sand-wave heights up to 8 m with tidal currents up to 4 knots make this method non-viable and unsafe. Other methods indicate low fish numbers in non-coastal / inlet areas in CG.

3. Further details of the main methods are presented in sections 9.2.2 to 9.2.7 below.

9.2.2 Literature search & review

1. In accordance with standard procedure for commencing any environmental study, the first step was to undertake a search for existing reports, papers, studies and data of the area, using Google, Google Scholar and academic search engines, searching the research directories and web sites of relevant institutions such the Australian Institute of Marine Science (AIMS), the Commonwealth Scientific and Industrial Research Organization (CSIRO) and the Western Australian Marine Science Institute (WAMSI), and searching government directories such as the National Marine Biodiversity Hub, the Atlas of Living Australia, the National Conservation Values Atlas and the Digital Atlas of Australia.

2. While very useful reports, papers and datasets were obtained relating to geology, sediments, hydrodynamics and coastal processes, and some on water quality, very few were found relating to marine fauna. This reflects a general lack of previous studies on marine fauna in CG.

3. The most useful references and datasets that were identified, obtained and reviewed were:

a) Flatback turtles:
   - Whiting et al (2008), Cape Domett Flatback Turtle nesting study 2006-2007.
   - DBCA Cape Domett annual Flatback Turtle nesting surveys 2012-2022 (BKA entered into a data-sharing agreement with DBCA to obtain 10-years of data from that program, which was analysed as reported in Annex 12).

b) Dolphins:
   - Brown et al (2016) and Brown et al (2017), Cambridge Gulf Snubfin & Humpback Dolphin surveys 2012-2014.

c) Crocodiles:
   - Kay, 2004. Cambridge Gulf & Order River Crocodile Study 2001-2003.

d) River sharks.
   - P Kyne, Charles Darwin University, web site news postings on Cambridge Gulf and Order River on River Shark surveys 2015 and 2019 (no published report found).

e) Banana Prawns:
   - Loneragen et al (2002) (CSIRO) Cambridge Gulf Juvenile Banana Prawn Surveys.

4. The district DBCA staff advised that they have undertaken dolphin and crocodile surveys in CG in cooperation with local TOs, but no reports have been produced and no data was available.

5. The DPIRD Fisheries division advised that they have undertaken exploratory fisheries surveys in CG but no reports have been produced and no data was available.

6. No other studies, reports or datasets on other marine fauna types specifically relating to CG were identified.

9.2.3 Vessel-based MMF surveys

1. Dedicated, systematic vessel-based marine mega-fauna (MMF), visual transect surveys were undertaken over eight-days in the dry-season and nine-days in the wet-season. These targeted larger (mega) marine fauna including dugong, snubfin dolphins, humpback dolphins, other dolphins, marine turtles, crocodiles, seasnakes, sharks and rays and any other sightings.

2. The objectives of the MMF surveys were, for each season:

    a) to inform the assessment of potential impacts of the BKA sand-sourcing proposal on MMF,

    b) to establish spatial occurrence of target MMF including number of individuals, behaviors and where possible, health condition, and production of a sightings map,

    c) where possible with photography, establish means to identify individual animals between sampling periods from characteristic markings such as, depending on the species, dorsal fin shapes, scars, markings etc; and

    d) create the basis for a long-term database and photographic catalogue of MMF in CG, to assist monitoring should the BKA sand-sourcing proposal be approved and go ahead.

3. The dry-season MMF survey was led by marine zoologist Dr Helen Penrose. The wet-season survey was led by Mia McIntyre, an internationally experienced, certified marine fauna observer who also works with the DBCA North-west Shelf Flatback Turtle Program, and Yasmin Hunt who is also an internationally experienced, certified marine fauna observer with extensive experience in WA waters.

4. Both surveys were designed to be as consistent as possible, subject to variable site conditions and logistics, and followed established best practice methods for such surveys.

5. During the dry-season survey the MMF team worked from a dedicated 8 m jetboat. The wet-season team worked from both a dedicated small boat and from the main research vessel, depending on other survey work being undertaken at the time.

6. Both surveys had a minimum of two observers equipped with high-powered binoculars and cameras with telescopic lenses (100-400 mm lens capturing high resolution geotagged images). Observers were positioned on the port and starboard bows of the survey vessel, scanning their respective 180º views (Figure 9.1). Often there were supplementary observers on board (other team members, vessel crew etc) to add extra eyes to the search effort.

7. Observers went 'off effort' when a sighting was made, the vessel slowed and attempts were made to photograph the sighting. Data was recorded including location, species identity, group size, group age composition, any notable health observations and general behavior. Environmental variables, visibility, beaufort scale and tide state etc were recorded. Records were kept of 'on effort' and 'off-effort' times and used to calculate daily and total observer hours.

8. Surveys were carried out at a consistent low speed while 'on-effort' (10-12km/h or 6-8 knots). Vessel tracks were captured using GPS tracking and MFF sighting locations were recorded as way points on GPS, and also recorded through geotagged imagery where photos were possible.

9. Survey transects were distributed to provide as much coverage of the LAU as possible, including BKA's proposed operational area, and spaced to reduce the likelihood of re-sightings while being relevant to the spatial scale of the proposal. Both surveys covered over 800 km and over 50 hours of transects each during their respective periods. Areas covered included throughout all of CG, into upstream areas, and also areas slightly outside of CG and along the seaward coast to both west and east of CG, as shown on Figure 9.2.

10. Passive acoustic monitoring for dolphin sounds with a hydrophone was attempted at several sites during the dry-season survey without any recordings being made.

11. Figure 9.2 shows the survey transects for each survey. Figure 9.3 shows the locations of all sightings made during each survey. Table 9.1 lists combined number of sightings of each species per MMF survey and combined totals. Table 9.2 lists

all sightings made per day during each survey. Figure 9.4 shows three examples of MMF-images captured during the surveys. Annex 13 contains the full set of images captured, as well as the sighting location descriptions and coordinates for dolphins, turtle and crocodiles, and identifies the sightings that occurred within the proposed operational area.

12. It should be noted that separate sightings on the same day or different days could be the same individual(s), so the number of sightings does not equate to number of animals. Positive photo ID of distinguishable identifying features is required to be able to identify distinct individuals and count numbers.

13. All of the animals observed in CG including most crocodiles were quite elusive and moved away and submerged out of site rapidly, making photography difficult. Out of a total of 59 MMF sightings of all species across both surveys only 10 were successfully photographed, and only three have identifying features, as shown in Figure 9.4.

14. The summary results for the dry-season survey were (note numbers are sightings not necessarily separate individuals) (POA = Proposed Operational Area – refer Figure 9.3):

a)	Days surveyed:	Eight - 15 to 22 July 2023 inclusive, + incidental sightings 8 Aug 2023.
b)	Total effort:	56 hours and 823 km of transects.
c)	Snubfin Dolphin:	11 (3 in POA)
d)	Humpback Dolphin:	0
e)	Other dolphin (identified):	0
f)	Unidentified dolphin:	2 (0 in POA)
g)	Flatback turtle:	6 (0 in POA)
h)	Green turtle:	1 (outside CG to west)
i)	Other turtle (identified):	0
j)	Unidentified turtle:	7 (1 in south of POA)
k)	Saltwater crocodile:	10 (zero on POA)
l)	Seasnake:	0
m)	Shark / ray:	2 (juvenile Blacktip south of Adolphus Is. & juvenile Tiger Shark outside CG).
n)	Other:	0

15. The results for the wet-season survey were:

a)	Days surveyed:	Nine - 18 Feb then 21 to 28 Feb inclusive, + incidental sightings 8 Feb 2024.
b)	Total effort:	51.5 hours and 850 km of transects.
c)	Snubfin Dolphin:	4 (2 in POA)
d)	Humpback Dolphin:	1 (in POA)
e)	Other dolphin (identified):	0
f)	Unidentified dolphin:	1 (not in POA)
g)	Flatback turtle:	0
h)	Green turtle:	0
i)	Other turtle (identified):	0
j)	Unidentified turtle:	2 (1 in POA)
k)	Saltwater crocodile:	5 (1 in POA)
l)	Seasnake:	0
m)	Shark / ray:	0
n)	Other:	0

16. There were a number of notable features in the findings as follows:

    a) For both seasons there were zero sightings of Dugong, identified species of dolphin other than Snubfins and Humpbacks, identified species of turtle other than Flatbacks and one Green Turtle (sighted outside of CG to the west of Cape Dussejour) and zero sightings of seasnakes, rays and other MMF species.

    b) The overall number of sightings for all species sighted were very low considering the very large area covered and the hours of effort with two observers per survey (all sightings were low single digits except for 11 Snubfin sightings in the dry-season survey).

    c) Despite almost the same distance and hours covered between surveys, the number of sightings for all species were lower in the wet season than in the dry-season, except there was one Humpback Dolphin sighting in the wet-season and none in the dry-season (refer also Figure 9.5).

    d) The seasonal differences in turtle sightings relate to the dry-season survey being in late July close to the peak Flatback nesting period, when more turtles are present in the general area. The seasonal differences in Snubfin Dolphin sightings are consistent with advice from the local commercial fisherman who has more than 20 years of experience in CG, who advised that they seem to migrate out of CG in the wet season, perhaps due to increased freshwater inputs (Douglas pers. comms. 2024).

e) The majority of sightings for all species were outside of BKA's proposed operational area (POA), although there were three Snubfin sightings in the POA in the dry season survey, and two Snubfin and one Humpback Dolphin sightings in the POA in the wet-season survey (in all cases they were swimming purposefully and directionally), showing that these two species do move through that area.

f) The majority of all turtle sightings were outside of the POA, except for one unidentified turtle in the POA in each survey.

g) Similarly, the majority of all crocodile sightings were outside of the POA, except for one during the wet-season survey. Most crocodile sightings were in or near coastal mangrove areas, except in the dry-season a total of six were observed outside of CG at the Cape Domett turtle nesting beach. They were positioned either on the beach or in the water just off the beach, ready to feed on nesting and hatchling turtles each evening (Figure 9.3 inset and Annex 13).

17. More detailed location descriptions for all sightings are provided in Annex 13.

FIGURE 9.1: *Observers were positioned on the port bow (top image) and starboard bow (bottom image)of the survey vessel, scanning their respective 180º views while on-transect.*

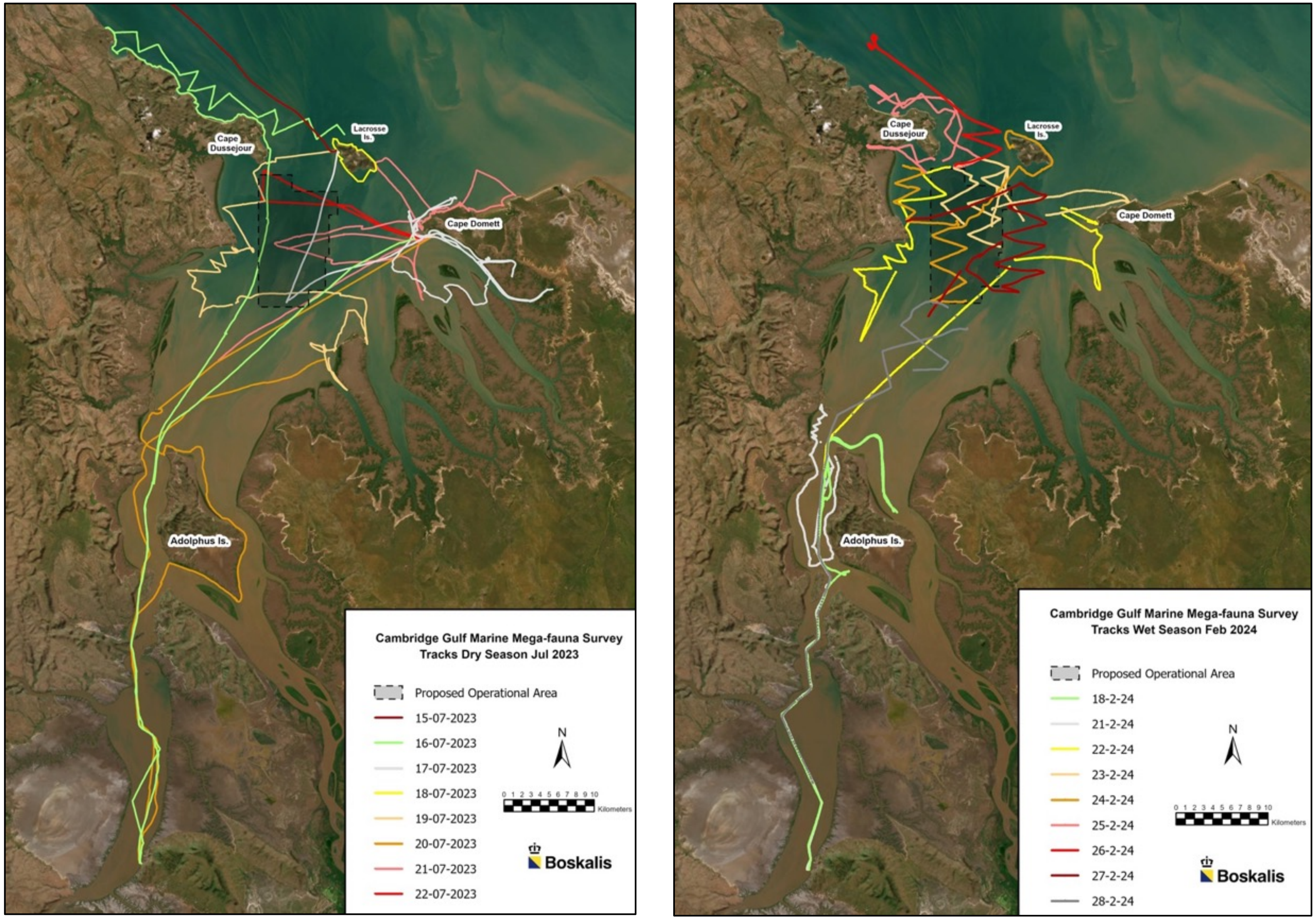


FIGURE 9.2: *Left: Dry-season MMF survey tracks. Right: Wet-season MMF survey tracks.*

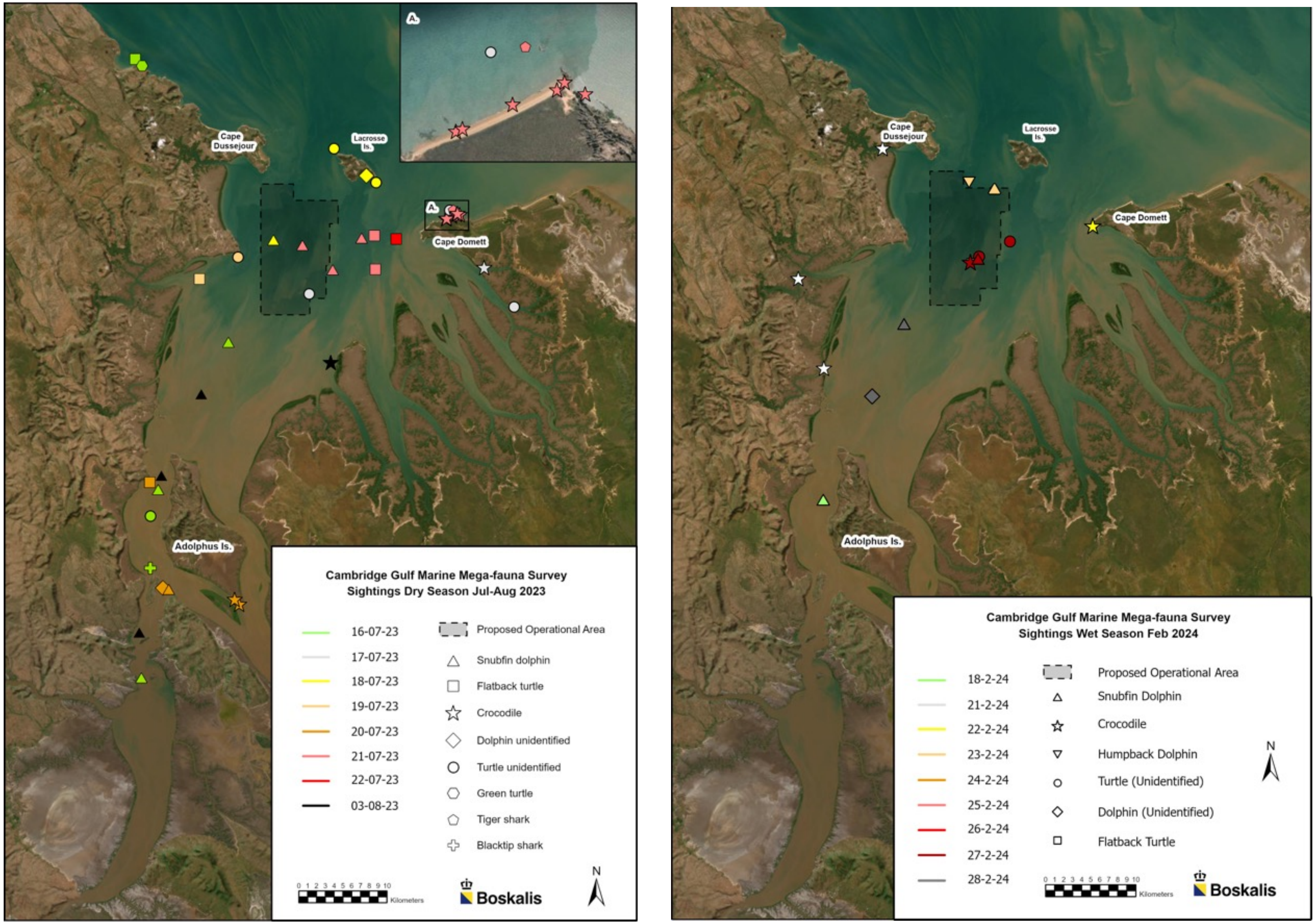


FIGURE 9.3: *Left: Dry-season MMF sightings. Right: Wet-season MMF sightings.*

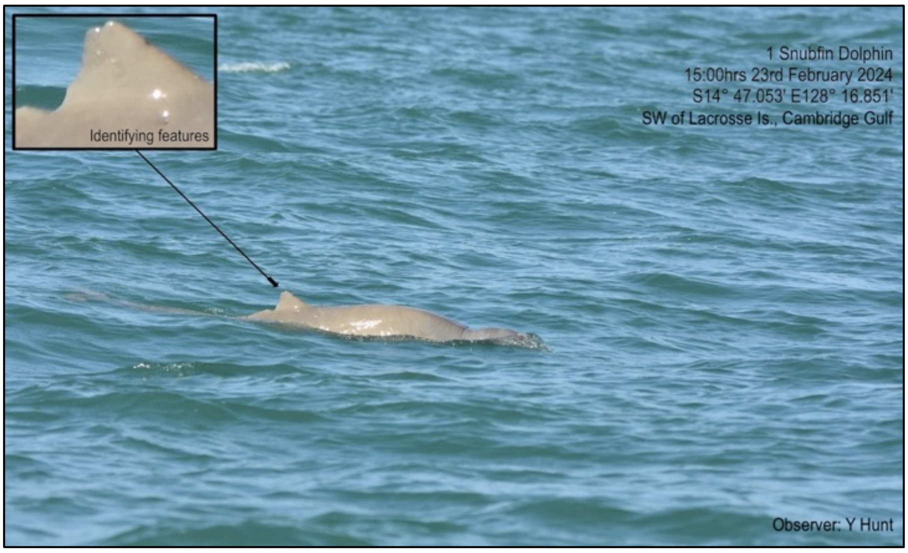


FIGURE 9.4: *Three examples of images of MMF that were captured during the surveys. All images captured are presented in Annex 13. These create the basis for a long-term database and photographic catalogue of MMF in CG, to assist monitoring should the BKA proposal be approved and go ahead.*

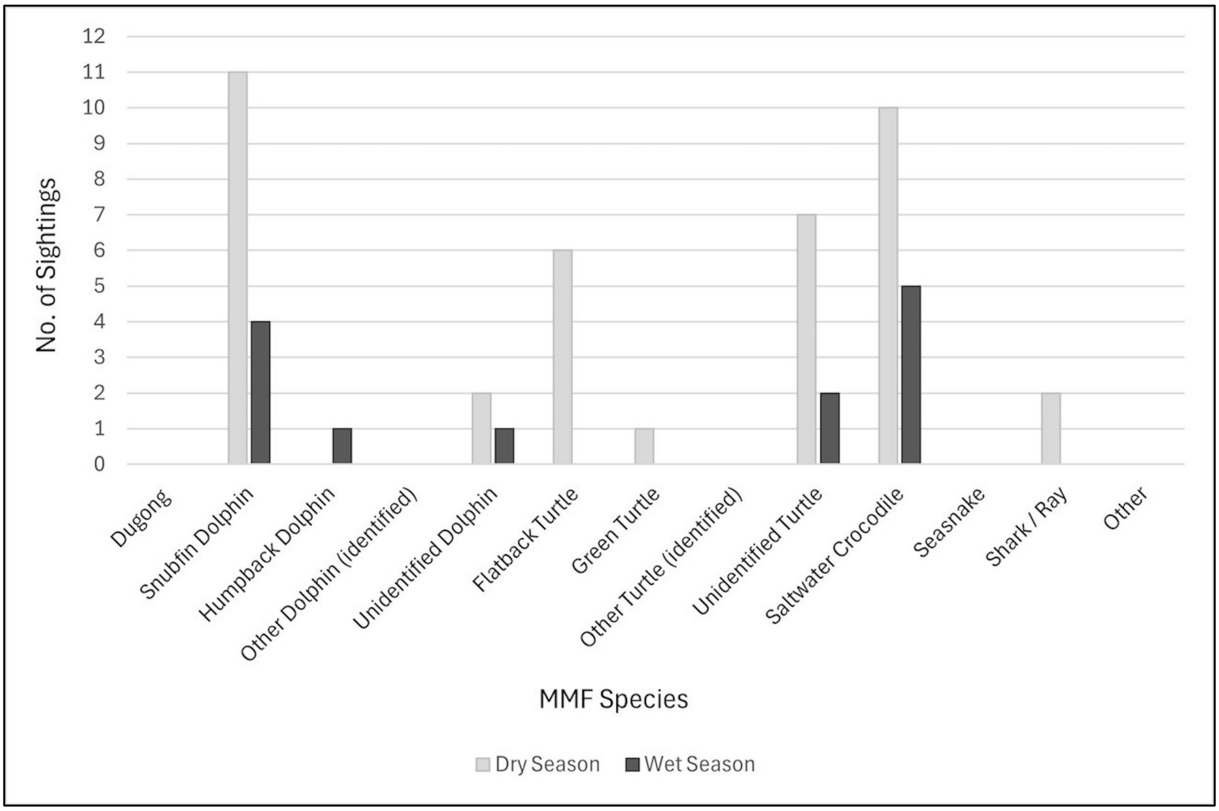


FIGURE 9.5: *Comparison between dry- and wet-season sighting numbers.*

TABLE 9.1: *Combined sightings of each species per MMF survey and combined totals*

	Dry-Season	Wet Season	Total Sightings
Dugong	0	0	**0**
Snubfin Dolphin:	11	4	**15**
Humpback Dolphin:	0	1	**1**
Other Dolphin (identified):	0	0	**0**
Unidentified Dolphin:	2	1	**3**
Flatback Turtle:	6	0	**6**
Green Turtle:	1	0	**1**
Other Turtle (identified):	0	0	**0**
Unidentified Turtle:	7	2	**9**
Saltwater Crocodile:	10	5	**15**
Seasnake:	0	0	**0**
Shark / Ray:	2	0	**2**
Other:	0	0	**0**
Total Sightings:	*39*	*13*	**52**

TABLE 9.2: *Summary data for the two MMF surveys in CG (see location data in Annex 13).*

	Dry-season Jul-Aug 2023										Wet-season Feb 2024											
	15-7	16-7	17-7	18-7	19-7	20-7	21-7	22-7	8-8	Sub-total	8-2	18-2	21-2	22-2	23-2	24-2	25-2	26-2	27-2	28-2	Sub-total	*Total*
Dugong	-	-	-	-	-	-	-	-	-	0	-	-	-	-	-	-	-	-	-	-	0	*0*
Snubfin Dolphin:	-	3(1P)	-	2(T)(P)	-	-	3	-	3	11	-	1(P)	-	-	1(P)	-	-	-	1(P)	1	4	*15*
Humpback Dolphin:	-	-	-	-	-	-	-	-	-	0	-	-	-	-	1	-	-	-	-	-	1	*1*
Other Dolphin (identified):	-	-	-	-	-	-	-	-	-	0	-	-	-	-	-	-	-	-	-	-	0	*0*
Unidentified Dolphin:	-	-	-	1	-	1	-	-	-	2	-	-	-	-	-	-	-	-	-	1	1	*3*
Flatback Turtle:	-	1	-		1(P)	1	2	1	-	6	-	-	-	-	-	-	-	-	-	-	0	*6*
Green Turtle:	-	1	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	0	*1*
Other Turtle (identified):	-	-	-	-	-	-	-	-	-	0	-	-	-	-	-	-	-	-	-	-	0	*0*
Unidentified Turtle:	-	1	3	2	1	-	-	-	-	7	-	-	-	-	-	-	-	-	2	-	2	*9*
Saltwater Crocodile:	-	-	1	-	-	2(1P)	6(2P)	-	1	10	3	-	-	1(P)	-	-	-	-	1	-	5	*15*
Seasnake:	-	-	-	-	-	-	-	-	-	0	-	-	-	-	-	-	-	-	-	-	0	*0*
Shark / Ray:	-	1(BT)	-	-	-	-	1(TS)	-	-	2	-	-	-	-	-	-	-	-	-	-	0	*2*
Other:	-	-	-	-	-	-	-	-	-	0	-	-	-	-	-	-	-	-	-	-	0	*0*

(P) = Photo captured. (T) = Together. (BT) = Blacktip. (TS) = Tiger Shark. Red = Incidental sightings, not on-survey.

9.2.4 Incidental marine fauna observations

1. Every opportunity was taken to observe and record marine fauna during other environmental survey work and routine vessel operations on all three survey trips to CG. This included:

    a) Briefing all team members and vessel-crew on incidental marine fauna observation protocols, asking all personnel to maintain watch for marine fauna when undertaking their day-to-day work and recording all incidental observations made, including species, location and date, and to photograph the sighting if possible.

    b) Assessing all drone video and photo-imagery for signs of marine fauna.

2. Incidental sightings were three Snubfin dolphins and one crocodile on 8 August 2023 after the dry-season MMF survey team had departed, and three crocodiles on 8 February 2024 before the wet-season MMF team commenced. These sightings were added to the MMF survey data as reported in section 9.2.3 and marked in red on Table 9.2.

9.2.5 Aerial drone survey of turtle nesting beaches

1. Prior to the dry-season environmental survey, satellite imagery was assessed to identify supra-tidal sand areas in the LAU that could potentially be used by marine turtles for nesting. Seventeen such areas were identified as shown on Figure 9.6 (yellow and orange shaded areas) (some of these have sub-areas as identified once the finer scale drone surveys were conducted, as shown on Figures 9.7 and 9.8). During the dry-season environmental survey, targeted aerial drone video and photography were taken at each of these locations at low tide. This was in late July 2023, near to peak Flatback Turtle nesting season. Turtle tracks and/or nests were observed at the sites marked in orange, and were not observed at the sites marked in yellow, on Figure 9.6 (blue is used instead of orange on Figures 9.7 and 9.8)

2. The video and photographs were analysed in detail once back from the field trip, and all visible nests and turtle track sets were counted (one track up and one down = one track set or one nesting attempt). The tracks were zoomed in to, in order to attempt to identify species, using the DBCA Turtle Monitoring Field Guide, which includes species identification by track characteristics. All appeared to be Flatbacks.

3. The data for the five locations surveyed that had turtle nests and/or tracks are shown in Table 9.2 (site numbers equate to those on Figure 9.6), and the number of tracks and nests observed are also mapped on Figure 9.8.

4. Figure 9.9 shows views of the five sites. Of note is while the four true-beach sites are all located outside of CG and face generally to seawards, the site at Barnett Point is located inside CG (although it still faces to seaward). It comprises sand ridges (ex-beaches) stranded behind mangroves (cheniers). The turtles move through gaps in the seaward fringe of mangroves to access and egress the sand nesting areas (Figure 9.10).

5. Figure 9.11 shows examples of aerial photo images and screen shots from the drone video with turtle tracks at each of the five sites. Figure 6.78 in section 6.4. above shows an example of an orthomosaic of stitched vertical images at Cape Domett Seaward Beach, showing the usefulness of orthomosaics for clearly showing turtle tracks on beaches.

6. It should be noted that the counts in Table 9.2 are based on a single drone flight over each area – and are therefore one-off counts. This limits the utility of the data in the broader context of the overall nesting period. Peak nesting in this area is July through September, and some nesting can reportedly occur at Cape Domett throughout the year (Whiting et al 2008). The one-off drone imagery also does not enable reliable differentiation of old tracks and fresh tracks, as the tide wipes evidence of tracks from the inter-tidal zone each day

7. Never-the-less, the data provides a relative indication of which sites are more significant than others in terms of numbers, at least on the days in late July 2023 when the drone was flown. Clearly, from Table 9.2, Cape Domett Seaward Beach is the most significant nesting site in terms of numbers. Of interest is that Cape Domett Seaward Beach with a length of 1.9 km has significantly higher numbers than Turtle Beach West (west of Cape Dussejour), with a longer length of 3 km, and more than at the stranded sand cheniers at Cape Barnett, which have a combined length of approximately 2.9 km.

8. Of further interest is that although Turtle Bay at Lacrosse Island has almost perfect conditions for turtle nesting, and historically supported very high numbers of nesting Flatbacks (hence its name), only six track sets and nests were observed there in late July 2023, near the peak season. The arrival of Europeans in the CG area in the late 1800s saw large-scale commercial harvesting of turtles, for meat and also for shell for the fashion industry (although the latter trade targeted Green and Hawksbill Turtles, as the softer shell of Flatbacks is not suitable for fashion items). Tens of thousands of turtles were harvested from northern Australia including in Cambridge Gulf until the industry was closed in 1973 (Halkyard 2014).

9. Figure 9.12 shows a record haul of Flatback Turtles at Turtle Bay on Lacrosse Island in 1924. The low numbers at Turtle Bay today may be a result of the intensive commercial turtle harvesting that occurred their historically. Like most marine

turtle species, female Flatbacks have a high fidelity to nesting beaches and will mostly (but not always) return to their hatching beach to nest, and will return to the same beach both within and between nesting seasons (Harmen et al 2009).

10. This means that historical mass harvesting at Turtle Bay may have broken the fidelity chain, depleting the population of females that return to this beach each year, resulting in the very low numbers seen even today. It is understood that similar mass harvesting did not occur at Cape Dommet or west of Cape Dussejour, as those areas are more remote in terms of access, and the supply at Turtle Bay met demand.

11. All of these five areas were surveyed by drone again in the wet-season February 2024 to assess any nesting in the 'off-season'. This included oblique video at all sites and high-resolution photogrammetry of the full extent of the beaches at Cape Domett, Turtle Bay and Turtle Beach West. Any tracks present would have shown on the imagery. A single track-set was observed by video at Cape Domett Seaward Beach (Figure 9.13), and none were observed at any of the other beaches. This indicates that seasonality of nesting might be stronger than reported by Whiting et al (2008).

TABLE 9.2: *Turtle nest and track counts from aerial drone surveys in CG in July 2023.*

Site	Beach Length (km)	No. Nests	No. Track Sets	Likely Species*
1. Cape Domett Seaward Beach:	1.9	190	449	Flatback
1A. Cape Domett Small Beach:	0.4	7	7	"
2. Turtle Beach West (W of Cape Dussejour):	3	28	34	"
3. Turtle Bay (Lacrosse Island):	0.3	6	6	"
4. Barnett Point:	2.9**	13	82	"

*****Based on track characteristics. **Approx. only. Separate sections combined – see Figure 9.9.

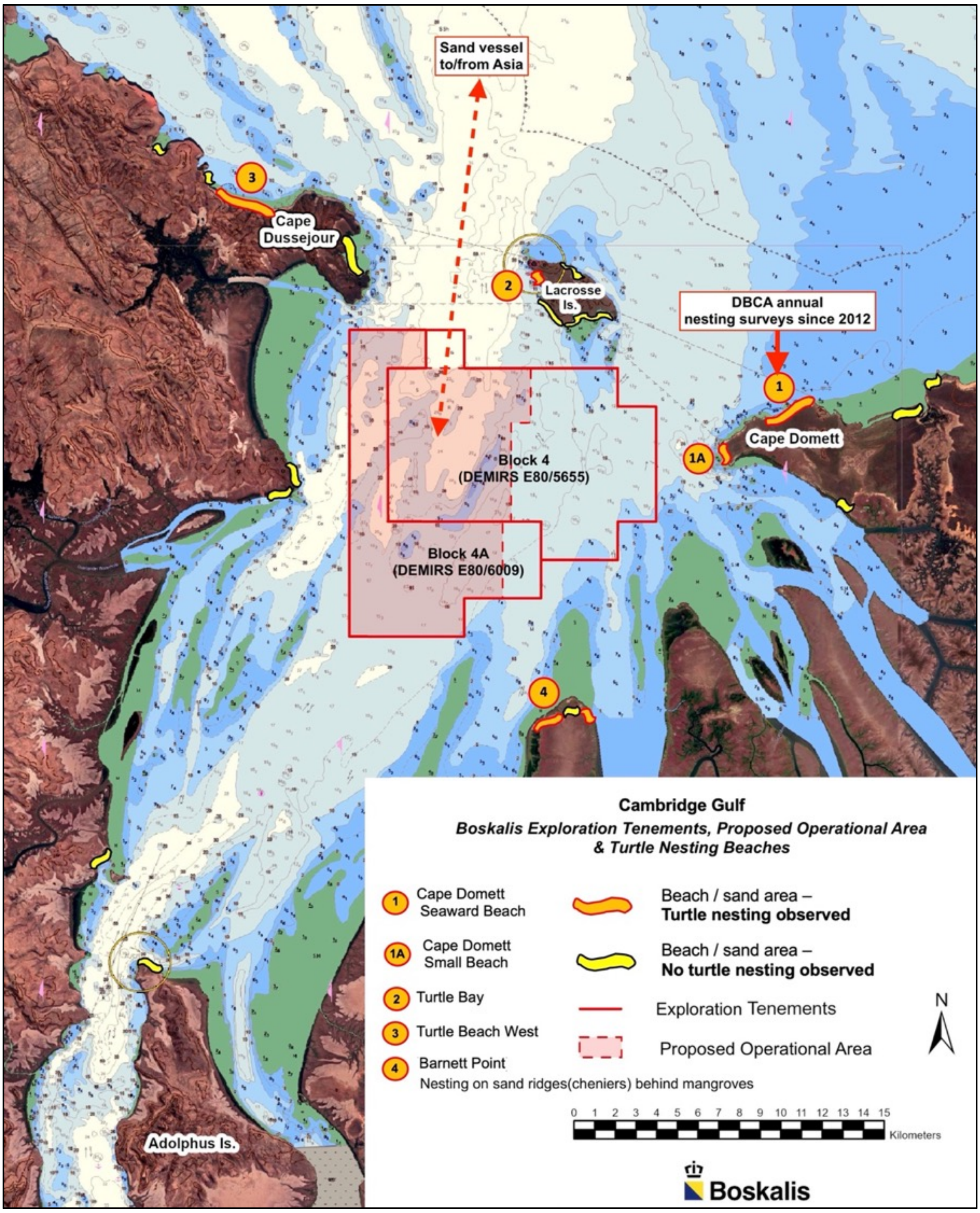


FIGURE 9.6: *Supra-tidal sand areas that could potentially host turtle nesting, surveyed by drone in late July 2023.*

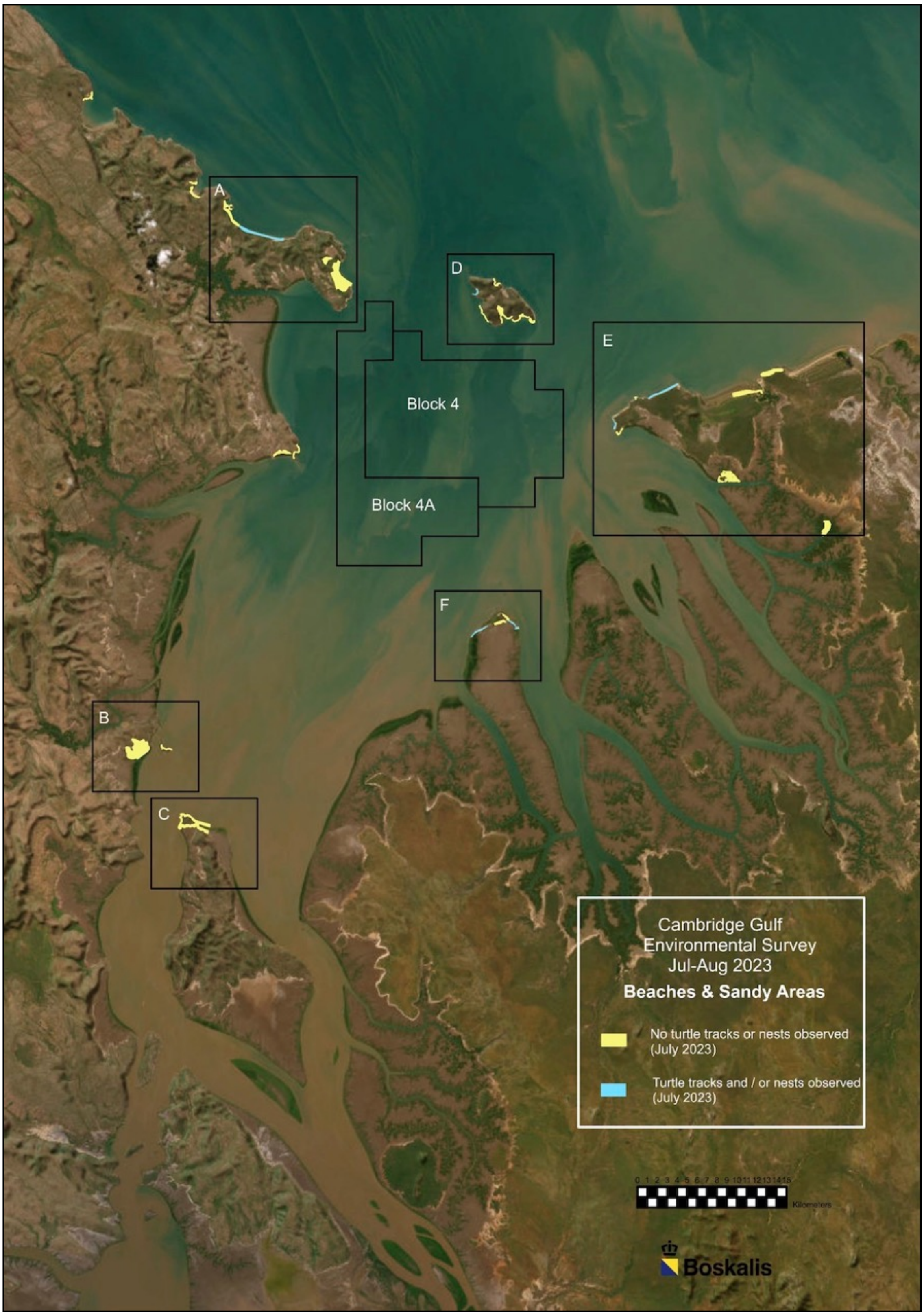


FIGURE 9.7: *Drone coverage at each supra-tidal sand area in the LAU in late July 2023.*

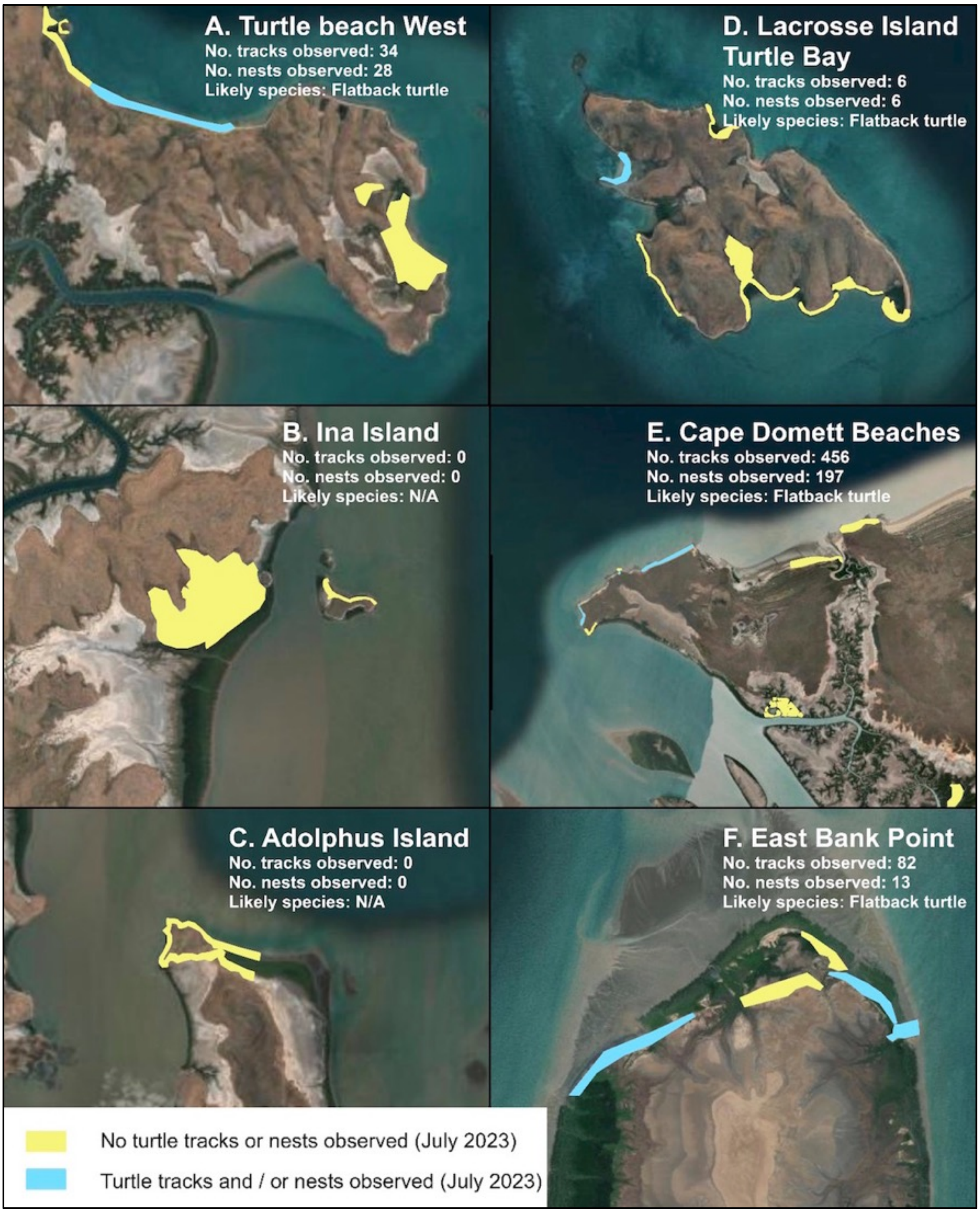


FIGURE 9.8: *Drone coverage and turtle track and nest counts at each supra-tidal sand area in late July 2023. The numbers shown for the 'Cape Domett Beaches' include seven tracks and seven nests at Cape Domett Small Beach, as separated in Table 9.2. East Bank Point = Barnett Point.*

1. Cape Domett Seaward Beach (looking west)

1. Cape Domett Seaward Beach (looking east - 2 crocs centre)

1A. Cape Domett Small Beach (looking to Lacrosse Island)

2. Turtle Bay (NW side of Lacrosse Island)

3. Turtle Beach West (looking west from Cape Dussejour)

4. Barnett Point (from east side)

FIGURE 9.9*: The five main Flatback Turtle nesting sites in the CG area. The top two images are both of Cape Domett Seaward Beach, where DBCA has surveyed annually since 2012. At Barnett Point (bottom right) nesting takes place on sand ridges (cheniers) behind mangroves (images: BKA 2023).*

FIGURE 9.10*: At Barnett Point the Flatback Turtles access and egress the sand chenier nesting areas located behind the mangroves through gaps in the mangroves.*

FIGURE 9.11: *Examples of turtle track images extracted from the July 2023 drone videos. The bottom image shows how track patterns can be used to identify likely species.*

FIGURE 9.12: *A haul of Flatback Turtles, placed on their backs to immobilise them, at Turtle Bay on Lacrosse Island in 1924. The commercial turtle harvesting industry was closed in 1973 (image: Alarmy).*

FIGURE 9.13*: The single-set of tracks observed by the aerial drone surveys in February 2024, at Cape Domett Seaward Beach.*

.

9.2.6 DBCA Cape Domett turtle nesting data

1. Since 2012 DBCA has been undertaking annual monitoring of turtle nesting at the Cape Domett Seaward Beach, in cooperation with the TOs of the area. While a wealth of useful data has been collected, up to 2023 it had not been fully analysed. During consultations between DBCA and BKA in 2023, access was granted to DBCA's data under a data-sharing agreement, to ensure that BKA's environmental assessment is based on the best available data, and thus optimize scope for protection of marine turtles.

2. Under the agreement BKA undertook an analysis of the data for DBCA, as reported in Annex 14. The data from the first year (2012) was not included in the analysis as the survey design was not the full s cope as the following years. In summary, the report finds that:

    a) The 10-years of Flatback Turtle nesting surveys at the Cape Domett Seaward Beach by DBCA from 2013 to 2022 inclusive, provides a significant long-term dataset to inform the management and conservation of this globally significant nesting site for this protected and vulnerable species.

    b) The data shows that over the ten-year period; a total of 130 nights were surveyed, the average number of nights surveyed annually was 13; a total of 6,270 track sets were counted, the average number of track sets counted per survey was 627; a total of 858 hatched nests were counted, the average number of hatched nests counted per survey was 85.7; a total of 84 predated nests were counted, and the average number of predated nests counted per survey was 8.4.

    c) The data supports earlier, more comprehensive studies by Whiting et al (2008) which found that Cape Domett is a significant nesting site for Flatback Turtles.

    d) Evidence of nesting by Green Turtles was counted on 12 occasions over 7 years within the ten-year period, equating to an average of 1.7 per year, indicating that Cape Domett is not a significant nesting site for this species.

    e) Overall, it appears that generally, Flatback Turtle nesting numbers at Cape Domett Seaward Beach may not have changed significantly since the surveys by Whiting et al (2008), although more rigorous data collection and analysis would be required to confirm this.

9.2.7 eDNA surveys for Sawfish & River Sharks

1. The upstream areas of the rivers and creeks that discharge into CG provide habitat that is suitable for the four species of Sawfish that occur in northern WA waters (*Anoxypristis cuspidata*, *Pristis clavata*, *Pristis zijsron* and *Pristis pristis*), and two species of River Sharks (*Glyphis spp*) have been found in the Lower Ord River upstream of CG.

2. Given the potential presence of sawfish species and the reported presence of the two River Shark species in the CG area, BKA is giving very high priority to assessing potential impacts of the proposed operation on these species. This included undertaking surveys of their presence/absence, distribution and abundance in the area. Conventional survey techniques for these species include setting gillnets to capture individuals. This sampling method was not adopted by BKA has it can cause injury and harm to the animals, as well as pose significant safety risks to sampling personnel, including from potential crocodile attack. The much less invasive and much safer survey technique of environmental DNA (eDNA) sampling was therefore adopted by BKA.

3. The National eDNA Reference Centre (NeRC) at the University of Canberra was contracted by BKA to undertake marine eDNA sampling in February 2024 and subsequent analysis. Their full report is contained in Annex 14.

4. In summary, a total of 86 environmental samples were collected, comprising 60 sediment samples and 26 water samples at 20 separate locations within CG. Sampling sites included up rivers and inlets around the coast of CG, which are the typical habitat of the target species, and the open-water areas of CG, including within BKA's proposed operational area (Figure 9.14).

5. There was no detection of the four Sawfish species at any site when using species-specific assays.

6. There was no detection of the two River Shark species *Glyphis garricki*, *Glyphis glyphis* at any site when using the metabarcoding assay.

7. A low number of the Narrow Sawfish (*Anoxypristis cuspidate)* DNA sequence reads were detected at site 03 by metabarcoding. The very low amount of DNA detected could indicate the presence of old DNA associated with possible historical occurrence of the species in the area, or the current presence of the species in the area in very low abundance. Site 03 is ~8 km upstream in the Lyne River on the western side of CG (Figure 9.14).

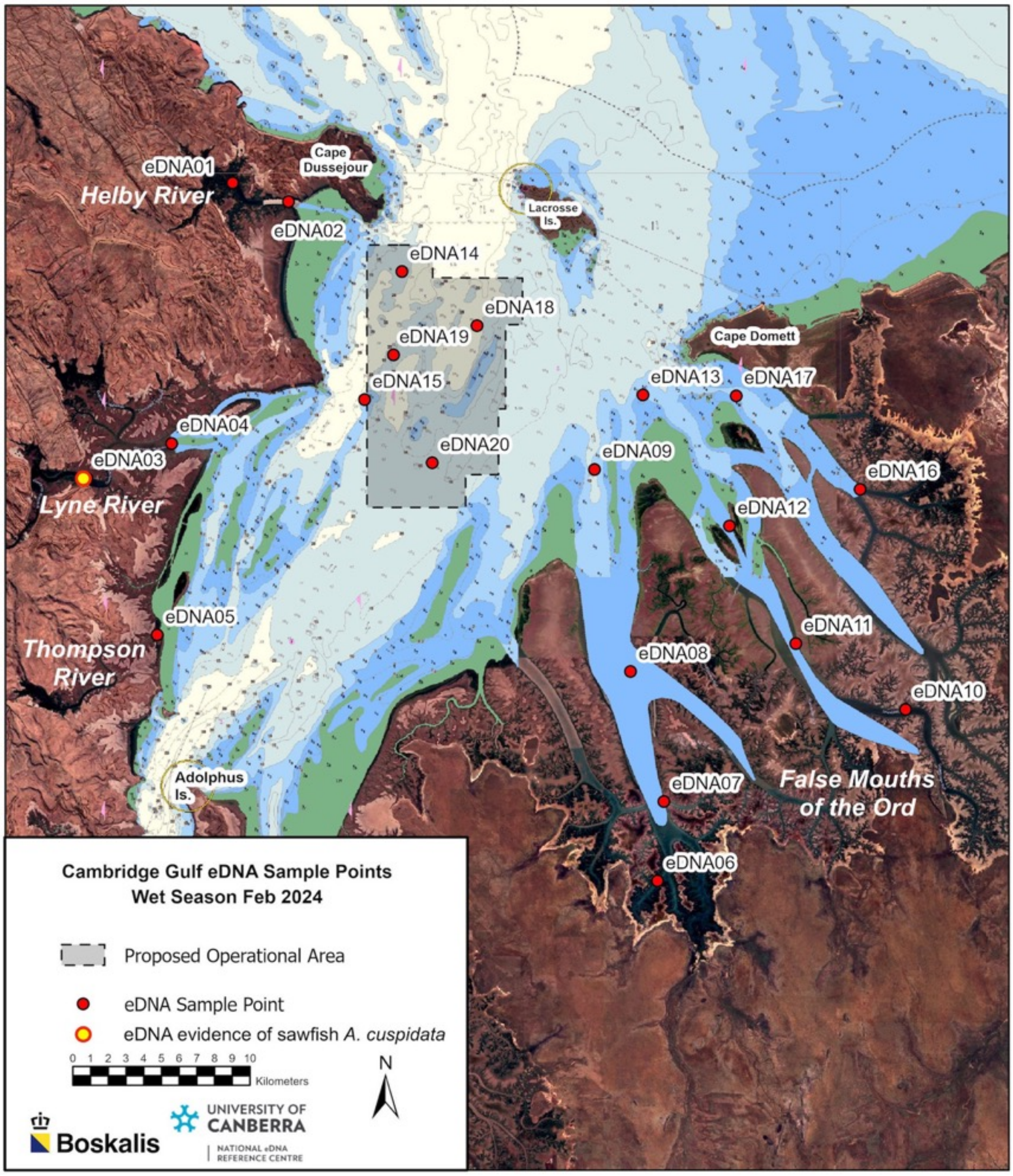


FIGURE 9.14: *The eDNA sampling sites in CG and the one location at site 03 where a small trace of Narrow Sawfish DNA was detected.*

9.3 Description of Marine Fauna

9.3.1 General description of marine fauna in CG

1. The environment and habitats of CG including the highly dynamic and turbid open waters in the main body of CG, the mangrove-lined coastlines, the three tidally dominated, relatively small and short rivers that flow into the western side of CG (from north to south the Helby, Lyne and Thompson Rivers), the highly turbid tidal inlets of the False Mouths of the Ord on the eastern side of CG, and the sand beaches found mainly on the seaward coast outside of CG, all provide habitats that are suitable for a range of marine fauna species.

2. Like any ecosystem, the types of marine fauna and their numbers and distribution in CG are driven by the environmental conditions. As outlined in section 6.4.2, environmental conditions in CG are generally not hospitable to marine fauna, as manifested in the low abundance and diversity of benthic species as described in section 6.4. These conditions include strong tidal currents, very high suspended sediment concentrations and associated turbidity, acute wet season inputs of freshwater and sediments, permanently aphotic benthic zone, highly mobile seabed sediments and exposure to tropical

cyclone impacts. Such conditions are also environmental inhibitors for larger species, and the types of marine fauna found in CG are therefore species that are specifically adapted to extreme, highly dynamic and turbid conditions.

3. Of note is that during all three vessel-based environmental surveys conducted by BKA in CG to date, comprising nine days on site in March 2023, 20 days on site in July-August 2023 and 20 days on site in February 2024, all personnel on board, including marine biologists, other scientists and vessel crew, each with decades or many years of experience at sea, commented on how astounded they were by the lack of evidence of marine fauna, compared to other areas of tropical northern Australia.

4. During surveys up the rivers and inlets, which have dense mangrove fringes, team members expected to see signs of life such as schools of mullet feeding along the surface and bait fish jumping being chased by predators, as typically occurs in such habitats. These were not evident. When at anchor at night the team expected to see bait fish, squid, larger fish and even small sharks near the surface attracted by the stern light, as typically occurs in such areas, but night-after-night there was nothing at all, over a combined 49 nights across all three surveys. Not a single flock of seabirds feeding on schools of fish was seen in CG during the combined 49 days spent in CG. Crew monitoring the vessel's depth-sounder/fish finder commented on a constant lack of signs of fish. The highly experienced MMF surveyors covered over 800 km of transects over eight- and nine-days during each survey, and on many days returned with zero sightings (in the wet season on most days). When there were sightings, they were a single sighting or single digits. They commented on the very low abundance of MMF compared to other areas where they work, including further west on the WA coast. The lack of observed biological activity in CG was so stark that it became a feature of discussion and hypotheses on every trip.

5. When operating outside of CG in the clearer, bluer waters of Joseph Bonaparte Gulf, the scenario was starkly different, with numerous signs of marine fauna including marine turtles at the surface, pelagic fish jumping and flocks of seabirds feeding on schools of fish.

6. While there is obviously a productive food-web in CG, as evidenced by the presence of larger animals such as crocodiles and a small number of Snubfin and Humpback Dolphins (see below), it appears that despite the extensive mangrove fringe around the coast, in-water primary productivity and biological activity may be constrained by the extreme environmental conditions. As outlined in section 8 on MEQ, chlorophyll-a concentrations in CG were relatively low in both the dry- and wet seasons. As a result of these factors, it appears that overall abundance of marine fauna is low relative to other areas.

7. The presence/absence of marine fauna in CG can be systematically assessed by following a hierarchy of phyla, in order from marine mammals including whales, dolphins and dugongs, to marine reptiles including marine turtles, crocodiles and seasnakes, to sharks and rays to bony fishes to invertebrates, including crustaceans such as crabs and prawns. Accordingly, sections 9.3.2 to 9.3.7 below address each of these taxanomic groupings in turn.

8. Because most invertebrates are part of the benthos, they are not addressed in this section, however mud-crabs and prawns are addressed in sections 9.3.6 and 9.3.7 respectively, as they have significance for fisheries.

9. A separate section 9.4 specifically addresses species of conservation significance in CG. In addition, Referral Report No. 7 - *Commonwealth Protected Matters* (BKA 2924f), contains a detailed description of all marine fauna that are protected under the Commonwealth EPBC Ac that are found or could potentially be found in the area, based on the DCCEEW Protected Matters Search Tool (PMST) outputs.

9.3.2 Marine mammals

Whales:

1. While CG is within the general, global geographic range of a number of whale species, no published records of whale sightings in CG were identified through literature search. Local marine stakeholders that were consulted, including the local TOs, DBCA staff and a commercial fisherman with over 20-years of experience in CG (Douglas pers. comms. 2024), all advised that whales are not seen in CG.

2. Whales were not observed during BKA's three environmental survey campaigns in CG, either in the systematic MMF surveys or incidental observations.

3. The environmental conditions and general lack of food sources discussed in section 9.3.1, and the relative shallow waters (mean depth -12 m LAT), do not provide suitable habitat for whales. Whales are also generally absent from the adjacent waters of Joseph Bonaparte Gulf, due to their relative shallowness (a depth range of 15 to 75 m LAT) (Galaiduk et al. 2018).

Dolphins:

1. The presence of small numbers of Australian Snubfin Dolphins (*Orcaella heinshoni*) and Australian Humpback Dolphins (*Sousa sahulensis*) in CG is clearly established, including through surveys by Brown et al (2016 & 2017), BKA's MMF surveys in July 2023 and February 2024 (section 9.2.3 above) and anecdotal reports from relevant stakeholders that were consulted.

2. Both of these species are adapted to highly turbid inshore coastal waters in estuaries, bays and gulfs such as CG, where they typically hunt for small fish, squid and crustaceans in the water column and on and in seabed sediments, often along the shoreline.

3. The Commonwealth has designated a breeding, calving, foraging and resting Biologically Important Area (BIA) for Snubfin Dolphins in CG.

4. Because these are species of conservation significance, they are discussed in more detail under section 9.4 below.

5. While CG is within the general, global geographic range of a number of other dolphin species, no published records of sightings in CG were identified through literature search. Local marine stakeholders that were consulted, including the local commercial fisherman with over 20-years of experience in CG (Douglas pers. comms., 2024), advised that dolphins other than Snubfins and Humpbacks are not seen in CG.

6. Other dolphin species were not observed by Brown et al (2016 & 2017) and nor during BKA's three environmental survey campaigns in CG, either in the systematic MMF surveys or incidental observations.

7. While Snubfin and Humpback Dolphins are specifically adapted to the highly turbid waters found in CG, other dolphin species are not adapted to such conditions, which is likely the main reason that they do not appear to be present in CG.

Dugong:

1. While CG is within the general, global geographic range of Dugong (*Dugong dugong*), no published records of Dugong sightings in CG could be identified. Local marine stakeholders that were consulted, including the local TOs, DBCA staff and a commercial fisherman with over 20-years of experience in CG (Douglas pers. comms. 2024), all advised that Dugong are not seen in CG.

2. Dugong were not observed during BKA's three environmental survey campaigns in CG, either in the systematic MMF surveys or incidental observations.

3. The lack of seagrasses in CG, which provide the primary food-source for Dugong, is the primary limiting factor, as well as the strong tidal currents. The lack of seagrasses is also a limiting factor for Dugong in the adjacent waters of Joseph Bonaparte Gulf, which are less inhospitable than CG. As outlined in section 6.4.3, Galaiduk et al. (2018) state that Joseph Bonaparte Gulf '. . . *is not expected to be a major area for dugong, given the lack of seagrass.'* McMahon et al. (2017) assessed seagrasses across the north of WA from Shark Bay to the NT border, and identified the Bonaparte/Cambridge IMCRA Bioregion, which includes CG, as not having any seagrass species (IMCRA = Commonwealth *Integrated Marine and Coastal Regionalisation of Australia*).

9.3.3 Marine reptiles

Marine turtles:

1. Six of the seven species of marine turtle that exist globally are found in Australian tropical marine waters, these being the Flatback Turtles *(Natator depressus),* the Green Turtle *(Chelonia mydas), the* Hawksbill turtle (*Eretmochelys imbricata*), the Leatherback turtle (*Dermochelys coriacea*), the Loggerhead turtle (*Caretta caretta*) and the Olive Ridley turtle *(Lepidochelys olivacea).*

2. While CG is within the general, global geographic range of all six of these species, three are most relevant to the CG area – the Flatback, the Green and the Olive Ridley.

3. As outlined in section 9.2.5, Cape Domett Seaward Beach on the seaward coast outside of CG is a highly significant nesting site for Flatback turtles. The drone surveys commissioned by BKA as outlined in section 9.2.5 also identified additional Flatback nesting sites in the area. The Commonwealth has designated an inter-nesting BIA for Flatback turtles within a 60 km radius around Cape Domett and Lacrosse Island, which includes BKA's proposed operational area.

4. The Commonwealth has also designated foraging BIA's for both Green and Olive Ridley turtles in waters of Joseph Bonaparte Gulf offshore from CG.

5. Because these are species of conservation significance, they are discussed in more detail under section 9.4 below.

Saltwater Crocodiles:

1. Saltwater Crocodiles *(Crocodylus porosus)* inhabit CG, especially up the rivers and inlets, with the highest numbers being present up the lower Ord River, over 35 km upstream from the proposed operational area (Kay 2004, Taylor pers, comms.

2024). Most research and monitoring of crocodiles in the CG region has focussed on the Lower Ord rather than the marine area of CG, given much higher numbers in the Ord – due to more suitable habitat, including freshwater areas and grassy banks for nesting.

2. In the early 2000s an annual survey program on the Ord River system upstream from CG was implemented as a monitoring component related to an egg harvesting program (WMI 2012). This work indicated that saltwater crocodile numbers had increased from historical lows (since crocodiles became protected from hunting in WA in 1970), had most likely reoccupied their historical ranges and were no longer under any significant known pressures.

3. Kay (2004) tracked 16 radio-tagged crocodiles between October 2001 and May 2003 in the Lower Ord River. Male and female crocodiles exhibited distinctly different patterns of movement. Females occupied a small core linear range (1.3 ± 0.9 km) on the main river channel during the dry season and moved upstream by up to 62 km to nesting habitat during the wet season, returning to the same core area the following dry season. They occasionally made excursions away from their core areas during the dry season.

4. Males moved considerable distances along the Ord River throughout the year. The largest range recorded was 87 km for a 2.5-m juvenile male. There were significant seasonal differences, with the highest mean rates of movement occurring during the summer wet season (4.0 ± 5.4 km day^{-1}).

5. Neither males nor females showed exclusive habitat preferences for any of four broad riverine habitats identified on the Ord River. However, the three largest males had activity centres that they returned to frequently despite numerous excursions throughout the year, both up- and downriver. Males had substantial range overlaps with no obvious spatial partitioning, suggesting that territoriality is not an important behavioural characteristic of free-ranging male crocodiles along the Ord River.

6. It is not clear if these movement patterns in the Lower Ord River are representative of crocodile behaviour in CG itself.

7. As outlined in section 9.2.3 the surveys commissioned by BKA in July 2023 and February 2024 recorded six and five crocodile sightings respectively, with their locations shown on Figure 9.3 in that section.

8. The six July 2023 sightings were as follows:

    a) Three crocodiles were sighted basking in the sun on the beach at Cape Domett, where they appeared to be awaiting the evening Flatback turtle nesting event, to feed on the turtles. All three crocodiles appeared to have engorged midriffs, perhaps from the previous night's feeding, and were perhaps basking in the sun to aid digestion. Two are shown in Figure 9.5 in section 9.2.3. The third entered the water and swam to seaward.

    b) Two were sighted in mangroves up the inlets of the False Mouths of the Ord.

    c) One was sighted at the southern tip of Adolphus Island.

9. The five February 2024 sightings were as follows:

    a) One each were sighted at the mouths of the Helby, Lyne and Thompson Rivers on the western side of CG.

    b) One was sighted just off Cape Domett.

    c) On was sighted in the proposed operational area, hanging off and apparently watching the main survey vessel when it was at anchor taking benthic grab samples.

Seasnakes:

1. While CG is within the general geographic range of many of the seasnake species found in northern Australian waters, no published records of sightings in CG were identified through literature search. A local commercial fisherman with over 20-years of experience in CG advised that seasnakes are not seen in CG (Douglas pers. comms. 2024).

2. Seasnakes were not observed during BKA's three environmental survey campaigns in CG, either in the systematic MMF surveys or incidental observations. Several seasnakes were observed on the sea surface in Joseph Bonaparte Gulf offshore from CG.

3. The environmental conditions and general lack of food sources discussed in section 9.3.1 may be the reason why seasnakes are not seen in CG.

9.3.4 Sharks & rays

1. While CG is within the general geographic range of many of the shark and ray species found in northern Australian waters, no published records of sightings in CG were identified through literature search. A local commercial fisherman with over 20-years of experience in CG advised that sharks and rays are not generally seen in CG (Douglas pers. comms. 2024). The environmental conditions and general lack of food sources discussed in section 9.3.1 may be factors.

2. An exception is River Sharks and Sawfish, which are species that are adapted to the highly turbid estuarine conditions found in the upstream parts of CG, including the Lower Ord River. Because these are species of conservation significance, they are discussed under section 9.4 below.

3. As outlined in section 9.2.3 the surveys commissioned by BKA in July 2023 recorded two shark sightings. These were a small Tiger Shark *(Galeocerdo cuvier)* outside of CG at the eastern end of Cape Domett beach, likely preying up turtle hatchlings, and a juvenile Black-tip Shark *(Carcharhinus melanopterus)* near mangroves at Adolphus Island. Juvenile Blacktip Sharks are known to utilize mangrove habitat to feed as the grow and then migrate to offshore habitats as they get larger (George et al 2017). The February 2024 survey did not have any shark sightings.

9.3.5 Bony fishes

1. The waters of CG overall and especially the mangrove-lined coast and inlets provide habitat for a range of fish species that are typically found in such areas, including Barramundi (*Lates calcarifer*) and Threadfin Salmon (*Eleutheronema tetradactylum*), that are targeted by both commercial and recreational fishermen. Environmental surveys and stakeholder consultations indicate that the proposed operational area does not provide suitable habitat for benthic or demersal fishes or support populations of such, due to the nature of the substrate (highly dynamic sand waves), strong tidal currents, lack of benthic light and lack of food sources for fishes.

2. During consultations with the commercial gillnet fisherman who is sometimes active in CG he advised that he sets his nets on intertidal banks along coastal areas and is not concerned about the proposed operation in the center of CG (Douglas pers. comms 2023 & 2024). During consultations with the recreational fishing sector, they advised that the proposed operational area in the center of CG is referred to as 'the washing machine' due to the effects of currents. Even in more sheltered areas along the coast and up the creeks and inlets they advised that recreational fishing focusses on neap tide periods when currents are less extreme.

3. They also advised that part from fishing up the mangrove-lined creeks and inlets, rocky substrates at and around Vancouver Point / Myrmidon Ledge on the western side of CG, around Capes Dussejour and Domett and at Bream Ledge at the north-west point of Lacrosse Island, are known to be the best habitats for demersel fish species such as Fingermark Bream (Lutjanus rusellii) and sometimes Black Jewfish (Protonibea diacanthus), although the latter are also found up the creeks and inlets.

4. Table 9.3 lists the main fish species of the CG area that are of fishery or conservation interest, along with their preferred habitats. None of them are likely to utlize the highly-dynamic sand seabed habitat found in the proposed operational area.

TABLE 9.3: *The main fish species of the CG area that are of fishery or conservation interest.*

Species	Species & Characteristics	Preferred Habitat	References
Barramundi (*Lates calcarifer*)	A prized food-fish that is important to commercial and recreational fisheries (also farmed). Widely distributed across coastal northern Australia and Indo-West Pacific. Targeted by the commercial gillnet fisherman who is active in CG and sets his nets on intertidal banks along coastal areas (Douglas pers. comms 2023 & 2024). Targeted by recreational fisherman in CG along coast and up inlets, creeks and rivers (Gooding pers. comms 2024). Opportunistic predator that feeds on a wide variety of prey. Inhabits freshwater rivers and lagoons, estuaries and coastal mangrove areas depending on life-stage - complex life cycle freshwater, estuarine and marine phases. Protandrous hermaphrodite, which matures first as a functional male fish and undergoes sex change to become female.	Preferred habitat is freshwater rivers and lagoons, estuaries and coastal mangrove areas depending on life-stage. Unlikely to be present in the proposed operational area which is open-water in the centre of CG with depths around 20-30 m, strong currents, constantly shifting seabed sand-waves and lack of food resources for fishes.	DPIRD Fisheries Fact Sheet: Barramundi https://www.fish.wa.gov.au/Documents/recreational_fishing/fact_sheets/fact_sheet_barramundi.pdf Russell (1987, 1990)

Species	Species & Characteristics	Preferred Habitat	References
	Adults migrate in early wet season (October) from freshwater to coastal estuaries assisted by heavy flooding of rivers and streams. Night-time spawning during wet season in/around tidal mudflats. Flood tides wash eggs and larvae into mangrove and wetland habitats, where larvae and juveniles grow. On reaching age of one-year they migrate back to freshwater where they stay for next 3 to 4 years until sexually mature.		
Threadfin Salmon (*Polydactylus macrochir*)	A prized food-fish that is important commercial and recreational fisheries. Widely distributed in coastal inshore waters of northern Australia and New Guinea. Targeted by the commercial gillnet fisherman who is active in CG and sets his nets on intertidal banks along coastal areas (Douglas pers. comms 2023 & 2024). Targeted by recreational fisherman in CG along the coast and up inlets and creeks. Juveniles mainly live in shallow inshore turbid waters where they feed on small prawns, crabs and worms. Adults also favour estuarine areas and coastal waters, where they aggregate in large schools over tidal flats and in river mouths around autumn and spring. Their pectoral threadfin filaments help to find food in turbid waters by picking up vibrations of moving prey such as worms, prawns and crabs hiding in mud and sand.	Preferred habitat is the mangrove areas, river mouths and tidal flats along the coast and up the inlets. Unlikely to be present in the proposed operational area which is open-water in the centre of CG with depths around 20-30 m, strong currents, constantly shifting seabed sand-waves and lack of food resources for fishes.	DPIRD Fisheries Fact Sheet: Threadfins https://www.fish.wa.gov.au/documents/recreational_fishing/fact_sheets/fact_sheet_threadfin.pdf Pember (2006)
Streamer Threadfin (*Parapolynemus verekeri*) Also known as Dwarf Paradise Fish.	A prized food-fish that is important commercial and recreational fisheries. Found in northern Australia and southern New Guinea. In Australia its distribution extends from CG to Point Stuart in the Northern Territory. Occurs in the lower parts of rivers, muddy estuaries and turbid shallow nearshore waters throughout whole life cycle. Assumed to take part in mass spawning and has a protracted spawning period of approx. 6 months, peaking during spring and early summer (Sep-Dec). Their pectoral threadfin filaments help to find food in turbid waters.	Preferred habitat is the lower parts of rivers, muddy estuaries and turbid shallow nearshore waters. Unlikely to be present in the proposed operational area which is open-water in the centre of CG with depths around 20-30 m, strong currents, constantly shifting seabed sand-waves and lack of food resources for fishes.	Fishes of Australia www.fishesofaustralia.net.au Pember (2006)
Black Jewfish (*Protonibea diacanthus*) Also known as Black-	A prized food-fish that is important commercial and recreational fisheries. Found throughout northern Australia and the wider Indo-Pacific region. Preferred habitat is tidal rivers, estuaries and turbid coastal waters.	Preferred habitat is tidal rivers, estuaries and turbid coastal waters. Unlikely to be present in the proposed operational area which is open-water in the centre of CG with depths around 20-30 m,	Northern Territory Government: Black Jewfish - *Protonibea diacanthus* https://nt.gov.au/marine/recreational-fishing/types-of-fish/fish-species/black-jewfish

Species	Species & Characteristics	Preferred Habitat	References
spotted Croaker.	Feeds on/near the seabed on crustaceans and small fishes. Matures in around 4 years. Forms spawning aggregations and returns yearly to discreet coastal spawning grounds adjacent to rivers. Peak spawning is Nov-Dec. Listed as 'Near Threatened' on the IUCN Red List.	strong currents, constantly shifting seabed sand-waves and lack of food resources for fishes.	Fishing World: Black Jewfish https://fishingworld.com.au/fish-facts/fish-facts-black-jewfish/ DPID Fisheries (Saunders et al.): Black Jewfish *Protonibea diacanthus* https://fish.gov.au/2014-Reports/black_jewfish
Fingermark Bream (*Lutjanus rusellii*) Also known as Russel's Snapper & Golden Snapper.	A prized food-fish that is important commercial and recreational fisheries. Widely distributed in tropical Indo-Pacific and northern Australia. Adults inhabit inshore reefs and rocky areas, occasionally entering estuaries, while juvenile snapper are often seen in the lower reaches of freshwater streams, mangrove estuaries and turbid coastal waters. Recreational fishermen in CG target them in rocky areas at Vancouver Point / Myrmidon Ledge on the western side of CG and near Cape Dussejour and Cape Domett (Gooding pers. comms 2024). Feeds primarily on benthic invertebrates and small fishes. Reaches sexual maturity after 4 years. Prolonged spawning season from early September to late April, with adult fish moving to relatively shallow turbid nearshore waters and forming spawning aggregations.	Preferred habitat is inshore reefs and rocky areas and inshore waters and estuaries for spawning and juveniles. Unlikely to be present in the proposed operational area where there are no rocky reefs and which is open-water in the centre of CG with depths around 20-30 m, strong currents, constantly shifting seabed sand-waves and lack of food resources for fishes.	FishBase: Russell's Snapper *Lutjanus rusellii* https://www.fishbase.se/summary/176 fishIDER: Russell's Snapper *Lutjanus rusellii* https://fishider.org/en/guide/osteichthyes/lutjanidae/Lutjanus/Lutjanus-rusellii Rome & Newman (2010)
Nurseryfish (*Kurtus gulliveri*)	A prized food-fish that is important to recreational fisheries but not targeted by commercial fisheries. Found across northern Australia and southern New Guinea. Preferred habitat is fresh and brackish muddy waters in lower reaches of slow-flowing rivers and mangrove areas with high turbidity. Feeds on crustaceans (prawns and shrimps), small fish and insect larvae. Breeding occurs during the northern Australian dry season (May to November) Males carry egg clusters on a prominent hook on the forehead, which is considered an adaptation to environments with low oxygen and high turbidity.	Preferred habitat is fresh and brackish muddy waters in lower reaches of slow-flowing rivers and mangrove areas with high turbidity. Unlikely to be present in the proposed operational area which is open-water in the centre of CG with depths around 20-30 m, strong currents, constantly shifting seabed sand-waves and lack of food resources for fishes.	FishBase: *Kurtis gulliveri* Nurseryfish https://fishbase.mnhn.fr/summary/Kurtus-gulliveri Berra & Neira (2003)
Warrior Catfish (*Hemiarius dioctes*)	Important to commercial and recreational fisheries. Found across northern Australia and New Guinea.	Preferred habitat is river systems ranging from upstream freshwater areas to estuarine and coastal mangrove areas. Unlikely to be present in the proposed operational area which is	FishBase: *Hemiarius dioctes* Warrior catfish (see: https://www.fishbase.se/summary/60002 Kailola (2000)

Species	Species & Characteristics	Preferred Habitat	References
	Preferred habitat is river systems ranging from upstream freshwater areas to estuarine and coastal mangrove areas. Predator that feeds on invertebrates and fish. Spawning occurs at the start of the wet season (Oct/Nov).	open-water in the centre of CG with depths around 20-30 m, strong currents, constantly shifting seabed sand-waves and lack of food resources for fishes.	
Scaly Croaker (*Nibea squamosa*)	Important to commercial and recreational fisheries. Found across northern Australia and New Guinea. Preferred habitat is river systems ranging from upstream freshwater areas to estuarine and coastal mangrove areas. Prefers soft sediments, most likely feeding on bottom-dwelling invertebrates and small fishes. Known to form spawning aggregations.	Preferred habitat is river systems ranging from upstream freshwater areas to estuarine and coastal mangrove areas. Unlikely to be present in the proposed operational area which is open-water in the centre of CG with depths around 20-30 m, strong currents, constantly shifting seabed sand-waves and lack of food resources for fishes.	Larson et al. (2020) Gorman (2020)

9.3.6 Mud crabs

1. The mangrove-lined coast and inlets around CG provide habitat for Mud Crabs *(Scylla spp)*. There are currently two commercial mud-crab licences that cover the CG area. One holder is based in Broome and does not fish in CG, and one is based in Port Headland with the licence for sale. There is currently no active commercial mud crab fishing in CG. The crabs are taken recreationally by locals in accordance with WA recreational fishing regulations.

2. Adult female Mud Crabs migrate to clearer waters offshore each spring/early summer to spawn, and the multi-staged larvae are carried by currents and larval advection (active movement) back to inshore areas where they settle and continue the lifecycle (WA Fisheries 2013). It is therefore possible that the outward migrating adult females and the returning juveniles could potentially pass through the proposed operational area during these movements.

3. However, the location of the proposed operational area within the central, deep, open water area of CG, with very strong currents and constantly moving seabed, indicates that they are unlikely to migrate through this zone. They are more likely to move in and out of CG closer to the protection of the coastal mangrove habitats that they come from and go back to (Alberts-Hubatsch 2015). They likely exit and enter CG along the eastern coast past Cape Domett and along the western side past Cape Dussejour.

9.3.7 Prawns

1. The mangrove-lined coast and inlets around CG provide nursery areas for red-legged banana prawns (*Penaeus indicus*) and white banana prawns (*P. merguiensis*) (Loneragan et al 2002). Interestingly, Loneragan et al (2002) found that mangrove areas on the western side of CG mainly support juvenile white banana prawns, while the mangroves on the eastern side including up the tidal inlets of the False Mouths of the Ord, mainly support juvenile red-legged banana prawns. No explanation for this division was postulated.

2. Juvenile banana prawns are flushed from the upstream mangrove areas during wet season rains, and migrate offshore into Joseph Bonaparte Gulf where as adults they reproduce. The multi-staged larvae are carried by currents and larval advection back to inshore areas where they settle in the mangroves and continue the lifecycle (Loneragan et al 2002) (Figures 9.15 & 9.16).

3. When the adult prawns are in offshore waters they are targeted by trawlers of the Commonwealth-regulated Northern Prawn Fishery (NPF), in an area approximately 100 km offshore from CG (Figure 9.16). Red-legged banana prawns comprise a relatively small percentage of the overall NPF catch (4.6 % on average since 2012). However, sporadic large annual catches can occur, driven by a range of environmental variables including wet-season rainfall, that affect annual stock sizes (Pascoe et al 2020).

4. These same factors can also drastically reduce annual catches. In recent years, there have been considerable fluctuations of catch and fishing effort in Joseph Bonaparte Gulf, resulting in limited data to support stock assessments. Given these

uncertainties, and in order to ensure the ecological sustainability of the fishery, the prawn industry itself, through the industry umbrella group NPF Industry Pty Ltd, has voluntarily imposed a closure on banana prawn fishing in Joseph Bonaparte Gulf during the first phase of the season each year, from April to June, commencing from April 2021. This partial seasonal closure is intended to stabilise fishing effort, improve the stock assessment process and add value to the fishery by catching larger prawns in the second phase of the season (August to November).

5. Given the distance of approximately 100 km between CG and the banana prawn fishing grounds in Joseph Bonaparte Gulf, there is no scope for the BKA proposal to impact directly on the fishery. However, given the importance of the mangroves in CG as nursery areas for juvenile banana prawns, and the biological connectivity between CG and the offshore fishing grounds through the prawns' migratory lifecycle, it is necessary to consider potential impacts of the BKA proposal on that connectivity. This is assessed in Referral Report No. 4 - *Impact Assessments* (BKA 2024d).

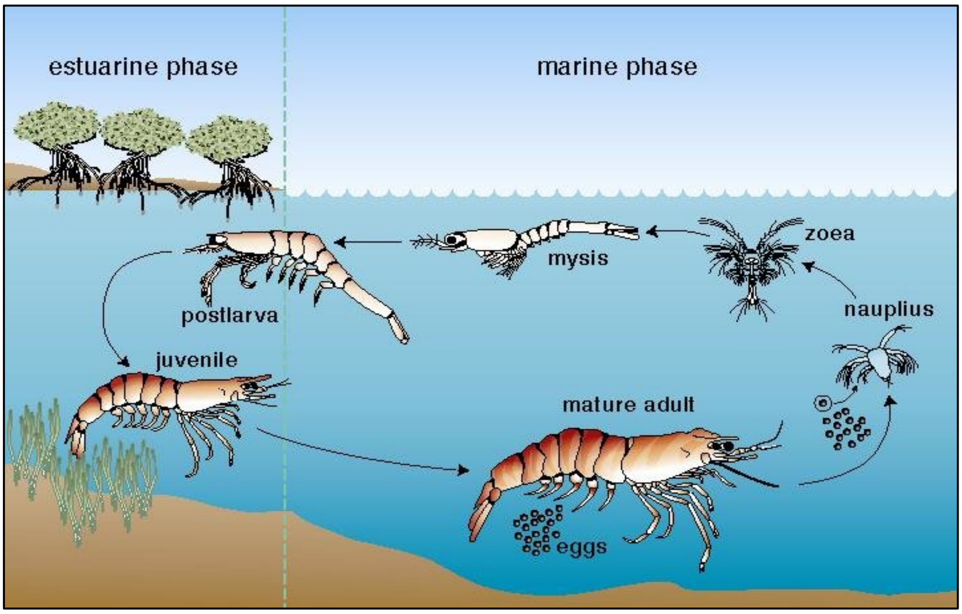


FIGURE 9.15: *Banana prawn lifecycle showing inshore post-larval & juvenile phase, offshore migration of juveniles, offshore adult phase including spawning, and inshore migration of larval and post-larval phase (source: AFMA)*

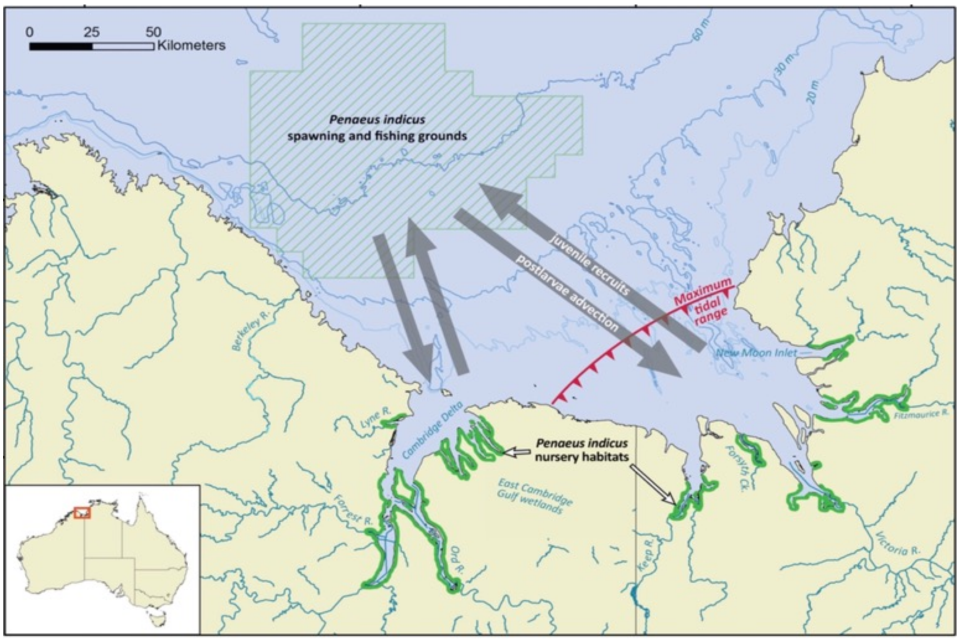


FIGURE 9.16: *The inshore mangrove nursery habitats for juvenile banana prawns in solid green and the offshore spawning and fishing grounds in hatched green, showing the biological connectivity between the two areas (source: Plaganyi et al 2020).*

9.4 Description of Key Species of Conservation Significance

1. There are several species of marine fauna that are known to found, or which could potentially be found, in CG and/or in the general CG area, that have particular conservation significance, and these are discussed in the following sections.

2. In addition, Referral Report No. 7 - *Commonwealth Protected Matters* (BKA 2924f), contains a detailed description of all marine fauna that are protected under the Commonwealth EPBC Ac that are found or could potentially be found in the area, based on the DCCEEW Protected Matters Search Tool (PMST) outputs, including the species discussed below.

9.4.1 Australian Snubfin Dolphin

IUCN status: Vulnerable

EPBC Act: Protected as marine mammal & migratory species (= Matter of National Environmental Significance MNES).

WA BC Act: Migratory. Priority 4 = Rare, Near Threatened and other species in need of monitoring.

1. The Australian Snubfin Dolphin (*Orcaella heinshoni*) inhabits turbid inshore waters, bays and estuaries such as CG. The presence of small numbers of Snubfin Dolphins in CG is clearly established, including through surveys by Brown et al (2016 & 2017), BKA's MMF surveys in July 2023 and February 2024 (section 9.2.3 above) and anecdotal reports from relevant stakeholders that were consulted.

2. The Commonwealth has designated a breeding, calving, foraging and resting Biologically Important Area (BIA) for this species over CG (Figure 9.16).

3. As outlined in section 9.2.3 above, the nine-day MMF survey covering over 800 km of transects throughout CG in February 2024 recorded four sightings, and the eight-day survey in July 2023 also covering over 800 km of transects recorded 11 sightings. In both surveys most sightings were in the southern part of CG towards and around Adolphus Island, which is 20 km south of the closest (southern) boundary of the proposed operational area.

4. The main local commercial fisherman who has over 20-years of experience working in CG, confirmed that Snubfins are mostly seen near and around Adolphus Island (Douglas pers comms 2024). This may be where their preferred food source is located - small fish, crustaceans and cephalopods (Marshe et al 1989). However, there were two and three sightings in the proposed operational area in the 2024 and 2023 surveys respectively, so they do appear to pass through this area. Douglas (pers. comms 2024) also advised that there is a marked reduction in sightings of Snubfin Dolphins in CG in the wet season, as per the BKA surveys, as they seem to move to other areas, possibly offshore away from the wet season freshwater and terrestrial sediment inputs.

5. A nine-day survey over a much larger area than CG in August 2016 by Brown et al (2016) recorded 34 sightings, mainly near Cape Dussejour and outside of CG, and none in the proposed operational area. The number of sightings cannot be directly compared to the BKA surveys as in addition to CG, they also surveyed out into Joseph Bonaparte Gulf and 50 kms westward along the coast to the Berkley River and up that river.

6. It should be noted that for all surveys, different sightings could possibly be the same individual(s), so the actual number of dolphins may be less than the number of sightings. This indicates that the population of Snubfins within CG could be in the order of less than 10 individuals or a few tens at most. These numbers are extremely low compared to other sites such as Roebuck Bay at Broome with an estimated population of ~130 Snubfin Dolphins (DBCA 2024), and other areas with higher numbers such as Cone Bay and Cygnet Bay in the West Kimberley (Brown et al 2016). This may be reflective of the extreme environmental conditions in CG, which may not be as suitable for this species as the areas further west, where waters are less turbid and food sources more abundant.

6. Given that CG is a BIA for this species, and its conservation significance and protected status under both the Commonwealth EPBC Act and WA BC Act, it is necessary to rigorously consider potential impact of BKA's proposal on this species. This is assessed in Referral Report No. 4 - *Impact Assessments* (BKA 2024d).

7. See also Referral Report No. 7 - *Commonwealth Protected Matters* (BKA 2924f).

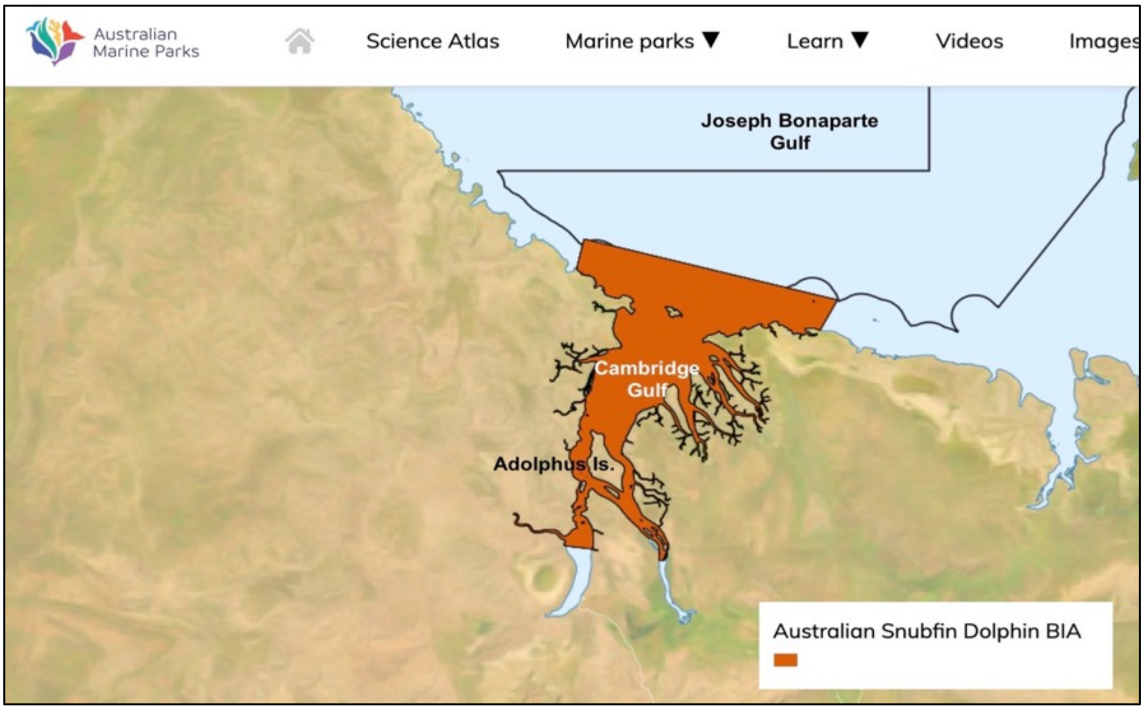


FIGURE 9.16: *Cambridge Gulf is within a Commonwealth-defined breeding, calving, foraging and resting Biologically Important Area (BIA) for the Australian Snubfin Dolphin (Orcaella heinshoni).*

9.3.4 Australian Humpback Dolphin

IUCN status: Vulnerable

EPBC Act: Protected as marine mammal & migratory species (= MNES).

WA BC Act: Migratory. Priority 4 = Rare, Near Threatened and other species in need of monitoring.

1. Like Snubfins, the Australian Humpback Dolphin (*Sousa sahulensis*) also inhabits turbid inshore waters, and CG is within their overall geographical range. BKA's survey in February 2024 recorded one sighting just to the north of the proposed operational area, towards Cape Dussejour, and the survey in July 2023 had no sightings. The broader-area survey in August 2016 by Brown et al (2016) recorded 42 sightings, mostly near Cape Dussejour and outside and to the west of CG, and none in the proposed operational area. There is an area of expansive inter-tidal sand-banks along the coast just south of Cape Dussejour, and Humpback Dolphins are known to target such areas for feeding (Parra & Jefferson 2017). This may be why most sightings have been in that area.

2. As above, for all surveys different sightings could possibly be the same individual(s), so the actual number of dolphins may be less than the number of sightings. These numbers are quite low considering that typical local area population sizes for Humpback Dolphins average ~50 to 90 individuals (based mainly on Queensland data due to lack of published studies in WA to date) (Parra & Cagnazzi 2016).

3. Given the conservation significance and protected status of this species under both the Commonwealth EPBC Act and WA BC Act, it is necessary to rigorously consider potential impact of BKA's proposal on this species. This is assessed in Referral Report No. 4 - *Impact Assessments* (BKA 2024d).

9.3.5 Flatback Turtle

IUCN status: Data deficient.

EPBC Act: Protected as marine species & migratory species (= MNES).

WA BC Act: Vulnerable.

1. As outlined in section 9.2.5, Cape Domett Seaward Beach on the seaward coast outside of CG is a highly significant nesting site for Flatback turtles *(Natator depressus).* Cape Domett Beach is estimated to host over 3,000 nesting turtles annually,

with peak nesting in July-September, which contrasts with the west coast of WA where nesting is in the summer months (Whiting et al 2008). The drone surveys commissioned by BKA as outlined in section 9.2.5 also identified additional Flatback nesting sites in the area.

2. As outlined in section 9.2.6. since 2012 DBCA has been undertaking annual monitoring of turtle nesting at the Cape Domett Seaward Beach, in cooperation with the TOs of the area. During consultations between DBCA and BKA in 2023, access was granted to DBCA's data under a data-sharing agreement, to ensure that BKA's environmental assessment is based on the best available data, and thus optimize scope for protection of marine turtles.

3. Under the agreement BKA undertook an analysis of the data for DBCA, as reported in Annex 14. The report finds that, *inter alia*:

    a) The data supports earlier, more comprehensive studies by Whiting et al (2008) which found that Cape Domett is a significant nesting site for Flatback Turtles.

    b) Evidence of nesting by Green Turtles was counted on 12 occasions over 7 years within the ten-year period, equating to an average of 1.7 per year, indicating that Cape Domett is not a significant nesting site for this species.

    c) Overall, it appears that generally, Flatback Turtle nesting numbers at Cape Domett Seaward Beach may not have changed significantly since the surveys by Whiting et al (2008), although more rigorous data collection and analysis would be required to confirm this.

4. The Commonwealth has designated an inter-nesting 'buffer' BIA over a 60 km radius around Cape Domett and Lacrosse Island, which includes the proposed operational area in CG (Commonwealth of Australia 2017) (Figures 9.17 & 9.18).

5. The Commonwealth can declare BIAs over areas where a specific biologically important behaviour for species that are protected under the EPBC Act is assessed to occur, such as breeding, foraging, resting and migration areas. The BIAs do not have any legal standing or regulatory bases, but they should be taken into account when assessing potential impacts of proposed developments.

6. The Flatback inter-nesting BIA in CG implies that inter-nesting Flatback Turtles could be present within CG, including within the proposed operational area. This is predicated on the assumption that there is a scientific basis for the inter-nesting buffer to extend shoreward to include CG, and on the assumption that the waters of CG are actually used as inter-nesting habitat by the Flatback Turtles that nest at Cape Domett and the other nesting sites in the area. An objective assessment based on the realities of the environmental conditions within CG, and the findings of dedicated MMF surveys, indicate that the waters and seabed within CG are unlikely to actually be used as inter-nesting habitat by Flatback Turtles.

7. Inter-nesting BIAs are areas where marine turtles 'rest' between nocturnal nesting events, often being inactive and resting on the seabed to conserve energy for the next nesting event (Hays et al 1999). Studies on the Pilbara Coast of WA indicate that the inter-nesting area for Flatback Turtles in that region can range from 3.4 to 60 km from the nesting beach (Whittock et al 2014), with an average inter-nesting interval of around 13 days (Thums et al 2019). It is understood that the 60 km radius for the inter-nesting buffer around the Cape Domett nesting beach is derived from the range of up to 60 km assessed by Whittock et al (214) for the Pilbara, without considering site conditions and turtle behaviour in the Cape Domett area.

8. The 60 km inter-nesting buffer is likely to be appropriate for the areas to seaward and extending offshore from Cape Domett, Lacrosse Island, Cape Dussijour and CG in general. However, it is assessed that the area within CG is highly unlikely to be used as inter-nesting habitat, due to the hostile environmental conditions, the known inter-nesting behaviour of Flatbacks and their preference for offshore areas for inter-nesting.

9. As outlined in various sections above the environmental conditions within CG and especially in the proposed operational area are extremely dynamic, with tidal currents up to 4 knots (2.06 m/s), constantly moving seabed sediments and no light at the seabed. These conditions make the area highly unsuitable for marine turtles to use as an inter-nesting resting area – they would have to expend significant energy just to remain there, and would be buffeted around on the seabed in totally dark conditions.

10. The main nesting beaches in the CG area are on the seaward coast and face out to sea. After each nesting event Flatbacks would most likely head straight offshore to the inner waters of Joseph Bonaparte Gulf for their inter-nesting rest, before coming back to the beach again. Flatbacks are known for heading quickly offshore between nesting efforts (MacIntyre pers comms. 2024).

11. There is also no feeding habitat for Flatbacks (or other turtle species) within CG. Flatbacks are carnivorous, feeding mostly on soft-bodied prey such as sea cucumbers, soft corals and jellyfish (DCCEEW). Based on benthic sampling undertaken at a control site offshore in Joseph Bonaparte Gulf in July 2023 - there is feeding habitat, clearer water and less strong currents offshore - which is another reason that Flatback mostly to head offshore and not into CG for inter-nesting.

12. As outlined in section 9.2.3, dedicated on-water MMF surveys were undertaken over nine-days each in February 2024 and July 2023, covering over 600 km of transects for each survey. This extremely comprehensive survey effort included observing for marine turtles at sea throughout CG and in the proposed operational area, with the following findings:

    a) February 2024:

        – Two unidentified turtle sightings in CG, one inside the proposed operational area, and no other sightings.

    b) Late July 2023 (near peak nesting period):

        – Five Flatback Turtle sightings (three near Cape Domett where the main nesting beach is, one near Adolphus Island and one on west side of CG).

        – Seven unidentified turtle sightings (one near Cape Domett, one near Adolphus Island, one on west side of CG, one on east side of CG, two near Lacrosse Island and one within the proposed operational area).

13. As with the dolphin sightings, different sightings could be the same individual(s), so the actual number of turtles may be less than the number of sightings. These are very low numbers of on-water sightings considering the very large area covered, especially in late July 2023 near the peak nesting season, when hundreds of tracks and nests were observed on the nesting beaches. These low sighting numbers tend to indicate that the area within CG is not used as an inter-nesting, resting or foraging area. It should also be noted that only one turtle was observed within the proposed operational area during each survey.

14. Given that CG is a BIA for this species, and its conservation significance and protected status under both the Commonwealth EPBC Act and WA BC Act, it is necessary to rigorously consider potential impact of BKA's proposal on this species. This is assessed in Referral Report No. 4 - *Impact Assessments* (BKA 2024d).

15. See also Referral Report No. 7 - *Commonwealth Protected Matters* (BKA 2924f).

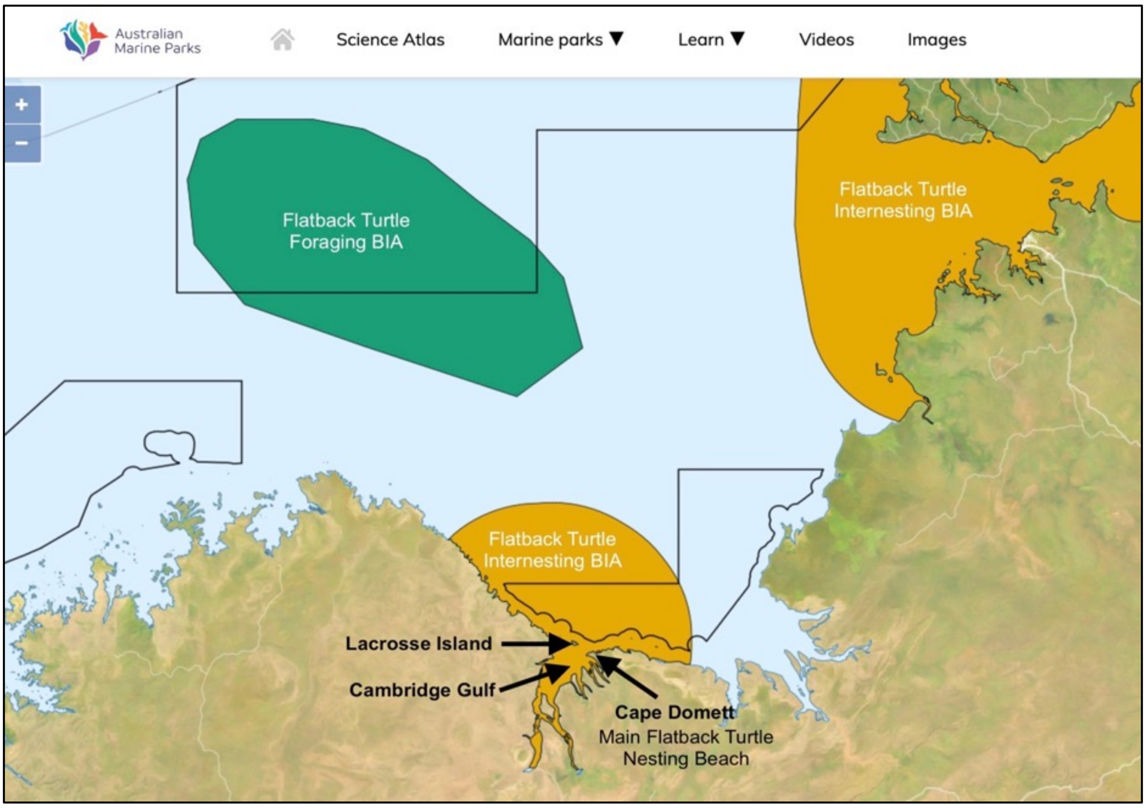


FIGURE 9.17: *The inter-nesting 'buffer' BIA for Flatback Turtles over a 60 km radius around Cape Domett and Lacrosse Island (map source: Australian Marine Parks).*

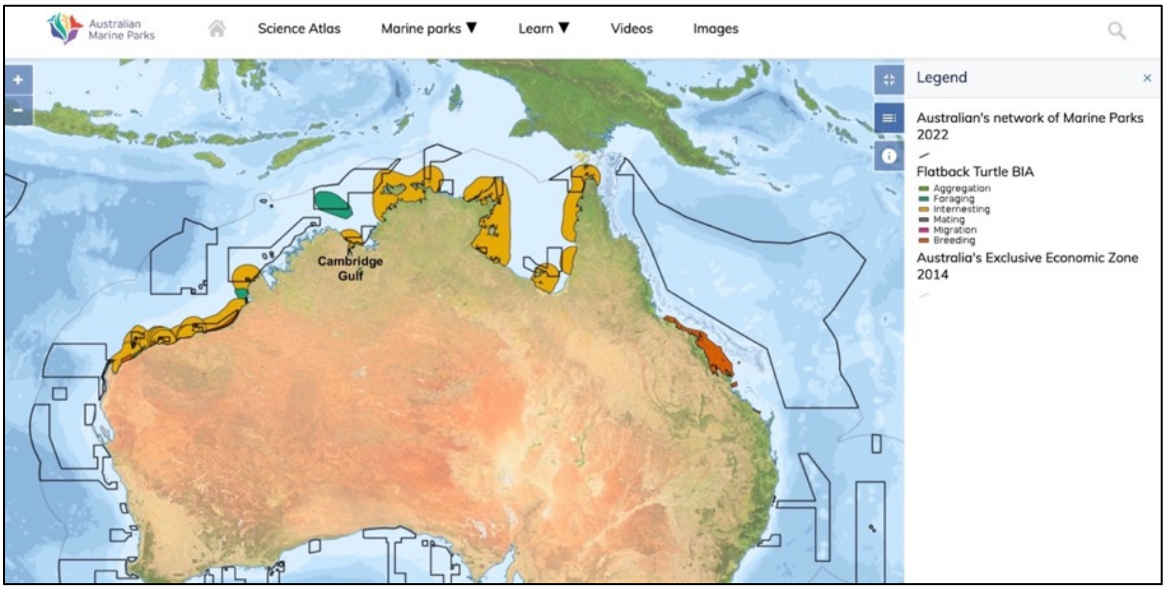


FIGURE 9.18: *BIAs for Flatback Turtles at national level (map source: Australian Marine Parks).*

9.3.6 Green & Olive Ridley Turtles

Green Turtle (*Chelonia mydas*):

- IUCN status: Endangered.
- EPBC Act: Vulnerable. Protected as marine species & migratory species (= MNES).
- WA BC Act: Vulnerable.

Olive Ridley Turtle (*Lepidochelys olivacea*):

- IUCN status: Vulnerable.
- EPBC Act: Endangered. Protected as marine species & migratory species (= MNES).
- WA BC Act: Endangered.

1. There is a broadly defined foraging BIA for Green Turtles offshore from CG in Joseph Bonaparte Gulf, which will not be impacted by the proposal (Figure 9.19). No food sources for this species (seagrass, macroalgae etc) are present in CG, and surveys indicate very low occurrence of occasional individuals in the Cape Domett area.

2. There is a broadly defined foraging BIA for Olive Ridely turtles offshore from CG in Joseph Bonaparte Gulf, which will not be impacted by the proposal (Figure 9.20). This species mainly feeds on molluscs which are generally not present in CG. There are no previous recorded sightings of Olive Ridley Turtles within CG. The nearest rookery for Olive Ridleys is in northwest Arnhem Land in the Northern Territory, 1,000 km by sea from CG (DCCEEW).

3. The MMF surveys conducted in February 2024 and July 2023 did not observe either of these species in or near CG. Twelve years of monitoring Flatback Turtle nesting at the Cape Domett beach by DBCA recorded a total of 12 Green Turtles nesting on that beach, equating to an average of one per year, amongst hundreds of Flatback nests per survey – these are considered opportunistic nesting attempts by the occasional Green Turtle and the area is obviously not a Green Turtle rookery.

4. It seems unlikely that waters within CG and the proposed operational area would be used for foraging or other purposes by either Green or Olive Ridley Turtles, for similar reasons described for Flatback Turtles above. The environmental conditions are inhospitable.

5. Given the nearby BIAs for these species, and their conservation significance and protected status under both the Commonwealth EPBC Act and WA BC Act, it is necessary to rigorously consider potential impact of BKA's proposal on these species. This is assessed in Referral Report No. 4 - *Impact Assessments* (BKA 2024d).

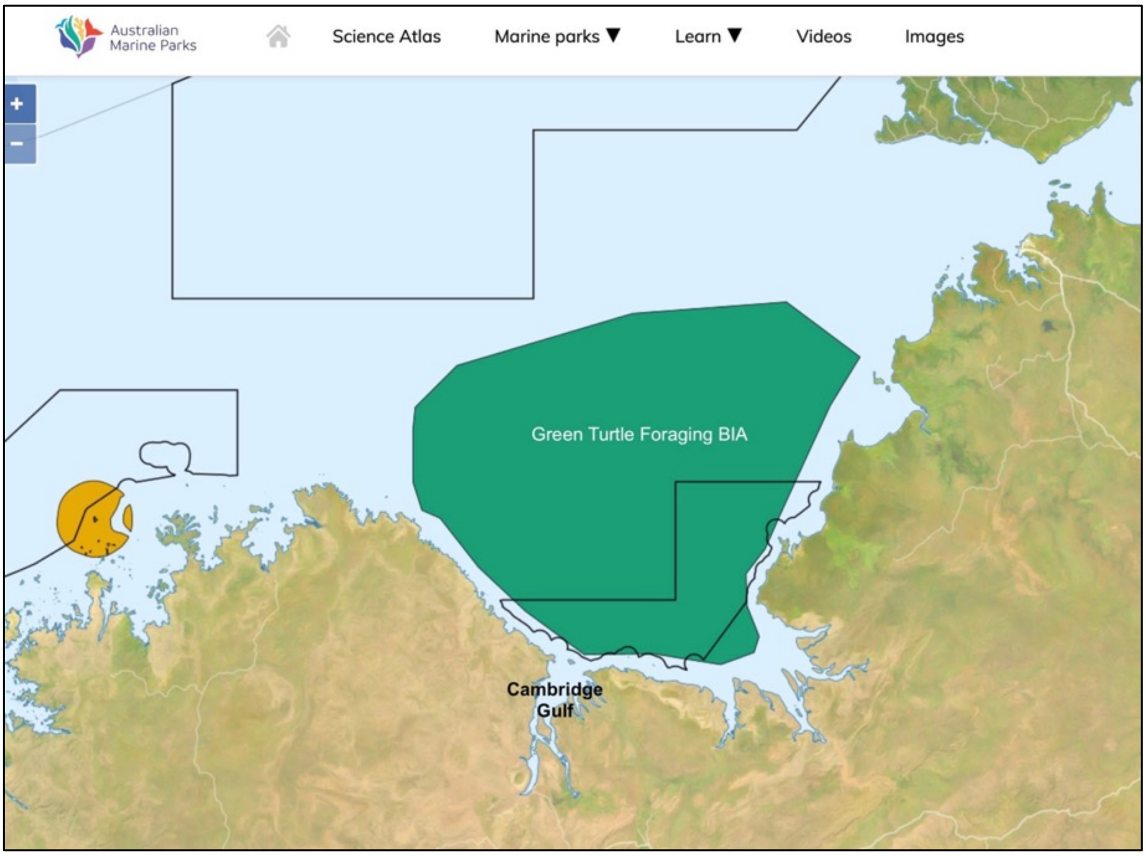


FIGURE 9.19: *The foraging BIA for Green Turtles offshore from CG (map source: Australian Marine Parks).*

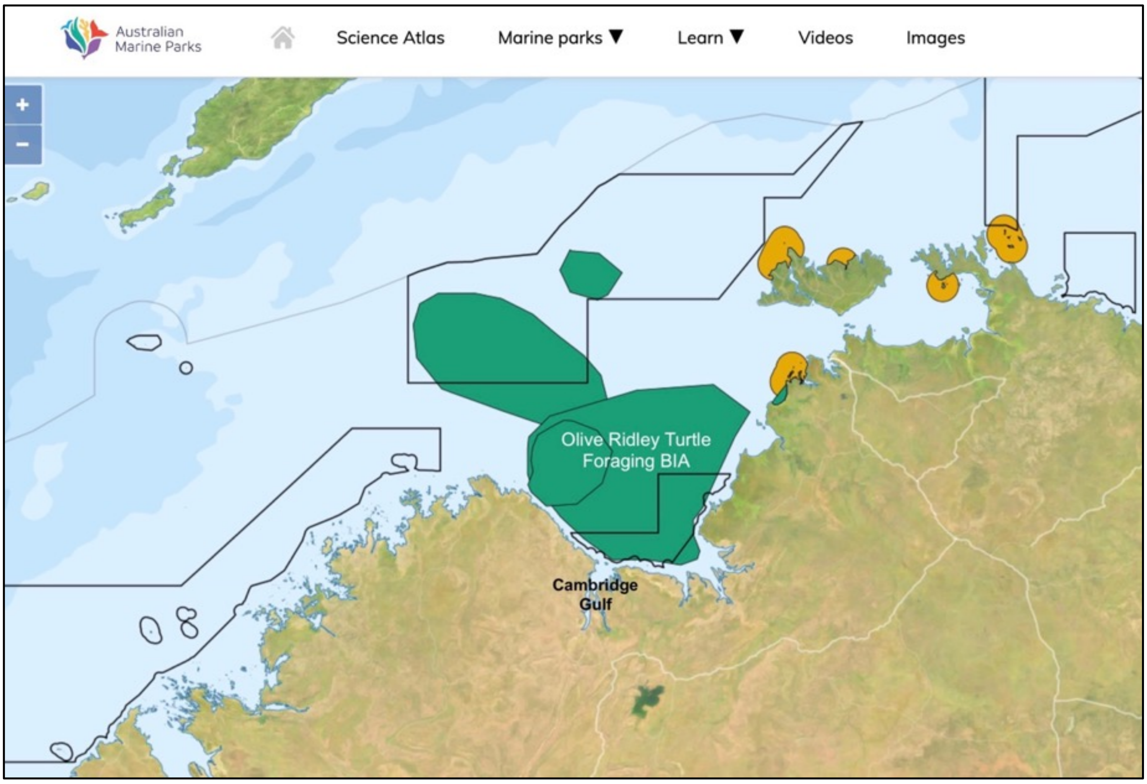


FIGURE 9.20: *The foraging BIA for Oilve Ridley Turtles offshore from CG (map source: Australian Marine Parks).*

9.3.7 Sawfish

Freshwater Sawfish *(Pristis pristis)*

- IUCN status: Critically Endangered
- EPBC Act: Vulnerable. Protected as marine species and migratory species (= MNES).
- WA BC Act: Migratory & Priority 3 (= Poorly known species).

Green Sawfish *(P. zijsron)*

- IUCN status: Critically Endangered
- EPBC Act: Vulnerable. Protected as marine species and migratory species (= MNES).
- WA BC Act: Vulnerable.

Dwarf Sawfish *(P. clavata)*

- IUCN status: Critically Endangered
- EPBC Act: Vulnerable. Protected as marine species and migratory species (= MNES).
- WA BC Act: Migratory & Priority 1 (= Poorly known species).

Narrow Sawfish *(Anoxypristis cuspidata)*

- IUCN status: Critically Endangered
- EPBC Act: Protected as marine species and migratory species (= MNES).
- WA BC Act: Migratory.

1. Sawfish are large, shark-like rays with saw-like tooth-studded snouts (rostra) that inhabit warm, shallow, coastal waters, estuaries and rivers. The upstream areas of the rivers and creeks that discharge into CG provide habitat that may be suitable for the four species of Sawfish that occur in northern WA waters as listed above. However, no previously published papers, reports or verifiable data could be found confirming their presence in CG. As outlined in section 9.2.7, BKA commissioned eDNA sampling throughout CG and up the rivers and creeks in February 2024, and found trace DNA evidence of the presence of the Narrow Sawfish *Anoxypristis cuspidae* at one site ~8 km upstream in the Lyne River on the western side of CG, but not at other sites, and no evidence of the other species at any sites, including in the proposed operational area.
2. The preferred habitat of Sawfish is well up the rivers and inlets, especially during their reproduction (pupping) phase. However, adults of some species are known to migrate to coastal waters and it is therefore possible that Sawfish could occasionally move through the proposed operational area.
3. Given their conservation significance and protected status under both the Commonwealth EPBC Act and WA BC Act, it is necessary to rigorously consider potential impact of BKA's proposal on these species. This is assessed in Referral Report No. 4 - *Impact Assessments* (BKA 2024d).
4. See also Referral Report No. 7 - *Commonwealth Protected Matters* (BKA 2924f).

9.3.8 River Sharks

Speartooth Shark (*Glyphis glyphis*)

- IUCN status: Vulnerable
- EPBC Act: Critically endangered. Protected as marine species.
- WA BC Act: Not listed.

Northern River Shark (*G. garricki*)

- IUCN status: Vulnerable

- EPBC Act: Endangered. Protected as marine species.
- WA BC Act: Priority 1 (= Poorly known species).

1. The two species of river sharks listed above have been found in the Lower Ord River over 30 km upstream of the proposed operational area (P. Kyne, Charles Darwin University online news, no published reports or papers found). The eDNA sampling commissioned by BKA as cited above did not detect DNA evidence of river sharks at any sites in CG itself or in upstream areas on both the west and east side of CG.

2. While it is possible that river sharks could transit through the proposed operational area in CG, the environment in that area is not their preferred habitat, and eDNA sampling of seabed sediments in February 2024 did not detect any evidence of their presence in the proposed operational area.

3. Given their conservation significance and protected status under both the Commonwealth EPBC Act and WA BC Act, it is necessary to rigorously consider potential impact of BKA's proposal on these species. This is assessed in Referral Report No. 4 - *Impact Assessments* (BKA 2024d).

4. See also Referral Report No. 7 - *Commonwealth Protected Matters* (BKA 2924f).

10. AIR QUALITY

10.1 Relevant EPA Guidance

1. The EPA has published one guidance document relating to air quality - EPA 2016, *Environmental Factor Guideline - Air Quality.* The objective is:

   – *To maintain air quality and minimise emissions so that environmental values are protected.*

2. 'Air' refers to all the air above the ground up to and including the stratosphere and air quality is defined as:

   – *The chemical, physical, biological and aesthetic characteristics of air.*

3. The objective recognises the fundamental link between good air quality and the environmental values it supports, including:

   a) human health,
   b) amenity and social surroundings,
   c) flora and vegetation,
   d) terrestrial environmental quality; and
   e) marine environmental quality.

10.2 Methods Used to Describe Air Quality

1. No previous studies or existing data on air quality of the CG area could be identified. The description is based on existing meteorological information and the fact that the coast around CG is not inhabited and there is no urban development or industry that could affect air quality in the area.

10.3 Description of Air Quality

1. The receiving environment is the atmosphere above CG, which has a hot, semi-dry climate. The annual average maximum temperature is 35.6 °C, one of the highest in Australia. The cooler, winter dry season runs from April to early November, with average maximum temperatures (measured at Wyndham) of 31° C and virtually no rainfall, and the hot, summer wet season runs from late November to March, with average maximum temperatures of 39.5° C. The wettest month is usually January with an average rainfall of 108 mm, although rainfall can be much higher during cyclones and tropical 'low' depressions (www.weather-atlas.com).

2. In general terms, the larger-scale winds are dominated by the seasonal monsoons. North-westerly winds generally blow during the Summer Monsoon centred on the months of January to March/April, followed by strong easterlies/south-easterlies over winter (the 'south-east trade winds') and then a gradual return to north-westerly conditions in spring. Immediately around Wyndham, in the south of CG, the spring and summer winds are almost due north-to-south and the winter regime effectively due westward (Pearce et al 2015). Average wind speeds tend to be strongest at between 20 and 40 km/hour from the east and south-east during winter and into spring , although highest (extreme) wind speeds occur during Tropical Cyclones in the summer wet season.

2. There is no urban, industrial or other development on the coast or in the immediate catchment of CG that could be potential sources of air pollution inputs to the receiving atmospheric environment. Dry-season bush fires affect air quality through smoke, ash and particulate matter but these are natural occurrence.

3. Currently, the only potential source of anthropogenic air pollution in CG is the ships that transit through CG when entering and departing the Port of Wyndham. Over the three-financial year period 2019/20 to 2022/23 there was an average of 1.3 commercial ship transits per week through CG (CGL 2024). These included small cruise ships, bulk carriers, petroleum tankers and general cargo ships, all of which have air emissions from their engines and machinery.

4. All such ships that enter Australian ports must comply with Annex VI (Air Pollution) of the *International Convention for the Prevention of Pollution form Ships* (MARPOL) and the implementing Australian regulations (AMSA Marine Order 97). Assuming that they comply, these ships should not cause negative impacts on air quality in the CG area.

11. SOCIAL SURROUNDINGS

11.1 Relevant EPA Guidance

1. The EPA has published two guidance documents relating to social surroundings:

   - EPA 2016, *Environmental Factor Guideline* - Social Surroundings.
   - WA EPA 2023, *Interim Technical Guidance, Environmental impact assessment of Social Surroundings - Aboriginal cultural heritage.*

2. The objective of the *Environmental Factor Guideline* is:

   - *To protect social surroundings from significant harm.*

3. The definition of social surroundings under the EP Act requires that for social surroundings to be considered in an assessment, there must be a clear link between a proposal's impact on the physical or biological surroundings and any subsequent impact on peoples' aesthetic, cultural, economic or social surroundings.

4. Aboriginal cultural heritage is identified as a specific and significant value within social surroundings. The 2023 *Interim Technical Guidance* outlines the criteria for whether or not the EPA will assess Aboriginal cultural heritage, and how potential impacts on Aboriginal cultural heritage should be assessed.

5. Separate from the EP Act the WA *Aboriginal Cultural Heritage Act* (ACH Act) protects Aboriginal cultural heritage in WA, and is administered by the Department of Planning, Lands & Heritage (DPLH). The EPA considers that potential harm to Aboriginal cultural heritage within an activity area may be mitigated by the ACH Act processes in most cases. However, this will be determined on a case-by-case basis and EPA assessment may still be required:

   - where ACH Act processes are not reasonably likely to be meet the EPA's objectives for social surroundings; and
   - for proposals where there is likely to be a significant impact from physical or biological surroundings which directly affect to ACH values outside an activity area.

6. Section 13.3 addresses the requirements of the 2023 *Interim Technical Guidance.*

11.2 Methods Used to Describe Social Surroundings

1. The receiving environment for social surroundings in the CG area was researched through relevant Commonwealth, State and local government statistics and reports and consultation with key stakeholders as outlined in Referral Report No. 6 - *Consultation Report* (BKA 2024e). Methods used to assess and describe Aboriginal cultural heritage, both on-land and underwater, are described in Referral Report No. 3 - *Traditional Owner Matters* (BKA 2024c).

11.3 Description of Social Surroundings

1. The receiving environment for social surroundings in the CG area has the following main features:

   a) Lack of human habitation & activity:

   - The receiving environment for social surroundings in CG is strongly influenced by the fact that the area is completely uninhabited, with no road access and no built facilities or infrastructure at all, except for an AMSA navigation light on a hill on Lacrosse Island.
   - The closest human habitation is at Wyndham located 80 km upstream of CG.
   - Human presence in CG is restricted to vessel-based operations, including:
     - commercial vessels that transit through CG entering and departing the Port of Wyndham located 80 km upstream (an average of 1.3 ships per week),
     - small private vessels from Wyndham and Kununurra used mainly for recreational fishing along the coast and up the inlets of CG; and

– one commercial gillnet fisherman who is sometimes active in CG (and also along the adjacent coast outside CG.

b) Aesthetic values:

– CG has very high aesthetic values in the form of wild, untouched, natural scenery including rugged limestone cliffs along parts of the coast.

c) Non-Aboriginal cultural heritage values:

– No non-Aboriginal cultural heritage values including historic shipwrecks have been identified in the proposed operational area.

d) Aboriginal cultural heritage values:

– Full details of consultations held with the two relevant TO groups in the area (Balanggarra and Miriuwung-Gajerrong), search of the WA Aboriginal Cultural Heritage Inquiry System (ACHIS) and the comprehensive marine surveys undertaken by BKA for Aboriginal cultural heritage are presented in Referral Report No. 3 - *Traditional Owners, Native Title & Aboriginal Cultural Heritage (BKA 2024c).* In summary:

  – Marine-based / inside activity area: Consultation with the two relevant TO groups and comprehensive marine surveys have not identified Aboriginal cultural heritage within the activity area (proposed operational area).

  – Marine-based / outside activity area: Consultation with the two relevant TO groups and comprehensive marine surveys have not identified Aboriginal cultural heritage in other marine areas of CG outside of the proposed operational area.

  – Land-based / outside activity area: There are significant Aboriginal cultural heritage sites on Lacrosse Island and on the adjacent mainland centred on Cape Domett, which will not be impacted in any way by the proposal.

e) Economic activity:

– Economic activity in CG currently comprises:
  – commercial ships that transit to and from the Port of Wyndham,
  – recreational fishing; and
  – one commercial gillnet fisherman who is sometimes active in CG (and also along the adjacent coast outside CG).

– Based on discussions held with a broad range of local and State stakeholders as part of BKA's consultation program, it appears that, apart from BKA's proposal, there is unlikely to be any other economic activity in CG in the foreseeable future.

2. The potential for significant impacts on social surroundings in CG is limited by the fact that the area is completely uninhabited, with no road access and no built facilities or infrastructure.

3. Wyndham is too distant from the proposed operational area for social surroundings there to be affected. The proposal does not include any facilities or activities in Wyndham that could impact on social surroundings. The Sand Production Vessel (SPV) will not enter the Port of Wyndham as it will be too large to do so. A small vessel might be based in the Port of Wyndham to support environmental monitoring in CG and for occasional transfers to and from the SPV if needed.

4. The aesthetic values of CG will not be affected by the proposal as there will not be any alteration of the coastline or construction of any onshore or marine facilities or infrastructure, except perhaps a small, 10 m high meteorological mast in the Cape Dussejour area. This would be painted to blend with the environment.

5. The SPV will only be present in CG for one to two days every two weeks, so there will be zero visual activity in CG for 86% of the time each year. As outlined above, over the last three financial years an average of 1.3 commercial ships transited through CG per week (CGL 2024).

6. There is no marine non-Aboriginal cultural heritage with the activity area (proposed operational area) that might be impacted.

7. There is no marine Aboriginal cultural heritage with the activity area (proposed operational area) that might be impacted.

8. Land-based Aboriginal cultural heritage sites on Lacrosse Island and on the adjacent mainland centred on Cape Domett will not be impacted by the proposal, as there will not be any construction of onshore facilities or infrastructure or any land-based

operations, except perhaps the small meteorological mast mentioned above, which would have TO approval and cultural heritage clearance.

9. Despite the fact that the proposal will not impact on land-based sites, should the proposal be approved and go ahead, BKA is offering to assist the TO groups to enhance protection of these sites, by supporting the development and implementation of a joint Aboriginal Cultural Heritage Management Plan (ACHMP), in accordance with their needs and requirements.

10. The economic activity of commercial vessels that transit to and from the Port of Wyndham will not be impacted by the proposal as normal navigational safety laws and procedures will apply to the Sand Production Vessel. BKA is consulting closely with relevant maritime and port authorities on this. The proposal will bring economic benefits to the Port of Wyndham as outlined below.

11. Recreational and commercial fishing will not be affected by the proposal as neither are active in the proposed operational area and the proposed operation will not affect fish stocks in CG, as outlined in Referral Report No. 4 – Impact Assessments (BKA 2024d).

12. The proposal will generate the following economic benefits for Wyndham, Kununurra, the surrounding region and the state of WA:

    a) Payment of royalties per dry-tonne of sand to the State under the WA *Mining Act* over the 15-year life of the proposal.

    b) Payment of additional royalties per dry-tonne of sand to the two registered TO groups in the area (BAC and MG Corporation). This is not legally required but is being offered by BKA under MoUs being developed with each TO group. This may include establishing trust-fund mechanisms to support TO community development initiatives. Depending on the rate agreed with the TO groups and the volume of sand actually exported, this could potentially generate over $17 million for each group over the 15-year life of the proposal.

    c) Up to forty jobs for Australian crew on the SPV (alternating two-week swings of 20 crew each), with first priority given to local TOs, including training and career development.

    d) Offer of marine crew cadetships and training to local TOs on the Boskalis global fleet.

    e) Support to TOs to establish a small marine services business in Wyndham to support the operation in CG, for example transferring people, equipment and supplies when needed (bulk provisioning and refuelling of the SPV will be done at Asian sand delivery port as it will be too large to enter the Port of Wyndham).

    f) Environmental monitoring contract for the 15-year life of the proposal, ideally with TO indigenous ranger groups, including training, vessel and equipment.

    g) Funding for scientific research on key marine biodiversity and fisheries issues in the CG area, in consultation and cooperation with relevant partners.

    h) Possible sponsorship of the Wyndham Volunteer Marine Rescue Group and other similar groups and community initiatives.

12. PROTECTED AREAS

1. As shown on Figure 12.1 there are five protected areas in the general vicinity of CG, as follows:

    a) The State North Kimberley Marine Park which starts at the seaward entrance to CG along the territorial sea baseline and extends out to the 3 nm limit of State coastal waters.
    b) The Commonwealth Joseph Bonaparte Gulf Marine Park located seaward of the State Marine Park.
    c) The State Ord River Nature Reserve which covers the Ord River Floodplain Ramsar Wetland to the east of CG.
    d) The State Mijing Conservation Park located 20 km inland from the east coast of CG.
    e) The Balanggarra Indigenous Protected Area (BIPA) which commences 10 km inland from the west coast of CG.

2. Each of these is briefly described in the following sections.

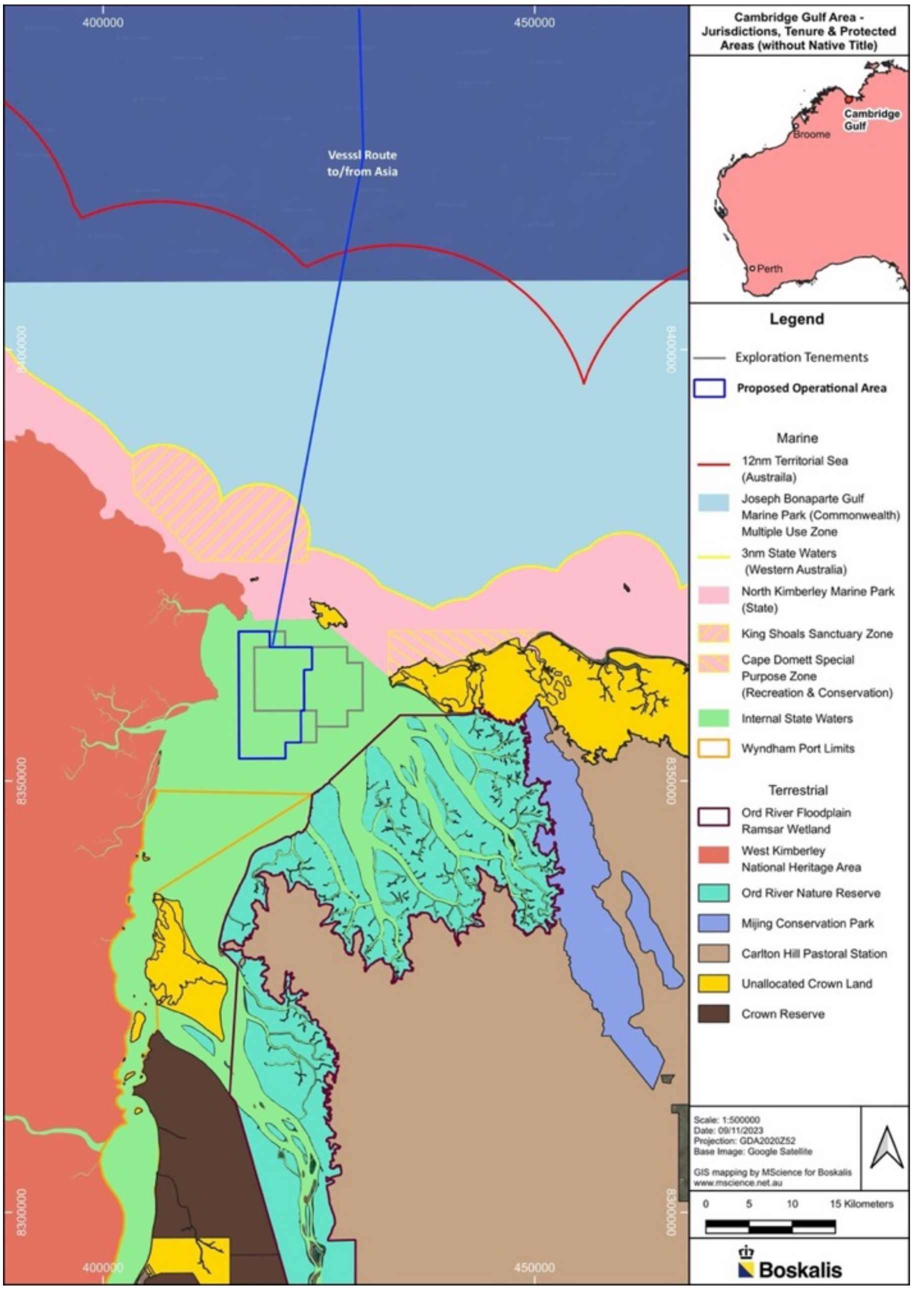


FIGURE 12.1: *Jurisdictions, Tenure & Protected Areas in the vicinity of the proposed operational area.*

12.1 The State North Kimberley Marine Park

1. The State North Kimberley Marine Park was gazetted in 2016 and starts at the seaward entrance to CG along the territorial sea baseline and extends out to the 3 nm limit of State coastal waters. The closest distance from the proposed operational area to the Marine Park is ~1.8 km from the northern boundary of the former to the southern boundary of the latter.

2. The Park is managed cooperatively with the two TO groups in the area, with a designated Balanggarra Management Area extending from CG to the west and a Miriuwung-Gajerrong Management Area extending from CG to the east. There are three Marine Park Zones in the CG area (Figure 12.2):

    a) Sanctuary Zone over King Shoals outside the western entrance to CG.
    b) Special Purpose Zone (Recreation & Conservation) extending east from Cape Domett.
    c) General Use Zone for the remaining areas.

3. Table 12.1 shows the activities that are permitted / prohibited in each zone. Vessel transits are permitted in all zones and there is a specific provision in the Marine Park Management Plan that no restrictions will be placed on commercial vessel transits to, from or within CG. The SPV will transit through the State Marine Park when arriving at and departing from CG, as marked on Figure 12.1, as per the commercial vessels that routinely enter and depart CG to service the Port of Wyndham (an average of 1.3 per week over the last three financial years). The SPV will comply with all relevant maritime laws and regulations and there will not be any discharges from the SPV when transiting the Marine Park.

4. The dry- and wet-season benthic surveys conducted by BKA to support this assessment, included significant sampling in the State Marine Park including in the King Shoals Sanctuary Zone, under permit from DBCA. The seabed substrate at King Shoals is mainly comprised of highly dynamic sand waves and supports relatively little benthic biota, with strong tidal currents, high turbidity and lack of light at the seabed. The most benthic biota was found in the General Use Zone on rocky seabed between Cape Dussejour and Fathom Rock, comprising a few very small hydroids, other coelenterates, bryozoans etc, attached to small rocks.

5. Given the factors above, it is assessed that the proposal will not cause any significant direct or indirect impacts on the State Marine Park.

TABLE 12.1: *The activities that are permitted / prohibited in each zone (source: North Kimberley Marine Park Management Plan)*

Activity	Sanctuary zones	Special purpose zone (recreation and conservation)	Special purpose zone (cultural heritage)	General use zones
Customary				
Customary activities (e.g. hunting and fishing)	Yes [a]	Yes [a]	Yes [a]	Yes [a]
Commercial				
Commercial gillnet fishing	No	No	Yes	Yes
Commercial prawn trawl fishing	No	No	Yes [b]	Yes [b]
Commercial fishing (other than gillnet and prawn trawl)	No	Yes	Yes	Yes
Pearling and associated activities	No	Assess	Yes	Yes
Aquaculture	No	Assess	Assess	Yes
Scenic flights (charter)	Yes	Yes	Yes	Yes
Ground-disturbing mineral and petroleum exploration and development [c]	No	Assess	No	Assess
Non-ground-disturbing geophysical surveys [d]	Assess	Assess	Assess	Assess
Ship loading and other mining related infrastructure (e.g. ship loading docks, cabling or pipelines)	No	Assess	No	Assess
General marine infrastructure (e.g. groynes or jetties)	No	Assess	Assess	Assess
Artificial structures (e.g. artificial reefs)	No	Assess	Assess	Assess
Dredging and dredge spoil dumping	No	Assess [e]	Assess [e]	Assess [e]
Charter tour operators – fishing	No	Yes	Yes	Yes
Charter tour operators – non-extractive (e.g. wildlife viewing)	Yes	Yes	Yes	Yes
Wildlife/fish feeding [f]	No	No	No	No
Recreational				
Boating (motorised and non-motorised)	Yes	Yes	Yes	Yes
Nature appreciation and wildlife viewing	Yes	Yes	Yes	Yes
Shore and boat fishing	No	Yes [h]	Yes	Yes
Other use				
Vessel transit [g]	Yes	Yes	Yes	Yes
Navigation aids	Yes	Yes	Yes	Yes
Research and monitoring	Yes	Yes	Yes	Yes
Anchoring (soft bottom only)	Yes	Yes	Yes	Yes
Seaplane, helicopter and remotely piloted aircraft (drone) launching and landing [i]	Assess	Assess	Assess	Yes
Vessel sewage discharge and de-ballasting	No	Yes [j]	Yes [j]	Yes [j]

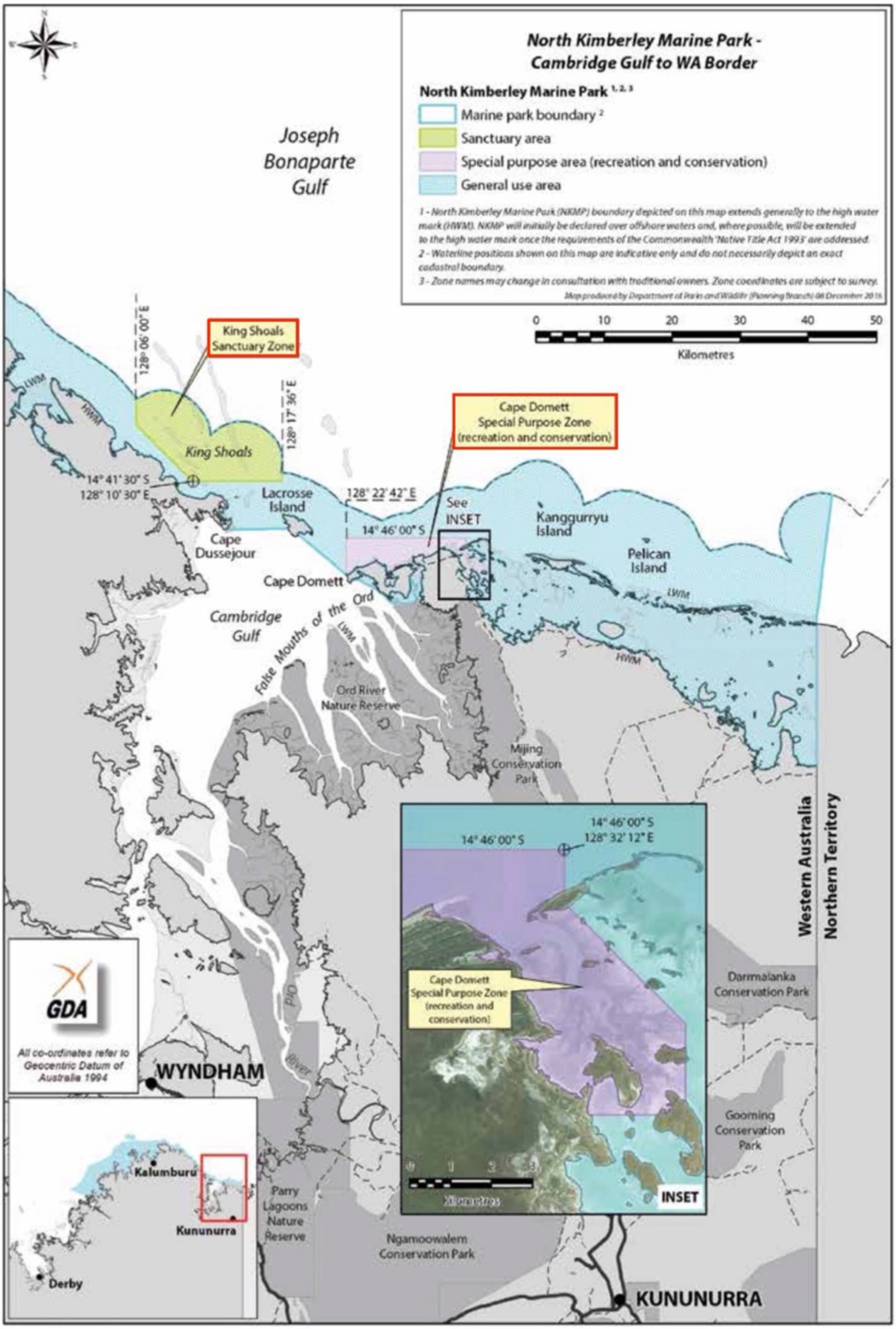


FIGURE 12.2: *The North Kimberley Marine Park zones in the CG area (source: North Kimberley Marine Park Management Plan)*

12.2 The Commonwealth Joseph Bonaparte Gulf Marine Park

1. The Joseph Bonaparte Gulf Marine Park covers Commonwealth waters seaward of the State Marine Park. The closest distance from the proposed operational area to the Marine Park is ~8 km from the northern boundary of the former to the southern boundary of the latter.

2. As shown on Figure 12.3 the Marine Park Zone immediately offshore from CG is a Multiple Use Zone which is the least restrictive zone, and vessel transits are permitted. The SPV will transit through the Commonwealth Marine Park when arriving at and departing from CG, as marked on Figure 12.3, as per the commercial vessels that routinely enter and depart CG to service the Port of Wyndham. The SPV will comply with all relevant maritime laws and regulations and there will not be any discharges from the SPV when transiting the Marine Park.

3. Given these factors, it is assessed that the proposal will not cause any significant direct or indirect impacts on the Commonwealth Marine Park.

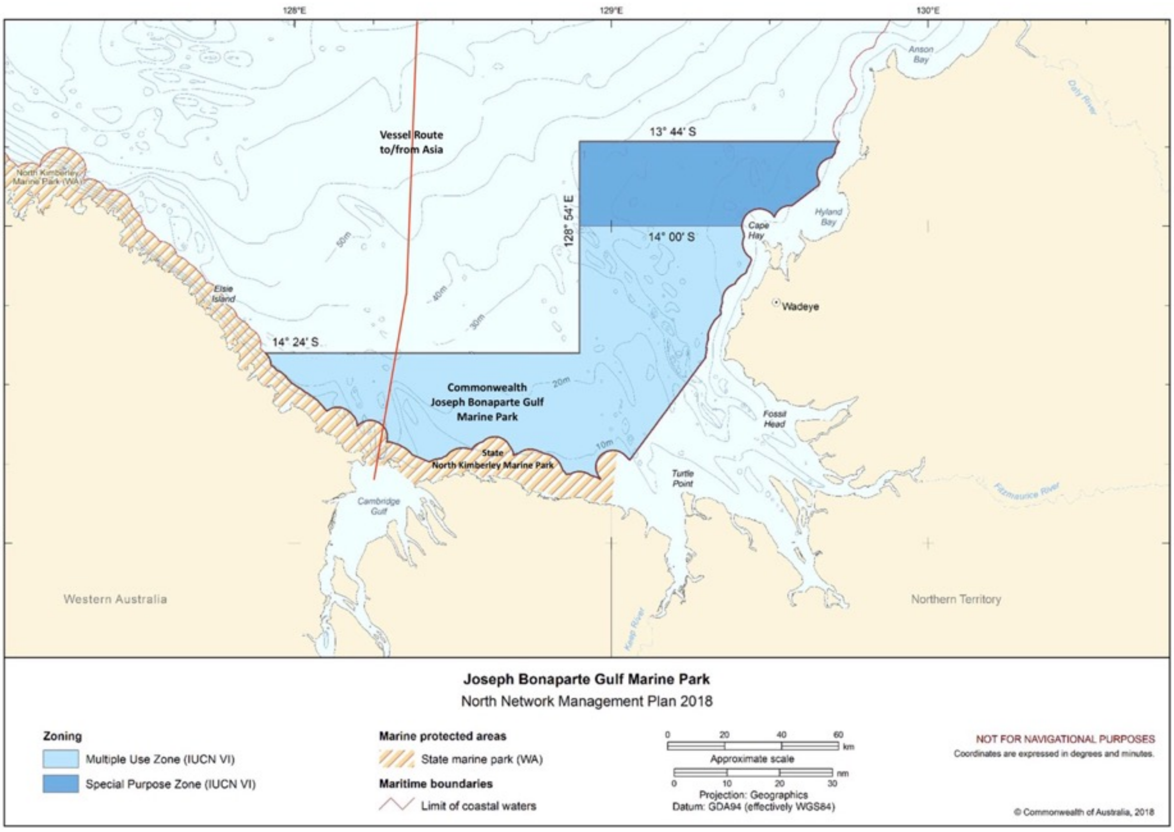


FIGURE 12.3: *The Commonwealth Joseph Bonaparte Gulf Marine Park (source: North Network Management Plan 2018)*

12.3 The State Ord River Nature Reserve

1. The State Ord River Nature Reserve covers the Ord River Floodplain Ramsar Wetland on the eastern side of CG (Figure 12.4). Part of the eastern boundary abuts the Mijing Conservation Park (see section 12.4).

2. The Ramsar Wetland is of international significance, being designated under the *Convention on Wetlands of International Importance* signed at Ramsar, Iran in 1971. The wetland comprises a complex system of estuarine inlets just inshore from Cape Domett, lined with relatively narrow bands of fringing mangroves and backed by tidal flats, known as the 'False Mouth of the Ord River'. It was listed under the Ramsar Convention in 1990 with the following values:

    a) The site represents the best example of wetlands associated with the floodplain and estuary of a tropical river system in the Kimberley region of WA.

    b) Of the 19 species of mangrove found in WA, 15 have been recorded within the Ramsar Site.

    c) It is a nursery, feeding and/or breeding ground for migratory birds and waterbirds.

d) The site supports a number of species protected under the EPBC Act, including Freshwater Sawfish (*Pristis microdon),* Green Sawfish *(Pristis zijsron),* Northern River Shark *(Glyphis garricki)*, Saltwater Crocodile *(Crocodylus porosus)* and the Australian Painted Snipe *(Rostratula australis)*.

e) The site regularly supports 1% of the population of Plumed Whistling Duck *(Dendrocygna eytoni)* and Little Curlew *(Numenius minutes).*

3. The closest distance from the proposed operational area to the Ord River Nature Reserve is ~6 km from the eastern boundary of the former and the western boundary of the latter. There will therefore not be any direct impacts from the proposal on the reserve.

4. However, given its international significance as a Ramsar-listed wetland, BKA has given particular attention to assessing potential indirect impacts of the proposal on the area, including but not limited to potential changes to sediment dynamics and coastal processes, as presented in detail in Referral Report No. 5 - *Cambridge Gulf Metcocean & Sediment Dynamics - System Understanding, Conceptual Model & Initial Modelling & Supplementary Technical Note* (PCS 2024a).

6 As assessed in that report and presented in section 7 - *Coastal Processes* of this report, there does not appear to be significant sediment connection between the proposed operational area and the wetland – there appears to be net outflow of sediment from CG, the proposed operational area is located ‘downstream’ of the wetland, and most input appears to be on the western side of the Gulf (Wolanski et al 2001 & 2004), while the wetland is located on the eastern side. It is assessed that the proposal is unlikely to affect the wetland through changes to coastal processes.

7 In terms of coastal processes it should be noted that the wetland is formed by and naturally adapted to extreme inter-annual variations in wet season flooding and sedimentation and extreme natural destructive forces such as cyclones (Wolanski et al 2001 & 2004) (Hale 2008). As outlined in sections 6.4.5 and 7, the False Mouths of the Ord appear to be naturally highly dynamic with numerous areas of significant natural erosion and undercutting of mangroves. These erosion areas mainly face to the north west and may therefore be impacted by north westerly winds and waves and less sheltered from cyclone impacts than other parts of CG.

5. Because Ramsar sites are listed as Matters of National Environmental Significance (MNES) under the Commonwealth EPBC Act, a detailed assessment of potential impacts is included in Referral Report No. 7 - *Commonwealth Matters* (BKA 2024f). The assessment was undertaken in accordance with the DCCEEW Significant Impact Criteria for Ramsar wetlands, which are as follows:

Is there is a real chance or possibility that the proposal will result in:

- *Areas of the wetland being destroyed or substantially modified?*
- *A substantial and measurable change in the hydrological regime of the wetland, for example, a substantial change to the volume, timing, duration and frequency of ground and surface water flows?*
- *The habitat or lifecycle of native species, including invertebrate fauna and fish species, dependant upon the wetland being seriously affected?*
- *A substantial and measurable change in the water quality of the wetland – for example, a substantial change in the level of salinity, pollutants or nutrients in the wetland, or water temperature which may adversely impact on biodiversity, ecological integrity, social amenity or human health?*
- *An invasive species that is harmful to the ecological character of the wetland being established (or an existing invasive species being spread) in the wetland?*

6. The assessment as presented in Referral Report No. 7, supported by Referral Report No. 5, finds that no significant impact is likely against each of these significant impact criteria.

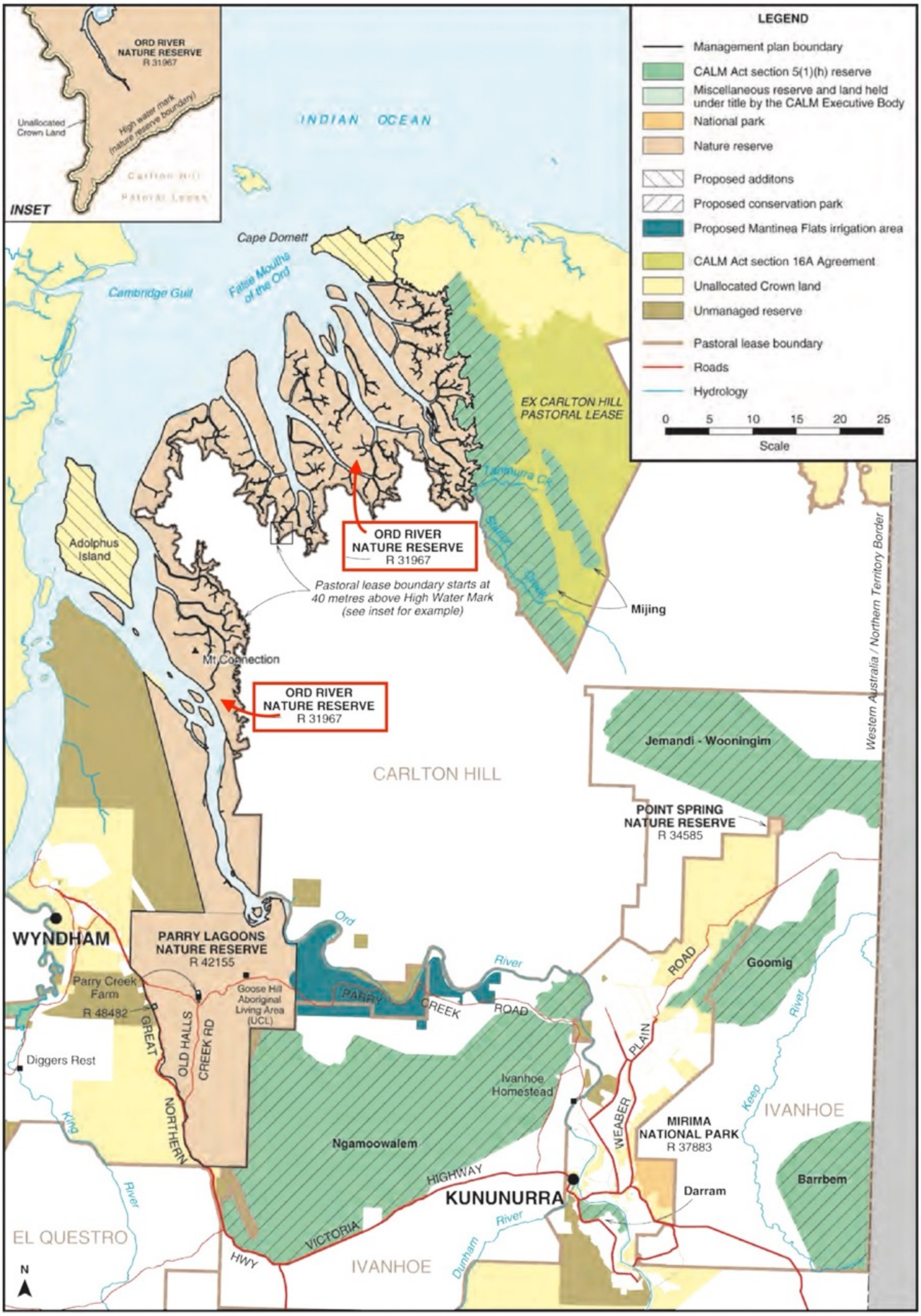


FIGURE 12.4: *The Ord River Nature Reserve which covers the Ord River Floodplain Ramsar Wetland (source: Ord River & Parry Lagoons Nature Reserves Management 2017)*

12.4 The State Mijing Conservation Park

1. On the eastern side of CG the Miriuwung-Gejerrong (MG) people co-manage a number of conservation areas jointly with DBCA, with their Indigenous Rangers being employed directly by DBCA. The land is owned by MG Corporation and leased to the State Government for conservation purposes, with agreed Joint Management Plans between the parties.

2. These areas are mainly clustered around Kununurra as shown on Figure 12.5. The closest of these to CG is the Mijing Conservation Park (MCP) just south of Cape Domett, abutting the north-eastern boundary of the Ord River Floodplain Ramsar wetland, which is protected by the State-designated Ord River Nature Reserve (Figure 12.1 and Figure 12.5).

3. The MCP covers 25,529 ha and is managed to protect a number of key biodiversity values. The landscape is defined by the Ningbing Range, consisting of limestone that was formed as part of an ancient (Devonian) barrier reef system and contains large deposits of marine fossils. The limestone range and its karst outcrops are surrounded by dense, low deciduous vine thickets. These are uniquely diverse and species rich in comparison to similar areas in the North and East Kimberley. The rugged topography of the range provides important refuge habitat for animals from fire. Freshwater creeks and waterbodies on the western side of the range towards CG provide important habitat for various waterbirds and other bird species (Graham & White 1999). There are also significant Aboriginal cultural heritage values throughout the MCP.

4. The closest distance between the MCP and the proposed operational area is over 20 km, and the proposal will therefore not cause any direct or indirect impacts on the MCP, or on any coastal or land areas around CG.

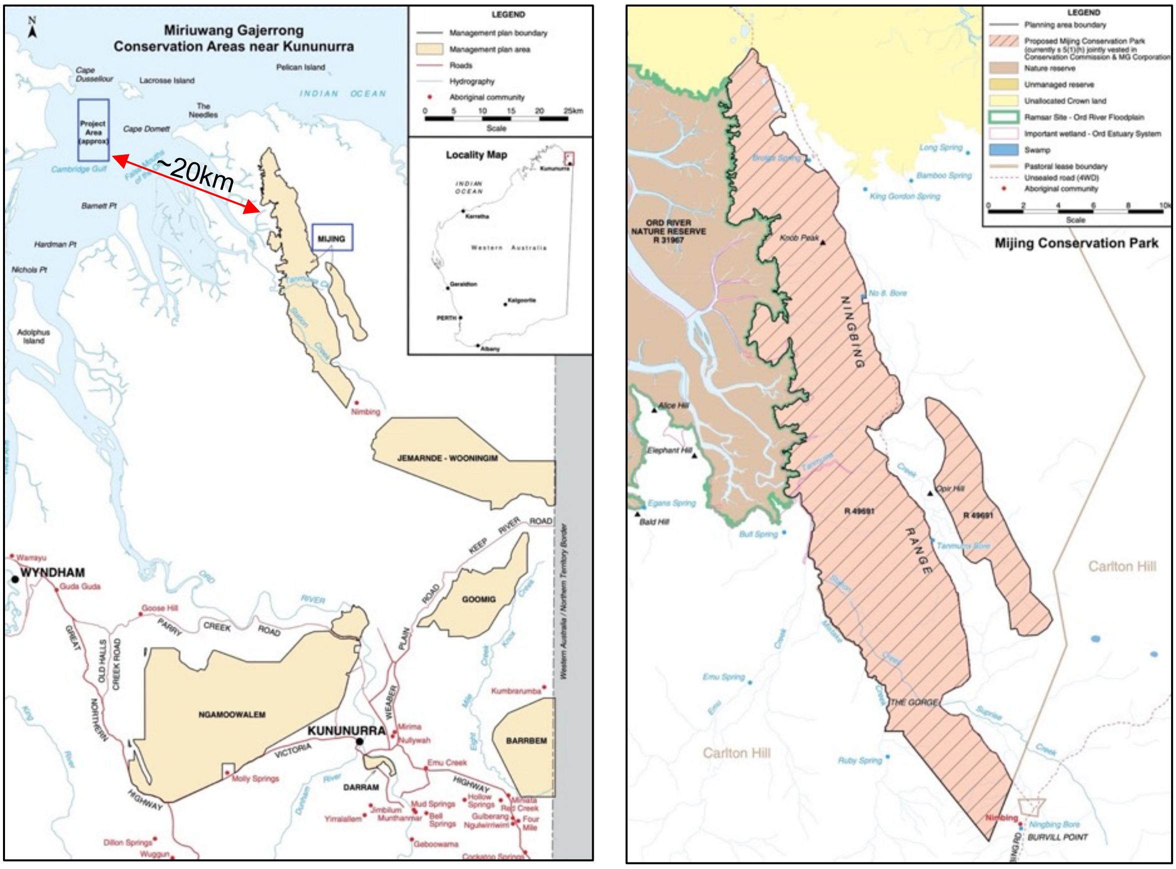


FIGURE 12.5: Left: *MG conservation areas near Kununurra.* Right: *The closest to CG is the Mijing Conservation Park (source: MG Corporation)*

12.5 The Balanggarra Indigenous Protected Area

1. An Indigenous Protected Area (IPA) is a voluntary agreement between TOs and the Australian Commonwealth Government to manage areas of their land and/or sea country for environmental protection, biodiversity conservation and cultural heritage preservation, balanced with sustainable use of the area to deliver cultural, social and economic benefits for the local indigenous people. Some areas of IPAs with high conservation value are recognized as part for the National Reserve System for protection of Australia's biodiversity and cultural heritage, and IPAs currently make up over 50% of the National Reserve System.

2. Management of IPAs is undertaken by the TOs including Indigenous Rangers, often in partnership with either or both the Commonwealth Government and/or the relevant State Government. Management plans for IPAs are developed in accordance with the TOs objectives for their area, and often seek to blend traditional indigenous approaches to natural resource management with modern scientific methods.

3. Nationally, the IPA program is jointly administered by the Commonwealth Department of Climate Change, Energy, the Environment and Water (DCCEEW) and the National Indigenous Australians Agency (NIAA), a Commonwealth Government Agency which coordinates implementation of much of the Australian Government's indigenous affairs program.

4. The Balanggarra IPA was declared in May 2013 and covers over 10,000 km^2 of the Balanggarra Native Title determination area to the west of CG as shown on Figure 48. The IPA includes both significant biodiversity values and cultural heritage sites, including significant areas of rock art with elegant human-like images of *Girri-girro* (Bradshaw figures).

5. The Balanggarra IPA is managed as a Category VI protected area under the classification scheme of the International Union for Conservation of Nature (IUCN), which is a protected area that allows sustainable use of natural resources. It is managed by the Commonwealth-funded Balangarra Indigenous Rangers in partnership with the WA Department of Biodiversity Conservation & Attractions (DBCA), in accordance with the vision, targets and principles outlined in the Balanggarra Healthy Country Plan. The BAC has also signed a Joint Management Agreement with DBCA for the joint management of the Balanggarra parts of the North Kimberley Marine Park.

6. The eastern boundary of the Balanggarra IPA is set back from the west coast of CG by around 10 km (Figures 12.1 and 12.6), and the proposal will therefore not cause any impacts on the IPA, or on any coastal or land areas around CG.

7. Should the proposal be approved and go ahead, BKA is offering to support the TO groups in undertaking research and monitoring of marine biodiversity and key marine fauna species, which will enhance protection and management of marine areas.

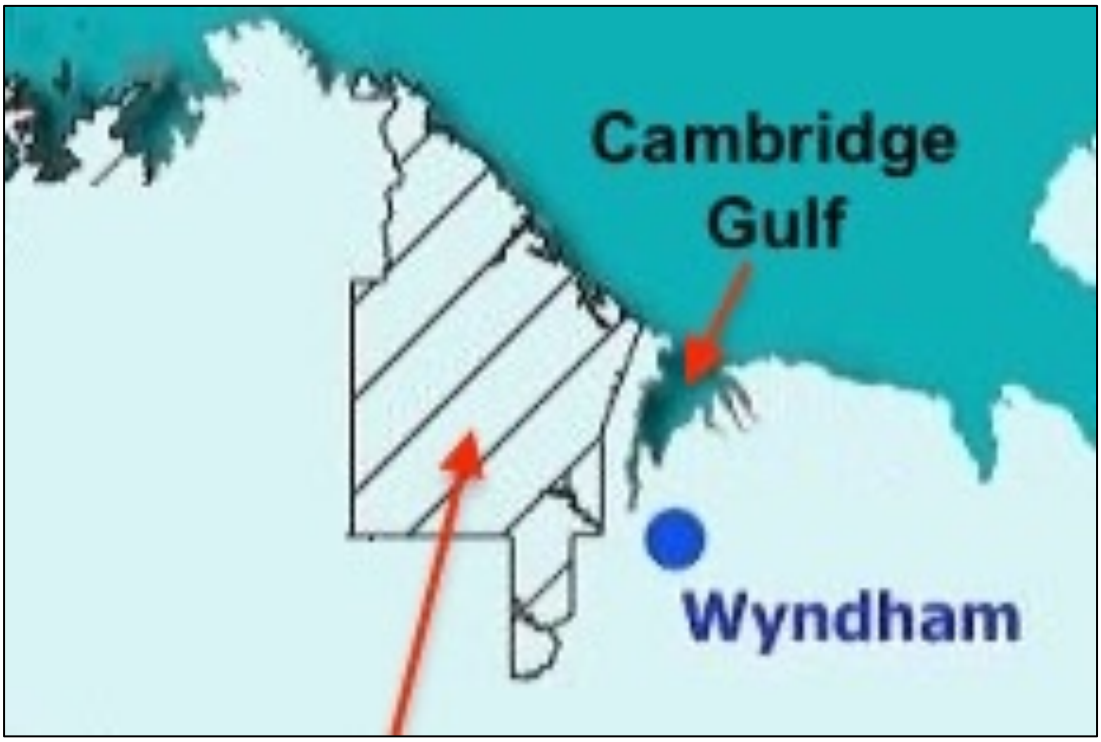


FIGURE 12.6: *The Balanggarra IPA (source: KLC)*

REFERENCES

Alongi, D.M., 2008. Mangrove forests: resilience, protection from tsunamis, and responses to global climate change. Estuar. Coast. Shelf Sci. 76, 1–13. https://doi.org/10.1016/ j.ecss.2007.08.024.

Alongi, D.M., 2007. The Dynamics of Tropical Mangrove Forests. Springer, Berlin, July 2007, 216 pp.

Berra, T.M. and F.J. Neira, 2003. Early Life History of the Nurseryfish, *Kurtus gulliveri* (Perciformes: Kurtidae), from Northern Australia. Copeia 2003(2), pp. 384–390.

Berg Soto, A., Marsh, H., Everingham, Y., Smith, J.N., Parra, G.J., Noad, M.: Discriminating between the vocalizations of Indo-Pacific humpback and Australian snubfin dolphins in Queensland. J. Acoust. Soc. Am. 136, 930 (2014)

Brown, Alexander & Smith, Joshua & Salgado Kent, Chandra & Marley, Sarah & Allen, Simon & Thiele, Deborah & Bejder, Lars & Erbe, Christine & Chabanne, Delphine. (2017). Relative abundance, population genetic structure and passive acoustic monitoring of Australian snubfin and humpback dolphins in regions within the Kimberley. 10.13140/RG.2.2.17354.06082.

Brown, A.M., Smith, J., Salgado-Kent, C., Marley, S., Allen, S.J., Thiele, D., Bejder, L., Erbe, C. & Chabanne, D. (2016). Relative abundance, population genetic structure and acoustic monitoring of Australian snubfin and humpback dolphins in regions within the Kimberley. Report of Project 1.2.4 prepared for the Kimberley Marine Research Program, Western Australian Marine Science Institution, Perth, Western Australia, 61pp plus appendices.

Bunting, P., A. Rosenqvist, L. Hilarides, R.M. Lucas, N. Thomas, T. Tadono, T.A. Worthington, M. Spalding, N.J. Murray, and L.-M. Rebelo, 2022. Global Mangrove Extent Change 1996–2020: Global Mangrove Watch Version 3.0. Remote Sensing 2022, 14, 3657. https://doi.org/10.3390/rs14153657

Cresswell, Ian & Semeniuk, Vic. (2011). Mangroves of the Kimberley coast: Ecological patterns in a tropical Ria coast setting. Journal of the Royal Society of Western Australia. 94. 213-237.
Coleman & Wright (1978), *Sedimentation in an Arid Macrotidal Alluvial River System: Ord River, Western Australia.* The Journal of Geology, Sep., 1978, Vol. 86, No. 5 (Sep., 1978), pp. 621-642

Commonwealth of Australia (2020), National Light Pollution Guidelines for Wildlife Including Marine Turtles, Seabirds and Migratory Shorebirds.

Commonwealth of Australia (2017), Recovery Plan for Marine Turtles in Australia.

DRA 2024. www.dolphinresearchaustralia.org

DBCA 2024. https://www.riverguardians.com/projects/dolphin-watch/dolphin-watch-roebuck-bay/#:~:text=In%20Western%20Australia%2C%20snubfins%20are,population%20in%20the%20Kimberley%20region.

De Jong, C.A.F., Ainslie, M.A., Dreschler, J., Jansen, E., Heemskerk, E. and W. Groen, 2010. Underwater noise of Trailing Suction Hopper Dredgers at Maasvlakte 2: Analysis of source levels and background noise. Report number TNO-DV 2010 C335.

Galaiduk, R., et al., (2018). An eco-narrative of Joseph Bonaparte Gulf Marine Park: North-west marine region. Report to the National Environmental Science Program, Marine Biodiversity Hub.

Gammon, Malindi,Scott Whiting, and Sabrina Fossette. 2023.“Vulnerability of Sea Turtle Nesting Sites toErosion and Inundation: A Decision SupportFramework to Maximize Conservation.” Ecosphere14(6): e4529. https://doi.org/10.1002/ecs2.4529ECOSPHERE 17 of 17

Gehrke, P., 2009. *Ecological Patterns & Processes in the Lower Ord Estuary.* CSIRO Water for a Healthy Country National Research Flagship.

George, Lachlan & Simpfendorfer, Colin & Heupel, Michelle. (2017). Movement and habitat use of juvenile blacktip reef sharks (Carcharhinus melanopterus) in a nearshore environment.

Gorman, C.E., 2020. Global conservation status of croaker and drum (family: Sciaenidae) and role of the Maw trade. MSc thesis, Old Dominion University, USA, Dec 2020, 97 pp.

Hale, J., 2008, Ecological Character Description of the Ord River Floodplain Ramsar Site, Report to the Department of Environment and Conservation, Perth, Western Australia.

Hanf, Daniella & Hunt, Tim & Parra, Guido. (2016). Humpback Dolphins of Western Australia: A Review of Current Knowledge and Recommendations for Future Management. Advances in Marine Biology. 73. 193-218. 10.1016/bs.amb.2015.07.004.
Marsh H.. Lloze R, Heinsohn G.E. & T. Kasuya (1989). Irrawaddy dolphin *Orcaell brevirostris*. Ridgeway S.H. & R. Harrison, eds. *Handbook of Marine Mammals. River Dolphins and the Larger Toothed Whales*. Vol 4:101-118.

Jennings, J.N., 1975. Desert dunes and estuarine fill in the Fitzroy estuary (north-western Australia). Catena 2: 215-262.

Kay Winston R. (2004) Movements and home ranges of radio-tracked *Crocodylus porosus* in the Cambridge Gulf region of Western Australia. *Wildlife Research* 31, 495-508.

Kailola, P.J, 2000. Six new species of fork-tailed catfishes (Pisces, Teleostei, Ariidae) from Australia and New Guinea. The Beagle, Records of the Museums and Art Galleries of the Northern Territory 2000; 16: 127-144

Kastelijn, R.A., M. Horvers, L. Helder-Hoek, S. Van de Voorde, R. ter Hofstede and H. van der Meij, 2017. Behavioral responses of harbor seals (*Phoca vitulina*) to FaunaGuard seal module sounds at two background noise levels. Aquatic Mammals 43(4): 347-363.

Larson, H., Chao, L., Seah, Y.G., Wong, L., Kar-Hoe, K.-H., Hadiaty, R.K., Suharti, S., Russell, B. & Shah, N.H.A. 2020. Nibea squamosa. The IUCN Red List of Threatened Species 2020: e.T49187516A49234334. https://dx.doi.org/10.2305/IUCN.UK.2020-1.RLTS.T49187516A49234334.en

Li, Songhai & Liu, Mingming & Dong, Lijun & Dong, Jianchen & Wang, Ding. (2018). Potential impacts of shipping noise on Indo-Pacific humpback dolphins and implications for regulation and mitigation: a review. Integrative Zoology. 13. 10.1111/1749-4877.12304.

Loneragan, N. et al (2002). The growth, mortality, movements and nursery habitats of red-legged banana prawns (Penaeus indicus) in the Joseph Bonaparte Gulf : project FRDC 97/105/

Lough, Janice & Lewis, Stephen & Cantin, Neal. (2015). Freshwater impacts in the central Great Barrier Reef: 1648-2011. Coral Reefs. 34. 10.1007/s00338-015-1297-8.

Lymburner, L. et al (2020) Mapping the multi-decadal mangrove dynamics of the Australian coastline. Remote Sensing of Environment. Volume 238, 1 March 2020, 111185

Marley, S.A., Salgado Kent, C.P., Erbe, C. and Thiele D. (2017) A Tale of Two Soundscapes: Comparing the acoustic characteristics of urban versus pristine coastal dolphin habitats in Western Australia. *Acoustics Australia,* 45: 159-178. DOI: 10.1007/s40857-017-0106-7

Marsh H.. Lloze R, Heinsohn G.E. & T. Kasuya (1989). Irrawaddy dolphin *Orcaell brevirostris*. Ridgeway S.H. & R. Harrison, eds. *Handbook of Marine Mammals. River Dolphins and the Larger Toothed Whales*. Vol 4:101-118.

McKenzie, LJ, Yoshida, RL & Unsworth, R (Eds) (2011) Seagrass-Watch News. Issue 43, April 2011. Seagrass-Watch HQ. 28pp.

McMahon K, Statton J and Lavery P (2017) Seagrasses of the north west of Western Australia: biogeography and considerations for dredging-related research. Report of Theme 5 - Project 5.1.2 prepared for the Dredging Science Node, Western Australian Marine Science Institution, Perth, Western Australia. 39 pp.

Mount R, Bricher P (2008) Estuarine, Coastal and Marine (ECM) National Habitat Mapping Project. ECM National Habitat Map Series User Guide. Department of Climate Change and University of Tasmania.

Mount R, Bricher P, Newton J (2007) National Intertidal/Subtidal Benthic (NISB) Habitat Classification Scheme Version 0.1 October 2007ID - 4750.

NAGD (2009). National Assessment Guidelines for Dredging. Commonwealth Government.

Paling, E.I., K.T. Kobryn and G. Humphreys, 2008. Assessing the extent of mangrove change caused by Cyclone Vance in the eastern Exmouth Gulf, northwestern Australia. Estuarine, Coastal and Shelf Science 77: 603-613.

Parra, G.J., & D. Cagnazzi (2016). Conservation Status of the Australian Humpback Dolphin (Sousa sahulensis) Using the IUCN Red List Criteria. *Advances in Marine Biology*. 73:157-192.

Parijs, S.M.Van, Parra, G.J., Corkeron, P.J.: Sounds produced by Australian Irrawaddy dolphins. *Orcaella brevirostris*. J. Acoust. Soc. Am. 108, 1938–1940 (2000)

Parra, G. & Jefferson, T. (2017) in *Encyclopedia of Marine Mammals* Vol. Third Edition (eds B Würsig, J.G.M. Thewissen, & K.M. Kovacs) (Academic Press, Elsevier, 2017

Parslow, J., Margvelashvili, N., Palmer, D., Revill, A., Robson, B., Sakov, P., Volkman, J., Watson, R., and Webster, I. 2003. The Response of the Lower Ord River and Estuary to Management of Catchment Flows and Sediment and Nutrient Loads: Final Science Report. 2003. CSIRO Marine Research / Land and Water Australia.

Pember, M.B., 2006. Characteristics of fish communities in coastal waters of north-western Australia, including the biology of the threadfin species *Eleutheronema tetradactylum* and *Polydactylus macrochir*. PhD thesis, Murdoch University, 297 pp.

Plaganyi, Eva & Deng, Roy & Hutton, Trevor & Kenyon, Rob & Lawrence, Emma & Upston, Judy & Miller, Margaret & Moeseneder, Christian & Pascoe, Sean & Blamey, Laura & Eves, Stephen. (2020). From past to future: understanding and accounting for recruitment variability of Australia's redleg banana prawn (Penaeus indicus) fishery. ICES Journal of Marine Science. 78. 10.1093/icesjms/fsaa092.

Reine, K.J., D.G. Clarke and C. Dickerson, 2014. Characterization of underwater sounds produced by hydraulic and mechanical dredging operations. Journal of the Acoustical Society of America 135(5): 3280–3294.

Robinson, Stephen & Theobald, Pete & Hayman, Gary & Wang, Lian & Lepper, Paul & Humphrey, Victor & Mumford, Samantha. (2011). Measurement of underwater noise arising from marine aggregate dredging operations.

Robson, B.J. et al., 2008. Response of the Lower Ord River and Estuary to Changes in Flow and Sediment and Nutrient Loads. CSIRO Water for a Healthy Country National Research Flagship.

Rome, B.M. and S.J. Newman, 2010. North Coast Fish Identification Guide. Department of Fisheries, Perth, Western Australia, 89 pp. (see: https://www.fish.wa.gov.au/documents/occasional_publications/fop080.pdf)

Russell, D.J., 1990. Some aspects of the biology of the Barramundi, *Lates calcarifer* (Bloch) in Eastern Queensland. Masters by Research thesis, Queensland University of Technology.

Russell, D.J., 1987. Review of juvenile barramundi (*Lates calcarifer*) wildstocks in Australia. In 'Management of Wild and Cultured Sea Bass/Barramundi (Lates calcarifer)'. (Eds J. W. Copland and D. L. Grey.) Vol. 20, pp. 44–49. (ACIAR: Darwin, NT.)

Suedel, B.C., A.D. McQueen, J.L. Wilkens and M.P. Fields, 2019. Evaluating Effects of Dredging-Induced Underwater Sound on Aquatic Species: A Literature Review. US Army Corps of Engineers, DOER Technical Report ERDC/EL TR-19-18, September 2019, 138 pp.

Southall, B.L., Bowles, A.E., Ellison, W.T., Finneran, J.J., Gentry, R.L., Greene Jr, C.R., Kastak, D., Ketten, D.R., Miller, J.H., Nachtingall, P.E., Richardson, W.J., Thomas, J.A. & Tyack, P.L., (2007), Marine Mammal Noise Exposure Criteria: Initial Scientific Recommendations, Aquatic Mammals 33: 411-509.

Thom, B.J., L.D. Wright and J.M. Coleman, 1975. Mangrove ecology and deltaic-estuarine geomorphology: Cambridge Gulf-Ord River, Western Australia. Journal of Ecology 63(1): 203-232.

Thums, Michele & Rossendell, Jason & Fisher, Rebecca & Guinea, Michael. (2019). Nesting ecology of flatback sea turtles Natator depressus from Delambre Island, Western Australia. Marine and Freshwater Research. 71. 10.1071/MF19022.

WA Fisheries 2013, Fisheries Fact Sheet - Mud Crab.

Walker, D., Wella, F., & Hanley, T. (1996). Survey of the marine biota of the eastern Kimberley, Western Australia. University of WA, WA Museum and Museum of the Northern Territory.

Wenger, Amelia & Harvey, Euan & Wilson, Shaun & Rawson, Chris & Newman, Stephen & Clarke, Douglas & Saunders, Benjamin & Browne, Nicola & Travers, Michael & Mcilwain, Jennifer & Erftemeijer, Paul & Hobbs, Jean-Paul & Mclean, Dianne & Depczynski, Martial & Evans, Richard. (2017). A critical analysis of the direct effects of dredging on fish. Fish and Fisheries. 18. 10.1111/faf.12218.

Whiting, A., Thomson, A., Chaloupka, M., & Limpus, C. (2008). Seasonality, abundance and breeding biology of one of the largest populations of nesting flatback turtles, Natator depressus: Cape Domett, Western Australia. *Australian Journal of Zoology*, *2008*(5), 297-303.

Whittock, Paul & Pendoley, Kellie & Hamann, Mark. (2014). Inter-nesting distribution of flatback turtles Natator depressus and industrial development in Western Australia. Endangered Species Research. 26. 25-38. 10.3354/esr00628.

WMI (2012) Results of Spotlight and Helicopter Surveys of Crocodiles in Cambridge Gulf, Lake Argyle and Lake Kununurra, 2012. Wildlife Management International, Karama, NT 0813

WODA, 2015. Report on a WODA Underwater Sound Workshop in Paris, France, 26 March (2015). Compiled by Gerald van Raalte, WODA Expert Group Underwater Sound, Boskalis Hydronamic, Netherlands, 5 pp.

Wolanski, E., K. Moore, S. Spagnol, N. d'Adamo, and C. Pattiaratchi, 2001. Rapid, human-induced siltation of the macro-tidal Ord River Estuary, Western Australia. Estuarine, Coastal & Shelf Science 53(5): 717-732.

Wolanski, E., S. Spagnol and D. Williams, (2004). The impact of damming the Ord River on the fine sediment budget in Cambridge Gulf, Northwestern Australia. Journal of Coastal Research 20(3): 801-807.

Yamamoto, Kristina & Anderson, Sharolyn & Sutton, Paul. (2015). Measuring the Effects of Morphological Changes to Sea Turtle Nesting Beaches over Time with LiDAR Data. Journal of Sea Research. 104. 10.1016/j.seares.2015.07.001.

ANNEX 1: SAND RESOURCE ASSESSEMENT REPORT

See separate report.

File Name: Referral Report No. 2 - ANNEX 1 - SAND ASSESSMENT - Boskalis Cambridge Gulf.

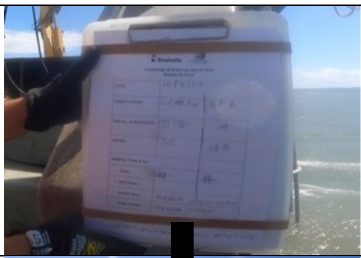
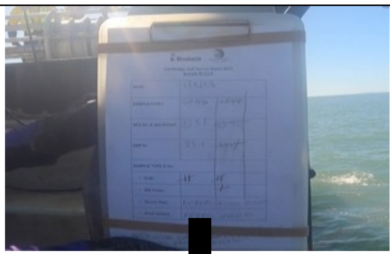
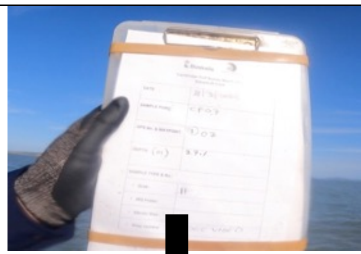
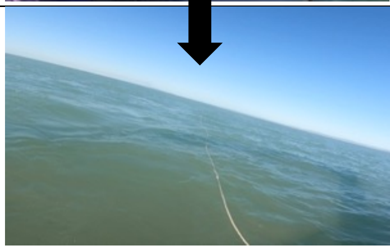
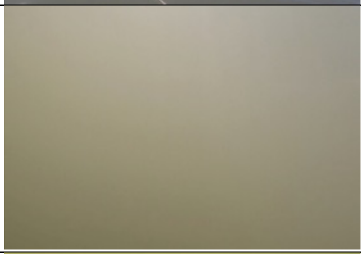
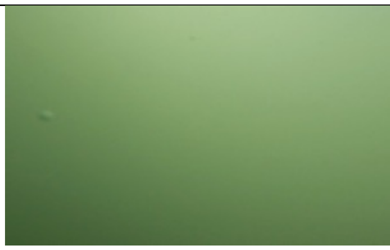
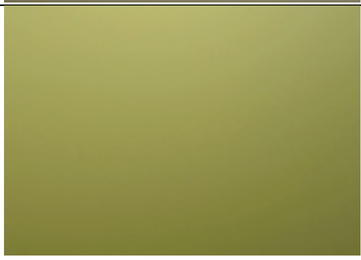
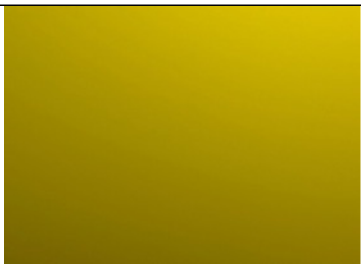
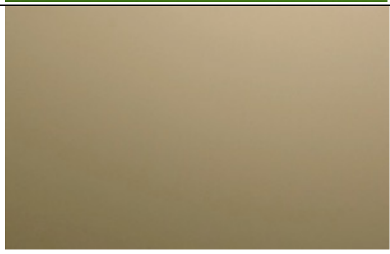
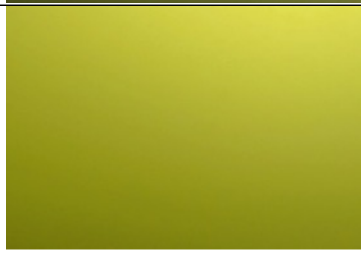
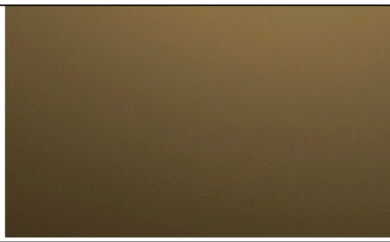
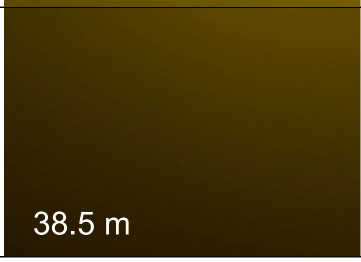
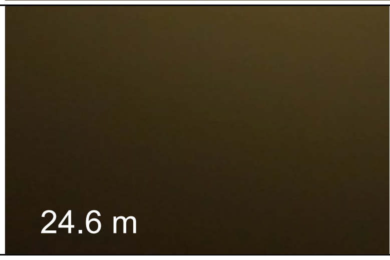
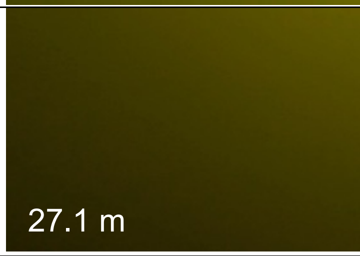
ANNEX 2: MSCIENCE BENTHIC MAPPING METHODS STATEMENT

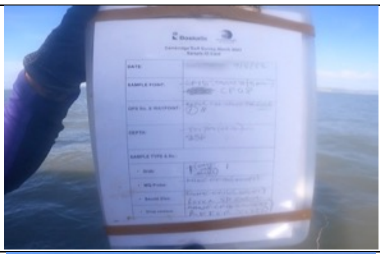
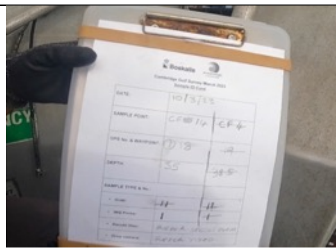
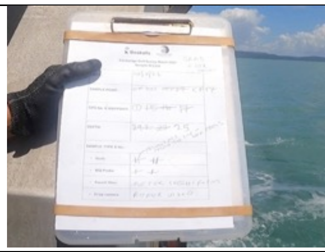
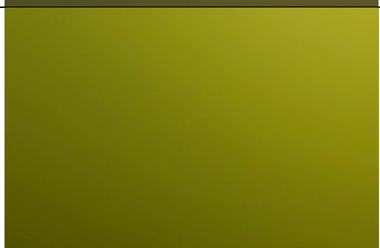
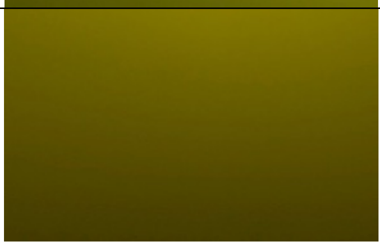
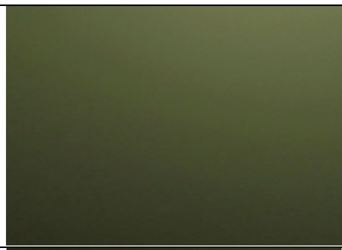
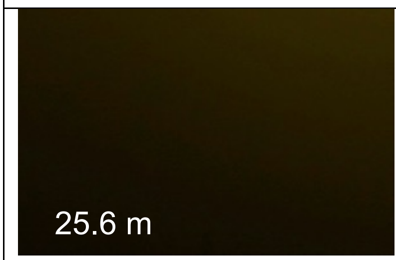
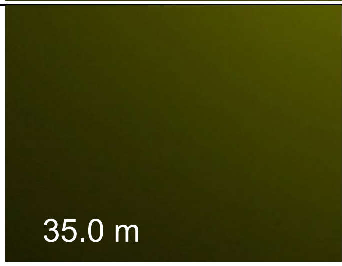
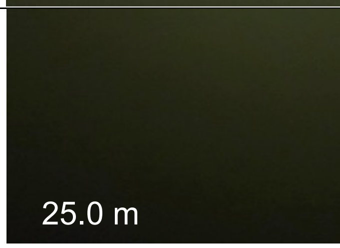
See separate report.

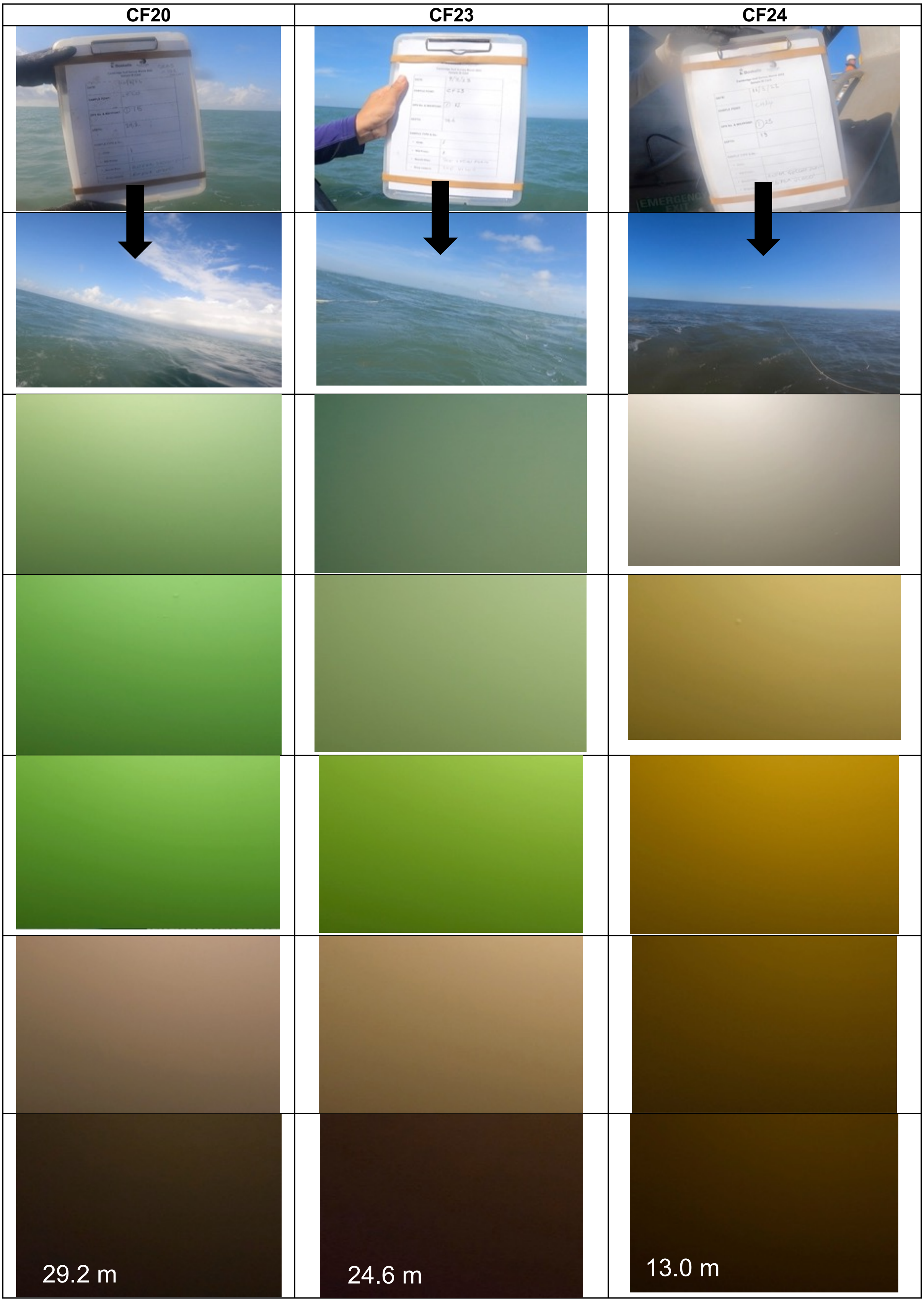
File Name: Referral Report No. 2 - ANNEX 2 - MSCIENCE BCH METHODS - Boskalis Cambridge Gulf.

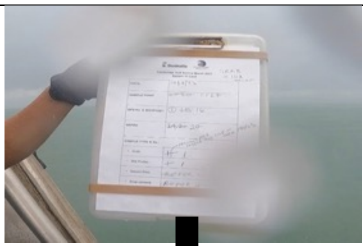
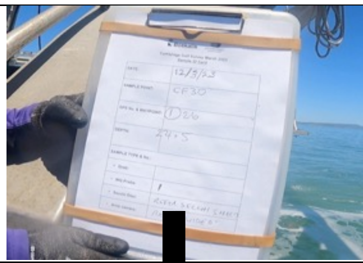
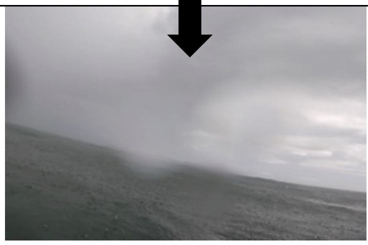
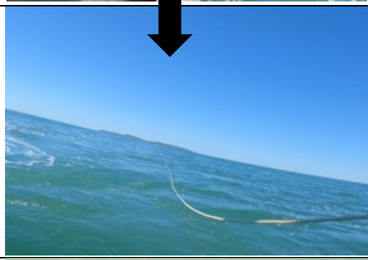
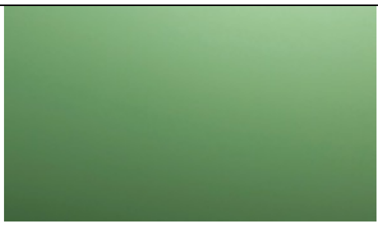
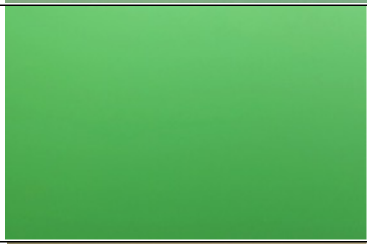
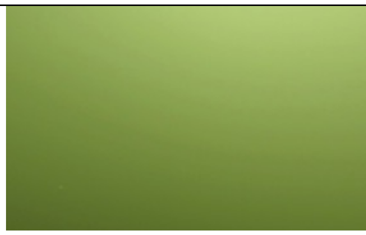
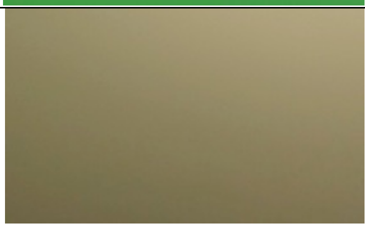
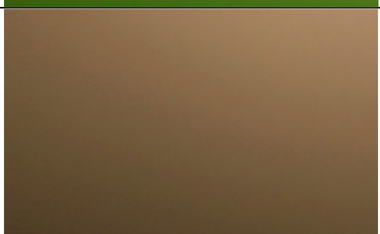
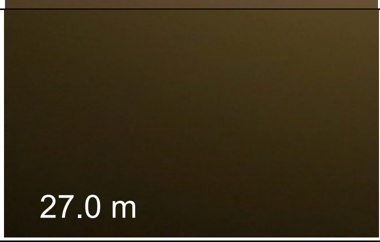
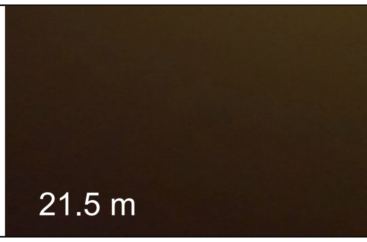
ANNEX 3: DROP CAMERA VIDEO EXTRACTS

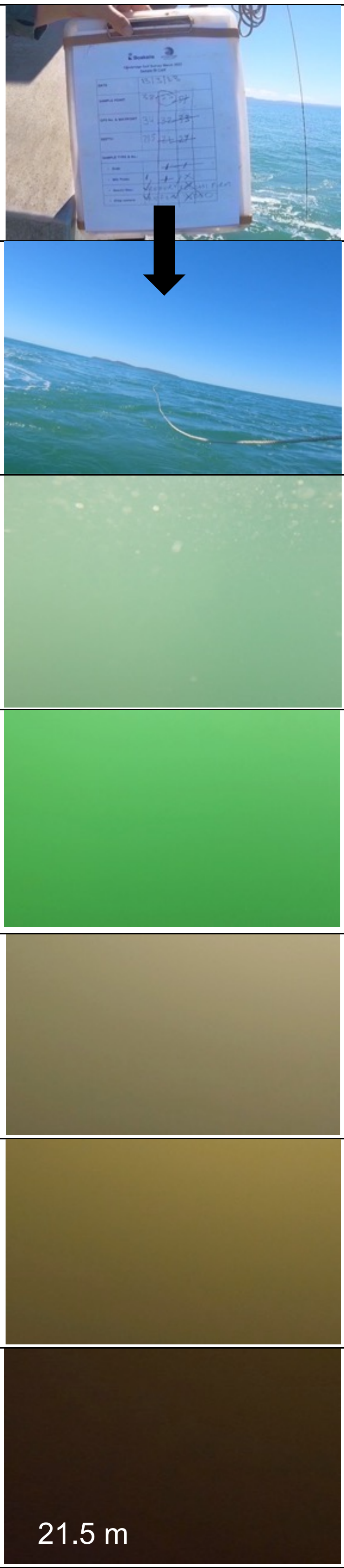
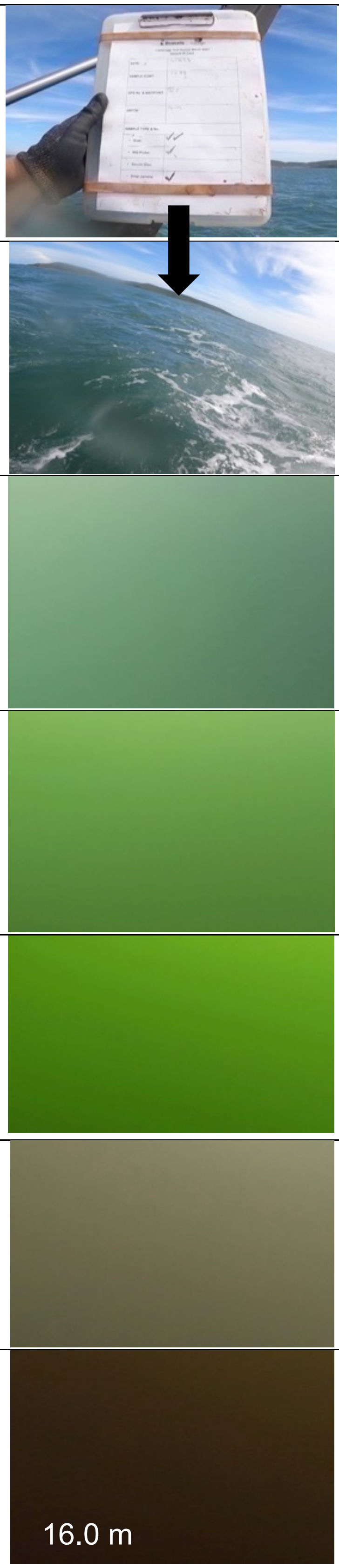
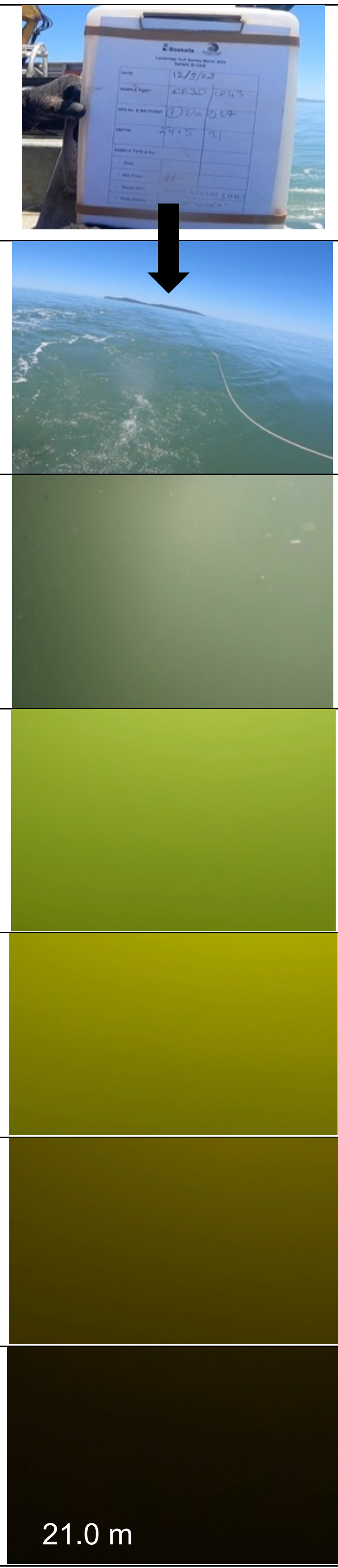
- From drop camera videos taken March 2023.
- The raw videos for all 17 sites in March 2023 and 117 sites in July-August 2023 are archived and can be made available to regulatory agencies if required.
- There are also drop-camera videos from a control location ~50 km offshore from CG in Joseph Bonaparte Gulf, where waters are clearer than in CG, and where seabed habitat was visible, that can be made available.

CF04	CF06	CF07
		
		
		
		
		
		
		

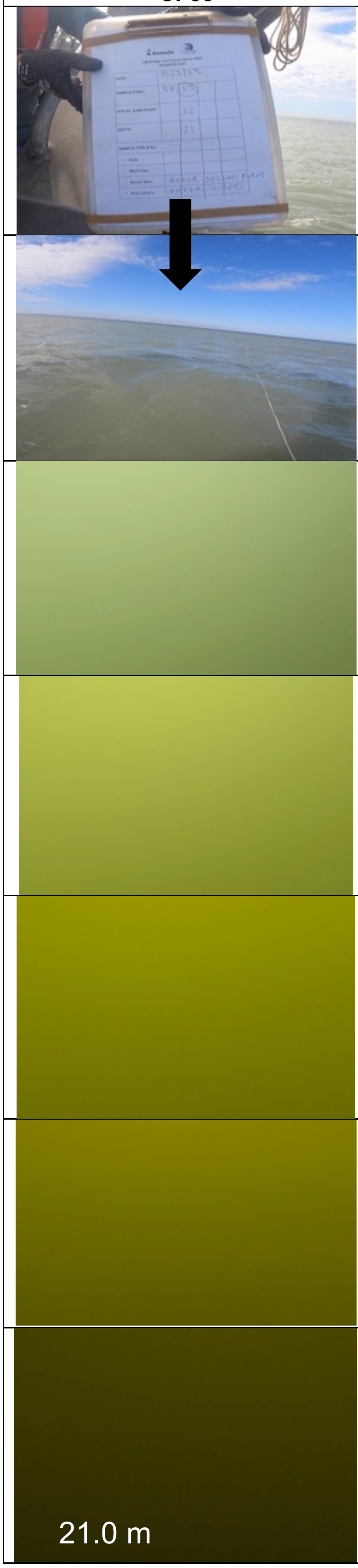
CF08	CF14	CF17
		
		
		
		
		
		
		


CF20
CF23
CF24
29.2 m
24.6 m
13.0 m

CF27	CF29	CF30
		
		
		
		
		
		
		

CF33	CF39	CF43
		

CF55



ANNEX 4: DRY-SEASON SAMPLE POINT SPECS

- Figure A.4.1 shows the locations of all 105 sampling points in Cambridge Gulf and all 27 sampling points at King Shoals.
- Table A.4.1 summarizes key data from the following Tables A.4.3 and A.4.4.
- Table A.4.2 lists the coordinates for each sampling point shown on Figure A.4.1.
- Table A.4.3 lists the following data for each sampling point in Cambridge Gulf from CG01 to CG105:
  - Date sampled.
  - Sample Point Code.
  - Grab Replicate (A, B C) including ID of sites where <3 grabs replicates were taken.
  - Dop camera (Y = deployed / N = not-deployed).
  - WQ-YSI (Water Quality YSI multi-parameter sonde) (Y = deployed / N = not deployed).
  - Niskin (water samples for Total Suspended Solids & Chlorophyll analysis) (Y = deployed / N = not deployed).
  - NADG Sample (sediment collected for chemical analysis (Y = collected / N = not collected).
  - Biota (found in benthic grab sample) (Y = yes / N = no).
  - Notes (mainly on any biota found)
  - Sediment type (from visual description of the grab return).
  - Depth (to seabed, as measured by the vessel's depth sounder at the time of sampling. Note the tidal range is 8 m).
- Table A.4.4 lists the same data as Table A.4.3 but for King Shoals.

TABLE A.4.1: *Summary of key data from Tables A.4.3 and A.4.4 below.*

Parameter	Cambridge Gulf (CG)	King Shoals (KS)	CG & KS combined
Total number of sample points:	105	27	132
No. of sample points where 3 replicate grabs deployed:	88 (x 3 = 264 grabs)	25 (x 3 = 75 grabs)	113
No. of sample points where 2 replicate grabs deployed:	Nil	2 (x 2 = 4 grabs)	2
No. of sample points where 1 replicate grab deployed:	17	Nil	17
No. of sample points where no grabs deployed:	Nil	Nil	Nil
Total number of grabs deployed:	264 + 17 = 281	75 + 4 = 79	281 + 79 = 360
No. of sampling points that returned biota:	46	14	60
Percentage of sampling points that returned biota:	46 / 105 = 44%	14 / 27 = 52%	60 / 132 =45%
No. of grabs that returned biota:	94	23	117
Percentage of grabs that returned biota:	94 / 281 = 33%	23 / 79 = 29%	117 / 360 = 32%
No. of sample points where drop camera deployed:	90	27	117 (+18 in Jul 23)
No. of sample points where YSI multi parameter sonde deployed:	46	20	66
No. of sample points where Niskin water samples collected:	24	3	27
No. of sample points where sediment collected for NADG analysis:	21	N/a	21

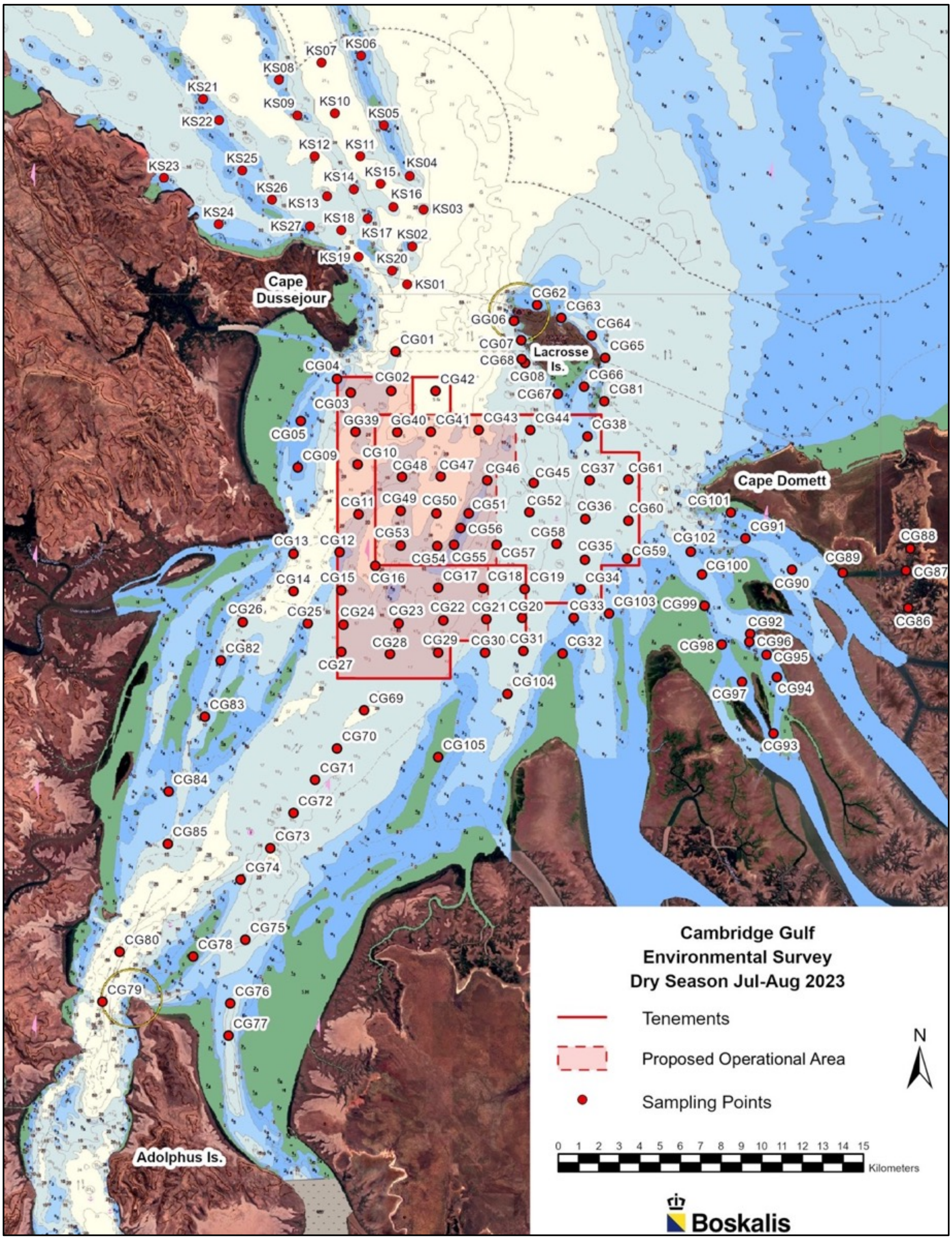


FIGURE A.4.1 - Dry-season: *Locations of the 105 benthic grab sampling sites in Cambridge Gulf from CG01 to CG105 and the 27 sites at King Shoals from KS01 to KS27 (total dry-season sites = 132).*

TABLE A.4.2: *Coordinates for each sampling point shown on Figure A.4.1 above.*

GPX files are archived and can be provided to regulatory agencies if required.

Cambridge Gulf Dry-season Jul-Aug 2023		
Sample Point	**Lat (S)**	**Long (E)**
CG01	-14.755375	128.242403
CG02	-14.772871	128.240412
CG03	-14.773539	128.222672
CG04	-14.76746	128.21653
CG05	-14.786129	128.200624
GG06	-14.741898	128.294741
CG07	-14.750301	128.297859
CG08	-14.760468	128.299595
CG09	-14.806734	128.199234
CG10	-14.805392	128.225628
CG11	-14.827334	128.226066
CG12	-14.844128	128.217604
CG13	-14.844916	128.197299
CG14	-14.861513	128.197393
CG15	-14.861136	128.21851
CG16	-14.85017	128.23345
CG17	-14.859984	128.261272
CG18	-14.860073	128.281041
CG19	-14.860474	128.299531
CG20	-14.873245	128.298224
CG21	-14.873735	128.282554
CG22	-14.874419	128.263587
CG23	-14.875616	128.243649
CG24	-14.876205	128.219414
CG25	-14.875768	128.203677
CG26	-14.87513	128.174855
CG27	-14.888171	128.218463
CG28	-14.889139	128.239979
CG29	-14.888541	128.261145
CG30	-14.888672	128.281948
CG31	-14.887914	128.298831
CG32	-14.88896	128.316181
CG33	-14.873153	128.321164
CG34	-14.860769	128.324099
CG35	-14.847484	128.326092
CG36	-14.829582	128.326294
CG37	-14.812381	128.328136

Cambridge Gulf Dry-season Jul-Aug 2023		
Sample Point	**Lat (S)**	**Long (E)**
CG38	-14.792915	128.327115
GG39	-14.790802	128.224805
GG40	-14.791124	128.243141
CG41	-14.790856	128.258032
CG42	-14.772894	128.260038
CG43	-14.790052	128.279084
CG44	-14.790176	128.301998
CG45	-14.813469	128.303425
CG46	-14.812345	128.282911
CG47	-14.810652	128.262323
CG48	-14.81085	128.245257
CG49	-14.825819	128.244685
CG50	-14.826948	128.260547
CG51	-14.826948	128.274685
CG52	-14.82652	128.301599
CG53	-14.841224	128.244686
CG54	-14.841459	128.260894
CG55	-14.840835	128.268333
CG56	-14.833469	128.271026
CG57	-14.84083	128.287179
CG58	-14.840437	128.313602
CG59	-14.846914	128.344641
CG60	-14.830246	128.345205
CG61	-14.811995	128.345188
CG62	-14.734782	128.304877
CG63	-14.740539	128.315674
CG64	-14.748281	128.329054
CG65	-14.758109	128.334913
CG66	-14.770986	128.325655
CG67	-14.774077	128.314091
CG68	-14.758821	128.298165
CG69	-14.9141	128.228531
CG70	-14.930954	128.216629
CG71	-14.944961	128.206915
CG72	-14.959606	128.197295
CG73	-14.975079	128.187147
CG74	-14.988994	128.173961
CG75	-15.015622	128.176117
CG76	-15.043857	128.169324

Cambridge Gulf Dry-season Jul-Aug 2023		
Sample Point	**Lat (S)**	**Long (E)**
CG77	-15.058111	128.168605
CG78	-15.023113	128.153082
CG79	-15.043113	128.112901
CG80	-15.021038	128.120596
CG81	-14.777326	128.334659
CG82	-14.891961	128.165132
CG83	-14.916931	128.158234
CG84	-14.950073	128.142124
CG85	-14.973149	128.141875
CG86	-14.868817	128.468941
CG87	-14.852249	128.467901
CG88	-14.842642	128.469828
CG89	-14.853174	128.440031
CG90	-14.85201	128.417601
CG91	-14.838073	128.396971
CG92	-14.880338	128.399141
CG93	-14.924371	128.409433
CG94	-14.899483	128.410831
CG95	-14.889581	128.406331
CG96	-14.883825	128.398747
CG97	-14.901471	128.395399
CG98	-14.885108	128.386543
CG99	-14.867979	128.378837
CG100	-14.854029	128.377835
CG101	-14.826593	128.390482
CG102	-14.843908	128.372864
CG103	-14.871383	128.33663
CG104	-14.906795	128.291825
CG105	-14.934812	128.26132

King Shoals Dry-season Jul-Aug 2023		
Sample Point	**Lat (S)**	**Long (E)**
KS01	-14.725731	128.247512
KS02	-14.708867	128.249909
KS03	-14.692678	128.254814
KS04	-14.67775	128.248724
KS05	-14.655296	128.237223
KS06	-14.624469	128.227123
KS07	-14.627553	128.209677
KS08	-14.635241	128.190808
KS09	-14.651004	128.199013
KS10	-14.649979	128.215609
KS11	-14.66907	128.226849
KS12	-14.669022	128.2066
KS13	-14.686757	128.212121
KS14	-14.683681	128.223886
KS15	-14.68124	128.23567
KS16	-14.691501	128.241457
KS17	-14.696604	128.230044
KS18	-14.701764	128.218467
KS19	-14.71357	128.2261
KS20	-14.719545	128.240933
KS21	-14.643652	128.157345
KS22	-14.653129	128.164513
KS23	-14.678612	128.140163
KS24	-14.699072	128.164343
KS25	-14.675203	128.174649
KS26	-14.688214	128.187917
KS27	-14.699946	128.204597

TABLE A.4.3: *Specifications for each benthic grab sampling point in Cambridge Gulf - dry-season Jul-Aug 2023*

	Date	Sample Point	Grab Replicate	Drop camera	WQ YSI	Niskin	NADG Sample	Biota	Notes	Sediment Type	Depth (m)
1	17/7/2023	**CG01**	A	Y	Y	Y	Y	N	No biota	Sand	30
			B	N	N	N	Combined A	N	No biota	Sand	
			C	N	N	N	"	N	No biota	Sand	
2	17/7/2023	**CG02**	A	Y	N	N	N	N	No biota	Sand	24
			B	Y	N	N	N	N	No biota	Sand	
			C	N	N	N	N	N	No biota	Sand	
3	17/7/2023	**CG03**	A	Y	N	N	N	Y	Juvenile spanner crab - see pic	Sand	20
			B	Y	N	N	N	N	No biota	Sand	
			C	N	N	N	N	N	No biota	Sand	
4	17/7/2023	**CG04**	A	Y	Y	Y	N	Y	Juvenile spanner crab	Sand	13
			B	N	N	N	Y	Y	See biota sample	Sand	
			C	N	N	N	N	Y	See biota sample	Sand	
5	17/7/2023	**CG05**	A	Y	N	N	N	Y	See biota sample	Clay	8
			B	N	N	N	N	Y	See biota sample	Clay	
			C	N	N	N	N	N	No biota	Clay	
6	18/7/2023	**CG06**	A	Y	N	N	N	Y	Urchin (photo, not sampled)	Clay & small % sand	17
			B	N	N	N	N	N	No biota	Clay & small % sand	
			C	N	N	N	N	Y	Polychaete & bryozoan	Clay & small % sand	
7	18/7/2023	**CG07**	A	Y	N	N	N	Y	Tubeworms	Clay & small % gravel	20
			B	N	N	N	N	N	No biota	Clay & small % gravel	
			C	N	Y	Y	N	N	No biota	Clay & small % gravel	
8	18/7/2023	**CG08**	A	Y	N	N	N	Y	Soft coral	Clay / gravel	20
			B	N	N	N	N	Y	Various (brittle star, hydroids etc)	Clay / gravel	
			C	N	N	N	N	Y	Various (brittle star, hydroids etc)	Clay / gravel	
9	18/7/2023	**CG09**	A	Y	Y	Y	N	Y	Polychaete	Clay	6
			B	N	N	N	N	Y	Bivalve, small worm	Clay	

	Date	Sample Point	Grab Replicate	Drop camera	WQ YSI	Niskin	NADG Sample	Biota	Notes	Sediment Type	Depth (m)
			C	N	N	N	N	Y	Polychaete	Clay	
10	18/7/2023	**CG10**	A	Y	Y	Y	N	N	No biota	Sand & small % shell grit	20
			B	N	N	N	N	N	No biota	Sand & small % shell grit	
			C	N	N	N	N	Y	Small hermit crab in shell	Sand & small % shell grit	
11	18/7/2023	**CG11**	A	N	N	N	Y	Y	See biota sample	Sand	17
			B	Y	N	N	Combined A	N	No biota	Sand	
			C	N	N	N	"	N	No biota	Sand	
12	18/7/2023	**CG12**	A	Y	Y	Y	N	N	No biota	Sand	13
			B	N	N	N	N	N	No biota	Sand	
			C	N	N	N	N	N	No biota	Sand	
13	18/7/2023	**CG13**	A	Y	N	N	N	N	No biota	Sand	16
			B	N	N	N	N	N	No biota	Sand	
			C	N	N	N	N	N	No biota	Sand	
14	19/7/2023	**CG14**	A	Y	Y	Y	N	Y	See biota sample	Clay & small % gravel	40
			B	N	N	N	N	Y	See biota sample	Clay & small % gravel	
			C	N	N	N	N	Y	See biota sample	Clay & small % gravel	
15	19/7/2023	**CG15**	A	Y	Y	Y	Y	N	No biota	Fine sand / gravel	19
			B	N	N	N	Combined A	Y	Soft coral, various biota	Clay / gravel	
			C	N	N	N	"	Y	Hydroids	Clay / gravel	
16	19/7/2023	**CG16**	A	Y	Y	Y	N	N	No biota	Sand	8
			B	N	N	N	N	N	No biota	Sand	
			C	N	N	N	N	N	No biota	Sand	
17	19/7/2023	**CG17**	A	Y	Y	Y	Y	N	No biota	Sand	17
			B	N	N	N	Combined A	N	No biota	Sand	
			C	N	N	N	"	N	No biota	Sand	
18	19/7/2023	**CG18**	A	Y	Y	Y	N	Y	Small yellow tunicates	Sand & small % shell grit	18
			B	N	N	N	N	Y	Juvenile spanner crab	Sand & small % shell grit	

	Date	Sample Point	Grab Replicate	Drop camera	WQ YSI	Niskin	NADG Sample	Biota	Notes	Sediment Type	Depth (m)
			C	N	N	N	N	N	No biota	Sand & small % shell grit	
19	19/7/2023	**CG19**	A	Y	Y	Y	N	N	No biota	Clay & small % gravel	15
			B	N	N	N	N	Y	2 small brittle-stars	Clay & small % gravel	
			C	N	N	N	N	N	No biota	Clay & small % gravel	
20	19/7/2023	**CG20**	A	N	Y	Y	Y	N	No biota	Clay / shell grit	18
			B	Y	N	N	Combined A	Y	See biota sample	Clay / shell grit	
			C	N	N	N	"	N	No biota	Clay / shell grit	
21	19/7/2023	**CG21**	A	Y	Y	Y	N	N	No biota	Clay / shell grit / gravel	18
			B	N	N	N	N	N	No biota	Clay / shell grit / gravel	
			C	N	N	N	N	Y	See biota sample	Clay / shell grit / gravel	
22	19/7/2023	**CG22**	A	Y	N	N	Y	Y	Hydroids	Clay / gravel	13
			B	N	N	N	Combined A	Y	Hydroids	Clay / gravel	
			C	N	N	N	"	Y	Hydroids	Clay / gravel	
23	19/7/2023	**CG23**	A	Y	N	N	N	N	No biota	Sand	20
			B	N	N	N	N	N	No biota	Sand	
			C	N	N	N	N	N	No biota	Sand	
24	20/7/2023	**CG24**	A	Y	N	N	N	Y	See biota sample	Clay / gravel	24
			B	N	N	N	N	Y	See biota sample	Clay / gravel	
			C	N	N	N	N	Y	See biota sample	Clay / gravel	
25	20/7/2023	**CG25**	A	Y	N	N	N	N	No biota	Sand	5
			B	N	N	N	N	N	No biota	Sand	
			C	N	N	N	N	Y	See biota sample	Sand	
26	20/7/2023	**CG26**	A	Y	Y	Y	Y	N	No biota	Sand & small % shell grit	21-28
			B	N	N	N	N	N	No biota	Sand & small % shell grit	
			C	N	N	N	N	N	No biota	Sand & small % shell grit	
27	20/7/2023	**CG27**	A	Y	N	N	Y	Y	See biota sample	Clay / gravel	20
			B	N	N	N	Combined A	Y	See biota sample	Clay / gravel	

	Date	Sample Point	Grab Replicate	Drop camera	WQ YSI	Niskin	NADG Sample	Biota	Notes	Sediment Type	Depth (m)
			C	N	N	N	"	Y	See biota sample	Clay / gravel	
28	20/7/2023	CG28	A	Y	N	N	N	N	No biota	Sand	21
			B	N	N	N	N	N	No biota	Sand	
			C	N	N	N	N	N	No biota	Sand	
29	20/7/2023	CG29	A	Y	N	N	Y	Y	See biota sample	Clay / gravel	20
			B	N	N	N	Combined A	Y	See biota sample	Clay / gravel	
			C	N	N	N	"	Y	See biota sample	Clay / gravel	
30	20/7/2023	CG30	A	Y	N	N	Y	N	No biota	Clay	12
			B	N	N	N	Combined A	N	No biota	Clay	
			C	N	N	N	"	N	No biota	Clay	
31	20/7/2023	CG31	A	Y	N	N	N	N	No biota	Clay	11
			B	N	N	N	N	N	No biota	Clay	
			C	N	N	N	N	N	No biota	Clay	
32	20/7/2023	CG32	A	Y	N	N	N	N	No biota	Sand	3
			B	N	N	N	N	Y	See biota sample	Sand	
			C	N	N	N	N	N	No biota	Sand	
33	20/7/2023	CG33	A	Y	N	N	N	N	No biota	Sand	3
			B	N	N	N	N	N	No biota	Sand	
			C	N	N	N	N	N	No biota	Sand	
34	20/7/2023	CG34	A	Y	N	N	Y	N	No biota	Clay / shell grit	10
			B	N	N	N	Combined A	N	No biota	Clay / shell grit	
			C	N	N	N	"	N	No biota	Clay / shell grit	
35	20/7/2023	CG35	A	N	N	N	N	N	No biota	Sand & small % clay	10
			B	N	N	N	N	N	No biota	Sand & small % clay	
			C	N	N	N	N	N	No biota	Sand & small % clay	
36	20/7/2023	CG36	A	N	N	N	N	Y	See biota sample	Clay / shell grit / gravel	15
			B	N	N	N	N	Y	See biota sample	Clay / shell grit / gravel	

	Date	Sample Point	Grab Replicate	Drop camera	WQ YSI	Niskin	NADG Sample	Biota	Notes	Sediment Type	Depth (m)
			C	N	N	N	N	Y	See biota sample	Clay / shell grit / gravel	
37	20/7/2023	**CG37**	A	Y	Y	Y	Y	N	No biota	Clay / shell grit / gravel	17
			B	N	N	N	Combined A	N	No biota	Clay / shell grit / gravel	
			C	N	N	N	"	Y	Shrimp & crab	Clay / shell grit / gravel	
38	20/7/2023	**CG38**	A	Y	N	N	N	N	No biota	Sand & small % shell grit	15
			B	N	N	N	N	N	No biota	Sand & small % shell grit	
			C	N	N	N	N	N	No biota	Sand & small % shell grit	
39	21/7/2023	**CG39**	A	Y	N	N	Y	N	No biota	Sand	27
			B	N	N	N	Combined A	Y	See biota sample	Sand	
			C	N	N	N	"	N	No biota	Sand	
40	21/7/2023	**CG40**	A	Y	N	N	N	N	No biota	Sand & small % shell grit	43
			B	N	N	N	N	N	No biota	Sand & small % shell grit	
			C	N	N	N	N	N	No biota	Sand & small % shell grit	
41	21/7/2023	**CG41**	A	Y	N	N	Y	Y	See biota sample	Clay / shell grit / gravel	33
			B	N	N	N	Combined A	Y	See biota sample	Clay / shell grit / gravel	
			C	N	N	N	"	Y	Copepods & other small invertebrates.	Clay / shell grit / gravel	
42	21/7/2023	**CG42**	A	Y	N	N	N	Y	See biota sample	Clay / gravel	45
			B	N	N	N	N	Y	See biota sample	Clay / gravel	
			C	N	N	N	N	Y	See biota sample	Clay / gravel	
43	21/7/2023	**CG43**	A	Y	N	N	N	N	No biota	Clay / gravel	30
			B	N	N	N	N	N	No biota	Clay / gravel	
			C	N	N	N	N	N	No biota	Clay / gravel	
44	21/7/2023	**CG44**	A	Y	N	N	N	N	No biota	Clay / gravel	20
			B	N	N	N	N	N	No biota	Clay / gravel	
			C	N	N	N	N	N	No biota	Clay / gravel	
45	21/7/2023	**CG45**	A	Y	N	N	N	N	No biota	Clay / gravel	20
			B	N	N	N	N	N	No biota	Clay / gravel	

	Date	Sample Point	Grab Replicate	Drop camera	WQ YSI	Niskin	NADG Sample	Biota	Notes	Sediment Type	Depth (m)
			C	N	N	N	N	N	No biota	Clay / gravel	
46	21/7/2023	**CG46**	A	Y	N	N	Y	Y	See biota sample	Sand	10
			B	N	N	N	Combined A	N	No biota	Sand	
			C	N	N	N	"	N	No biota	Sand	
47	21/7/2023	**CG47**	A	Y	N	N	N	Y	See biota sample	Clay / shell grit / gravel	25
			B	N	N	N	N	Y	See biota sample	Clay / shell grit / gravel	
			C	N	N	N	N	Y	See biota sample	Clay / shell grit / gravel	
48	21/7/2023	**CG48**	A	Y	N	N	Y	N	No biota	Sand	15
			B	N	N	N	Combined A	Y	See biota sample	Sand	
			C	N	N	N	"	N	No biota	Sand	
49	21/7/2023	**CG49**	A	Y	N	N	N	N	No biota	Sand	16
			B	N	N	N	N	N	No biota	Sand	
			C	N	N	N	N	N	No biota	Sand	
50	21/7/2023	**CG50**	A	Y	N	N	Y	Y	Rock with crabs & colonising organisms.	Clay / gravel	22
			B	N	N	N	Combined A	Y	See biota sample	Clay / gravel	
			C	N	N	N	"	N	No biota	Clay / gravel	
51	21/7/2023	**CG51**	A	Y	N	N	N	N	No biota	Sand	6
			B	N	N	N	N	N	No biota	Sand	
			C	N	N	N	N	N	No biota	Sand	
52	22/7/2023	**CG52**	A	Y	N	N	Y	Y	See biota sample	Clay / gravel	37
			B	N	N	N	Combined A	Y	See biota sample	Clay / gravel	
			C	N	N	N	"	Y	See biota sample	Clay / gravel	
53	22/7/2023	**CG53**	A	Y	N	N	Y	N	No biota	Sand	25
			B	N	N	N	Combined A	N	No biota	Sand	
			C	N	N	N	"	N	No biota	Sand	
54	22/7/2023	**CG54**	A	Y	N	N	N	N	No biota	Sand & small % shell grit	25
			B	N	N	N	N	Y	See biota sample	Sand & small % shell grit	

	Date	Sample Point	Grab Replicate	Drop camera	WQ YSI	Niskin	NADG Sample	Biota	Notes	Sediment Type	Depth (m)
			C	N	N	N	N	N	No biota	Sand & small % shell grit	
55	22/7/2023	**CG55**	A	Y	N	N	Y	N	No biota	Sand	10
			B	N	N	N	Combined A	N	No biota	Sand	
			C	N	N	N	"	Y	See biota sample	Sand	
56	22/7/2023	**CG56**	A	Y	N	N	N	N	No biota	Sand	11
			B	N	N	N	N	N	No biota	Sand	
			C	N	N	N	N	N	No biota	Sand	
57	22/7/2023	**CG57**	A	Y	N	N	N	N	No biota	Sand & small % shell grit	20
			B	N	N	N	N	N	No biota	Sand & small % shell grit	
			C	N	N	N	N	N	No biota	Sand & small % shell grit	
58	22/7/2023	**CG58**	A	Y	N	N	N	Y	See picture	Clay / gravel	18
			B	N	N	N	N	Y	See biota sample	Clay / gravel	
			C	N	N	N	N	Y	See biota sample	Clay / gravel	
59	22/7/2023	**CG59**	A	Y	N	N	N	N	No biota	Clay & small % sand	12
			B	N	N	N	N	N	No biota	Clay & small % sand	
			C	N	N	N	N	N	No biota	Clay & small % sand	
60	22/7/2023	**CG60**	A	Y	N	N	N	N	3x hydroids (See picture)	Clay / shell grit / gravel	15
			B	N	N	N	N	Y	See biota sample	Clay / shell grit / gravel	
			C	N	N	N	N	Y	See biota sample	Clay / shell grit / gravel	
61	22/7/2023	**CG61**	A	Y	N	N	N	Y	See biota sample	Gravel / clay	15
			B	N	N	N	N	Y	See biota sample	Gravel / clay	
			C	N	N	N	N	Y	See biota sample	Gravel / clay	
62	23/7/2023	**CG62**	A	Y	N	N	N	N	No biota	Clay	8
			B	N	N	N	N	N	No biota	Clay	
			C	N	N	N	N	N	No biota	Clay	
63	23/7/2023	**CG63**	A	Y	N	N	N	Y	See biota sample	Clay	8
64	1/8/2023	**CG64**	A	Y	Y	N	N	Y	See biota sample	Clay / shell grit	17

	Date	Sample Point	Grab Replicate	Drop camera	WQ YSI	Niskin	NADG Sample	Biota	Notes	Sediment Type	Depth (m)
			B	N	N	N	N	Y	See biota sample	Clay / shell grit	
			C	N	N	N	N	Y	See biota sample	Clay / shell grit	
65	1/8/2023	**CG65**	A	Y	Y	N	N	N	No biota	Shell grit.	17
			B	N	N	N	N	N	No biota	N/a	
			C	N	N	N	N	N	No biota	N/a	
66	23/7/2023	**CG66**	A	Y	N	N	N	Y	See biota sample	Clay / shell grit	15
67	23/7/2023	**CG67**	A	Y	N	N	N	N	No biota	Clay	10
			B	N	N	N	N	Y	See biota sample	Clay	
			C	N	N	N	N	Y	See biota sample	Clay	
68	23/7/2023	**CG68**	A	Y	N	N	N	Y	See biota sample	Clay / shell grit	24
			B	N	N	N	N	Y	See biota sample	Clay / shell grit	
			C	N	N	N	N	Y	See biota sample	Clay / shell grit	
69	25/7/2023	**CG69**	A	Y	Y	Y	N	N	No biota	Small rocks	24
			B	N	N	N	N	N	No biota	Small rocks	
			C	N	N	N	N	N	No biota	Small rocks	
70	25/7/2023	**CG70**	A	Y	Y	Y	N	N	No biota	Sand	24
			B	N	N	N	N	Y	See biota sample	Sand	
			C	N	N	N	N	N	No biota	Sand	
71	25/7/2023	**CG71**	A	Y	Y	Y	N	N	No biota	Clay / gravel	21
			B	N	N	N	N	N	No biota	Clay / gravel	
			C	N	N	N	N	N	No biota	Clay / gravel	
72	25/7/2023	**CG72**	A	Y	Y	Y	N	N	No biota	Small rocks	21
			B	N	N	N	N	N	No biota	Small rocks	
			C	N	N	N	N	Y	See photos & biota sample	Small rocks	
73	25/7/2023	**CG73**	A	Y	Y	Y	N	Y	See photos & biota sample	Clay / gravel	26
			B	N	N	N	N	Y	See photos & biota sample	Clay / gravel	
			C	N	N	N	N	N	No biota	Clay / gravel	
74	25/7/2023	**CG74**	A	Y	Y	Y	N	N	No biota	Sand & small % clay	11

	Date	Sample Point	Grab Replicate	Drop camera	WQ YSI	Niskin	NADG Sample	Biota	Notes	Sediment Type	Depth (m)
			B	N	N	N	N	N	No biota	Sand & small % clay	
			C	N	N	N	N	N	No biota	Sand & small % clay	
75	25/7/2023	**CG75**	A	N	Y	Y	N	N	No biota	Sand & small % clay	16
			B	N	N	N	N	N	No biota	Sand & small % clay	
			C	Y	N	N	N	N	No biota	Sand & small % clay	
76	26/7/2023	**CG76**	A	Y	Y	Y	N	N	No biota	Small rocks	20
			B	N	N	N	N	N	No biota	Small rocks	
			C	N	N	N	N	N	No biota	Small rocks	
77	26/7/2023	**CG77**	A	Y	Y	N	N	N	No biota	Small rocks	25
			B	N	N	N	N	N	No biota	Small rocks	
			C	N	N	N	N	N	No biota	Small rocks	
78	26/7/2023	**CG78**	A	Y	Y	N	N	N	No biota	Sand	3
			B	N	N	N	N	Y	See biota sample	Sand	
			C	N	N	N	N	N	No biota	Sand	
79	26/7/2023	**CG79**	A	Y	Y	N	N	N	No biota	Rock	40
			B	N	N	N	N	N	No biota	Rock	
			C	N	N	N	N	N	No biota	Rock	
80	26/7/2023	**CG80**	A	Y	Y	N	N	N	No biota	Rock	18
81	1/8/2023	**CG81**	A	Y	Y	N	N	Y	See biota sample	Clay / shell grit	17
			B	N	N	N	N	Y	See biota sample	Clay / shell grit	
			C	N	N	N	N	Y	See photo and sample	Clay / shell grit	
82	1/8/2023	**CG82**	A	Y	N	N	N	N	No biota	Sand	11
			B	N	N	N	N	N	See photo for worm	Sand	
			C	N	N	N	N	N	No biota	Sand	
83	1/8/2023	**CG83**	A	Y	N	N	N	N	No biota	Sand	20
			B	N	N	N	N	N	No biota	Sand	
			C	N	N	N	N	N	No biota	Sand	

	Date	Sample Point	Grab Replicate	Drop camera	WQ YSI	Niskin	NADG Sample	Biota	Notes	Sediment Type	Depth (m)
84	1/8/2023	**CG84**	A	Y	N	N	N	N	No biota	Sand	10
			B	N	N	N	N	N	No biota	Sand	
			C	N	N	N	N	N	No biota	Sand	
85	1/8/2023	**CG85**	A	Y	N	N	N	N	No biota	Sand	20
			B	N	N	N	N	N	No biota	Sand	
			C	N	N	N	N	N	No biota	Sand	
86	2/8/2023	**CG86 ***	A	N	Y	N	N	N	No biota	Clay & gravel	7
87	2/8/2023	**CG87 ***	A	N	Y	N	N	Y	See pic - small Caulerpa	Minimal return - rock seabed.	5
88	2/8/2023	**CG88 ***	A	N	Y	N	N	N	No biota	Minimal return - rock seabed.	6
89	2/8/2023	**CG89 ***	A	N	Y	N	N	N	No biota	Clay & gravel	8.7
90	2/8/2023	**CG90 ***	A	N	Y	N	N	N	No biota	2 small rocks	12.5
91	2/8/2023	**CG91 ***	A	N	Y	N	N	N	No biota	Sand & small % clay	9.5
92	2/8/2023	**CG92 ***	A	N	Y	N	N	N	No biota	Sand	7.5-9
93	2/8/2023	**CG93 ***	A	N	Y	N	N	N	No biota	Sand & small % clay	4
94	2/8/2023	**CG94 ***	A	N	Y	N	N	N	No biota	Clay & gravel	6.6
95	2/8/2023	**CG95 ***	A	N	Y	N	N	N	No biota	Sand & small % clay	7.2
96	2/8/2023	**CG96 ***	A	N	Y	N	N	N	No biota	Fine sand	6.4
97	2/8/2023	**CG97 ***	A	N	Y	N	N	N	No biota	Fine sand	2.1
98	2/8/2023	**CG98 ***	A	N	Y	N	N	N	No biota	Clay	4.8
99	2/8/2023	**CG99***	A	N	Y	N	N	N	No biota	Clay & gravel	11.7
100	2/8/2023	**CG100 ***	A	N	Y	N	N	N	No biota	Fine sand	9.8
101	2/8/2023	**CG101**	A	Y	N	N	N	Y	See biota sample	Clay & gravel	5
			B	N	N	N	N	Y	See biota sample	Clay & gravel	
			C	N	N	N	N	Y	See biota sample	Clay & gravel	
102	2/8/2023	**CG102**	A	Y	N	N	N	N	No biota	Sand & small % shell grit	10
			B	N	N	N	N	N	No biota	Sand & small % shell grit	
			C	N	N	N	N	N	No biota	Sand & small % shell grit	

	Date	Sample Point	Grab Replicate	Drop camera	WQ YSI	Niskin	NADG Sample	Biota	Notes	Sediment Type	Depth (m)
103	2/8/2023	**CG103**	A	Y	N	N	N	N	No biota	Fine sand	2
			B	N	N	N	N	N	No biota	Fine sand	
			C	N	N	N	N	N	No biota	Fine sand	
104	2/8/2023	**CG104**	A	Y	N	N	N	N	No biota	Clay	12
			B	N	N	N	N	N	No biota	Clay	
			C	N	N	N	N	N	No biota	Clay	
105	2/8/2023	**CG105**	A	Y	N	N	N	N	No biota	Clay / shell grit	2
			B	N	N	N	N	N	No biota	Clay / shell grit	
			C	N	N	N	N	N	No biota	Clay / shell grit	

*Sites CG86 to CG100 were located in the 'False Mouths of the Ord River' on the eastern side of CG. Only one grab sample was undertaken per site as grabs returned very little sediment due to substrate type (rock, gravel, clay and very fie sand) and strong tidal currents. Drop camera was not used due to almost zero visibility even near the surface.

TABLE A.4.4: *Specifications for each benthic grab sampling point at King Shoals - dry-season Jul-Aug 2023*

	Date	Sample Point	Grab Replicate	Drop camera	WQ YSI	Niskin	NADG Sample	Biota	Notes	Sediment Type	Depth (m)
1	27/7/2023	**KS01**	A	Y	Y	N	N	N	No biota	Sand	32
			B	N	N	N	N	N	No biota	Sand	
			C	N	N	N	N	N	No biota	Sand	
2	27/7/2023	**KS02**	A	Y	Y	Y	N	Y	See biota sample & pic	Sand	22
			B	N	N	N	N	Y	See biota sample & pic	Sand	
			C	N	N	N	N	N	No biota	Sand	
3	27/7/2023	**KS03**	A	Y	Y	N	N	N	No biota	Sand & small % shell grit	30
			B	N	N	N	N	N	No biota	Sand & small % shell grit	
			C	N	N	N	N	N	No biota	Sand & small % shell grit	
4	27/7/2023	**KS04**	A	Y	Y	N	N	N	No biota	Sand	12
			B	N	N	N	N	N	No biota	Sand	
			C	N	N	N	N	N	No biota	Sand	
5	27/7/2023	**KS05**	A	Y	Y	N	N	N	No biota	Sand	10
			B	N	N	N	N	N	No biota	Sand	
			C	N	N	N	N	N	No biota	Sand	
6	27/7/2023	**KS06**	A	Y	Y	Y	N	N	Seabed visible in drop-cam.	Shell grit	6
			B	N	N	N	N	N	No biota	Shell grit	
			C	N	N	N	N	N	No biota	Shell grit	
7	27/7/2023	**KS07**	A	Y	Y	N	N	N	No biota	Clay / gravel	27
			B	N	N	N	N	Y	See biota sample	Clay / gravel	
			C	N	N	N	N	Y	See biota sample	Clay / gravel	
8	27/7/2023	**KS08**	A	Y	Y	N	N	N	No biota	Sand	9
			B	N	N	N	N	N	No biota	Sand	
			C	N	N	N	N	Y	See biota sample	Sand	
9	27/7/2023	**KS09**	A	Y	Y	N	N	N	No biota	Sand & small % shell grit	11
			B	N	N	N	N	N	No biota	Sand & small % shell grit	

	Date	Sample Point	Grab Replicate	Drop camera	WQ YSI	Niskin	NADG Sample	Biota	Notes	Sediment Type	Depth (m)
			C	N	N	N	N	N	No biota	Sand & small % shell grit	
10	27/7/2023	**KS10**	A	Y	Y	N	N	N	No biota	Sand	27
			B	N	N	N	N	N	No biota	Sand	
			C	N	N	N	N	N	No biota	Sand	
11	27/7/2023	**KS11**	A	Y	Y	N	N	Y	See biota sample	Rock bottom	27
			B	N	N	N	N	N	No biota	Rock bottom	
			C	N	N	N	N	N	No biota	Rock bottom	
12	27/7/2023	**KS12**	A	Y	Y	N	N	N	No biota	Rock bottom	17
			B	N	N	N	N	N	No biota	Rock bottom	
13	27/7/2023	**KS13**	A	Y	Y	N	N	Y	Sponge on small rock	Rock bottom	
			B	N	N	N	N	N	No biota	Rock bottom	
			C	N	N	N	N	N	No biota	Rock bottom	
14	27/7/2023	**KS14**	A	Y	Y	Y	N	N	No biota	Sand	12
			B	N	N	N	N	Y	See biota sample	Sand	
			C	N	N	N	N	N	No biota	Sand	
15	27/7/2023	**KS15**	A	Y	Y	N	N	Y	See sample - various biota	Clay / gravel	26
			B	N	N	N	N	Y	See sample - various biota	Clay / gravel	
			C	N	N	N	N	Y	See sample - various biota	Clay / gravel	
16	27/7/2023	**KS16**	A	Y	Y	N	N	Y	See sample - various biota	Stones / gravel	25
			B	N	N	N	N	N	No biota	Stones / gravel	
			C	N	N	N	N	Y	See sample - various biota	Stones / gravel	
17	27/7/2023	**KS17**	A	Y	Y	N	N	N	No biota	Sand	10
			B	N	N	N	N	N	No biota	Sand	
			C	N	N	N	N	N	No biota	Sand	
18	27/7/2023	**KS18**	A	Y	Y	N	N	Y	See biota sample	Fine sand	20
			B	N	N	N	N	Y	See biota sample	Fine sand	
			C	N	N	N	N	Y	See biota sample	Fine sand	

	Date	Sample Point	Grab Replicate	Drop camera	WQ YSI	Niskin	NADG Sample	Biota	Notes	Sediment Type	Depth (m)
19	27/7/2023	**KS19**	A	Y	Y	N	N	Y	See sample - various biota	Stones / gravel	26
			B	N	N	N	N	Y	See sample - various biota	Stones / gravel	
			C	N	N	N	N	Y	See sample - various biota	Stones / gravel	
20	27/7/2023	**KS20**	A	Y	Y	N	N	N	No biota	Sand	15
			B	N	N	N	N	N	No biota	Sand	
			C	N	N	N	N	N	No biota	Sand	
21	1/8/2023	**KS21**	A	Y	N	N	N	N	No biota	Sand	12
			B	N	N	N	N	N	No biota	Sand	
			C	N	N	N	N	N	No biota	Sand	
22	1/8/2023	**KS22**	A	Y	N	N	N	N	No biota	Sand	15
			B	N	N	N	N	Y	See biota sample	Sand	
			C	N	N	N	N	N	No biota	Sand	
23	1/8/2023	**KS23**	A	Y	N	N	N	N	No biota	Clay	7
			B	N	N	N	N	Y	See biota sample	Clay	
24	1/8/2023	**KS24**	A	Y	N	N	N	N	No biota	Clay / gravel	10
			B	N	N	N	N	Y	See biota sample	Clay / gravel	
			C	N	N	N	N	N	No biota	Clay / gravel	
25	1/8/2023	**KS25**	A	Y	N	N	N	Y	See biota sample	Fine sand	1
			B	N	N	N	N	N	No biota	Fine sand	
			C	N	N	N	N	N	No biota	Fine sand	
26	1/8/2023	**KS26**	A	Y	N	N	N	N	No biota	Fine sand	4
			B	N	N	N	N	N	No biota	Fine sand	
			C	N	N	N	N	N	No biota	Fine sand	
27	1/8/2023	**KS27**	A	Y	N	N	N	N	No biota	No return - likely rock	20
			B	N	N	N	N	N	No biota	No return - likely rock	

ANNEX 5: WET-SEASON SAMPLE POINT SPECS

- Figure A.5.1 shows the locations of all 105 sampling points in Cambridge Gulf and all 27 sampling points at King Shoals.
- Table A.5.1 summarizes key data from the following Tables A.5.3 and A.5.4.
- Table A.5.2 lists the coordinates for each sampling point shown on Figure A.5.1.
- Table A.5.3 lists the following data for each sampling point in Cambridge Gulf:
  - Date sampled.
  - Sample Point Code.
  - Grab Replicate (A, B C) including ID of sites where <3 grabs replicates were taken.
  - Dop camera (Y = deployed / N = not-deployed).
  - WQ-YSI (Water Quality YSI multi-parameter sonde) (Y = deployed / N = not deployed).
  - Niskin (water samples for Total Suspended Solids & Chlorophyll analysis) (Y = deployed / N = not deployed).
  - NADG Sample (sediment collected for chemical analysis (Y = collected / N = not collected).
  - Biota (found in benthic grab sample) (Y = yes / N = no).
  - Notes (mainly on any biota found)
  - Sediment type (from visual description of the grab return).
  - Depth (to seabed, as measured by the vessel's depth sounder at the time of sampling. Note the tidal range is 8 m).
- Table A.5.4 lists the same data as Table A.4.3 but for King Shoals.

TABLE A.5.1: *Summary of key data from Tables A.5.3 and A.5.4 below.*

Parameter	Cambridge Gulf (CG)	King Shoals (KS)	CG & KS combined
Total number of sample points:	27	14	41
No. of sample points where 3 replicate grabs deployed:	27 (x 3 = 81 grabs)	14 (x 3 = 42 grabs)	41
No. of sample points where 2 replicate grabs deployed:	Nil	Nil	Nil
No. of sample points where 1 replicate grab deployed:	Nil	Nil	Nil
No. of sample points where no grabs deployed:	Nil	Nil	Nil
Total number of grabs deployed:	81	42	123
No. of sampling points that returned biota:	13	10	23
Percentage of sampling points that returned biota:	13 / 27 = 48%	10 /14 = 71%	23 / 41 = 56%
No. of grabs that returned biota:	29	17	46
Percentage of grabs that returned biota:	29 / 81 = 36%	17 / 42 = 40%	46 / 123 = 37%

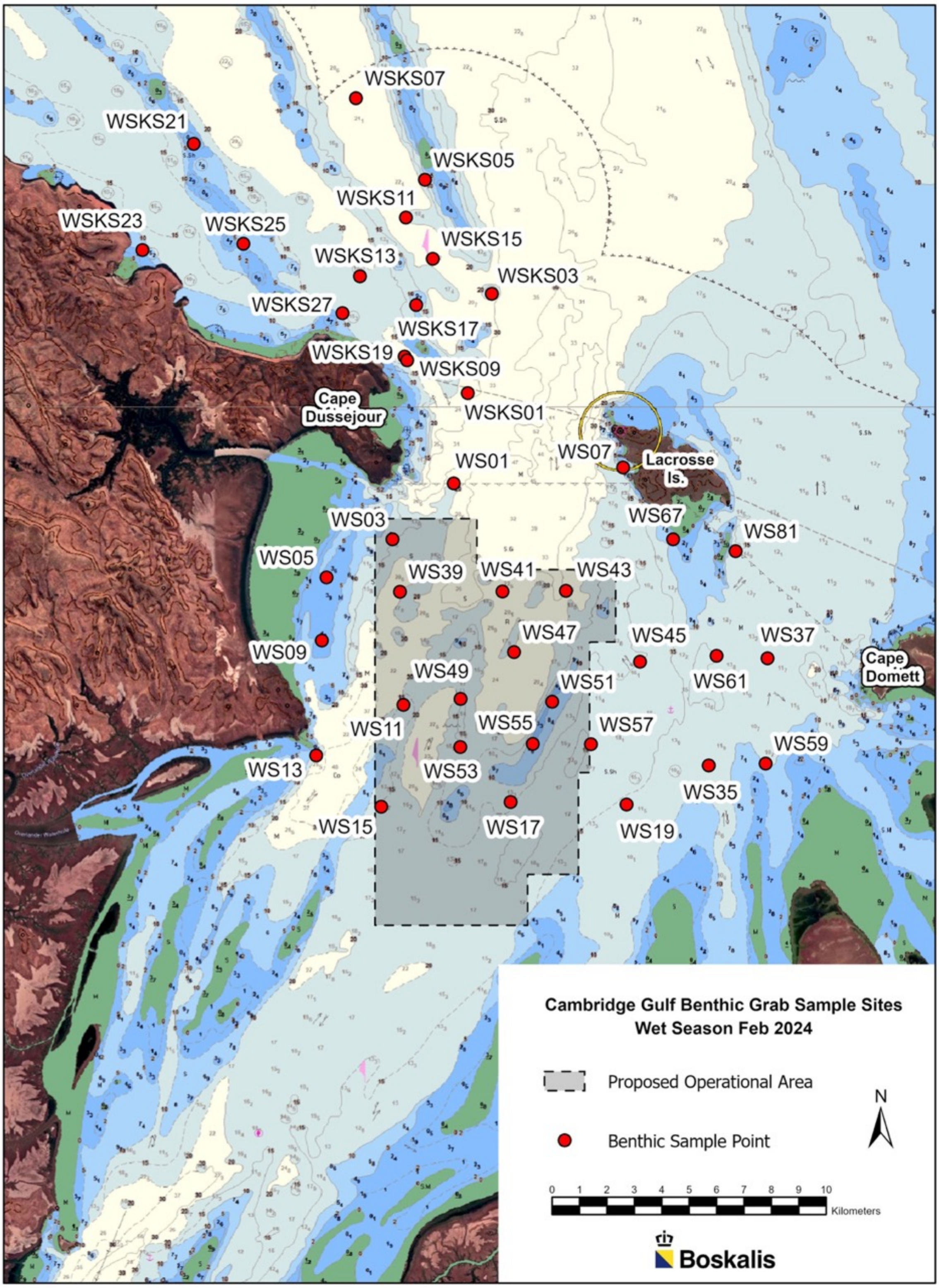


FIGURE A.5.1 - Wet-season: *Locations of the 27 benthic grab sampling sites in Cambridge Gulf and the 14 sites at King Shoals (total wet season sites = 41).*

TABLE A.5.2: *Coordinates for each sampling point shown on Figure A.5.1 above.*

GPX files are archived and can be provided to regulatory agencies if required.

Cambridge Gulf Wet-season Feb 2024			
	Sample Point	**Lat (S)**	**Long (E)**
1	WS 01	-14.755141	128.242428
2	WS 03	-14.773464	128.222353
3	WS 05	-14.785955	128.200797
4	WS07	-14.773459	128.314388
5	WS09	-14.806628	128.199259
6	WS 11	-14.827762	128.225989
7	WS 13	-14.844301	128.197406
8	WS 15	-14.861160	128.218660
9	WS 17	-14.859550	128.261112
10	WS 19	-14.860410	128.299128
11	WS 35	-14.847580	128.326045
12	WS 37	-14.811700	128.328621
13	WS 39	-14.790649	128.224844
14	WS 41	-14.790503	128.258430
15	WS 43	-14.790308	128.279178
16	WS 45	-14.813623	128.303441
17	WS 47	-14.810453	128.262184
18	WS 49	-14.825816	128.244710
19	WS 51	-14.826703	128.274756
20	WS 53	-14.841588	128.244625
27	WS 55	-14.840489	128.268351
22	WS 57	-14.840667	128.287413
23	WS 59	-14.846937	128.344628
24	WS 61	-14.812423	128.345281
25	WS 67	-14.773459	128.314388
26	WS 79	-15.043181	128.112688
27	WS 81	-14.777325	128.334815

King Shoals Wet-season Feb 2024			
	Sample Point	**Lat (S)**	**Long (E)**
1	WSKS 01	-14.725482	128.247040
2	WSKS 03	128.254950	128.254950
3	WSKS 05	-14.655601	128.233017
4	WSKS 07	-14.628787	128.210435
5	WSKS 09	-14.714723	128.227206
6	WSKS 11	-14.668001	128.226727
7	WSKS 13	-14.687254	128.211743
8	WSKS 15	-14.681445	128.235566
9	WSKS 17	-14.696664	128.230130
10	WSKS 19	-14.713561	128.226329
11	WSKS 21	-14.643804	128.157179
12	WSKS 23	-14.678585	128.140380
13	WSKS 25	-14.676606	128.173480
14	WSKS 27	-14.699271	128.205933

TABLE A.5.3: *Specifications for each benthic grab sampling point in Cambridge Gulf wet-season Feb 2024.*

	Date	Sample Point	Grab Replicate	Biota	Notes	Sediment Type	Depth (m)
1	21-Feb-24	**WS79**	A	No	None	1 small rock	33
			B	No	None	None	
			C	No	None	None	
2	22-Feb-24	**WS19**	A	Yes	Gastropods, hydroids, crustaceans etc	Clay/gravel	15
			B	Yes	Gastropod	Clay/gravel	
			C	Yes	Small sea pen	Clay/gravel	
3	22-Feb-24	**WS35**	A	No	No	Clay/sand	10
			B	Yes	Worms	Clay/sand	
			C	Yes	Small crustaceans & worm	Clay/sand	
4	22-Feb-24	**WS59**	A	No	None	Sand/clay	12
			B	No	None	Sand/clay	
			C	No	None	Sand/clay	
5	22-Feb-24	**WS61**	A	Yes	Hydrozoan	Clay/gravel	15
			B	Yes	Hydrozoan & bivalve	Clay/gravel	
			C	Yes	Small hydroids	Clay/gravel	
6	22-Feb-24	**WS01**	A	No	None	Sand	33
			B	No	None	Sand	
			C	No	None	Sand	
7	22-Feb-24	**WS03**	A	No	None	Sand	20
			B	No	None	Sand	
			C	No	None	Sand	
8	22-Feb-24	**WS05**	A	No	None	Clay	9
			B	No	None	Clay	
			C	Yes	Small Worms	Clay	
9	22-Feb-24	**WS39**	A	No	None	Sand	26

	Date	Sample Point	Grab Replicate	Biota	Notes	Sediment Type	Depth (m)
			B	No	None	Sand	
			C	No	None	Sand	
10	22-Feb-234	**WS09**	A	Yes	Small Worms	Clay	9
			B	No	No	Clay	
			C	Yes	Small worm	Clay	
11	22-Feb-24	**WS11**	A	No	None	Sand	22
			B	No	None	Sand	
			C	No	None	Sand	
12	22-Feb-24	**WS13**	A	Yes	Small red gorgonian	Gravel/shell grit	17
			B	Yes	Small tubular sponge	Sand	
			C	No	Some encrusting small bivalves (dead) & barnacles on small rock	Rock	
13	23-Feb-24	**WS49**	A	No	None	Sand	20
			B	No	None	Sand	
			C	No	None	Sand	
14	23-Feb-24	**WS43**	A	No	None	Sand	23
			B	No	None	Sand	
			C	No	None	Sand	
15	23-Feb-24	**WS17**	A	No	None	Sand	18
			B	No	None	Sand	
			C	No	None	Sand	
16	23-Feb-24	**WS55**	A	No	None	Sand	6
			B	No	None	Sand	
			C	No	None	Sand	
17	23-Feb-24	**WS51**	A	No	None	Sand	10
			B	No	None	Sand	
			C	No	None	Sand	

	Date	Sample Point	Grab Replicate	Biota	Notes	Sediment Type	Depth (m)
18	23-Feb-24	**WS47**	A	Yes	Small hydroid on rock	Clay/shell grit	25
			B	Yes	Crinoid	Clay/shell grit	
			C	Yes	Hydroid / worm	Clay/shell grit	
19	23-Feb-24	**WS41**	A	Yes	Hydroids	Pebbles	27
			B	Yes	Hydroids	Rocks	
			C	Yes	Hydroids / small crabs	Clays/shell grit	
20	23-Feb-24	**WS43**	A	Yes	Various	Clay/gravel	27
			B	No		Clay/gravel	
			C	Yes	Sponge	Clay/gravel	
21	23-Feb-24	**WS81**	A	Yes	Various	Clay/gravel	16
			B	Yes	Various	Clay/shell grit	
			C	Yes	Various	Clay/shell grit	
22	23-Feb-24	**WS37**	A	Yes	None	Clay/shell grit	16
			B	No	None	Clay/gravel	
			C	No	None	Clay/gravel	
23	23-Feb-24	**WS45**	A	No	None	Clay/shell grit	20
			B	Yes	Worm?	Clay/shell grit	
			C	Yes	Worm?	Clay/shell grit	
24	23-Feb-24	**WS67**	A	No	None	Clay	10
			B	No	None	Clay	
			C	No	None	Clay	
25	23-Feb-24	**WS07**	A	No	None	Clay	22
			B	No	None	Clay	
			C	No	None	Clay	
26	23-Feb-24	**WS57**	A	No	None	Sand	21
			B	No	None	Sand	

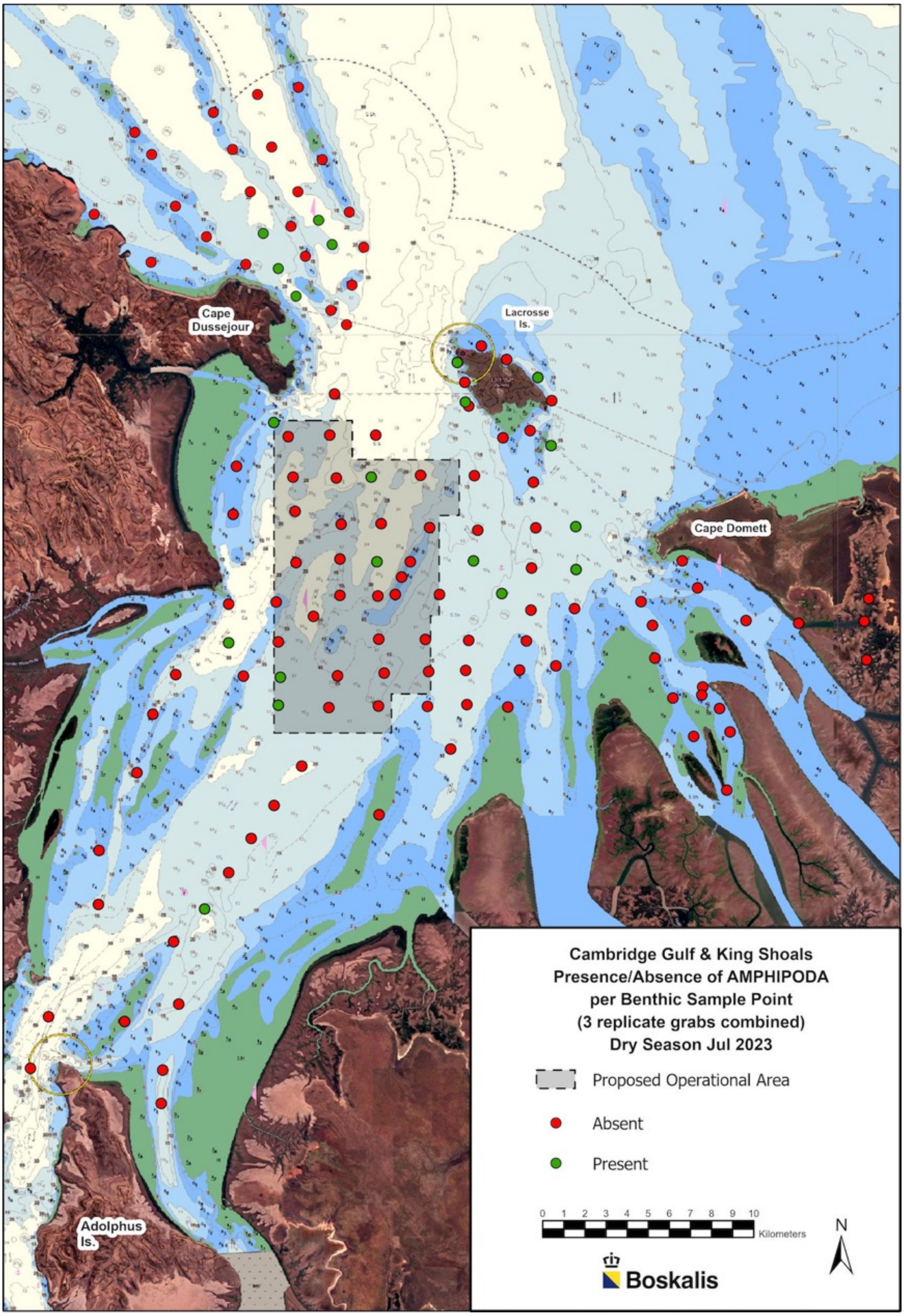
	Date	Sample Point	Grab Replicate	Biota	Notes	Sediment Type	Depth (m)
			C	No	None	Sand	
27	24-Feb-24	**WS15**	A	Yes	Worms	Clay	19
			B	Yes	Hydroids	Clay	
			C	No	None	Pebbles	

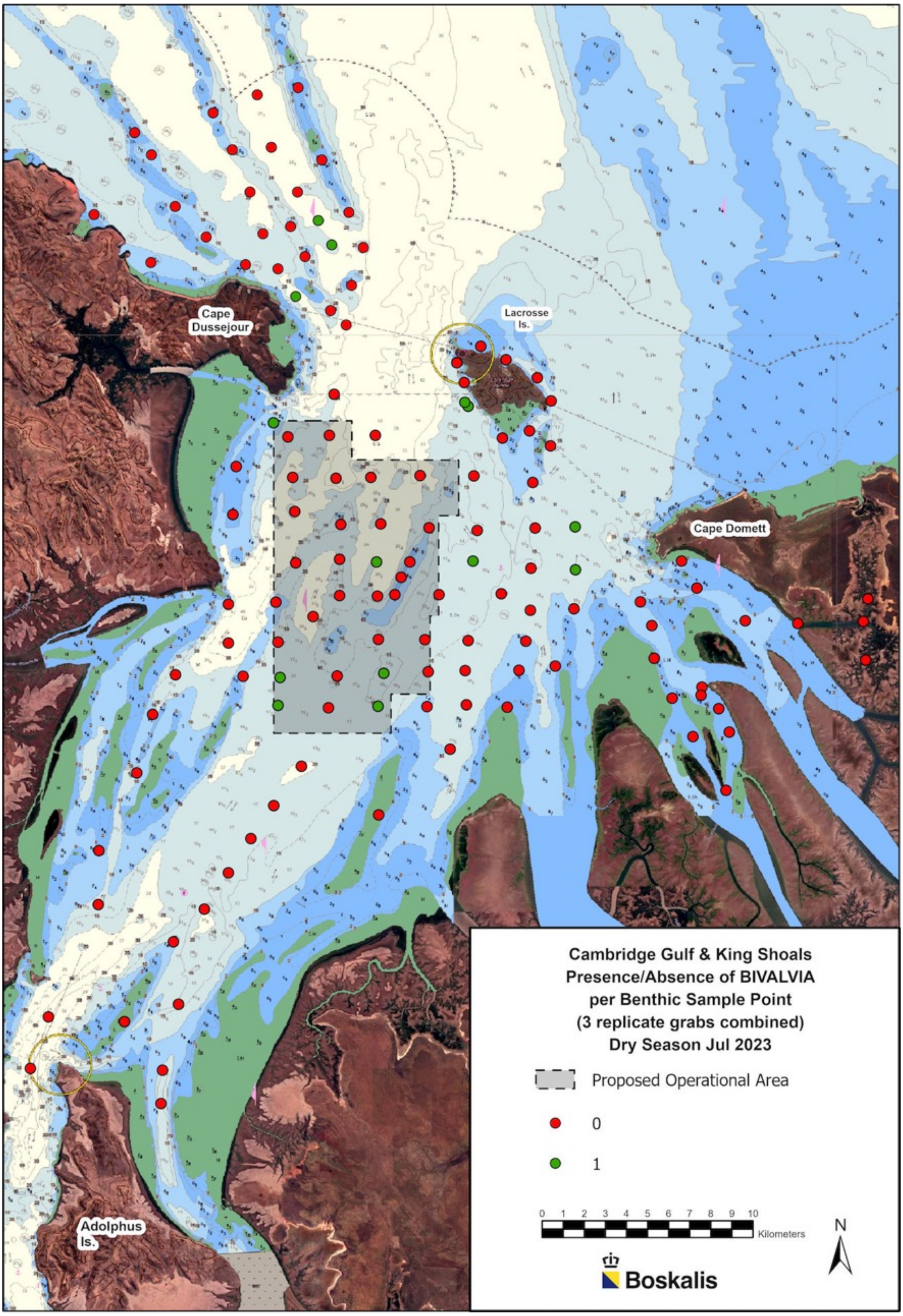
TABLE A.5.4: *Specifications for each benthic grab sampling point at King Shoals wet-season Feb 2024.*

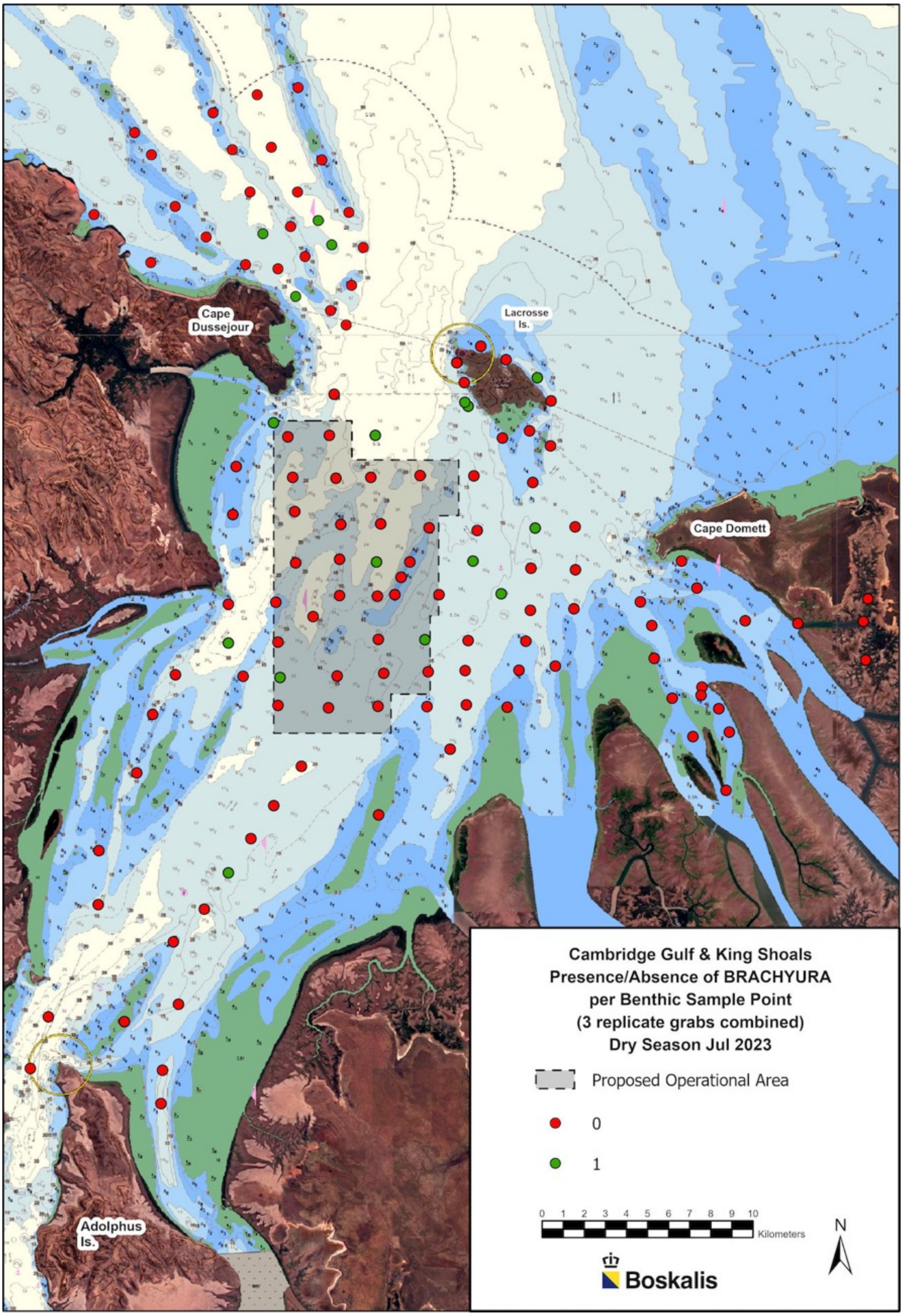
	Date	Sample Point	Grab Replicate	Biota	Notes	Sediment Type	Depth (m)
1	25-Feb-24	**WSKS27**	A	Yes	Sponge, Fan Coral, Crinoid, Small Crabs	Few Pebbles	19
			B	No	None	Few Pebbles	
			C	Yes	Sponge, small crabs	Few Pebbles	
2	25-Feb-24	**WSKS19**	A	No	None	Few Pebbles	19
			B	No	None	Shell Grit	
			C	Yes	Assorted Biota - Sponges, lace corals etc - Multiple juvenile mud crabs	Shell Grit	
3	26-Feb-24	**WSKS21**	A	No	None	Sand	16
			B	Yes	Crinoid	Sand	
			C	No		Sand	
4	26-Feb-24	**WSKS23**	A	Yes	Small worms, crab, isopod	Clay/gravel	6
			B	Yes	"	Clay	
			C	Yes	"	Clay	
5	26-Feb-24	**WSKS25**	A	No	None	Sand	4
			B	No	None	Sand	
			C	No	None	Sand	
6	26-Feb-24	**WSKS13**	A	Yes	Algae? See sample pic	None (3 attempts)	21
			B	No	None	"	
			C	Yes	Algae? See sample pic	"	
7	26-Feb-24	**WSKS09**	A	No	None	Sand/shell grit	10
			B	No	None	Sand/shell grit	
			C	Yes	Mole crab	Sand/shell grit	
8	26-Feb-24	**WSKS07**	A	Yes	Hydroids, sponges	Clay	24
			B	Yes	Various	Clay/shell grit	
			C	No	None	Clay/shell grit	
9	26-Feb-24	**WSKS05**	A	No	None	Sand	4

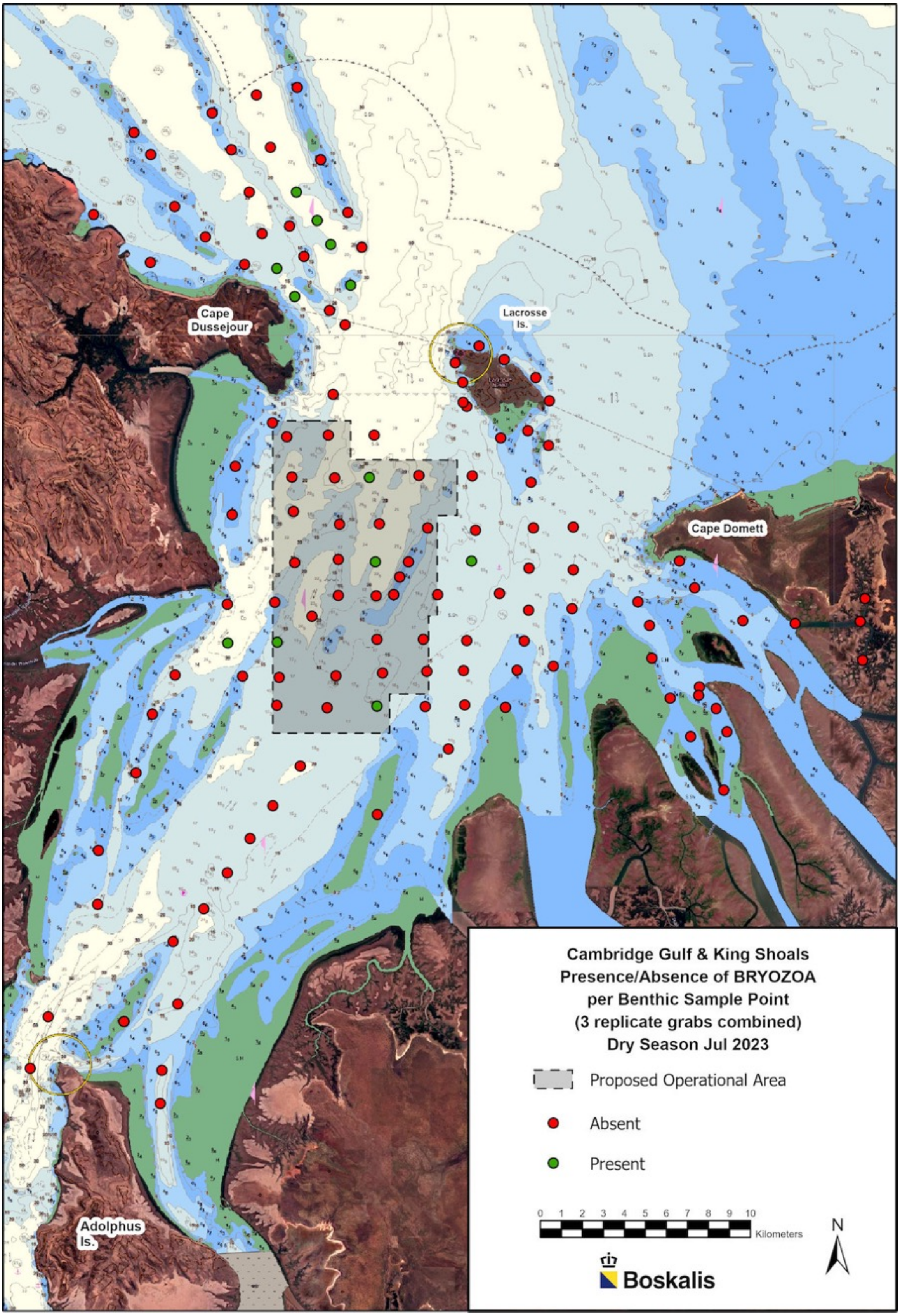
	Date	Sample Point	Grab Replicate	Biota	Notes	Sediment Type	Depth (m)
			B	No	None	Sand	
			C	No	None	Sand	
10	26-Feb-24	**WSKS11**	A	No	None	Sand/gravel	23
			B	No	None	Sand	
			C	Yes	Hydroids	Sand	
11	26-Feb-24	**WSKS15**	A	No	None	Gravel	25
			B	Yes	Various	Gravel	
			C	Yes	Various	Gravel	
12	26-Feb-24	**WSKS17**	A	Yes	Mole crabs	Sand	12
			B	Yes	Mole crabs	Sand	
			C	No	None	Sand	
13	26-Feb-24	**WSKS03**	A	No	None	Clay/shell grit	22
			B	No	None	Clay/shell grit	
			C	No	None	Clay/shell grit	
14	26-Feb-24	**WSKS01**	A	No	None	Sand	28
			B	No	None	Sand	
			C	No	None	Broke grab - no further sampling	

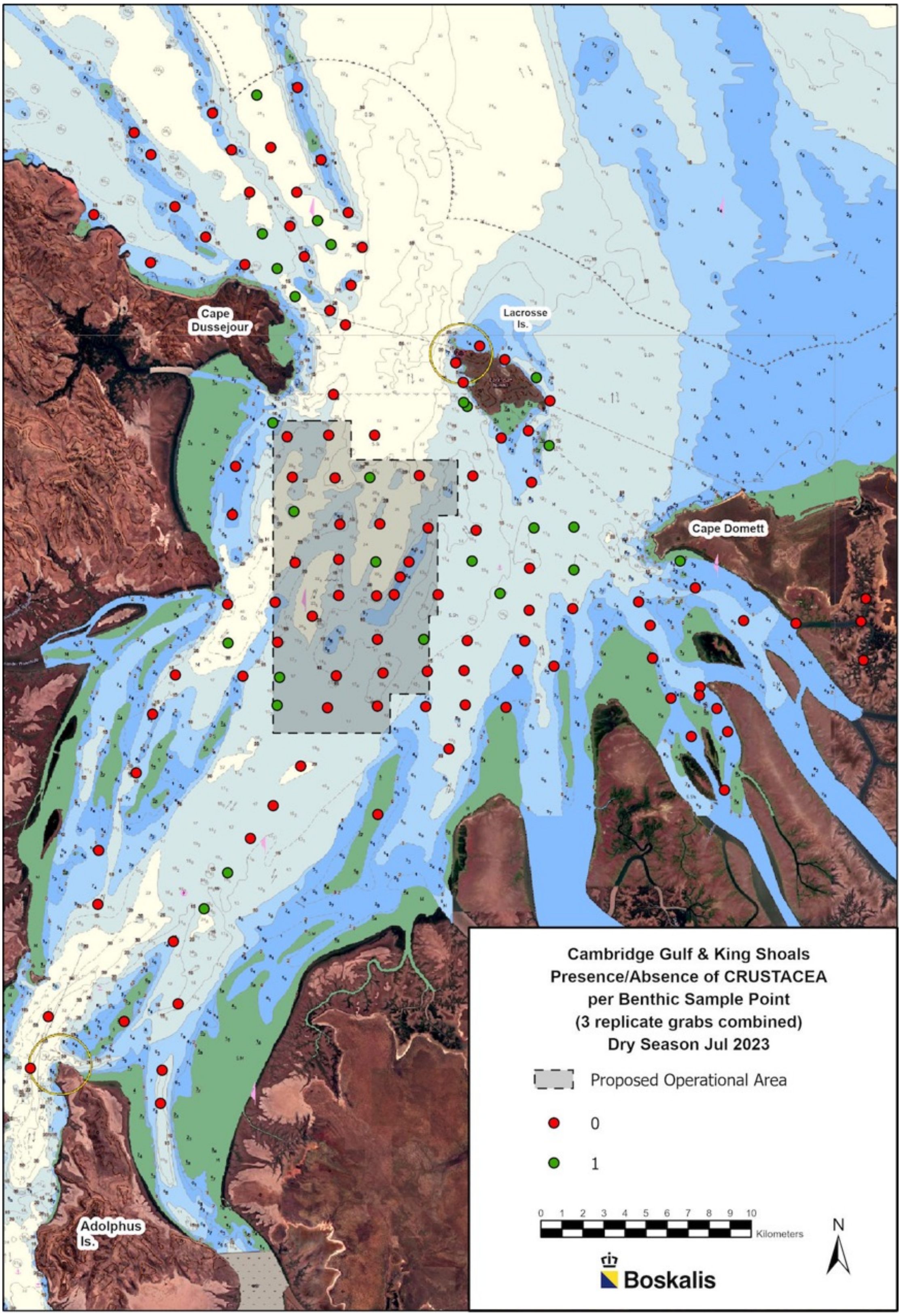
ANNEX 6: BENTHIC TAXA PER SAMPLE POINT – DRY SEASON MAPS

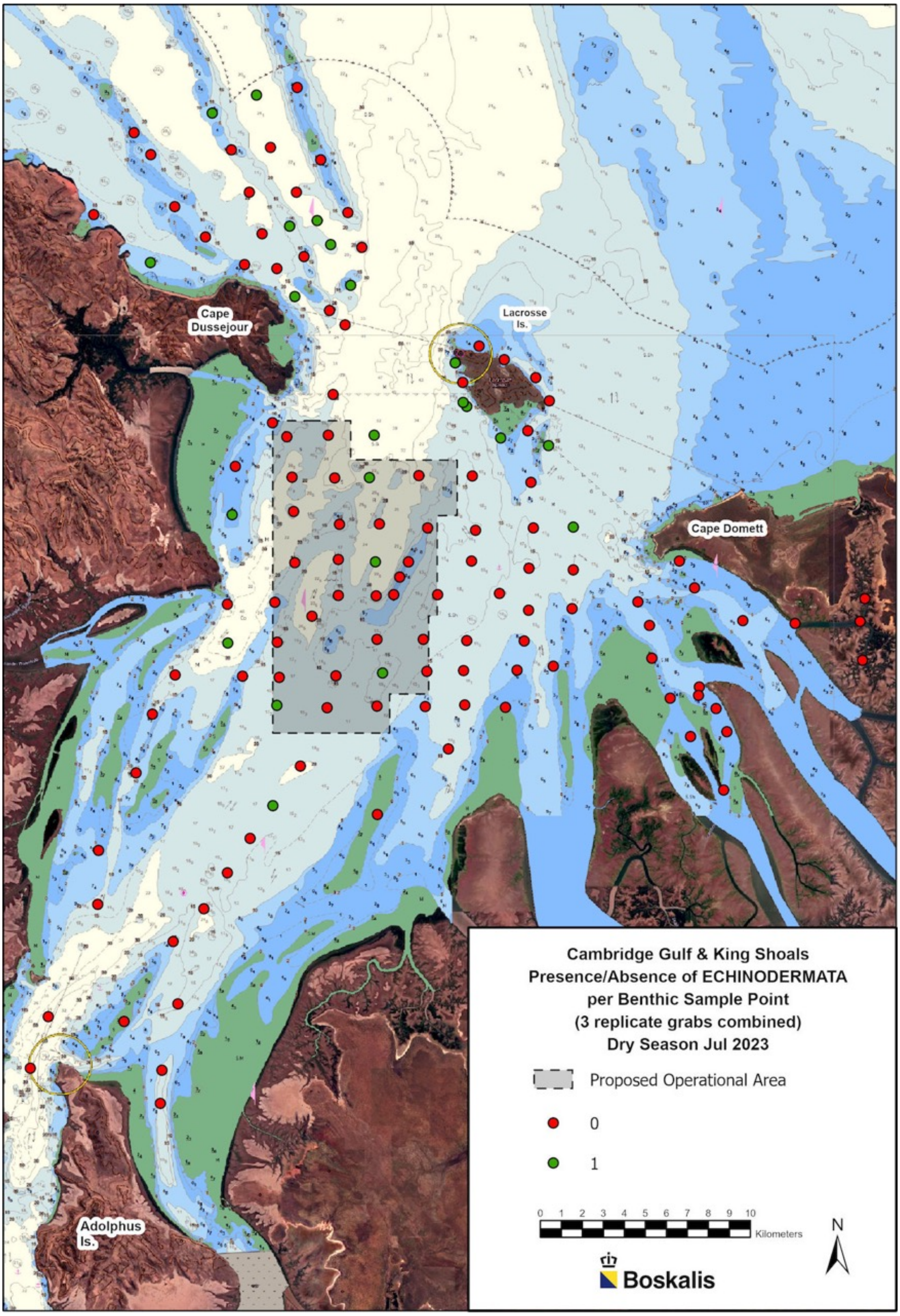


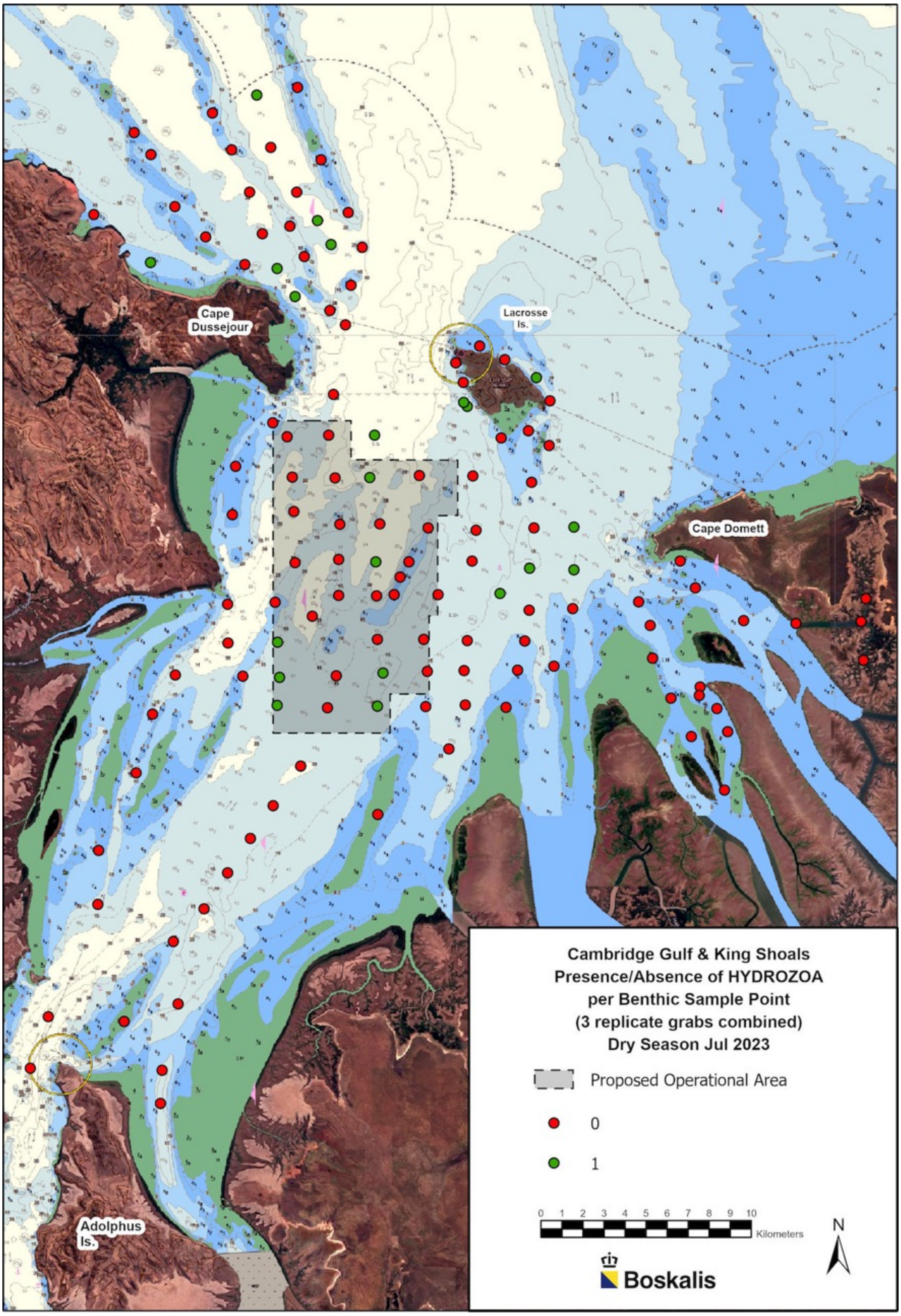

Cape Dussejour
Lacrosse Is.
Cape Domett
Adolphus Is.
Cambridge Gulf & King Shoals
Presence/Absence of BIVALVIA
per Benthic Sample Point
(3 replicate grabs combined)
Dry Season Jul 2023
Proposed Operational Area
0
1
0 1 2 3 4 5 6 7 8 9 10
Kilometers
N
Boskalis

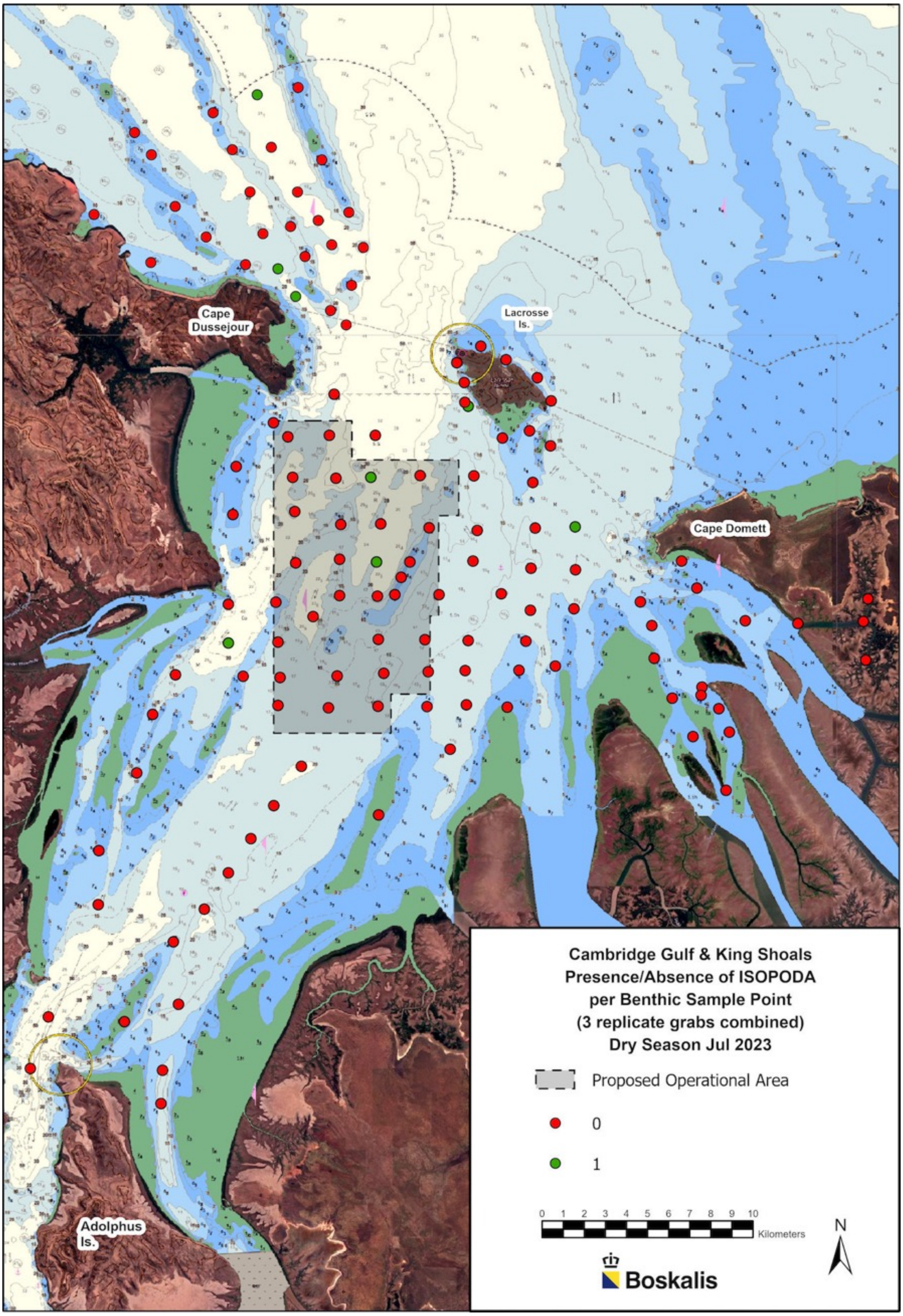

Cape Dussejour
Lacrosse Is.
Cape Domett
Adolphus Is.
Cambridge Gulf & King Shoals
Presence/Absence of BRACHYURA
per Benthic Sample Point
(3 replicate grabs combined)
Dry Season Jul 2023
Proposed Operational Area
0
1
0 1 2 3 4 5 6 7 8 9 10
Kilometers
N
Boskalis

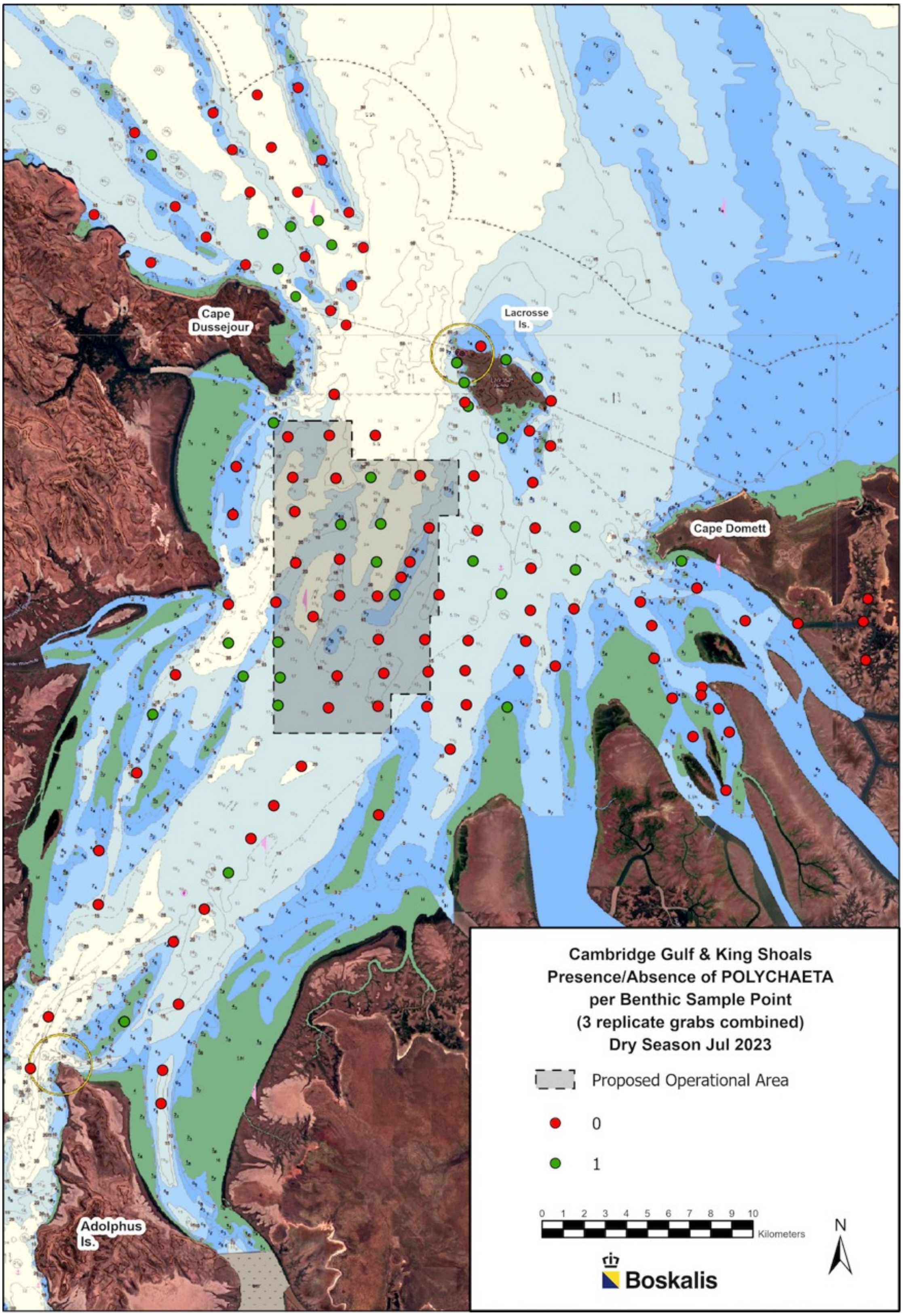

Cape Dussejour
Lacrosse Is.
Cape Domett
Adolphus Is.
Cambridge Gulf & King Shoals
Presence/Absence of BRYOZOA
per Benthic Sample Point
(3 replicate grabs combined)
Dry Season Jul 2023
Proposed Operational Area
Absent
Present
0 1 2 3 4 5 6 7 8 9 10
Kilometers
N
Boskalis

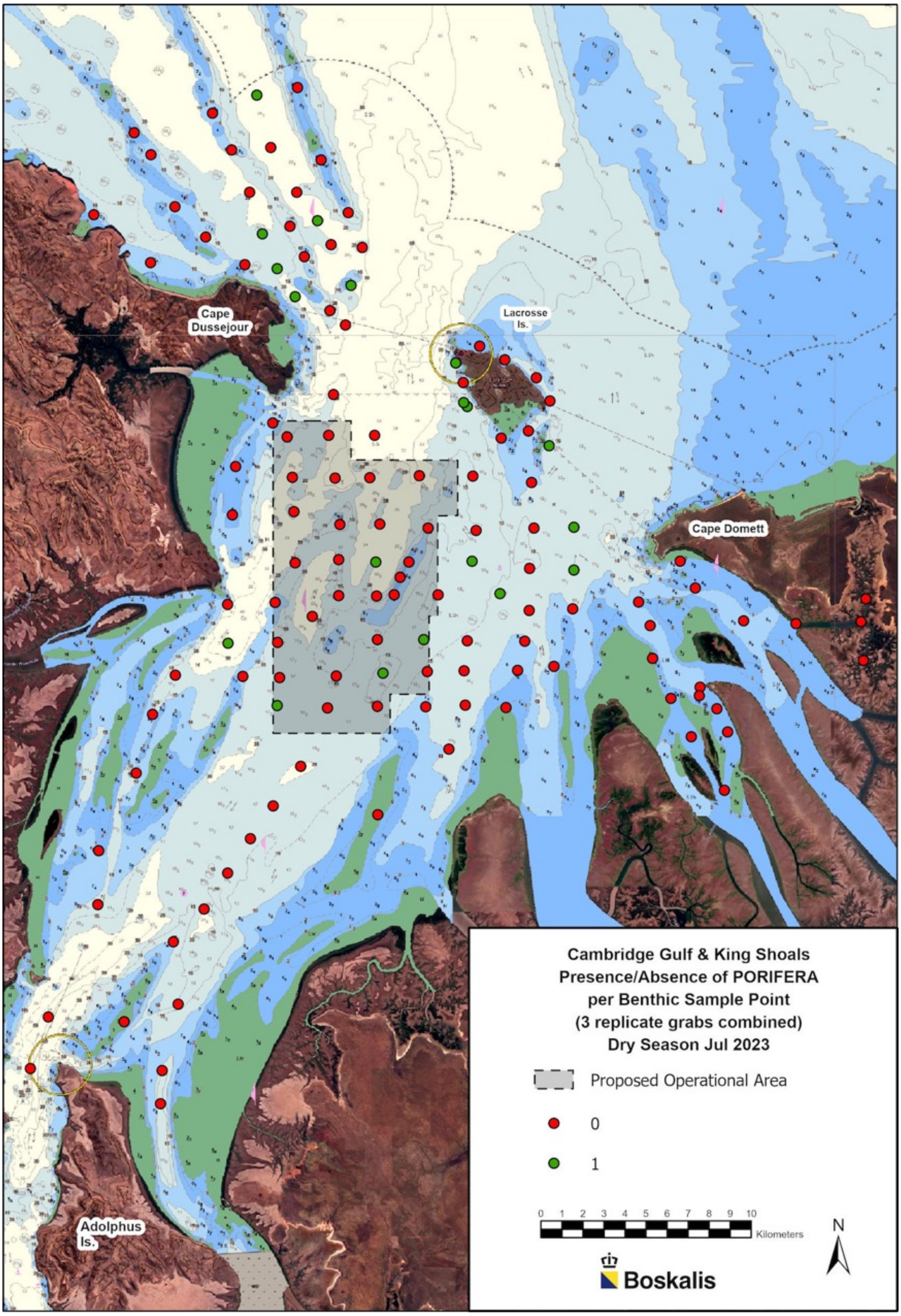

Cambridge Gulf & King Shoals
Presence/Absence of CRUSTACEA
per Benthic Sample Point
(3 replicate grabs combined)
Dry Season Jul 2023
Proposed Operational Area
0
1
0 1 2 3 4 5 6 7 8 9 10
Kilometers
N
Boskalis
Cape Dussejour
Lacrosse Is.
Cape Domett
Adolphus Is.

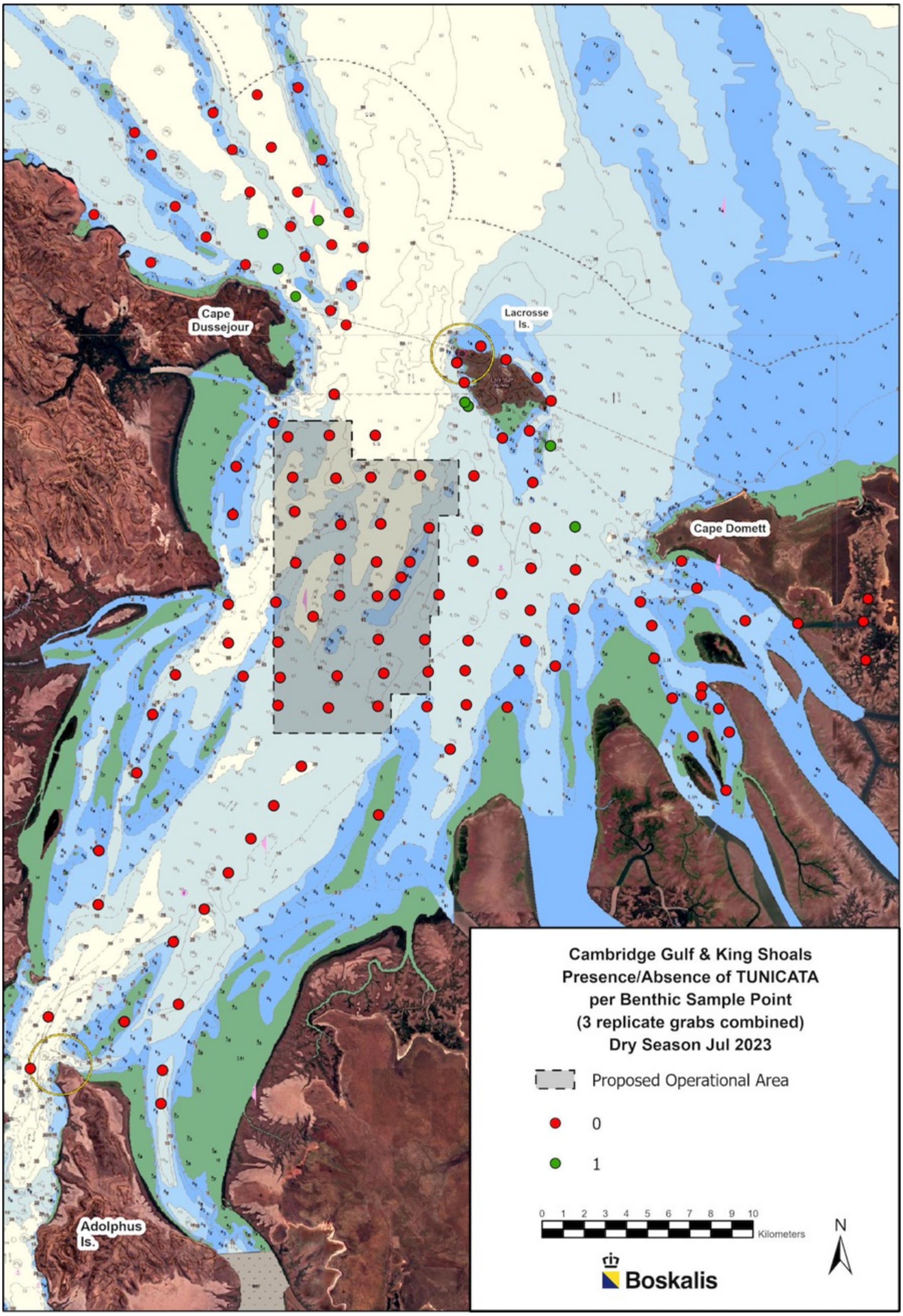

Cape Dussejour
Lacrosse Is.
Cape Domett
Adolphus Is.
Cambridge Gulf & King Shoals
Presence/Absence of ECHINODERMATA
per Benthic Sample Point
(3 replicate grabs combined)
Dry Season Jul 2023
Proposed Operational Area
0
1
0 1 2 3 4 5 6 7 8 9 10
Kilometers
N
Boskalis


Cape Dussejour
Lacrosse Is.
Cape Domett
Adolphus Is.
Cambridge Gulf & King Shoals
Presence/Absence of HYDROZOA
per Benthic Sample Point
(3 replicate grabs combined)
Dry Season Jul 2023
Proposed Operational Area
0
1
0 1 2 3 4 5 6 7 8 9 10
Kilometers
N
Boskalis

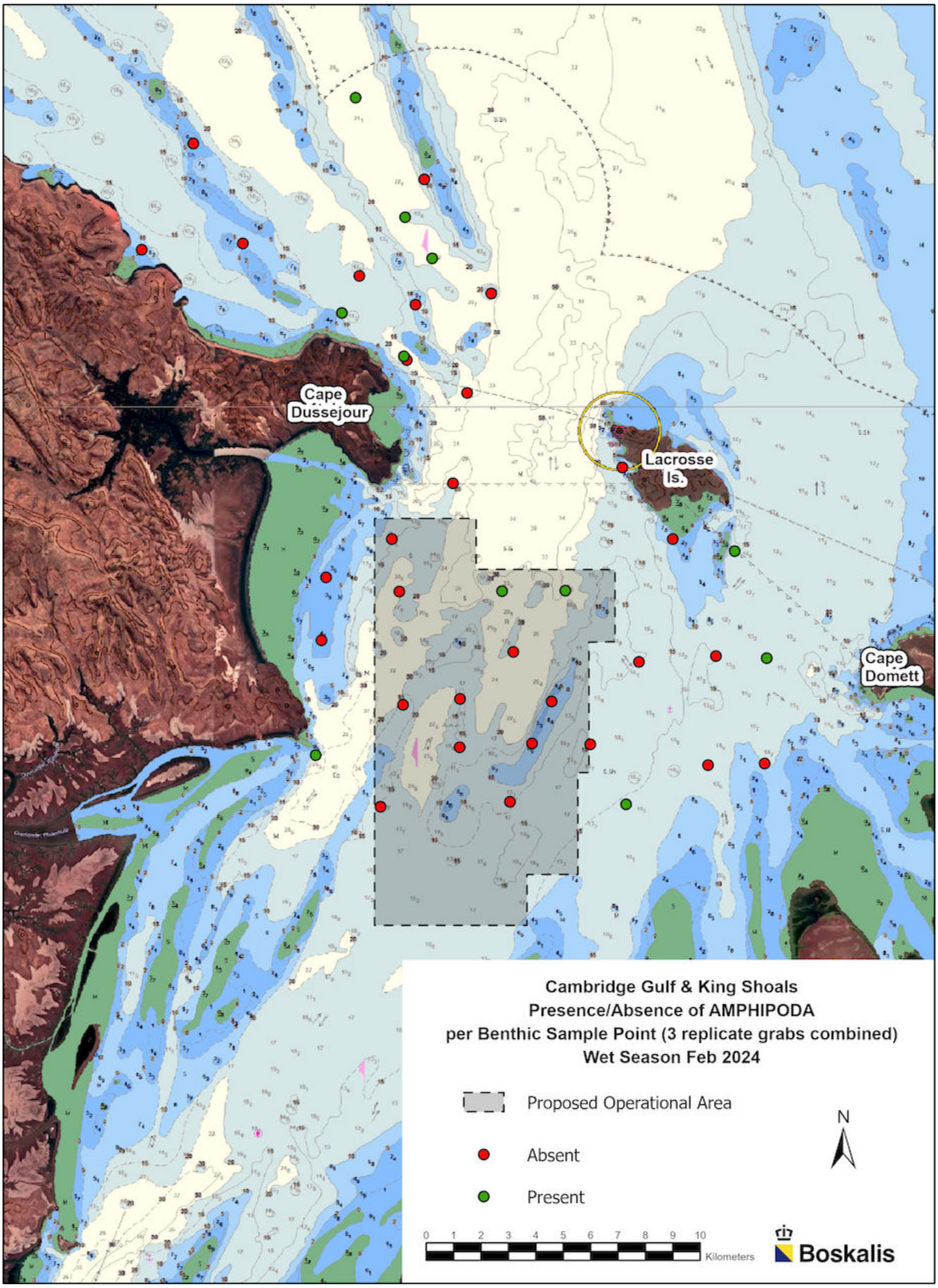

Cape Dussejour
Lacrosse Is.
Cape Domett
Adolphus Is.
Cambridge Gulf & King Shoals
Presence/Absence of ISOPODA
per Benthic Sample Point
(3 replicate grabs combined)
Dry Season Jul 2023
Proposed Operational Area
0
1
0 1 2 3 4 5 6 7 8 9 10
Kilometers
N
Boskalis

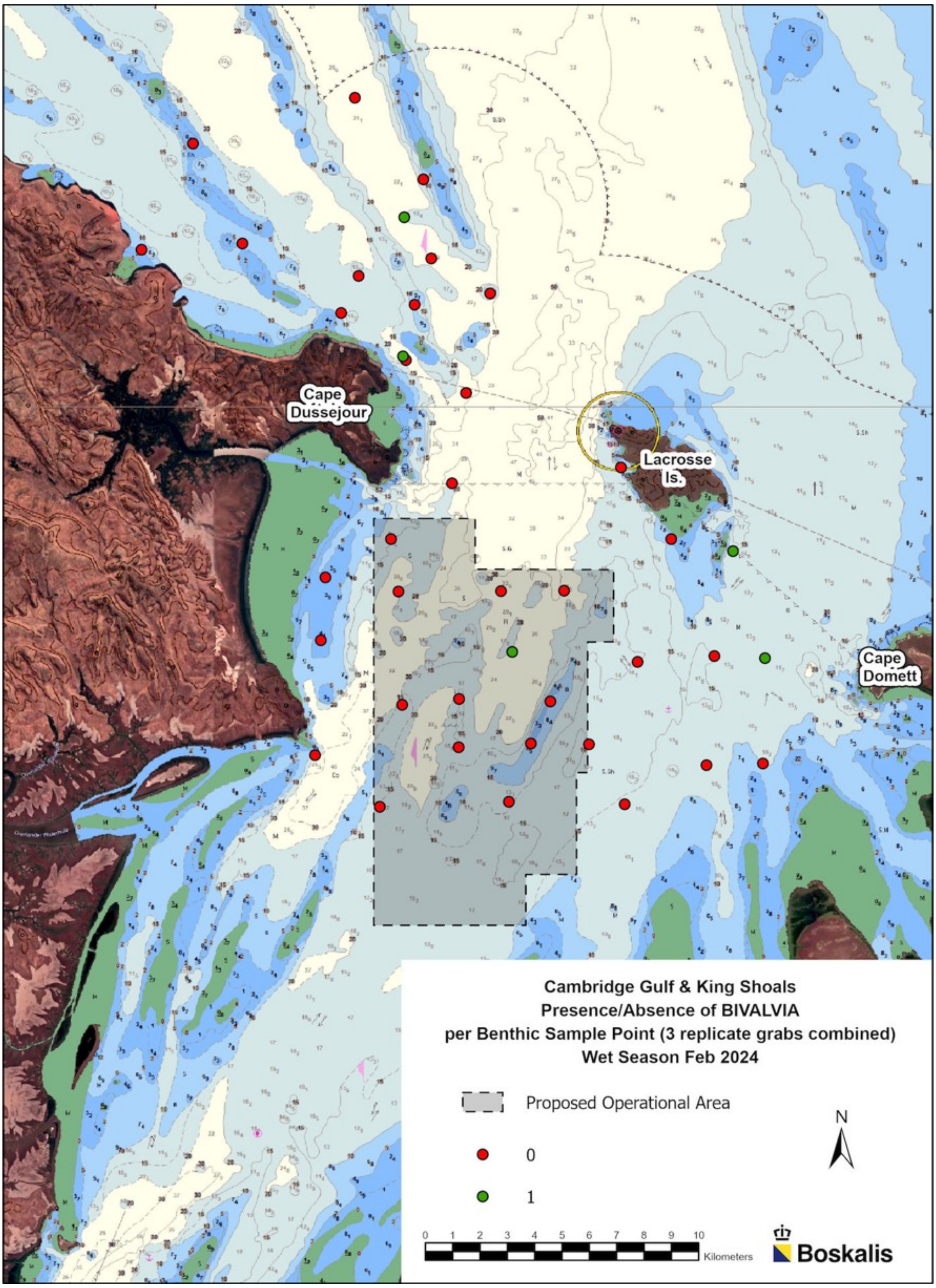

Cape Dussejour
Lacrosse Is.
Cape Domett
Adolphus Is.
Cambridge Gulf & King Shoals
Presence/Absence of POLYCHAETA
per Benthic Sample Point
(3 replicate grabs combined)
Dry Season Jul 2023
Proposed Operational Area
0
1
0 1 2 3 4 5 6 7 8 9 10
Kilometers
N
Boskalis

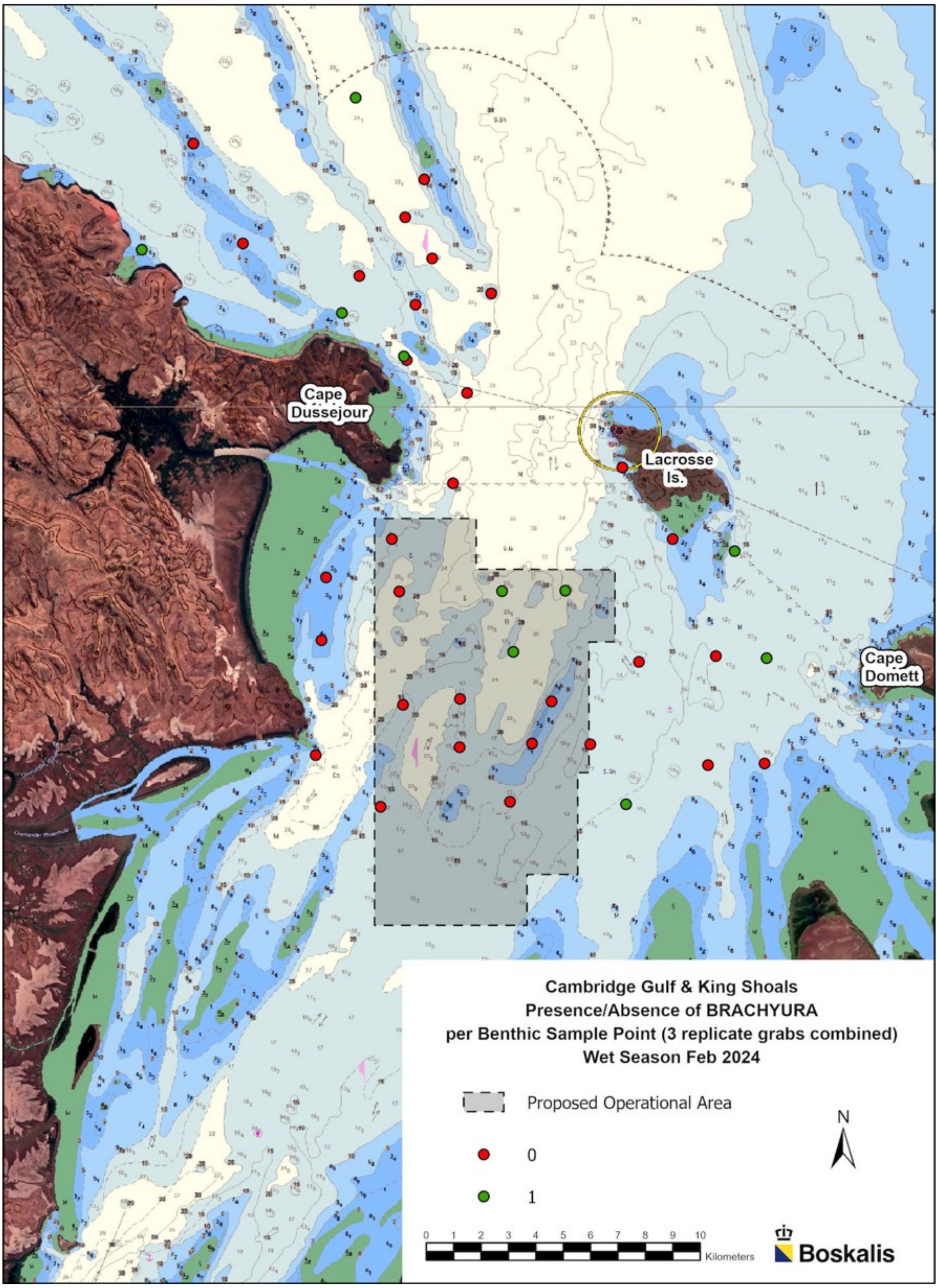

Cape Dussejour
Lacrosse Is.
Cape Domett
Adolphus Is.
Cambridge Gulf & King Shoals
Presence/Absence of PORIFERA
per Benthic Sample Point
(3 replicate grabs combined)
Dry Season Jul 2023
Proposed Operational Area
0
1
0 1 2 3 4 5 6 7 8 9 10
Kilometers
N
Boskalis

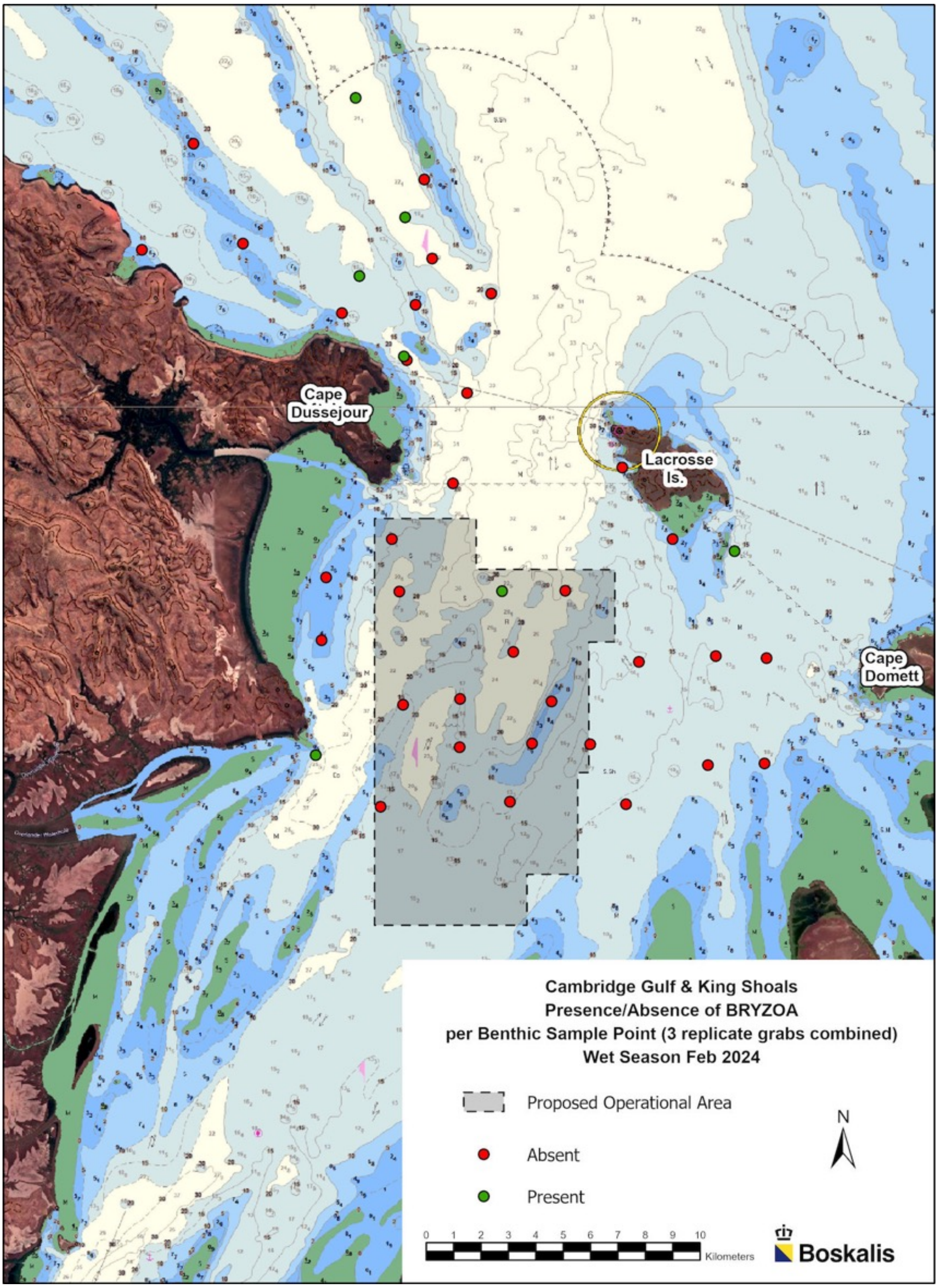

Cape Dussejour
Lacrosse Is.
Cape Domett
Adolphus Is.
Cambridge Gulf & King Shoals
Presence/Absence of TUNICATA
per Benthic Sample Point
(3 replicate grabs combined)
Dry Season Jul 2023
Proposed Operational Area
0
1
0 1 2 3 4 5 6 7 8 9 10
Kilometers
N
Boskalis

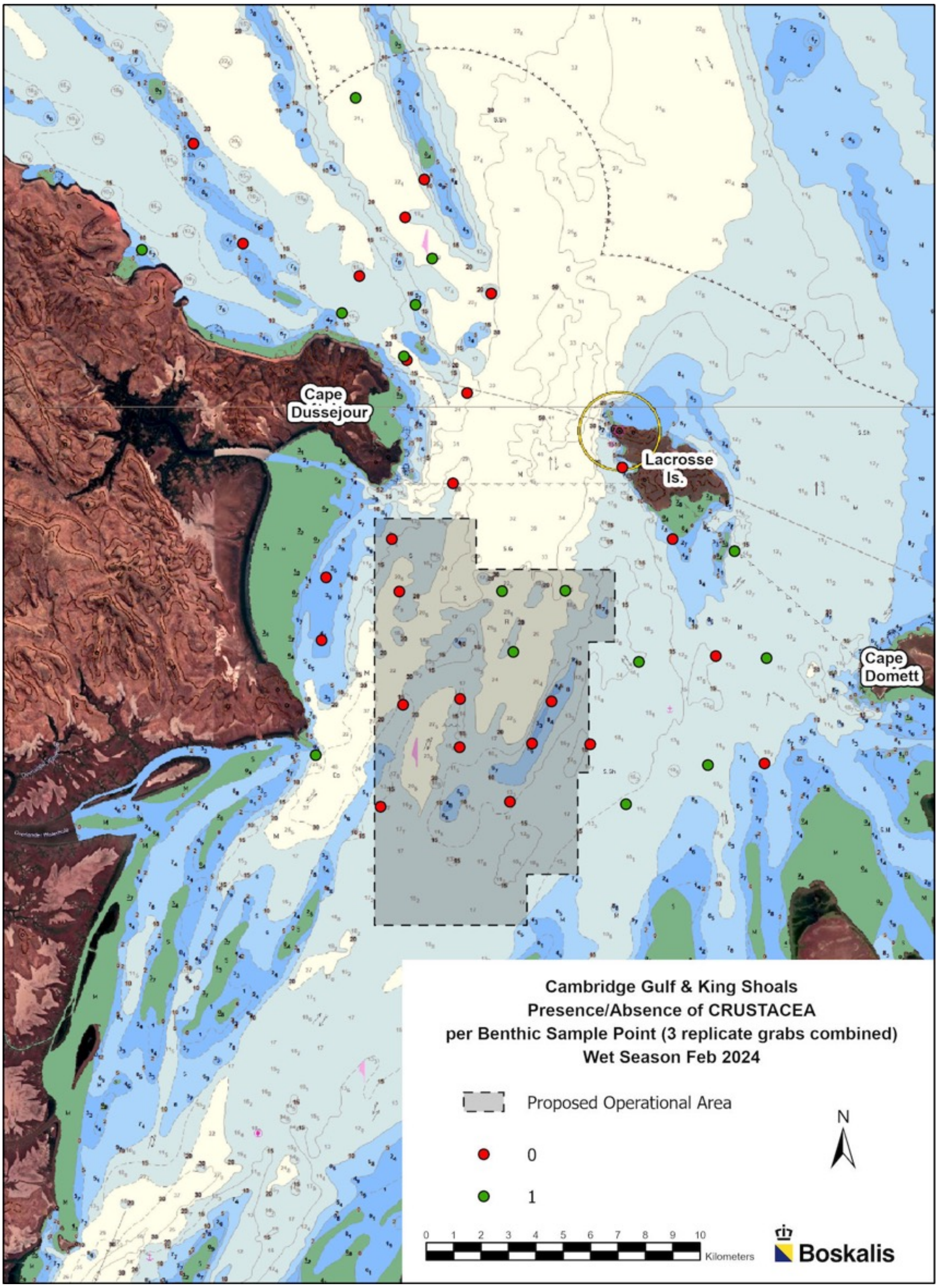
ANNEX 7: BENTHIC TAXA PER SAMPLE POINT – WET SEASON MAPS

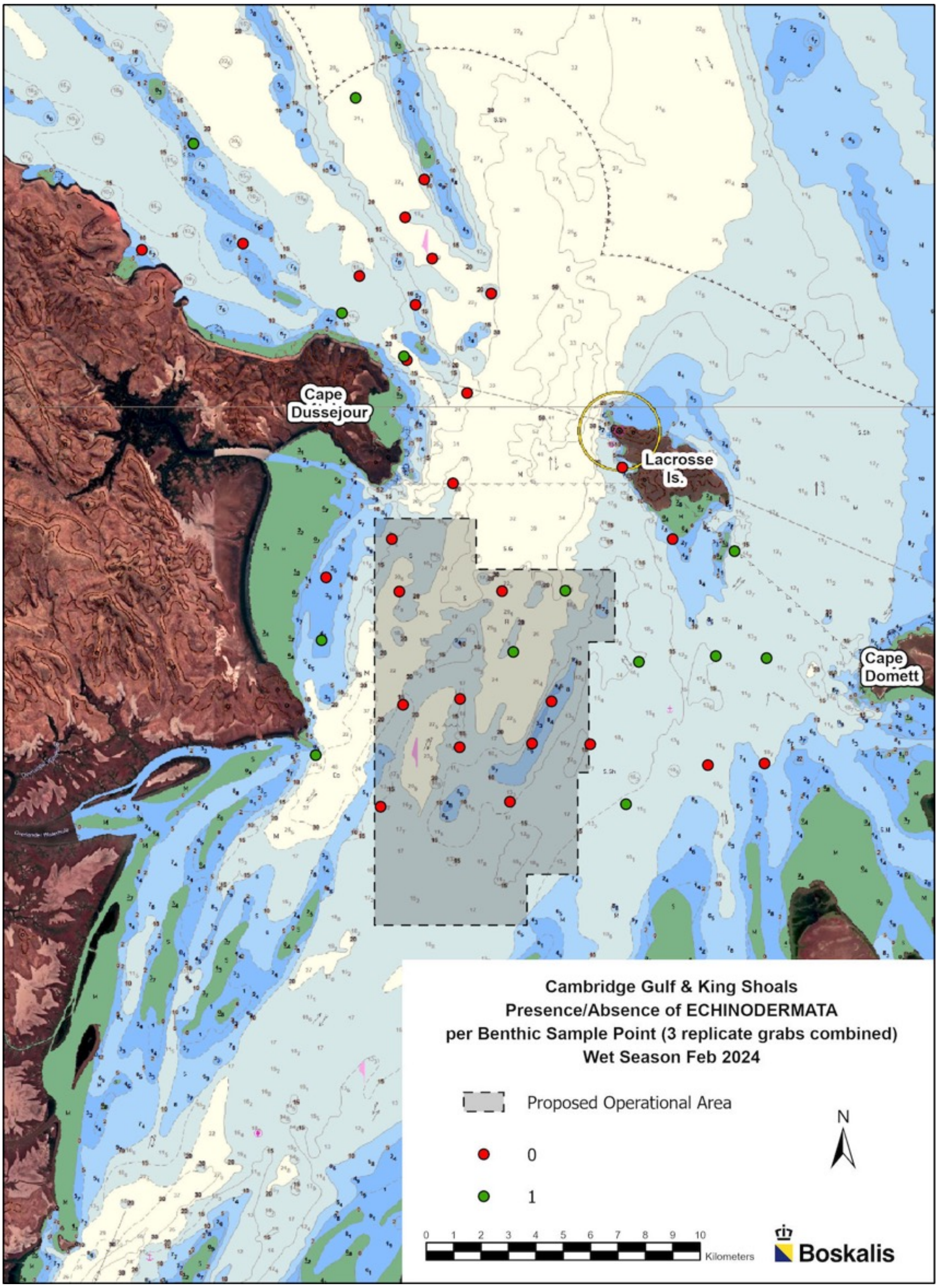


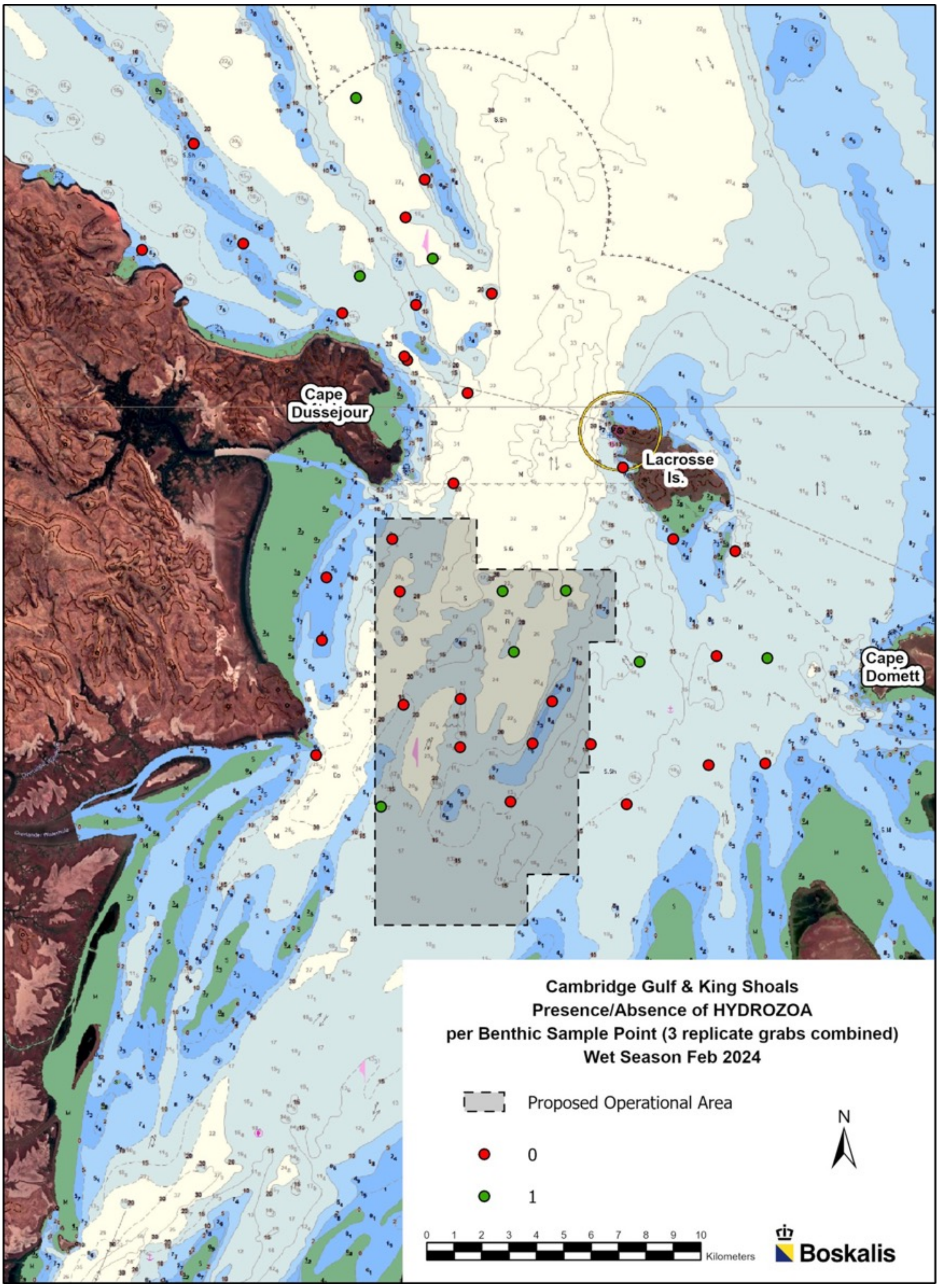

Cape Dussejour
Lacrosse Is.
Cape Domett
Cambridge Gulf & King Shoals
Presence/Absence of BIVALVIA
per Benthic Sample Point (3 replicate grabs combined)
Wet Season Feb 2024
Proposed Operational Area
0
1
N
0 1 2 3 4 5 6 7 8 9 10
Kilometers
Boskalis

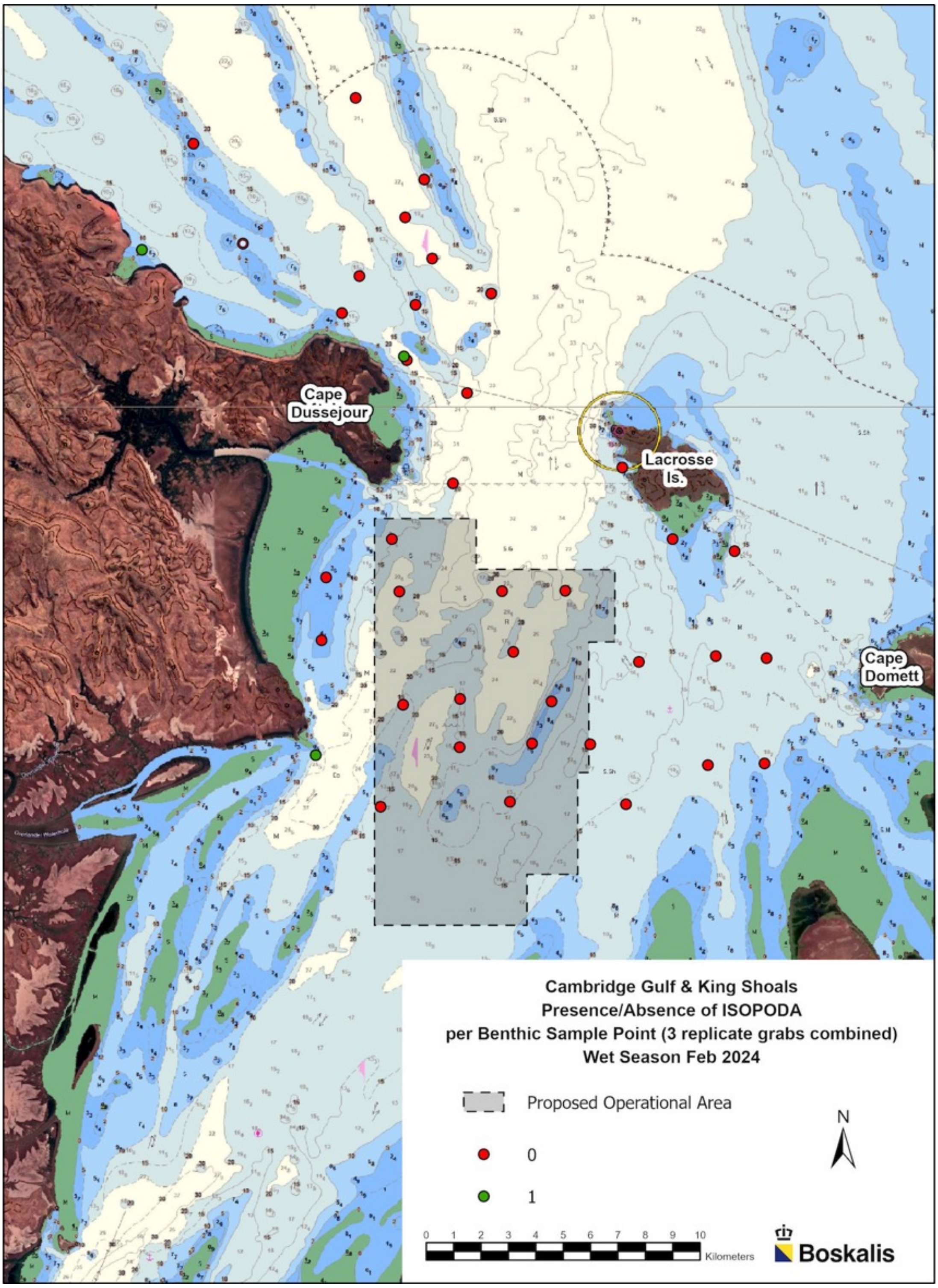

Cape Dussejour
Lacrosse Is.
Cape Domett
Cambridge Gulf & King Shoals
Presence/Absence of BRACHYURA
per Benthic Sample Point (3 replicate grabs combined)
Wet Season Feb 2024
Proposed Operational Area
0
1
N
0 1 2 3 4 5 6 7 8 9 10
Kilometers
Boskalis

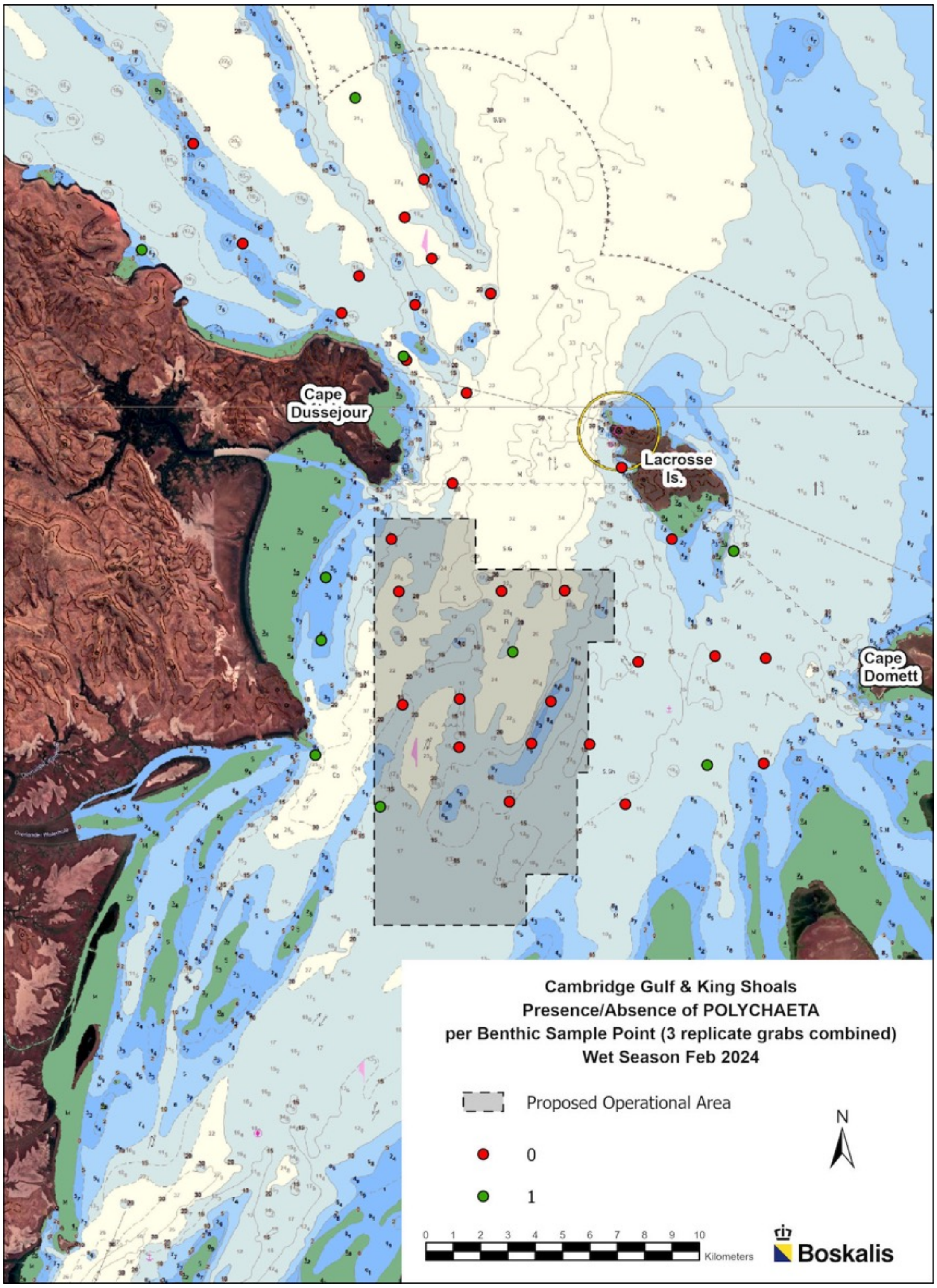

Cape Dussejour
Lacrosse Is.
Cape Domett
Cambridge Gulf & King Shoals
Presence/Absence of BRYZOA
per Benthic Sample Point (3 replicate grabs combined)
Wet Season Feb 2024
Proposed Operational Area
Absent
Present
N
0 1 2 3 4 5 6 7 8 9 10
Kilometers
Boskalis

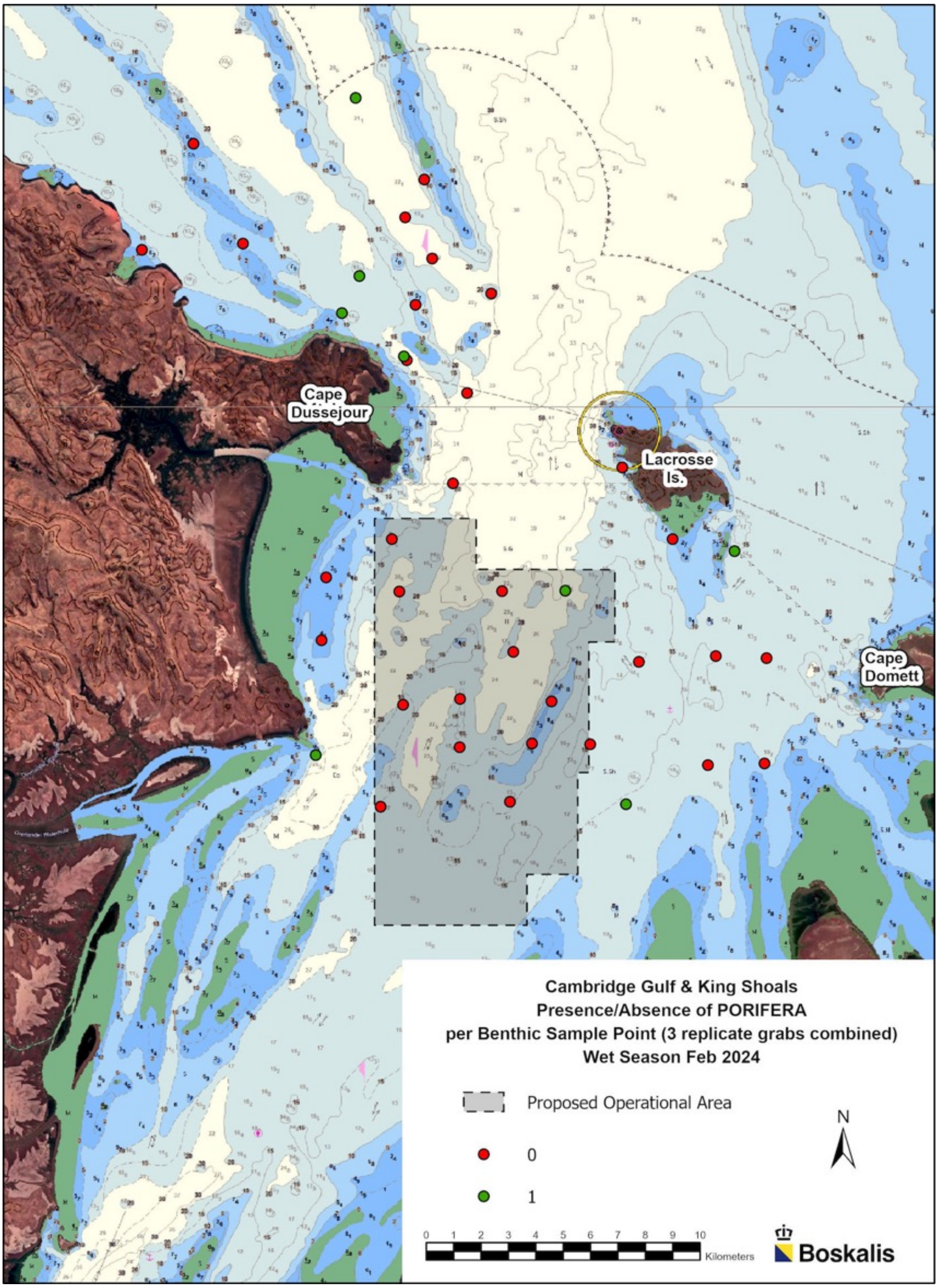

Cape Dussejour
Lacrosse Is.
Cape Domett
Cambridge Gulf & King Shoals
Presence/Absence of CRUSTACEA
per Benthic Sample Point (3 replicate grabs combined)
Wet Season Feb 2024
Proposed Operational Area
0
1
N
0 1 2 3 4 5 6 7 8 9 10
Kilometers
Boskalis

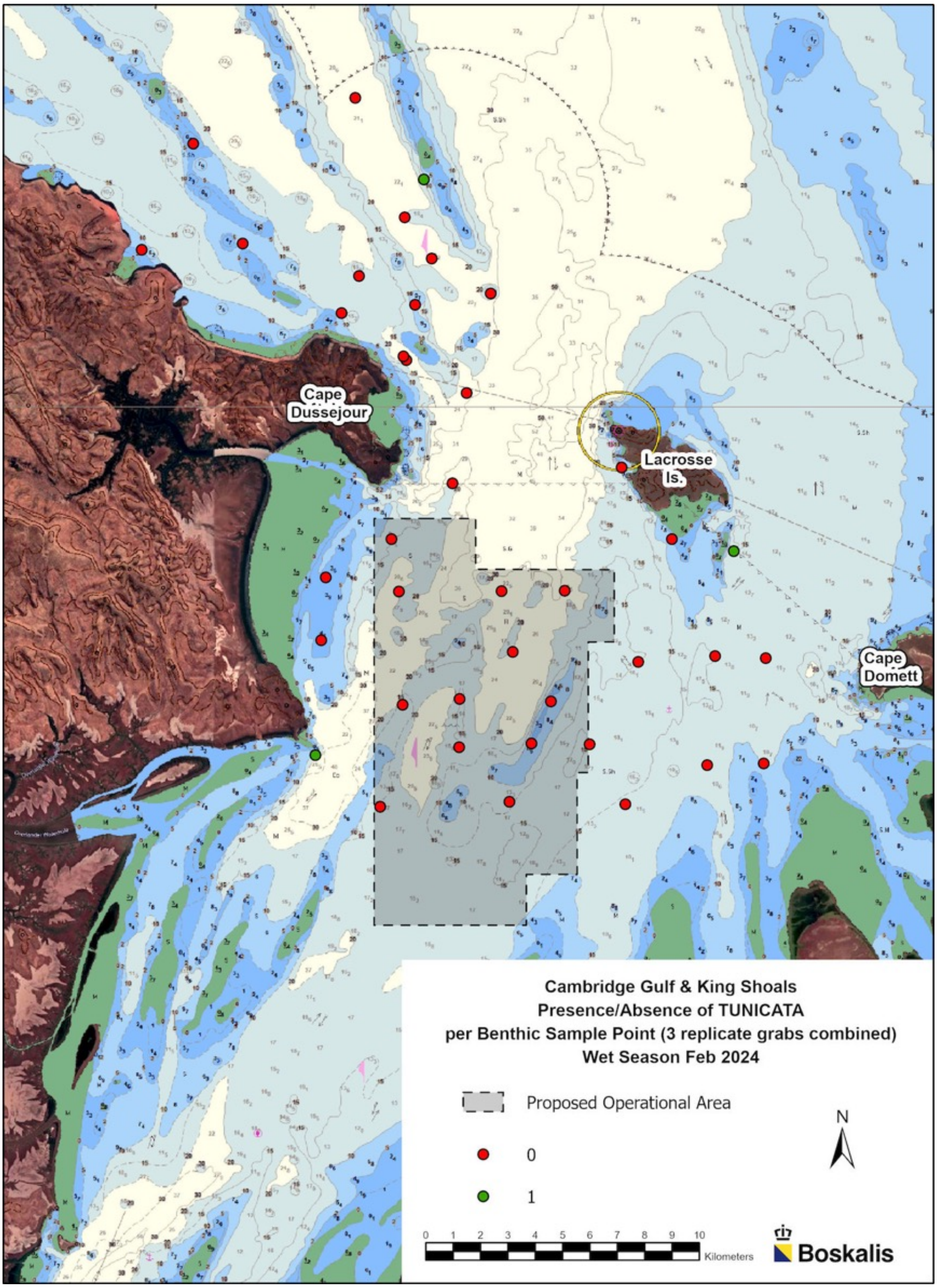

Cape Dussejour
Lacrosse Is.
Cape Domett
Cambridge Gulf & King Shoals
Presence/Absence of ECHINODERMATA
per Benthic Sample Point (3 replicate grabs combined)
Wet Season Feb 2024
Proposed Operational Area
0
1
N
0 1 2 3 4 5 6 7 8 9 10 Kilometers
Boskalis


Cape Dussejour
Lacrosse Is.
Cape Domett
Cambridge Gulf & King Shoals
Presence/Absence of HYDROZOA
per Benthic Sample Point (3 replicate grabs combined)
Wet Season Feb 2024
Proposed Operational Area
0
1
N
0 1 2 3 4 5 6 7 8 9 10 Kilometers
Boskalis

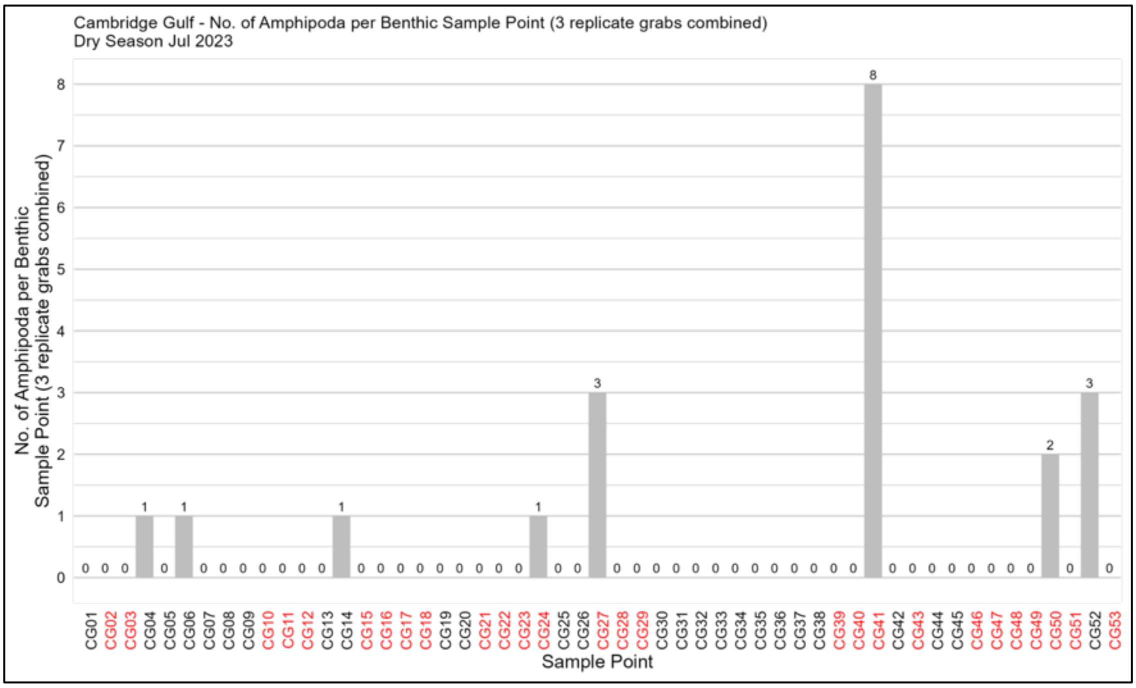

Cape Dussejour
Lacrosse Is.
Cape Domett
Cambridge Gulf & King Shoals
Presence/Absence of ISOPODA
per Benthic Sample Point (3 replicate grabs combined)
Wet Season Feb 2024
Proposed Operational Area
0
1
N
0 1 2 3 4 5 6 7 8 9 10
Kilometers
Boskalis

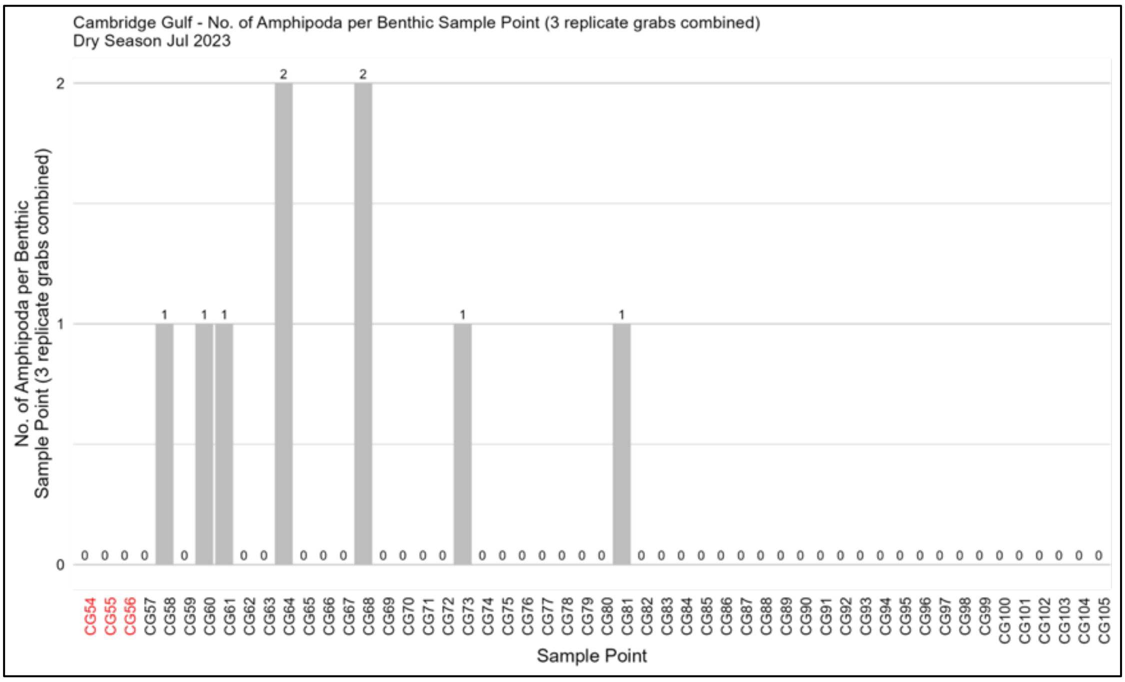

Cape Dussejour
Lacrosse Is.
Cape Domett
Cambridge Gulf & King Shoals
Presence/Absence of POLYCHAETA
per Benthic Sample Point (3 replicate grabs combined)
Wet Season Feb 2024
Proposed Operational Area
0
1
N
0 1 2 3 4 5 6 7 8 9 10
Kilometers
Boskalis


Cape Dussejour
Lacrosse Is.
Cape Domett
Cambridge Gulf & King Shoals
Presence/Absence of PORIFERA
per Benthic Sample Point (3 replicate grabs combined)
Wet Season Feb 2024
Proposed Operational Area
0
1
N
0 1 2 3 4 5 6 7 8 9 10 Kilometers
Boskalis

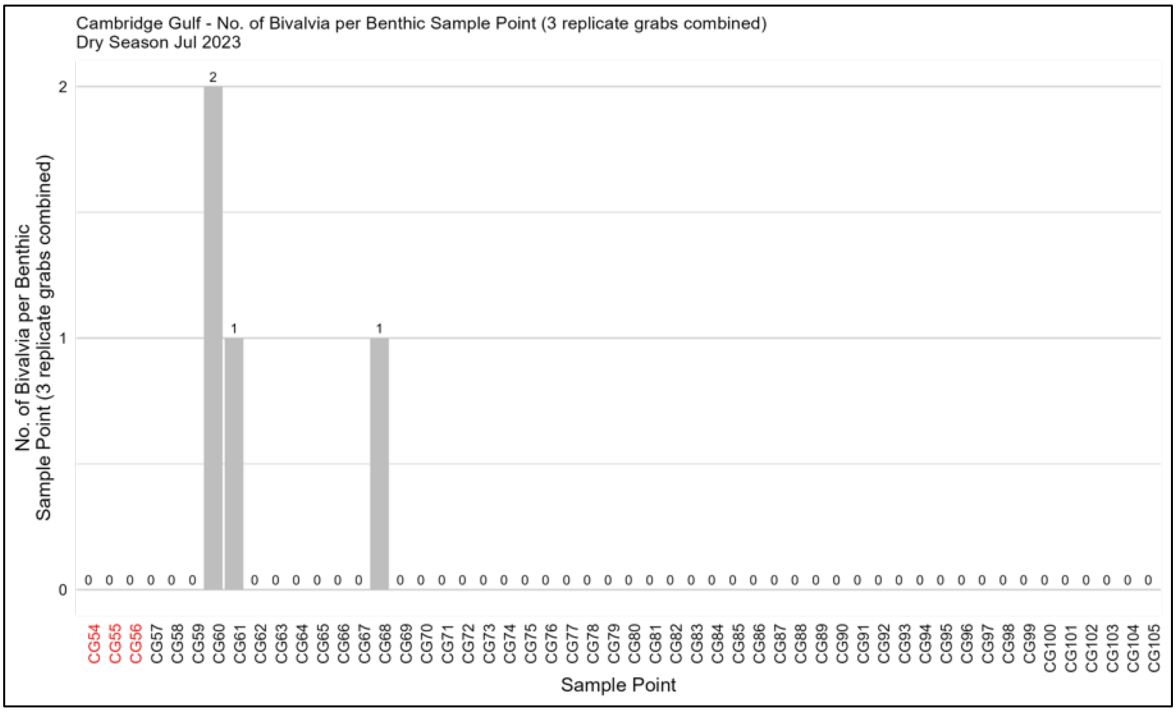

Cape Dussejour
Lacrosse Is.
Cape Domett
Cambridge Gulf & King Shoals
Presence/Absence of TUNICATA
per Benthic Sample Point (3 replicate grabs combined)
Wet Season Feb 2024
Proposed Operational Area
0
1
N
0 1 2 3 4 5 6 7 8 9 10
Kilometers
Boskalis

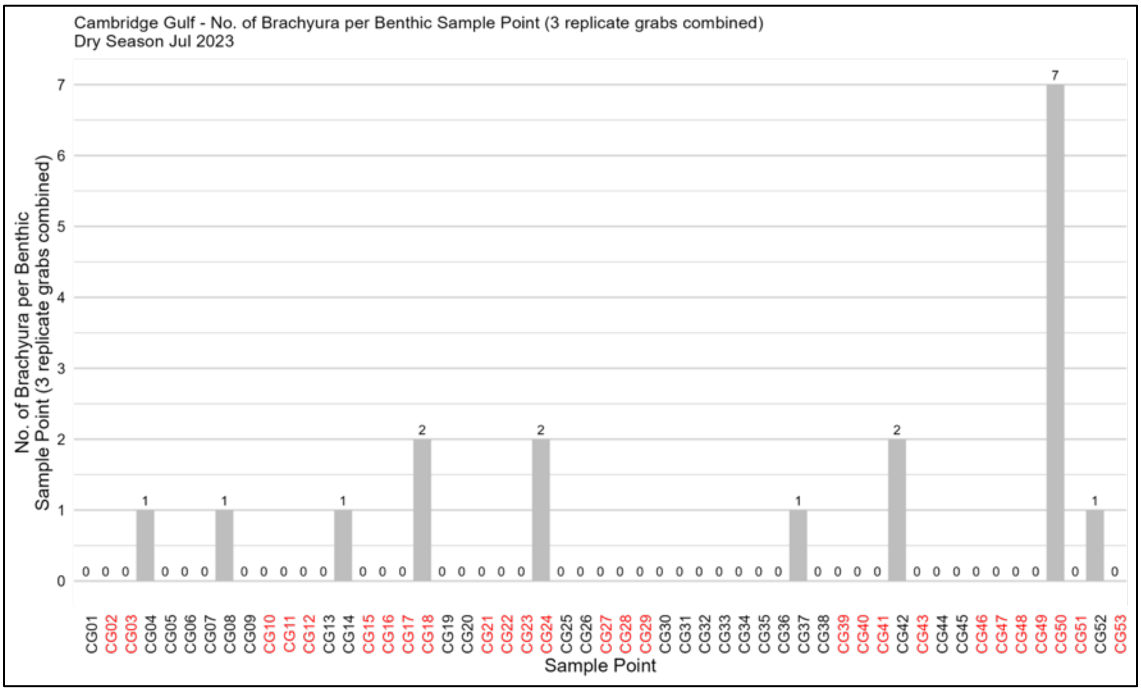
ANNEX 8: BENTHIC TAXA PER SAMPLE POINT – DRY SEASON GRAPHS

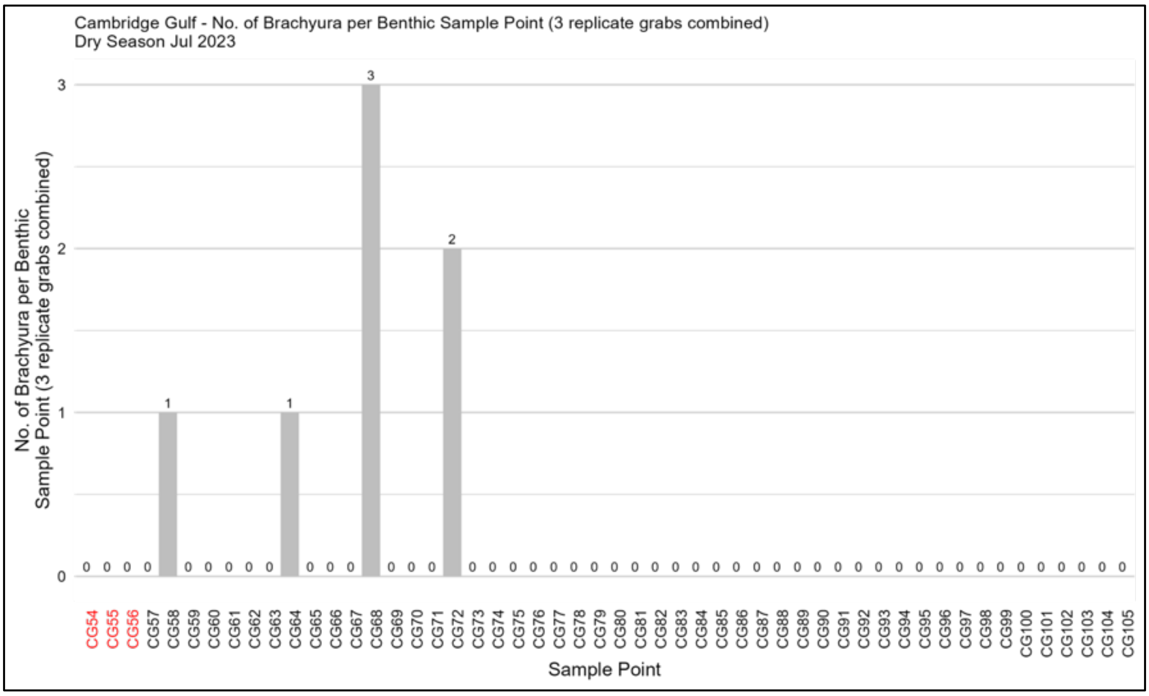


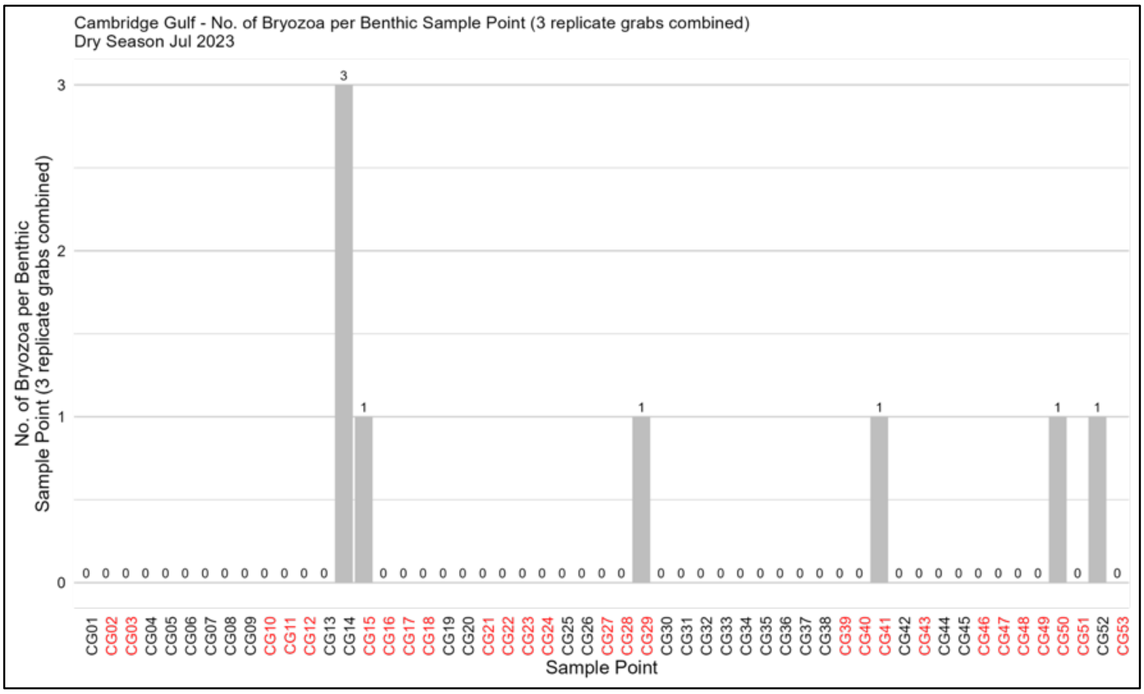


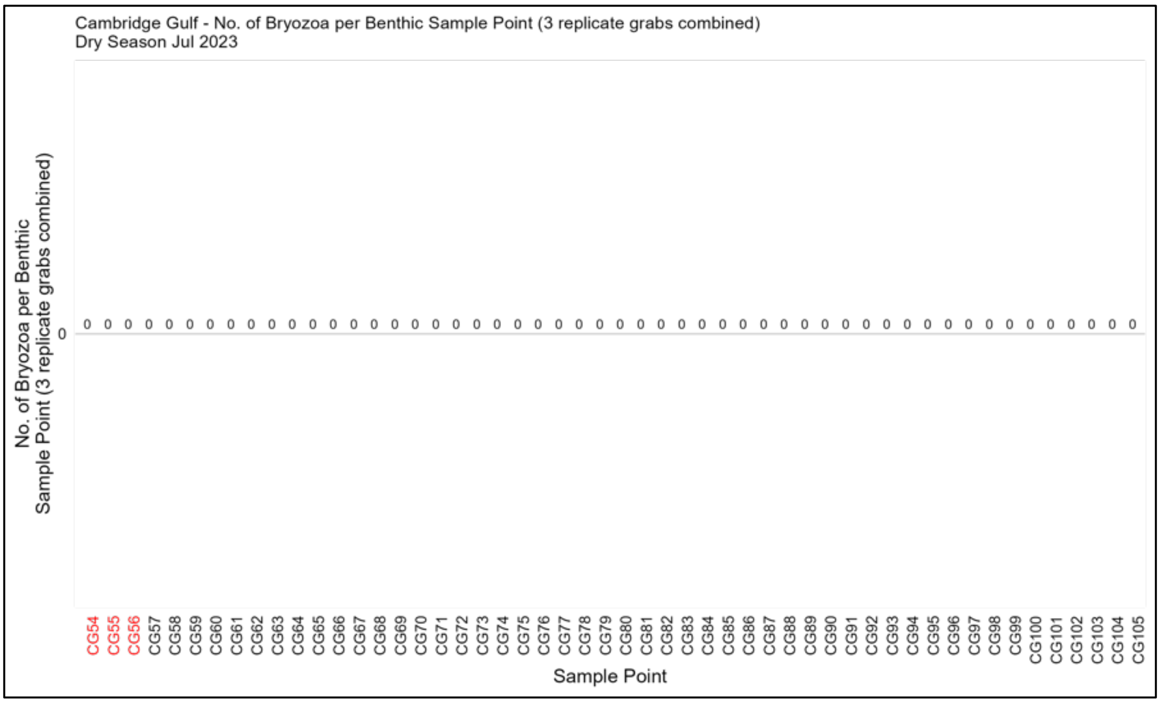

Cambridge Gulf - No. of Bivalvia per Benthic Sample Point (3 replicate grabs combined)
Dry Season Jul 2023
No. of Bivalvia per Benthic Sample Point (3 replicate grabs combined)
Sample Point

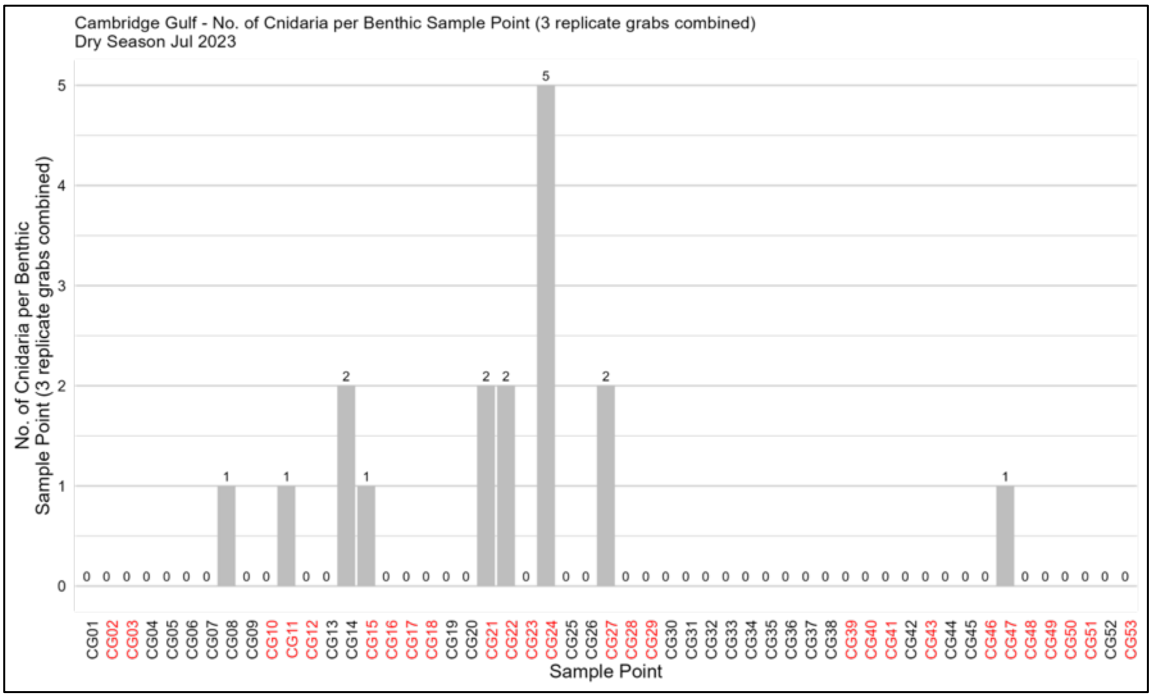

Cambridge Gulf - No. of Bivalvia per Benthic Sample Point (3 replicate grabs combined)
Dry Season Jul 2023
No. of Bivalvia per Benthic Sample Point (3 replicate grabs combined)
Sample Point

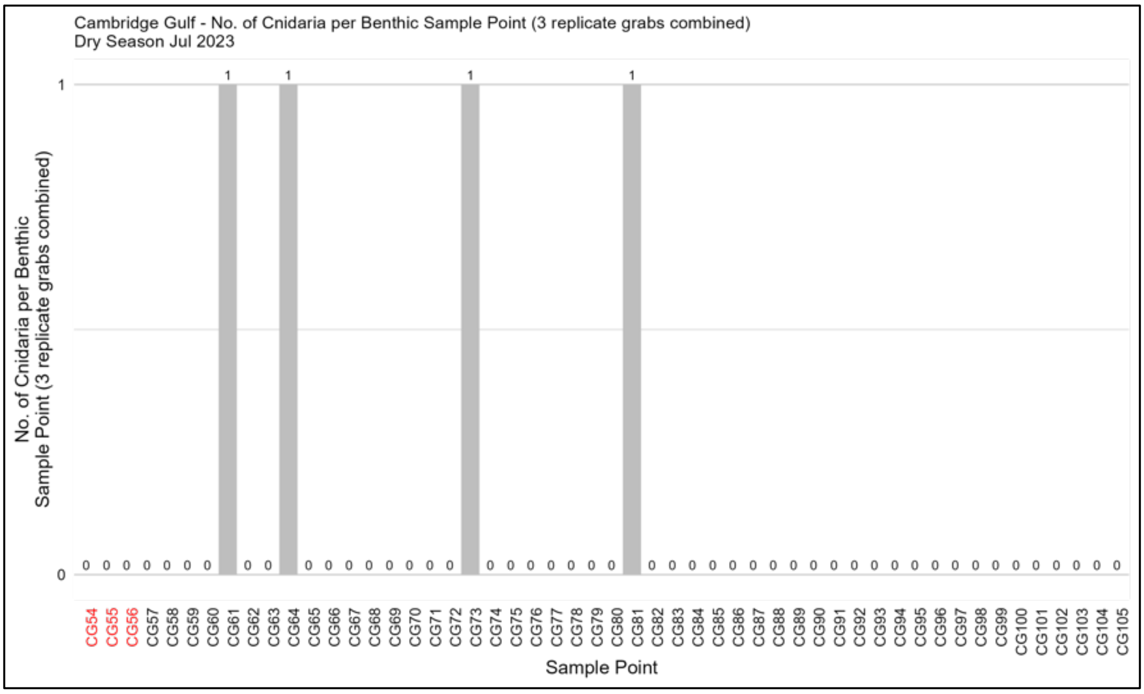

Cambridge Gulf - No. of Brachyura per Benthic Sample Point (3 replicate grabs combined)
Dry Season Jul 2023
No. of Brachyura per Benthic Sample Point (3 replicate grabs combined)
Sample Point

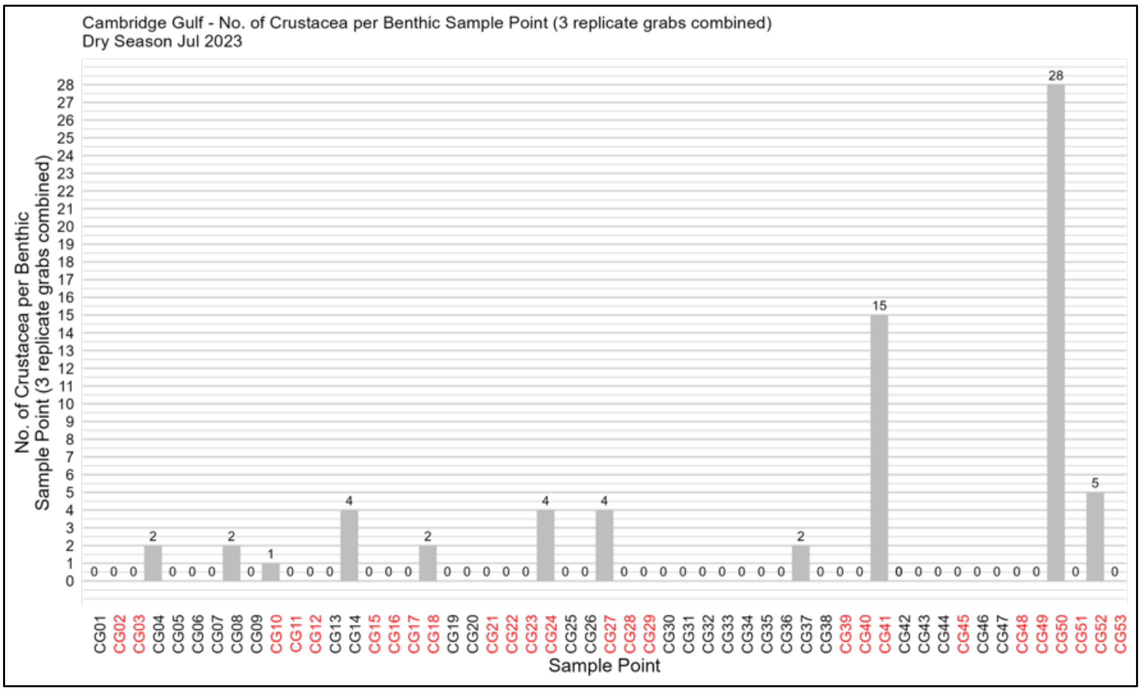

Cambridge Gulf - No. of Brachyura per Benthic Sample Point (3 replicate grabs combined)
Dry Season Jul 2023
No. of Brachyura per Benthic Sample Point (3 replicate grabs combined)
Sample Point

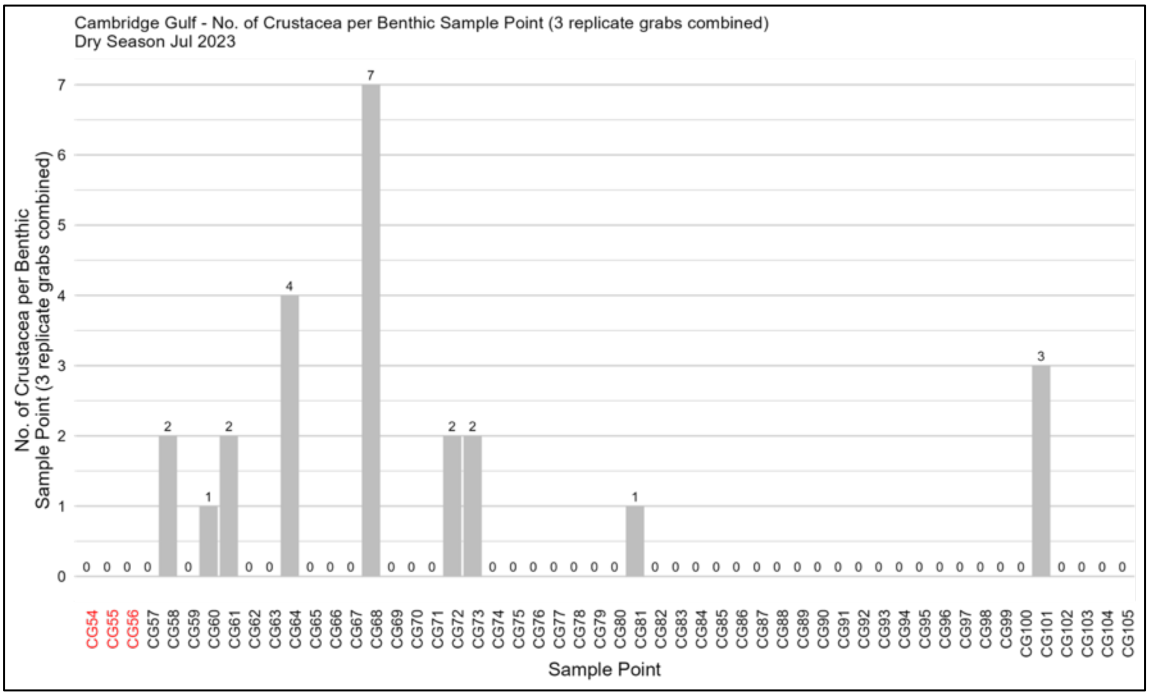

Cambridge Gulf - No. of Bryozoa per Benthic Sample Point (3 replicate grabs combined)
Dry Season Jul 2023
No. of Bryozoa per Benthic Sample Point (3 replicate grabs combined)
Sample Point

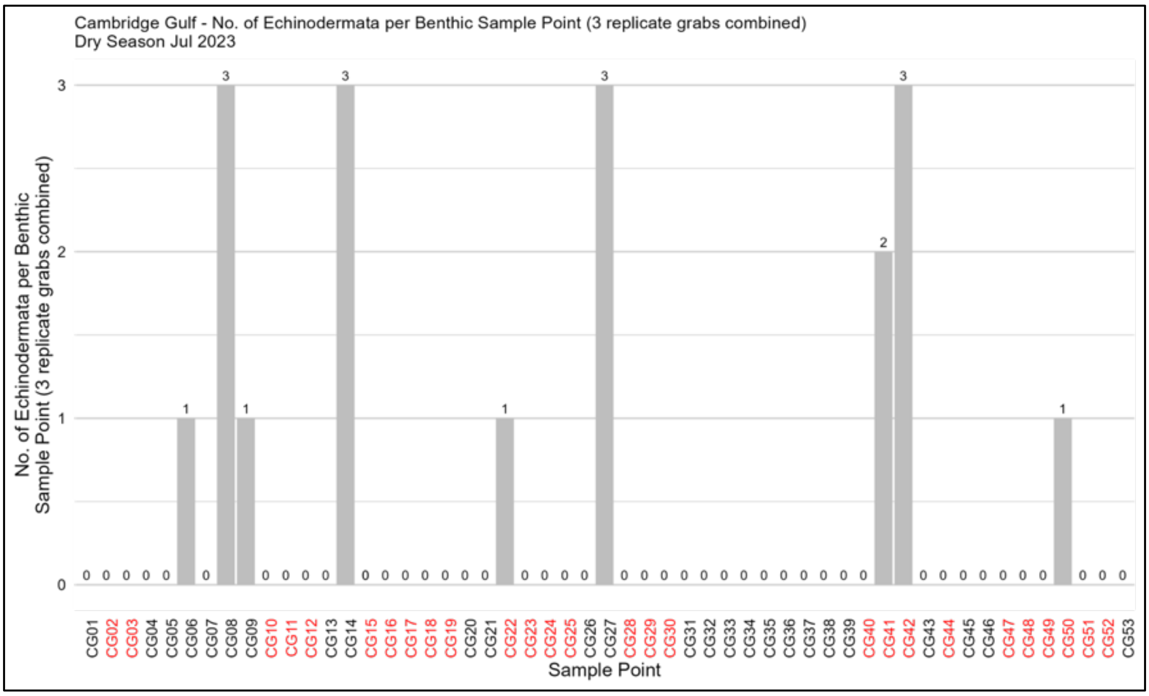

Cambridge Gulf - No. of Bryozoa per Benthic Sample Point (3 replicate grabs combined)
Dry Season Jul 2023
No. of Bryozoa per Benthic Sample Point (3 replicate grabs combined)
Sample Point

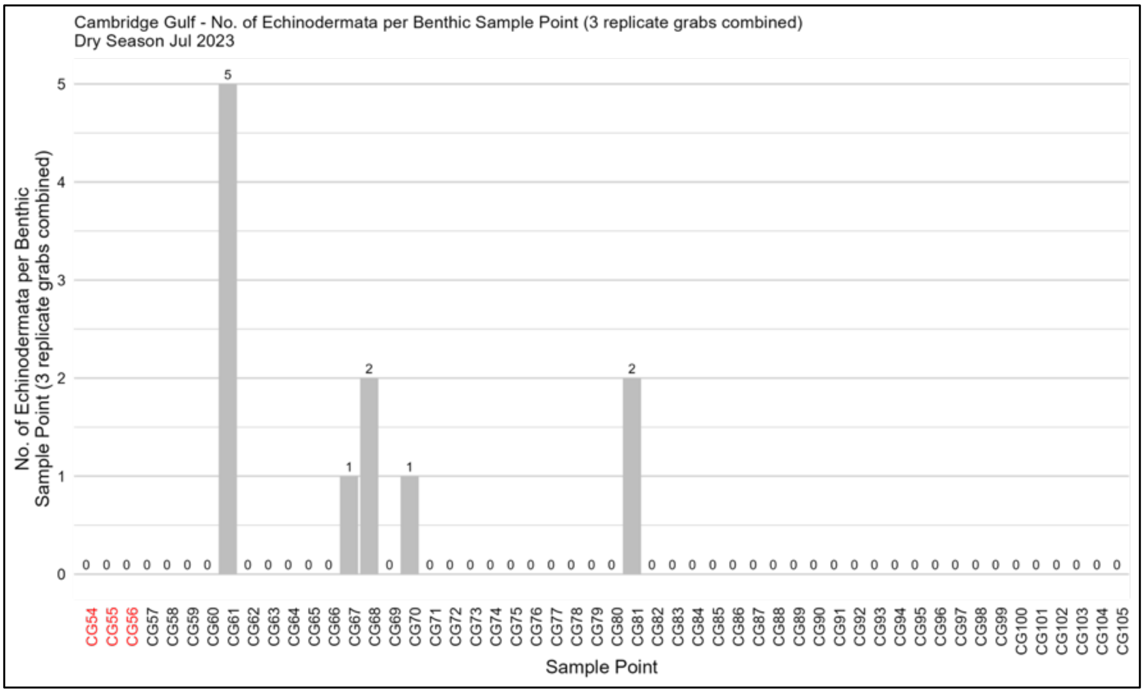

Cambridge Gulf - No. of Cnidaria per Benthic Sample Point (3 replicate grabs combined)
Dry Season Jul 2023
No. of Cnidaria per Benthic Sample Point (3 replicate grabs combined)
Sample Point

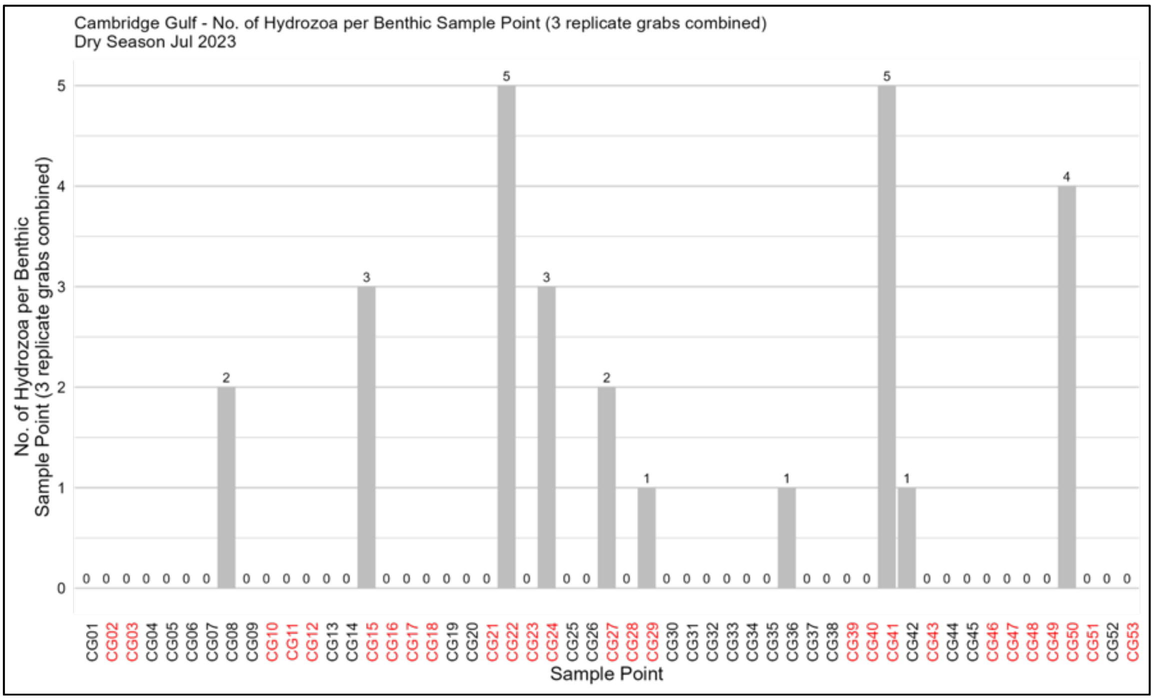

Cambridge Gulf - No. of Cnidaria per Benthic Sample Point (3 replicate grabs combined)
Dry Season Jul 2023
No. of Cnidaria per Benthic Sample Point (3 replicate grabs combined)
Sample Point

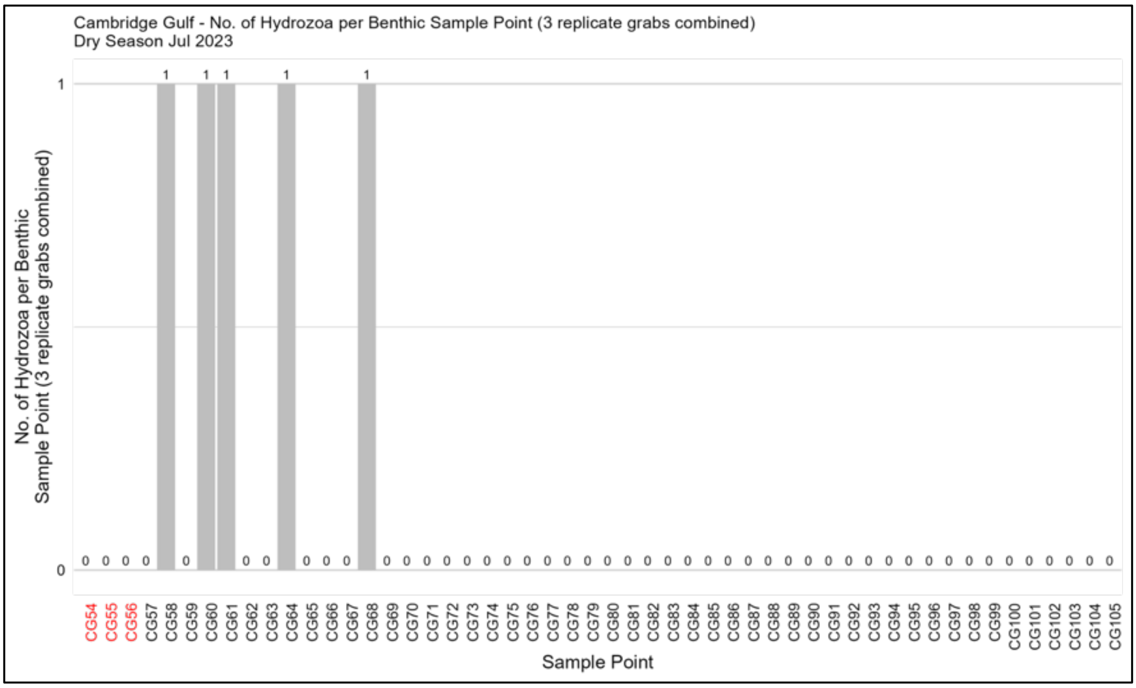

Cambridge Gulf - No. of Crustacea per Benthic Sample Point (3 replicate grabs combined)
Dry Season Jul 2023
No. of Crustacea per Benthic Sample Point (3 replicate grabs combined)
Sample Point

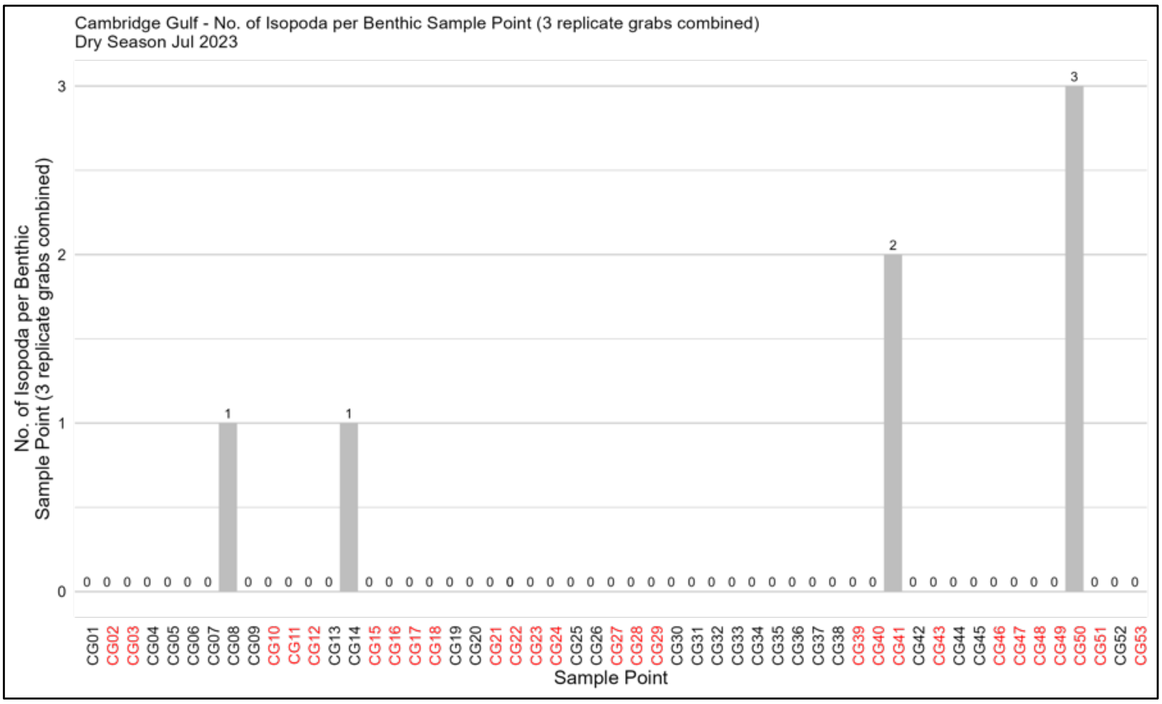

Cambridge Gulf - No. of Crustacea per Benthic Sample Point (3 replicate grabs combined)
Dry Season Jul 2023
No. of Crustacea per Benthic Sample Point (3 replicate grabs combined)
Sample Point

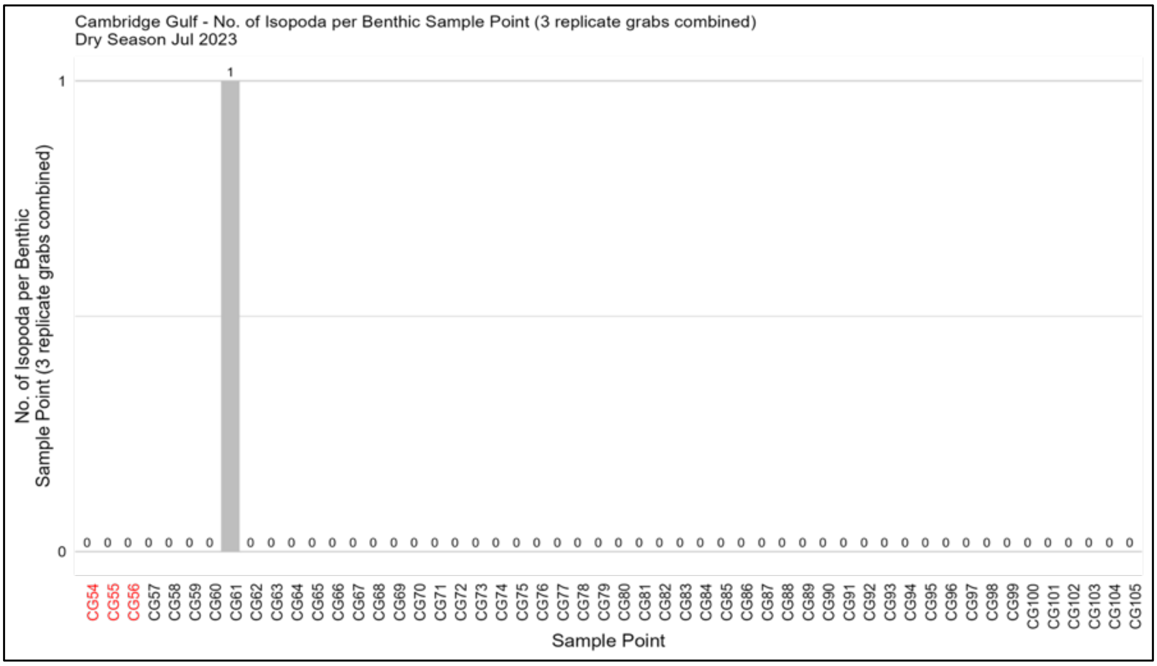

Cambridge Gulf - No. of Echinodermata per Benthic Sample Point (3 replicate grabs combined)
Dry Season Jul 2023
No. of Echinodermata per Benthic Sample Point (3 replicate grabs combined)
Sample Point

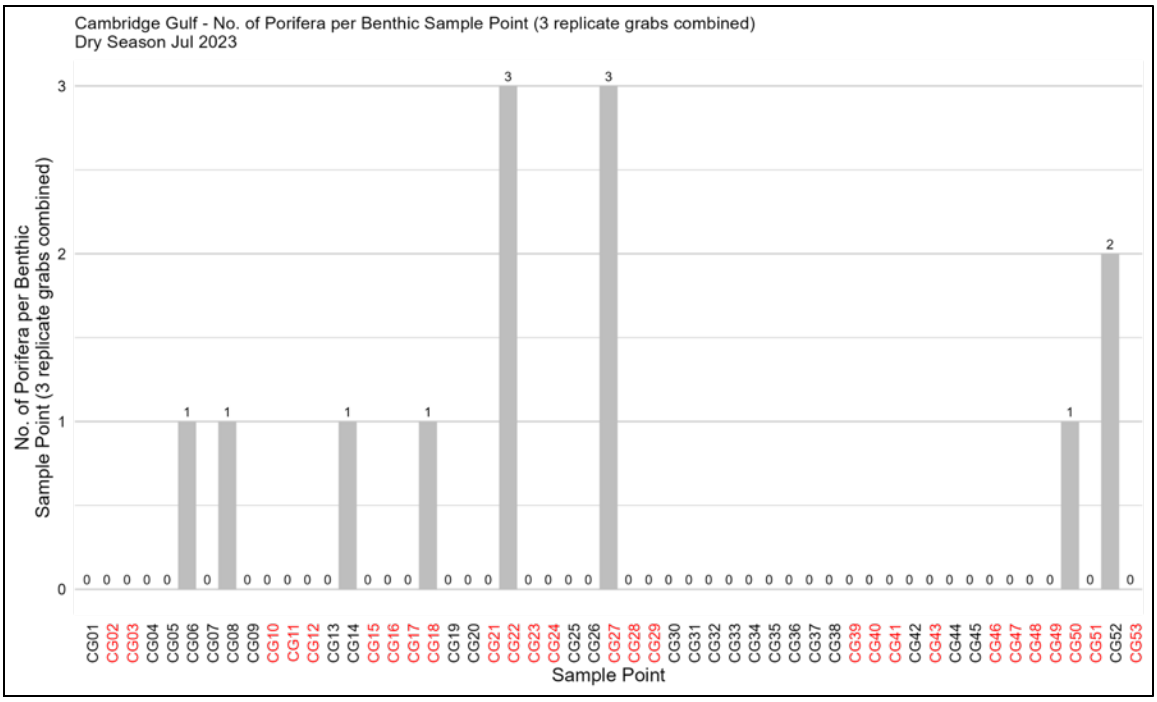

Cambridge Gulf - No. of Echinodermata per Benthic Sample Point (3 replicate grabs combined)
Dry Season Jul 2023
No. of Echinodermata per Benthic Sample Point (3 replicate grabs combined)
Sample Point

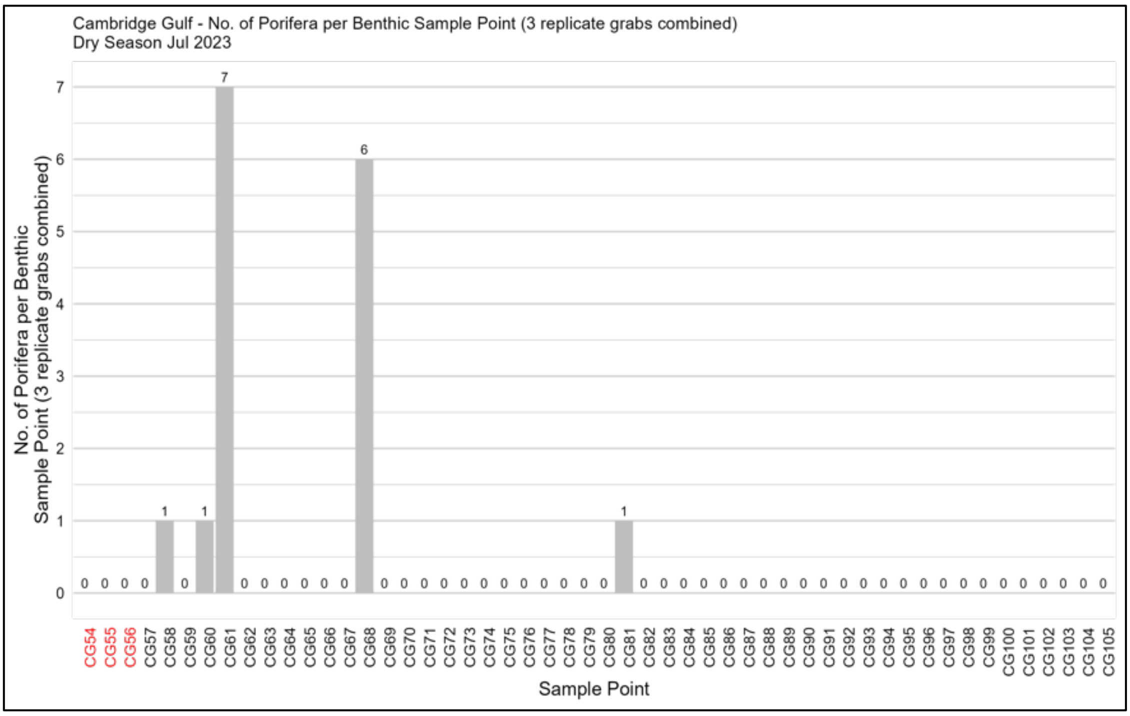

Cambridge Gulf - No. of Hydrozoa per Benthic Sample Point (3 replicate grabs combined)
Dry Season Jul 2023
No. of Hydrozoa per Benthic Sample Point (3 replicate grabs combined)
Sample Point
0
1
2
3
4
5
CG01 CG02 CG03 CG04 CG05 CG06 CG07 CG08 CG09 CG10 CG11 CG12 CG13 CG14 CG15 CG16 CG17 CG18 CG19 CG20 CG21 CG22 CG23 CG24 CG25 CG26 CG27 CG28 CG29 CG30 CG31 CG32 CG33 CG34 CG35 CG36 CG37 CG38 CG39 CG40 CG41 CG42 CG43 CG44 CG45 CG46 CG47 CG48 CG49 CG50 CG51 CG52 CG53
0 0 0 0 0 0 0 2 0 0 0 0 0 0 3 0 0 0 0 0 0 5 0 3 0 0 2 0 1 0 0 0 0 0 0 1 0 0 0 0 5 1 0 0 0 0 0 0 0 4 0 0 0

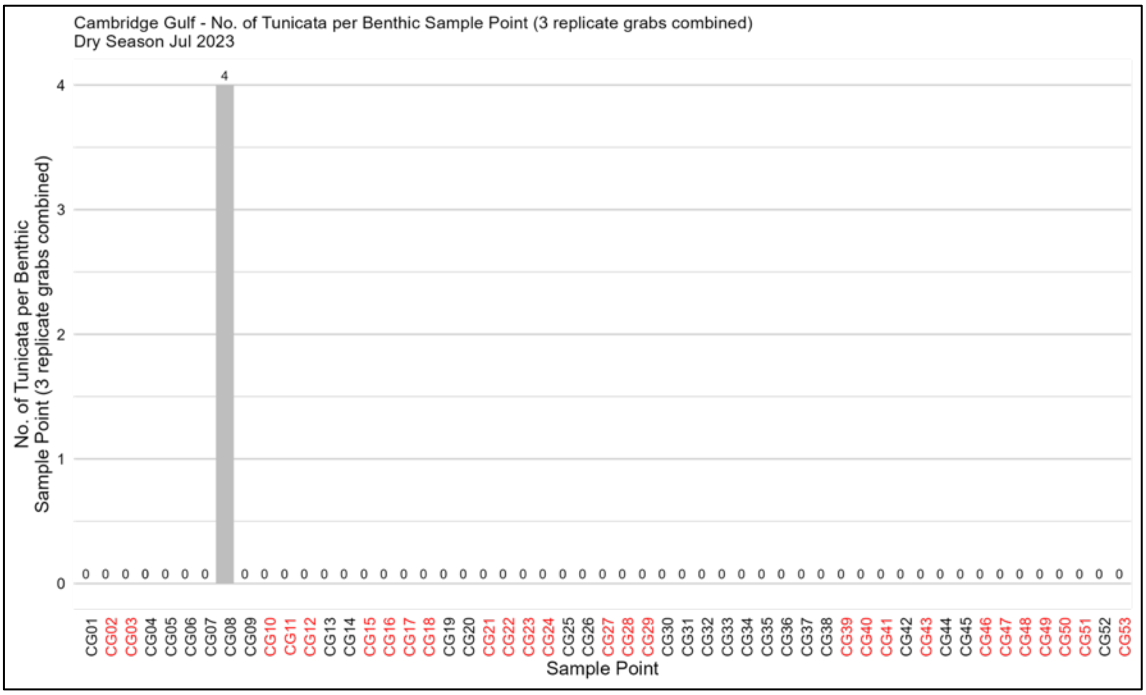

Cambridge Gulf - No. of Hydrozoa per Benthic Sample Point (3 replicate grabs combined)
Dry Season Jul 2023
No. of Hydrozoa per Benthic Sample Point (3 replicate grabs combined)
Sample Point
0
1
CG54 CG55 CG56 CG57 CG58 CG59 CG60 CG61 CG62 CG63 CG64 CG65 CG66 CG67 CG68 CG69 CG70 CG71 CG72 CG73 CG74 CG75 CG76 CG77 CG78 CG79 CG80 CG81 CG82 CG83 CG84 CG85 CG86 CG87 CG88 CG89 CG90 CG91 CG92 CG93 CG94 CG95 CG96 CG97 CG98 CG99 CG100 CG101 CG102 CG103 CG104 CG105
0 0 0 0 1 0 1 1 0 0 1 0 0 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0

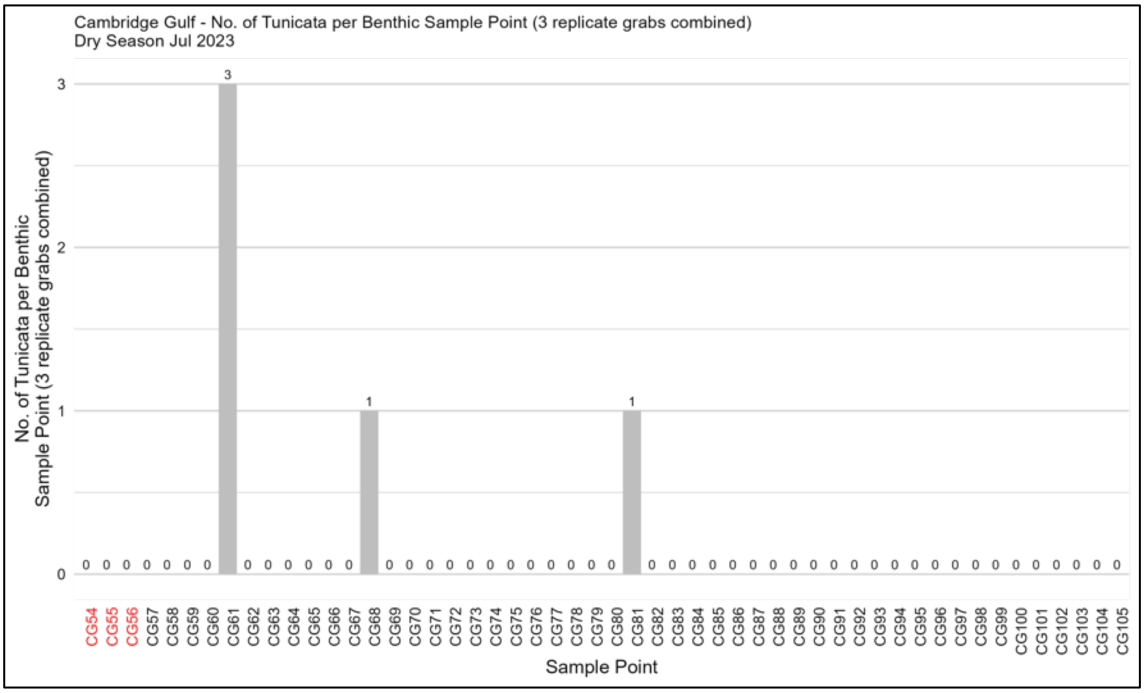

Cambridge Gulf - No. of Isopoda per Benthic Sample Point (3 replicate grabs combined)
Dry Season Jul 2023
No. of Isopoda per Benthic Sample Point (3 replicate grabs combined)
Sample Point

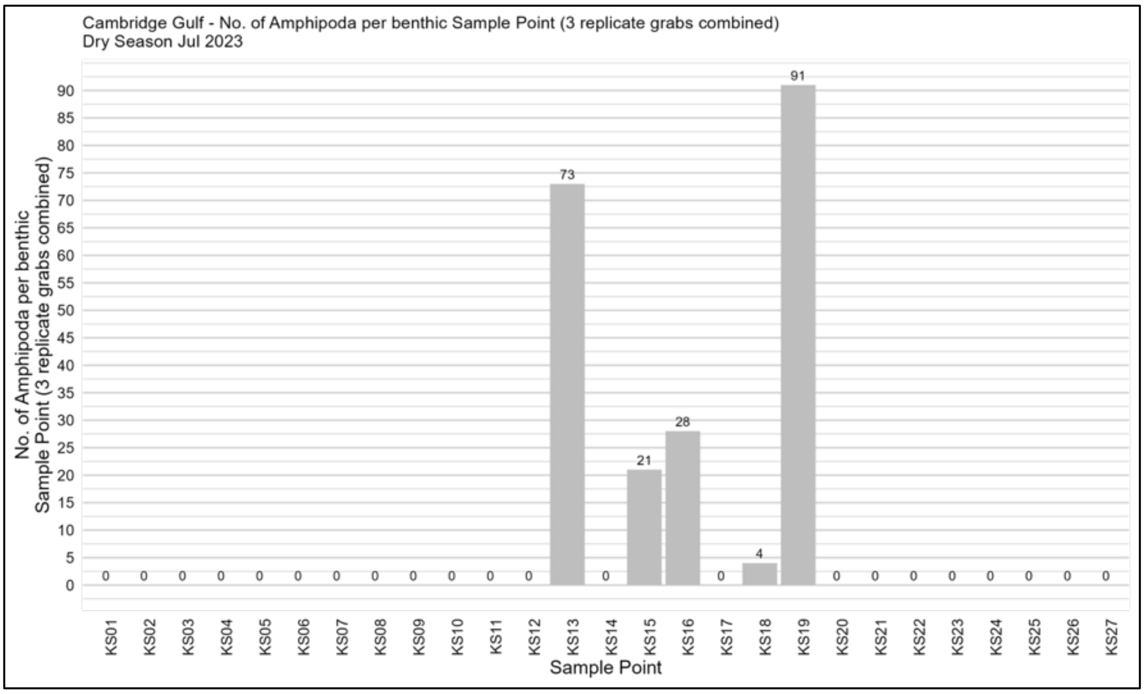

Cambridge Gulf - No. of Isopoda per Benthic Sample Point (3 replicate grabs combined)
Dry Season Jul 2023
No. of Isopoda per Benthic Sample Point (3 replicate grabs combined)
Sample Point

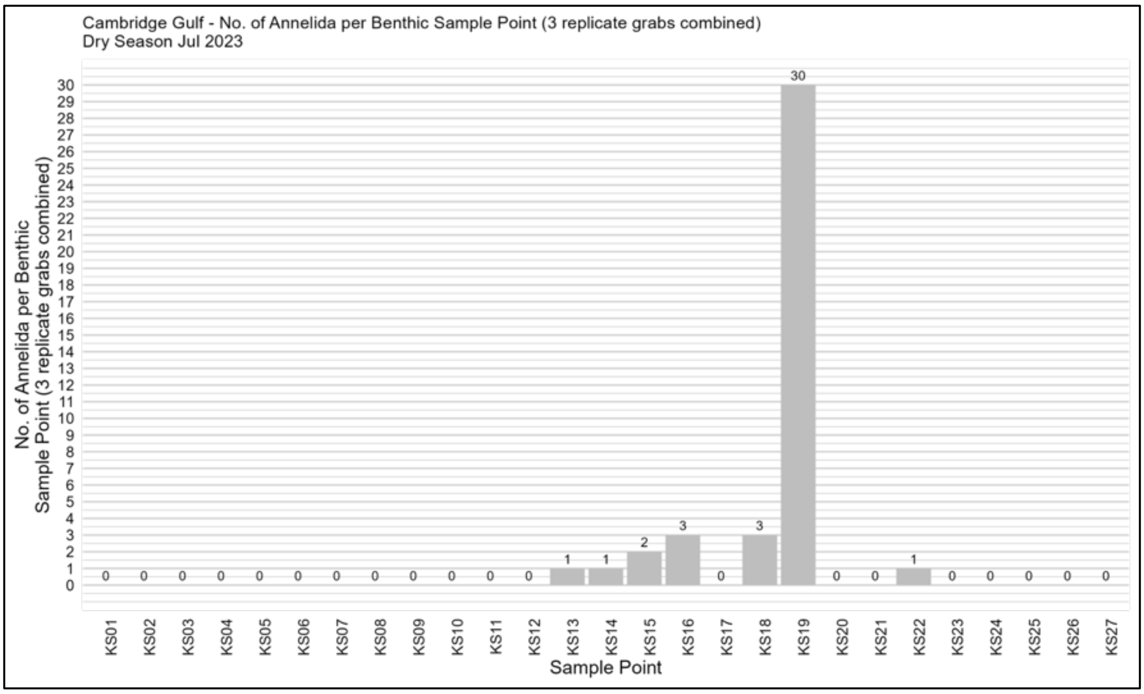

Cambridge Gulf - No. of Porifera per Benthic Sample Point (3 replicate grabs combined)
Dry Season Jul 2023
No. of Porifera per Benthic Sample Point (3 replicate grabs combined)
Sample Point

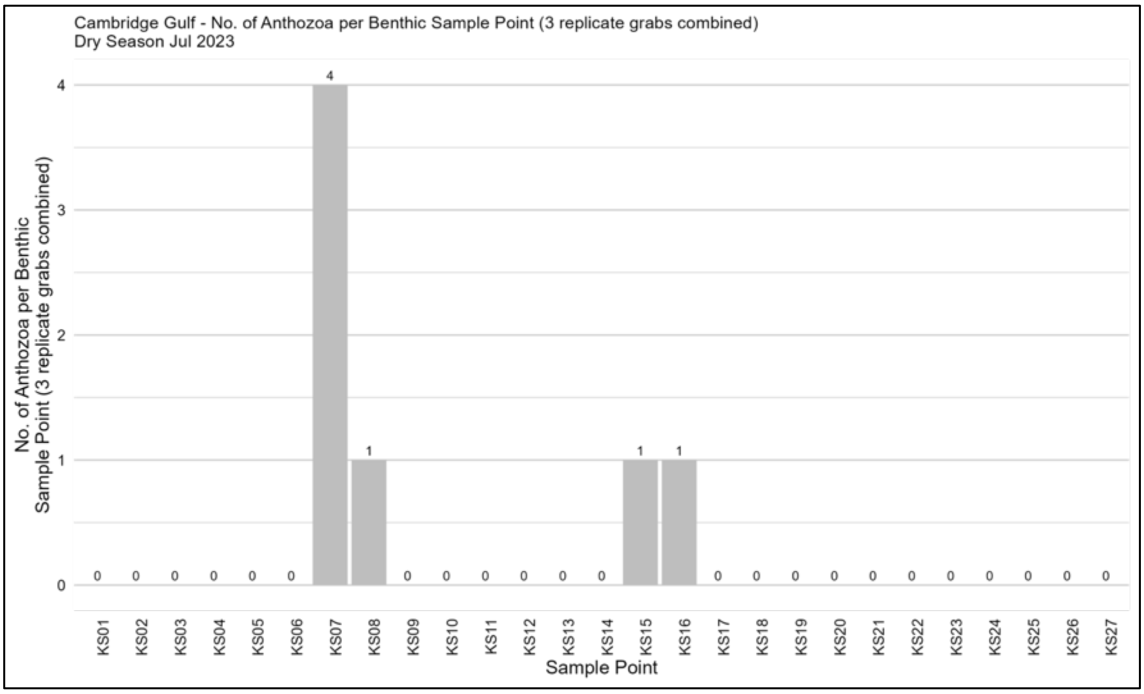

Cambridge Gulf - No. of Porifera per Benthic Sample Point (3 replicate grabs combined)
Dry Season Jul 2023
No. of Porifera per Benthic Sample Point (3 replicate grabs combined)
Sample Point

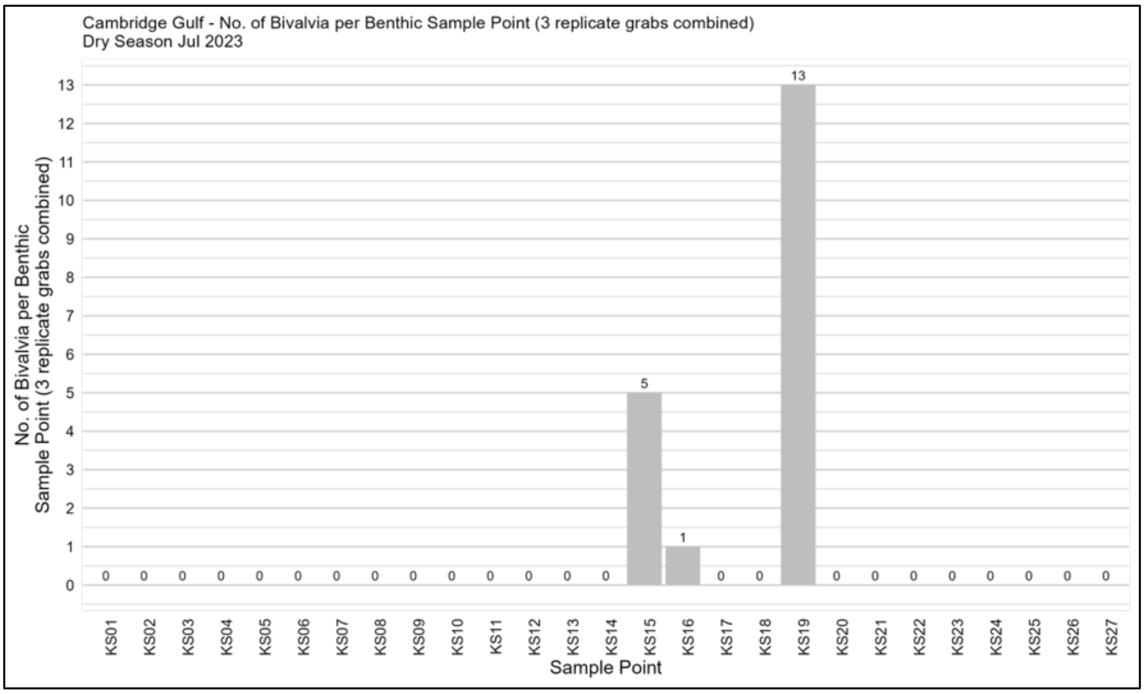

Cambridge Gulf - No. of Tunicata per Benthic Sample Point (3 replicate grabs combined)
Dry Season Jul 2023
No. of Tunicata per Benthic Sample Point (3 replicate grabs combined)
Sample Point

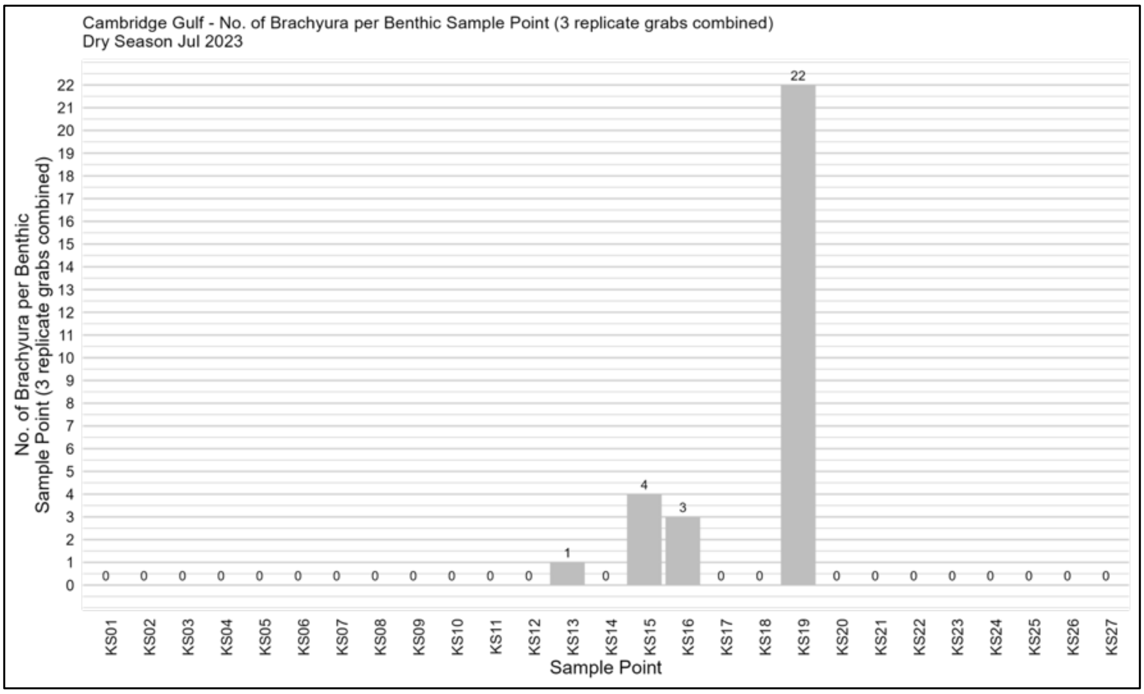

Cambridge Gulf - No. of Tunicata per Benthic Sample Point (3 replicate grabs combined)
Dry Season Jul 2023
No. of Tunicata per Benthic Sample Point (3 replicate grabs combined)
Sample Point

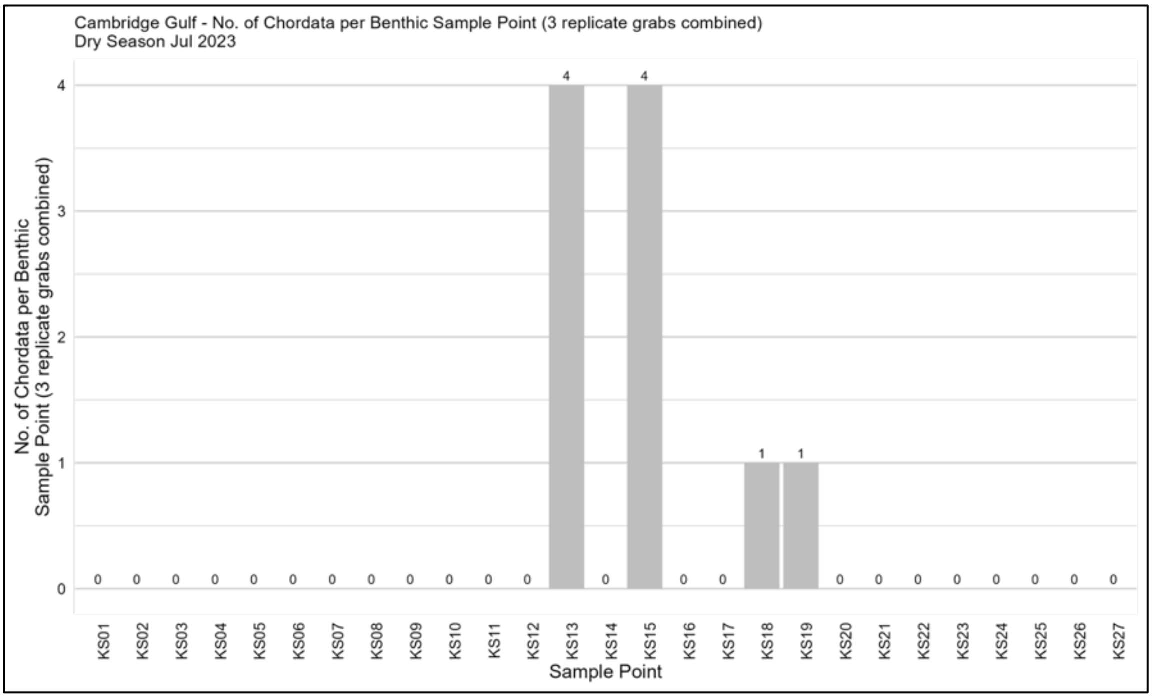

Cambridge Gulf - No. of Amphipoda per benthic Sample Point (3 replicate grabs combined)
Dry Season Jul 2023
No. of Amphipoda per benthic Sample Point (3 replicate grabs combined)
Sample Point
KS01 0
KS02 0
KS03 0
KS04 0
KS05 0
KS06 0
KS07 0
KS08 0
KS09 0
KS10 0
KS11 0
KS12 0
KS13 73
KS14 0
KS15 21
KS16 28
KS17 0
KS18 4
KS19 91
KS20 0
KS21 0
KS22 0
KS23 0
KS24 0
KS25 0
KS26 0
KS27 0

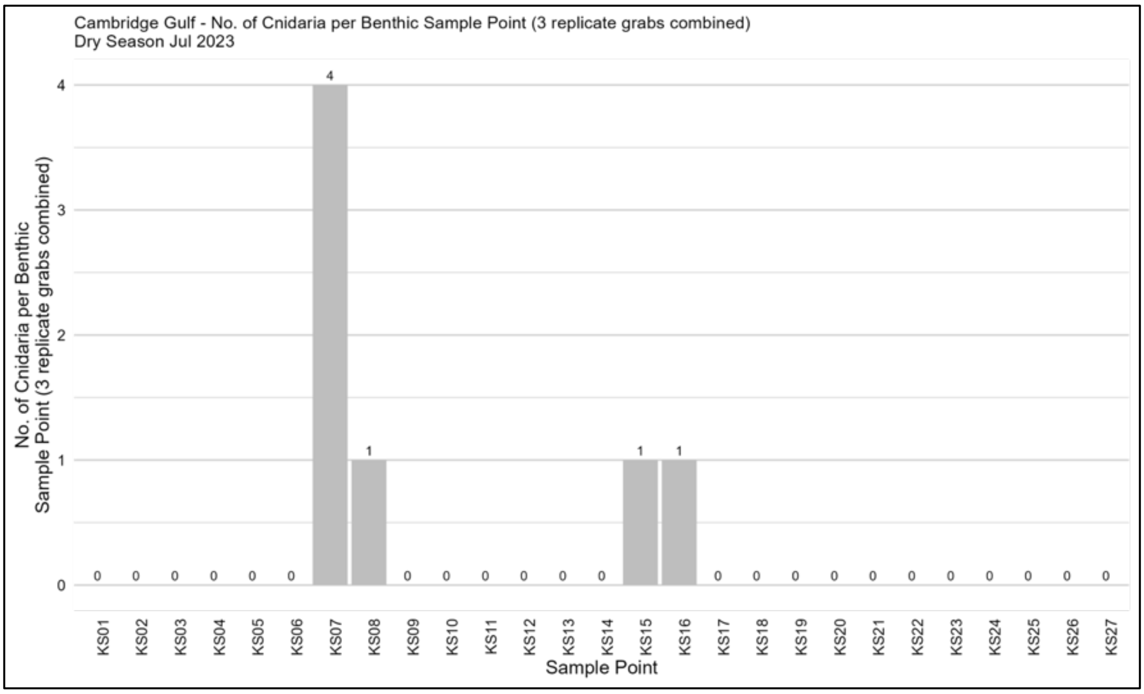

Cambridge Gulf - No. of Annelida per Benthic Sample Point (3 replicate grabs combined)
Dry Season Jul 2023
No. of Annelida per Benthic Sample Point (3 replicate grabs combined)
Sample Point
KS01 0
KS02 0
KS03 0
KS04 0
KS05 0
KS06 0
KS07 0
KS08 0
KS09 0
KS10 0
KS11 0
KS12 0
KS13 1
KS14 1
KS15 2
KS16 3
KS17 0
KS18 3
KS19 30
KS20 0
KS21 0
KS22 1
KS23 0
KS24 0
KS25 0
KS26 0
KS27 0

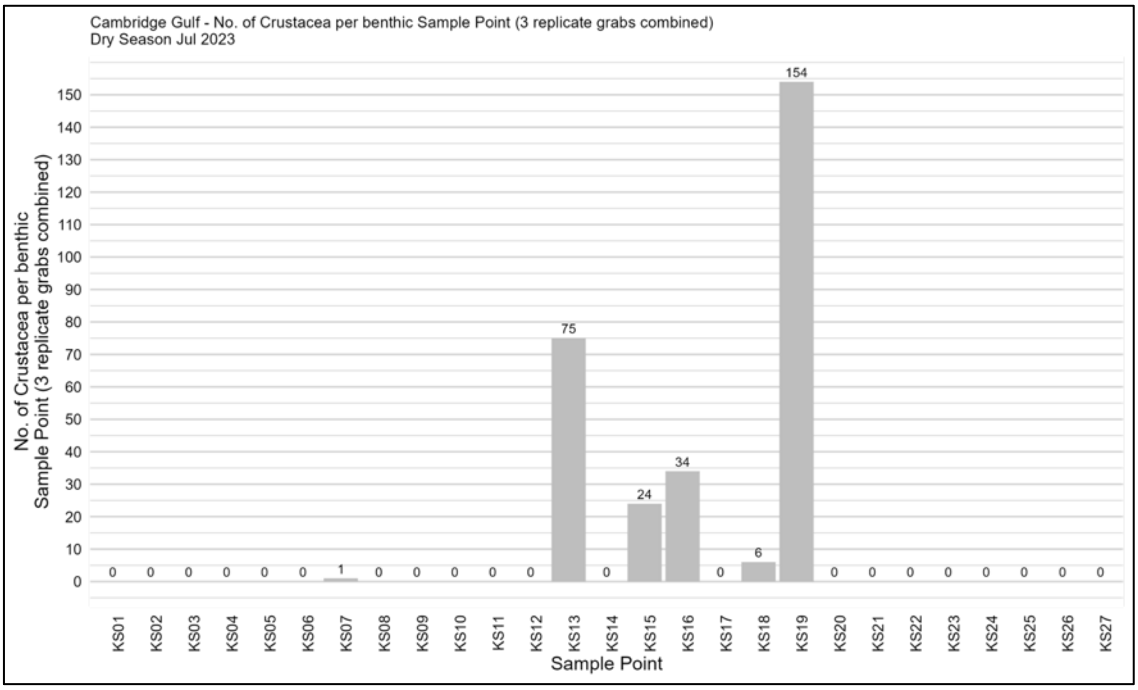

Cambridge Gulf - No. of Anthozoa per Benthic Sample Point (3 replicate grabs combined)
Dry Season Jul 2023
No. of Anthozoa per Benthic Sample Point (3 replicate grabs combined)
Sample Point
KS01 KS02 KS03 KS04 KS05 KS06 KS07 KS08 KS09 KS10 KS11 KS12 KS13 KS14 KS15 KS16 KS17 KS18 KS19 KS20 KS21 KS22 KS23 KS24 KS25 KS26 KS27
0 0 0 0 0 0 4 1 0 0 0 0 0 0 1 1 0 0 0 0 0 0 0 0 0 0 0

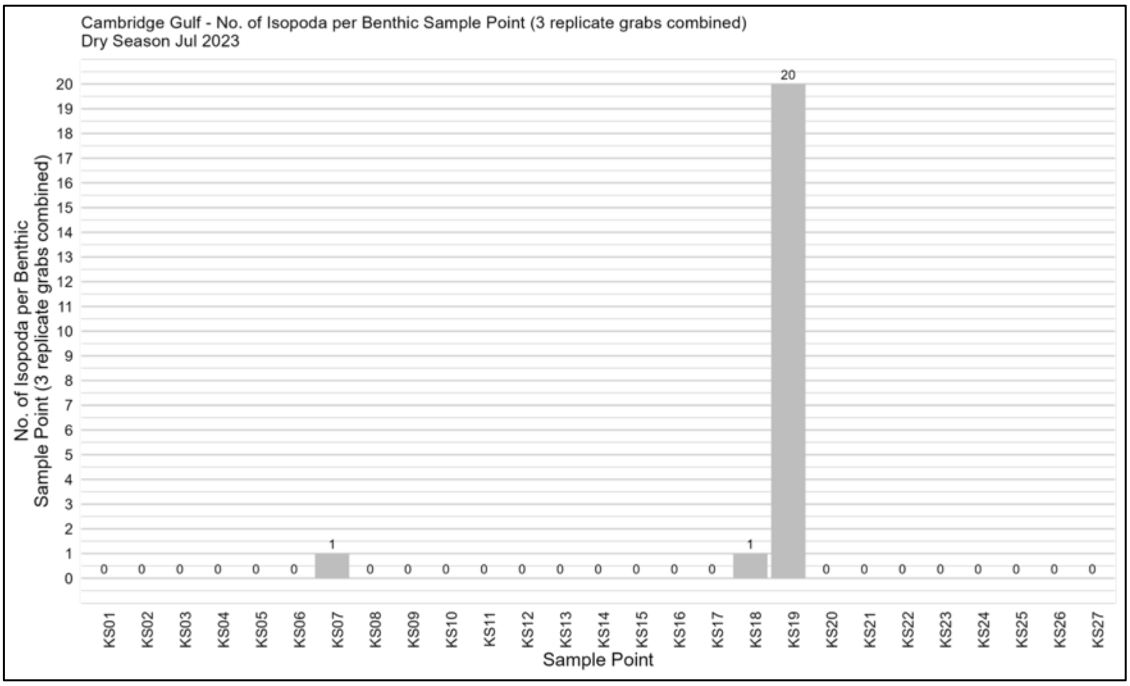

Cambridge Gulf - No. of Bivalvia per Benthic Sample Point (3 replicate grabs combined)
Dry Season Jul 2023
No. of Bivalvia per Benthic Sample Point (3 replicate grabs combined)
Sample Point
KS01 KS02 KS03 KS04 KS05 KS06 KS07 KS08 KS09 KS10 KS11 KS12 KS13 KS14 KS15 KS16 KS17 KS18 KS19 KS20 KS21 KS22 KS23 KS24 KS25 KS26 KS27
0 0 0 0 0 0 0 0 0 0 0 0 0 0 5 1 0 0 13 0 0 0 0 0 0 0 0

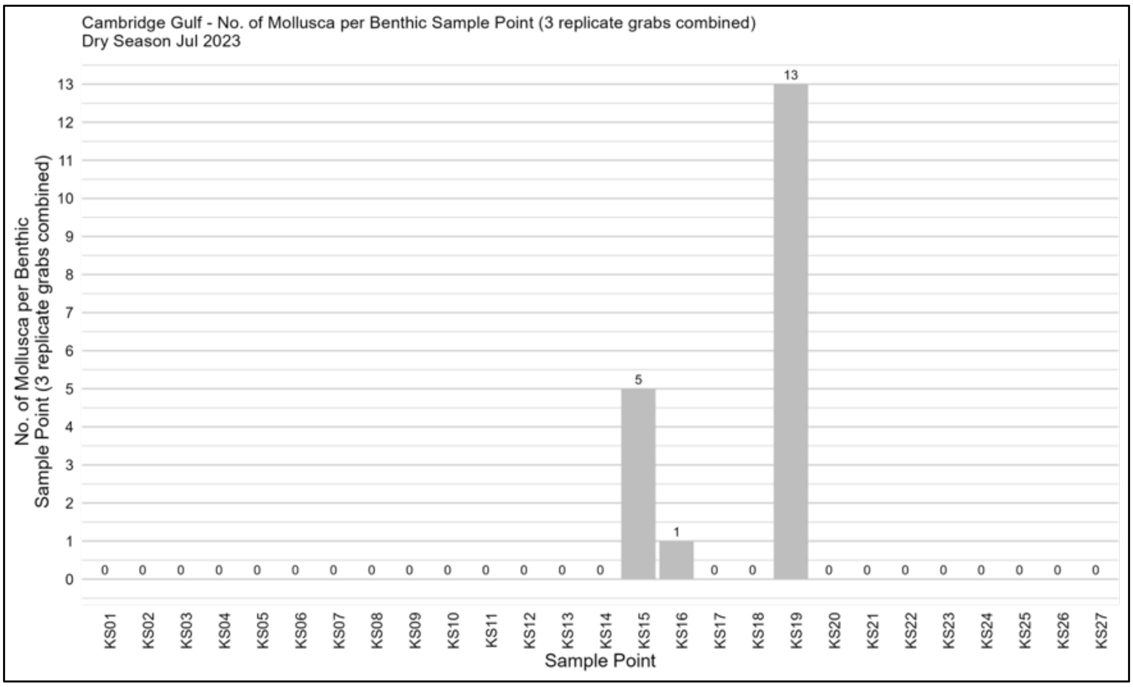

Cambridge Gulf - No. of Brachyura per Benthic Sample Point (3 replicate grabs combined)
Dry Season Jul 2023
No. of Brachyura per Benthic Sample Point (3 replicate grabs combined)
Sample Point
KS01 KS02 KS03 KS04 KS05 KS06 KS07 KS08 KS09 KS10 KS11 KS12 KS13 KS14 KS15 KS16 KS17 KS18 KS19 KS20 KS21 KS22 KS23 KS24 KS25 KS26 KS27
0 0 0 0 0 0 0 0 0 0 0 0 1 0 4 3 0 0 22 0 0 0 0 0 0 0 0 0

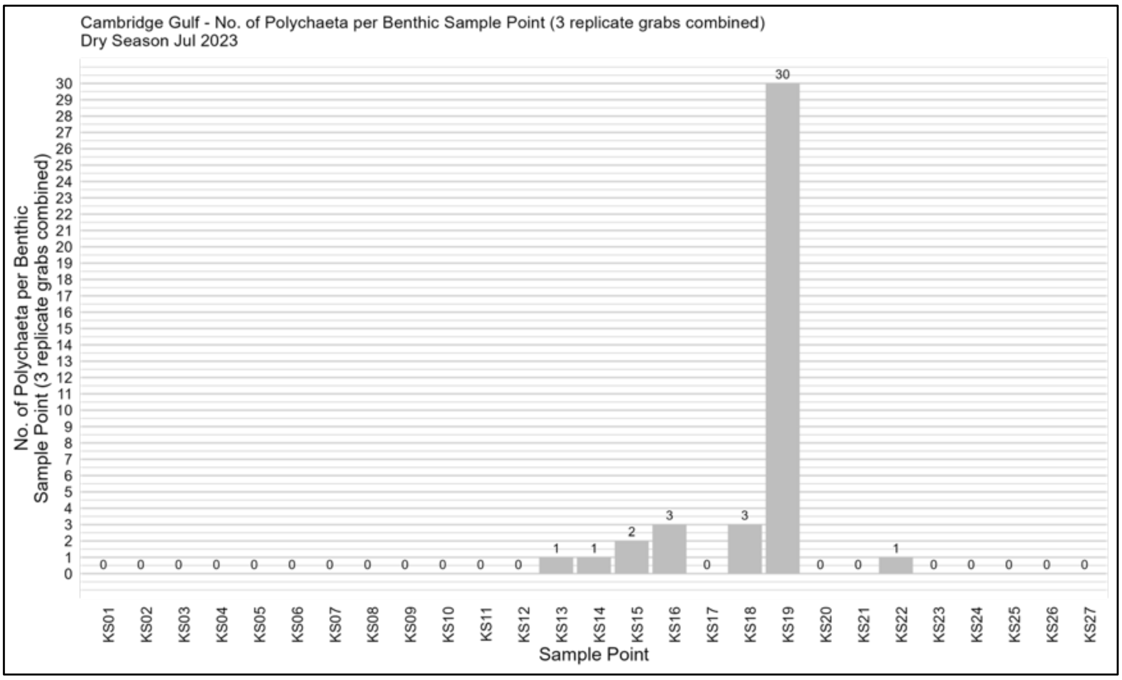

Cambridge Gulf - No. of Chordata per Benthic Sample Point (3 replicate grabs combined)
Dry Season Jul 2023
No. of Chordata per Benthic Sample Point (3 replicate grabs combined)
Sample Point
KS01 KS02 KS03 KS04 KS05 KS06 KS07 KS08 KS09 KS10 KS11 KS12 KS13 KS14 KS15 KS16 KS17 KS18 KS19 KS20 KS21 KS22 KS23 KS24 KS25 KS26 KS27
0 0 0 0 0 0 0 0 0 0 0 0 4 0 4 0 0 1 1 0 0 0 0 0 0 0 0 0

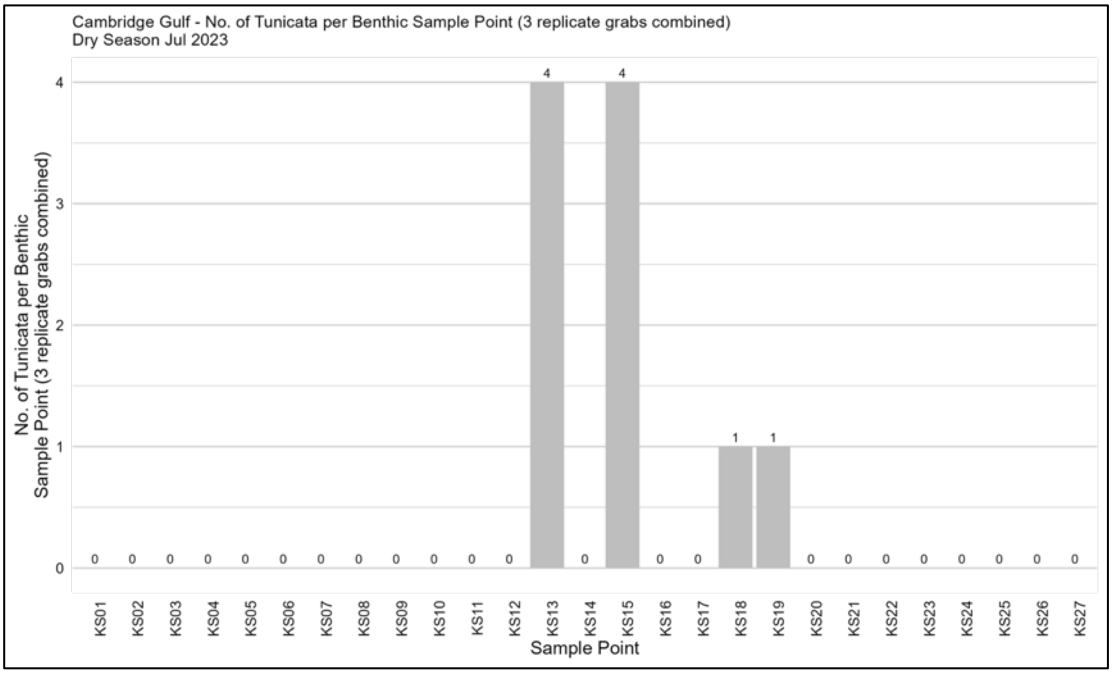

Cambridge Gulf - No. of Cnidaria per Benthic Sample Point (3 replicate grabs combined)
Dry Season Jul 2023
No. of Cnidaria per Benthic Sample Point (3 replicate grabs combined)
Sample Point
KS01 KS02 KS03 KS04 KS05 KS06 KS07 KS08 KS09 KS10 KS11 KS12 KS13 KS14 KS15 KS16 KS17 KS18 KS19 KS20 KS21 KS22 KS23 KS24 KS25 KS26 KS27
0 0 0 0 0 0 4 1 0 0 0 0 0 0 1 1 0 0 0 0 0 0 0 0 0 0 0


Cambridge Gulf - No. of Crustacea per benthic Sample Point (3 replicate grabs combined)
Dry Season Jul 2023
No. of Crustacea per benthic Sample Point (3 replicate grabs combined)
Sample Point
KS01 KS02 KS03 KS04 KS05 KS06 KS07 KS08 KS09 KS10 KS11 KS12 KS13 KS14 KS15 KS16 KS17 KS18 KS19 KS20 KS21 KS22 KS23 KS24 KS25 KS26 KS27
0 0 0 0 0 0 1 0 0 0 0 0 75 0 24 34 0 6 154 0 0 0 0 0 0 0 0

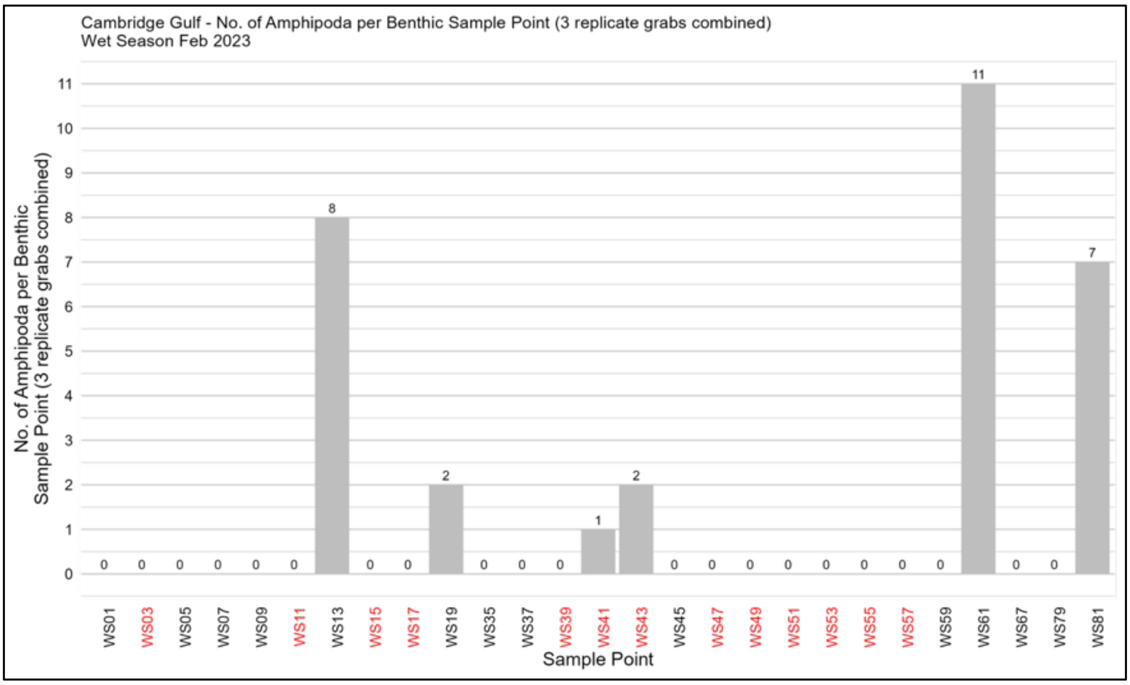

Cambridge Gulf - No. of Isopoda per Benthic Sample Point (3 replicate grabs combined)
Dry Season Jul 2023
No. of Isopoda per Benthic Sample Point (3 replicate grabs combined)
Sample Point
KS01 KS02 KS03 KS04 KS05 KS06 KS07 KS08 KS09 KS10 KS11 KS12 KS13 KS14 KS15 KS16 KS17 KS18 KS19 KS20 KS21 KS22 KS23 KS24 KS25 KS26 KS27
0 0 0 0 0 0 1 0 0 0 0 0 0 0 0 0 0 1 20 0 0 0 0 0 0 0 0

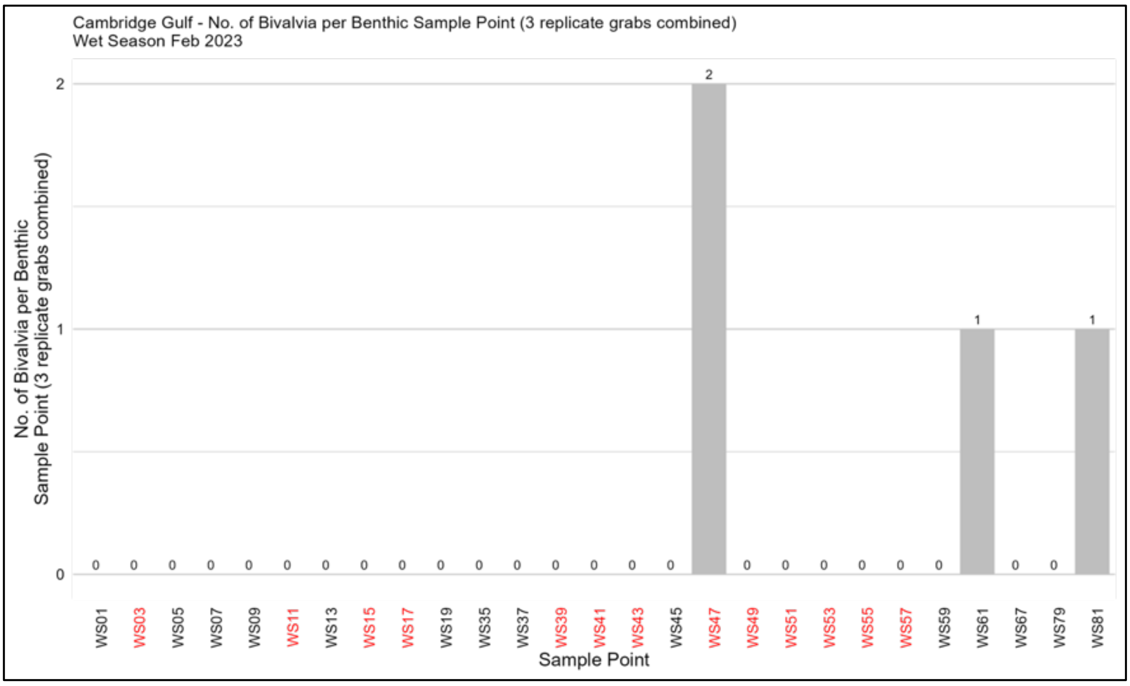

Cambridge Gulf - No. of Mollusca per Benthic Sample Point (3 replicate grabs combined)
Dry Season Jul 2023
No. of Mollusca per Benthic Sample Point (3 replicate grabs combined)
Sample Point
KS01 KS02 KS03 KS04 KS05 KS06 KS07 KS08 KS09 KS10 KS11 KS12 KS13 KS14 KS15 KS16 KS17 KS18 KS19 KS20 KS21 KS22 KS23 KS24 KS25 KS26 KS27
0 0 0 0 0 0 0 0 0 0 0 0 0 0 5 1 0 0 13 0 0 0 0 0 0 0 0

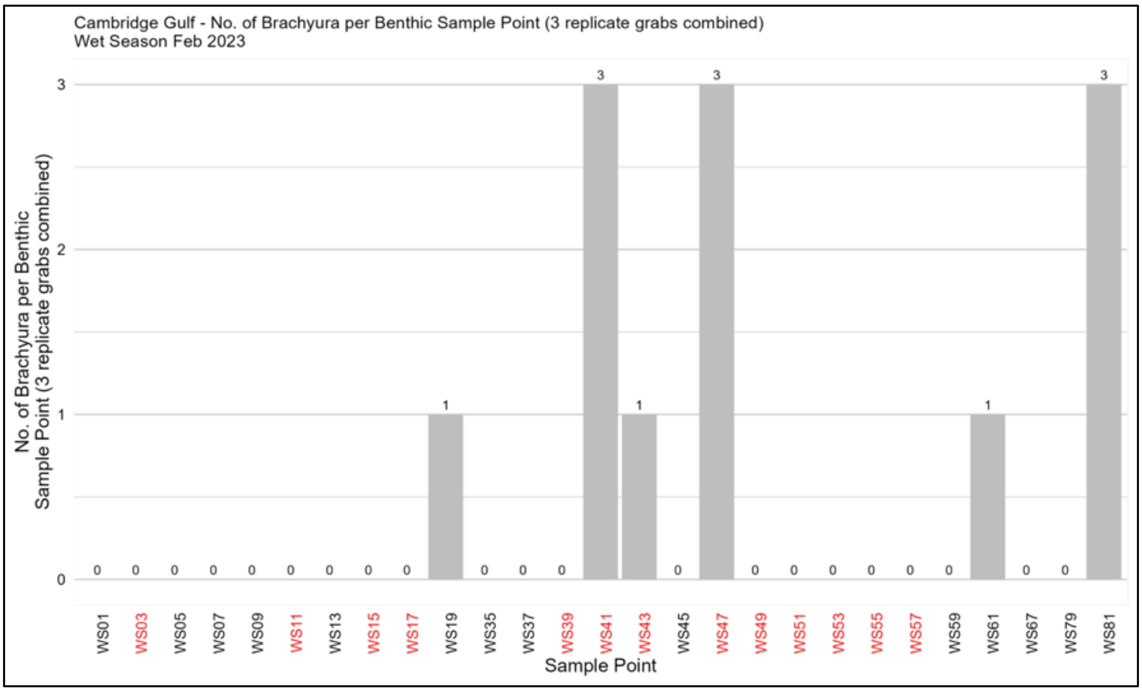

Cambridge Gulf - No. of Polychaeta per Benthic Sample Point (3 replicate grabs combined)
Dry Season Jul 2023
No. of Polychaeta per Benthic Sample Point (3 replicate grabs combined)
Sample Point
KS01 KS02 KS03 KS04 KS05 KS06 KS07 KS08 KS09 KS10 KS11 KS12 KS13 KS14 KS15 KS16 KS17 KS18 KS19 KS20 KS21 KS22 KS23 KS24 KS25 KS26 KS27
0 0 0 0 0 0 0 0 0 0 0 0 1 1 2 3 0 3 30 0 0 1 0 0 0 0 0

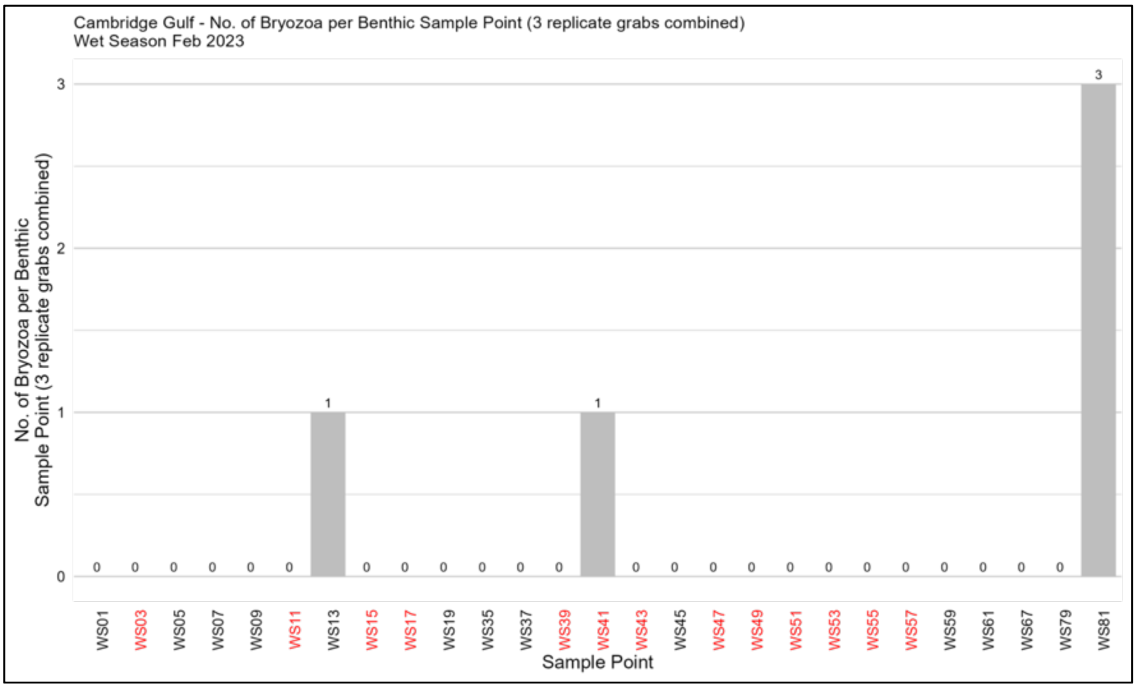

Cambridge Gulf - No. of Tunicata per Benthic Sample Point (3 replicate grabs combined)
Dry Season Jul 2023
No. of Tunicata per Benthic Sample Point (3 replicate grabs combined)
Sample Point
KS01 KS02 KS03 KS04 KS05 KS06 KS07 KS08 KS09 KS10 KS11 KS12 KS13 KS14 KS15 KS16 KS17 KS18 KS19 KS20 KS21 KS22 KS23 KS24 KS25 KS26 KS27
0 0 0 0 0 0 0 0 0 0 0 0 4 0 4 0 0 1 1 0 0 0 0 0 0 0 0

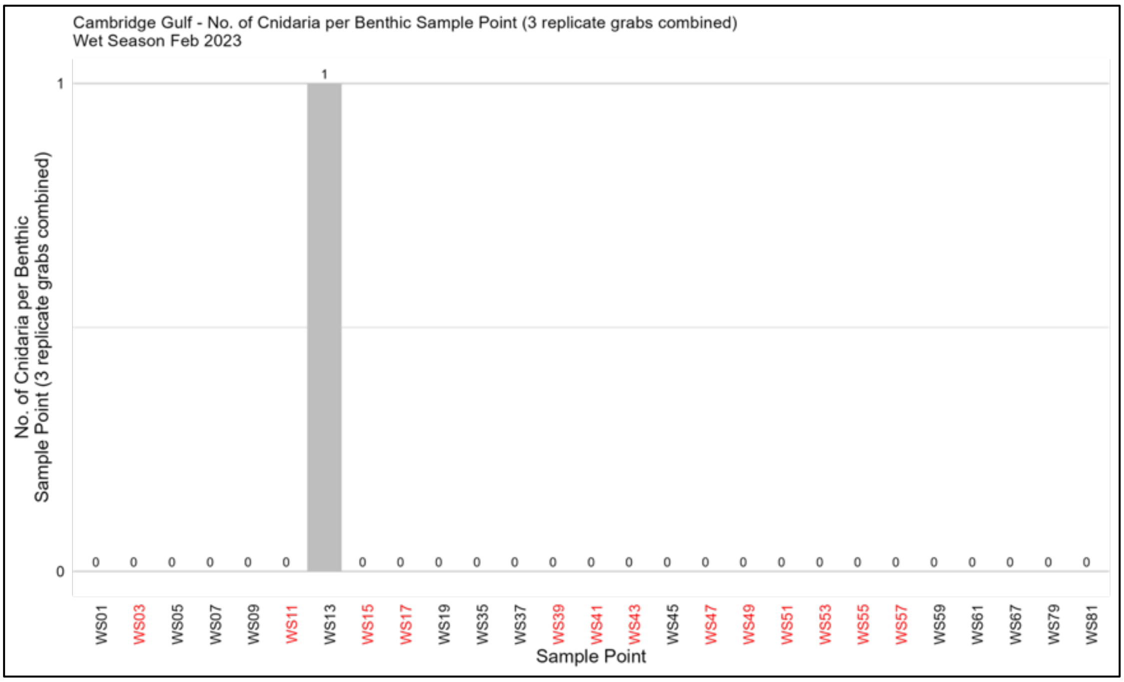
ANNEX 9: BENTHIC TAXA PER SAMPLE POINT – WET SEASON GRAPHS

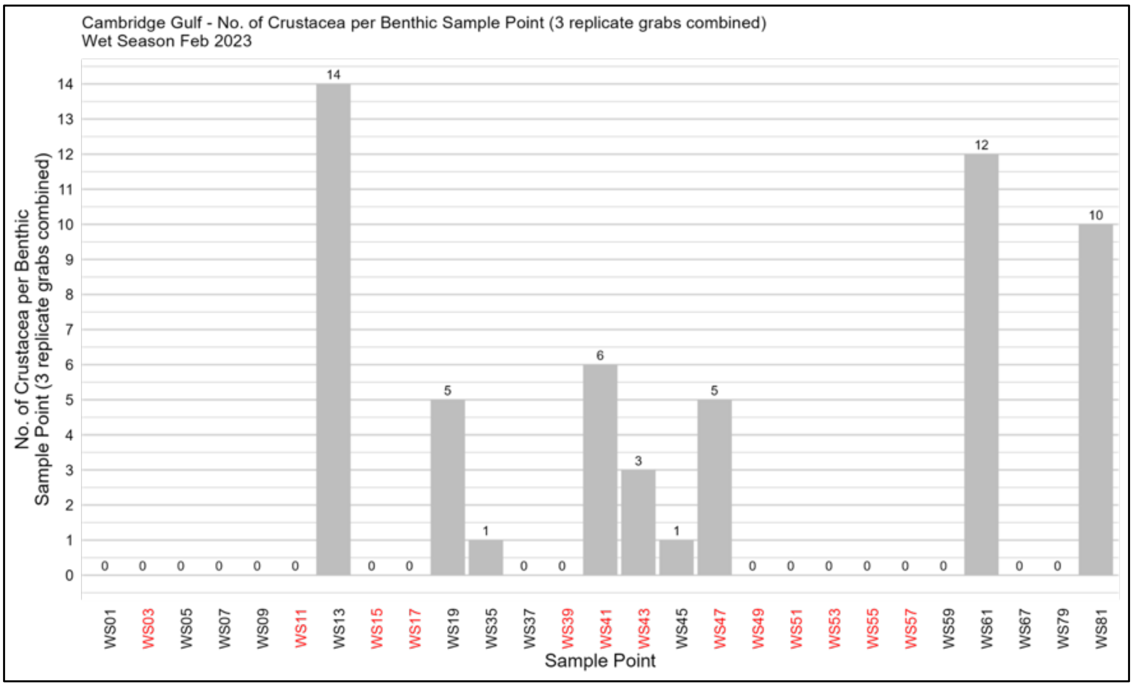


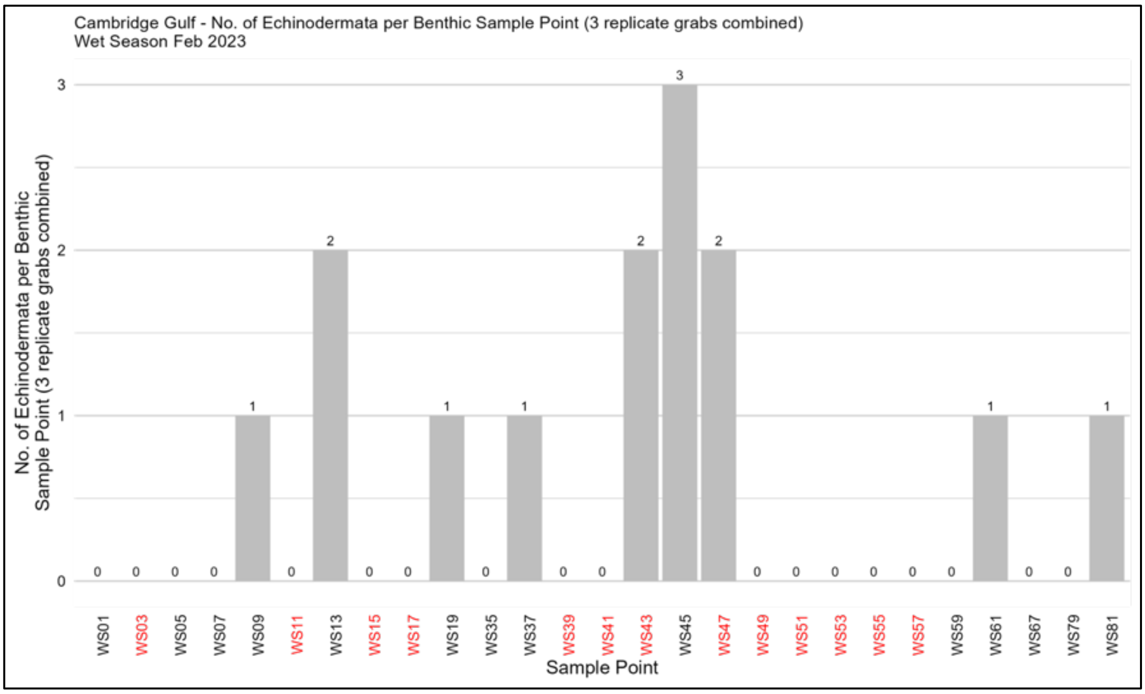


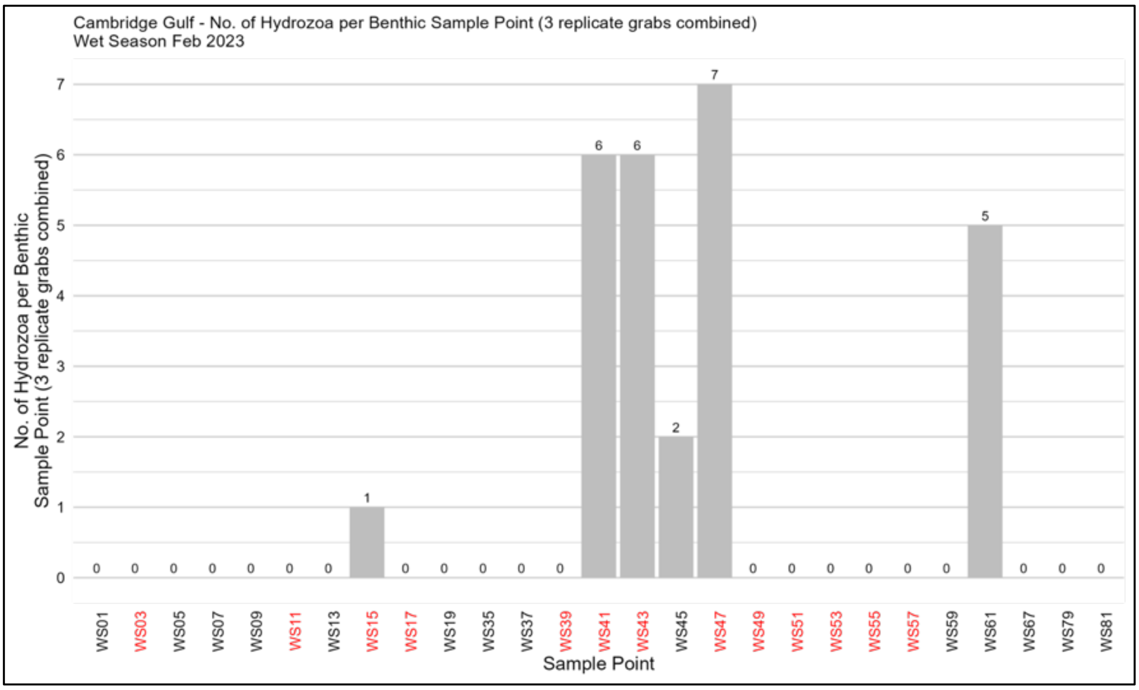

Cambridge Gulf - No. of Brachyura per Benthic Sample Point (3 replicate grabs combined)
Wet Season Feb 2023
No. of Brachyura per Benthic Sample Point (3 replicate grabs combined)
Sample Point
WS01 WS03 WS05 WS07 WS09 WS11 WS13 WS15 WS17 WS19 WS35 WS37 WS39 WS41 WS43 WS45 WS47 WS49 WS51 WS53 WS55 WS57 WS59 WS61 WS67 WS79 WS81
0 0 0 0 0 0 0 0 0 1 0 0 0 3 1 0 3 0 0 0 0 0 0 1 0 0 3

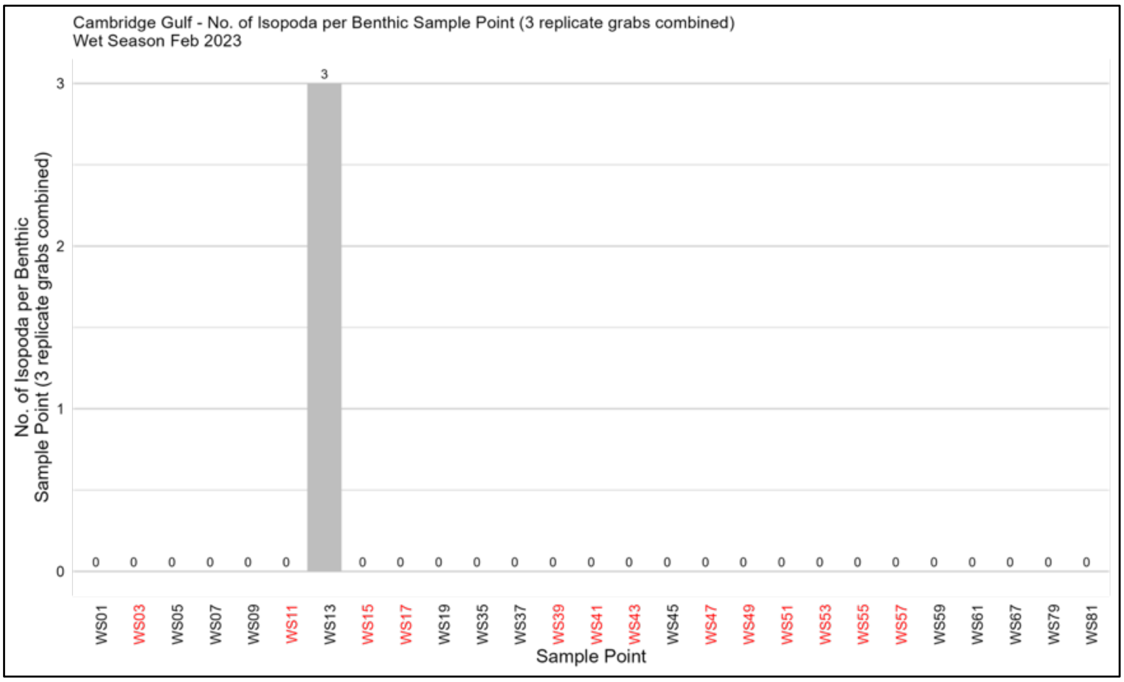

Cambridge Gulf - No. of Bryozoa per Benthic Sample Point (3 replicate grabs combined)
Wet Season Feb 2023
No. of Bryozoa per Benthic Sample Point (3 replicate grabs combined)
Sample Point
WS01 WS03 WS05 WS07 WS09 WS11 WS13 WS15 WS17 WS19 WS35 WS37 WS39 WS41 WS43 WS45 WS47 WS49 WS51 WS53 WS55 WS57 WS59 WS61 WS67 WS79 WS81
0 0 0 0 0 0 1 0 0 0 0 0 0 1 0 0 0 0 0 0 0 0 0 0 0 0 3

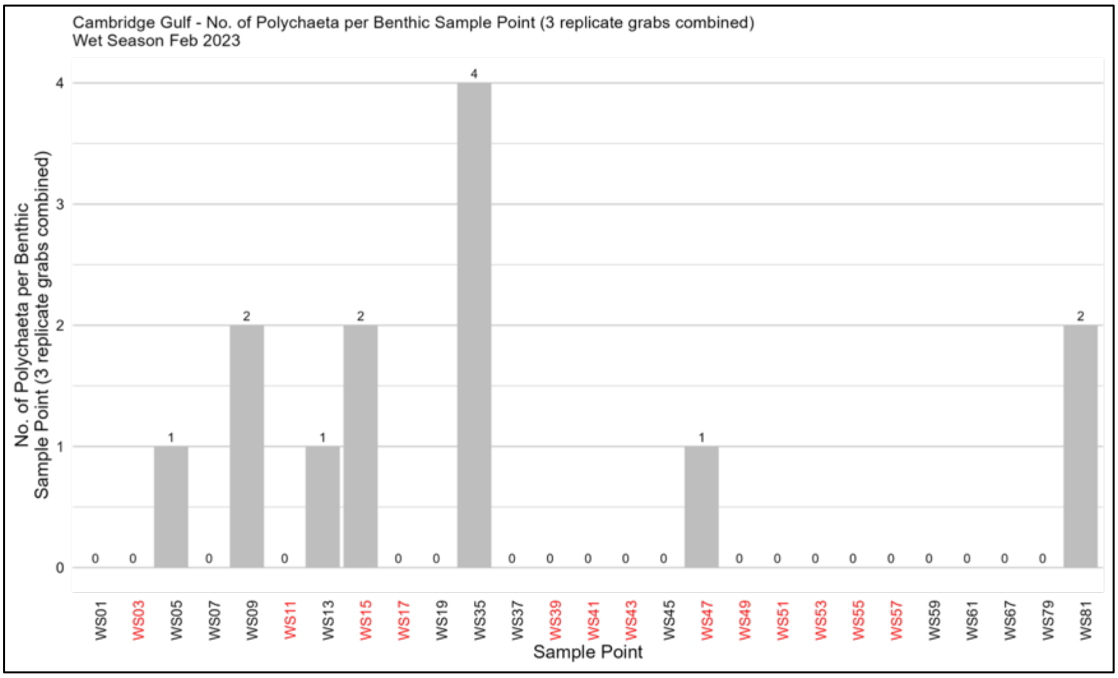

Cambridge Gulf - No. of Cnidaria per Benthic Sample Point (3 replicate grabs combined)
Wet Season Feb 2023
No. of Cnidaria per Benthic Sample Point (3 replicate grabs combined)
Sample Point
WS01 WS03 WS05 WS07 WS09 WS11 WS13 WS15 WS17 WS19 WS35 WS37 WS39 WS41 WS43 WS45 WS47 WS49 WS51 WS53 WS55 WS57 WS59 WS61 WS67 WS79 WS81

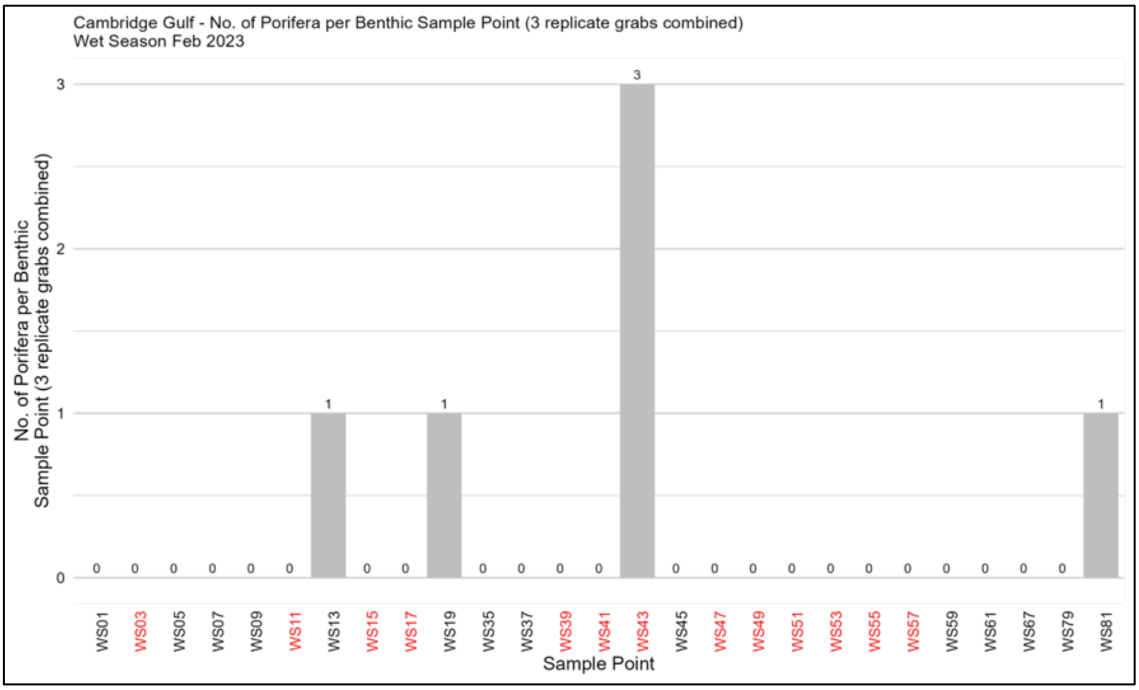

Cambridge Gulf - No. of Crustacea per Benthic Sample Point (3 replicate grabs combined)
Wet Season Feb 2023
No. of Crustacea per Benthic Sample Point (3 replicate grabs combined)
Sample Point
WS01 WS03 WS05 WS07 WS09 WS11 WS13 WS15 WS17 WS19 WS35 WS37 WS39 WS41 WS43 WS45 WS47 WS49 WS51 WS53 WS55 WS57 WS59 WS61 WS67 WS79 WS81

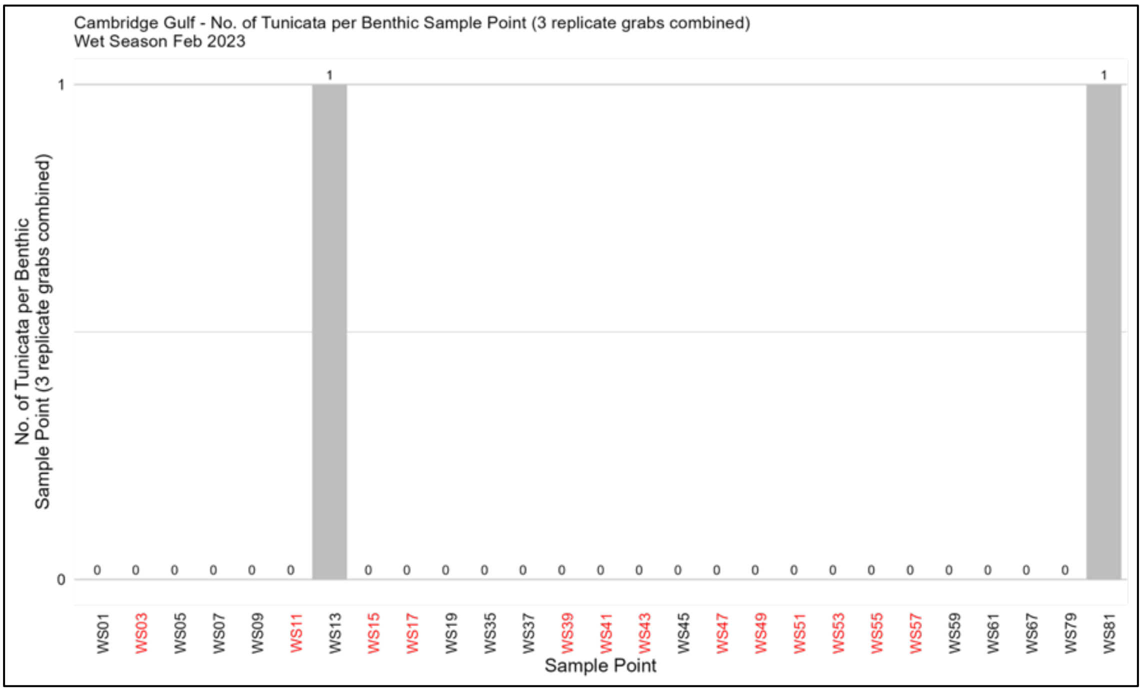

Cambridge Gulf - No. of Echinodermata per Benthic Sample Point (3 replicate grabs combined)
Wet Season Feb 2023
No. of Echinodermata per Benthic Sample Point (3 replicate grabs combined)
Sample Point
WS01 WS03 WS05 WS07 WS09 WS11 WS13 WS15 WS17 WS19 WS35 WS37 WS39 WS41 WS43 WS45 WS47 WS49 WS51 WS53 WS55 WS57 WS59 WS61 WS67 WS79 WS81
0 0 0 0 1 0 2 0 0 1 0 1 0 0 2 3 2 0 0 0 0 0 0 1 0 0 1

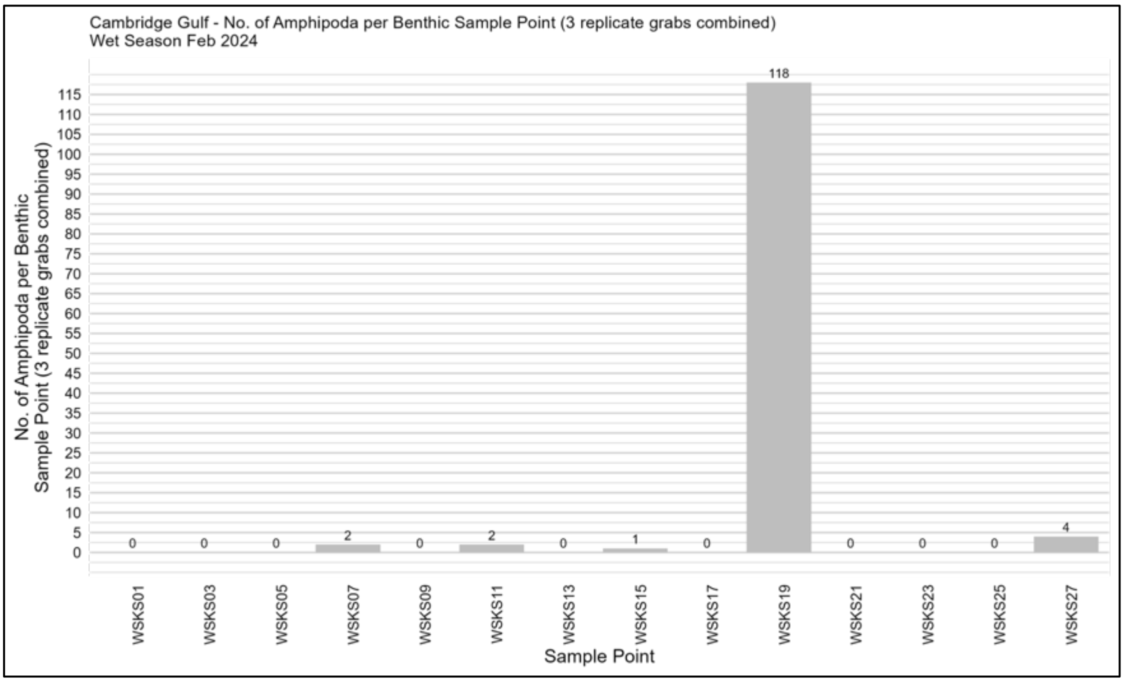

Cambridge Gulf - No. of Hydrozoa per Benthic Sample Point (3 replicate grabs combined)
Wet Season Feb 2023
No. of Hydrozoa per Benthic Sample Point (3 replicate grabs combined)
Sample Point
WS01 WS03 WS05 WS07 WS09 WS11 WS13 WS15 WS17 WS19 WS35 WS37 WS39 WS41 WS43 WS45 WS47 WS49 WS51 WS53 WS55 WS57 WS59 WS61 WS67 WS79 WS81
0 0 0 0 0 0 0 1 0 0 0 0 0 6 6 2 7 0 0 0 0 0 0 5 0 0 0

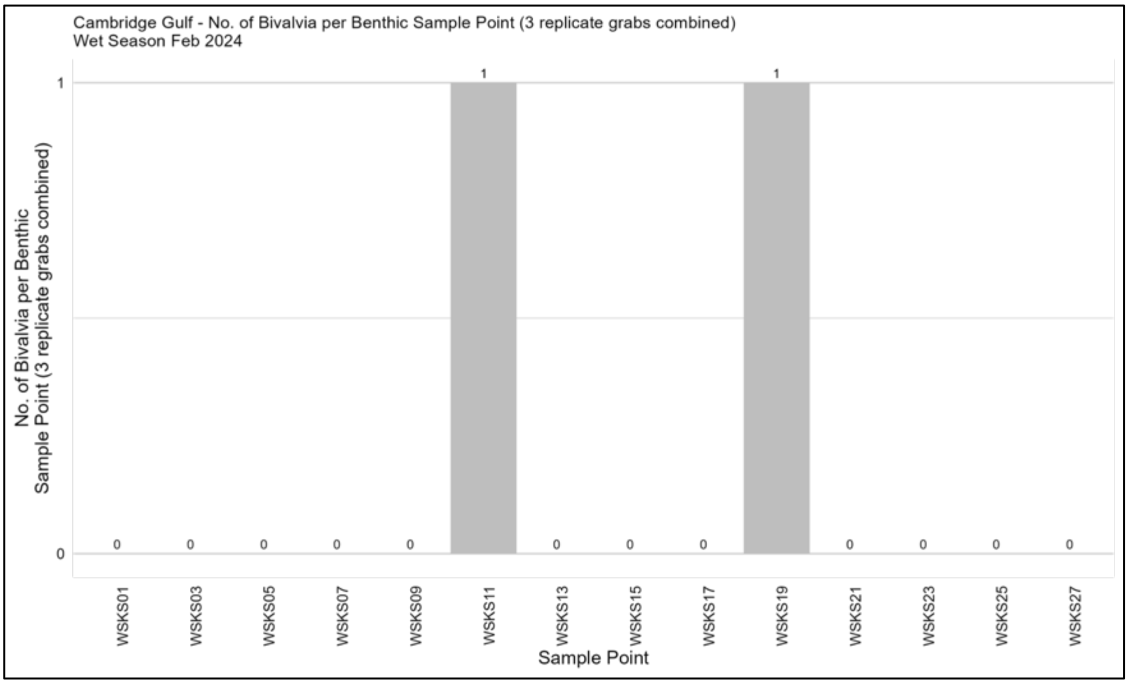

Cambridge Gulf - No. of Isopoda per Benthic Sample Point (3 replicate grabs combined)
Wet Season Feb 2023
No. of Isopoda per Benthic Sample Point (3 replicate grabs combined)
Sample Point
WS01
WS03
WS05
WS07
WS09
WS11
WS13
WS15
WS17
WS19
WS35
WS37
WS39
WS41
WS43
WS45
WS47
WS49
WS51
WS53
WS55
WS57
WS59
WS61
WS67
WS79
WS81

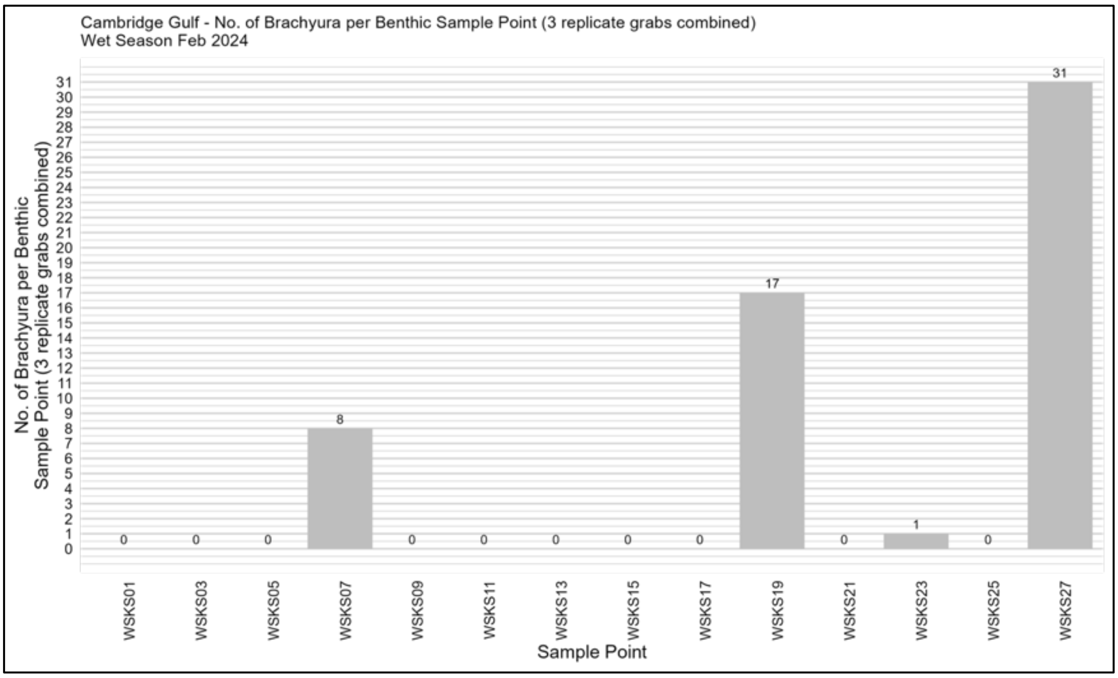

Cambridge Gulf - No. of Polychaeta per Benthic Sample Point (3 replicate grabs combined)
Wet Season Feb 2023
No. of Polychaeta per Benthic Sample Point (3 replicate grabs combined)
Sample Point
WS01
WS03
WS05
WS07
WS09
WS11
WS13
WS15
WS17
WS19
WS35
WS37
WS39
WS41
WS43
WS45
WS47
WS49
WS51
WS53
WS55
WS57
WS59
WS61
WS67
WS79
WS81

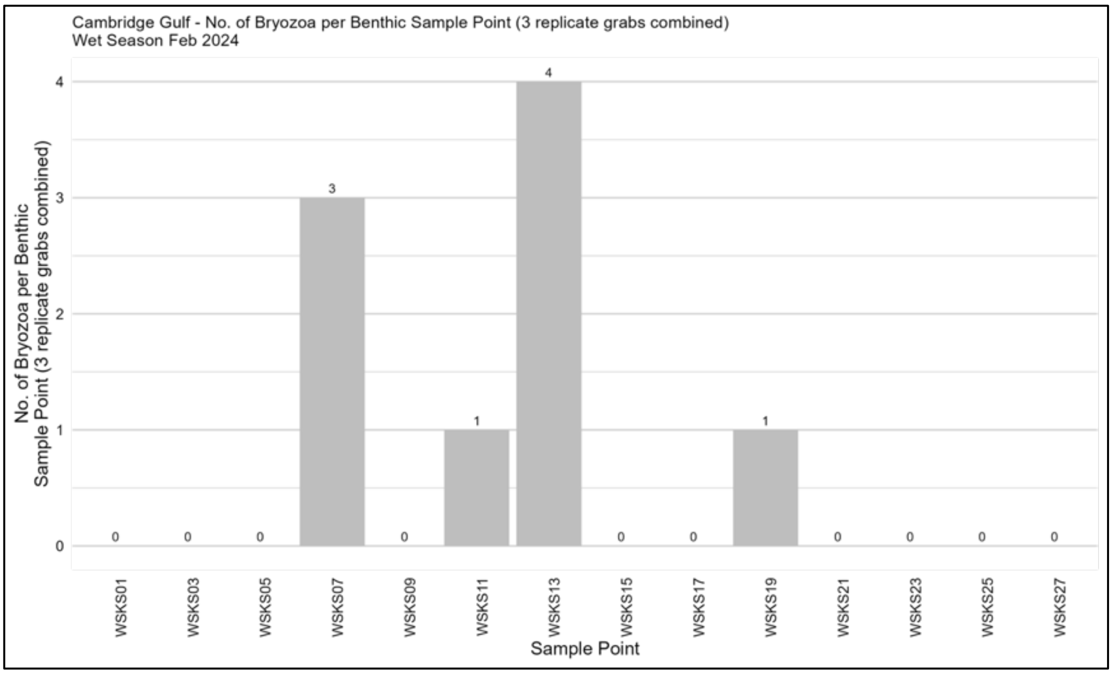

Cambridge Gulf - No. of Porifera per Benthic Sample Point (3 replicate grabs combined)
Wet Season Feb 2023
No. of Porifera per Benthic Sample Point (3 replicate grabs combined)
Sample Point
WS01 WS03 WS05 WS07 WS09 WS11 WS13 WS15 WS17 WS19 WS35 WS37 WS39 WS41 WS43 WS45 WS47 WS49 WS51 WS53 WS55 WS57 WS59 WS61 WS67 WS79 WS81
0 0 0 0 0 0 1 0 0 1 0 0 0 0 3 0 0 0 0 0 0 0 0 0 0 0 1

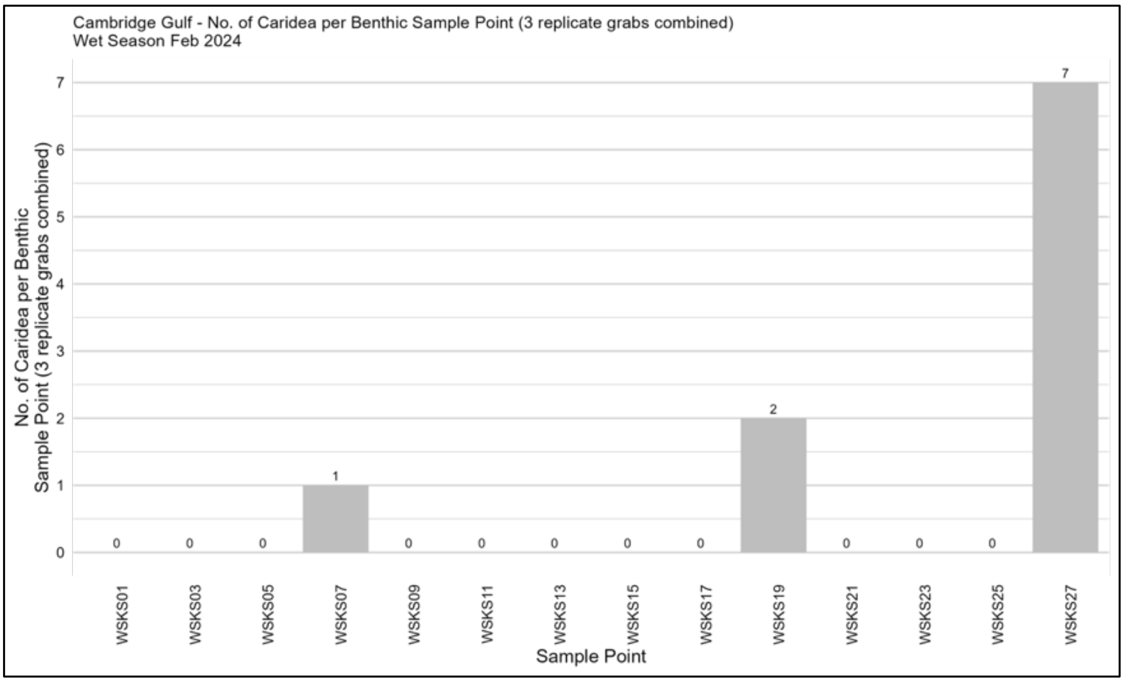

Cambridge Gulf - No. of Tunicata per Benthic Sample Point (3 replicate grabs combined)
Wet Season Feb 2023
No. of Tunicata per Benthic Sample Point (3 replicate grabs combined)
Sample Point
WS01 WS03 WS05 WS07 WS09 WS11 WS13 WS15 WS17 WS19 WS35 WS37 WS39 WS41 WS43 WS45 WS47 WS49 WS51 WS53 WS55 WS57 WS59 WS61 WS67 WS79 WS81
0 0 0 0 0 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1

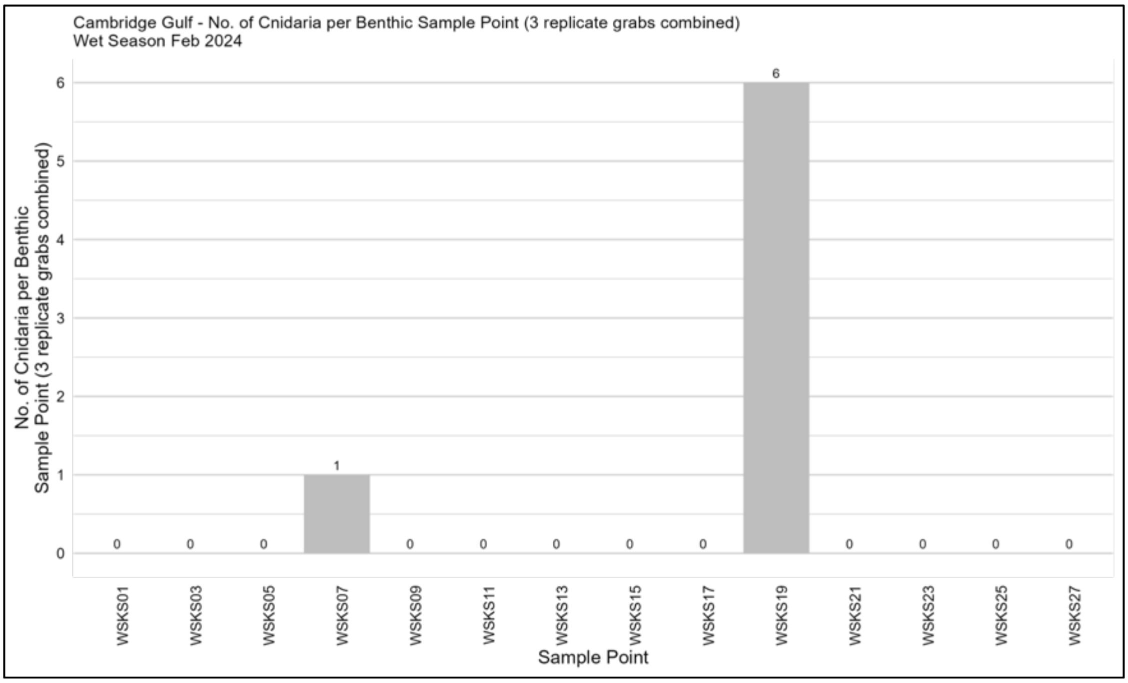

Cambridge Gulf - No. of Amphipoda per Benthic Sample Point (3 replicate grabs combined)
Wet Season Feb 2024
No. of Amphipoda per Benthic Sample Point (3 replicate grabs combined)
Sample Point
WSKS01 0
WSKS03 0
WSKS05 0
WSKS07 2
WSKS09 0
WSKS11 2
WSKS13 0
WSKS15 1
WSKS17 0
WSKS19 118
WSKS21 0
WSKS23 0
WSKS25 0
WSKS27 4

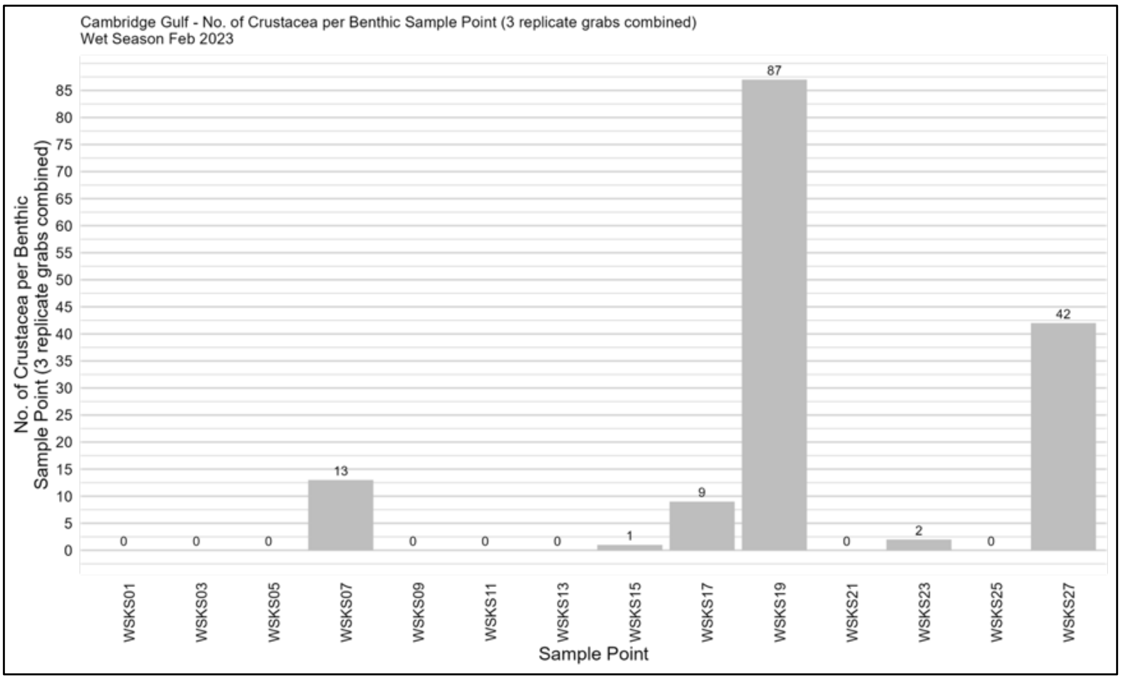

Cambridge Gulf - No. of Bivalvia per Benthic Sample Point (3 replicate grabs combined)
Wet Season Feb 2024
No. of Bivalvia per Benthic Sample Point (3 replicate grabs combined)
Sample Point
WSKS01 0
WSKS03 0
WSKS05 0
WSKS07 0
WSKS09 0
WSKS11 1
WSKS13 0
WSKS15 0
WSKS17 0
WSKS19 1
WSKS21 0
WSKS23 0
WSKS25 0
WSKS27 0

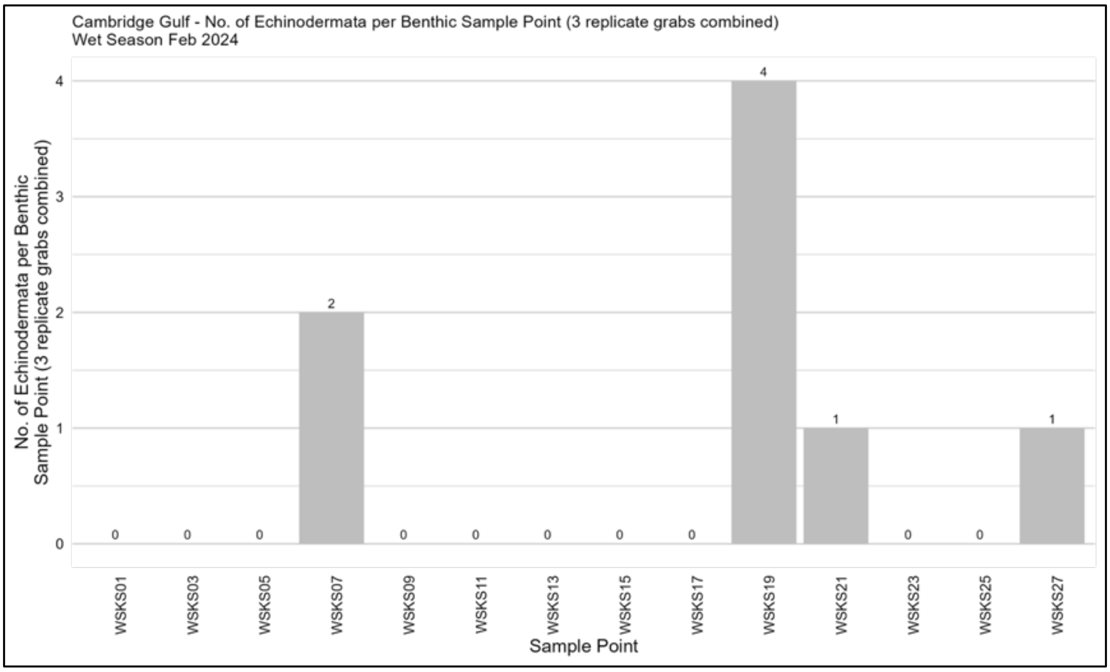

Cambridge Gulf - No. of Brachyura per Benthic Sample Point (3 replicate grabs combined)
Wet Season Feb 2024
No. of Brachyura per Benthic Sample Point (3 replicate grabs combined)
Sample Point
WSKS01 0
WSKS03 0
WSKS05 0
WSKS07 8
WSKS09 0
WSKS11 0
WSKS13 0
WSKS15 0
WSKS17 0
WSKS19 17
WSKS21 0
WSKS23 1
WSKS25 0
WSKS27 31

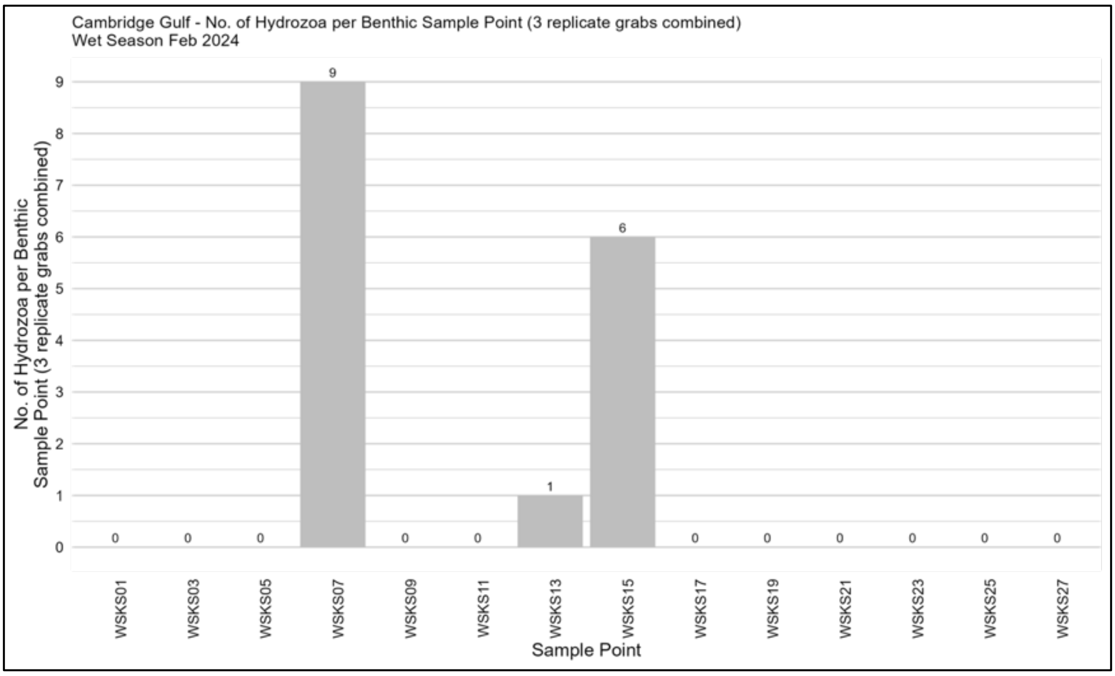

Cambridge Gulf - No. of Bryozoa per Benthic Sample Point (3 replicate grabs combined)
Wet Season Feb 2024
No. of Bryozoa per Benthic Sample Point (3 replicate grabs combined)
Sample Point
WSKS01 0
WSKS03 0
WSKS05 0
WSKS07 3
WSKS09 0
WSKS11 1
WSKS13 4
WSKS15 0
WSKS17 0
WSKS19 1
WSKS21 0
WSKS23 0
WSKS25 0
WSKS27 0

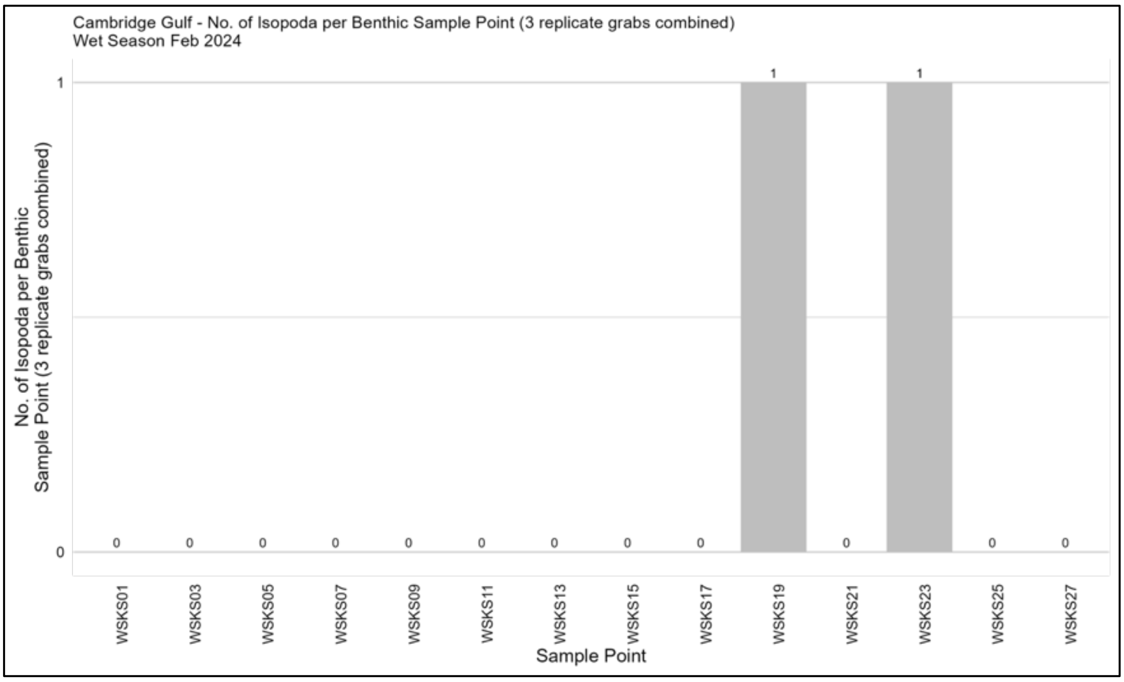

Cambridge Gulf - No. of Caridea per Benthic Sample Point (3 replicate grabs combined)
Wet Season Feb 2024
No. of Caridea per Benthic Sample Point (3 replicate grabs combined)
Sample Point
WSKS01
WSKS03
WSKS05
WSKS07
WSKS09
WSKS11
WSKS13
WSKS15
WSKS17
WSKS19
WSKS21
WSKS23
WSKS25
WSKS27

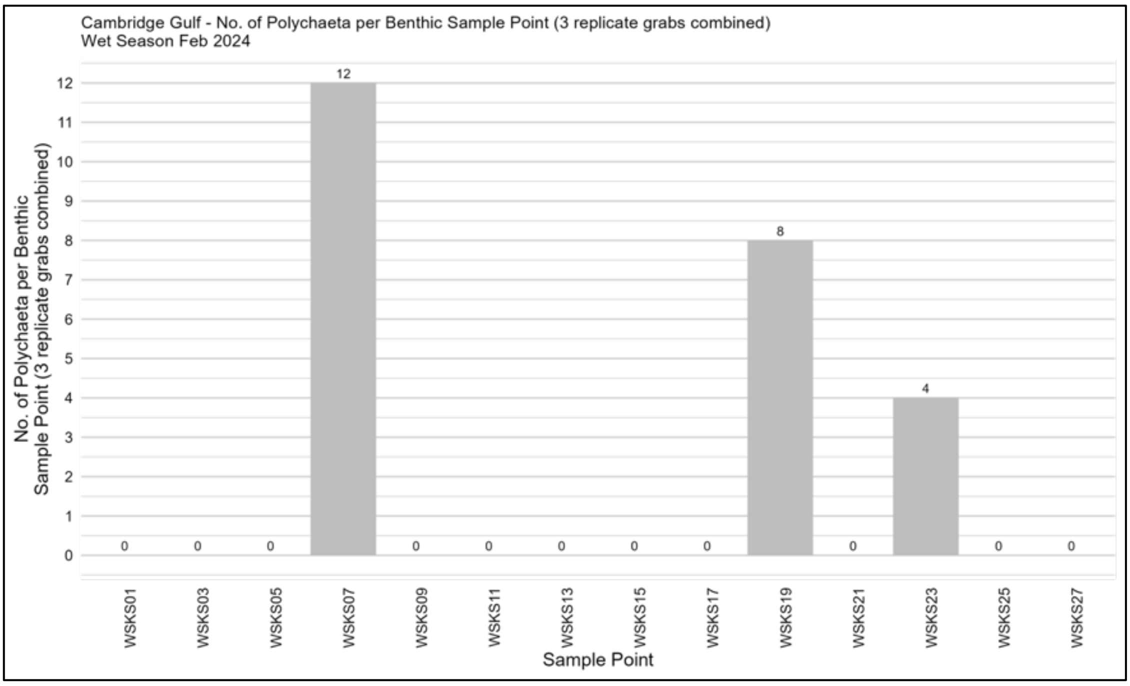

Cambridge Gulf - No. of Cnidaria per Benthic Sample Point (3 replicate grabs combined)
Wet Season Feb 2024
No. of Cnidaria per Benthic Sample Point (3 replicate grabs combined)
Sample Point
WSKS01
WSKS03
WSKS05
WSKS07
WSKS09
WSKS11
WSKS13
WSKS15
WSKS17
WSKS19
WSKS21
WSKS23
WSKS25
WSKS27

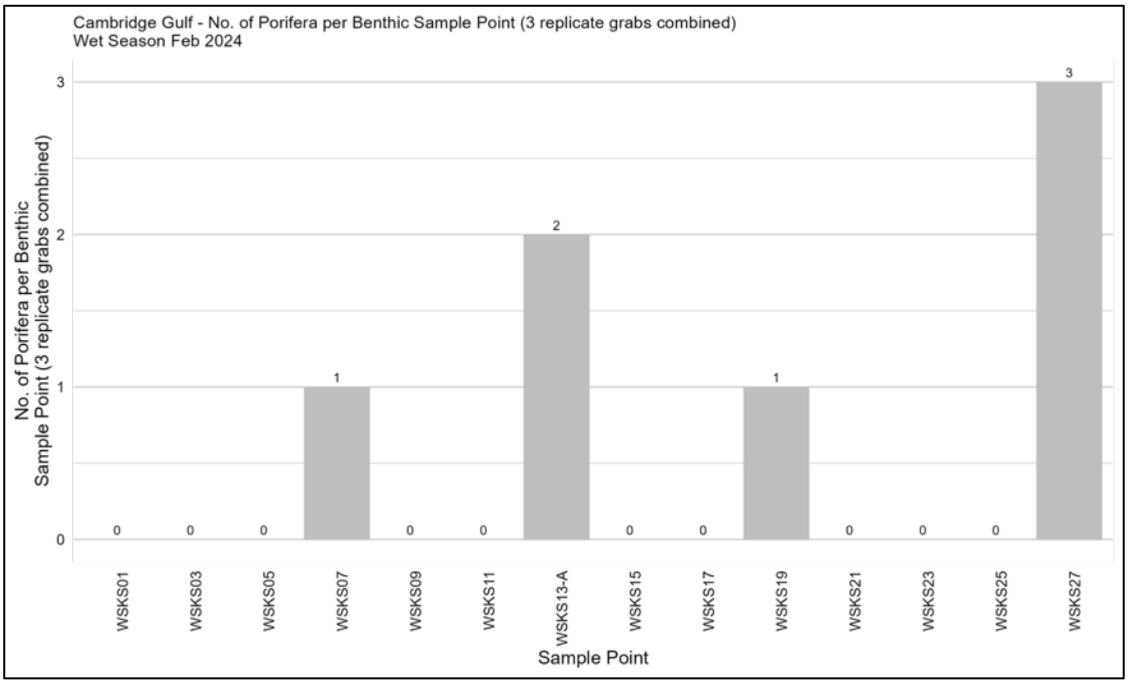

Cambridge Gulf - No. of Crustacea per Benthic Sample Point (3 replicate grabs combined)
Wet Season Feb 2023
No. of Crustacea per Benthic Sample Point (3 replicate grabs combined)
Sample Point
WSKS01 0
WSKS03 0
WSKS05 0
WSKS07 13
WSKS09 0
WSKS11 0
WSKS13 0
WSKS15 1
WSKS17 9
WSKS19 87
WSKS21 0
WSKS23 2
WSKS25 0
WSKS27 42

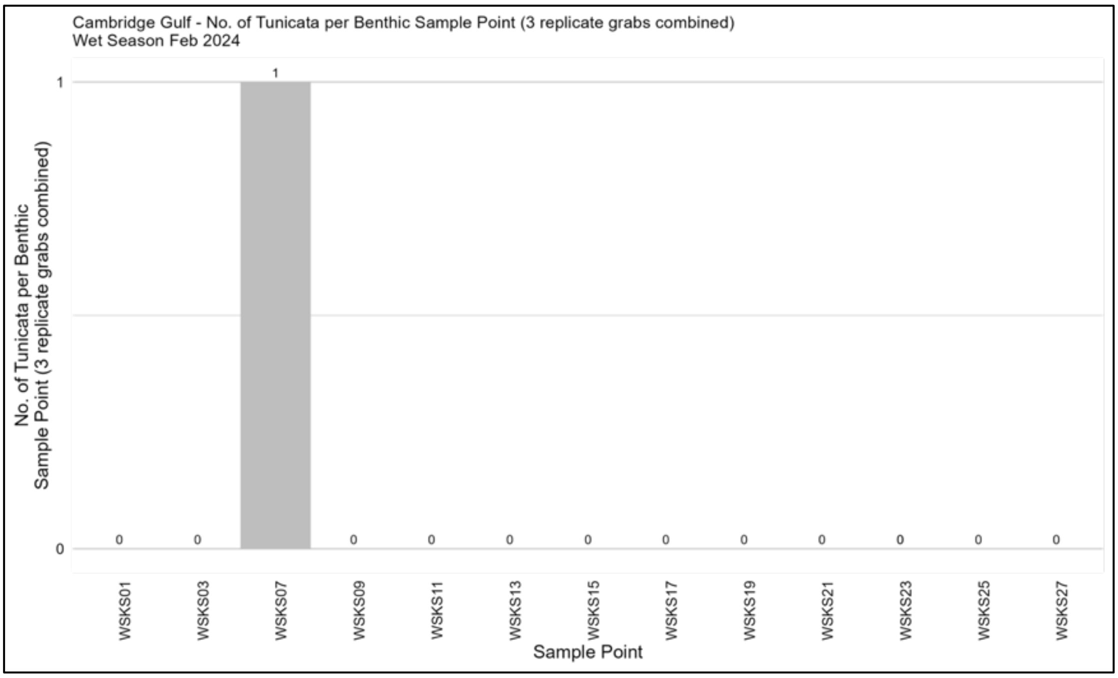

Cambridge Gulf - No. of Echinodermata per Benthic Sample Point (3 replicate grabs combined)
Wet Season Feb 2024
No. of Echinodermata per Benthic Sample Point (3 replicate grabs combined)
Sample Point
WSKS01 0
WSKS03 0
WSKS05 0
WSKS07 2
WSKS09 0
WSKS11 0
WSKS13 0
WSKS15 0
WSKS17 0
WSKS19 4
WSKS21 1
WSKS23 0
WSKS25 0
WSKS27 1


Cambridge Gulf - No. of Hydrozoa per Benthic Sample Point (3 replicate grabs combined)
Wet Season Feb 2024
No. of Hydrozoa per Benthic Sample Point (3 replicate grabs combined)
Sample Point
WSKS01 0
WSKS03 0
WSKS05 0
WSKS07 9
WSKS09 0
WSKS11 0
WSKS13 1
WSKS15 6
WSKS17 0
WSKS19 0
WSKS21 0
WSKS23 0
WSKS25 0
WSKS27 0


Cambridge Gulf - No. of Isopoda per Benthic Sample Point (3 replicate grabs combined)
Wet Season Feb 2024
No. of Isopoda per Benthic Sample Point (3 replicate grabs combined)
Sample Point
WSKS01 0
WSKS03 0
WSKS05 0
WSKS07 0
WSKS09 0
WSKS11 0
WSKS13 0
WSKS15 0
WSKS17 0
WSKS19 1
WSKS21 0
WSKS23 1
WSKS25 0
WSKS27 0


Cambridge Gulf - No. of Polychaeta per Benthic Sample Point (3 replicate grabs combined)
Wet Season Feb 2024
No. of Polychaeta per Benthic Sample Point (3 replicate grabs combined)
Sample Point
WSKS01
WSKS03
WSKS05
WSKS07
WSKS09
WSKS11
WSKS13
WSKS15
WSKS17
WSKS19
WSKS21
WSKS23
WSKS25
WSKS27
0
0
0
12
0
0
0
0
0
8
0
4
0
0


Cambridge Gulf - No. of Porifera per Benthic Sample Point (3 replicate grabs combined)
Wet Season Feb 2024
No. of Porifera per Benthic Sample Point (3 replicate grabs combined)
Sample Point
WSKS01
WSKS03
WSKS05
WSKS07
WSKS09
WSKS11
WSKS13-A
WSKS15
WSKS17
WSKS19
WSKS21
WSKS23
WSKS25
WSKS27
0
0
0
1
0
0
2
0
0
1
0
0
0
3


Cambridge Gulf - No. of Tunicata per Benthic Sample Point (3 replicate grabs combined)
Wet Season Feb 2024
No. of Tunicata per Benthic Sample Point (3 replicate grabs combined)
Sample Point
WSKS01
WSKS03
WSKS07
WSKS09
WSKS11
WSKS13
WSKS15
WSKS17
WSKS19
WSKS21
WSKS23
WSKS25
WSKS27

ANNEX 10: SENSOREM AERIAL DRONE LIDAR & IMAGERY REPORT

See separate report.

File Name: Referral Report No. 2 - ANNEX 10 - AERIAL DRONE LIDAR REPORT - Boskalis Cambridge Gulf.

ANNEX11: SEDIMENT CONTAMINATION ASSESSMENT

The tables below present the analytical results from NATA-accredited ALS laboratories for sediments collected from 21 sample sites in and near the proposed operational area, as shown on Figure A.2.1. All sampling and analysis were undertaken in accordance with NAGD (2009).

All analytes for all samples returned below the NAGD screening levels. Analytes tested for were:

- Metals and metaloids, Antimony, Arsenic, Cadmium, Chromium, Copper, Lead, Nickel, Silver, Zinc, Mercury.
- Total Petroleum Hydrocarbons (TPH) plus fractions C6 - C9, C10 - C14, C15 - C28, C29 - C36, C10 - C36 (sum).
- Polynuclear Aromatic Hydrocarbons - Sum of PAHs.
- Organotin Compounds -Tributyltin.
- Polychlorinated biphenyls; Total Polychlorinated biphenyls (PCBs) and Aroclors (1016, 1221, 1232, 1242, 1248, 1254 and 1260).

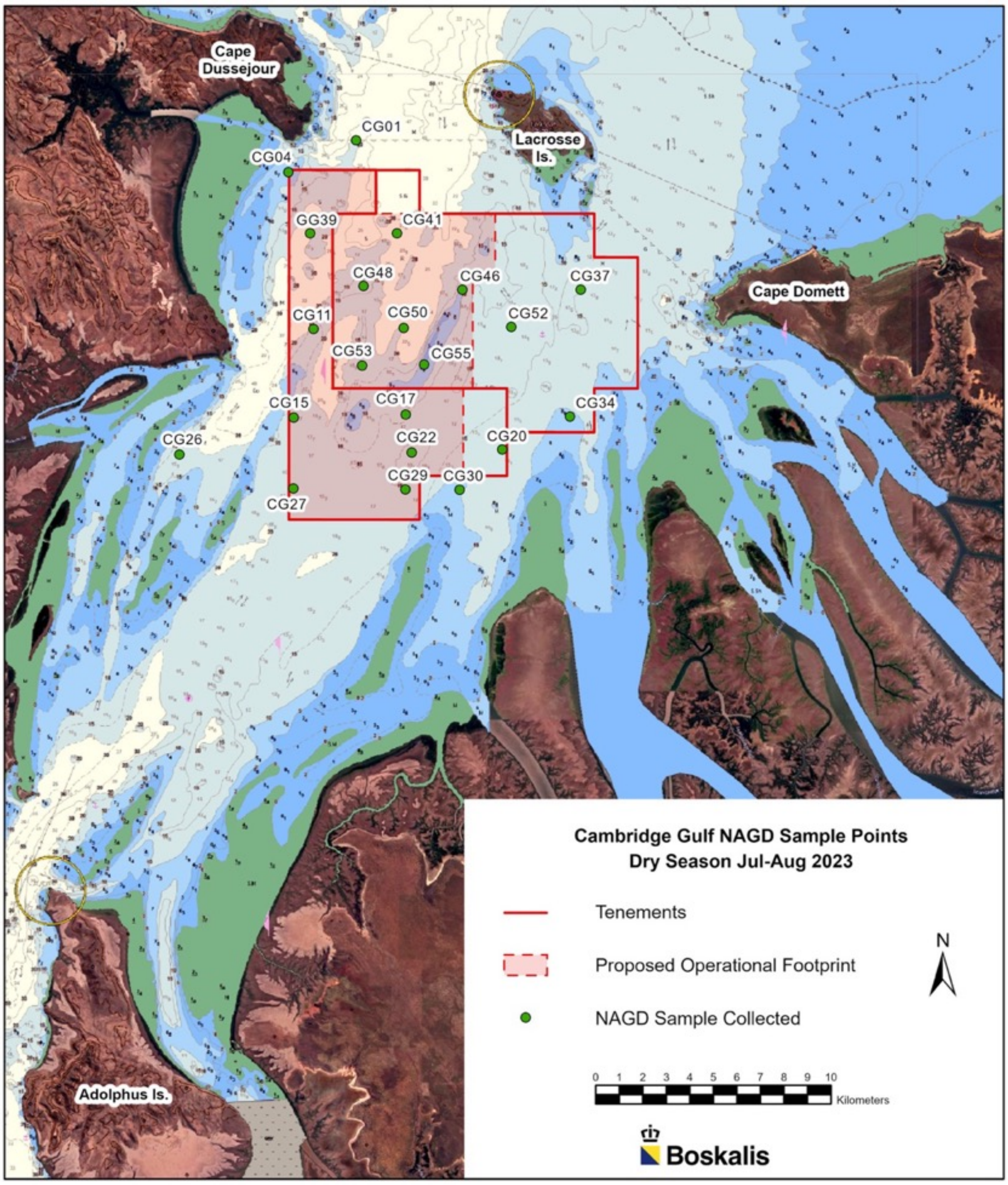


FIGURE A.11.1: *Locations of sediment quality sampling sites assessment against NAGD 2009 – dry-season July 2023.*

Matrix:	SOIL		Sample Type:		REG		REG		REG		REG	
Workgroup:	EP2310803		ALS Sample Number:		EP2310803001		EP2310803002		EP2310803003		EP2310803004	
Project name/number:	Cambridge Gulf		Sample Date:		17/07/2023		17/07/2023		18/07/2023		19/07/2023	
			Client Sample ID (1st):		CG-SP-01		CG-SP-04		CG-SP-11		CG-SP-15	
Analyte grouping/Analyte	**CAS Number**	**Unit**	**Limit of reporting**	**NAGD Screening Level**	**ALS Result**	**Above/ Below NAGD?**	**ALS Result**	**Above/ Below NAGD?**	**ALS Result**	**Above/ Below NAGD?**	**ALS Result**	**Above/ Below NAGD?**
EA055: Moisture Content (Dried @ 105-110_C)												
Moisture Content		%	1	N/a	21.6		25.6		22.4		21	
EG020-SD: Total Metals in Sediments by ICPMS												
Antimony	7440-36-0	mg/kg	0.5	2	<0.50	B	<0.50	B	<0.50	B	<0.50	B
Arsenic	7440-38-2	mg/kg	1	20	9.73	B	8.36	B	9.72	B	17.6	B
Cadmium	7440-43-9	mg/kg	0.1	1.5	<0.1	B	<0.1	B	<0.1	B	<0.1	B
Chromium	7440-47-3	mg/kg	1	80	6.8	B	10.6	B	6.8	B	11.9	B
Copper	7440-50-8	mg/kg	1	65	3.4	B	3.8	B	3.7	B	4.7	B
Lead	7439-92-1	mg/kg	1	50	3.6	B	3.8	B	3.2	B	5	B
Nickel	7440-02-0	mg/kg	1	21	6.2	B	8.4	B	6.2	B	8.8	B
Silver	7440-22-4	mg/kg	0.1	1	<0.1	B	<0.1	B	<0.1	B	<0.1	B
Zinc	7440-66-6	mg/kg	1	200	8.8	B	13.9	B	8.8	B	13.2	B
EG035T: Total Recoverable Mercury by FIMS												
Mercury	7439-97-6	mg/kg	0.01	0.15	<0.01	B	<0.01	B	<0.01	B	<0.01	B
EP003: Total Organic Carbon (TOC) in Soil												
Total Organic Carbon		%	0.02	N/a	0.03		0.03		0.04		0.1	
EP080-SD / EP071-SD: Total Petroleum Hydrocarbons (TPH)		mg/kg		550		B		B		B		B
C6 - C9 Fraction		mg/kg	3		<3		<3		<3		<3	
C10 - C14 Fraction		mg/kg	3		<3		<3		<3		<3	
C15 - C28 Fraction		mg/kg	3		<3		<3		3		<3	
C29 - C36 Fraction		mg/kg	5		<5		<5		<5		<5	
C10 - C36 Fraction (sum)		mg/kg	3		<3		<3		3		<3	
EP090: Organotin Compounds												

Tributyltin	56573-85-4	ugSn/kg	0.5	9	<0.5	B	<0.5	B	<0.5	B	<0.5	B
Matrix:	SOIL		**Sample Type:**		**REG**		**REG**		**REG**		**REG**	
Workgroup:	EP2310803		**ALS Sample Number:**		**EP2310803001**		**EP2310803002**		**EP2310803003**		**EP2310803004**	
Project name/number:	Cambridge Gulf		**Sample Date:**		**17/07/2023**		**17/07/2023**		**18/07/2023**		**19/07/2023**	
			Client sample ID (1st):		**CG-SP-01**		**CG-SP-04**		**CG-SP-11**		**CG-SP-15**	
Analyte grouping/Analyte	**CAS Number**	**Unit**	**Limit of reporting**	**NAGD Screening Level**	**ALS Result**	**Above/ Below NAGD?**	**ALS Result**	**Above/ Below NAGD?**	**ALS Result**	**Above/ Below NAGD?**	**ALS Result**	**Above/ Below NAGD?**
EP131A: Organochlorine Pesticides												
4.4`-DDD	72-54-8	ug/kg	0.5	2	<0.50	B	<0.50	B	<0.50	B	<0.50	B
4.4`-DDE	72-55-9	ug/kg	0.5	2.2	<0.50	B	<0.50	B	<0.50	B	<0.50	B
4.4`-DDT	50-29-3	ug/kg	0.5	1.6	<0.50	B	<0.50	B	<0.50	B	<0.50	B
Dieldrin	60-57-1	ug/kg	0.5	280	<0.50	B	<0.50	B	<0.50	B	<0.50	B
Endrin	72-20-8	ug/kg	0.5	10	<0.50	B	<0.50	B	<0.50	B	<0.50	B
Gamma-BHC (Lindane)	58-89-9	_g/kg	0.25	0.32	<0.25	B	<0.25	B	<0.25	B	<0.25	B
Total Chlordane (sum)		ug/kg	0.5	0.5	<0.50	B	<0.50	B	<0.50	B	<0.50	B
EP131B: Polychlorinated Biphenyls (as Aroclors)												
Total Polychlorinated biphenyls (PCBs)		ug/kg	5	23	<5.0	B	<5.0	B	<5.0	B	<5.0	B
Aroclor 1016	12674-11-2	ug/kg	5	23	<5.0	B	<5.0	B	<5.0	B	<5.0	B
Aroclor 1221	11104-28-2	ug/kg	5	23	<5.0	B	<5.0	B	<5.0	B	<5.0	B
Aroclor 1232	11141-16-5	ug/kg	5	23	<5.0	B	<5.0	B	<5.0	B	<5.0	B
Aroclor 1242	53469-21-9	ug/kg	5	23	<5.0	B	<5.0	B	<5.0	B	<5.0	B
Aroclor 1248	12672-29-6	ug/kg	5	23	<5.0	B	<5.0	B	<5.0	B	<5.0	B
Aroclor 1254	11097-69-1	ug/kg	5	23	<5.0	B	<5.0	B	<5.0	B	<5.0	B
Aroclor 1260	11096-82-5	ug/kg	5	23	<5.0	B	<5.0	B	<5.0	B	<5.0	B
EP132B: Polynuclear Aromatic Hydrocarbons												
Sum of PAHs		ug/kg	4	10,000	<4	B	<4	B	<4	B	<4	B

Matrix:	SOIL		Sample Type:		REG		REG		REG		REG	
Workgroup:	EP2310803		ALS Sample Number:		EP2310803005		EP2310803006		EP2310803007		EP2310803008	
Project name/number:	Cambridge Gulf		Sample Date:		19/07/2023		19/07/2023		19/07/2023		20/07/2023	
			Client sample ID (1st):		CG-SP-17		CG-SP-20		CG-SP-22		CG-SP-26	
Analyte grouping/Analyte	**CAS Number**	**Unit**	**Limit of reporting**	**NAGD Screening Level**	**ALS Result**	**Above/ Below NAGD?**	**ALS Result**	**Above/ Below NAGD?**	**ALS Result**	**Above/ Below NAGD?**	**ALS Result**	**Above/ Below NAGD?**
EA055: Moisture Content (Dried @ 105-110_C)												
Moisture Content		%	1	N/a	25.4		33.7		29.5		20.2	
EG020-SD: Total Metals in Sediments by ICPMS												
Antimony	7440-36-0	mg/kg	0.5	2	<0.50	B	<0.50	B	<0.50	B	<0.50	B
Arsenic	7440-38-2	mg/kg	1	20	7.38	B	6.07	B	4.49	B	7.12	B
Cadmium	7440-43-9	mg/kg	0.1	1.5	<0.1	B	<0.1	B	<0.1	B	<0.1	B
Chromium	7440-47-3	mg/kg	1	80	9.6	B	24.1	B	19.7	B	4.8	B
Copper	7440-50-8	mg/kg	1	65	4.8	B	12	B	9	B	1.5	B
Lead	7439-92-1	mg/kg	1	50	3.9	B	7.5	B	6.2	B	1.7	B
Nickel	7440-02-0	mg/kg	1	21	8.4	B	14.5	B	12.9	B	3.3	B
Silver	7440-22-4	mg/kg	0.1	1	<0.1	B	<0.1	B	<0.1	B	<0.1	B
Zinc	7440-66-6	mg/kg	1	200	12.9	B	26.4	B	22.2	B	4.7	B
EG035T: Total Recoverable Mercury by FIMS												
Mercury	7439-97-6	mg/kg	0.01	0.15	<0.01	B	<0.01	B	<0.01		<0.01	B
EP003: Total Organic Carbon (TOC) in Soil												
Total Organic Carbon		%	0.02	N/a	0.03		0.28		0.24		0.03	
EP080-SD / EP071-SD: Total Petroleum Hydrocarbons (TPH)		mg/kg		550		B		B				B
C6 - C9 Fraction		mg/kg	3		<3		<3		<3		<3	
C10 - C14 Fraction		mg/kg	3		<3		<3		<3		<3	
C15 - C28 Fraction		mg/kg	3		<3		<3		<3		<3	
C29 - C36 Fraction		mg/kg	5		<5		<5		<5		<5	
C10 - C36 Fraction (sum)		mg/kg	3		<3		<3		<3		<3	
EP090: Organotin Compounds												
Tributyltin	56573-85-4	ugSn/kg	0.5	9	<0.5	B	<0.5	B	<0.5	B	<0.5	B

Matrix:	SOIL		Sample Type:		REG		REG		REG		REG	
Workgroup:	EP2310803		ALS Sample Number:		EP2310803005		EP2310803006		EP2310803007		EP2310803008	
Project name/number:	Cambridge Gulf		Sample Date:		19/07/2023		19/07/2023		19/07/2023		20/07/2023	
			Client sample ID (1st):		CG-SP-17		CG-SP-20		CG-SP-22		CG-SP-26	
Analyte grouping/Analyte	**CAS Number**	**Unit**	**Limit of reporting**	**NAGD Screening Level**	**ALS Result**	**Above/ Below NAGD?**	**ALS Result**	**Above/ Below NAGD?**	**ALS Result**	**Above/ Below NAGD?**	**ALS Result**	**Above/ Below NAGD?**
EP131A: Organochlorine Pesticides												
4.4`-DDD	72-54-8	ug/kg	0.5	**2**	**<0.50**	**B**	**<0.50**	**B**	**<0.50**	**B**	**<0.50**	**B**
4.4`-DDE	72-55-9	ug/kg	0.5	**2.2**	**<0.50**	**B**	**<0.50**	**B**	**<0.50**	**B**	**<0.50**	**B**
4.4`-DDT	50-29-3	ug/kg	0.5	**1.6**	**<0.50**	**B**	**<0.50**	**B**	**<0.50**	**B**	**<0.50**	**B**
Dieldrin	60-57-1	ug/kg	0.5	**280**	**<0.50**	**B**	**<0.50**	**B**	**<0.50**	**B**	**<0.50**	**B**
Endrin	72-20-8	ug/kg	0.5	**10**	**<0.50**	**B**	**<0.50**	**B**	**<0.50**	**B**	**<0.50**	**B**
Gamma-BHC (Lindane)	58-89-9	_g/kg	0.25	**0.32**	**<0.25**	**B**	**<0.25**	**B**	**<0.25**	**B**	**<0.25**	**B**
Total Chlordane (sum)		ug/kg	0.5	**0.5**	**<0.50**	**B**	**<0.50**	**B**	**<0.50**	**B**	**<0.50**	**B**
EP131B: Polychlorinated Biphenyls (as Aroclors)												
Total Polychlorinated biphenyls (PCBs)		ug/kg	5	**23**	**<5.0**	**B**	**<5.0**	**B**	**<5.0**	**B**	**<5.0**	**B**
Aroclor 1016	12674-11-2	ug/kg	5	**23**	**<5.0**	**B**	**<5.0**	**B**	**<5.0**	**B**	**<5.0**	**B**
Aroclor 1221	11104-28-2	ug/kg	5	**23**	**<5.0**	**B**	**<5.0**	**B**	**<5.0**	**B**	**<5.0**	**B**
Aroclor 1232	11141-16-5	ug/kg	5	**23**	**<5.0**	**B**	**<5.0**	**B**	**<5.0**	**B**	**<5.0**	**B**
Aroclor 1242	53469-21-9	ug/kg	5	**23**	**<5.0**	**B**	**<5.0**	**B**	**<5.0**	**B**	**<5.0**	**B**
Aroclor 1248	12672-29-6	ug/kg	5	**23**	**<5.0**	**B**	**<5.0**	**B**	**<5.0**	**B**	**<5.0**	**B**
Aroclor 1254	11097-69-1	ug/kg	5	**23**	**<5.0**	**B**	**<5.0**	**B**	**<5.0**	**B**	**<5.0**	**B**
Aroclor 1260	11096-82-5	ug/kg	5	**23**	**<5.0**	**B**	**<5.0**	**B**	**<5.0**	**B**	**<5.0**	**B**
EP132B: Polynuclear Aromatic Hydrocarbons												
Sum of PAHs		ug/kg	4	**10,000**	**<4**	**B**	**<4**	**B**	**<4**	**B**	**<4**	**B**

Matrix:	SOIL		**Sample Type:**		**REG**		**REG**		**REG**		**REG**	
Workgroup:	EP2310803		**ALS Sample Number:**		**EP2310803009**		**EP2310803010**		**EP2310803011**		**EP2310803012**	
Project name/number:	Cambridge Gulf		**Sample Date:**		**20/07/2023**		**20/07/2023**		**20/07/2023**		**20/07/2023**	
			Client sample ID (1st):		**CG-SP-27**		**CG-SP-29**		**CG-SP-30**		**CG-SP-34**	
Analyte grouping/Analyte	**CAS Number**	**Unit**	**Limit of reporting**	**NAGD Screening Level**	**ALS Result**	**Above/Below NAGD?**	**ALS Result**	**Above/Below NAGD?**	**ALS Result**	**Above/Below NAGD?**	**ALS Result**	**Above/Below NAGD?**
EA055: Moisture Content (Dried @ 105-110_C)												
Moisture Content		%	1	**N/a**	**21.3**		**26.2**		**39.3**		**32.3**	
EG020-SD: Total Metals in Sediments by ICPMS												
Antimony	7440-36-0	mg/kg	0.5	**2**	**<0.50**	**B**	**<0.50**	**B**	**<0.50**	**B**	**<0.50**	**B**
Arsenic	7440-38-2	mg/kg	1	**20**	**15.8**	**B**	**6.34**	**B**	**4.9**	**B**	**11.2**	**B**
Cadmium	7440-43-9	mg/kg	0.1	**1.5**	**<0.1**	**B**	**<0.1**	**B**	**<0.1**	**B**	**<0.1**	**B**
Chromium	7440-47-3	mg/kg	1	**80**	**12.1**	**B**	**18.9**	**B**	**21.8**	**B**	**13.6**	**B**
Copper	7440-50-8	mg/kg	1	**65**	**6.9**	**B**	**8.4**	**B**	**9.1**	**B**	**5.3**	**B**
Lead	7439-92-1	mg/kg	1	**50**	**6.1**	**B**	**6.4**	**B**	**6.4**	**B**	**4.6**	**B**
Nickel	7440-02-0	mg/kg	1	**21**	**11.6**	**B**	**12.1**	**B**	**13.3**	**B**	**9.3**	**B**
Silver	7440-22-4	mg/kg	0.1	**1**	**<0.1**	**B**	**<0.1**	**B**	**<0.1**	**B**	**<0.1**	**B**
Zinc	7440-66-6	mg/kg	1	**200**	**13.5**	**B**	**19.3**	**B**	**23.1**	**B**	**13.8**	**B**
EG035T: Total Recoverable Mercury by FIMS												
Mercury	7439-97-6	mg/kg	0.01	**0.15**	**<0.01**	**B**	**<0.01**	**B**	**<0.01**	**B**	**<0.01**	**B**
EP003: Total Organic Carbon (TOC) in Soil												
Total Organic Carbon		%	0.02	**N/a**	**0.12**		**0.24**		**0.2**		**0.24**	
EP080-SD / EP071-SD: Total Petroleum Hydrocarbons (TPH)		mg/kg		**550**		**B**		**B**		**B**		**B**
C6 - C9 Fraction		mg/kg	3		**<3**		**<3**		**<3**		**<3**	
C10 - C14 Fraction		mg/kg	3		**<3**		**<3**		**<3**		**6**	
C15 - C28 Fraction		mg/kg	3		**<3**		**6**		**<3**		**<3**	
C29 - C36 Fraction		mg/kg	5		**<5**		**<5**		**<5**		**<5**	
C10 - C36 Fraction (sum)		mg/kg	3		**<3**		**6**		**<3**		**6**	
EP090: Organotin Compounds												
Tributyltin	56573-85-4	ugSn/kg	0.5	**9**	**<0.5**	**B**	**<0.5**	**B**	**<0.5**	**B**	**<0.5**	**B**

Matrix:	SOIL		Sample Type:		REG		REG		REG		REG	
Workgroup:	EP2310803		ALS Sample Number:		EP2310803009		EP2310803010		EP2310803011		EP2310803012	
Project name/number:	Cambridge Gulf		Sample Date:		20/07/2023		20/07/2023		20/07/2023		20/07/2023	
			Client sample ID (1st):		CG-SP-27		CG-SP-29		CG-SP-30		CG-SP-34	
Analyte grouping/Analyte	CAS Number	Unit	Limit of reporting	NAGD Screening Level	ALS Result	Above/ Below NAGD?	ALS Result	Above/ Below NAGD?	ALS Result	Above/ Below NAGD?	ALS Result	Above/ Below NAGD?
EP131A: Organochlorine Pesticides												
4.4`-DDD	72-54-8	ug/kg	0.5	**2**	**<0.50**	**B**	**<0.50**	**B**	**<0.50**	**B**	**<0.50**	**B**
4.4`-DDE	72-55-9	ug/kg	0.5	**2.2**	**<0.50**	**B**	**<0.50**	**B**	**<0.50**	**B**	**<0.50**	**B**
4.4`-DDT	50-29-3	ug/kg	0.5	**1.6**	**<0.50**	**B**	**<0.50**	**B**	**<0.50**	**B**	**<0.50**	**B**
Dieldrin	60-57-1	ug/kg	0.5	**280**	**<0.50**	**B**	**<0.50**	**B**	**<0.50**	**B**	**<0.50**	**B**
Endrin	72-20-8	ug/kg	0.5	**10**	**<0.50**	**B**	**<0.50**	**B**	**<0.50**	**B**	**<0.50**	**B**
Gamma-BHC (Lindane)	58-89-9	_g/kg	0.25	**0.32**	**<0.25**	**B**	**<0.25**	**B**	**<0.25**	**B**	**<0.25**	**B**
Total Chlordane (sum)		ug/kg	0.5	**0.5**	**<0.50**	**B**	**<0.50**	**B**	**<0.50**	**B**	**<0.50**	**B**
EP131B: Polychlorinated Biphenyls (as Aroclors)												
Total Polychlorinated biphenyls (PCBs)		ug/kg	5	**23**	**<5.0**	**B**	**<5.0**	**B**	**<5.0**	**B**	**<5.0**	**B**
Aroclor 1016	12674-11-2	ug/kg	5	**23**	**<5.0**	**B**	**<5.0**	**B**	**<5.0**	**B**	**<5.0**	**B**
Aroclor 1221	11104-28-2	ug/kg	5	**23**	**<5.0**	**B**	**<5.0**	**B**	**<5.0**	**B**	**<5.0**	**B**
Aroclor 1232	11141-16-5	ug/kg	5	**23**	**<5.0**	**B**	**<5.0**	**B**	**<5.0**	**B**	**<5.0**	**B**
Aroclor 1242	53469-21-9	ug/kg	5	**23**	**<5.0**	**B**	**<5.0**	**B**	**<5.0**	**B**	**<5.0**	**B**
Aroclor 1248	12672-29-6	ug/kg	5	**23**	**<5.0**	**B**	**<5.0**	**B**	**<5.0**	**B**	**<5.0**	**B**
Aroclor 1254	11097-69-1	ug/kg	5	**23**	**<5.0**	**B**	**<5.0**	**B**	**<5.0**	**B**	**<5.0**	**B**
Aroclor 1260	11096-82-5	ug/kg	5	**23**	**<5.0**	**B**	**<5.0**	**B**	**<5.0**	**B**	**<5.0**	**B**
EP132B: Polynuclear Aromatic Hydrocarbons												
Sum of PAHs		ug/kg	4	**10,000**	**<4**	**B**	**<4**	**B**	**<4**	**B**	**<4**	**B**

Matrix:	SOIL		**Sample Type:**		**REG**		**REG**		**REG**		**REG**	
Workgroup:	EP2310803		**ALS Sample Number:**		**EP2310803013**		**EP2310803014**		**EP2310803015**		**EP2310803016**	
Project name/number:	Cambridge Gulf		**Sample Date:**		**20/07/2023**		**21/07/2023**		**21/07/2023**		**21/07/2023**	
			Client sample ID (1st):		**CG-SP-37**		**CG-SP-39**		**CG-SP-41**		**CG-SP-46**	
Analyte grouping/Analyte	**CAS Number**	**Unit**	**Limit of reporting**	**NAGD Screening Level**	**ALS Result**	**Above/ Below NAGD?**	**ALS Result**	**Above/ Below NAGD?**	**ALS Result**	**Above/ Below NAGD?**	**ALS Result**	**Above/ Below NAGD?**
EA055: Moisture Content (Dried @ 105-110_C)					**33**		**25.6**		**29.2**		**21**	
Moisture Content		%	1	**N/a**								
EG020-SD: Total Metals in Sediments by ICPMS					**<0.50**	**B**	**<0.50**	**B**	**<0.50**	**B**	**<0.50**	**B**
Antimony	7440-36-0	mg/kg	0.5	**2**	**10.4**	**B**	**8.94**	**B**	**6.39**	**B**	**12.1**	**B**
Arsenic	7440-38-2	mg/kg	1	**20**	**<0.1**	**B**	**<0.1**	**B**	**<0.1**	**B**	**<0.1**	**B**
Cadmium	7440-43-9	mg/kg	0.1	**1.5**	**17.6**	**B**	**8.7**	**B**	**16.5**	**B**	**7.6**	**B**
Chromium	7440-47-3	mg/kg	1	**80**	**7.6**	**B**	**4**	**B**	**6.9**	**B**	**3.9**	**B**
Copper	7440-50-8	mg/kg	1	**65**	**5.9**	**B**	**3.4**	**B**	**6.2**	**B**	**3.3**	**B**
Lead	7439-92-1	mg/kg	1	**50**	**10.2**	**B**	**7.8**	**B**	**9.8**	**B**	**7.1**	**B**
Nickel	7440-02-0	mg/kg	1	**21**	**<0.1**	**B**	**<0.1**	**B**	**<0.1**	**B**	**<0.1**	**B**
Silver	7440-22-4	mg/kg	0.1	**1**	**15.7**	**B**	**11**	**B**	**16**	**B**	**8.8**	**B**
Zinc	7440-66-6	mg/kg	1	**200**								
EG035T: Total Recoverable Mercury by FIMS					**<0.01**	**B**	**<0.01**	**B**	**<0.01**	**B**	**<0.01**	**B**
Mercury	7439-97-6	mg/kg	0.01	**0.15**								
EP003: Total Organic Carbon (TOC) in Soil					**0.32**		**0.04**		**0.26**		**0.05**	
Total Organic Carbon		%	0.02	**N/a**		**B**		**B**		**B**		**B**
EP080-SD / EP071-SD: Total Petroleum Hydrocarbons (TPH)		mg/kg		**550**	**<3**		**<3**		**<3**		**<3**	
C6 - C9 Fraction		mg/kg	3		**3**		**3**		**5**		**3**	
C10 - C14 Fraction		mg/kg	3		**<3**		**<3**		**<3**		**3**	
C15 - C28 Fraction		mg/kg	3		**<5**		**<5**		**<5**		**<5**	
C29 - C36 Fraction		mg/kg	5		**3**		**3**		**5**		**6**	
C10 - C36 Fraction (sum)		mg/kg	3									
EP090: Organotin Compounds												
Tributyltin	56573-85-4	ugSn/kg	0.5	**9**	**<0.5**	**B**	**<0.5**	**B**	**<0.5**	**B**	**<0.5**	**B**

Matrix:	SOIL		Sample Type:		REG		REG		REG		REG	
Workgroup:	EP2310803		ALS Sample Number:		EP2310803013		EP2310803014		EP2310803015		EP2310803016	
Project name/number:	Cambridge Gulf		Sample Date:		20/07/2023		21/07/2023		21/07/2023		21/07/2023	
			Client sample ID (1st):		CG-SP-37		CG-SP-39		CG-SP-41		CG-SP-46	
Analyte grouping/Analyte	**CAS Number**	**Unit**	**Limit of reporting**	**NAGD Screening Level**	**ALS Result**	**Above/ Below NAGD?**	**ALS Result**	**Above/ Below NAGD?**	**ALS Result**	**Above/ Below NAGD?**	**ALS Result**	**Above/ Below NAGD?**
EP131A: Organochlorine Pesticides												
4.4`-DDD	72-54-8	ug/kg	0.5	2	<0.50	B	<0.50	B	<0.50	B	<0.50	B
4.4`-DDE	72-55-9	ug/kg	0.5	2.2	<0.50	B	<0.50	B	<0.50	B	<0.50	B
4.4`-DDT	50-29-3	ug/kg	0.5	1.6	<0.50	B	<0.50	B	<0.50	B	<0.50	B
Dieldrin	60-57-1	ug/kg	0.5	280	<0.50	B	<0.50	B	<0.50	B	<0.50	B
Endrin	72-20-8	ug/kg	0.5	10	<0.50	B	<0.50	B	<0.50	B	<0.50	B
Gamma-BHC (Lindane)	58-89-9	_g/kg	0.25	0.32	<0.25	B	<0.25	B	<0.25	B	<0.25	B
Total Chlordane (sum)		ug/kg	0.5	0.5	<0.50	B	<0.50	B	<0.50	B	<0.50	B
EP131B: Polychlorinated Biphenyls (as Aroclors)												
Total Polychlorinated biphenyls (PCBs)		ug/kg	5	23	<5.0	B	<5.0	B	<5.0	B	<5.0	B
Aroclor 1016	12674-11-2	ug/kg	5	23	<5.0	B	<5.0	B	<5.0	B	<5.0	B
Aroclor 1221	11104-28-2	ug/kg	5	23	<5.0	B	<5.0	B	<5.0	B	<5.0	B
Aroclor 1232	11141-16-5	ug/kg	5	23	<5.0	B	<5.0	B	<5.0	B	<5.0	B
Aroclor 1242	53469-21-9	ug/kg	5	23	<5.0	B	<5.0	B	<5.0	B	<5.0	B
Aroclor 1248	12672-29-6	ug/kg	5	23	<5.0	B	<5.0	B	<5.0	B	<5.0	B
Aroclor 1254	11097-69-1	ug/kg	5	23	<5.0	B	<5.0	B	<5.0	B	<5.0	B
Aroclor 1260	11096-82-5	ug/kg	5	23	<5.0	B	<5.0	B	<5.0	B	<5.0	B
EP132B: Polynuclear Aromatic Hydrocarbons												
Sum of PAHs		ug/kg	4	10,000	<4	B	<4	B	<4	B	<4	B

Matrix:	SOIL		**Sample Type:**		**REG**		**REG**		**REG**		**REG**		**REG**	
Workgroup:	EP2310803		**ALS Sample Number:**		**EP2310803017**		**EP2310803018**		**EP2310803019**		**EP2310803020**		**EP2310803021**	
Project name/number:	Cambridge Gulf		**Sample Date:**		**21/07/2023**		**21/07/2023**		**22/07/2023**		**22/07/2023**		**22/07/2023**	
			Client sample ID (1st):		**CG-SP-48**		**CG-SP-50**		**CG-SP-52**		**CG-SP-53**		**CG-SP-55**	
Analyte grouping/Analyte	**CAS Number**	**Unit**	**Limit of reporting**	**NAGD Screening Level**	**ALS Result**	**Above/ Below NAGD?**	**ALS Result**	**Above/ Below NAGD?**	**ALS Result**	**Above/ Below NAGD?**	**ALS Result**	**Above/ Below NAGD?**	**ALS Result**	**Above/ Below NAGD?**
EA055: Moisture Content (Dried @ 105-110_C)					**25.6**									
Moisture Content		%	1	**N/a**			**30.3**		**29.5**		**25.2**		**24.8**	
EG020-SD: Total Metals in Sediments by ICPMS					**<0.50**	**B**								
Antimony	7440-36-0	mg/kg	0.5	**2**	**7.85**	**B**	**<0.50**	**B**	**<0.50**	**B**	**<0.50**	**B**	**<0.50**	**B**
Arsenic	7440-38-2	mg/kg	1	**20**	**<0.1**	**B**	**9.74**	**B**	**6.6**	**B**	**7.68**	**B**	**8.5**	**B**
Cadmium	7440-43-9	mg/kg	0.1	**1.5**	**7.6**	**B**	**<0.1**	**B**	**<0.1**	**B**	**<0.1**	**B**	**<0.1**	**B**
Chromium	7440-47-3	mg/kg	1	**80**	**4.2**	**B**	**18.5**	**B**	**23.2**	**B**	**8.5**	**B**	**8.1**	**B**
Copper	7440-50-8	mg/kg	1	**65**	**3.5**	**B**	**6.7**	**B**	**10.7**	**B**	**4.3**	**B**	**4.9**	**B**
Lead	7439-92-1	mg/kg	1	**50**	**7**	**B**	**5.7**	**B**	**7.4**	**B**	**3.7**	**B**	**3.9**	**B**
Nickel	7440-02-0	mg/kg	1	**21**	**<0.1**	**B**	**11**	**B**	**14.1**	**B**	**7.7**	**B**	**8**	**B**
Silver	7440-22-4	mg/kg	0.1	**1**	**9.7**	**B**	**<0.1**	**B**	**<0.1**	**B**	**<0.1**	**B**	**<0.1**	**B**
Zinc	7440-66-6	mg/kg	1	**200**			**18.5**	**B**	**22.9**	**B**	**11.5**	**B**	**11.1**	**B**
EG035T: Total Recoverable Mercury by FIMS					**<0.01**	**B**								
Mercury	7439-97-6	mg/kg	0.01	**0.15**			**<0.01**	**B**	**<0.01**	**B**	**<0.01**	**B**	**<0.01**	**B**
EP003: Total Organic Carbon (TOC) in Soil					**<0.02**									
Total Organic Carbon		%	0.02	**N/a**		**B**	**0.15**		**0.36**		**0.04**		**0.05**	
EP080-SD / EP071-SD: Total Petroleum Hydrocarbons (TPH)		mg/kg		**550**	**<3**			**B**		**B**		**B**		**B**
C6 - C9 Fraction		mg/kg	3		**<3**		**<3**		**<3**		**<3**		**<3**	
C10 - C14 Fraction		mg/kg	3		**<3**		**<3**		**<3**		**<3**		**<3**	
C15 - C28 Fraction		mg/kg	3		**<5**		**<3**		**<3**		**<3**		**<3**	
C29 - C36 Fraction		mg/kg	5		**<3**		**<5**		**<5**		**<5**		**<5**	
C10 - C36 Fraction (sum)		mg/kg	3				**<3**		**<3**		**<3**		**<3**	
EP090: Organotin Compounds														
Tributyltin	56573-85-4	ugSn/kg	0.5	**9**	**<0.5**	**B**	**<0.5**	**B**	**<0.5**	**B**	**<0.5**	**B**	**<0.5**	**B**

Matrix:	SOIL		Sample Type:		REG		REG		REG		REG		REG	
Workgroup:	EP2310803		ALS Sample Number:		EP2310803017		EP2310803018		EP2310803019		EP2310803020		EP2310803021	
Project name/number:	Cambridge Gulf		Sample Date:		21/07/2023		21/07/2023		22/07/2023		22/07/2023		22/07/2023	
			Client sample ID (1st):		CG-SP-48		CG-SP-50		CG-SP-52		CG-SP-53		CG-SP-55	
Analyte grouping/Analyte	**CAS Number**	**Unit**	**Limit of reporting**	**NAGD Screening Level**	**ALS Result**	**Above/ Below NAGD?**	**ALS Result**	**Above/ Below NAGD?**	**ALS Result**	**Above/ Below NAGD?**	**ALS Result**	**Above/ Below NAGD?**	**ALS Result**	**Above/ Below NAGD?**
EP131A: Organochlorine Pesticides														
4.4`-DDD	72-54-8	ug/kg	0.5	2	<0.50	B	<0.50	B	<0.50	B	<0.50	B	<0.50	B
4.4`-DDE	72-55-9	ug/kg	0.5	2.2	<0.50	B	<0.50	B	<0.50	B	<0.50	B	<0.50	B
4.4`-DDT	50-29-3	ug/kg	0.5	1.6	<0.50	B	<0.50	B	<0.50	B	<0.50	B	<0.50	B
Dieldrin	60-57-1	ug/kg	0.5	280	<0.50	B	<0.50	B	<0.50	B	<0.50	B	<0.50	B
Endrin	72-20-8	ug/kg	0.5	10	<0.50	B	<0.50	B	<0.50	B	<0.50	B	<0.50	B
Gamma-BHC (Lindane)	58-89-9	_g/kg	0.25	0.32	<0.25	B	<0.25	B	<0.25	B	<0.25	B	<0.25	B
Total Chlordane (sum)		ug/kg	0.5	0.5	<0.50	B	<0.50	B	<0.50	B	<0.50	B	<0.50	B
EP131B: Polychlorinated Biphenyls (as Aroclors)														
Total Polychlorinated biphenyls (PCBs)		ug/kg	5	23	<5.0	B	<5.0	B	<5.0	B	<5.0	B	<5.0	B
Aroclor 1016	12674-11-2	ug/kg	5	23	<5.0	B	<5.0	B	<5.0	B	<5.0	B	<5.0	B
Aroclor 1221	11104-28-2	ug/kg	5	23	<5.0	B	<5.0	B	<5.0	B	<5.0	B	<5.0	B
Aroclor 1232	11141-16-5	ug/kg	5	23	<5.0	B	<5.0	B	<5.0	B	<5.0	B	<5.0	B
Aroclor 1242	53469-21-9	ug/kg	5	23	<5.0	B	<5.0	B	<5.0	B	<5.0	B	<5.0	B
Aroclor 1248	12672-29-6	ug/kg	5	23	<5.0	B	<5.0	B	<5.0	B	<5.0	B	<5.0	B
Aroclor 1254	11097-69-1	ug/kg	5	23	<5.0	B	<5.0	B	<5.0	B	<5.0	B	<5.0	B
Aroclor 1260	11096-82-5	ug/kg	5	23	<5.0	B	<5.0	B	<5.0	B	<5.0	B	<5.0	B
EP132B: Polynuclear Aromatic Hydrocarbons														
Sum of PAHs		ug/kg	4	10,000	<4	B	<4	B	<4	B	<4	B	<4	B

ANNEX 12: DBCA CAPE DOMETT TURTLE DATA REPORT

See separate report.

File Name: Referral Report No. 2 - ANNEX 12 – CAPE DOMETT TURTLE DATA REPORT - Boskalis Cambridge Gulf.

ANNEX 13: MARINE MEGA-FAUNA SURVEYS IMAGES & LOCATIONS

A.13.1: Dry-season Survey Fauna Images

In chronological order.


1 Flatback Turtle
19 July 2023
S 14.863487o E 128.154086o
Off Lyne River. W side Cambridge Gulf
Observer: H Penrose


1 Saltwater Crocodile
20 July 2023
S15.193103o E128.192685o
S end Adolphus Is.
Observer: H Penrose

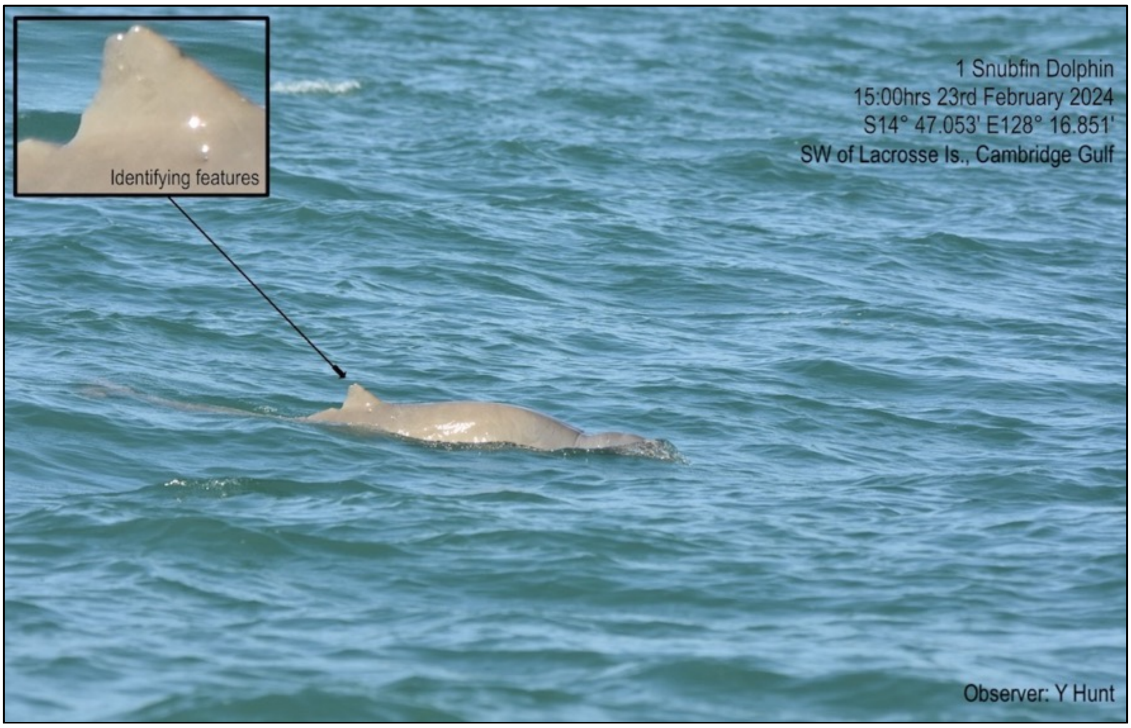

1 Saltwater Crocodile
21 July 2023
S14.796477o E128.416962o
The Needles, Cape Domett
Observer: H Penrose


3 Saltwater Crocodiles
21 July 2023
S14° 48' 08.298" E128° 24' 22.32"
Cape Domett Seaward Bch
Croc
Observer: J Dickie

A.13.2: Wet-season Survey Fauna Images

In chronological order.


11:22 hrs 22 Feb 2024
Cape Domett, Cambridge Gulf
Possible Identifying Feature
(although similar teeth are common)


Identifying features
1 Snubfin Dolphin
15:00hrs 23rd February 2024
S14° 47.053' E128° 16.851'
SW of Lacrosse Is., Cambridge Gulf
Observer: Y Hunt


Snubfin Dolphin
10:27hrs 27th February 2024
S14°.234' E128°15.865'
Centre of Cambridge Gulf
Identifying Feature
Observer Mia McIntyre

A.13.3: Sighting Location Descriptions per Species

Snubfin Dolphins Sighting Location Descriptions

POA = Proposed Operational Area.

Dry-season	
Date	**Locations**
15 Jul:	Nil
16 Jul:	1 x West Arm S of Adolphus Is. 1 x West Arm W of Adolphus Is. 1 x N of Adolphus Is.
17 Jul:	Nil
18 Jul:	2 (pair) in POA.
19 Jul:	Nil
20 Jul:	Nil
21 Jul:	1 in POA 2 x E of POA
22 Jul:	Nil
8 Aug:	1 x West Arm S of Adolphus Is. 1 x West Arm W of Adolphus Is. 1 x N of Adolphus Is.
-	-
Combined:	**2 x West Arm S of Adolphus Is.** **2 x West Arm W of Adolphus Is.** **2 x N of Adolphus Is.** **3 in POA.** **2 x E of POA**

Wet-season	
Date	**Locations**
8 Feb:	Nil
18 Feb:	1 x West Arm W of Adolphus Is.
21 Feb:	Nil
22 Feb:	Nil
23 Feb:	1 in POA
24 Feb:	Nil
25 Feb:	Nil
26 Feb:	Nil
27 Feb:	1 in POA
28 Feb:	1 x S of POA.
Combined:	**1 x West Arm W of Adolphus Is.** **1 x S of POA** **2 in POA**

Humpback Dolphin Sighting Location Descriptions

POA = Proposed Operational Area.

Dry-season	
Date	**Locations**
15 Jul:	Nil
16 Jul:	Nil
17 Jul:	Nil
18 Jul:	Nil
19 Jul:	Nil
20 Jul:	Nil
21 Jul:	Nil
22 Jul:	Nil
8 Aug:	Nil
-	-
Combined:	**Nil**

Wet-season	
Date	**Locations**
8 Feb:	Nil
18 Feb:	Nil
21 Feb:	Nil
22 Feb:	Nil
23 Feb:	1 x N of PoA
24 Feb:	Nil
25 Feb:	Nil
26 Feb:	Nil
27 Feb:	Nil
28 Feb:	Nil
Combined:	**1 x N of PoA**

Unidentified Dolphins Sighting Location Descriptions

POA = Proposed Operational Area.

Dry-season	
Date	**Locations**
15 Jul:	Nil
16 Jul:	Nil
17 Jul:	Nil
18 Jul:	1 x S of Lacrosse Is.
19 Jul:	Nil
20 Jul:	1 x West Arm S of Adolphus Is.
21 Jul:	Nil
22 Jul:	Nil
8 Aug:	Nil
-	-
Combined:	**1 x S of Lacrosse Is.** **1 x West Arm S of Adolphus Is.**

Wet-season	
Date	**Locations**
8 Feb:	Nil
18 Feb:	Nil
21 Feb:	Nil
22 Feb:	Nil
23 Feb:	Nil
24 Feb:	Nil
25 Feb:	Nil
26 Feb:	Nil
27 Feb:	Nil
28 Feb:	1 x N of Adolphus Is.
Combined:	**1 x N of Adolphus Is.**

Flatback Turtle Sighting Location Descriptions

POA = Proposed Operational Area.

Dry-season	
Date	**Locations**
15 Jul:	Nil
16 Jul:	1 x W of C. Dussejour (outside CG)
17 Jul:	Nil
18 Jul:	Nil
19 Jul:	1 x mouth of Lyne RV (W side of CG)
20 Jul:	1 x West Arm W of Adolphus Is.
21 Jul:	2 x W of Cape Domett
22 Jul:	1 x W of Cape Domett
8 Aug:	Nil
-	-
Combined:	**1 x W of C. Dussejour (outside CG)** **1 x mouth of Lyne RV (W side of CG)** **1 x West Arm W of Adolphus Is.** **3 x W of Cape Domett**

Wet-season	
Date	**Locations**
8 Feb:	Nil
18 Feb:	Nil
21 Feb:	Nil
22 Feb:	Nil
23 Feb:	Nil
24 Feb:	Nil
25 Feb:	Nil
26 Feb:	Nil
27 Feb:	Nil
28 Feb:	Nil
Combined:	**Nil**

Green Turtle Sighting Location Descriptions

POA = Proposed Operational Area.

Dry-season	
Date	**Locations**
15 Jul:	Nil
16 Jul:	1 x W of C. Dussejour (outside CG)
17 Jul:	Nil
18 Jul:	Nil
19 Jul:	Nil
20 Jul:	Nil
21 Jul:	Nil
22 Jul:	Nil
8 Aug:	Nil
-	-
Combined:	**1 x W of C. Dussejour (outside CG)**

Wet-season	
Date	**Locations**
8 Feb:	Nil
18 Feb:	Nil
21 Feb:	Nil
22 Feb:	Nil
23 Feb:	Nil
24 Feb:	Nil
25 Feb:	Nil
26 Feb:	Nil
27 Feb:	Nil
28 Feb:	Nil
Combined:	**Nil**

Unidentified Turtles Sighting Location Descriptions

POA = Proposed Operational Area. FMO = False Mouths of Ord (E side of CG).

Dry-season	
Date	**Locations**
15 Jul:	Nil
16 Jul:	1 x West Arm W of Adolphus Is.
17 Jul:	1 in S POA. 1 in FMO. 1 off Cape Domett Bch (outside CG)
18 Jul:	1 x E end of Lacrosse Is. 1 x NW end of Lacrosse Is.
19 Jul:	1 at Vancouver Point
20 Jul:	Nil
21 Jul:	Nil
22 Jul:	Nil
8 Aug:	Nil
-	-
Combined:	**1 x West Arm W of Adolphus Is.** **1 in S POA.** **1 in FMO.** **1 off Cape Domett Bch (outside CG)** **1 x E end of Lacrosse Is.** **1 x NW end of Lacrosse Is.** **1 at Vancouver Point**

Wet-season	
Date	**Locations**
8 Feb:	Nil
18 Feb:	Nil
21 Feb:	Nil
22 Feb:	Nil
23 Feb:	Nil
24 Feb:	Nil
25 Feb:	Nil
26 Feb:	Nil
27 Feb:	Nil
28 Feb:	1 x in POA. 1 x E of POA.
Combined:	**1 x in POA.** **1 x E of POA.**

Crocodile Sighting Location Descriptions

POA = Proposed Operational Area. FMO = False Mouths of Ord (E side of CG).

Dry-season	
Date	**Locations**
15 Jul:	Nil
16 Jul:	Nil
17 Jul:	1 in FMO.
18 Jul:	Nil
19 Jul:	Nil
20 Jul:	2 x S Adolphus
21 Jul:	6 x C. Domett Bch (outside CG)
22 Jul:	Nil
8 Aug:	1 x East Bank
-	-
Combined:	**1 in FMO** **2 x S Adolphus** **6 x C. Domett Bch (outside CG)** **1 x East Bank**

Wet-season	
Date	**Locations**
8 Feb:	3 at W of CG: - 1 x mouth of Helby Rv. - 1 x mouth of Lyne Rv. - 1 x mouth of Thompson Rv.
18 Feb:	Nil
21 Feb:	Nil
22 Feb:	1 x C. Domett
23 Feb:	Nil
24 Feb:	Nil
25 Feb:	Nil
26 Feb:	1 in POA
27 Feb:	Nil
28 Feb:	Nil
Combined:	**3 at W of CG:** **- 1 x mouth of Helby Rv.** **- 1 x mouth of Lyne Rv.** **- 1 x mouth of Thompson Rv.** **1 x C. Domett** **1 in POA**

ANNEX 14: SAWFISH & RIVER SHARKS eDNA REPORT

See separate report.

File Name: Referral Report No. 2 - ANNEX 14 - MARINE eDNA REPORT - Boskalis Cambridge Gulf.