ATTACHMENT TWELVE
Assessment of Benthic Ecology Effects (Bioresearches)

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Te Ākau Bream Bay Sand Extraction Project

Assessment of Ecological Effects

for: McCallum Bros Limited

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Prepared for	McCallum Bros Limited

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Cover Illustration: Sand extraction vessel "William Fraser" in operation off Pākiri beach (November 2019).

Code of Conduct Reference for Application Material

Although this is not a hearing before the Environment Court, we record that we have read and agree to comply with the Environment Court's Code of Conduct for Expert Witnesses as specified in the Environment Court's Practice Note 2023 as relevant to preparation of a report for this Fast-track application. In particular, we confirm that this report is within our area of expertise, except where we state that we rely upon the evidence or reports of other expert witnesses lodged forming part of the project's application material. We have not omitted to consider any material facts known to us that might alter or detract from the opinions expressed.

EXECUTIVE SUMMARY

McCallum Bros Limited (MBL) plan to submit a resource consent application for sand extraction in Te Ākau Bream Bay, Northland, to meet future sand supply needs for Northland, Auckland, Waikato, and Bay of Plenty regions. The proposed extraction area is a 15.4 km^2 rectangle, located 4.7 km offshore in water depths of 20-30 meters. The project will initially involve the extraction of 150,000 m^3 of sand annually for the three years. After this it is proposed to increase the extraction rate to 250,000 m^3 annually for up to 32 years, this will be contingent on monitoring results showing no significant adverse effects.

Sand will be extracted using the Trailing Suction Hopper Dredge (TSHD) such as the *William Fraser*, operating at 1.5-2.5 knots for up to 3.5 hours per session. Extraction will occur in the afternoon, an Extraction Management Plan will show how the proposed extraction will be evenly spread and/or spatially distributed across the sand extraction area. The sand extraction area will be divided into 77 monitoring and extraction cells, reporting volumes extracted in each cell will ensure compliance.

The report assesses the ecological values of the sand extraction area:

- **Coastal Vegetation**: No ecological value, as no significant vegetation found in the extraction area. Seagrass (*Zostera muelleri*) was not found or expected to be found within the proposed sand extraction area.
- **Macroalgae**: Negligible ecological value, as sparse presence of macroalgae, with no significant macroalgae meadows were observed in the proposed sand extraction area photographic survey.
- **Benthic Habitat and Fauna**: Moderate ecological value due to diverse but regionally typical species, with no invasive biota, or significant habitat-forming biota. No beds of large habitat forming biota such as horse mussels were present.
- **Benthic Fish**: Low ecological value, with common species present, with no threatened or at-risk species.
- **Sharks and Rays**: Very high ecological value due to the presence of threatened and endangered species, with no significant habitats in the extraction area.
- **Marine Reptiles**: Very high ecological value due to the presence of migratory turtles (e.g., green turtles) and rare sightings of marine snakes, with no significant habitats in the extraction area.

The major effects from sand extraction are expected to come in the form of:

- **Water Quality**: **Negligible** with temporary, highly localised increases in turbidity within the sand extraction area, with no significant long-term effects, and no release by disturbance or introduction of contaminants.
- **Underwater Noise**: No risk for auditory injury onset or temporary threshold shift beyond 1 m from the draghead to marine reptiles, fish, or invertebrates. Potential short-term behavioural responses on fish and marine reptiles, within a limited range but no long-term impacts. Behavioural responses in invertebrates are predicted to be **Negligible** over a much reduced range than for fish and marine reptiles.
- **Seabed disturbance**: The sand extraction from each track will result in the temporary, loss of 0.135% seabed habitat, from within the sand extraction area. The method of sand extraction creates a patchwork of 1.6 m wide, 100 mm deep disturbance tracks but does not create large consecutive areas of disturbed habitat. The disturbance is temporary as the biota will recolonise and recover over time; thus the magnitude of effects is described as **Low** on the overall benthic community within the sand extraction area.

The report describes the potential level of effects from the activity of sand extraction to;

- **Benthic Biota**: The benthic biota are expected to be affected by seabed disturbance, survivability of the sand extraction process, underwater noise and water quality. The sand extraction will result in temporary disturbance with an expected recovery of the biota within 2-3 years. Some very minor loss of biota abundance and very minor changes in diversity are possible within the sand extraction area, but not beyond the sand extraction area. Due to the planned even spatial distribution of extraction activity, and management of extraction over the proposed area, sufficient recovery times between sand extraction events is available to minimise potential benthic community effects. Approximately 86% of the larger biota are expected to survive passage through the dredge.
  For benthic biota underwater noise will only be minor behavioural, temporary, and short term < 3 minutes in any one location per sand extraction event.
  Overall low magnitude of effects is possible within the sand extraction area and **Negligible** effects in the wider Te Ākau Bream Bay.
- **Benthic Fish**: The benthic fish are expected to be affected by underwater noise, entrainment, water quality, and food source reduction. Different fish have different sound sensitivities; the NZ Bigeye has been used as a proxy for the most sensitive fish while the Triplefin has been used as proxy for most other fish. The underwater noise created by sand extraction will not be sufficient to cause injury to fish, however a range of temporary behavioural effects are possible at varying distances from the vessel in operation. The effects of underwater noise will extend beyond the sand extraction area only when the vessel is actively extracting on the edge of the area.
  Due to the draghead's close proximity to the seabed while actively extracting, there is little chance of entrainment of fish other than those species that are not mobile.
  There is potential for a very minor reduction or change in food resources due to minor changes in benthic biota ecology, but only within the sand extraction area. No effects to food resources are expected in the wider Te Ākau Bream Bay.
  Overall effects to fish within the sand extraction area are estimated to be **Low**, while no or **Negligible** effects are estimated to occur in the wider Te Ākau Bream Bay.
- **Marine food web**: The marine food web in Te Ākau Bream Bay is typical of open-coast sandy environments and is driven primarily by pelagic primary production, with benthic–pelagic coupling operating at broader spatial scales. Sand extraction may result in short-term, localised disturbance to benthic communities and water clarity within the sand extraction area; however, these effects are highly localised, temporary, and affect only a very small proportion of the seabed at any one time. Small pelagic fish, which form the primary prey base for seabirds (including tara iti) and marine mammals, are mobile and not dependent on benthic production within the extraction area. **Accordingly, the magnitude of effects on marine food-web processes is assessed as Negligible within the sand extraction area and Negligible in the wider Te Ākau Bream Bay**.
- **Sharks and Rays:** Sharks and rays could be impacted by underwater noise, habitat modification, ship strike, exposure to contaminants, marine debris, artificial lighting, and cumulative effects.
  Underwater noise levels are such that effects to sharks and rays will only be behavioural, and for the duration the shark or ray is in range when sand extraction is in operation.
  Vessel strike is unlikely to happen as potentially present sharks and rays swim faster than the TSHD while actively extracting. None of the sharks and rays listed in the Wildlife Act have been reported as sighted with in Te Ākau Bream Bay.
  Artificial lighting will only be required under very limited circumstances, and the vessel lighting has been reduced as much as is possible.
  Overall effects to sharks and rays within the sand extraction area are **Negligible**.

- **Marine Reptiles**: Marine reptiles could be impacted by underwater noise, habitat modification, ship strike, exposure to contaminants, marine debris, artificial lighting, and cumulative effects.
  Underwater noise levels are such that effects to reptiles will only be behavioural, and for the duration the reptile is in range when sand extraction is in operation.
  Vessel strike is unlikely to happen as potentially present reptiles swim faster than the TSHD while actively extracting. Only one reptile has been sighted in the extraction area in 2006 since records began 126 years ago.
  Artificial lighting will only be required under very limited circumstances, and the vessel lighting has been reduced as much as is possible.
  Overall effects to marine reptiles within the sand extraction area are **Negligible**.

A comprehensive monitoring program will be implemented to track ecological impacts and ensure compliance with environmental standards. Adaptive management strategies will be employed to mitigate any unforeseen adverse effects.

The proposed sand extraction project is expected to have **low to negligible** ecological impacts within the sand extraction area and **negligible** ecological impacts in the wider Te Ākau Bream Bay. With effective monitoring and mitigation measures in place, potential risks within the sand extraction area can be managed and eliminated or minimised. The project aligns with regional and national environmental policies, ensuring the protection of marine biodiversity and ecosystem health.

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1 INTRODUCTION

To meet expected future sand supply requirements for the Auckland, Northland, Waikato and Bay of Plenty regions, McCallum Bros Limited® (MBL) has identified a potential sand extraction area in Te Ākau Bream Bay, Northland (Figure 1).

MBL intends to submit an application for a coastal permit under the Fast Track Approvals (FTA) Act (2024) to extract sand in Te Ākau Bream Bay from the area indicated in (red) Figure 1.

The proposed sand extraction area forms a (15.4 km²) rectangle extending approximately northwest to southeast, roughly parallel with the central Te Ākau Bream Bay shoreline, in water between approximately 20 - 30 m deep and at least 4.7 km offshore. The proposed extraction area occurs west of the existing anchorage sites that are used by commercial vessels awaiting berthage at Northport, and south of the shipping channel used by vessels transiting to and from Marsden Point and the Whangārei Harbour. It is estimated 1,150 ship port related movements per year (Northport, 2022) currently occur while only 161 sand extraction related ship movements per year will occur in the first 3 years and with up to 271 ship movements per year occurring from 3 years. The major difference is that port ship movements will be at up to 10 knots while the *William Fraser's* movements will be at less than 2.5 knots while actively extracting sand (MBL, 2025).

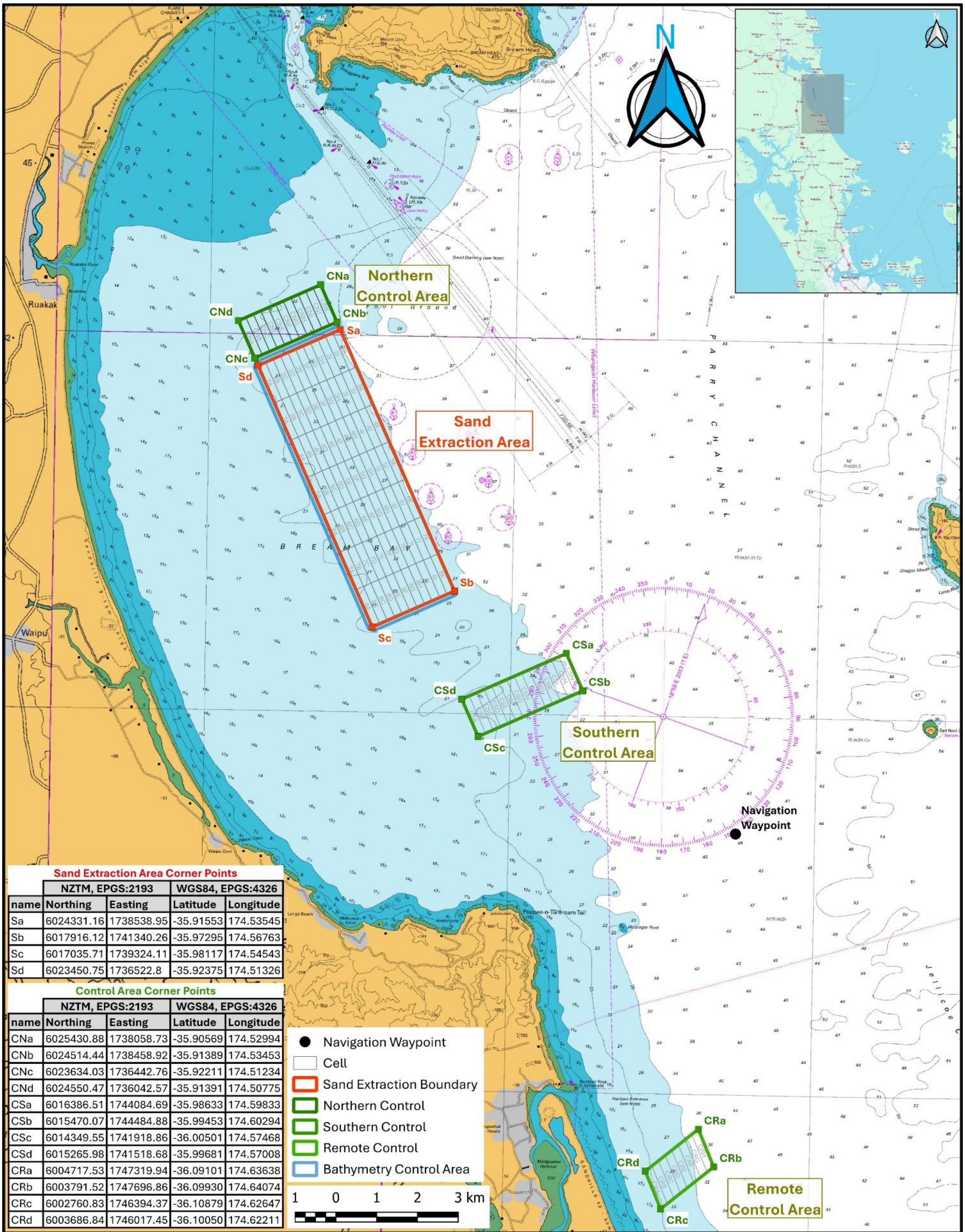
The project proposes the extraction of 150,000 m³ per year for the first three years spread across the entire proposed sand extraction area. In the fourth year the project proposes to increase this rate to 250,000 m³ per year over the same extraction area, for up to 32 years.

The sand extraction activities involve extracting and pumping of a sand slurry from the seabed by MBL's modern TSHD travelling between 1.5-2.5 knots for up to 3.5 hours, within the proposed sand extraction area. Sand extraction is proposed to take place in the afternoon between 12:00 pm – 6:00 pm (April-September) and 12:00 pm – 8:00 pm (October-March) and be spread as evenly as possible across the entire extraction site. To ensure this is achieved, the extraction area is divided into 77 cells (1000 m x 200 m), and extraction volume recorded against each cell to ensure even distribution of extraction. Once the vessel's hopper is full of sand, the vessel will return to the Port of Auckland (or other destination Port) for unloading.

The objectives of this report are to:

- Identify and summarise the ecological values of
    - Coastal vegetation,
    - Macroalgae communities,
    - Benthic biota assemblages,
    - Benthic fish assemblages,
    - Marine reptile assemblages,

  that occur in the vicinity of the proposed sand extraction area.
- Identify and assess the potential effects of sand extraction activity on:
    - Benthic biota,
    - Benthic fish,
    - Marine reptiles.



Sand Extraction Area Corner Points

	NZTM, EPGS:2193		WGS84, EPGS:4326	
name	Northing	Easting	Latitude	Longitude
Sa	6024331.16	1738538.95	-35.91553	174.53545
Sb	6017916.12	1741340.26	-35.97295	174.56763
Sc	6017035.71	1739324.11	-35.98117	174.54543
Sd	6023450.75	1736522.8	-35.92375	174.51326

Control Area Corner Points

	NZTM, EPGS:2193		WGS84, EPGS:4326	
name	Northing	Easting	Latitude	Longitude
CNa	6025430.88	1738058.73	-35.90569	174.52994
CNb	6024514.44	1738458.92	-35.91389	174.53453
CNc	6023634.03	1736442.76	-35.92211	174.51234
CNd	6024550.47	1736042.57	-35.91391	174.50775
CSa	6016386.51	1744084.69	-35.98633	174.59833
CSb	6015470.07	1744484.88	-35.99453	174.60294
CSc	6014349.55	1741918.86	-36.00501	174.57468
CSd	6015265.98	1741518.68	-35.99681	174.57008
CRa	6004717.53	1747319.94	-36.09101	174.63638
CRb	6003791.52	1747696.86	-36.09930	174.64074
CRc	6002760.83	1746394.37	-36.10879	174.62647
CRd	6003686.84	1746017.45	-36.10050	174.62211

CLIENT / PROJECT
McCallum Bros. Ltd.

CD – Chart Datum as measured at Marsden Point (LINZ code DJM9)
Map projection - NZ Transverse Mercator EPGS:2193
GPS points - NZTM EPGS:2193, WGS 84 EPGS:4326

MAP REVISIONS
Drawing Date: 12/11/2025 Version 1.0.4 by SW.

MAP FILE NAME
Map Showing Sand Extraction Area and Control Areas With Cells

Bioresearches

Figure 1 Proposed Te Ākau Bream Bay Sand Extraction Area and proposed benthic ecology Control areas.

2 ECOLOGICAL INPUT INTO KEY DESIGN ELEMENTS

The initial ecological benthic biota sampling included samples in the anchorage area, 1000 m further north and 400 m further inshore than the sand extraction area applied for. Following the identification of the species of importance in the anchorage area, the MBL was advised to avoid this area to limit potential effects.

In environmental impact assessments—especially those involving benthic biota, control site data should ideally be statistically similar to the impact area before the impact occurs. However, perfect similarity is rare in practice, natural variability in benthic communities due to sediment type, depth, hydrodynamics, and other ecological factors can make it hard to find a truly "identical" control site. The initial control sites (South and Remote) were chosen to match the impact site as closely as possible in terms of physical (depth range, substrate type) and biological characteristics. An initial control area to the north was not defined as there is an absence of similar habitat to the initially proposed sand extraction area. With Three mile reef located just north of the proposed sand extraction area altering the seabed topography and substrate type. North of Three mile reef the Whangarei Harbour channel enters the bay, again altering the topography and providing ecologically influencing factors such as currents variable water quality. The topography of the seabed north of the Whangarei harbour channel is much steeper meaning if the substrate type was the same the area of any control area would be less than half the width of the sand extraction area.

Initial benthic surveys across the 8 km long, 2.2 km wide initial sand extraction area revealed a distinct gradient in benthic community composition and abundance, with biota varying systematically from north to south. This spatial heterogeneity indicated that the sand extraction area was not ecologically uniform, and that the originally designated control sites - located 2 km and remotely further south of the impact area - did not adequately represent the full range of benthic conditions present within the sand extraction zone. This necessitated the need for a northern control area.

To address this, the northernmost 1 km section of the sand extraction area was reclassified as a **northern control area**. This section exhibited benthic characteristics more similar to the northern portion of the impact zone than to the southern controls. By incorporating this northern control, the revised control design now spans the observed gradient in benthic biota, improving ecological representativeness and strengthening the validity of subsequent impact assessments.

This adjustment ensures that the control areas collectively reflect the natural variability within the sand extraction zone, allowing for more accurate detection of impact-related changes and reducing the risk of confounding due to pre-existing ecological differences.

There was space available to move the northern control 200 m north to provide a small buffer between the control and the sand extraction area.

Thus, the final proposed sand extraction area and control sites were defined.

3 EXTRACTION ACTIVITIES

All extraction activities in the proposed consent area will be conducted by a TSHD such as the *William Fraser*. TSHD's operate by sucking material from the seabed as a sand slurry using a trailing suction head fitted to pipes that trail over the bed as the ship sails over the extraction area. The sand pumps lift the extracted sand slurry through the pipework to pass through sand screens to be deposited in the onboard hopper. A key component of the activity is that once the vessel is fully loaded, it returns directly by sea to the Port of Auckland (or other destination ports) for unloading, hence there are no local onshore components to the extraction operation.

A schematic diagram of a TSHD is presented in Figure 2.

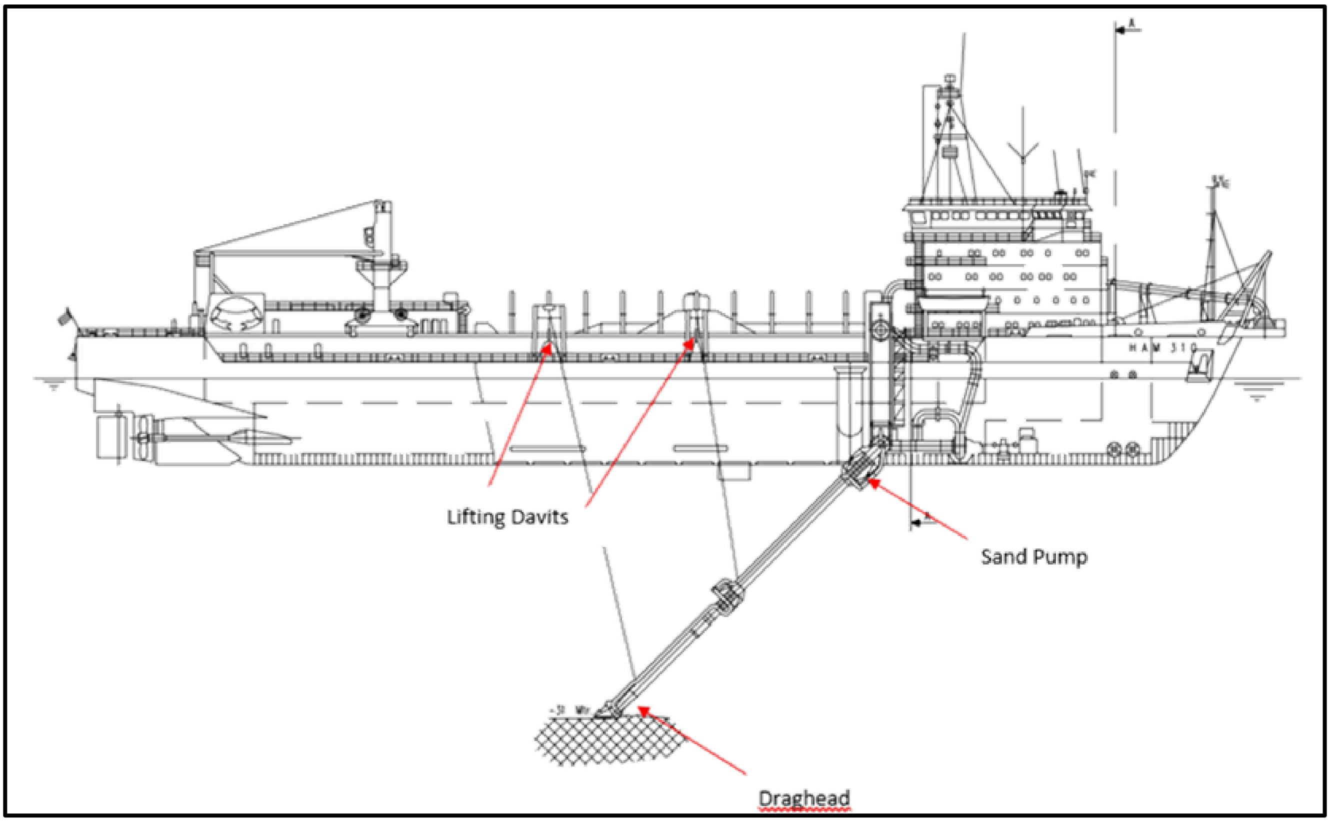


Figure 2 Schematic Diagram of a TSHD (not an actual MBL vessel)

The *William Fraser* has been specifically built for trailing suction extraction of sand and has a number of new technologies that increase the efficiency of operation whilst minimising other impacts on the surrounding environment (MBL, 2025).

The *William Fraser* is 68 m long with a hopper volume capacity of 923 m³. The draghead used by the *William Fraser* is 1.6 m wide and shown in operation on the seabed in Figure 3, with the resulting 1.6 m wide extraction profile that is approximately 0.1 m deep. The sand pump lifts the extracted sand slurry through the pipework to pass through a 2 mm screen (Figure 4) to remove any larger material; then the sand goes into the hopper where the sand settles. The water and any finer sediments pass out of the hopper into one of the six moon pools before being discharged under the vessel, and any larger material captured by the screen is also discharged through a moon pool under the vessel.

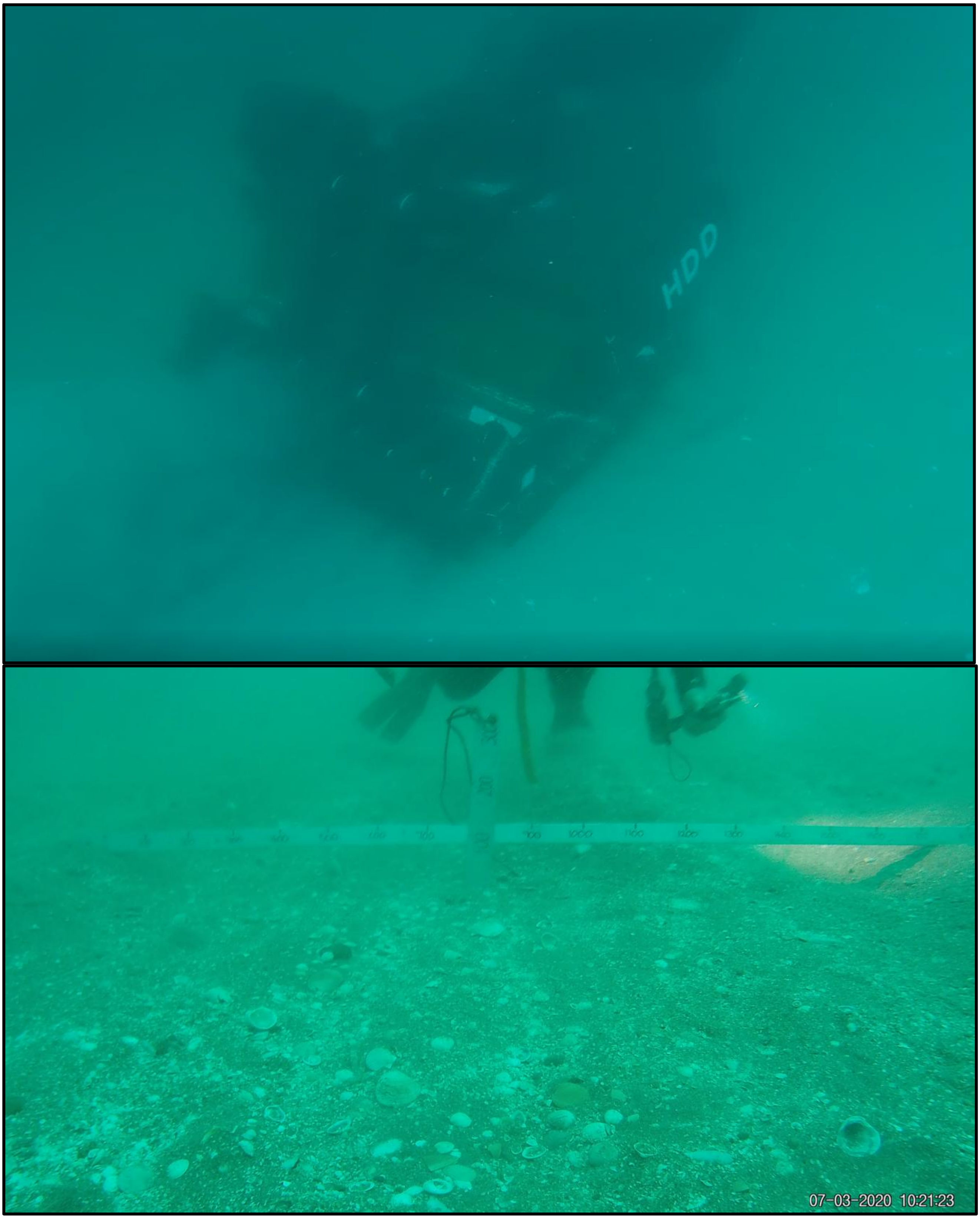


Figure 3 William Fraser draghead and seabed extraction profile.

Figure 4 Sand and water pumped into the screening system where sampling occurred (Left); and mesh basket used for sampling (right)

The process of sand extraction starts once the vessel is inside the extraction area. The speed is reduced to 1.5-2.5 knots, and the crew prepare the extraction equipment. The draghead is partially lowered to less than 3 m from the seabed in readiness and the pump is started. The draghead is then lowered all the way to the sea floor and extraction of a sand slurry (a mixture of sand and seawater) begins. In order to turn at the end of each extraction track the pump is slowed and the draghead is lifted off the seabed. If the hopper is full, the draghead is lifted off the seabed and the equipment is flushed with seawater before it is stowed onboard, and the vessel returns to its desired port to unload. Based on the sand extraction operation plan (SEOP) (MBL, 2025) information the longest expected dredge path per trip is 13 km (two lengths of the sand extraction area).

4 ECOLOGICAL IMPACT ASSESSMENT METHODOLOGY

In its simplest form, the Ecological Impact Assessment (EIA) framework needs to include the following:

- Describe and assign value to ecological features and components potentially impacted;
- Describe and determine the magnitude of effects; and
- Combine value and magnitude to assess the level of effect.

This EIA has been undertaken in accordance with the Environment Institute of Australia and New Zealand (EIANZ) guidelines for use in New Zealand: terrestrial and freshwater ecosystems (2018) including Module 1 Assigning Ecological Value to Marine Benthic Habitats EIANZ (2024), with some modification, herein referred to as the EIANZ (2024) and best practice methodology. The following outlines how ecological values, magnitudes of effect and level of effects have been determined.

The scale at which values and effects are assessed has major implications for values and effects assigned. For the assessment of ecological values, the ‘zone of influence’ (ZOI), which refers to all land, water bodies and receiving environments that could be potentially impacted by the project, should be used. The EIANZ (2024) recommends mapping the areas potentially affected by direct, indirect, and cumulative effects. Direct effects are only expected to occur within the proposed sand extraction area. Indirect effects such as noise, mobile water quality plumes may extend beyond the area of direct effects. Cumulative effects are the combined impacts of multiple activities or stressors on the environment over time and space. They may arise from, multiple projects or actions occurring together or sequentially, and interactions among different environmental components. These effects are not just additive they can also be synergistic (where combined effects are greater than the sum of individual ones) or antagonistic (where one effect lessens another). Both spawning stock impacts and food source changes are explicitly evaluated as cumulative effects when, they interact with other activities (e.g., fisheries), or they influence ecosystem functions over time. The direct effect of sand extraction occurs at the scale of the sand extraction track and to a lesser extent the settlement of discharged over size material. "Assessing magnitude of effect at the spatial scale of the effect is not recommended, since it does not assist in developing impact management options. For many activities, this is a narrow perspective on the effect on ecological value and provides no information about the impact of the effect in the context of the local ecosystems, or in the context of the site's value" (EIANZ, 2024). For this assessment the spatial scale of the direct effects to benthic biota is mapped as the area of sand extraction, while indirect effects area widened to the 25% listening space reduction for the most sensitive benthic related biota assessed (Figure 5). The zones of influence for more mobile biota such as marine reptiles and protected sharks and rays are similar, but a much wider area has been used for the assessments. Comments are provided for each assessment of effects as to the scale at which the assessment is made.

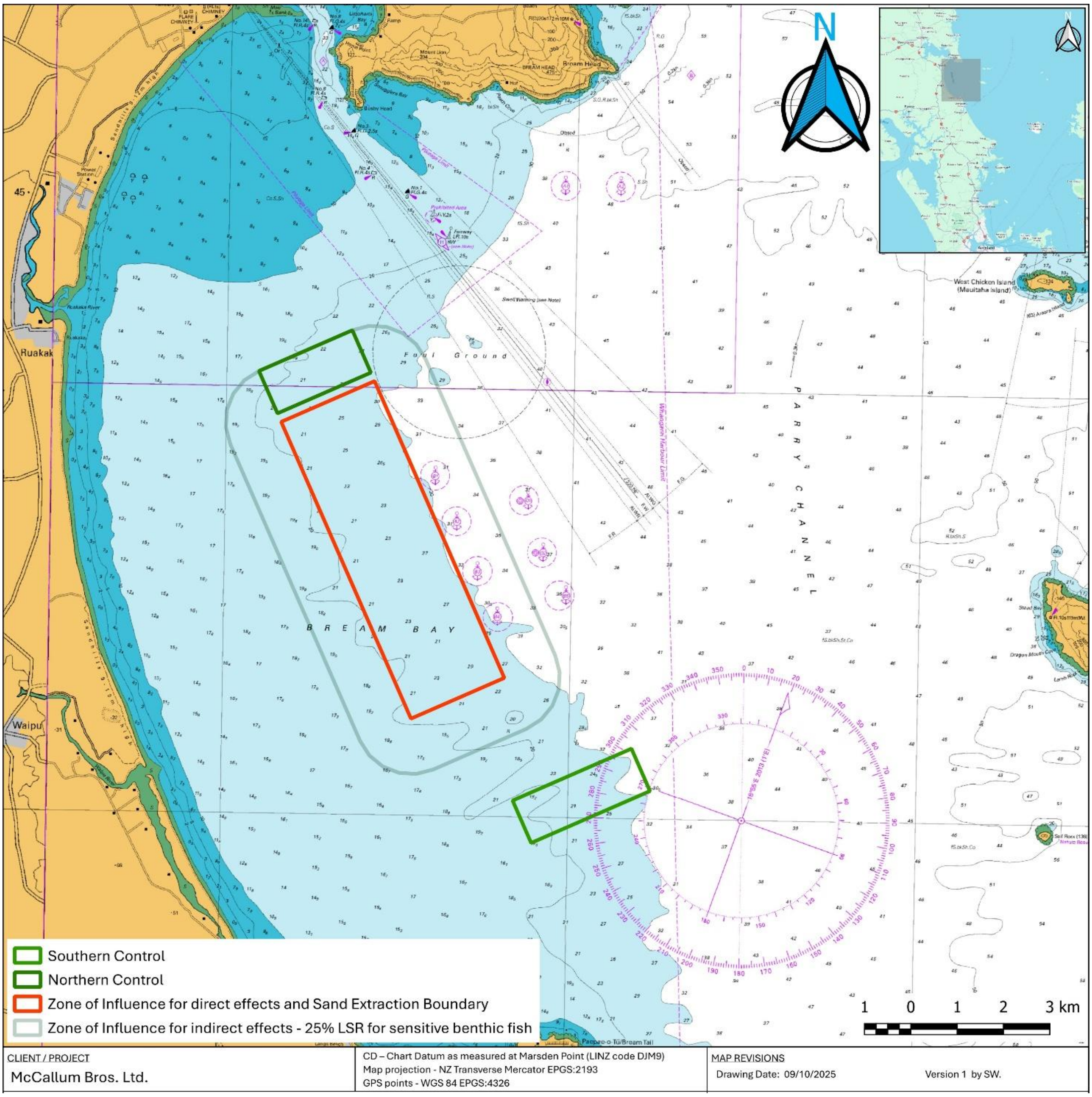


Figure 5 Zones of Influence

Ecological **values** of sites, species, habitats, communities or ecosystems are ranked from "very high" to "negligible". Full listing of the factors considered behind any rankings is provided in Table 1. Ecological values are presented in section 5 of the report. While the list of factors (Table 1) is based on the EIANZ (2024) the soft sediment factors included in the list are biased towards estuarine environments. As such some of the factors (benthic health model) are not applicable to the sand open coast subtidal habitat, data for other factors are not available (Shellfish contaminants, sedimentation rates), or not considered relevant (tolerance to contaminants).

The **magnitude of effect** has been ranked from "very high" to "negligible". The criteria for determining the magnitude of the effect on the marine environment are given in Table 2. The magnitude of effects are presented in section 6 of the report.

The **level of effect** has been determined by combining the value of the ecological feature, and the rating for the magnitude of effect (Table 3). In the EIANZ (2024) guidelines the term "low" is used, for this assessment this term has been equated as similar to the term "minor effects" used in RMA effects assessments. The assessment of level of effects is presented in section 7.

Table 1 Method for assigning ecological values (from EIANZ 2024).

	Ecological Value				
	Very High	**High**	**Moderate**	**Low**	**Negligible**
Benthic invertebrate community - diversity, species richness and abundance for the habitat type	Very High	High	Moderate	low	Physical habitat highly modified
Benthic invertebrate community - to organic enrichment, contaminants and mud	Dominated Sensitive	Many Sensitive	has taxa both tolerant and sensitive	Dominated tolerant few Sensitive	Dominated tolerant No Sensitive
Benthic invertebrate community using the Auckland Council (AC) or National Benthic Health Model (BHM) or similar index rated	Excellent	Good	Fair	Marginal	Poor
Invasive opportunistic and disturbance tolerant species	absent	largely absent	Present	dominant	highly dominant
Marine sediments dominated by silt and clay grain sizes, or BHMmud rating	<20% or Excellent	<40% or Good	<60% or Fair	>60% of Marginal	> 80% or Poor
Surface Sediment oxygenation	Oxygenated to >5 cm, no anoxic layer	Oxygenated to <=5 cm	Oxygenated to 1-2 cm	predominantly anoxic	All anoxic
Annual average sedimentation rates typically	< 1mm	< 2 mm	< 5 mm	< 10 mm	> 10 mm
Elevated contaminant concentrations in surface sediment	Significantly below ANZG Low and AC orange	rarely above ANZG Low and AC orange	Generally below ANZG Low and AC Red	Between ANZG Low and high	> ANZG High
Where shellfish are present, flesh has contaminant concentrations	at or below background or no detection	close to background or no detection	low to moderate contamination	moderate contamination	moderate to high contamination
Water column contaminant concentrations related to ANZWQ or WQI	better than 99% and/or Excellent	Between 95 and 99% and /or Good	Between 90 and 95% and /or Fair	Between 80 and 90% and /or Marginal	worse than 80% SPL and/or Poor
Fish community species richness, diversity and abundance	very high	high	moderate	low	very low
Native estuarine vegetation or macroalgae community	provides significant habitat for native fauna	dominated by native species and provides high quality habitat for native fauna	dominated by native species and provides moderate habitat for native fauna	minimal/limited habitat for native fauna	absent or so sparse as to provide very limited ecological value
Nuisance phytoplankton or macroalgal blooms	absent	may occur infrequently at a limited spatial scale	may occur sporadically over a moderate spatial scale	may occur commonly over a moderate scale	may occur frequently over a large spatial scale
Threatened or At Risk marine species	abundant	present	few present	none present	none present
Threatened ecosystem types	abundant	present	few present	none present	none present
Physical habitat	unmodified	largely unmodified	moderately modified	largely modified	extremely modified

Table 2 Criteria for describing the magnitude of effects (EIANZ 2018)

Magnitude	Description
Very High	Total loss of, or a very major alteration to, key elements/features of the existing baseline conditions, such that the post-development character, composition and/or attributes will be fundamentally changed and may be lost form the site altogether; AND/OR Loss of a very high proportion of the known population or range of the element/feature.
High	Major loss of major alteration to key elements/features of the existing baseline conditions such that the post-development character, composition and/or attributes will be fundamentally changed; AND/OR Loss of a high proportion of the known population or range of the element/feature.
Moderate	Loss or alteration to one or more key elements/features of the existing baseline conditions, such that the post-development character, composition and/or attributes will be partially changed; AND/OR Loss of a moderate proportion of the known population or range of the element/feature.
Low	Minor shift away from existing baseline conditions. Change arising from the loss/alteration will be discernible, but underlying character, composition and/or attributes of the existing baseline condition will be similar to pre-development circumstances and patterns; AND/OR Having minor effect on the known population or range of the element/feature.
Negligible	Very slight change from the existing baseline condition. Change barely distinguishable, approximating to the 'no change' situation; AND/OR Having negligible effect on the known population or range of the element/feature.

Table 3 Criteria for describing the level of effects (EIANZ 2018)

		Ecological Value				
		Very High	**High**	**Moderate**	**Low**	**Negligible**
Magnitude of Effect	**Very High**	***Very High***	***Very High***	***High***	***Moderate***	Low
	High	***Very High***	***Very High***	***Moderate***	Low	Negligible
	Moderate	***High***	***High***	***Moderate***	Low	Negligible
	Low	***Moderate***	Low	Low	Negligible	Negligible
	Negligible	Low	Negligible	Negligible	Negligible	Negligible
	Positive	Net Gain	Net Gain	Net Gain	Net Gain	Net Gain

5 ECOLOGICAL VALUES

The ecological value of each ecological feature was assessed by assigning a score based on professional judgement (with justification) to the applicable attributes listed in Table 1.

5.1 Coastal Vegetation

Seagrass (*Zostera muelleri*) was not found or expected to be found within the proposed sand extraction area. The closest known populations are located on the intertidal flats between One Tree Point and Northport in the Whangārei harbour some 13 km from the proposed sand extraction area.

Seagrass is listed as an "At Risk" species under the NZTCS due to the seagrass population being very large but subject to low to high ongoing or predicted decline. It is a non-endemic species that is secure overseas and experiences extreme population fluctuations.

Based on the absence of seagrass, the coastal vegetation community is ascribed an ecological value classification of **none**.

5.2 Macroalgae

Intertidal and subtidal reef surveys at the outer harbour and surrounding Te Ākau Bream Bay area indicate they contain typical macroalgae assemblages, with seaweed species.

While natural rocky reefs are not present in the proposed sand extraction area (an area of foul ground is located to the north) individual common algae species were sparsely attached to larger shell fragments throughout the sand extraction area.

Macroalgal communities in the soft sediment habitats can form habitats known as macroalgae meadows. **No macroalgae meadows were observed in the proposed sand extraction area** photographic survey (section 3.4.1 in West, *et al*., 2025). The nearest known macroalgae meadows are at the entrance to Whangārei Harbour around Northport. However, macroalgae were observed as part of the photographic studies for the Channel infrastructure project in 2014 (Bioresearches, 2016a), 5 km northwest of the proposed sand extraction area, approximately in 5-10 m water depth.

Four of the taxa in the outer Whangārei Harbour have been listed as at risk under the NZTCS. These are:

- ***Microdictyon mutabile***, an endemic green seaweed that inhabits the mid to low intertidal on sheltered, gently sloping rocks in Northern New Zealand, where it forms extensive undulating pads.
- ***Feldmannia mitchelliae***, a filamentous brown seaweed that is little known and poorly studied in New Zealand but is widespread internationally.
- ***Hincksia granulosa***, a filamentous brown seaweed that is little known and poorly studied in New Zealand but is widespread internationally, particularly in temperate seas.
- ***Aeodes nitidissima***, a red seaweed that grows on rocks in the low-intertidal subtidal, on open coasts and harbours. It is reported as being widespread, with a New Zealand distribution of Three Kings Islands, North Island, South Island, Stewart Island, Chatham Island, Auckland Island, and Campbell Island.

None of these species are known to be located in the proposed sand extraction area.

Based on the rarity of the macroalgae community in the sand extraction area and low abundance in nearby habitats it is ascribed a classification of **Negligible** ecological value.

5.3 Benthic Habitat and Fauna

The proposed sand extraction area and the three control areas were surveyed in March 2024 and the data presented in West, *et al*. (2025) and summarised in Table 4.

Table 4 Summary of Benthic Biota Population Statistics per area, March 2024

Alongshore	Sand Area		Northern		Southern		Remote		Controls	
	Ave.	SD	Ave.	SD	Ave.	SD	Ave.	SD	Ave.	SD
Number of samples	231		33		70		40		110	
Average number of Individuals	103.2	55.9	101.5	49.7	97.3	59.6	79.5	37.1	93.3	52.3
Average number of Taxa	26.7	6.6	28.5	5.7	25.3	6.2	22.9	5.0	25.4	6.1
Total Number of Taxa	197		127		141		95		181	
Diversity Index	2.630	0.343	2.748	0.225	2.505	0.385	2.510	0.235	2.562	0.330
Evenness	0.810	0.086	0.829	0.082	0.783	0.105	0.810	0.074	0.801	0.094

The benthic biota of the proposed sand extraction area was diverse with a total of 197 taxa with an average of 26.7, ranging from 8 to 41 taxa per sample. Studies conducted in 2014 as part of the extraction application for the Channel Infrastructure Project (Bioresearches, 2016a) showed that higher numbers of taxa were also present in the Whangārei Harbour channel, with between 3 and 85 per sample, averaging 33.4. Thus, although the Te Ākau Bream Bay proposed sand extraction area has a high diversity of taxa, it is typical of the Whangārei Heads area.

The number of individuals per sample in the proposed sand extraction area ranged from 12 to 520 averaging 103.2. In comparison, the results from studies conducted in 2014 as part of the extraction application for the Channel Infrastructure Project (Bioresearches, 2016a, 2016b) showed that the numbers of individuals per sample in the outer channel area ranged from 43 to 865 averaging 302. However, these are slightly different habitats, and it can be assumed due to higher water flow, that the influence of the channel facilitates higher densities of individuals compared to the sand application area. For the purposes of assessing ecological values of the benthic biota the sand extraction area has been used as the ZOI as effects to benthic biota is not expected to occur beyond.

No invasive species were recorded as present in the proposed sand extraction area. **No beds of large habitat forming biota such as horse mussels were present**. Several larger bivalve species were detected however they were not present in significant numbers. Scallops represent the only taxa with commercial value but were found in low numbers, ranging from 0 to 2.5 scallops per 100 m^2, with an average density of 0.35 scallops per 100 m^2 from tows within the sand extraction area (Table E.1 West, *et al*., 2025)

Of note, two species (*Kionotrochus sutrei*, *Sphenotrochus* sp.) of stony cup corals were recorded as present but in **very low numbers** with only 2 *Kionotrochus* and 7 *Sphenotrochus* recorded. These species of stony corals are single polyps that are solitary, free living species, less than 10 mm in height, and burrow into the top layer of the sand, they live individually and do not form reefs or seabed structures (Beaumont, *et al*., 2025). The *Sphenotrochus* species is most likely *Sphenotrochus ralphae* not *Sphenotrochus squiresi* which is listed as "At risk - Naturally uncommon" in the NZTCS (Funnell *et al*. 2023). While neither

Kionotrochus nor *Sphenotrochus* were listed as at risk, yet they are both protected under the Wildlife Act (1953). Under the Act, it is illegal to deliberately collect or damage these corals. If stony corals are accidentally brought to the surface, they must be immediately returned to the sea. All stony corals accidentally captured (meaning removed from the seabed) will be returned to the sea immediately as part of the sand extraction process. The stony corals are too big to pass through the 2 mm screen into the sand hopper, and are thus discharged along with all oversized material under the vessel through the moon pools.

Based on the moderately abundant populations of a diverse group of 150 taxa of biota of nationally and locally common species, with no “At Risk” species, and with lack of invasive species, the benthic biota faunal community is ascribed a classification of **moderate ecological value**. While the diversity index results (Table 4) suggests the diversity was in the high range and as described in Table 1 the ecological value should be high, however the diversity in this habitat is typically high and was higher in nearby locations. To account for the typically high to very diversity in this habitat the ecological value was downgraded to moderate, as the diversity was moderate for this habitat. In addition, the abundance was only moderate for this habitat. The detection of a few stony corals while they are protected and add to the diversity, does not significantly increase the ecological value of the area, as these species do not form habitats, as other species of corals do, and are not listed as “At risk”.

5.4 Benthic Fish

Demersal fish, also known as bottom dwellers or benthic fish, they live and feed on or near the seabed, this can include fish that intermittently rest on the seafloor. Their diet usually consists of benthic invertebrates, smaller fish, and detritus. The fish included in this assessment are small demersal fish that do not swim far from their habitat and that rely on local food resources in the seafloor. The pelagic fish and larger demersal fish with a large feeding area are considered in the report by Boyd (2025).

No fish count assessments were conducted in the proposed sand extraction area in Te Ākau Bream Bay; however, literature (Brook, 2002) and online information (iNaturalist) indicate that a number of fish species are present within the wider Te Ākau Bream Bay area surrounding the proposed sand extraction area. Full results are presented in Appendix A. Several species were confirmed as present by capture either in photographs or in benthic samples. The list is non-exhaustive as very few surveys of fish community composition have been undertaken in the region of the sand extraction area; however, it captures the most abundant species present. Boyd (2025) presents a list of fish species derived from fishery research trawls between the 1960s to 1997 in the wider Tīkapa Moana Hauraki gulf. The results of these surveys were summarised and analysed by Kendrick and Francis (2002). The Table 1 list in Boyd (2025) includes a number of species not included in Appendix A, due to the wider survey area covered by the fishery research trawl data.

Snapper (*Pagrus auratus*), Kahawai (*Arripis trutta*) and kingfish (*Seriola lalandi*), are known to be present in the proposed sand extraction area as they were recorded by the underwater cameras during surveys in March 2024 (West, *et al*., 2025) and 2014. A school of kingfish were recorded west of the sand extraction area in 2014 (Bioresearches 2016).

Long-finned sand diver (*Limnichthys polyactis*), New Zealand sand diver (*Tewara cranwellae*), Sand snake-eel (*Ophisurus serpens*) and New Zealand lumpfish (*Trachelochismus pinnulatus*) are known to be present in the proposed sand extraction area as they were captured in either the benthic grab samples or in the epibenthic extraction tow samples in March 2024 (West, *et al*., 2025).

Of the species recorded, none are listed as being Threatened or At risk by the NZTCS. However, it is possible some shark species on the NZTCS list could pass through the area on occasion but are not expected to be resident in the area.

As well as their intrinsic ecological value, fish will provide a foraging resource for local coastal bird populations.

For the purposes of assessing ecological values of the benthic fish the 25% LSR area for Big eye fish has been used as the ZOI as shown in Figure 5, as effects to benthic fish is not expected to occur beyond.

The fish identified as present within Te Ākau Bream Bay were all typical of the region. The demersal fish community is ascribed a classification of **low ecological value**.

5.5 Sharks and Rays

New Zealand's Chondrichthyes fauna comprises 113 known species (Duffy *et al*., 2025), including 70 sharks, 26 rays and skates, and 12 chimaeras. Between 15 and 20 sharks and rays are endemic to New Zealand, meaning they are found only in New Zealand's waters. It is difficult to determine an exact number because these creatures are very mobile. Most of the endemic species are rays or skates, which do not travel as far as sharks. Only a select few of New Zealand's shark and ray species in are fully protected under the Wildlife Act 1953, including the;

Carcharhiniformes (ground sharks)

- Oceanic whitetip shark (*Carcharhinus longimanus*)

Lamniformes (mackerel sharks)

- Basking shark (*Cetorhinus maximus*)
- Deepwater nurse shark (*Odontaspis ferox*)
- White pointer shark (*Carcharodon carcharias*)

Orectolobiformes (carpet sharks)

- Whale shark (*Rhincodon typus*)

Rajiformes (skates and rays)

- Oceanic Manta ray (*Mobula birostris*)
- Spinetail devil ray (*Mobula mobular*)

5.5.1 Sharks

Global sharks range in size from the small dwarf lanternshark (*Etmopterus perryi*), a deep sea species that is only 17 centimetres in length, to the whale shark (*Rhincodon typus*), the largest fish in the world, which reaches approximately 12 metres in length. They are found in all seas and are common to depths up to 2,000 metres. They generally do not live in freshwater, although there are a few known exceptions.

Several shark species are apex predators, examples including the bull shark, tiger shark, great white shark, mako sharks, thresher sharks and hammerhead sharks. Some sharks are filter-feeding planktivorous, such as the whale shark and basking shark, which are among the largest fish ever lived.

New Zealand has its own distinctive shark fauna, with species occupying habitats ranging from the shores to the open ocean, to the depths of the continental slope. Around half of the shark species found in New Zealand waters are believed to breed locally, particularly those that inhabit coastal and continental shelf areas. These species often use shallow bays, estuaries, and coastal waters as nursery grounds, especially during the warmer months. For example, rig sharks are known to give birth in shallow coastal waters around spring and summer, and school sharks have well-documented breeding grounds around the South Island.

In contrast, many deep-sea and pelagic sharks, such as the blue shark, mako, and great white, may migrate long distances and breed elsewhere, though some may still give birth in New Zealand waters depending on environmental conditions.

5.5.2 Rays

Mobulid rays (family Mobulidae) are large, filter-feeding elasmobranchs in which two species: Spinetail devil ray (*Mobula mobular*) and Oceanic manta rays (*Mobula birostris*) are known to occur in New Zealand waters (Paulin *et al.,* 1982). Slow life histories including low reproductive rates, late maturation and slow growth have contributed to a lack of population growth (Myers & Worm, 2003; Stevens *et al*., 2000; Ward-Paige *et al*., 2013). There is a scarcity of data and knowledge, namely on their biology, distribution, habitat preference and abundance. Under the most recent New Zealand Threat Classification System reassessment (NZTCS 2024), the Oceanic manta ray (*Mobula birostris*) is classified as Threatened – Nationally Vulnerable (Duffy *et al.* 2025).

Mobulid rays are considered seasonal visitors to New Zealand waters, particularly during the warmer months of summer and early autumn. Most sightings occur in northern coastal regions such as the Poor Knights Islands, Bay of Islands, and Hauraki Gulf. These areas benefit from warm subtropical currents, which bring in plankton-rich waters - ideal feeding conditions for manta and devil rays. Sightings tend to peak between December and April, aligning with higher sea surface temperatures and increased biological productivity.

5.5.3 Review of Sightings Records

To our knowledge DOC do not hold a database of sightings of these species of sharks and rays. A review of historical records from within 50 km[1] of the proposed sand extraction area was undertaken to gauge the likelihood and frequency of occurrence of sharks and rays. Databases explored included:

[1] An arbitrary distance selected to capture protected shark and ray species considered to have a likely or possible presence in the Te Ākau Bream Bay area.

1) The Ocean Biodiversity Information System (OBIS) website for all species of sharks and rays listed in the Wildlife Act (accessed 2025);
2) The Global Biodiversity Information Facility (GBIF) website for all species of sharks and rays listed in the Wildlife Act (accessed 2025);
3) NIWA conducted satellite tagging of white sharks in New Zealand waters in 2005. Data from these tagged sharks has been obtained and used to supplement the OBIS sights database;
4) *iNaturalist* (www.inaturalist.org/) (accessed June 2025); and
5) Manta Watch NZ holds a private database of sightings of Oceanic Manta Rays and Spinetail Devil Rays.

The combined OBIS, GBIF, NIWA and iNaturalist database held a total of 22 records of four species of sharks and rays, within 50 km of the proposed sand extraction area spanning 2001 to 2024. The species include:

- Whale shark
- White pointer shark
- Oceanic Manta ray
- Spinetail devil ray

Some of the databases do not provide accurate locations for observations (i.e., records are obscured by approximately a meter to several kilometres for sensitivity reasons. Despite this the location data as recorded from all four data sources have been plotted in Figure 6.

The nearest sighting of ;

- Oceanic whitetip shark was some 107km northeast of the proposed sand extraction area.
- Deepwater nurse shark was some 190 km southeast of the proposed sand extraction area.
- Basking shark were only reported from the South Island.

None of the 2214 tagged White pointer sharks from the NIWA study were located within 50 km[2] of the proposed sand extraction area.

Manta Watch NZ database was unable to be downloaded however was available as a webpage image. This image data was obtained and georeferenced to allow comparison with the online database records. The Manta Watch NZ database held a total of 4 records of Spinetail devil ray and 198 records of Oceanic Manta ray, within 50 km of the proposed sand extraction area.

By far the greatest number of sightings are for Mobulid rays mostly provided by Manta Watch NZ due to their many hours of observation and study. The distribution of Oceanic Manta rays appears to have a western boundary aligned between Bream Head and Cape Rodney, which lies some 7.5 km east of the proposed sand extraction area. This is not to say that Mobulid rays could not or do not visit the location of the proposed sand extraction, but that the observations recorded show they are typically not found in this location.

The shark species, particularly White pointer sharks, are all highly mobile, records of sightings near the sand extraction area are far fewer than for rays, but interestingly the sights available show a similar western limit to that for the Oceanic Manta rays for area close to the sand extraction area. Spinetail devil rays and Whale sharks have a western limited to their distribution further offshore more in the order of greater than 35 km east of the sand extraction area.

[2] An arbitrary distance selected to capture protected shark and ray species considered to have a likely or possible presence in the Te Ākau Bream Bay area.

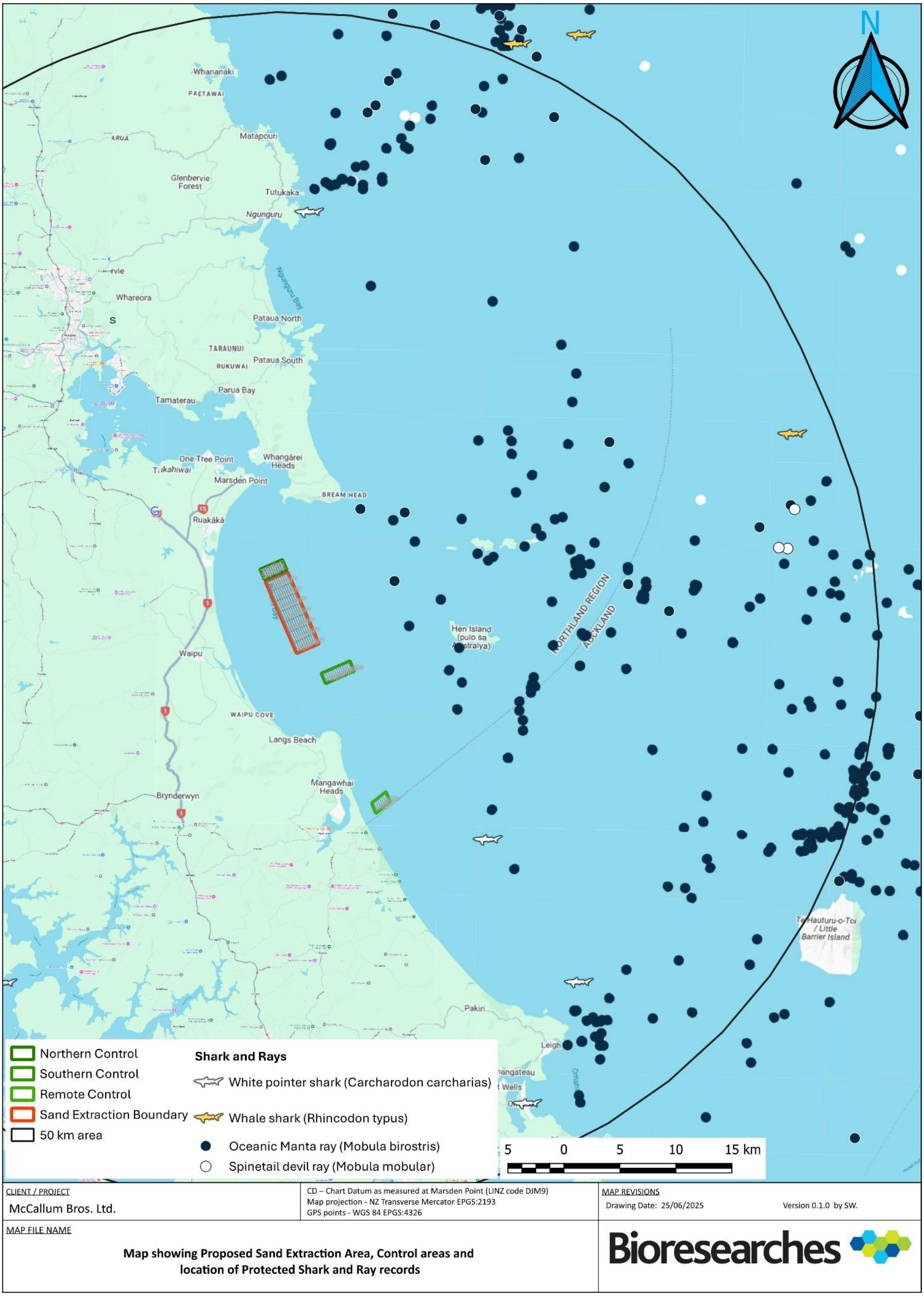


Figure 6 Records of protected sharks and rays observed within a 50 km radius of the proposed sand extraction area.

5.5.4 Ecological value assignment

The EIANZ guidelines suggested ecological value for 'threatened' NZTCS listed species, is very high. The EIANZ guidelines do not provide suggested ecological value categories for 'migrant' and 'data deficient' NZTCS listed species, thus the relevant IUCN Red List categories for sharks and rays have been considered. Table 7 lists the relevant NZTCS and IUCN Red List category, as well as an assessment against the NZCPS policies, for each assessed shark and ray species. Under the NZCPS, policy 11(a)(i) - Taxa listed as 'threatened' in the NZTCS was applicable to the White pointer shark. Under the NZCPS, policy 11(a)(ii) - Taxa listed by the International Union for Conservation of Nature (IUCN) as 'threatened' was applicable to Whale sharks and the two ray species.

Overall, **Very high** ecological value has been assigned to the White pointer sharks due to their Threaten Nationally Endangered NZCS status, while Whale sharks are assigned a **Very High** ecological value due to their 'Endangered' IUCN Red List status, and the two rays are assigned a **Very High** ecological value due to their Threatened – Nationally Vulnerable (Oceanic manta ray) and 'Endangered' IUCN Red List (Spinetail devil ray) status (Table 7).

Table 5 Ecological values for protected shark and ray species reported within a 50 km radius of the proposed sand extraction area.

Common name ***Scientific name***	**Ecological value**	**Likelihood of occurrence**
White pointer shark *Carcharodon carcharias*	**Very high** Threat Classification: • **Threatened – Nationally Endangered.** (NZTCS: Duffy *et al.* 2025) • Vulnerable A2bd, ver 3.1, 2018 (IUCN Red list, 2022) • **Policy 11(a) species** (NZCPS Policy 11a status)	Infrequently (at best) present in coastal and offshore waters. 4 verified records within 50 km of the project area in the past 20 years.
Whale Shark *Rhincodon typus*	**Very high** Threat Classification: • **Migrant.** (NZTCS: Duffy *et al.* 2025) • Endangered A2bd+4bd, ver 3.1, 2016 (IUCN Red list, 2016) • **Policy 11(a) species** (NZCPS Policy 11a status)	Infrequently (at best) present in offshore and coastal waters, during summer. 1 verified record within 50 km of the project area in the past 20 years
Oceanic Manta ray *Mobula birostris*	**Very high** Threat Classification: • **Threatened – Nationally Vulnerable.** (NZTCS: Duffy *et al.* 2025) • Endangered A2bcd+3d, ver 3.1, 2019 (IUCN Red list, 2022) • **Policy 11(a) species** (NZCPS Policy 11a status)	Present in offshore waters, occasionally present in coastal waters, during summer. 198 verified records within 50 km of the project area in the past 20 years
Spinetail devil ray *Mobula mobular*	**Very high** Threat Classification: • **Data Deficient** (NZTCS: Duffy *et al.* 2025) • Endangered A2bd+3d, ver 3.1, 2018 (IUCN Red list, 2022) • **Policy 11(a) species** (NZCPS Policy 11a status)	Present in offshore waters, Infrequently (at best) present in coastal waters, during summer. 4 verified records within 50 km of the project area in the past 20 years

5.6 Marine Reptiles

New Zealand's marine reptile fauna comprises nine species of marine turtles and snakes (Gill 1997; van Winkel *et al.* 2018; Hitchmough & van Winkel 2023). Among these are five species of turtles belonging to two families:

Dermochelyidae

- leatherback turtle, *Dermochelys coriacea*,

Cheloniidae

- loggerhead turtle, *Caretta caretta,*
- green turtle, *Chelonia mydas*,
- hawksbill turtle, *Eretmochelys imbricata*,
- olive ridley turtle, *Lepidochelys coriacea*.

Additionally, there are four species of marine snakes in two subfamilies:

Laticaudinae

- yellow-lipped sea krait, *Laticauda colubrina,*
- brown- or blue-lipped sea krait, *Laticauda laticaudata,*
- Saint Giron's sea krait, *Laticauda saintgironsi*,

Hydrophiinae

- yellow-bellied sea snake, *Hydrophis platurus*.

5.6.1 Marine turtles

Marine turtles primarily inhabit warm tropical and subtropical regions. While New Zealand's temperate waters are generally much cooler than the preferred temperature range for most turtles, all species listed above have been recorded in our waters (Gill 1997). The distribution of turtle sightings spans the length of the country, from the Kermadec Islands in the north to Rakiura Stewart Island in the south. However, Cheloniid turtles (especially green turtles) are most regularly observed around northern New Zealand, while leatherbacks have been recorded much further south (e.g., southern South Island) (Eggleston 1971; DOC Herpetofauna database). Sightings of turtles are most frequent during the warmer summer-autumn months, when sea surface temperatures are highest (Gill 1997).

The green turtle—while currently listed as a migrant species (Hitchmough *et al.* 2021) - in fact occurs in New Zealand's northern waters year-round. Juvenile oceanic-phase turtles arrive and transition through the neritic habitats in northern New Zealand, using them as year-round feeding grounds during their growth to maturity, following an initial pelagic phase as hatchlings. As they approach breeding age, they leave to presumably return to the breeding areas where they hatched, and after that seldom return to New Zealand. Godoy *et al*. (2016) showed that several tens to possibly hundreds of juvenile green turtles are resident around northern New Zealand at any given time, and that most originate from eastern Australia and the western Pacific.

5.6.2 Marine snakes

Of the four species of marine snake, the yellow-bellied sea snake is the most encountered in New Zealand. Indeed, it is probable that the species is resident in the northern subtropical waters of the Kermadec Islands (30°S latitude), and possibly at the Three Kings Islands (34°S latitude) (Gill & Whitaker 2014; Hitchmough & van Winkel 2023). On mainland New Zealand this species is often observed beach-wrecked, having been carried on currents further south into colder waters, where they can succumb to 'cold water-shock'. The semi-aquatic, oviparous (live bearing), marine kraits are mostly reef-dwelling and are much less frequently reported in New Zealand (Gill & Whitaker 2014). Most of the kraits are incidentally carried by ocean currents from tropical regions and are occasionally found stranded on New Zealand beaches or very rarely free-swimming. All records of sea kraits are from the North Island, and mainly from the northeast coastline (DOC Herpetofauna database, accessed 2025).

5.6.3 Review of Sightings Records

A review of historical records from within 50 km[3] of the proposed sand extraction area was undertaken to gauge the likelihood and frequency of occurrence of marine reptiles. Databases explored included:

1) The Department of Conservation (DOC) BIOWEB Herpetofauna database (accessed 2025)
2) *iNaturalist* (www.inaturalist.org/) (accessed February 2025)[4]; and
3) Additional records collected and held by D. van Winkel since approximately 2015.

The DOC herpetofauna database (Appendix B) held a total of 85 records of five species of turtles and snakes, including indeterminate turtle species (n = 14) and a single record of an indeterminate marine snake, within 50 km of the proposed sand extraction area spanning a timeframe of 126 years. The species include:

- green turtle, *Chelonia mydas*,
- hawksbill turtle, *Eretmochelys imbricata*,
- leatherback turtle, *Dermochelys coriacea*,
- loggerhead turtle, *Caretta caretta*,
- yellow-bellied sea snake*, Hydrophis platurus*.
- unidentified turtle and marine snake species

The marine reptile records cover observations from the 1880s to current, the age distribution of the records is shown in Figure 7. The locations of the marine reptile records are shown in Figure 8.

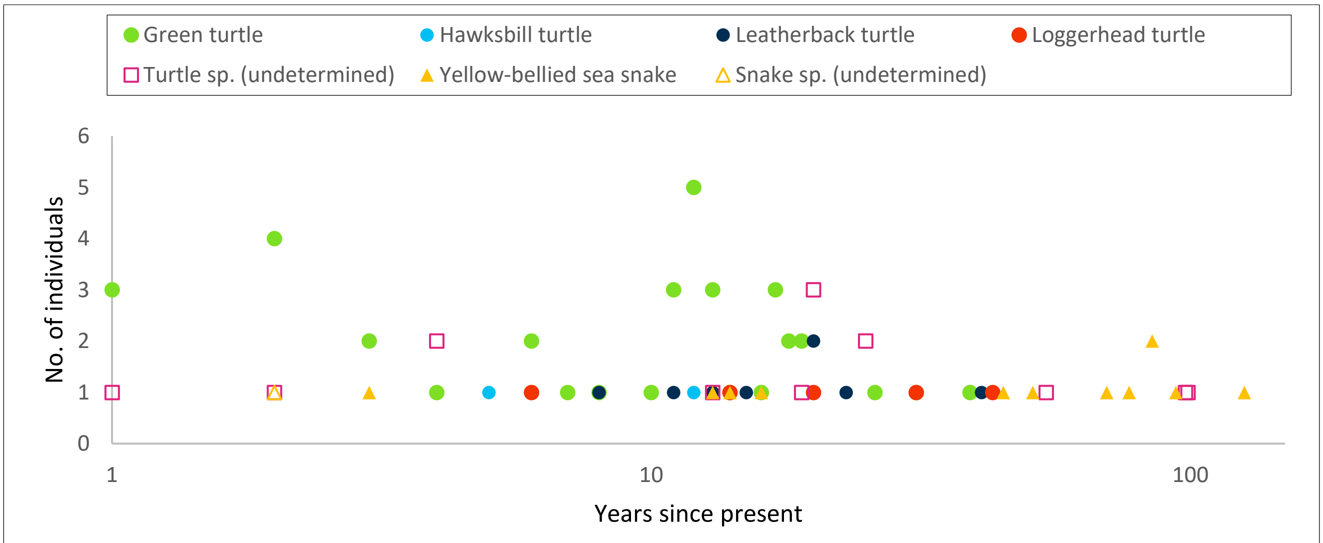


Figure 7 Records of marine reptiles (turtles and snakes) observed within a 50 km radius of the proposed sand extraction area, showing the number of individuals of each species and the age of each record (in years since present from the 1880s to current). Note: x axis is log scaled.

[3] An arbitrary distance selected to capture marine reptile species considered to have a likely or possible presence in the Te Ākau Bream Bay area.
[4] iNaturalist does not provide accurate locations for marine reptile observations (i.e., records are obscured by approximately 15 km² for sensitivity reasons).

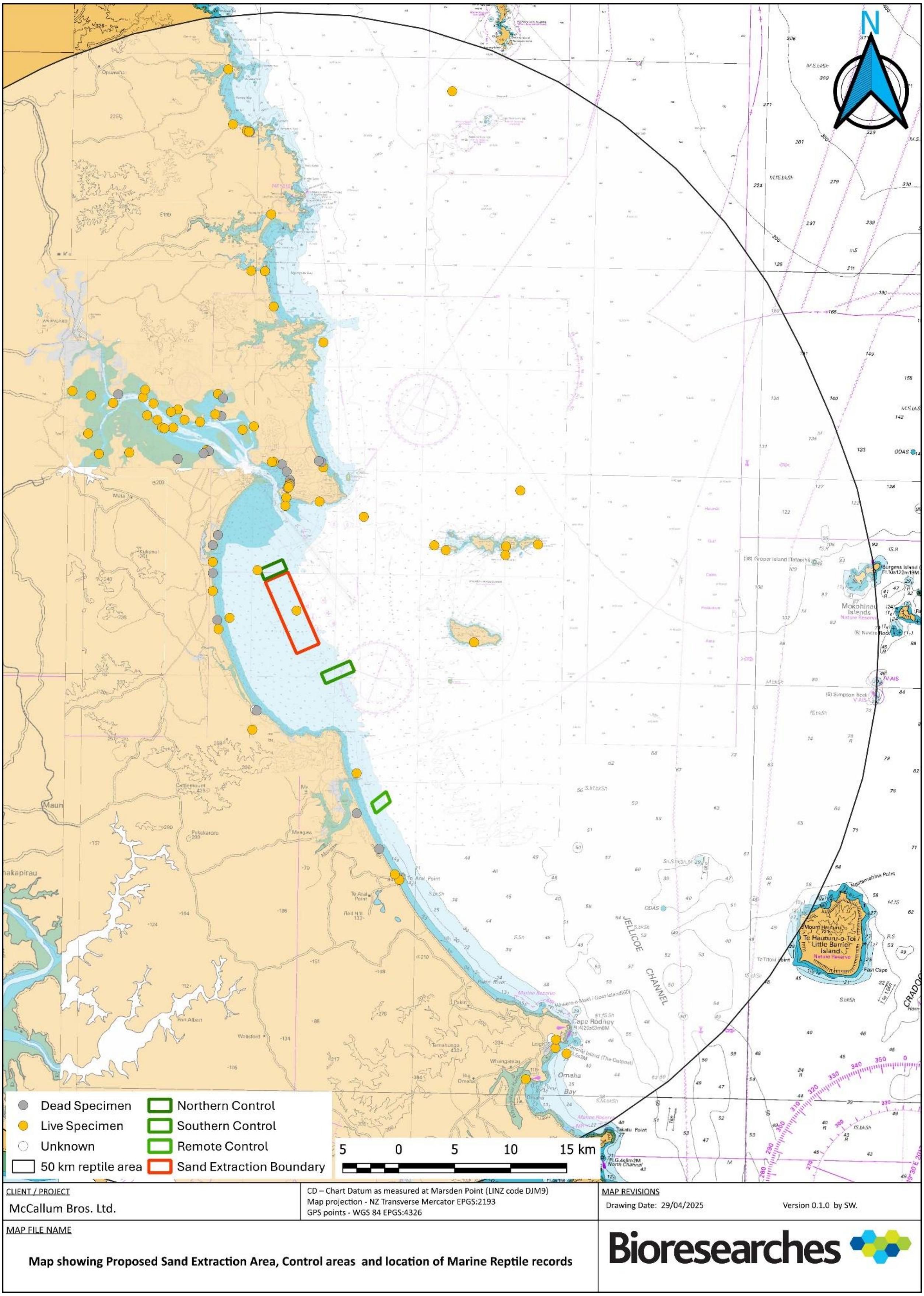


Figure 8 ***Records of marine reptiles (turtles and snakes) observed within a 50 km radius of the proposed sand extraction area, showing the locations from the 1880s to current.*** (Symbols are all the same to protect the specific locations of marine reptile species, as required by the Department of Conservation data use agreement.)

Twenty eight (32.9%) of the 85 observations were recorded within the past decade, and 47% of the records within 50 km were represented by green turtles (*Chelonia mydas*) (Table 6). Most (73%) of all records within 50 km were of live individuals, those either washed ashore or sighted free-swimming close to shore. Records of dead individuals were also included, as not all individuals will have been observed immediately after stranding or may have succumbed to cold shock as they approached the coast. In general, marine reptiles were observed year-round but a high proportion (44%) of the observations were made in the summer season (December–February) (Table 6). Only one observation over this period has occurred in the extraction proposal area, this was of a live leatherback turtle in March 2006.

Trends in the historical data indicate green turtles are the most frequently reported species, with a total of 24 records, followed by yellow-bellied sea snake with 9 records. In particular, the Whangārei Harbour appears to be an important area for green turtles with approximately 50% of records from the inner harbour area. It is probable that green turtles frequently enter the sheltered harbour, possibly to feed on sea grass in the shallower waters. With no sea grass or algae beds in the sand extraction area there is little reason to expect green turtles to be in the sand extraction area other than for passing through it.

Table 6 Monthly and seasonal records of marine reptiles (turtles and snakes) observed within 50 km radius of the proposed sand extraction area from the 1880s to current.

Season	Month	Species							Total	Season Total (1880 – 2024)
		Green turtle	Hawksbill turtle	Leatherback turtle	Loggerhead turtle	Turtle sp. (indet.)	Yellow-bellied sea snake	Snake sp. (indet.)		
Summer	Dec	4		2	1				7	23
	Jan	5		1		4	5		15	
	Feb	5		3	1	4	1		14	
Autumn	Mar	2	1	2		1	2	1	9	16
	Apr	5			1	2	4		12	
	May	4	1				1		6	
Winter	Jun								0	8
	Jul	4	1		1				6	
	Aug	5	1						6	
Spring	Sep	1				1			2	5
	Oct	3	1			2			6	
	Nov	2							2	

iNaturalist held 10 records of two marine turtle species, green turtle and hawksbill turtle, for the same 50 km radius area. Of these, seven represented verified ('Research Grade') records of living or recently deceased green turtles. The other three observations were of curated/ mounted shells (two green turtles and one hawksbill turtle). The most recent record of a live turtle was from August 2024, from the wider Whangārei area. There were also three verified records of yellow-bellied sea snakes (all 'beach-wrecked').

The author is aware of one additional record of a suspected Pacific black turtle (*C. agassizii* or *C. mydas agassizii*) that was found dead on Proctors Beach, Whangārei Heads in December 2024[5].

[5] The author is unsure whether an Amphibian and Reptile Distribution Scheme (ARDS) card has since been lodged with the Department of Conservation. The author holds copies of photographs and details of the observation.

It is important to note that the New Zealand database records primarily consist of anecdotal observations of marine reptiles. Given the challenges of encountering and identifying marine turtles and snakes in the open ocean, these records likely represent only a fraction of the actual numbers of individuals in New Zealand's waters. Research from other regions suggests that the probability of turtle strandings may be as low as 10–20%, even in nearshore waters (Koch *et al.* 2013). While in New Zealand the likelihood of marine reptile strandings will be higher, since the country lies at the outer range of many species' distributions and individuals arriving here are likely to be in poorer health and more prone to standings. It is reasonable to expect that reported strandings represent a small proportion of the total number of marine reptiles that enter New Zealand waters (Gill 1997), including those entering Te Ākau Bream Bay. Aerial-based surveys for some turtle species (e.g., leatherback turtle) in near shore areas around New Zealand have only recently commenced in 2025, focusing primarily on regions with high fisheries bycatch (e.g., Whakatane). Until similar studies are completed in the Te Ākau Bream Bay area for all turtle species the sightings database remains the most reliable source of information. As a part of its own monitoring of the Bay, MBL will be recording all marine reptile sightings and reporting them to DOC if and when they occur.

5.6.4 Protection and conservation status

Most (89%) of New Zealand's marine reptiles are all classed as 'Non-resident' native species, while one species, the yellow-bellied sea snake, is considered a 'Not Threatened' resident under the New Zealand Threat Classification System (NZTCS) (Hitchmough *et al*. 2021; Rolfe *et al*. 2022). Accordingly, all nine species of marine reptiles are legally protected under the Wildlife Act 1953.

Of the non-resident natives, most (67%) are considered vagrants[6], while two of the marine turtles (green turtle and leatherback turtle) are listed as migrants[7] (Table 7) (Hitchmough *et al.* 2021). None of the New Zealand marine reptiles are confirmed to breed in New Zealand.

Marine turtles are slow-growing, long-lived, slow to mature, and have low recruitment (Kemf *et al.* 2000). These traits render them vulnerable to anthropogenic disturbance, with human exploitation, trade, and habitat destruction all contributing to significant declines in the abundance. Indeed, six of the seven species worldwide are now recognised as threatened, endangered, or critically endangered under the World Conservation Union (IUCN) 1996 Red List of Threatened Animals (IUCN Red List, ver. 3.1, 2024). The marine snakes appear less threatened by anthropogenic disturbance and all species that occur in New Zealand are listed as 'Least Concern' (Stable) under the IUCN Red List (IUCN Red List, ver. 3.1, 2024).

[6] "Taxa that are found unexpectedly in New Zealand and whose presence in this region is naturally transitory or migratory taxa that have fewer than 15 individuals being known or presumed to visit each year are classified as Vagrant." (Rolfe *et al*. 2022).

[7] "Taxa that predictably and cyclically visit New Zealand as part of their normal life cycle (with a minimum of 15 individuals being known or presumed to visit each year) but do not breed here are classified as Migrant." (Rolfe *et al*. 2022).

Table 7 Ecological values for marine reptile (turtle and snake) species reported within a 50 km radius of the proposed sand extraction area.

Common name *Scientific name*	Ecological value	Likelihood of occurrence
Loggerhead turtle ***Caretta caretta***	**Very high** Threat Classification: • **Vagrant** (NZTCS: Hitchmough *et al.* 2021) • Vulnerable A2b, ver 3.1, 2017 (IUCN Red list, 2024) • **Policy 11(a) species** (NZCPS Policy 11a status)	Infrequently (at best) present in coastal and offshore waters. No verified records within 50 km of the project area in the past 20 years.
Green turtle *Chelonia mydas*	**Very high** Threat Classification: • **Migrant** (NZTCS: Hitchmough *et al.* 2021) • Endangered A2bd, ver 3.1, 2004 (IUCN Red list, 2024) • **Policy 11(a) species** (NZCPS Policy 11a status)	Likely present all year in coastal waters and the Whangārei Harbour.
Leatherback turtle *Dermochelys coriacea*	**Very high** Threat Classification: • **Migrant** (NZTCS: Hitchmough *et al.* 2021) • Vulnerable A2bd, ver 3.1, 2013 (IUCN Red list, 2024) • **Policy 11(a) species** (NZCPS Policy 11a status)	Likely present in offshore waters, occasionally present in coastal waters, during summer.
Hawksbill turtle *Eretmochelys imbricata*	**Very high** Threat Classification: • **Vagrant** (NZTCS: Hitchmough *et al.* 2021) • Critically Endangered A2bd, ver 3.1, 2008 (IUCN Red list, 2024) • **Policy 11(a) species** (NZCPS Policy 11a status)	Likely infrequently present in coastal and offshore waters.
Yellow-bellied sea snake *Hydrophis platurus*	**Low** Threat Classification: • **Not Threatened** (NZTCS: Hitchmough *et al.* 2021) • Least Concern, ver 3.1, 2009 (IUCN Red list, 2024) • **No policy 11(a) status** (NZCPS Policy 11a status)	Likely present in coastal and offshore waters, in summer and autumn.
Unidentified turtle sp.	**Very high** Conservative assessment based on the 'Vulnerable' and 'Endangered' IUCN status' of turtle species known to occur in the affected area.	Likely present in coastal and offshore waters.

5.6.5 Ecological value assignment

The EIANZ guidelines do not provide suggested ecological value categories for 'migrant' and 'vagrant' NZTCS listed species, thus the relevant IUCN Red List categories for marine reptiles have been considered. Table 7 lists the relevant NZTCS and IUCN Red List category, as well as an assessment against the NZCPS policies, for each assessed marine reptile species.

Under the NZCPS, policy 11(a)(ii) - Taxa listed by the International Union for Conservation of Nature (IUCN) as 'threatened'—was applicable to the four marine turtles but not the yellow-bellied sea snake.

Overall, **Very high** ecological value has been assigned to the four identified marine turtles due to their 'Vulnerable' or higher IUCN Red List status, and a value of **Low** has been assigned to the 'Not Threatened' yellow-bellied sea snake (Table 7).

5.7 Summary of Ecological Values

The sand extraction area represents a habitat type (clean sandy seabed) that is also found in other areas of the outer Hauraki Gulf and northeastern New Zealand. The habitat is, dynamic, with mobile sediments supporting common, opportunistic benthic fauna; and a fish community containing common nearshore species. Less common fish (including sharks and rays) and reptile species may pass through the area. However, they are considered to be vagrant and therefore not part of the water community.

Table 8 provides a summary of ecological values for the marine environment using the criteria described in Table 1. The values for large demersal and pelagic fish, marine birds and marine Mammals are covered by separate reports (Boyd, 2025; Thompson, 2025; McConnell, 2025).

Table 8 Summary of ecological values within the sand extraction area and surrounding areas

Habitat value assessment	Overall Ecological value	Justification
Coastal Vegetation	**None**	No coastal vegetation including seagrass present or likely to be influenced by the sand extraction
Benthic Macroalgae	**Negligible**	Very little macroalgae present within the proposed sand extraction area
Benthic fauna	**Moderate**	Species adapted to the high energy environment. Benthic fauna was sparse but moderately diverse for the habitat. Benthic community has an ecological function as a food resource for the fish community
Benthic Fish	**Low**	Species that frequent the area are locally common, present within the Hauraki Gulf area. Most species are widely distributed around New Zealand
Sharks and Rays	**Very High**	One shark classed as 'threatened – national endangered', and one shark and two species of rays classed as 'Endangered' by the IUCN Red List, but rarely present
Marine reptiles	**Very High**	four turtles classed as 'Vulnerable' or with higher IUCN Red List status, but rarely present

6 MAGNITUDE OF EFFECTS OF SAND EXTRACTION ON BIOTA

Sand has been extracted from Auckland's shallow nearshore environment on both the east and west coasts, but sand from water depths deeper than 25 m has only been extracted since 2003. The quantities recovered have varied over the years based on demand and consenting constraints. Sand has not been extracted in Te Ākau Bream Bay previously. However, Te Ākau Bream Bay, does not have an untouched/pristine benthic environment, the embayment has historically been extensively dredged, with a total of 160,649 dredge tows recorded from 1990 to 2021 (MacGibbon and Mules, 2023), for scallops Te Ākau Bream Bay, up to 2021. Due to the deteriorating state of the scallop fishery in Northland, SCA1 was then closed on 1 April 2022. In addition, Te Ākau Bream Bay outside the trawl limit line for bottom contact fishing methods has been extensively trawled and commercially fished for well over a century.

The comments presented below are based on literature and data obtained as part of the monitoring of other sand extraction consents. The size of the potential impacts caused by sand extraction and disposal depends on the:

- quantity of material extracted and disposed;
- frequency and duration of extraction;
- extraction methods;
- depth, current speeds, waves, and water quality at the site;
- sediment composition;
- presence of any contaminants in the sediment; and,
- distance from ecologically sensitive habitats and the tolerance of plants and animals to suspended sediments.

A set of sampling methodologies has been developed to describe, quantify, and evaluate the benthic fauna and physical seabed environment, these are detailed in West, *et al*., 2025. As part of these methodologies, a set of criteria will be developed to provide guidance in evaluating potential effects and preventing potential adverse effects. The assessment uses small scale spatial planning principles to manage and avoid the potential risks of effects to biota and seabed environments. By dividing the proposed sand extraction area into cells each 1000 m long and 200 m wide, the distribution of fine sediment particles or significant biota can be mapped, and the impacts managed by control of the sand extraction activity in each cell.

The effects of sand extraction occur in three general categories: seabed disturbance, underwater noise, and water quality. The effects can be either direct such as changes to seabed, removal of biota, changes on water quality, or indirect, such as cascading changes on community structure, changes in currents as a result of seabed depth, which may affect settlement of larvae.

The assessment of effects includes:

- changes to benthic biota;
- changes to the benthic fish community;
- impacts sharks, rays and marine reptiles, protected in the Wildlife Act.

Effects to stony corals, pelagic and large demersal fish, marine mammals and birds are addressed in separate reports (Beaumont, *et al*., 2025; Boyd 2025; McConnell, 2025; Thompson, 2025). This assessment relies in part on the information provided in Beaumont, *et al*., 2025; Wilson, 2025 and Styles Group, 2025.

6.1 Benthic Biota and Macrobenthic Epifauna

6.1.1 Community structure and habitat

Sand extraction by TSHD will result in a loss of surface substrates, and disturbance of epibiota and infauna within the area directly affected. At a worst case scenario, a 13 km long by 1.6 m wide area (20,800 m²) will be disturbed to a depth of 0.1 m, each extraction trip, this equates to 0.135% of the proposed sand extraction area (0.0208/15.4 *100). The screening methods proposed to be used in this application will result in the return of biota (>2 mm) to the top of the water column under the vessel. Ultimately, the larger biota will settle to the seabed where they will potentially rebury themselves in the substrate, meaning not all biota entrained in the draghead will be permanently removed. In addition, some <2 mm sized particles may not pass through the screen and will also be discharge to the top of the water column under the vessel.

The magnitude and frequency of occurrence at any one location will influence the level of effects on biota. More frequent intermittent disturbances caused by extracting sand will likely result in greater observed effects on the biota population, than less frequent events. Repeated extraction[8] along the same track lines could potentially result in increased seabed depth, which has the potential to influence biota community composition. Hence the sand extraction operations plan (MBL, 2025) proposes to space sand extraction tracks far enough apart that repeated extraction along the same track is very unlikely.

This is in contrast to port type dredging, where large consecutive areas are extracted. In most port area dredging cases a thick layer (> 200 mm) of sediment is removed resulting in the total removal of all biota. Recovery times of benthic communities following the cessation of extraction appear to depend on the substrates and communities present. The rates of recovery will vary on a site-by-site basis; however, literature suggests the following:

- 6–8 months for muddy communities;
- 2–3 years for sandy/gravelly communities; and
- 5–10 years for coarser sediment communities (Newell *et al*., 1998, Michel *et al*. 2013).

This contrasts with other more stable biogenic habitats (such as mussel beds, maerl beds, and seagrass beds), in which habitat recovery takes a great deal of time if it occurs at all (Hall-Spencer and Moore, 2000; Peterson *et al*., 1987).

The draghead currently used by the *William Fraser* has been shown to extract a shallow layer of sand to an average depth of 100 mm below the seabed (Figure 3). The proposed sand extraction operations plan for Te Ākau Bream Bay will result in a patchwork of shallow (100 mm deep) disturbed strips where not all species are removed (e.g. deeper burrowing polychaete worms and stomatopods, have been observed to remain in the seabed), thus the reduction in benthic biota communities does not form large consecutive areas. Recovery of the benthic biota in the sand extracted strips will begin to occur as soon as the extraction event has happened. Those biota left in the sediment will re-establish themselves, the seabed profile levels out over a period of days (McCallum Bros Limited Diver observation), and mobile biota will move into the extracted strips, over a longer period of time new biota will recruit to the seabed and grow. Shallower layers (~100 mm) of extracting as proposed by MBL are likely to recover quicker than deeper layers (>200 mm) of extraction (Dernie *et al*., 2003).

[8] Meaning more than 5 dredge tracks over exactly the same point of seabed within 6 months.

The degree of impact on the composition and abundance of the benthic communities caused by the extraction operation will, to some extent, determine the recovery time. Incomplete removal of biota will result in shorter recovery times.

Based on the lack of biogenic habitats and sediment grain size composition recorded in the proposed sand extraction area (West, *et al.*, 2025), and research in other locations, recovery is expected to be in the 2-3 year range, assuming no additional disturbance or change of habitat occurs as a result of sand extraction in that 2-3 year period. Based on the proposed sand extraction operations plan the return period for dredge tracks is expected to be in excess of 20 months with 150,000 m^3 per year extraction rate, and about 12 months under the 250,000 m^3 per year extraction rate. There is no way to determine the exact recovery rate in the proposed sand extraction area, prior to sand extraction. During sand extraction each part of the seabed will be in a different phase of recovery, thus the proposed monitoring will not be able to determine the recovery rate but will determine any population level effects. To determine a biota recovery rate sand extraction would need to occur only once in an area and that exact area repeatedly sampled over time to determine when recovery has occurred.

The coastal processes report (Tonkin and Taylor, 2025) suggests that subsurface sediments can be broadly described as fine to coarse sand with minor shells. Beds containing silt and peat were also identified. Variation in the lateral distribution and bed thicknesses between investigations is apparent. A semi-permanent change in community composition can occur if the characteristics of subsurface substrates that are exposed by extraction differ from the original seabed substrates. The variation in subsurface sediments suggests some changes may occur as sand extraction progress.

Implications of benthic disturbance for benthic-pelagic coupling and food-web processes are assessed in Section 6.3.

6.1.1.1 Recovery

The concept of "recovery" of a biological community is not an easy one to define, for complex communities whose composition can vary over time, even in areas that remain undisturbed.

Ideally recovery would be measured as the return of the benthic biota community to what was present before extraction including the species composition and abundance, the age and size of larger biota. However, if the benthic biota community composition and abundance is naturally variable, a more practical approach to the question of "recovery" will be the recognition of the establishment of a community that is capable of maintaining itself and in which at least 80% of the species diversity and biomass has been restored.

The benthic community in the sand extraction area is seasonally subjected to the settlement of juvenile biota from planktonic larvae and constantly subjected to the migration of biota from adjacent habitats. Seasonal timing will thus influence the speed of recovery. Initially, recovery will be by survival and lateral migration of juvenile and adult benthic organisms into the extracted depression from adjacent habitats, which will occur almost immediately (Brooks, *et al*. 2004, 2006). Most benthic biological recovery occurs through subsequent larval settlement and interactive community development, analogous to recovery from other mass perturbations of seafloor sediments and benthos at these depths where sand extraction occurs. This will take place over a longer timeframe, as reproductive settlement will be seasonal and vary from species to species. Mature communities will depend on the growth rates of the species involved.

Observation has shown the draghead on the *William Fraser* creates a profile approximately 100 mm deep and 1.6 m wide, that affects fewer species compared to other dragheads that penetrate deeper. Observations by divers of the extraction tracks immediately post-extraction have recorded Stomatopods surviving the passage of the draghead staying in the sediments and resuming feeding less than 5 minutes after extracting, and predatory gastropods moving into the extracted footprint in search of prey (Figure 9). The larger biota passes over the screens and are returned to the sea.

Figure 9 Survival and migration biota in the extraction track, August 2020 MBL.

The shallow (100 mm) profile has been shown to result in faster recovery times from the disturbance. Dernie *et al.* (2003) working in dynamic sandy habitats in northern Wales reported that sediment disturbances to deeper depths (200 mm) took more than 107 days to recover, and areas of shallower (100 mm) sediment disturbance took 64 days to recover.

Thus, with some benthic biota surviving the passage of the draghead, the sand extraction does not create areas devoid of life. Observations after sand extraction operations show this method creates a patchwork of disturbed strips, thus the reduction in benthic biota communities does not form large consecutive areas. The removal of sediment in bands creates the opportunity for mobile biota to spread laterally, recolonising the extraction tracks. A large percentage of the hard-shell biota are known to survive passage through the draghead and are returned to the seabed (see Section 6.1.2). Thus, the benthic biota communities on the seabed in the proposed sand extraction area will be in varying states of recovery depending on the time since it was last extracted.

The ideal method to determine a biota recovery rate of the benthic biota is very onerous and should include;

- At least four surveys prior to any sand extraction with samples spanning seasonal variability,
- Post extraction sampling at 2 weeks, 1, 3, 6, 12, 18 months, and 2 and 3 years, extending to 4 and 5 years if needed.

The sampling design should include four test areas scheduled for sand extraction and four reference areas outside the footprint and expected plume, with the same depth and sediment grain size characteristics. Within the sampling test areas stations should be established along an impact gradient such as, within the draghead path, 5 m from the track, 20 m from the track. Replication at each station should include at least 5 grab samples. The number of stations and replicates should be repeated in the reference areas.

Sand extraction would need to occur once per test area, ideally the sand extraction would be conducted in different seasons in each of the four test areas.

To our knowledge, there are no studies of the recovery of the sandy habitat in 20 to 30 m of water following sand extraction in New Zealand and only a handful of international studies found targeting recovery of sand mining (Boyd *et al* 2004, Desprez 2000, Fraser *et al* 2006, Jewett *et al* 1999, Kenny and Rees 1996, Newel *et al* 2004, Szymelfenig *et al* 2006), none of which match the Te Ākau Bream Bay site conditions and extraction methods. It is predicted that the shallow sand layer extracted by the *William Fraser*'s draghead will result in a relatively short recovery time, with mobile biota moving back within a week, recolonization of non-mobile biota within a year, and growth of larger biota to similar sizes by 2 to 3 years after extraction.

While recovery monitoring has not been conducted, sand extraction monitoring has been conducted. The *William Fraser* has been used by McCallum Bros Limited to extract sand in the Pakiri embayment under the Temporary sand extraction consent. The Pakiri Offshore Sand Extraction Monitoring (2023–2025) (Bioresearches, 2024a, 2025) provides a strong analogue for predicting potential ecological responses at Te Ākau Bream Bay, since both sites share similar sedimentary and ecological settings.

Across the Temporary Sand Extraction Area (TSEA), silt and clay content remained below 6%, well under the exclusion threshold of 20%, confirming a stable sandy seabed with minimal fine sediment accumulation. When the grain size data was compared by multivariate statistical testing (PERMANOVA) the data showed geographic variations between the sand extraction area and the control area. However, there were no statistically significant differences between the 2023 and 2025 sampling events, nor were there statistically significant changes in the TSEA over time that were greater or less than observed in the Control areas, i.e. there is no statistically significant effect of sand extraction on grain size composition.

168 taxa were recorded in the TSEA, with no major loss of diversity or dominance shift relative to control areas between 2023 and 2025. Some species (e.g., Dosinia clams and hermit crabs) exhibited significant temporal fluctuations (Figure 10), but overall community composition remained stable.

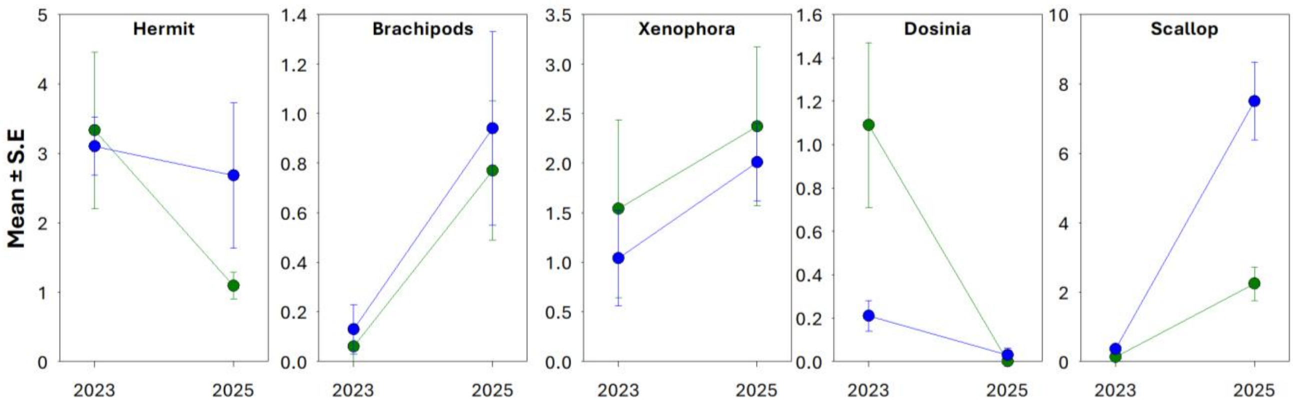


Figure 10 Interaction plots (raw mean ± SE) for the five macrofauna taxa abundance and in 2023 and 2025.
(Lines connect the two sampling years to highlight temporal trends within each zone. Means are calculated from the raw data.)

The numbers of scallops have greatly increased in both zones between 2023 and 2025 (Figure 10). The control has increased by more than 17 times the 2023 density while the TSEA has increased by more than

20 times the 2023 density. With the TSEA proportional increase being greater than that of the control areas, no adverse effect has been measured. The average sizes of scallops have decreased over time in both the control areas and TSEA, and the size of scallops has not changed differently in the TSEA over time compared to natural changes (Bioresearches, 2025).

The numbers of taxa, abundance and diversity of benthic communities in the TSEA and control areas increased for both the epibenthic (Figure 11) and the infauna biota (Figure 12). Statistically testing showed the changes were not statistically significantly different between the TSEA and Control areas (Bioresearches, 2025).

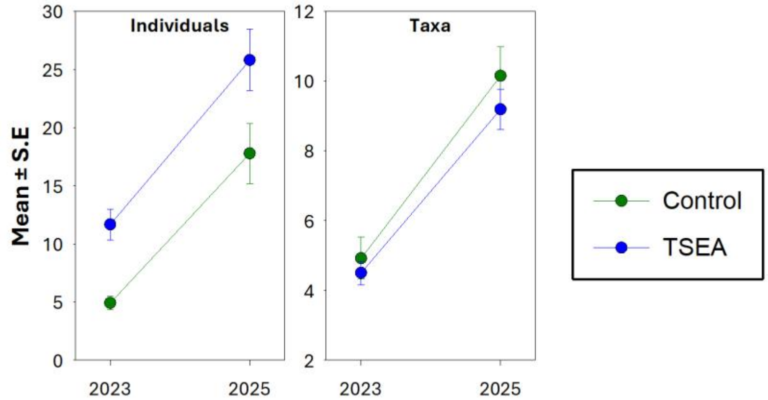


Figure 11 Interaction plots (raw mean ± SE) for the two macrofauna community metrics number of Individuals, number of Taxa and in 2023 and 2025.
(Lines connect the two sampling years to highlight temporal trends within each zone. Means are calculated from the raw data.)

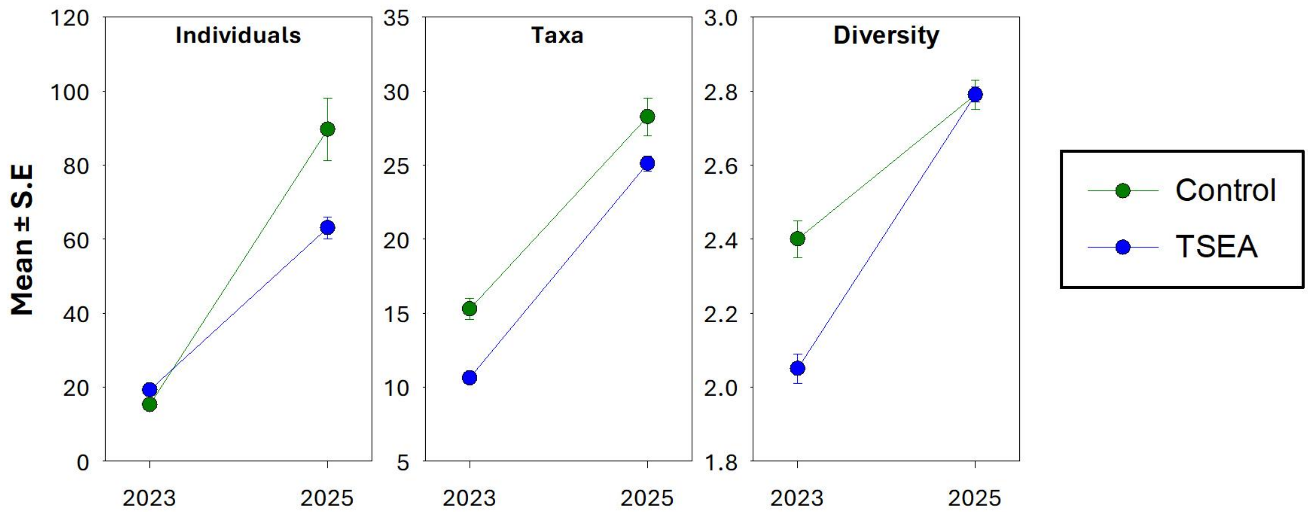


Figure 12 Interaction plots (raw mean ± SE) for the three Infuana community metrics number of Individuals, number of Taxa and Shannon-Weiner Diversity Index, in 2023 and 2025.
(Lines connect the two sampling years to highlight temporal trends within each zone. Means are calculated from the raw data.)

Multivariate testing showed there were statistically significant changes in the composition and abundance of benthic infuana between the TSEA and control areas over time and these changes were different between the areas. Thus, there is a potential that sand extraction has had an effect overtime on the composition and abundance of benthic biota (Bioresearches, 2025). The PERMANOVA testing does not differentiate between positive or negative effects.

By comparing the similarities and differences between the comparisons over time in the individual zones it is possible to describe which species have had responses over time greater than natural variation as recorded by the changes in the Control area. The majority of changes over time appeared to be similar between the TSEA and Control areas. However, an adverse effect where the numbers in the TSEA decreased (-40%) at a greater proportional rate than in the Control area (-17%) was recorded for Cumaceans. Cumaceans are short lived taxa with life spans of typically 1 year or less, they exhibit direct development with no free-swimming planktonic larval stage, thus they show limited dispersal capability. This reproductive mode is likely a contributing factor to the adverse effects observed on cumaceans. The cessation of sand extraction will see a gradual recovery of the cumacean population via lateral spread from unaffected populations within and nearby the TSEA. The speed of recovery will depend on reproductive rates and successful recruitment.

Similarly, an adverse effect was recorded for the Maldanidae polychaete worms as the numbers decreased in the TSEA (-19%) but naturally increased in the Control area (147%). Maldanidae worms typically live for a few months to a couple of years. The reproductive mode of Maldanidae varies some have short planktonic larval phases while others have direct development and no dispersal. Like cumaceans, direct development will be a contributing factor to the observed adverse effect. The cessation of sand extraction will see a gradual recovery of the Maldanidae worms population via lateral spread and potentially short planktonic dispersion from unaffected populations within and nearby the TSEA. The speed of recovery will depend on reproductive rates and successful recruitment.

Under the extraction regime in the TSEA at Pakiri of up to 76,000 m^3 per year from an area of 11.7 km^2, which equates to up to 6.49 mm of sediment removed per year, the results indicate rapid recolonisation and community resilience following extraction, consistent with historical monitoring at Pakiri and Mangawhai.

While the initial extraction regime proposed for Te Ākau Bream Bay (up to 150,000 m^3 per year from 15.4 km^2, or up to 9.74 mm per year) is approximately 50% higher than in the TSEA the effects in the proposed sand extraction area are expected to be similar. Yearly monitoring studies are proposed for at least the first three years, with the aim of confirming no adverse effects. If adverse effects are detected the proposed conditions allow for a number of management options, such as reducing extraction volumes by cell or as a whole, or temporarily closing cells. If no adverse effects are detected, then the proposed conditions would allow the sand extraction volume to increase to 250,000 m^3 per year or 16.23 mm per year. Yearly monitoring studies are proposed for at least the first three years after the increase in volume, with the aim of confirming no adverse effects. The same management controls would be applied. Yearly monitoring should be continued if adverse effects are detected. If no adverse effects are detected, then the frequency of monitoring could be decreased to no greater the three yearly intervals.

There is a considerable amount of scientific literature on the recovery of seabed habitats following bottom contact fishing methods such as trawling and scallop dredging. Bottom contacting trawls can affect seafloor habitats and communities by damaging or removing structure forming species, reducing habitat complexity and altering the seafloor structure. The greatest impacts from bottom trawling are on hard complex grounds, while the effects are less on sandy bottoms (MacGibbon *et al*., 2024). The seabed within Te Ākau Bream Bay is non-complex and comprises of soft sandy ripple bedforms. Figure 12 in Boyd (2025) demonstrates the active trawl and Danish seine limit line which covers approximately half of the proposed extraction area on the seaward side. While these activities result in disturbance to the seabed communities, they do not generally involve the removal of the seabed substrate and small biota contained within. Thus, while the reports document biota recovery they are not assessing recovery from the same starting point as for sand extraction. As noted earlier the Te Ākau Bream Bay has had significant scallop dredging activity over a long time period, the fact that benthic communities are present with moderate abundances and high diversity shows that recovery from these activities has occurred. Given the long period of disturbance, it is likely that the benthic communities currently present are more tolerant to disturbance than those of a pristine undisturbed environment.

The Te Ākau Bream Bay area is considered a dynamic environment with currents and sea swells influencing the movement of the seabed surface (e.g. large ripples of sand visible on seabed photographs) (West, *et al*., 2025). Considering the naturally dynamic environment in the embayment and the shallow (~ 100 mm) layer of sand extracted, it is not expected to alter the benthic community over and above what is experienced naturally in extreme events. Therefore, based on the definitions in Table 2 no complete loss of any key features is expected to occur in the sand extraction area as a whole. There may be some temporary partial changes in composition but generally the underlying character of the sand extraction area will be similar to the pre-extraction area, thus the magnitude of effects is described as **Low** on the overall benthic community within the sand extraction area. Assessing the magnitude of effect at the spatial scale of the effect is not a recommended practice (EIANZ, 2024). “Generally, it is recommended that an assessment at the scale of the feature (e.g. contiguous dunes, wetland system, forest community) should be done.” (EIANZ, 2024), thus the potential changes in the benthic community of the wider Te Ākau Bream Bay beyond the sand extraction area need to be considered. The effects to benthic biota and composition are not expected to occur much beyond the sand extraction area as disturbance and biota loss will not occur, but there may be a very minor reduction in biota numbers as it potentially migrates into the edges of the sand extraction. Thus, the magnitude of effects is described as **Negligible** on the overall benthic community, and beyond the sand extraction area within the wider Te Ākau Bream Bay.

Within the sand extraction area during the period of the coastal permit when sand extraction is occurring there will always be small areas recently extracted which will be in recovery, with slightly reduced diversity and abundances. Once sand extraction has stopped at the end of the coastal permit then complete recovery is expected to occur. The complexity of some habitats and changes in the benthic environment resulting from extraction can result in total recovery not occurring for many years, the length of time is dependent on the species. However, the aim is to avoid damaging sensitive biogenic habitats by conducting regular pre-extraction surveys to map sensitive habitats (West, *et al*., 2025) and avoid adverse effects by not extracting in these locations. If the habitat was present, but has naturally disappeared prior to extracting sand, then it is possible that other seabed disturbance activity such as ship anchoring, scallop dredging or bottom trawling, may prevent recolonisation.

Longer recovery time periods of benthic communities have been linked to coarser sediment particle sizes (Newell *et al*., 1998, Michel *et al*. 2013). However, this is generalisation based on a small number of international studies, there are no specific published recovery studies following sand extraction in northeastern New Zealand. The seabed grain size in the proposed Te Ākau Bream Bay sand extraction area is generally mid-range with most sediment in sand sizes (West, *et al*., 2025) with relatively minor proportions of gravel or silt and clay. Thus, the sediment composition at Te Ākau Bream Bay is not expected to increase recovery times.

6.1.1.2 Factors affecting recovery time

Extraction activities can significantly alter the physical and chemical characteristics of the sediment. These changes can impact the benthic communities in several ways:

- **Sediment Composition**: Extraction can change the grain size, organic content, and overall composition of the sediment. For example, if finer sediments are removed and replaced with coarser materials, the habitat becomes less suitable for species that prefer finer sediments (Sánchez-Moyano, *et al*., 2004). In the case of the proposed Te Ākau Bream Bay sand extraction, the sediment larger than 2 mm and smaller than about 0.063 mm is returned to the sea as it is extracted, by partial removal of sand sized particles it is theoretically possible the seabed grain size may increase slightly. Consent conditions will require the seabed grain size to be monitored for changes. There have not been any detected changes in seabed grain size at other nearby sand extraction sites (Bioresearches, 2021). If changes are detected, then an investigation of whether they are ecologically significant will be conducted, and mitigations measures proposed to reduce adverse effects.
- **Chemical Environment**: Extraction can release nutrients and contaminants trapped in the sediment, altering the chemical environment. This can affect the types of species that can thrive in the area post-extraction (Crowe, *et al*. 2016). As reported in West, *et al*., 2025, the sediment quality is well below the ANZG 2018 guideline values above which adverse effects occur in benthic biota communities.
- **Recovery Dynamics**: The recovery of benthic communities after extraction is influenced by the new sediment characteristics. Some species may recolonize quickly if the new conditions are favourable, while others may be replaced by different species better adapted to the altered environment.
- **Biodiversity and Abundance**: The changes in sediment characteristics can lead to shifts in species composition and abundance. For instance, areas that were once dominated by a diverse array of species might become dominated by a few opportunistic species that can quickly exploit the new conditions. Note shifts in species composition and abundance can happen naturally as well such as with the establishment of shellfish beds like horse mussels.

Overall, the recovery of benthic communities after extraction is a complex process influenced by the extent of the disturbance and the specific changes in sediment characteristics. This can result in a community that is different in composition and abundance compared to the pre-extraction state. **The proposed Te Ākau Bream Bay sand extraction is not expected to significantly alter the seabed conditions**, as only narrow bands of seabed will be affected at any one time and then only to shallow profile depths, and the sediment quality is good, therefore the same benthic biota communities are expected to be maintained.

Considering the potential for possible temporal changes in composition and abundance in isolated areas within the sand extraction area, the extraction is assigned a **low** magnitude effect on benthic biota composition and abundance within the sand extraction area. **Negligible** effects are expected beyond the sand extraction area.

6.1.2 Benthic Fauna Survival

Large fragile thin shelled biota are more likely to be affected by passage through the TSHD and screening equipment than robust biota. Smaller, less robust biota may potentially be damaged by impact with hard surfaces on passage through the draghead, pump, pipes and screen. The level of damage will vary among species and sizes, from minor scratches and chips to mortal cracks and dismemberment. Some species are able to recover and repair shell damage, such as clams and other bivalve shellfish. The ability varies between species and is not well understood for all species.

Macrofauna survivorship studies (Bioresearches, 2020) conducted on the *William Fraser* showed that the shellfish macrofauna passing through the draghead and screening deck suffer some damage, but the majority (93%) survive, and are returned to the sea. More fragile species such as echinoderms and polychaete worms are likely to be more affected than robust species such as molluscs. The data showed bivalves are more likely to suffer some shell damage and potential mortality than gastropods. Gastropods are generally more robust and compact than bivalves and suffered no lethal damage by the passage through the draghead of the *William Fraser*. Crustaceans, which consisted mostly of small crabs, showed a **high survival rate of 96%**, this is largely due to many of the crabs being hermit crabs living inside robust gastropod shells (Bioresearches 2020).

With daytime extraction, the surviving benthic fauna passing through the extraction pumps, screens, and discharged through moon pools below the *William Fraser*, will likely suffer predation by fish that use visual predation methods for feeding during their descent to the seabed. Fish will also be able to target the biota on the seabed surface prior to the biota rebury themselves in the seabed. The large volume discharged means a significant proportion will reach the seabed quickly and intact. Having the discharge flowing through the moon pools forces the discharges down into the water column which decreases the time it takes for the surviving biota to settle (compared to piping the discharge over the side of the vessel). There are no studies of how much biota survive the trip to the seabed following sand extraction in New Zealand, and conducting such studies in the currently active extraction areas or in this area if approved is impractical due to the depth. Recent international studies (Bargione *et al*. 2023) looking at clam extraction have shown that mortality after discharge was in the order of 7% for non-lethally damaged clams. While this does not replicate the exact conditions under the proposed sand extraction, it provides a good indication that a large proportion (86%) of shellfish will survive the passage from the seabed via the draghead, pump, and screen, back to the seabed.

Considering the low mortality, large volume and sub-surface discharge, the extraction is expected to have effects of a **low** magnitude on macrofauna survival in the sand extraction area, and **negligible** magnitude of effect in the wider Te Ākau Bream Bay.

6.1.3 Water Quality

The effects on water quality are by discharge to the ocean from the extraction vessel and may occur in several ways:

- **Discharge of by-wash containing oversized material that is too large to pass through the sand screens to the hopper.** Once discharged, the concentration of Total Suspended Solids (TSS) quickly reduces back to ambient conditions in both depth and distance from the discharge point, this is further defined in Wilson (2025) and Jacobs (2020).

- **Discharge over the weir boards as the hopper fills with sand.** Water sampling of the weir board discharges indicated TSS values of 450 to 1240 mg/L (Jacobs, 2020), to form part of the overall plume with the by-wash discharge as noted above. All discharge going over weir boards passes into moon pools and discharges below the vessel.
- **Contamination of the water.** The process of the disturbance of seabed sediments may release contaminants if they are present in the sediments, into the water column potentially having ecotoxicology effects. The level of contaminant release is dependent on what concentration of contaminants is present in the seabed and the chemical process that binds the contaminants to the sediments. Different species have different tolerances to contaminants.

The effects of sand extraction are summarised in Figure 13.

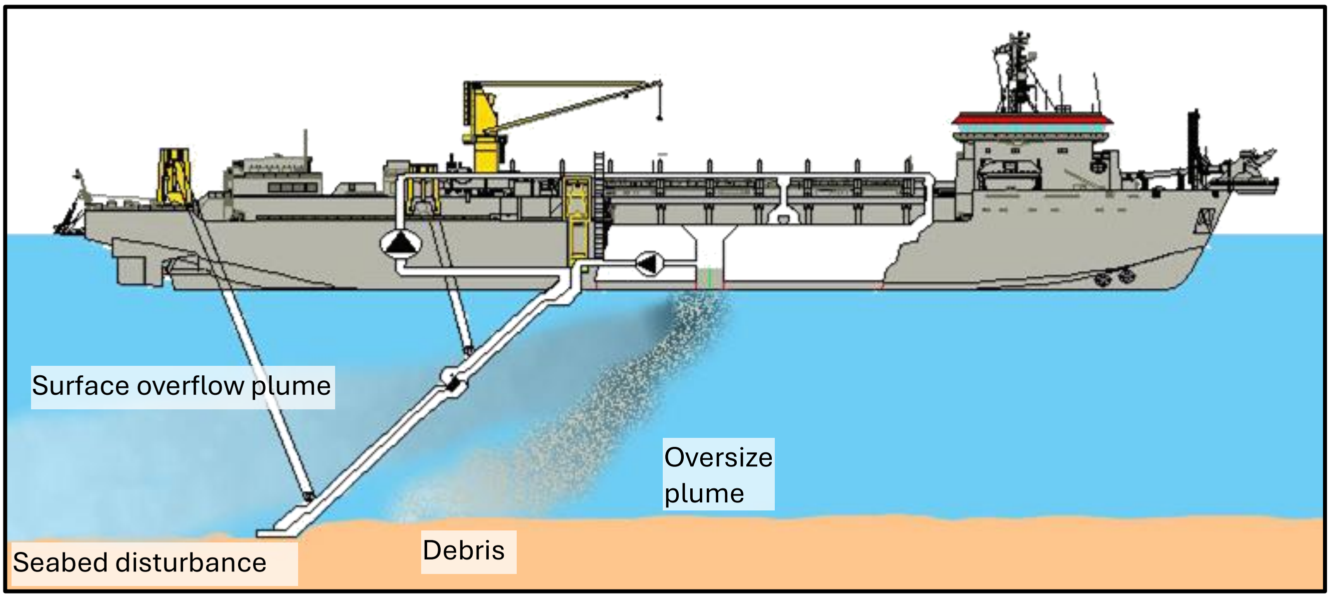


Figure 13 Summary of the effects of sand extraction (note not an actual MBL vessel)

6.1.3.1 Contaminants

The sediment quality has been assessed, (West, *et al.*, 2025; Wilson, 2025) and shown to be devoid of harmful concentrations of contaminants. There are no discharges of contaminants from land into or near the proposed sand extraction area with the closest shoreline 4.7 km away. The draghead does not inject anything into the seabed or leave any deposits. Therefore, there is no source of chemical contamination in or near the proposed sand extraction area. Thus, the composition of the seabed sediments will not result in the release of contaminants causing adverse effects if disturbed. As such, the overall effects on general water quality in Te Ākau Bream Bay is determined to be **negligible**.

6.1.3.2 Suspended sediment and Turbidity

Water clarity is important for the healthy functioning of marine ecosystems. Increased suspended solid loads that reduce water clarity, through increased turbidity, can affect the amount of photosynthesis (primary production) of aquatic plants, which in turn means less food for filter feeders. Increased suspended solids concentrations can harm benthic biota by causing physical smothering through sedimentation, clogging feeding and respiratory mechanisms, leading to decreased biodiversity and abundance of benthic organisms in the affected area. Reduced water clarity can also affect the feeding efficiency of visual predators like fish and sea birds.

The ambient water quality in Te Ākau Bream Bay has been assessed for this project by SLR (Wilson, 2025). Comparisons have been made with the water quality in the Pākiri embayment where testing of the discharges from the *William Fraser* at a similar consented location site was conducted and reported by Jacobs (2020).

The sand extraction methods and processes are described in MBL (2025) and the effects to water quality described in Wilson (2025).

Since the water quality tests were conducted in 2019 (Jacobs, 2020), the vessel travels at similar speeds of 1.5-2.5 knots, which it maintains while extracting sand, but the efficiency of the screening deck has been improved. The screening deck improvements have resulted in 50% less sediment discharged per extraction event. Since the fall rate of sediments in the water column will be relatively similar, due to the similar particle size proportions and particle density, the duration of the plume would be similar, the similar speeds will result in a similar plume length of about 2,000 m and area of ~0.13 km^2. The water quality study (Wilson, 2025) estimates the turbidity and suspended solids within the plume will be reduced, compared to the tested scenario (Jacobs, 2020).

There is potential for an adverse effect by the plumes if they are created during the day, as photosynthetic production will potentially be impacted, and visual predators will be potentially adversely affected. It was originally proposed to mitigate this by operating the vessel at night, which would eliminate effects to photosynthesis, and minimise effects to visual predators. However, the production of underwater noise at night has been determined to have high impacts to marine mammals in the area, thus extraction is proposed to occur in the afternoon between 12:00 pm – 6:00 pm NZST (April-September) and 12:00 pm – 8:00 pm NZST (October-March).

Each extraction event will have a maximum plume time of 4 hours duration. The visual plume will potentially cover a maximum area of approximately 0.13 km^2 which is 0.8% of the proposed sand extraction area. The plume area would expand for approximately the first 30 minutes after extraction starts, then it would stabilise at the estimated maximum area, and then decrease in size and disappear approximately 30 minutes after extraction stops. The coastal processes report (Tonkin and Taylor, 2025) reports currents within the proposed sand extraction area are generally less than 0.15 m/s and typically in the range 0.05 m/s to 0.1 m/s. The current directions are variable and indicative of non-tidal effects. Based on modelling the currents are generally north to south and not onshore or offshore. With a peak current speed of 0.15 m/s the plume could move by as much as 234 m in the 26 minutes it is present for and generally from north to south. As extraction will follow the general north south alignment of the proposed sand extraction area the currents are likely to impact the plume by expanding it when extraction track is south to north and contracting it when the track is north to south. The currents are not likely to push the plume towards shore, in the event they do, it would only be a few hundred meters. Generally, the plume will remain within the proposed sand extraction area. However, if extraction started on the southern boundary there is a possibility the plume could be pushed south out of the proposed sand extraction area by up to 230 m. However, the closest location to shore is 4.7 km so there will be no chance of the turbidity plume reaching the shore.

The underwater light regime is a vital factor for the ecology of aquatic systems but is a limiting factor for photosynthesis in phytoplankton. Sediment plumes elevate water turbidity, diminishing light penetration essential for photosynthesis. This reduction can adversely affect primary producers like phytoplankton.

Marine phytoplankton require at least 0.5-1.0% of incident light measured just below the water surface (Dennison *et al*, 1993). Although the Jacobs (2020) water quality study does not report light transmissivity or secchi disk data, the level of turbidity is not expected to reduce light transmissivity that marine phytoplankton will be unable to photosynthesize. This assumption, combined with the relatively small area and short duration, demonstrates that any effects of the sand extraction water quality plumes will be much less than that produced by natural storm events or heavy rainfall which occur for longer periods over wider areas. Whatever the loss of production is it will be inconsequential to the wider Te Ākau Bream Bay.

As such, the magnitude of effects on TSS and turbidity in the water quality is determined to be **Low** within the area of the plume for its duration. Beyond the plume within the sand extraction area and within the wider Te Ākau Bream Bay the effects of turbidity and TSS are **Negligible**.

6.1.3.3 Deposition of sediment

Biota in and on the seabed areas adjacent to the extraction path could suffer temporary minor smothering from the settlement of oversized material discharges. However, the level of discharge is not expected to result in complete coverage of the seabed causing the burial of biota, but be in the order of a few millimetres or less causing partial covering. Seabed images show bed forms ranging from flat, to up to about 100 mm high. These bedforms are likely to be mobile and regularly changing shape and size, caused by water movements either tidal or wave driven, this would cause natural minor smothering of benthic biota. Thus, it is likely that natural sediment movements in the bay could result in far higher burial depths than that resulting from the extraction plume.

As such overall the overall risk of project effects on sediment deposition is determined to be of **Negligible** risk.

6.2 Benthic Fish

No direct assessment has been made of the demersal fish population prior to and following sand extraction or in comparison between areas extracted and not extracted. This assessment of effects on fish is based on literature information.

Marine fish have life histories that can be divided up into spawning/reproduction, eggs and larval periods, a juvenile phase, and an adult phase, when reproductive maturity is reached. The juvenile life stages are generally considered more vulnerable. Many fish species spend their juvenile life stage in more sheltered estuarine habitats meaning **juvenile fish are not expected to be abundant in the sand extraction area**.

Pelagic and midwater living fish species will not be directly affected by the extraction activity in terms of physical impacts, however they could be affected by underwater noise and suspended sediment. Smaller benthic fish within a limited range will potentially be affected by a number of factors related to the operation of the *William Fraser*. These include:

- underwater noise

- entrainment
- suspended sediment; and
- food source reduction.

6.2.1 Effects of Underwater Noise

Marine mammals, fish, reptiles and invertebrates rely in some way on sound for communication, orientation, foraging, and predator avoidance (Erbe *et al*., 2022).

An underwater noise assessment, including measurement of sound created when the vessel is in operation was undertaken by Styles Group (Styles Group, 2020, Styles Group, 2025). The main noise sources associated with the activity will be the draghead making contact and sliding along the seafloor, and the movement of the sand slurry up the pipe to the hopper. The assessment was based on the loudest operational stage (active extracting), using measured noise level data of the *William Fraser*.

The Styles Group reported that the ambient 2024 soundscape within Te Ākau Bream Bay is complex with a range of sound sources occurring simultaneously at any given time. The effects of wind, waves, and tides (causing sediment entrainment) were the primary contributors to the bay's geophony, while fish, marine mammals and snapping shrimp formed the area's biophony. Vessels were the primary anthropogenic noise source. Within the proposed sand extraction area (during May and June 2024) the embayment's soundscape was largely dominated by the geophony and biophony. The area was also relatively quiet with 5th percentile sound level approximately 93 dB re 1 µPa and a median level approximately 99 dB re 1 µPa (Styles Group, 2025).

From the studies at Mangawhai-Pākiri the average source level of the *William Fraser* extracting was approximately 168 dB re 1 µPa @ 1m (Styles Group, 2020).

The effects to marine mammals are discussed in McConnell (2025), and the effects to birds are discussed in Thompson (2025).

The underwater noise modelling was undertaken by Styles Group (2025) recording sound pressure. There is a wide diversity in hearing structures in fish which leads to different auditory capabilities across species. The difference in hearing sensitivity in fish depends on the presence of a swim bladder, and if the swim bladder is present, on its proximity to the inner ear (Popper and Hawkins, 2019). The Styles Group sound pressure results were then converted to particle motion sound due to differences in the way some fish hear sound. Styles Group (2025) have reported auditory masking in the form of distances for different Listening space reductions (LSR) for two fish species; bigeye (*Pemphersis adspersa*), common triplefin (*Forsterygion lapillum*), which serve as proxies for the small benthic fish found in the extraction area, and two species of invertebrates; NZ paddle crab (*Ovalipes catharus*), and snapping shrimp (*Alpheus richardsoni*). They also reported audibility distances from the same four species. These distances are based on particle motion sound. As can be seen by the differences in the distances reported for mammals and fish in Styles Group (2025) particle motion sound dissipates more quickly than sound pressure particularly in shallow water thus the effects maps for fish cover less area than those for marine mammals. Since each species has different tolerances, there is no one rule as to what is too much noise. The safest approach is to use the most sensitive species (bigeye) to set any limits.

Styles Group (2025) summarises the noise criteria for the animal groups potentially affected in Te Ākau Bream Bay, and includes and outline of five effects categories. In general, the assessment of potential noise impact on marine mammals relies on the temporary threshold shift (TTS) distance to determine the management of effects. With the more limited understanding and greater variability of responses, the assessment of potential noise impact on fish is less clear but often relies on the permanent threshold shift (PTS) distance to determine the management of effects. However, in the case of long-term projects, LSR has been defined as a key factor in determining effects. **Listening space** refers to the area within which an animal can perceive acoustic cues, including those from conspecifics, other species, and the environment. It is a metric used to assess the masking effects of anthropogenic noise, indicating an animal's ability to receive critical auditory information.
Listening space is essential for various life functions:

- **Communication**: Animals rely on sound to communicate with each other for mating, group cohesion, and other social activities;
- **Orientation**: Many marine animals use sound for navigation and orientation; and,
- **Predator Avoidance**: The ability to hear predator cues is essential for survival.

There are gaps in the scientific knowledge of the actual effects on fish and invertebrates that take place as a result of underwater noise (Popper and Hawkins, 2018). Data that establishes the expected severity of a certain effect following the exposure to some pressure levels are scarce. However, this is an area of active scientific study, and the gaps are starting to be reduced. There have been very few measurements made of the sensitivity of different fishes and invertebrates to particle motion. Acoustic particle motion in the water and seabed, for example, has been shown to induce behavioural reactions in sole (Mueller-Blenkle *et al*. 2010). Wilson *et al*. (2023) showed that particle motion noise from small boats had effects on bigeye and the common triplefin fish.

The criteria in Table 9 for recoverable injury and TTS required exposure for longer periods (48 and 12 hours, respectively) than the vessel operates for (up to 3.5 hours per day), thus the sounds are not present for long enough to cause **recoverable injury or TTS in the sand extraction area or beyond**. Additionally, as the noise levels decreases with increased distance from the source only very small (<1 m) zones of influence would be present with noise levels expected to produce harmful effects (Styles Group, 2025). These effects will only occur while actively extracting, beyond 1 m effects will be limited to behavioural and auditory masking effects only (Styles Group 2025).

Table 9 Shipping and continuous sounds guidelines. (From Hawkins et al. 2014)

Type of Animal	Mortality & Potential Mortal injury		Impairment						Behaviour	
			Recoverable injury		Temporary Threshold Shifts (TTS)		Masking			
Fish: no swim bladder (Particle motion detection)	N	Low	N	Low	N	Moderate	N	High	N	Moderate
	I	Low	I	Low	I	Low	I	High	I	Moderate
	F	Low	F	Low	F	Low	F	Moderate	F	Low
Fish: swim bladder is not involved in hearing (Particle motion detection)	N	Low	N	Low	N	Moderate	N	High	N	Moderate
	I	Low	I	Low	I	Low	I	High	I	Moderate
	F	Low	F	Low	F	Low	F	Moderate	F	Low
Fish: swim bladder involved in hearing (primarily pressure detection)	N	Low	170 dB rms for 48 h		158 dB rms for 12 h		N	High	N	High
	I	Low					I	High	I	Moderate
	F	Low					F	High	F	Low
Eggs and larvae	N	Low	N	Low	N	Low	N	High	N	Moderate
	I	Low	I	Low	I	Low	I	Moderate	I	Moderate
	F	Low	F	Low	F	Low	F	Moderate	F	Low

Notes: rms sound pressure levels dB re 1 µPa. All criteria are presented as sound pressure even for fish without swim bladders since no data for particle motion exist. Relative risk (high, moderate, low) is given for animals at three distances from the source defined in relative terms as near (N), intermediate (I), and far (F).

Based on the measured ambient sound levels and published hearing thresholds there is a risk of auditory masking and behavioural effects in fish occurring out to 2573 m for the most sensitive fish like the NZ bigeye (Figure 14), but only out to 1,100 m for triplefin fish (Figure 15), from the *William Fraser* (Styles Group, 2025). NZ Bigeye present the larger effects ranges for most common species within Te Ākau Bream Bay, including demersal and pelagic species. NZ Bigeye possess specialist hearing structures for sound pressure that are not found in snapper (Caiger *et al*. 2012; Mensinger *et al*. 2018), john dory or gurnard. Bigeye fish are reef fish and not expected to be present within the sand extraction area. The nearest reef is “Three mile reef” located approximately 1,000 m to the north-east of the north eastern corner of the sand extraction area. Kerr and Grace (2016) recorded the presence of triplefin fish at 2 of the 7 sites (65, 71) they photographed but given the habitats recorded they are likely present throughout the reef. No NZ bigeye were recorded and no observations of cervices or caves in which NZ bigeye inhabit during daylight hours, were made, suggesting NZ bigeye are not an abundant fish on Three mile reef. The LSR maps (Figure 14) shows that when the vessel is operating near the northeastern boundary of sand extraction area (monitoring cells 2G to 2K, 3G to 3K, 4I to 4K), the vessel will be heard by fish like NZ bigeye over the majority of the reef. For NZ bigeye the draghead will only impact the listening space if the draghead is operating in the northeastern corner of the sand extraction area), and then only with 0 – 25% LSR, which equates to a **Negligible** level effect (Styles Group, 2025).

Triplefins do not have specialist hearing structures for pressure detection (Radford *et al*. 2013) and therefore could represent the lower ranges of effects for fishes in Te Ākau Bream Bay. Snapper, john dory and gurnard have similar hearing thresholds in particle acceleration to some other species, including triplefins (Radford *et al*. 2012). The triplefin LSR maps (Figure 15) shows a reduced extent, with the vessel not likely to be heard by triplefins over most of the reef. For triplefin fish the vessel will not impact the listening space even if it is operating at the closest point to the reef. The larger fish like snapper, john dory and gurnard are expected to be present within the sand extraction area, and thus impacted by the sound. Unlike triplefins which have limited ability to swim distances due to the smaller size, snapper, john dory and gurnard could choose to swim away to avoid the noise.

The consequences of this masking and any attendant behavioural changes for the survival of fishes are unknown. The effects on fish could include.

- **Avoidance** - from swimming away from the noise source (not something smaller benthic fish are capable of);
- **Masking** – not being able to communicate or hear predators and prey; and
- **Stress** – living with increased noise causes stress which can have effects on growth and reproduction.

The biological significance of any masking effect will depend on:

- The significance of the habitat affected; and
- The duration of the effect.

Initially, extraction events will occur intermittently (approximately once every 2 days), when the maximum volume is approved to increase to 250,000 m^3 per year the frequency of extraction events will need to increase to 3 times in every 4 days. The extraction activity is not expected to occur in the northeastern corner of the extraction area on every extraction event thus the numbers of times extracting occurs result in under water sound LSR for reef fish will be small. Additionally, duration of LSR events will be less than the full duration of the extraction event as the vessel will only be in the affecting cells for < 2hrs per event.

The audibility range for crustaceans is much less than that for fish with the range estimates of 189 m for paddle crabs and 184 m for shrimp. Paddle crabs in the near shore along the Ruakākā coast are some 4 km away and will not be able to hear the vessel in operation, and thus not be affected by the underwater noise (Figure 16). Eighteen species of decapod crustaceans were recorded in the sand extraction area (West, *et al.*, 2025) including the snapping shrimp and smaller red paddle crabs (*Nectocarcinus antarcticus*). The most abundant decapod was the hermit crab. All of these decapods within the sand extraction area will experience underwater noise, however the area of audibility around the vessel when in operation will be limited to a radius of between 184 and 189 m. The sphere of audibility will move with the vessel and at 2.5 knots last for less than 3 minutes. LSRs for crustacea listed in Styles Group (2025) range from 113 to 180 m suggesting durations of less than 2 minutes for the 75% LSR to about 3 minutes for the 0% LSR. These durations are maximums experienced along the extraction track, if biota are located to the side of track, durations will be less reducing with increased distance away from the track.

As a consequence, the acoustic environment of animals living close to, on, and/or within the substrate can be highly complex and include vibration signals that are within and also emanate from the substrate, as well as sound signals that are generated in the water column. All of these signals are potentially detectable by benthic fishes and invertebrates living close to or within the substrate. Moreover, many of these anthropogenic signals often substantially overlap within the frequency range of biologically relevant signals used by these animals in many biologically critical ways (Roberts and Elliott, 2017; Popper and Hawkins, 2018).

For example, some fish are more vocal in dawn and dusk choruses, similar to birds singing in forests (Farina and Ceraulo, 2017, McWilliam *et al.*, 2017, Hawkins *et al.*, 2025). Styles Group (2025) reported that no dawn or dusk chorus increases were detected in the soundscape recorded in the proposed sand extraction area. However, the timing of the sand extraction is not expected to impact the audibility of the dusk chorus in the Te Ākau Bream Bay as the noise levels produced and modelled do not show the audibility and LSR for the noise to fish reaching significant reef areas with resident fish species.

The temporal and mobile nature of the extraction activity and thus noise, would suggest that the effects to reef fish and other benthic fish are limited to short term effects such as avoidance and short-term masking, resulting in **Negligible** effects. Larger mobile fish are expected to avoid the underwater noise effects of the draghead.

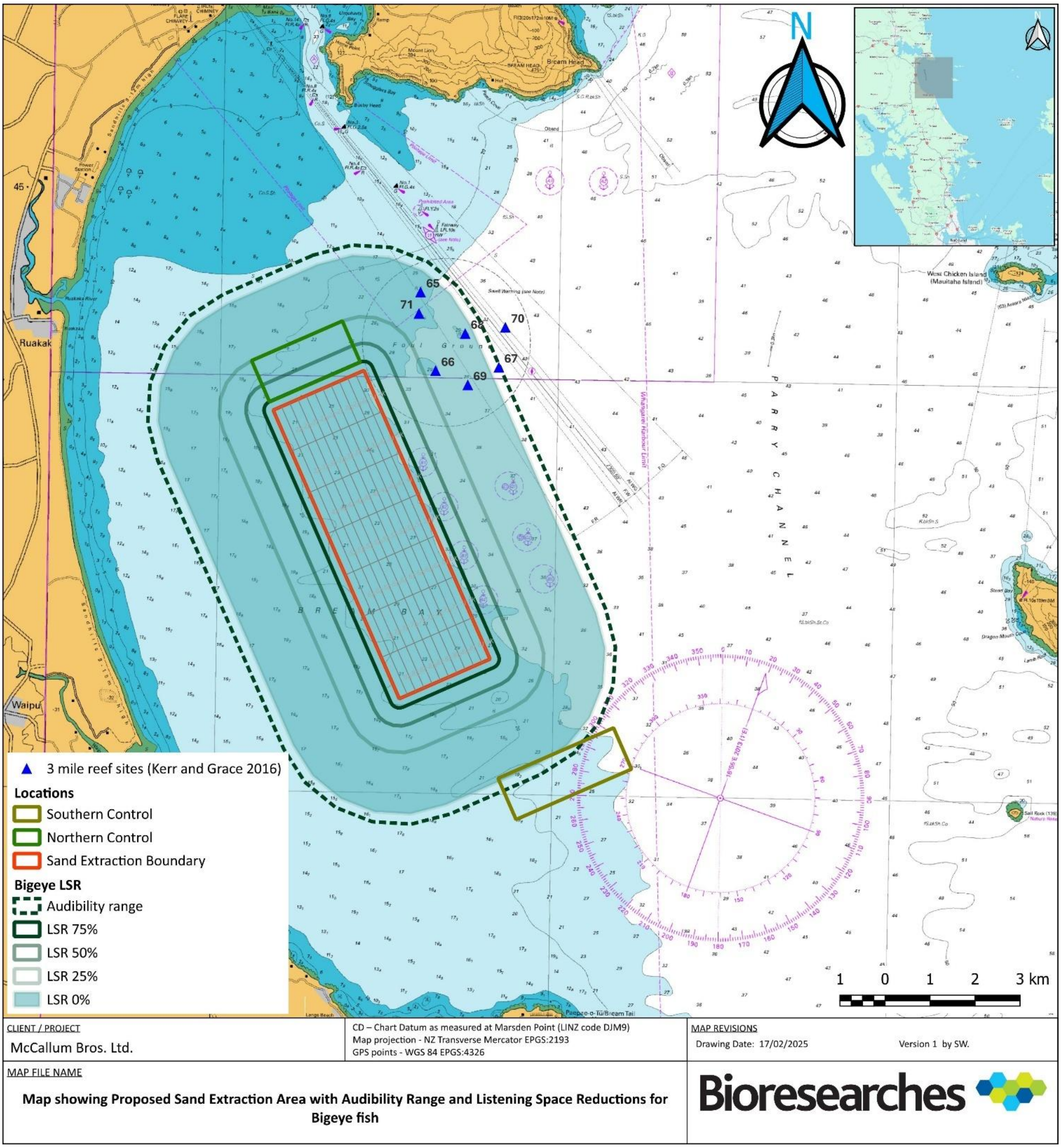


Figure 14 Map showing audibility range and LSR from the sand extraction area for Bigeye fish

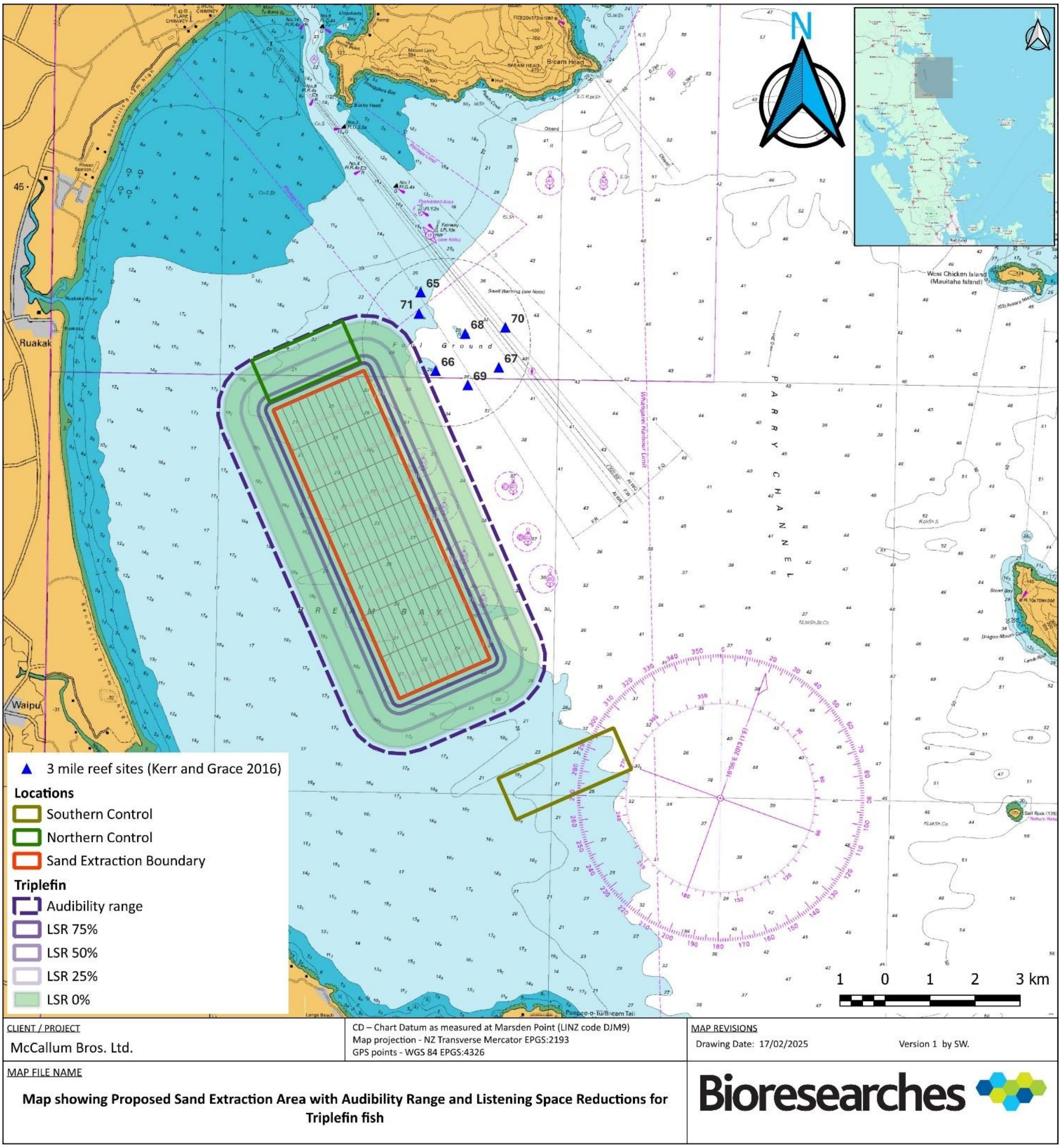


Figure 15 Map showing audibility range and LSR from the sand extraction area for Triplefin fish

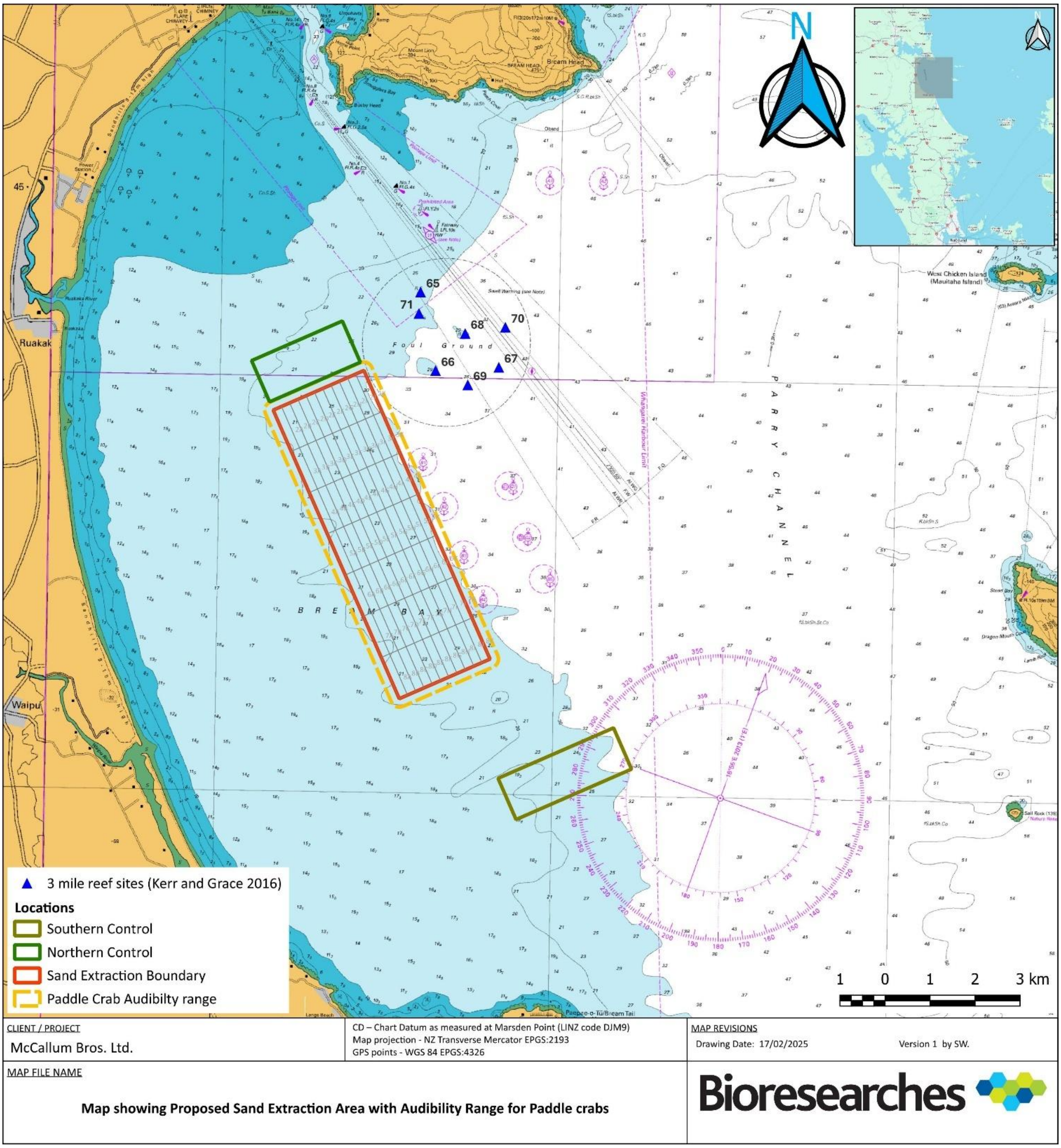


Figure 16 Map showing audibility range from the sand extraction area for paddle crabs

6.2.2 Effects of Entrainment

There is a very low probability that fish swimming in the water column will be entrained in the draghead as the water flow will be targeted at sucking sediment up from the seabed. Fish are highly mobile, and it is expected that the majority of fish species present will be able to avoid the draghead and avoid entrainment due to the slow speed (1.5 – 2.5 knots) of the vessel moving over the seabed. Fish species that are slow moving, have behaviours that limit escape or avoidance, or live within the sediment, may be entrained however this is unlikely. Several species of benthic fish, lizardfish, snake eel, sand divers and sole have been recorded as surviving passage through the draghead and screening deck and returned to sea via the moon pool discharge (Bioresearches, 2019, 2020). Similar fish species have been recorded in the proposed sand extraction area.

While it may be an adverse effect for individuals the magnitude of effects of entrainment on fish at a population level within the proposed sand extraction area are expected to be **Negligible**.

6.2.3 Effects of Suspended Sediment

Recent studies have identified that increased suspended solids in the water column are detrimental to juvenile snapper health in estuarine environments (Lowe, 2013). While the research was aimed at the effects of increased terrestrial sediment inputs, the discharge of fine marine sediments from the extraction vessel is unlikely to have similar effects. The peak suspended solids concentrations measured in the sand extraction plume (<10 mg/L) in 2019 (Jacobs, 2020) are less than the 35 mg/L reported to cause adverse effects for juvenile snapper.

The sediment particle sized data from the proposed sand extraction area (West, *et al*., 2025) shows that sediments in the area are relatively free of very fine silt and clay content that would contribute to high suspended sediment loads. The inclusion of a condition that excludes areas of seabed from extraction, where greater than 20 percent silt and clay sized particles by volume would prevent high concentrations of suspended solids from being discharged, thus avoiding adverse effects.

Improvements in the setup and operation of the screening deck on the *William Fraser* between when the sand extraction plume water quality data was collected, and current operations have resulted in 50% less sediment being discharged per extraction event. In the absence of site specific plume water quality data, empirically with 50% less sediment discharged the effects to water quality will be substantially lower.

The magnitude of effects of suspended sediment on fish is expected to be **Negligible**.

6.2.4 Effects of Food Source Reduction

Benthic biota forms the basis of many fish diets. A reduction in benthic biota abundance or a change in composition as a result of sand extraction could potentially impact bottom feeding fish species.

The production of phytoplankton, generally forms the base of the food chain, supporting zooplankton, benthic biota and thus fish. The changes in water quality are insufficient in concentration, geographic scale, duration, frequency, and timing to measurably affect the food chain.

Food-web scale implications of any temporary changes in benthic prey availability are synthesised in Section 6.3 and Appendix C.

161 trips per year are required to extract the proposed 150,000 m^3 in the first three years of the life of the proposed consent. MBL (2025) states approximately 13 km of 1.6 m wide extraction track is required to extract enough sand to fill the hopper on MBL's vessel the *William Fraser*. Therefore, if the full 150,000 m^3 was extracted in a year, then approximately 3.4 km^2 of seabed would have been the subject of extraction activity. As stated earlier, the extraction tracks are not aligned side-by-side creating a contiguous extraction area, but rather a patchwork of disturbed tracks will be created. Thus, extraction will likely have occurred across the entire extraction area, however less than 22% of the 15.4 km^2 will have been

extracted. This leaves over 78% of the proposed sand extraction area **not** disturbed or having had at least 1 year of benthic biota recovery. If the maximum volume per year is approved to increase to 250,000 m^3 per year, then the number of trips per year will need to increase to 271. Therefore, if the full 250,000 m^3 was extracted in a year, then approximately 5.6 km^2 of seabed would have been the subject of extraction activity. Thus, extraction will likely have occurred across the entire extraction area, just over a 36% of the 15.4 km^2 will have been extracted. This leaves over 64% of the proposed sand extraction area not disturbed or having had at least 1 year of benthic biota recovery. With the extraction of sand including sand sized biota the population of these sand sized biota as a whole of the proposed sand extraction area will be reduced. Similarly, a small percentage (estimated to be 4%) of the larger biota will be lost due to mortality while passing through the draghead (Bioresearches, 2020). The level of reduction is speculative and depends on how much extraction occurs, how well the biota survives, and how fast the populations recover, all of these are likely to vary year to year and be impacted by natural variations. However, there will be a good proportion (78%) of the proposed sand extraction area with a near normal benthic biota population to act as a food source for fish. It has also been noted that the discharge of oversized material from the TSHD, includes damaged and undamaged biota which could act as a food source for fish or scavenging mobile benthic fauna. In summary based on what is known and reasonably assumed **the proposed sand extraction is not expected to reduce the benthic biota population ecologically significantly.**

It is suggested that conditions be imposed to regularly monitor the benthic biota composition and abundance to ensure no ecologically significant unforeseen reduction in biota occurs. If something unforeseen does occur, then the conditions should proscribe trigger points for possible ecological parameters listed;

- Number of taxa present
- Diversity index
- Number of individuals present
- Benthic biota Assemblage composition
- Density of predatory/ scavenging species
- Density of hermit crabs
- Density of mobile epifauna
- Density of sedentary species

at which management actions

- Exclusion of an area prior to sand extraction, (Avoiding adverse effects)
- Monitoring sand extraction effects, further analysis and or collection of additional data,
- Reducing extraction volumes as a possible remedial step prior to exclusion of an area,
- Exclusion of an area, to ensure the biota population has chance to recover are imposed.

Based on the expected minor ecological shift away from existing baseline conditions in the benthic biota food resources within the sand extraction area. The magnitude of the effects of food reduction for fish within the sand extraction area is expected to be **Low**. No changes in benthic biota communities beyond the sand extraction area are expected, thus the magnitude of the effects of food reduction for fish for the wider Te Ākau Bream Bay area is expected to be **Negligible**.

6.3 Marine Food Web Processes and Trophic Pathways

Marine food-web processes describe the pathways by which energy and nutrients move from primary producers through successive trophic levels to higher predators, including fish, seabirds, and marine mammals. In Te Ākau Bream Bay, the marine food web is characteristic of open-coast neritic systems and is dominated by **pelagic primary production**, supported by phytoplankton in the water column, with secondary contributions from **benthic–pelagic coupling** processes operating over sandy seabed habitats.

Primary consumers in the bay comprise zooplankton and benthic infauna (e.g. polychaetes, bivalves, and small crustaceans), which in turn support small pelagic fish and other mid-trophic consumers. Higher trophic levels include predatory fish, seabirds (including tara iti), and marine mammals, many of which rely primarily on pelagic prey resources rather than benthic production within the proposed sand extraction area.

6.3.1 Potential food-web pathways of effect

In theory, sand extraction could interact with marine food-web processes through four potential pathways:

- **Short-term increases in turbidity and suspended sediments**, potentially influencing pelagic primary production or zooplankton availability;
- **Localised seabed disturbance**, resulting in temporary reductions in benthic infauna abundance;
- **Alteration of benthic–pelagic coupling**, through disturbance of sediment-water nutrient exchange processes; and
- **Behavioural disturbance from underwater noise**, potentially affecting prey distribution or availability.

These pathways were examined explicitly at a food-web scale in the Marine Food Web Dynamics technical assessment prepared in response to Department of Conservation pre-lodgement feedback (Appendix C).

6.3.2 Assessment of magnitude of food-web effects

Specialist assessments presented as part of this AEE and in other specialist reports, demonstrate that the above pathways operate at **spatial and temporal scales that are insufficient to result in measurable food-web effects**, for the following reasons:

- **Water quality effects** associated with sand extraction are highly localised and short-lived, with turbidity plumes dissipating within tens of minutes and remaining well below thresholds likely to affect phytoplankton productivity or zooplankton communities (Section 6.1.3).
- **Seabed disturbance** affects a very small proportion of the sandy seabed within the extraction area and occurs as a patchwork of narrow, shallow extraction tracks, with benthic communities expected to recolonise and recover within 2–3 years (Section 6.1.1).
- **Benthic–pelagic coupling** processes in Te Ākau Bream Bay operate at bay-wide spatial scales and are not dependent on the integrity of the small proportion of seabed affected at any one time by sand extraction.
- **Small pelagic fish**, which form the primary prey base for seabirds and marine mammals, are mobile, regionally distributed, and not reliant on benthic prey resources or sandy-bottom habitats within the proposed extraction area (Section 6.2).

- **Underwater noise effects** on fish and invertebrates are limited to short-term behavioural responses and do not result in injury, displacement at ecologically meaningful scales, or disruption of trophic interactions (Section 6.2.1).

6.3.3 Conclusion on food-web effects

On the basis of the above, sand extraction is **not expected to result in any measurable changes to marine food-web structure, energy flow, or prey availability** within Te Ākau Bream Bay. Any temporary and highly localised reductions in benthic infauna abundance within extraction tracks do not propagate through the food web at scales relevant to fish, seabirds (including tara iti), or marine mammals.

Accordingly, the **magnitude of effects on marine food-web processes is assessed as Negligible**, both within the sand extraction area and in the wider Te Ākau Bream Bay receiving environment.

6.4 Sharks and Rays

The assessment of effects on sharks and rays considered the status of each species under the New Zealand Threat Classification System (NZTCS), IUCN Red List listing[9], and New Zealand Coastal Policy Statement 2010 (NZCPS 2010), with ecological values and effects assigned according to the Ecological Impact Assessment Guidelines for New Zealand 2nd Edition ('EIANZ guidelines', Roper-Lindsay *et al*. 2018).

6.4.1 Magnitude of effect

Considering the paucity of information available on the potential effects of sand extraction on sharks and rays, the assessments of environmental effects on fishes (Section 5.2 of this report) and marine mammals (McConnell, 2025) are considered relevant and have been partially relied on for the purpose of assessing potential effects on sharks and rays.

Sharks and Rays are generally thought not use and interpret sound for communication unlike marine mammals. Therefore, there may be marked differences in the perceived sensitivity of sharks and rays to noise compared to that of marine mammals. Sharks and rays are expected to have LSR similar or less than the most sensitive fish, NZ bigeye fish, LSR are presented in Styles Group (2025).

Due the paucity of information available, a conservative approach has been taken when determining the magnitude of effect.

To determine the magnitude of effects of the proposed sand extraction on sharks and rays the following potential effects have been considered.

- Underwater noise;
- Habitat modification;
- Ship strike;
- Exposure to contaminants;
- Marine debris;
- Artificial lighting; and
- Cumulative effects.

[9] The IUCN listing has been considered for all data deficient and migrant sharks and rays referred to in this report. This is because the EIANZ guidelines do not provide suggested ecological value categories for 'data deficient' and 'migrant' NZTCS listed species. Although, it is recommended that the NZTCS be used in preference to other systems such as the IUCN system, in the current instance, use of the IUCN listing is considered appropriate.

6.4.1.1 Underwater noise

Sharks possess well-developed cognitive abilities comparable to other vertebrates, and sound plays a crucial role in their perception of the environment, particularly in detecting prey. Unlike many bony fish, sharks do not have a swim bladder for sound pressure detection, relying primarily on other systems.

Sharks are highly sensitive to low-frequency sounds, typically between 20 Hz and 1000 Hz. Studies have shown their highest sensitivity to be in the range of 40 Hz to approximately 800 Hz (Francis and Lyon, 2013). Sharks, such as the school shark (*Galeorhinus galeus*) and rig (*Mustelus lenticulatus*), exhibit hearing primarily tuned to low-frequency sounds. Recent auditory evoked potential (AEP) studies show that these benthopelagic sharks detect frequencies up to 600–800 Hz, with best sensitivity around 100–150 Hz (Nieder *et al*., 2023). In contrast, bottom-dwelling species like the New Zealand carpet shark (*Cephaloscyllium isabellum*) have a narrower hearing range, up to about 300 Hz, with peak sensitivity near 100 Hz (Nieder *et al*., 2023). Sharks detect particle motion rather than sound pressure and rely on internal ears complemented by the lateral line system to sense vibrations and low-frequency sounds, which are often associated with prey or environmental cues (Popper and Fay, 1977). Their hearing sensitivity thresholds are comparable to 'hearing non-specialist' teleost fishes, indicating limited frequency bandwidth but ecological specialization in sound detection (Nieder *et al*., 2023).

Shipping and smaller vessels and dredging, produce predominantly low-frequency sounds (below 1000 Hz) within the audible range for sharks from machinery, hydrodynamic flow, and propeller cavitation. Source levels can range from less than 150 dB to over 190 dB (Popper *et al*., 2014).

Potential underwater noise effects have been considered based on the noise levels presented in Styles Group (2025). This report assessed the impacts of five effect categories relevant to marine fauna.

There are no reported thresholds or criteria to identify when sharks and rays may experience changes in their hearing sensitivity (i.e., TTS; PTS) and/or auditory injury, as there are for marine mammals (NMFS 2024; Styles Group, 2025). Overall, while sharks likely can experience TTS under intense or prolonged noise exposure, their ability to regenerate hair cells suggests PTS is uncommon. More species-specific research is needed to establish precise acoustic thresholds for auditory injury in sharks. It has been shown that noise can induce stress hormone level changes and increase susceptibility to disease (Poppelier, *et al*., 2022).

Studies have shown that loud sounds within the sharks' audible range may repel them, while lower-level sounds might attract them. The response can depend on the distance from the source and the volume (Francis and Lyon, 2013). However, increasing sound intensity, specifically a sudden increase of 20 dB (10 times or more) above a previous transmission, can result in immediate withdrawal by sharks from a source (Francis and Lyon, 2013).

With respect to masking, audibility, and anthrophony/ soundscape effects, sharks generally expected to have similar hearing ranges to many fish, particularly those that do not possess a swim bladder and rely primarily on particle motion for sound detection. Based on the measured ambient sound levels and published hearing thresholds there is a risk of auditory masking and behavioural effects in fish occurring out to 2573 m for the most sensitive fish like the NZ bigeye (Figure 14), but only out to 1,100 m for triplefin fish (Figure 15), from the *William Fraser* (Styles Group, 2025). NZ Bigeye present the larger effects ranges for most common species within Te Ākau Bream Bay, including demersal, pelagic species, and likely sharks.

The potential adverse effects of underwater noise on sharks and rays are unclear, but auditory disturbance risks to individuals could be expected where a shark or ray passes through or near to the sand extraction area during active extraction. The high mobility of sharks and rays does however, mean that these animals can respond to underwater noise disturbance by actively and rapidly moving away from the extraction area, and avoid areas subject to temporary increases in underwater noise.

Anthropogenic noise effects are expected to be greatest in areas where sharks and rays congregate during key life-stages (e.g., breeding areas, juvenile nurseries, important feeding areas) and where crucial habitats exist in very populous areas. Based on available knowledge, the Te Ākau Bream Bay area does not provide congregation or habitual foraging grounds, breeding/nesting areas, nor migratory corridors for any of the sharks and rays considered in this assessment.

Considering the above, likelihood of underwater noise impacts from sand extraction on highly mobile and infrequently present sharks and rays is **Negligible.**

6.4.1.2 Habitat modification

The generation of sediment plumes, and the corresponding increase in turbidity, behind the *William Fraser* during extraction, can potentially alter the marine environment effecting sharks and rays, either directly by reducing spatial use of the water column, or indirectly by affecting habitat for potential prey species. However, the sediment plumes and increased turbidity are temporary and confined to a relatively discrete area of a few hundred meters around the sand extraction site (West, *et al*., 2025; Wilson, 2025). The pelagic habitats of the sharks and rays are largely located beyond 7 km offshore from the sand extraction area, thus there is little likelihood of impacts on sharks and rays habitat from sand extraction.

Overall, the extraction activity is not expected to have ecological impacts on shark and ray habitats, and the magnitude of effect is assessed as **Negligible**.

6.4.1.3 Vessel strike

Vessel strike incidents such as propeller strike and blunt force trauma caused by vessel collision can represent a major cause of injury (physical trauma) or mortality (immediately or after the incident) to fauna. There are no specific documented vessel strike incidents involving sharks or rays reported in New Zealand waters based on the available recent information.

Research indicates that vessel strikes are an underestimated threat to Whale sharks globally (Womersley *et al*., 2024), potentially contributing to population declines. While no confirmed vessel strike cases have been reported for New Zealand's whale sharks, there is a risk due to their presence in shipping lanes off the North Island's east coast (Bay of Plenty to North Cape). Similarly, the Oceanic manta rays and Spinetail devil rays inhabit a similar space to whale sharks would be susceptible to vessel strike.

One of the key factors in vessel strikes is speed. Speed restrictions have been effective in reducing vessel strike in overseas locations. Extraction vessels typically operate at slow speeds and the *William Fraser* will travel at a speed of 1.5–2.5 knots during extraction activities and will travel at a maximum speed of 9.5 knots between the extraction site and the Port of Auckland (Styles Group, 2025) or other destination Port.

Therefore, in keeping with the requirements of the Hauraki Gulf Transit Protocol (POAL, 2015) which recommends a speed limit of 10 knots to reduce the probability of vessel strike. These speeds are lower than speeds of recreational vessels and other shipping vessels (>10 knots), which will greatly reduce the probability of a serious vessel strike during the proposed sand extraction activities.

Accordingly, the magnitude of effect relating to vessel strike on sharks and rays is assessed as **Negligible**.

6.4.1.4 Exposure to contaminants

Extraction operations resuspend sediments both on the seabed at the draghead and in the upper water column during overflow, potentially exposing fauna to contaminants (e.g., like PCBs, PAHs, and heavy metals) through direct contact, ingestion of contaminated prey, or maternal transfer.

While there is potential for sharks and rays to be exposed to contaminated sediment as a result of the proposed sand extraction activities, the proposed sand extraction site has low contaminant levels (all contaminants assessed were well below the Australia and New Zealand Guidelines for Fresh and Marine Water Quality, West, *et al*., 2025). Sediments at the proposed extraction site are also described as 'sandy', with generally low mud content, and low organic content (West, *et al*., 2025). Furthermore, the exposure potential will be temporarily and spatially restricted. Each extraction event will have a maximum plume time of 4 hours duration. The visual plume will potentially cover a maximum area of approximately 0.1 km^2 which is 0.6% of the proposed sand extraction area. The plume area would expand for approximately the first 30 minutes after extraction starts, stabilise at the estimated maximum area and then decrease in size and disappear by approximately 30 minutes after extraction stops. All of this occurring in or near the sand extraction area some 7 km west of the areas typically inhabited by sharks and rays of concern.

Thus, the likelihood of contaminant impact from extraction is **Negligible**.

6.4.1.5 Marine debris

Marine vessels are potential sources of marine debris (solid material discarded, disposed of, or abandoned in the ocean), either intentionally or inadvertently. Plastics and other materials (especially those that drift in the water column) can have severe (lethal and sublethal) effects on marine fauna primarily due to ingestion and entanglement. Ingestion of plastics is a major concern, especially for large filter-feeding species like oceanic manta rays (*Mobula birostris*), Spinetail devil ray (*Mobula mobular*), whale sharks (*Rhincodon typus*), and basking sharks (*Cetorhinus maximus*) (Germanov *et al*., 2019). These animals filter vast amounts of water containing plankton but also microplastics and plastic fragments, which they inadvertently ingest.

With responsible waste management practices and a garbage disposal management plan recommended aboard the vessel and during all extraction operations, and compliance with New Zealand legislation (Resource Management [Marine Pollution] Regulations 1998), the impact from the sand extraction activity on the filter feeding sharks and rays is considered to be **Negligible**.

6.4.1.6 Artificial lighting

There is little evidence that artificial lighting has any effects on sharks and rays other than by the attraction of prey species.

The effects of artificial lighting on the dredge vessel during the limited times it would be required are considered to be **Negligible**.

6.4.1.7 Cumulative effects.

Cumulative effects are a result of combined impacts of past, present, and future human activities and natural processes over time. While the impacts of single activities (e.g., sand extraction) may be relatively minor, in combination with other human activities (e.g., recreational boating) effects may be additive and result in more significant environmental effects. Cumulative effects extend beyond local impacts, particularly in the marine environment where the spatial connectivity of aquatic species and ecosystems is great.

The Te Ākau Bream Bay area and wider northeastern coastline of New Zealand are subject to a variety of past and existing anthropogenic disturbances, including but not limited to high levels of marine traffic (e.g., recreational boating activities, commercial shipping), fisheries, extracting in ports and harbours, and a nearby existing sand extraction operation between Mangawhai and Pākiri. Pollution, including contaminant inputs, waste disposal, and terrestrial sediment run-off, as well as climate change, are other factors likely contributing to coastal environmental impacts, including on marine species, at Te Ākau Bream Bay.

Cumulative effects are challenging to predict, quantify, and manage due to insufficient environmental baseline data, complex ecological processes, and the extensive geographical scales at which these effects may occur (Clark 1994). The proposed sand extraction operation is expected to contribute to broader cumulative effects on sharks and rays, but at a minor level. Notably, increased but intermittent exposure to underwater noise from extraction (see "Underwater noise" section above), within a soundscape already influenced by anthropogenic noise, is considered to have the greatest effect, but the effects are considered **Negligible**.

The magnitude of cumulative effects on sharks and rays typically present at distance from the sand extraction area is conservatively assigned as **Negligible**.

6.4.2 Summary

The effects assessment indicates that the proposed sand extraction activities will potentially exposure sharks and rays to variety of disturbances such as noise, habitat modification, risk of vessel strike, contaminants, marine debris, artificial lighting, and cumulative effects. However, the magnitude of these potential effects is typically considered to be **Negligible** (having a Negligible effect on the known population or range of a species) (Table 11).

Any potential effects will be restricted within a limited range from the *William Fraser* while actively extracting and effects will be temporary (during the period of active extraction) in nature. That is, potential impacts are not considered to have significant impacts on the life cycle or habitats that are important during vulnerable life stages of sharks and rays that occasionally enter Te Ākau Bream Bay (NZCPS policy 11(b)(ii)), nor on habitats where sharks and rays are at the limit of their natural range (NZCPS policy 11(a)(iv)), nor ecological corridors and habitats important to migratory species (NZCPS policies 11(b)(vi) and 11(b)(vi)).

Table 10 Assessment of effects on shark and ray species reported within a 50 km radius of the proposed sand extraction area.

Common name *Scientific name*	Magnitude of effect	Duration of effect
White pointer shark *Carcharodon carcharias*	**Negligible** - Very slight change from existing baseline condition. Change barely distinguishable, approximating to the "no change" situation; and having a negligible effect on the known population or range of the element / feature. If, by chance, this species is present during the sand extraction operation, disturbance effects that may lead to avoidance behaviours and possibly disruption to feeding individual(s). Any changes to habitat would be negligible, affecting <1% of area of original New Zealand habitat (following MacDiarmid *et al.* 2014). Disturbance effects that may lead to avoidance behaviours and possibly disruption to feeding in coastal waters.	Temporary – intermittent disturbance over the duration of the sand extraction operation.
Whale Shark *Rhincodon typus*	**Negligible** - Very slight change from existing baseline condition. Change barely distinguishable, approximating to the "no change" situation; and having a negligible effect on the known population or range of the element/ feature. Any changes to habitat would be negligible, affecting <1% of area of original New Zealand habitat (following MacDiarmid *et al.* 2014). If, by chance, this species is present during the sand extraction operation, very minor disturbance effects (avoidance behaviour) could occur. Disruption to feeding (primarily feed on planktonic species) could occur but is considered unlikely.	Temporary – potential intermittent disturbance over the duration of the sand extraction operation.
Oceanic Manta ray *Mobula birostris*	**Negligible** - Very slight change from existing baseline condition. Change barely distinguishable, approximating to the "no change" situation; and having a negligible effect on the known population or range of the element/ feature. Any changes to habitat would be negligible, affecting <1% of area of original New Zealand habitat (following MacDiarmid *et al.* 2014). If, by chance, this species is present during the sand extraction operation, very minor disturbance effects (avoidance behaviour by the individual(s)) could occur. Disruption to feeding (primarily feed on planktonic species) could occur but is considered unlikely.	Temporary – potential intermittent disturbance over the duration of the sand extraction operation.
Spinetail devil ray *Mobula mobular*	**Negligible** - Very slight change from existing baseline condition. Change barely distinguishable, approximating to the "no change" situation; and having a negligible effect on the known population or range of the element/ feature. Any changes to habitat would be negligible, affecting <1% of area of original New Zealand habitat (following MacDiarmid *et al.* 2014). If, by chance, this species is present during the sand extraction operation, very minor disturbance effects (avoidance behaviour by the individual(s)) could occur. Disruption to feeding (primarily feed on planktonic species) could occur but is considered unlikely.	Temporary – potential intermittent disturbance over the duration of the sand extraction operation.

6.5 Marine Reptiles

The assessment of effects on marine reptiles considered the status of each species under the New Zealand Threat Classification System (NZTCS), IUCN Red List listing[10], and New Zealand Coastal Policy Statement 2010 (NZCPS 2010), with ecological values and effects assigned according to the Ecological Impact Assessment Guidelines for New Zealand 2nd Edition ('EIANZ guidelines', Roper-Lindsay *et al.* 2018).

6.5.1 Magnitude of effect

Considering the paucity of information available on the potential effects of sand extraction on marine reptiles, the assessments of environmental effects on fishes (Section 5.2 of this report) and marine

[10] The IUCN listing has been considered for all migrant and vagrant marine reptiles referred to in this report. This is because the EIANZ guidelines do not provide suggested ecological value categories for 'migrant' and 'vagrant' NZTCS listed species. Although, it is recommended that the NZTCS be used in preference to other systems such as the IUCN system, in the current instance, use of the IUCN listing is considered appropriate.

mammals (McConnell, 2025) are considered relevant and have been partially relied on for the purpose of assessing potential effects on marine reptiles.

Marine reptiles do not use and interpret sound for communication to the same extent as marine mammals. Therefore, there may be marked differences in the perceived sensitivity of marine turtles and snakes to noise compared to that of marine mammals. LSR presented in Styles Group (2025) show those for turtles are lower than for dolphins, but are comparable with those of little penguins and NZ bigeye fish.

Due the paucity of information available, a conservative approach has been taken when determining the magnitude of effect.

To determine the magnitude of effects of the proposed sand extraction on marine reptiles the following potential effects have been considered.

- Underwater noise;
- Habitat modification;
- Ship strike;
- Exposure to contaminants;
- Marine debris;
- Artificial lighting; and
- Cumulative effects.

6.5.1.1 Underwater noise

Research on the hearing abilities, use of sound, and vulnerability to sound exposure of marine turtles and snakes is limited (Popper *et al.* 2014). Electrophysiological studies indicate that certain reptilian species (e.g., American alligator, Stokes's sea snake, loggerhead turtle, and Green turtle) have greatest underwater auditory sensitivity to low-frequency sounds (< 1000 Hz) (Ridgway *et al*. 1969; Higgs *et al*. 2002; Lavender *et al*. 2014; Piniak *et al*. 2016; Chapuis *et al*. 2019), but there are limited data addressing whether high intensity underwater sound affects reptile hearing (Salas *et al*. 2023; Salas *et al*. 2024). As a result, surrogates (i.e., data from other taxonomic groups such as marine fishes) are often used to predict hearing loss and response in marine reptiles because they share similar hearing frequency ranges. However, this approach does not account for vast differences like ear morphology, sound conduction, and potentially higher-order processing (Webster *et al*. 1992). Recent research on underwater auditory sensitivity in freshwater turtles (Emydidae species) has yielded TTS values that may serve as more appropriate surrogates for assessing hearing loss in marine turtles, compared to marine fishes.

In marine turtles, the auditory sense organ within the inner ear is the basilar papilla (Wever & Vernon 1956), which is adapted to detect sound in water and potentially able to detect sound pressure (Ridgway *et al*. 1969; Bartol and Ketten 2006; Piniak *et al*. 2012; Bartol *et al*. 1999; Lavender *et al*. 2012). The auditory mechanism is dissimilar to the functioning of the cochlea in marine mammals but approximates that of fishes (Popper *et al*. 1999) and thus, auditory data from fishes provides a better analogy.

Marine turtles are known to sense low frequency sound and indeed, their hearing range of highest sensitivity is confined to low frequencies (range of highest sensitivity between 200 and 700 Hz, with a peak near 400 Hz) (Ridgway *et al*. 1969; Bartol *et al*. 1999; Dow Piniak *et al*. 2012). Juvenile green turtles are sensitive to a broader and higher frequency range of 50 Hz to 1600 Hz (Harding & Cousins, 2022). Few experimental studies have demonstrated deliberate responses such as abrupt body movements, changes in swimming patterns and orientation to acoustic stimuli at 430 Hz and 1.5 dB re 1 µPa (Lenhardt *et al*. 1996), sinusoidal stimuli at 250 and 500 Hz within the range of 55–59 dB (acceleration *re* 10^{-3} m/s^2) (Lenhardt *et al*. 1983), and high-pressure air gun pulses ~120 dB re 1 µbar at 1 m (loggerhead turtles; O'Hara 1990).

In sea snakes, both an external ear and a tympanic middle ear are absent, which reduces sensitivity to airborne sound. However, it has been demonstrated that Hydrophid sea snakes can detect underwater sounds of low frequency with a relatively low sensitivity compared with other aquatic vertebrates (e.g., fishes and marine turtles) (Chapuis *et al*. 2019). Auditory evoked potential (AEP) audiograms were recorded from 400 Hz (the lowest frequency tested) up to 600 Hz, with a peak in sensitivity identified at 600 Hz (163.5 dB re 1 µPa or 123 dB re 1 µm s) (Chapuis *et al*. 2019). There is also the possibility that other sensory systems (in addition to their inner ear) contribute to the detection of waterborne vibrations (sound pressure or particle motion) in sea snakes, though more research into this field is needed (Chapuis *et al*. 2019).

For marine turtles and sea snakes, little is known about the extent of noise exposure from anthropogenic sources in their natural habitats, or the potential impacts of increased anthropogenic noise exposure on the short- or longer-term behaviour, health, and life history of these aquatic reptiles (Samuel *et al*. 2005; Chapuis *et al*. 2019). There are no reported thresholds or criteria to identify when marine reptiles may experience changes in their hearing sensitivity (i.e., TTS; PTS) and/or auditory injury, as there are for marine mammals (NMFS 2024; Styles Group, 2025). However, inferences could be made based on the low frequency hearing ranges of marine turtles (200 –700 Hz, and with a peak near 400 Hz; Ridgway *et al*. 1969; Bartol *et al*. 1999; Dow Piniak *et al*. 2012) and Hydrophid snakes (< 600 Hz, Chapuis *et al*. 2019).

There is experimental evidence to show that freshwater turtles (Emydidae species) experience temporary reduction in underwater auditory sensitivity (i.e., noise-induced hearing loss) after exposure to broadband noise, suggesting decreased environmental awareness because of the impacts of anthropogenic noise (Salas *et al*. 2023; Salas *et al*. 2024). These studies reported TTS occurring after sound exposure levels (SELs) ranging from 151 to 171 dB re 1 lPa^2 s, leading to observed hearing loss greater than 40 dB at the highest (SEL). While the turtles' auditory thresholds always returned to their baseline sensitivity, this recovery process in some cases required >1 h and potentially up to 2 days (Salas *et al*. 2023; Salas *et al*. 2024).

Potential underwater noise effects have been considered based on the noise levels presented in Styles Group (2025). This report assessed the impacts of five effect categories relevant to marine fauna, including marine turtles (but excluded sea snakes due to lack of data). For two of the effect categories (physiological and behavioural effects), thresholds/ guidance for quantifying risks on marine turtles were not available and thus, not assessed.

With respect to masking, audibility, and anthrophony/ soundscape effects, these were assessed using a loggerhead turtle behavioural audiogram (Martin *et al*. 2012; Lavender *et al*. 2014; Styles Group 2025). The assessment showed that the auditability range of marine turtles within Te Ākau Bream Bay, during median daytime noise conditions, could be up to 4.8 km and there is a risk of auditory masking within 1.16 km of the extraction area, with up to 75% of a turtle active listening space reduced with 186 m of the extraction area. Furthermore, marine reptiles could be subject to predicted increases in ambient sound levels (soundscape change) of 3–37 dB re mPa within the extraction area and 0–2 dB re mPa outside the extraction area (within Te Ākau Bream Bay), respectively (Styles Group 2025).

The potential adverse effects of underwater noise on marine reptiles are unclear, but auditory disturbance risks to individuals could be expected where a marine turtle and/ or snake passes through or near to the sand extraction area during active extraction. Marine turtles are known to deliberately respond to low frequency, low intensity sounds (430 Hz and 1.5 dB re 1 µPa; Lenhardt *et al*. 1996), much lower than the predicated soundscape changes in the extraction area (Styles Group 2025). The high mobility of marine turtles and yellow-bellied sea snakes does however, mean that these animals can respond to underwater noise disturbance by actively and rapidly moving away from the extraction area, and avoid areas subject to temporary increases in underwater noise.

Anthropogenic noise effects are expected to be greatest in areas where marine reptiles congregate during key life-stages (e.g., breeding areas, juvenile nurseries, important feeding areas) and where crucial habitats exist in very populous areas (e.g., where marine reptile activity coincides with exposure to high human activity and underwater noise). Based on available knowledge, the Te Ākau Bream Bay area does not provide congregation or habitual foraging grounds, breeding/nesting areas, nor migratory corridors for any of the marine reptiles considered in this assessment. One exception might be migrant green turtles, given the records of this species in the Whangārei Harbour, which may suggest some importance of this harbour for this species. Yet the sound modelling indicates that sound produced during extraction in the sand extraction area that is audible to marine turtles would not travel beyond 4.8 km and would not adversely affect the movement of turtles in and out of the harbour (harbour entrance is approximately 17 km from the sand extraction area).

Considering the above, likelihood of underwater noise impacts from sand extraction on highly mobile, 'vagrant' and 'migrant' marine turtles and highly mobile and infrequently present 'Not threatened' yellow-bellied sea snakes is **Negligible.**

6.5.1.2 Habitat modification

Determining the potential effects of sand extraction on marine reptile habitat modification is problematic given the paucity of information on habitat use by turtles and snakes in New Zealand.

Other than for green turtles, which are known to be resident and forage in neritic[11] habitats of northern New Zealand, no data is available on local marine turtle or snake habitat use. Godoy (2016) reported that algal-dominated reef habitats and seagrass meadows (in sheltered harbours and estuaries) are important habitats for green turtles in New Zealand. These habitat types are not present in the sand extraction area, with the closest areas likely occurring in the Whangārei Harbour or outlying islands (e.g., Hen and Chickens, Poor Knights). Considering general information on turtle diets, the species that could potentially occur in and around sand extraction area feed primarily on soft-bodied prey (jellyfish, tunicates and salps) in the case of leatherback turtles or reef sponges in the case of hawksbill turtles (they will also consume anemones, squids, shrimp, crustaceans, and shellfish). Loggerhead turtles, however, are specialised to feed on shellfish and other invertebrates (sponges) and algae that occupy the sea floor (additionally, they also feed on fish and jellyfish). Thus, disturbance or loss of foraging habitat from removal of sand and biota from sandy substrates may have some implications for loggerheads. But

[11] shallow part of the sea near a coast and overlying the continental shelf.

considering the scarcity of records of this species in Te Ākau Bream Bay, it is highly unlikely that the area provides an important foraging site for this species.

Additionally, sand extraction will affect a relatively small area within Te Ākau Bream Bay, and West, *et al*., 2025 indicates that potential food resources for benthic feeding turtles are limited (i.e., very little macroalgae present and shellfish diversity and their abundance is low within the proposed sand extraction area). Thus, the proposed extraction will not significantly disrupt feeding behaviours nor permanently remove foraging habitat for turtles.

Yellow-bellied sea snakes will be unaffected because they are primarily piscivorous (feeding on fish, and occasionally cephalopods) and forage in the water column (rather than on the sea floor).

The generation of sediment plumes, and the corresponding increase in turbidity, behind the *William Fraser* during extraction, can potentially alter the marine environment effecting marine reptiles, either directly by reducing spatial use of the water column (i.e., marine reptiles avoiding turbid water), or indirectly by affecting habitat for potential prey species (Todd *et al*. 2015). However, work by Bioresearches (2019; 2020) at the Mangawhai and Pākiri sand extraction site south of Te Ākau Bream Bay found there to be no statistically significant differences in benthic fauna between sand extraction and control stations, suggesting no significant long-term effects on benthic fauna and fish (prey species for some marine reptiles). Furthermore, sediment plumes and increased turbidity are temporary and confined to a relatively discrete area of a few hundred meters around the sand extraction site (West, *et al*., 2025; Wilson, 2025). Any potential or unanticipated impacts on marine reptile habitat would not be significant considering the large areas inhabited by marine turtles and snakes.

Overall, the extraction activity is not expected to have tangible ecological impacts on marine reptile habitats, and the magnitude of effect is assessed as **Negligible**.

6.5.1.3 Vessel strike

Vessel strike incidents such as propeller strike and blunt force trauma caused by vessel collision can represent a major cause of injury (physical trauma) or mortality (immediately or after the incident) to marine reptiles (primarily turtles) (Work *et al*. 2010; Godoy 2016). However, monitoring such impacts in free-ranging marine reptiles is logistically challenging and therefore often overlooked (Chaloupka *et al*. 2008, Godoy 20216).

Accordingly, there is limited data on vessel strike occurrences for marine reptiles in New Zealand, though Godoy (2016) reports propeller strike injuries were identified in 14% (five of 35) of necropsied turtles exhibiting human related effects. Then Godoy went on to state that this figure should be treated as a minimum estimate when evaluating population wide impacts due to challenges in monitoring free-ranging turtles and accurately determining vessel strike rates. No data is available for vessel strike in marine snakes in New Zealand.

Given that marine reptiles are air-breathers and need to surface regularly to breathe, they spend considerable time at or near the water's surface. Consequently, all species potentially present in Te Ākau Bream Bay are potentially at risk of vessel strikes. Sea turtles are generally excellent swimmers and can reach speeds of about 13-19 knots when escaping predators or during short bursts of activity.

Extraction vessels typically operate at slow speeds and the *William Fraser* will travel at a speed of 1.5–2.5 knots during extraction activities and will travel at a maximum speed of 9.5 knots between the extraction site and the Port of Auckland (Styles Group, 2025) or other destination Port. Therefore, in keeping with the requirements of the Hauraki Gulf Transit Protocol (POAL, 2015) which recommends a speed limit of 10 knots to reduce the probability of vessel strike. These speeds are lower than speeds of recreational vessels and other shipping vessels (>10 knots), which will greatly reduce the probability of a serious vessel strike during the proposed sand extraction activities.

Accordingly, the magnitude of effect relating to vessel strike on marine reptiles is assessed as **Negligible**.

6.5.1.4 Exposure to contaminants

Extraction operations resuspend sediments both on the seabed at the draghead and in the upper water column during overflow, potentially exposing marine mammals to contaminants (e.g., like PCBs, PAHs, and heavy metals) through direct contact, ingestion of contaminated prey, or maternal transfer. While there is potential for marine reptiles to be exposed to contaminated sediment as a result of the proposed sand extraction activities, the proposed sand extraction site has low contaminant levels (all contaminants assessed were well below the Australia and New Zealand Guidelines for Fresh and Marine Water Quality, West, *et al*., 2025). Sediments at the proposed extraction site are also described as 'sandy', with generally low mud content, and low organic content (West, *et al*., 2025). Furthermore, the exposure potential will be spatially restricted (Todd *et al*. 2015; Styles Group, 2025). Each extraction event will have a maximum plume time of 4 hours duration. The visual plume will potentially cover a maximum area of approximately 0.1 km^2 which is 0.6% of the proposed sand extraction area. The plume area would expand for approximately the first 30 minutes after extraction starts, stabilise at the estimated maximum area and then decrease in size and disappear by approximately 30 minutes after extraction stops.

Marine reptiles considered in this assessment have large home ranges, and the plume would only represent a very small part of their habitat, which reduces prolonged exposure risk. Furthermore, the impact of exposure is expected to be greatest in areas where high contaminant burdens overlap with areas defined as important habitat or resources for marine reptiles. The marine reptiles considered in this assessment are either migrant, vagrant, or in the case of yellow-bellied sea snake, infrequent 'Not Threatened' visitors. Thus, no marine reptiles are confined to Te Ākau Bream Bay, and the area constitutes a very small part of large overall home ranges. Thus, the likelihood of contaminant impact from extraction is **Negligible**.

6.5.1.5 Marine debris

Marine vessels are potential sources of marine debris (solid material discarded, disposed of, or abandoned in the ocean), either intentionally or inadvertently. Plastics and other materials (especially those that drift in the water column) can have severe (lethal and sublethal) effects on marine reptiles primarily due to ingestion and entanglement (Schuyler *et al*. 2014; Wilcox *et al*. 2018). Indeed, a global review found that approximately 54% of examined marine turtles had ingested plastic debris (Moon *et al*. 2023). Ingestion can be direct (primary ingestion) or indirect (secondary ingestion via contaminated prey), with direct ingestion being either deliberate (items mistaken for prey items) or accidental (Ryan 2019). New Zealand data indicates that 34% (12 of 35) of green turtles examined had ingested synthetic marine debris such as soft plastics (e.g., single-use food packaging, plastic bags), and white and clear/translucent items (Godoy 2016; Godoy *et al*. 2018). These figures are likely to be highly conservative given the low sampling effort.

While there are no records of marine snakes consuming marine debris (e.g., plastics), marine debris entrapment, leading to injury and mortality, can occur (Udyawer *et al*. 2013).

With responsible waste management practices and a garbage disposal management plan recommended aboard the vessel and during all extraction operations, and compliance with New Zealand legislation (Resource Management [Marine Pollution] Regulations 1998), the impact on migrant and vagrant marine turtles and marine snakes is considered to be **Negligible**.

6.5.1.6 Artificial lighting

Research into the effects of artificial lighting on marine reptiles is limited to marine turtles, particularly light pollution effects on nesting behaviours (e.g., lighting deters sea turtles from emerging from the sea to nest on otherwise preferred beaches) and on the near shore trajectories of turtle hatchlings dispersing from natal beaches (i.e., ‘disrupted orientation’) (Witherington 1992; Salmon & Witherington 1995; Witherington 1997; Kamrowski *et al*. 2012; Thums *et al*. 2016). One study investigated the effects of ‘lightsticks’, which are often placed on longlines to attract fish, as an attractant to turtles and found a clear orientation of juvenile loggerhead turtles towards the lightsticks in a laboratory setting (Wang *et al*. 2007).

While the proposed extraction is to occur during the daytime, in a situation where the vessel is operating in the hours of darkness and requires navigation or safety lighting, light spill from the vessel could enter the surrounding ocean and there is potential for disturbance to marine turtles. Disturbance may manifest as turtles becoming disorientated or deterred by the light, or alternatively attracted to the light, which heightens the risk of vessel strike. With respect to the proposed sand extraction project, the *William Fraser* will operate only in the afternoon between the hours of 12:00 pm – 6:00 pm NZST (April-September) and 12:00 pm – 8:00 pm NZST (October-March). Accordingly, vessel lights are unlikely to be required during the late-spring, summer, and early-Autumn months when sunset occurs later in the evenings. However, outside of these periods, some light spill into the ocean immediately surrounding the vessel is anticipated, with the potential to affect the behaviour of marine reptiles that may intermittently pass near to the operational vessel. Considering the relatively slow operational speed of the vessel, the elevated noise of the extraction, lighting requirements for only some months of the year, and the intermittent nature of marine reptile occurrence in Te Ākau Bream Bay, the effects are considered to be **Negligible**.

6.5.1.7 Cumulative effects.

Cumulative effects are a result of combined impacts of past, present, and future human activities and natural processes over time. While the impacts of single activities (e.g., sand extraction) may be relatively minor, in combination with other human activities (e.g., recreational boating) effects may be additive and result in more significant environmental effects.

Cumulative effects extend beyond local impacts, particularly in the marine environment where the spatial connectivity of aquatic species and ecosystems is great. For instance, anthropogenic disturbances experienced by wide-ranging marine reptiles throughout their distribution can accumulate over their lifespan, resulting in a broader cumulative effect.

The Te Ākau Bream Bay area and wider northeastern coastline of New Zealand are subject to a variety of past and existing anthropogenic disturbances, including but not limited to high levels of marine traffic (e.g., recreational boating activities, commercial shipping), fisheries, extracting in ports and harbours, and a nearby existing sand extraction operation between Mangawhai and Pākiri. Pollution, including contaminant inputs, waste disposal, and terrestrial sediment run-off, as well as climate change, are other factors likely contributing to coastal environmental impacts, including on marine species, at Te Ākau Bream Bay.

Cumulative effects are challenging to predict, quantify, and manage due to insufficient environmental baseline data, complex ecological processes, and the extensive geographical scales at which these effects may occur (Clark 1994). The proposed sand extraction operation is expected to contribute to broader cumulative effects on marine reptiles, but at a minor level. Notably, increased but intermittent exposure to underwater noise from extraction (see "Underwater noise" section above), within a soundscape already influenced by anthropogenic noise, is considered to have the greatest effect, but the effects are considered **Negligible**.

The magnitude of cumulative effects on vagrant, migrant turtles and resident marine snakes is conservatively assigned as **Negligible**.

6.5.2 Summary

The effects assessment indicates that the proposed sand extraction activities will potentially exposure marine reptiles to variety of disturbances such as noise, habitat modification, risk of vessel strike, contaminants, marine debris, artificial lighting, and cumulative effects. However, the magnitude of these potential effects is typically considered to be **Negligible** (having a Negligible effect on the known population or range of a species) (Table 11).

Any potential effects will be restricted within a limited range from the *William Fraser* while actively extracting and effects will be temporary (during the period of active extraction) in nature. That is, potential impacts are not considered to have significant impacts on the life cycle or habitats that are important during vulnerable life stages of marine turtles or snakes that occasionally enter Te Ākau Bream Bay (NZCPS policy 11(b)(ii)), nor on habitats where marine reptiles are at the limit of their natural range (NZCPS policy 11(a)(iv)), nor ecological corridors and habitats important to migratory species (NZCPS policies 11(b)(vi) and 11(b)(vi)).

Table 11 Assessment of effects on marine reptile (turtle and snake) species reported within a 50 km radius of the proposed sand extraction area.

Common name *Scientific name*	Magnitude of effect	Duration of effect
Loggerhead turtle ***Caretta caretta***	**Negligible** - Very slight change from existing baseline condition. Change barely distinguishable, approximating to the "no change" situation; and having a negligible effect on the known population or range of the element / feature. Any temporary changes to habitat would be negligible, affecting <1% of area of original New Zealand habitat (following MacDiarmid *et al.* 2014). If, by chance, this species is present during the sand extraction operation, disturbance effects that may lead to avoidance behaviours and possibly disruption to feeding of individual(s).	Temporary – potential intermittent disturbance over the duration of the sand extraction operation.

Common name *Scientific name*	Magnitude of effect	Duration of effect
Green turtle *Chelonia mydas*	**Negligible** - Very slight change from existing baseline condition. Change barely distinguishable, approximating to the "no change" situation; and having a negligible effect on the known population or range of the element / feature. If, by chance, this species is present during the sand extraction operation, disturbance effects that may lead to avoidance behaviours and possibly disruption to feeding individual(s). Any changes to habitat would be negligible, affecting <1% of area of original New Zealand habitat (following MacDiarmid *et al.* 2014). Disturbance effects that may lead to avoidance behaviours and possibly disruption to feeding in coastal waters.	Temporary – intermittent disturbance over the duration of the sand extraction operation.
Leatherback turtle *Dermochelys coriacea*	**Negligible** - Very slight change from existing baseline condition. Change barely distinguishable, approximating to the "no change" situation; and having a negligible effect on the known population or range of the element/ feature. Any changes to habitat would be negligible, affecting <1% of area of original New Zealand habitat (following MacDiarmid *et al.* 2014). If, by chance, this species is present during the sand extraction operation, very minor disturbance effects (avoidance behaviour) could occur. Disruption to feeding (primarily feed on gelatinous invertebrates, e.g., jellyfish and salps) could occur but is considered unlikely.	Temporary – potential intermittent disturbance over the duration of the sand extraction operation.
Hawksbill turtle *Eretmochelys imbricata*	**Negligible** - Very slight change from existing baseline condition. Change barely distinguishable, approximating to the "no change" situation; and having a negligible effect on the known population or range of the element/ feature. Any changes to habitat would be negligible, affecting <1% of area of original New Zealand habitat (following MacDiarmid *et al.* 2014). If, by chance, this species is present during the sand extraction operation, very minor disturbance effects (avoidance behaviour by the individual(s)) could occur. Disruption to feeding is unlikely since this species primarily feeds on sponges, which do not occur in the proposed sand extraction area.	Temporary – potential intermittent disturbance over the duration of the sand extraction operation.
Yellow-bellied sea snake *Hydrophis platurus*	**Negligible** - Very slight change from existing baseline condition. Change barely distinguishable, approximating to the "no change" situation; and having a negligible effect on the known population or range of the element/ feature. Any changes to habitat would be negligible, affecting <1% of area of original New Zealand habitat (following MacDiarmid *et al.* 2014). Disturbance effects that may lead to avoidance behaviours but no anticipated effects on feeding as the proposed extraction area does not support habitat specific for foraging.	Temporary – potential intermittent disturbance over the duration of the sand extraction operation.
Unidentified turtle sp.	**Negligible** - Very slight change from existing baseline condition. Change barely distinguishable, approximating to the "no change" situation; and having a negligible effect on the known population or range of the element/ feature. Any changes to habitat would be negligible, affecting <1% of area of original New Zealand habitat (following MacDiarmid *et al.* 2014). Disturbance effects that may lead to avoidance behaviours and possibly disruption to feeding.	Temporary – potential intermittent disturbance over the duration of the sand extraction operation.

6.6 Summary of the Magnitude of Effects

Table 12 summarises the magnitude of potential effects associated with sand extraction in the proposed sand extraction area.

The EIANZ guidelines (EIANZ, 2024) state assessing the magnitude of effect at the spatial scale of the effect is not recommended, as such, the magnitude of effects on those determined to be greater than negligible within the sand extraction area have also been assessed at the scale of the wider Te Ākau Bream Bay.

Table 12 Magnitude of potential ecological effects from sand extraction

Biota	Effect	Magnitude Of effect	Comments
BENTHIC FAUNA	Community Structure	Negligible	Within the sand extraction area there may be some temporary partial changes in composition but generally the underlying character of the sand extraction area will be similar to the pre-extraction area, thus the magnitude of effects is described as **Low** on the overall benthic community. The disturbance and biota loss will not occur beyond the sand extraction area, but there may be a very minor reduction in biota numbers as it potentially migrates into the edges of the sand extraction area. Thus, the magnitude of effects is described as **Negligible** on the overall benthic community beyond the sand extraction area within the wider Te Ākau Bream Bay.
	Survival	Negligible	Mortality of macrofauna due to passage through the TSHD is estimated to be low (7%). Predation of fauna after being discharged from the boat is expected but the amount unknown it is assumed in the order of 7%. With an overall estimated mortality of 14%, thus a **Negligible** magnitude of effect This effect is limited to the sand extraction area, with no effects beyond.
	Water quality	Negligible	No contaminants will be released or introduced. The increases in turbidity and suspended solids concentrations recorded immediately behind the *William Fraser*, are temporary, expected to be within the range of natural variation, and not spread beyond the sand extraction area. Biota in and on the seabed areas adjacent to the extraction track could suffer temporary minor partial smothering from the settlement of oversized material discharges.
BENTHIC FISH	Underwater Noise	Negligible	The underwater noise created will not cause injury but may cause short term temporary behavioural effects within the sand extraction area.
	Entrainment	Negligible	Only a few benthic fish species are likely to pass through the draghead, and have survived in the past.
	Suspended Sediment	Negligible	The water quality data suggests that the suspended solids and turbidity effects of discharges are within the natural variation ranges for the proposed consent area.
	Food Reduction	Negligible	Within the sand extraction area, a minor ecological shift away from existing baseline conditions in the benthic biota food resources is expected, leading to an assessment of **Low**. No changes in benthic biota communities beyond the sand extraction area are expected, thus the magnitude of the effects of food reduction for fish for the wider Te Ākau Bream Bay area is expected to be **Negligible**.
SHARKS AND RAYS	Underwater Noise	Negligible	The underwater noise created will not cause injury but may cause behavioural effects when very close proximity to the pump.
	Habitat modification	Negligible	Extraction is not expected to have tangible ecological impacts on the sharks and rays pelagic habitats.
	Vessel strike	Negligible	The slow speed of the vessel reduces the potential for vessel strike.
	Exposure	Negligible	The likelihood of contaminant release from extraction is minimal.
	Debris	Negligible	The likelihood of debris release from extraction is minimal.
	Artificial Lighting	Negligible	Light may only be required in the winter months for short periods of time.
	Cumulative	Negligible	The proposed sand extraction operation is expected to contribute to broader cumulative effects on sharks and rays but only to a small extent
MARINE REPTILES	Underwater Noise	Negligible	The underwater noise created will not cause injury but may cause behavioural effects when in very close proximity to the pump.
	Habitat modification	Negligible	Extraction is not expected to have tangible ecological impacts on marine reptile habitats.
	Vessel strike	Negligible	The slow speed of the vessel reduces the potential for vessel strike.
	Exposure	Negligible	The likelihood of contaminant release from extraction is minimal.
	Debris	Negligible	The likelihood of debris release from extraction is minimal.
	Artificial Lighting	Negligible	Light may only be required in the winter months for short periods of time.
	Cumulative	Negligible	The proposed sand extraction operation is expected to contribute to broader cumulative effects on marine reptiles

7 LEVEL OF ECOLOGICAL EFFECTS

Table 13 presents the overall assessment of the potential level of ecological effects, based on the matrix shown in Table 3. The level of ecological effects is determined by combining the ecological values presented in Table 8 and the magnitude of potential ecological effects presented in Table 12.

Table 13 Level of ecological effects incorporating the ecology values (in Table 8) and magnitude of effects (in Table 12) for the project.

Biota	Ecological Value	Effects	Magnitude Of Effects	Level Of Effects
Coastal Vegetation	None	**Turbidity**	Negligible	Negligible
Benthic Macroalgae	Negligible	**Turbidity**	Negligible	Negligible
Benthic Fauna	Moderate	**Community Structure**	Negligible	Negligible
		Survival	Negligible	Negligible
		Turbidity	Negligible	Negligible
Benthic Fish	Low	**Noise**	Negligible	Negligible
		Entrainment	Negligible	Negligible
		Suspended Sediment	Negligible	Negligible
		Food Reduction	Negligible	Negligible
Sharks and Rays	Very high	**Underwater noise**	Negligible	Minor
		Habitat modification	Negligible	Minor
		Vessel strike	Negligible	Minor
		Exposure	Negligible	Minor
		Debris	Negligible	Minor
		Cumulative	Negligible	Minor
Marine Reptiles	Very high	**Underwater noise**	Negligible	Minor
		Habitat modification	Negligible	Minor
		Vessel strike	Negligible	Minor
		Exposure	Negligible	Minor
		Debris	Negligible	Minor
		Cumulative	Negligible	Minor

Overall, we estimate that at the 150,000 m^3 extraction rate, at most the level of effects will be **Low** within the sand extraction area but **Negligible** in the wider Te Ākau Bream Bay.

The consent application is for the extraction of 150,000 m^3 per year for the first three years spread across the entire proposed sand extraction area. If no significant or unexpected adverse effects such as loss of important species, more than minor reduction in benthic biota population, ecologically significant changes in grain size composition, arising from the extraction are identified through a monitoring programme that cannot be avoided, remedied or mitigated, then the consent proposes to increase the extraction rate to a maximum of 250,000 m^3 per year over the same extraction area, for the remainder of the consent. MBL have stated they plan to distribute the extraction spatially evenly within the proposed sand extraction area and this will be mandated should consent be granted. Details of how the spatial distribution of extraction will be managed is defined in the Sand Extraction Management Plan.

We estimate that at the 250,000 m^3 extraction rate, the magnitudes of effects to coastal and benthic vegetation, benthic fish and marine reptiles will be similar to the magnitudes at 150,000 m^3. The magnitude of effects will vary depending on the level of disturbance of the seabed and the ability of the biota to tolerate and recover from the disturbance. Thus, the magnitude of effects to benthic fauna under the higher extraction rate is less clear, and could potentially be moderate if unmanaged. The three years of monitoring data under the 150,000 m^3 extraction rate will be used to provide greater clarity of the magnitude of effects at the higher rates of extraction, before a higher rate is approved.

It is suggested that consent conditions be included to manage the volume extracted and thus the percentage of the area impacted per year so that the potential impacts to biota, if detected, be limited to acceptable levels. This will require regular monitoring and the setting of trigger values and mitigation measures, where extraction will be proactively managed under Conditions of Consent in the event a decision deems the reasonable grounds for the proposed activity to occur.

8 RELEVANT STATUTORY PROVISIONS

Te Ākau Bream Bay is subject to the provisions of the Northland Regional Policy Statement (Operative), the Northland Regional Coastal Plan and the Whangārei District Plan (Proposed), although the latter primarily relates to those parts of the District outside the CMA, and the New Zealand Coastal Policy. The following is a summary of key provisions that are directly pertinent to MBL's proposal from an ecological perspective, excluding marine mammals and birds which are reported elsewhere.

8.1 New Zealand Threat Classification Systems

This report refers to 'Threatened' or 'At Risk' species when such classifications have been made. These classifications are derived from the New Zealand Threat Classification System (NZTCS: Townsend *et al*. 2008, Rolfe *et al*. 2021, Duffy *et al*. 2025, Funnell *et al*. 2023) or from the International Union for Conservation of Nature (IUCN) 'Red List' classification system[12]. Both systems aim to classify species on the basis of the likelihood of extinction, and the resulting classifications are often referred to as the 'conservation status' of a particular species.

The NZTCS has four 'Threatened' categories: 'Nationally Critical', 'Nationally Endangered', 'Nationally Vulnerable', and 'Nationally Increasing' with decreasing levels of risk of extinction. Additionally, and sitting below the 'Threatened' categories, the NZTCS has three 'At Risk' categories: 'Declining', 'Naturally Uncommon', and 'Recovering'. The NZTCS also has a 'Not Threatened' category. Many of the less abundant species fall into a 'Data deficient' category, and cannot be classified.

The NZTCS does not in itself provide legal protection for species but highlights and provides guidance for those species that are at the most risk.

No permanent resident threatened or at risk species of marine algae, benthic biota or fish are known or expected to be present in the sand extraction area.

8.2 Wildlife Act (1953)

While all nine species of marine reptiles and all indigenous (native) birds are fully protected under the Wildlife Act (1953), very few fish and even less benthic biota are protected. The Wildlife Act provides legal protection to species which are listed in schedules 2 and 7. Schedule 7A lists a number of corals and anemones specifically all stony corals and a number of oceanic sharks and rays plus two species of grouper.

None of the New Zealand marine reptiles are confirmed to breed in New Zealand. Therefore, all marine reptiles present in New Zealand have travelled to New Zealand waters from other regions. The accidental loss of any individual would not have population level or ecological effects.

Two species (*Kionotrochus sutrei*, *Sphenotrochus* sp.) of stony cup corals were recorded as present but at very low numbers with only 2 *Kionotrochus* and 7 *Sphenotrochus* recorded. The *Sphenotrochus* species is most likely *Sphenotrochus ralphae* not *Sphenotrochus squiresi* which is listed as "At risk - Naturally uncommon" in the NZTCS (Funnell *et al*. 2023). The implications of the presence of these stony corals in the sand extraction area is the subject of further specific studies in Beaumont, *et al*., 2025.

[12] https://www.iucnredlist.org/

8.3 New Zealand Coastal Policy

Objective 1 – safeguard and sustain the coastal environment

To safeguard the integrity, form, functioning and resilience of the coastal environment and sustain its ecosystems, including marine and intertidal areas, estuaries, dunes and land, by:

- *maintaining or enhancing natural biological and physical processes in the coastal environment and recognising their dynamic, complex and interdependent nature;*
- *protecting representative or significant natural ecosystems and sites of biological importance and maintaining the diversity of New Zealand's indigenous coastal flora and fauna; and*
- *maintaining coastal water quality, and enhancing it where it has deteriorated from what would otherwise be its natural condition, with significant adverse effects on ecology and habitat, because of discharges associated with human activity.*

The sand extraction will maintain the natural biological processes. No Significant natural ecosystems occur in the sand extraction area, and biodiversity is not expected to be lost. Discharges from the sand extraction vessel are not expected to have significant adverse effects.

Policy 11: Indigenous biological diversity (biodiversity)

To protect indigenous biological diversity in the coastal environment:

a. avoid adverse effects of activities on:
   i. indigenous taxa that are listed as threatened or at risk in the New Zealand Threat Classification System lists;
   ii. taxa that are listed by the International Union for Conservation of Nature and Natural Resources as threatened;
   iii. indigenous ecosystems and vegetation types that are threatened in the coastal environment, or are naturally rare;
   iv. habitats of indigenous species where the species are at the limit of their natural range, or are naturally rare;
   v. areas containing nationally significant examples of indigenous community types; and
   vi. areas set aside for full or partial protection of indigenous biological diversity under other legislation; and
b. avoid significant adverse effects and avoid, remedy or mitigate other adverse effects of activities on:
   i. areas of predominantly indigenous vegetation in the coastal environment;
   ii. habitats in the coastal environment that are important during the vulnerable life stages of indigenous species;
   iii. indigenous ecosystems and habitats that are only found in the coastal environment and are particularly vulnerable to modification, including estuaries, lagoons, coastal wetlands, dunelands, intertidal zones, rocky reef systems, eelgrass and saltmarsh;
   iv. habitats of indigenous species in the coastal environment that are important for recreational, commercial, traditional or cultural purposes;
   v. habitats, including areas and routes, important to migratory species; and
   vi. ecological corridors, and areas important for linking or maintaining biological values identified under this policy.

As part of the pre-sand extraction monitoring, a baseline assessment utilising sampling has been undertaken prior to sand extraction occurring. No sensitive habitats were identified, that suggested a specific area should be excluded from sand extraction. Two species of stony coral protected under the Wildlife Act (1953) were detected in the proposed sand extraction area in low numbers and are the subject of further investigation in Beaumont, *et al*., 2025.

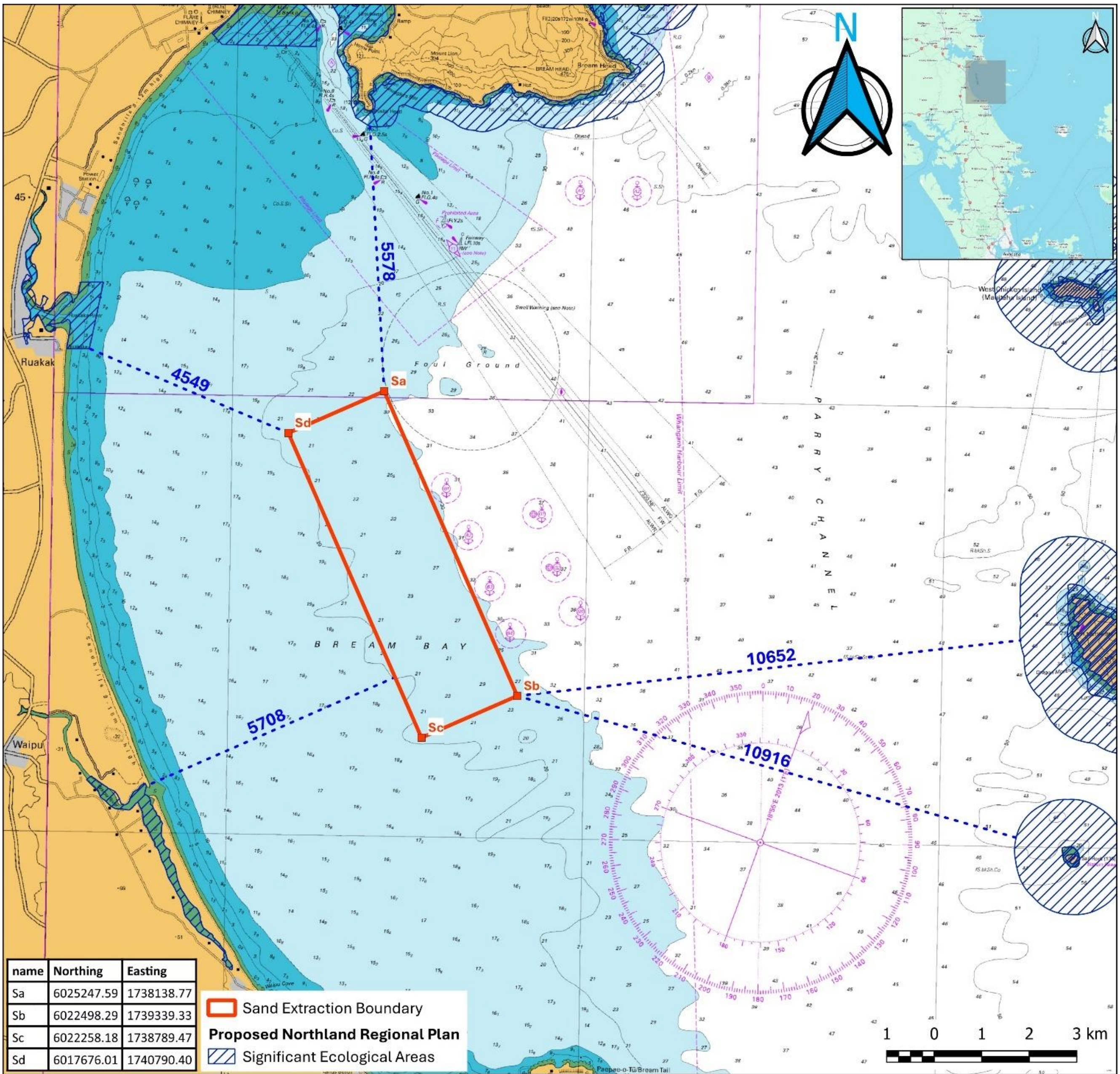
8.4 Regional Policy Statement for Northland (RPS) - Operative

Objective 3.4 Indigenous Ecosystems and Biodiversity

Safeguard Northland's ecological integrity by:

a) Protecting areas of significant indigenous vegetation and significant habitats of indigenous fauna;
b) Maintaining the extent and diversity of indigenous ecosystems and habitats in the region; and
c) Where practicable, enhancing indigenous ecosystems and habitats, particularly where this contributes to the reduction in the overall threat status of regionally and nationally threatened species.

The proposed sand extraction area is not within any area identified as having significant habitats of indigenous fauna (Figure 17). Given the distance of greater than 4.5 km to the nearest significant ecological areas (as identified in the Proposed Northland Regional Plan) and the nature of the effects arising from the sand extraction operation, no effects on these significant ecological areas are expected. Given the very localised nature of the sand extraction and expected effects, there will not be an overall effect on the extent and diversity of indigenous ecosystems and habitats in the Northland Region.



name	Northing	Easting
Sa	6025247.59	1738138.77
Sb	6022498.29	1739339.33
Sc	6022258.18	1738789.47
Sd	6017676.01	1740790.40

CLIENT / PROJECT
McCallum Bros. Ltd.

CD – Chart Datum as measured at Marsden Point (LINZ code DJM9)
Map projection - NZ Transverse Mercator EPGS:2193
GPS points - NZ Transverse Mercator EPGS:2193

MAP REVISIONS
Drawing Date: 07/11/2025 Version 1.3.5.2 by SW.

MAP FILE NAME
Map showing Proposed Sand Extraction Area with Distances (m) to Proposed Northland Regional Plan Significant Ecological Areas Overlays

Bioresearches

Figure 17 Distances from Proposed Sand Extraction area to Significant Ecological Areas Overlay

Policy 4.4.1 Policy – Maintaining and protecting significant ecological areas and habitats

1) In the coastal environment, avoid adverse effects, and outside the coastal environment avoid, remedy or mitigate adverse effects of subdivision, use and development so they are no more than minor on:
   (a) Indigenous taxa that are listed as threatened or at risk in the New Zealand Threat Classification System lists;
   (b) Areas of indigenous vegetation and habitats of indigenous fauna, that are significant using the assessment criteria in Appendix 5;
   (c) Areas set aside for full or partial protection of indigenous biodiversity under other legislation.
2) In the coastal environment, avoid significant adverse effects and avoid, remedy, or mitigate other adverse effects of subdivision, use and development on:
   (a) Areas of predominantly indigenous vegetation;
   (b) Habitats of indigenous species that are important for recreational, commercial, traditional or cultural purposes;
   (c) Indigenous ecosystems and habitats that are particularly vulnerable to modification, including estuaries, lagoons, coastal wetlands, dunelands, intertidal zones, rocky reef systems, eelgrass, northern wet heathlands, coastal and headwater streams, floodplains, margins of the coastal marine area and freshwater bodies, spawning and nursery areas and saltmarsh.
3) Outside the coastal environment and where clause (1) does not apply, avoid, remedy or mitigate adverse effects of subdivision, use and development so they are not significant on any of the following:
   (a) Areas of predominantly indigenous vegetation;
   (b) Habitats of indigenous species that are important for recreational, commercial, traditional or cultural purposes;
   (c) Indigenous ecosystems and habitats that are particularly vulnerable to modification, including wetlands, dunelands, northern wet heathlands, headwater streams, floodplains and margins of freshwater bodies, spawning and nursery areas
4) For the purposes of clause (1), (2) and (3), when considering whether there are any adverse effects and/or any significant adverse effects:
   (a) Recognise that a minor or transitory effect may not be an adverse effect;
   (b) Recognise that where the effects are or maybe irreversible, then they are likely to be more than minor;
   (c) Recognise that there may be more than minor cumulative effects from minor or transitory effects.
5) For the purpose of clause (3) if adverse effects cannot be reasonably avoided, remedied or mitigated then it may be appropriate to consider the next steps in the mitigation hierarchy i.e. biodiversity offsetting followed by environmental biodiversity compensation, as methods to achieve Objective 3.4.

As part of the pre-sand extraction monitoring, a baseline assessment utilising sampling has been undertaken prior to sand extraction occurring. No sensitive habitats were identified that suggested a specific area should be excluded from sand extraction. Two protected species of stony coral were detected in the proposed sand extraction area in low numbers and are the subject of further investigation in Beaumont, *et al*., 2025. The proposed sand extraction area is not an area with ecosystems and habitats that are particularly vulnerable to modification.

8.5 Proposed Regional Plan for Northland (PRPN)

D.2.18 Precautionary approach to managing effects on significant indigenous biodiversity

Where there is scientific uncertainty about the adverse effects of activities on:

1) species listed as Threatened or At Risk in the New Zealand Threat Classification System including those identified by reference to the Significant Bird Area and Significant Marine Mammal and Seabird Area maps (refer Maps), or
2) any values ranked high by the Significant Ecological Areas maps (Refer Maps), then the greatest extent of adverse effects reasonably predicted by science, must be given the most weight.

Policy D.2.18 directs that when assessing the potential adverse effects of activities on identified values of indigenous biodiversity a system-wide approach should be employed. In essence, this approach avoids micro-level assessment of effects with no cognisance of relevant scale and magnitude. There is no single system or scale that is appropriate for all aspects of marine ecology, therefore assessments need to be made at varying appropriate scales.

Of the assessments made above in this report only the marine reptiles have Threatened or At Risk classification. The assessment concluded No population level effects are expected which would impact marine reptile ecology in the wider Te Ākau Bream Bay, Whangārei Harbour, Ruakākā or Waipū estuaries.

While the assessments made above largely concentrate on the effects within the sand extraction area no adverse effects are expected significantly beyond the extraction area, the one exception to this is LSR for benthic fish. The assessment showed while a LSR could occur it was likely going to be small intermittent and only in the 0 -25 % reduction range result in negligible effects.

No population level effects are expected which would impact benthic biota or fish ecology in the wider Te Ākau Bream Bay, Whangārei Harbour, Ruakākā or Waipū estuaries.

F.1.3 Indigenous Ecosystems and Biodiversity

In the coastal marine area and in fresh waterbodies, safeguard ecological integrity by:

1) protecting areas of significant indigenous vegetation and significant habitats of indigenous fauna, and
2) maintaining regional indigenous biodiversity, and
3) where practicable, enhancing and restoring indigenous ecosystems and habitats to a healthy functioning state, and reducing the overall threat status of regionally and nationally Threatened or At Risk species, and
4) preventing the introduction of new marine or freshwater pests into Northland and slowing the spread of established marine or freshwater pests within the region.

The proposed sand extraction area is significantly outside any identified significant ecological areas and no significant habitats of indigenous flora or fauna have been identified within the sand extraction area. The proposal will not adversely impact on regional indigenous biodiversity.

MBL undertake regular cleaning of their vessels, and this is undertaken to maintain the vessel's performance and stay within Maritime NZ regulatory requirements. The discharging of any bilge water is to be avoided while at the sand extraction sites. The potential biosecurity effects are therefore considered to be negligible.

9 RECOMMENDED CONDITIONS AND MONITORING

Although the ecological effects assessment indicates that the proposed sand extraction at Te Ākau Bream Bay will result in **low to negligible effects within the extraction area** and **negligible effects in the wider bay**, it is best practice to implement a monitoring programme. This will validate predictions, provide early warning of any unexpected ecological responses, and allow for adaptive management if required. Key areas for monitoring are based around avoiding and managing the formation of water quality plumes, through seabed sediment samples for grain size, avoiding areas which contain sensitive benthic biota above trigger values to prevent adverse effects, and early identification of any adverse changes in the benthic biota ecology within the sand extraction area, through seabed grab samples, seabed photography, and epibenthic dredge tows for benthic biota composition and abundance.

NIWA (2013) describes and defines a number of sensitive benthic communities in New Zealand's Exclusive Economic Zone (EEZ) (Table 14). A number of these communities may occur in shallow coastal water; thus, the sensitive benthic community definitions should be taken as a starting point for determining communities that sand extraction should avoid. The list (Table 14) includes specific mention of a number of large bivalves.

The sand extraction area has been divided into cells 1000 m long x 200 m wide, with the aim of being able to manage the sand extraction activity within each cell. Firstly, a pre survey is required to determine if the cell is suitable for sand extraction based on its sediment grain size characteristics, benthic biota abundance and composition, this allows for the avoidance of effects. Secondly regular monitoring of sediment grain size characteristics and benthic biota abundance and composition is required to determine if the sand extraction is having an ecologically significant adverse effect. This also requires the monitoring of control areas to determine natural variation, so that the changes in the sand extraction area can be assessed in relation to this natural variation. The regular monitoring will also determine if additional areas need to be excluded from sand extraction or if previously excluded areas can be approved for sand extraction.

Table 14 Sensitive Benthic Communities from NIWA 2013.

Habitat	Primary indicators
Beds of large bivalve molluscs	A bed of large bivalves exists where living specimens of bivalve species: • are estimated to cover 30% or more of the seabed on average in visual images of either 1 m^2 or lateral view; or • comprise 30% or more by average weight or volume in grab samples. Large bivalves include: Horse mussels (*Atrina zelandica*), Scallops (*Pecten novaezelandiae*), Large dog cockle (*Tucetona laticostata*), Dredge oysters (*Ostrea chilensis*), Green lipped mussels (*Perna canaliculus*), Geoducks (*Panopea zelandica* and *P. smithae*), Trough Shells (*Spisula discors* and *S. murchisoni*), Triangle Shell (*Crassula aequilatera*). Shellfish known to pass through dredge alive at greater than 90% should be excluded; Clam (*Dosinia anus*, *D. subrosea*, *Bassina yatei, Myadora sp*.
Brachiopod beds	A brachiopod bed exists if: • one live brachiopod occurs per m^2 of seabed sampled using seabed photographs; or • one or more live specimens occur in grab samples.
Bryozoan thicket	A bryozoan thicket (here the term thicket is used synonymously with the terms bed, reef, meadow, etc.) is present if: • colonies of large frame-building bryozoan species cover at least 50% of the seabed in visual imaging surveys; • one or more colonies of large frame building bryozoan species occur per m^2 of seabed sampled using towed sampling gear; or • one or more large frame building bryozoan species is found in grab samples.
Calcareous tube worm thickets	A sensitive tube worm thicket is present if: • 2 or more colonies of a mound forming species of tube worm are found in any grab sample; or • 2 or more colonies are observed at a greater than 10% coverage in a visual image, either 1 m^2 or lateral view.
Chaetopteridae worm fields	A sensitive Chaetopteridae worm field is present if worm tubes and/or epifaunal species: • contribute 25% or more of the volume of a sample collected in a grab sample; or • colonies of tube worm species cover at least 50% of the seabed in visual imaging surveys.
Macro-algae beds	Detection of a single occurrence of any fixed specimen of a red, green, or brown macroalga at greater than 30% cover is sufficient to indicate that this habitat has been encountered.
Rhodolith (maerl) beds	A rhodolith bed exists if: • a single specimen of a rhodolith species is found in grab sample; or • there is more than 10% cover of living coralline thalli in visual images.
Sea pen field	A sea pen field exists if: • one or more specimens of any species of sea pen is found in a grab sample; or • two or more specimens per m^2 are found in seabed imaging surveys.
Sponge gardens	A sponge garden exists if metazoans of Class Demospongiae, Class Hexactinellida, Class Calcarea or Class Homoscleromorpha: • are estimated to cover 25% or more of the seabed in visual images of either 1 m^2 or lateral view.

9.1 Data collection

9.1.1 Timing

- The surveys should be conducted in March – April to be consistent with baseline monitoring in 2024.
- The baseline survey is recommended to be undertaken within 3 years prior to sand extraction commencing.

- Once sand extraction commences surveys are to be conducted annually for at least the first 3 years. If adverse effects are detected the proposed conditions allow for a number of management options, such as reducing extraction volumes by cell or as a whole, or temporarily closing cells. Annual monitoring should continue until no adverse effects are detected. If the extraction volume with no adverse effects is less than 150,000 m^3, then volume should remain at this level and the frequency of monitoring could be decreased to no greater the three yearly intervals.
- If no adverse effects are detected in the first three years of monitoring the extraction of 150,000 m^3 per year, then conditions allow the volume sand to be extracted to be increased from 150,000 to 250,000 m^3. Once the increase in volume commences then monitoring will be annually for the first 3 years. If adverse effects are detected the proposed conditions allow for a number of management options, such as reducing extraction volumes by cell or as a whole, or temporarily closing cells. Annual monitoring should continue until no adverse effects are detected, and then the frequency of monitoring could be decreased to no greater the three yearly intervals.
- The 3 yearly surveys are the maximum interval between sampling events, if the monitoring data shows trends, monitoring at shorter intervals could be recommended by the monitoring reports.

9.1.2 Sediment grain size survey

- Identify the presence of any areas with high (>20%) percentages of silt and clay sized sediments.
- Identify the changes in the sediment grain size characteristic which may influence benthic biota composition.

9.1.3 Benthic Photography

- Identify the presence of larger epibenthic sensitive biota.
- Identify the changes in the composition and abundance of larger epibenthic sensitive biota.
- Identify any changes in the physical seabed habitat that may contribute to changes in benthic biota.

9.1.4 Infauna Benthic Biota

- Identify the composition and abundance of infuana benthic biota.
- Identify the presence of sensitive benthic biota.
- Identify the changes in the composition and abundance of infuana benthic biota.

9.1.5 Epibenthic macrofauna

- Identify the composition and abundance of larger epibenthic biota.
- Identify the presence of larger epibenthic sensitive biota.
- Identify the changes in the composition and abundance of larger epibenthic sensitive biota.

9.2 Analysis and reporting

A Pre Sand Extraction Assessment Report (PSEAR) has been prepared (West, Beetham, *et al*. 2025) to report the results of the baseline survey conducted under a pre extracted state in 2024. The PSEAR will be used as a baseline for post extraction monitoring to be reported in a Sand Extraction Monitoring Report (SEMR). We recommend that SEMR reports are produced at the end of each year that any benthic biota survey is undertaken. The reports will need to present the raw data by replicate for each sampling method. Analysis would need to:

- Identify by mapping, any areas to be excluded based on;
    - sediment grain size finer than 0.063 mm exceeding 20% by weight,
    - the presence of sensitive benthic communities or benthic macrofauna (including shellfish beds),
    - the presence of benthic species absolutely protected under the provisions of the Wildlife Act 1953 that are in force as at the date of the SEMR, and not covered by wildlife authorities.
- Produce distribution maps for;
    - Sediment grain size,
    - Benthic biota community indices (abundance, richness, and diversity),
    - Sensitive biota and key species.
- Statistically compare differences in the grain size data, biota community indices and by multivariate analysis, between the sand extraction area and the controls, and within the sand extraction area for the survey. The results need to be discussed in relation to their ecological significance.
- Statistically compare differences in the grain size data, biota community indices and by multivariate analysis, over time between the sand extraction area and the controls, and within the sand extraction area. The analysis needs to account for the natural variation recorded at the controls, when assessing the changes in the sand extraction area. The results need to be discussed in relation to their ecological significance.
- Interpretate the causes of any adverse benthic biota composition and abundance changes, by relating them to extraction volume records and tracks, taking natural processes and storm events into consideration.
- Make recommendations for management of sand extraction activity and volumes to reduce ecologically significant adverse effects, or changes to the monitoring to better determine emerging trends.

9.3 Determination of adverse effects

In order to determine if an adverse effect has occurred, the benthic infauna and epibenthic macrofauna will be assessed against a set of "ecological criteria". These ecological criteria must be set in relation to baseline variability, ecological significance, and regulatory guidance, therefore cannot be fix values.
For the benthic infauna criteria could include;

- >25–30% decline in mean species richness or Shannon **diversity** at impact sites relative to reference sites (beyond natural seasonal variation).
- >50% reduction in mean infaunal **abundance of key taxa** (e.g. polychaetes, bivalves) compared to baseline / controls.
- **Community composition**, Significant BACI effect detected (PERMANOVA $p<0.05$) with >40% similarity loss (Bray–Curtis) relative to reference.
- **Loss of sensitive functional groups** (e.g. deep-burrowing bioturbators, suspension-feeders) with >30% shift in trait composition.

For the Epifauna & habitat features criteria could include;

- Biogenic habitat cover, >10–20% reduction in percent cover within or immediately adjacent to extraction area.
- Sensitive species occurrence, Absence of previously present keystone species (e.g. *Atrina zelandica*, Dog cockle *Glycymeris*, large sponges).

For the sediment grain size composition criteria could include;

- Grain size change, shift in median grain size >20% from baseline at reference/sentinel stations.

If these criteria are exceeded they provide an indication of an adverse effect. However, to account for natural variation multiple criteria should be exceeded and show a trend of decline over at least 2 consecutive surveys. Rather than defining these criteria as conditions it is suggested that they be included in a management plan as guidelines for assessment.

To avoid overreaction to natural variability, it is suggested to use a tiered approach such as

- **Level 1** (early warning): e.g. 20% decline in richness, moderate turbidity exceedances → intensify monitoring.
- **Level 2** (management): e.g. 30–40% decline, significant multivariate shift → restrict extraction rate/location.
- **Level 3** (stop/go): major loss of sensitive habitat/biogenic cover or persistent failure to recover → cease extraction until recovery verified.

9.4 Conditions

The sea bed of the sand extraction area is generally suitable for sand extraction; however, the environment is dynamic result in changes in sediment grain sizes and changes in ecology geographically and over time. Conditions are required to exclude areas not be suitable for sand extraction to avoid adverse effects, and to regularly reassess the sand extraction area opening and closing areas based on what is present.

The following conditions are recommended:

a. Identify areas (cells) which have high percentages of fine sediments as these fine sediments will remain in suspension longer if disturbed by the activity of sand extraction. Thus, areas having an average proportion of mud (grain size finer than 0.063mm) exceeding 20% by weight should be excluded from sand extraction. Reassessment of the area after a minimum of one year may show the area is suitable for sand extraction and thus be approved for sand extraction.
b. Identify areas (cells) which have sensitive benthic communities or benthic macrofauna (including shellfish beds). Table 14 sets trigger levels at which areas are considered to have these sensitive benthic communities. If one or more of these sensitive benthic communities are defined as being present, then the cell in which it occurs should be excluded from sand extraction. Reassessment of the area after a minimum of one year may show the area is suitable for sand extraction and thus be approved for sand extraction.
c. In addition to guidelines around sensitive benthic communities, there are other legal criteria that extend protection to marine species such as Wildlife Act 1953 and species protected within the New Zealand Coastal Policy. Therefore the presence of benthic species absolutely protected under the provisions of the Wildlife Act 1953 or benthic species that have a New Zealand threat

classification and protected under the New Zealand Coastal Policy. Exemptions for specific species may be provided by a wildlife authority.

Once sand extraction has commenced adaptive management is recommended if monitoring identifies that actual effects are occurring inside the extraction area.

The following conditions are recommended:

a. Surveys are to be undertaken annually for the first 3 years, then on a 3 yearly basis. If the volume sand to be extracted is approved to be increased from 150,000 to 250,000 m^3 then monitoring will be annually for the first 3 years, following the increase, and then on a 3 yearly basis. The surveys should be conducted in March – April to be consistent with baseline monitoring in 2024.
b. Surveys should include sampling for sediment grain size, infaunal benthic biota, epibenthic biota.
c. Surveys should include sampling in both the sand extraction area and in multiple control areas.
d. An effect is determined to be an ecologically significant adverse change over time. This will necessitate statistical comparison of the differences of the changes within the sand extraction area and within the control areas.
e. If ecologically significant adverse changes are detected they will be related to extraction volume records and tracks, taking natural processes and storm events into consideration.

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APPLICABILITY AND LIMITATIONS

Restrictions of Intended Purpose

This report has been prepared solely for the benefit of McCallum Bros Limited as our client with respect to the brief. The reliance by other parties on the information or opinions contained in the report shall, without our prior review and agreement in writing, be at such party's sole risk.

Legal Interpretation

Opinions and judgements expressed herein are based on our understanding and interpretation of current regulatory standards and should not be construed as legal opinions. Where opinions or judgements are to be relied on, they should be independently verified with appropriate legal advice.

Maps and Images

All maps, plans, and figures included in this report are indicative only and are not to be used or interpreted as engineering drafts. Do not scale any of the maps, plans or figures in this report. Any information shown here on maps, plans and figures should be independently verified on site before taking any action. Sources for map and plan compositions include LINZ Data and Map Services and local council GIS services. For further details regarding any maps, plans or figures in this report, please contact Bioresearches.

Bioresearches
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Appendix A Summary of Fish likely to be present in or near the proposed sand extraction area

Family Species	Comon name	Literature	Likely in sand area	NZTC	Biogeographic classification
Dasyatididae					
Dasyatis brevicaudata	Short-tail stingray	B	x	Not Threatened	Widespread
Dasyatis thetidis	Thorn tail stingray	B	x	Not Threatened	Warm temperate
Myliobatididae					
Myliobatis tenuicaudatus	New Zealand eagle ray	B	x	Not Threatened	Widespread
Creediidae					
Limnichthys polyactis	long-finned sand diver	BB	Detected		
Tewara cranwellae	New Zealand sand diver	BB	Detected		
Pempheridae					
Pempheris adspersa	New Zealand bigeye	B			Warm temperate
Pentacerotidae					
Zanclistius elevatus	Long finned boarfish	B			Warm temperate
Congridae					
Conger verreauxi	Southern conger	I Nat			Widespread
Conger wilsoni	Longfin conger	B			Subtropical
Muraenidae					
Gymnothorax prasinus	Green moray	B			Warm temperate
Ophichthidae					
Ophisurus serpens	sand snake-eel	BB	Detected		
Synodontidae					
Synodus similis	Shortfin lizardfish	B	x		Subtropical
Hemiramphidae					
Hyporhamphus ihi	Piper	B	x		Widespread
Berycidae					
Centroberyx affinis	Redfish	B			Warm temperate
Blenniidae					
Parablennius laticlavius	Crested blenny	B			Warm temperate
Parablennius tasmanianus	Crested blenny	?			
Plagiotremus tapeinosoma	Mimic blenny	B			Tropical
Tripterygiidae					
Forsterygion flavonigrum	Yellow-dot triplefin	B			Widespread
Forsterygion lapillum	Common triplefin	B			Widespread
Forsterygion malcolmi	Malcolm’s triplefin	B			Widespread
Forsterygion varium	Variable triplefin	B			Widespread
Karalepis stewarti	Stewart’s triplefin	B			Widespread
Notoclinops segmentatus	blue eyed triplefin	B			Widespread
Notoclinops yaldwyni	Yaldwyn’s triplefin	B			Widespread
Obliquichthys maryannae	Maryanne’s triplefin	B			Widespread
Ruanoho decemdigitatus	longfinned triplefin	B			Widespread
Ruanoho whero	spectacled triplefin	B			Widespread
Carangidae					
Decapterus koheru	Koheru	B	x		Warm temperate
Naucrates ductor	pilot fish	?			
Pseudocaranx dentex	Trevally	B	x		Widespread
Pseudocaranx georgianus	Silver trevally	?			
Seriola lalandi	Yellowtail kingfish	B	x		Widespread
Trachurus novaezelandiae	Jack mackerel	B, I Nat	x		Widespread
Aplodactylidae					
Aplodactylus arctidens	Marblefish	B			Widespread

Family Species	Comon name	Literature	Likely in sand area	NZTC	Biogeographic classification
Cheilodactylidae					
Cheilodactylus spectabilis	Red moki	B, I Nat			Widespread
Nemadactylus douglasii	Porae	B			Warm temperate
Nemadactylus macropterus	Tarakihi	B	x		Widespread
Chironemidae					
Chironemus marmoratus	hiwihiwi	B, I Nat			Warm temperate
Kyphosidae					
Atypichthys latus	Mado	B			Subtropical
Girella tricuspidata	Parore	B, I Nat			Warm temperate
Kyphosus sydneyanus	Silver drummer	B, I Nat			Warm temperate
Scorpis lineolatus	Sweep	B, I Nat			Warm temperate
Scorpis violaceus	Blue maomao	B, I Nat			Warm temperate
Latrididae					
Latridopsis ciliaris	Blue moki	B			Widespread
Callanthiidae					
Callanthias australis	Splendid perch	B			Warm temperate
Labridae					
Bodianus unimaculatus	Red pigfish	B			Subtropical
Coris sandageri	Sandager's wrasse	B			Subtropical
Notolabrus celidotus	Spotty	B, I Nat			Widespread
Notolabrus fucicola	Banded wrasse	B, I Nat			Widespread
Notolabrus inscriptus	Inscribed wrasse	B, I Nat			Subtropical
Pseudolabrus luculentus	Orange wrasse	B			Subtropical
Pseudolabrus miles	Scarlet wrasse	B			Widespread
Odacidae					
Odax pullus	Butterfish	B			Widespread
Sparidae					
Pagrus auratus	Snapper	B, I Nat	x		Widespread
Moridae					
Lotella rhacinus	Red codling	B			Widespread
Pseudophycis breviuscula	Northern bastard codling	?			
Gobiesocidae					
Trachelochismus aestuarium	clingfish	?	x		
Trachelochismus pinnulatus	New Zealand lumpfish	Tow	Detected		
Mugilidae					
Mugil cephalus	grey mullet	I Nat			Widespread
Mullidae					
Upeneichthys lineatus	Goatfish	B, I Nat	x		Warm temperate
Pomacentridae					
Chromis dispilus	New Zealand demoiselle	B			Warm temperate
Chromis hypsilepis	one spot demoiselle	B			Subtropical
Parma alboscapularis	black angelfish	B, I Nat			Subtropical
Pinguipedidae					
Parapercis colias	Blue cod	B, I Nat	x		Widespread
Scorpaenidae					
Scorpaena papillosa	Papillose scorpionfish	B, I Nat			Widespread
Serranidae					
Caesioperca lepidoptera	Butterfly perch	B, I Nat			Widespread
Caprodon longimanus	Pink maomao	B, I Nat			Warm temperate
Hypoplectrodes huntii	Scarlet perch	B			Widespread
Chelidonichthys kumu	Red gurnard		x		Widespread
Pleuronectidae					
Rhombosolea leporina	yellow belly flounder	I Nat			Widespread
Rhombosolea plebeia	sand flounder	I Nat			Widespread

Family Species	Comon name	Literature	Likely in sand area	NZTC	Biogeographic classification
Arripidae					
Arripis trutta	Kahawai	B, I Nat	x		Widespread
Syngnathidae					
Stigmatopora nigra	wide-bodied pipefish	I Nat			
Diodontidae					
Allomycterus jaculiferus	Arrow spine porcupinefish	B	x		Widespread
Molidae					
Mola tecta	sunfish	I Nat	x		
Monacanthidae					
Meuschenia scaber	Rough leatherjacket	B, I Nat			Widespread
Trachichthyidae					
Optivus elongatus	Slender roughy	B, I Nat			Warm temperate
Zeidae					
Zeus faber	John Dory	B, I Nat	x		Widespread

Key

BB = detected in West, *et al*., 2025 benthic grab sampling, tow = detected in West, *et al*., 2025 dredge tow sampling, B = from Brook (2002), I Nat = reported as present in the bay on iNaturalist website, ? = reported on iNaturalist website but suspected to be from outside Te Ākau Bream Bay.

Appendix B Department of Conservation BIOWEB Herpetofauna database, records within 50 km of Sand Extraction Area on the east coast.

Common Name	Scientific	Date	Place Name	Sighting Type	Identification	Card Number
Green turtle	*Chelonia mydas*	01 Feb 1985	Ruakaka Beach, Northland	Dead Specimen	Captured and identified	2640
Green turtle	*Chelonia mydas*	07 Feb 1985	Leigh	Unknown	Voucher/Photo examined	44939
Green turtle	*Chelonia mydas*	06 Apr 1997	Whangarei Harbour	Live Specimen	Captured and identified	30392
Green turtle	*Chelonia mydas*	25 Apr 1997	1.5 km E Taiharuru Bay, near Whangarei	Live Specimen	Captured and identified	30388
Green turtle	*Chelonia mydas*	05 Feb 1998	Onerahi Beach, Whangarei Harbour	Dead Specimen	Captured and identified	30772
Green turtle	*Chelonia mydas*	05 Apr 1998	Leigh, East coast of North Island	Live Specimen	Captured and identified	31148
Green turtle	*Chelonia mydas*	14 Apr 1998	Leigh	Live Specimen	Captured and identified	44988
Green turtle	*Chelonia mydas*	01 Mar 1999	Mangawhai Sandspit	Dead Specimen	Captured and identified	30909
Green turtle	*Chelonia mydas*	17 Oct 2000	Whangarei Harbour, Portland	Live Specimen	Captured and identified	30389
Green turtle	*Chelonia mydas*	01 May 2002	Ruakaka Beach, Whangarei	Dead Specimen	Captured and identified	31793
Green turtle	*Chelonia mydas*	23 Jan 2003	Taurikura, Whangarei Heads	Dead Specimen	Voucher/Photo examined	32278
Green turtle	*Chelonia mydas*	07 Aug 2003	Urquharts Bay, Whangarei Harbour	Dead Specimen	Captured and identified	32109
Green turtle	*Chelonia mydas*	18 Aug 2003	Manganese Point, Whangarei Harbour	Dead Specimen	Captured and identified	32108
Green turtle	*Chelonia mydas*	12 Jan 2004	Starfish Bay, Hen and Chickens Islands	Live Specimen	Other	32473
Green turtle	*Chelonia mydas*	27 Feb 2004	Parua Bay, Whangarei Harbour	Live Specimen	Captured and identified	33755
Green turtle	*Chelonia mydas*	03 Nov 2004	Pataua North, Parauwanui Beach, Whangarei	Live Specimen	Voucher/Photo examined	33754
Green turtle	*Chelonia mydas*	01 Dec 2004	Whangarei Harbour	Dead Specimen	Captured and identified	33674
Green turtle	*Chelonia mydas*	01 Jan 2005	Urquharts Bay	Live Specimen	Captured and identified	33398
Green turtle	*Chelonia mydas*	04 Oct 2005	Jacksons Bay, Manganese Point, Whangarei Harbour	Live Specimen	Captured and identified	34912
Green turtle	*Chelonia mydas*	26 May 2007	Whangerei Harbour.	Live Specimen	Captured and identified	41588
Green turtle	*Chelonia mydas*	30 May 2007	Whangarei Harbour	Live Specimen	Captured and identified	45223
Green turtle	*Chelonia mydas*	01 Jul 2007	Whangarei	Live Specimen	Captured and identified	45224
Green turtle	*Chelonia mydas*	30 Jan 2008	Mcgregors Bay, Whangarei Heads	Live Specimen	Voucher/Photo examined	38027
Green turtle	*Chelonia mydas*	05 Aug 2008	Urquharts Bay	Dead Specimen	Captured and identified	42368
Green turtle	*Chelonia mydas*	30 Jul 2012	Te Arai Point	Live Specimen	Captured and identified	45265
Green turtle	*Chelonia mydas*	13 Oct 2014	Ruakaka Beach	Dead Specimen	Voucher/Photo examined	41319
Green turtle	*Chelonia mydas*	12 Jul 2015	McGregors Bay, Whangarei	Live Specimen	Captured and identified	41483
Green turtle	*Chelonia mydas*	25 Jan 2017	The Nook, Parua Bay, Whangarei Harbour	Dead Specimen	Voucher/Photo examined	45314
Green turtle	*Chelonia mydas*	22 Mar 2018	Skull Creek, Whangarei Harbour	Live Specimen	Voucher/Photo examined	45329
Green turtle	*Chelonia mydas*	06 Jul 2018	Whangarei Heads	Live Specimen	Captured and identified	45334
Green turtle	*Chelonia mydas*	22 Aug 2019	Urquharts Bay	Live Specimen	Captured and identified	42717
Green turtle	*Chelonia mydas*	01 Dec 2020	One Tree Point, Whangarei	Dead Specimen	Voucher/Photo examined	45368
Green turtle	*Chelonia mydas*	28 Mar 2021	off Fisherman's Point, Whangarei Harbour	Live Specimen	Voucher/Photo examined	45376
Green turtle	*Chelonia mydas*	01 Feb 2022	Hen & Chickens Islands	Live Specimen	Voucher/Photo examined	45400
Green turtle	*Chelonia mydas*	01 Apr 2022	Bream Bay, between Whangarei Heads and Waipu	Live Specimen	Voucher/Photo examined	45407
Green turtle	*Chelonia mydas*	26 Nov 2022	Smuggler's Bay, Whangarei Heads	Live Specimen	Voucher/Photo examined	45420
Green turtle	*Chelonia mydas*	25 Dec 2022	Matakohe Island, Whangarei Harbour	Live Specimen	Voucher/Photo examined	45424
Green turtle	*Chelonia mydas*	04 Sept 2023	Uretiti Beach, Northland	Dead Specimen	Voucher/Photo examined	45440
Green turtle	*Chelonia mydas*	30 Aug 2024	McKenzie Bay	Dead Specimen	Voucher/Photo examined	45523
Green turtle	*Chelonia mydas*	18 Dec 2024	Ocean Beach Whangarei Heads	Dead Specimen	Other	47088
Hawksbill turtle	*Eretmochelys imbricata*	01 Jul 1973	Uretiti Beach, Northland	Live Specimen	Voucher/Photo examined	2714
Hawksbill turtle	*Eretmochelys imbricata*	09 Mar 1996	Smugglers Bay, Whangarei Heads, Northland	Live Specimen	Captured and identified	5330
Hawksbill turtle	*Eretmochelys imbricata*	10 May 2004	One Tree Point, Whangarei Harbour	Dead Specimen	Voucher/Photo examined	33753
Hawksbill turtle	*Eretmochelys imbricata*	04 Oct 2011	Woolleys Bay, Matapouri	Dead Specimen	Captured and identified	39506
Hawksbill turtle	*Eretmochelys imbricata*	05 Aug 2024	Te Arai Beach, Auckland	Live Specimen	Voucher/Photo examined	45466
Leatherback turtle	*Dermochelys coriacea*	01 Jan 1975	Jacksons Bay, Whangarei Harbour	Live Specimen	Voucher/Photo examined	2706
Leatherback turtle	*Dermochelys coriacea*	13 Feb 1993	McLeod Bay, Whangarei Harbour	Live Specimen	Captured and identified	4002
Leatherback turtle	*Dermochelys coriacea*	05 Feb 1996	Poor Knights Islands	Live Specimen	Captured and identified	5345
Leatherback turtle	*Dermochelys coriacea*	31 Dec 1996	Between Bream Head and Hen and Chickens Islands	Live Specimen	Captured and identified	30384
Leatherback turtle	*Dermochelys coriacea*	05 Mar 2003	Tamaterau Beach, Whangarei Harbour	Live Specimen	Other	34910
Leatherback turtle	*Dermochelys coriacea*	27 Feb 2005	Off Chickens Islands	Live Specimen	Other	34911
Leatherback turtle	*Dermochelys coriacea*	18 Mar 2006	Bream Bay, Whangerei	Live Specimen	Other	41567
Leatherback turtle	*Dermochelys coriacea*	08 Dec 2016	off Mangawhai Heads, Hauraki Gulf	Live Specimen	Voucher/Photo examined	45312
Loggerhead turtle	*Caretta caretta*	01 Jul 1973	Ruakaka Beach, S Whangarei	Live Specimen	Voucher/Photo examined	2733
Loggerhead turtle	*Caretta caretta*	01 Feb 1985	Leigh, Northland	Live Specimen	Voucher/Photo examined	33058
Loggerhead turtle	*Caretta caretta*	28 Apr 1996	Coppermine Island, Hen And Chicken Islands, Northland	Live Specimen	Captured and identified	5349
Loggerhead turtle	*Caretta caretta*	03 Dec 2018	Te Arai, just north of Pacific Rd.	Dead Specimen	Voucher/Photo examined	45339
Turtle species (undetermined)	Turtle sp.	01 Jan 1970	Whangarei Harbour	Live Specimen	Unknown	45449
Turtle species (undetermined)	Turtle sp.	01 Feb 1996	Uretiti Beach, Bream Bay, Northland	Live Specimen	Captured and identified	5355
Turtle species (undetermined)	Turtle sp.	25 Apr 1996	Whangarei Harbour, Northland	Live Specimen	Captured and identified	5356
Turtle species (undetermined)	Turtle sp.	25 Feb 1997	Tamaterau, Whangarei Harbour	Live Specimen	Other	30391
Turtle species (undetermined)	Turtle sp.	01 Jan 1999	Whangarei Harbour	Live Specimen	Unknown	44989
Turtle species (undetermined)	Turtle sp.	01 Feb 1999	Whangarei Harbour	Live Specimen	Unknown	44990
Turtle species (undetermined)	Turtle sp.	15 Jan 2003	Manganese Point, Whangarei Harbour	Live Specimen	Other	32282
Turtle species (undetermined)	Turtle sp.	26 Sept 2020	Parua Bay, Whangarei Harbour	Dead Specimen	Voucher/Photo examined	45359
Turtle species (undetermined)	Turtle sp.	01 Oct 2021	Whangarei Area	Live Specimen	Unknown	46888
Turtle species (undetermined)	Turtle sp.	01 Mar 2022	Wahine Bay, Hen Island, Northland	Live Specimen	Voucher/Photo examined	45404
Turtle species (undetermined)	Turtle sp.	02 Oct 2023	The Nook, Parua Bay, Whangarei Harbour	Live Specimen	Voucher/Photo examined	45443
Turtle species (undetermined)	Turtle sp.	01 Jan 2025	Hen & Chickens Islands	Live Specimen	Unknown	44890
Turtle species (undetermined)	Turtle sp.	10 Apr 2026	Hen & Chickens Islands	Live Specimen	Unknown	44891

Common Name	Scientific	Date	Place Name	Sighting Type	Identification	Card Number
Yellow-bellied sea-snake	*Pelamis platura*	1 Jan 1898	Whangarei Heads	Live Specimen	Unknown	44883
Yellow-bellied sea-snake	*Pelamis platura*	01 Mar 1930	Waipu Cove	Unknown	Voucher/Photo examined	44892
Yellow-bellied sea-snake	*Pelamis platura*	01 Jan 1931	Waipu Cove	Dead Specimen	Voucher/Photo examined	33129
Yellow-bellied sea-snake	*Pelamis platura*	06 Apr 1939	Horahora Beach, Ngunguru Bay	Live Specimen	Captured and identified	44898
Yellow-bellied sea-snake	*Pelamis platura*	15 Apr 1939	Horahora, N Whangarei Heads	Live Specimen	Captured and identified	2682
Yellow-bellied sea-snake	*Pelamis platura*	17 Feb 1946	Whangarei	Live Specimen	Voucher/Photo examined	2651
Yellow-bellied sea-snake	*Pelamis platura*	01 Jan 1965	Waipu Cove	Live Specimen	Voucher/Photo examined	2645
Yellow-bellied sea-snake	*Pelamis platura*	28 Jan 1971	Whananaki Inlet	Live Specimen	Voucher/Photo examined	2683
Yellow-bellied sea-snake	*Pelamis platura*	29 Jan 2000	Uretiti Beach, Bream Bay, Northland	Live Specimen	Captured and identified	30276
Yellow-bellied sea-snake	*Pelamis platura*	21 Apr 2002	Ocean Beach, Whangarei	Dead Specimen	Voucher/Photo examined	35512
Yellow-bellied sea-snake	*Pelamis platura*	10 Mar 2003	Sandy Bay, Northland	Live Specimen	Captured and identified	32110
Yellow-bellied sea-snake	*Pelamis platura*	08 May 2021	Woolley's Bay, Northland	Live Specimen	Voucher/Photo examined	45384
Yellow-bellied sea-snake	*Pelamis platura*	27 Apr 2025	Omaha beach	Live Specimen		
Snake species (undetermined)	Snake sp.	27 Mar 2021	Ngunguru	Live Specimen	Suspect	43996

Appendix C Marine Food Web Dynamics and Potential Effects of Sand Extraction in Te Ākau Bream Bay

Marine Food Web Dynamics and Potential Effects of McCallum Bros Sand Extraction on the Food Web in Te Ākau Bream Bay

A response to the Department of Conservation's pre-lodgement feedback on McCallum Bros Bream Bay Sand Extraction Project

November 2025

McCALLUM BROS. LTD
Established 1904

Revision history

Title: Marine Food Web Dynamics and Potential Effects of McCallum Bros Sand Extraction on the Food Web in Te Ākau Bream Bay				
Date	**Version**	**Description**	**Prepared by**	**Reviewed by**
17/11/2025	1	First draft	S.West, R.Boyd, P.Wilson, D. Thompson, H.McConnell.	L.Davis

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1 Introduction

This assessment evaluates how the proposed McCallum Bros Ltd (MBL) sand extraction activity at Te Ākau Bream Bay may influence the structure and function of the local marine food web. It has been prepared in response to pre-lodgement feedback from the Department of Conservation (DOC) and their technical advisors, who requested clearer articulation of food-web pathways, potential implications for prey availability for protected species, and ecosystem-scale responses to sediment disturbance. Notably:

1. Feedback – Northern New Zealand Seabird Trust. Sand extraction in Te Ākau Bream Bay: Potential effects on seabirds and shorebirds. Dated 5 September 2025.
2. Initial pre-lodgement feedback on the draft specialist assessment: Marine Mammal Environmental Impact Assessment (Jochen Zaeschmar). Dated 5 September 2025.
3. Summary of Shorebird and Tara Iti-Related Considerations (Tony Beauchamp). Dated 9 September 2025.
4. Significance of the proposed Te Ākau/Bream Bay Sand Extraction site, using NZCPS criteria – Tara iti and shorebirds (Tony Beauchamp). Dated 7 November 2025.

The analysis integrates findings from all specialist assessments prepared for the Fast-Track application, including:

- Benthic ecology (West, 2025), which identified a regionally typical sandy-bottom ecosystem with moderate ecological value and no sensitive or habitat-forming biota.
- Water quality (Wilson, 2025), which concluded that turbidity and suspended sediment effects are negligible, highly localised, and dissipate within about 30 minutes, with no measurable influence on coastal primary productivity.
- Fish and fisheries (Boyd, 2025), which described diverse demersal and pelagic fish communities with no spawning or nursery areas in the extraction area.
- Seabirds and shorebirds (Thompson, 2025), which assessed potential prey and foraging habitats relevant to protected species including tara iti.
- Marine mammals (McConnell, 2025), which found no evidence that extraction activities would alter prey availability or foraging behaviour at spatial scales relevant to cetaceans.

These technical reports collectively describe a neritic coastal ecosystem characterised by sandy seabed habitats, high water clarity, and a food web driven by both pelagic and benthic primary production. The benthic environment is typical of open-coast continental shelf sands, supporting diverse but regionally common macroinvertebrate assemblages, with no habitat-forming biogenic structures and no nursery or spawning areas of regional significance.

Given this ecological context, this assessment focuses on five key questions raised in DOC's feedback:

1. What are the dominant energy pathways in the Te Ākau Bream Bay food web?
2. What ecological mechanisms could link sand extraction to changes in prey availability for higher-trophic species?
3. Are small pelagic fish—particularly those important to seabirds and marine mammals—likely to be affected by extraction-related changes in turbidity, seabed disturbance, or trophic dynamics?
4. Could benthic disturbances influence coastal foragers such as tara iti (fairy tern), shags, or nearshore marine mammals through any depletion of prey resources?
5. Are any wider ecosystem-level or cumulative food-web effects plausible?

Overall, the assessment finds that the proposed sand extraction has negligible potential to influence the functioning of the Te Ākau Bream Bay food web, due to:

- The highly localised and short-duration nature of water-column sediment plumes;
- The small spatial footprint of seabed disturbance relative to the scale of the bay;
- Rapid benthic recovery and recolonisation;
- No reduction in coastal primary productivity; and
- The distributed and dynamic nature of small pelagic fish populations, whose habitat use is not linked to sandy-bottom benthic processes in the extraction area.

This report supplements the specialist assessments and clarifies the ecological pathways through which effects could occur, enabling a robust evaluation of whether any measurable food-web consequences are plausible.

The document has been produced collaboratively by a team of Suitably Qualified and Experienced Persons (SQEPs): Simon West (Bioresearches), Rick Boyd (Independent fisheries expert), Pete Wilson (SLR Consulting New Zealand), Helen McConnell (SLR Consulting New Zealand), and David Thompson (NIWA). Together, these specialists have reviewed the available environmental information and provided expert analysis on how the proposed sand extraction activity may influence the structure and function of the marine food web within Te Ākau Bream Bay, including potential implications for primary producers, small pelagic fishes, marine mammals, and seabirds.

This assessment has been compiled by MBL with input from the following SQEPs:

Section	Inputs
2, 2.1.2, 2.1.3, 2.1.4	Simon West - Bioresearches
2.1.1	Pete Wilson - SLR Consulting New Zealand
2.2, 2.3	Rick Boyd – Independent Fisheries Expert
2.3	Helen McConnell – SLR Consulting New Zealand
2.4	David Thompson - NIWA

2 Marine Food Web In Te Ākau Bream Bay

Prepared by: Simon West, Bioresearches

Marine food webs describe the network of feeding relationships among organisms in an ecosystem. It shows how energy and nutrients move from primary producers through consumers to top predators and decomposers. In neritic coastal systems, **primary production** is provided by phytoplankton in the water column and by benthic microalgae on the seabed. Coastal waters receive nutrients from the adjacent land, especially nitrogen, which influences primary productivity and phytoplankton abundance. These inputs support **primary consumers**, including zooplankton and benthic infauna such as polychaetes, bivalves, and small crustaceans. **Secondary consumers** comprise of small pelagic fish, and other mid-trophic taxa that feed on zooplankton and particulate organic matter. **Higher trophic levels** include predatory fish, squid, seabirds, and marine mammals, some of which rely heavily on small pelagic fish as prey (Fisheries New Zealand, 2025; Rodil *et al.,* 2020).

In sandy seabed habitats, primary production occurs both on the seabed and in the water column (pelagic), this can result in two communities based on the primary production, however the benthic–pelagic coupling is an important process for connections between these two communities. Bioturbation, suspension feeding, and sediment resuspension recycle nutrients and organic matter, influencing water-column productivity. While most small pelagic fish in northern New Zealand are planktivorous, their abundance and distribution can be **indirectly** affected by benthic processes that regulate the quality and availability of planktonic prey (Ubertini *et al.*, 2012; Rodil *et al.,* 2020).

2.1 Sand extraction and its ecological pathways of impact

DOC requested a clearer articulation of the ecological mechanisms through which sand extraction might influence the food web. Four potential pathways exist in theory, although the specialist assessments consistently show that effects will be negligible in practice.

2.1.1 Increased turbidity and suspended sediments

Prepared by: Pete Wilson, SLR Consulting New Zealand

Sand extraction by a trailing suction hopper dredger (TSHD), such as the *William Fraser*, in neritic waters alters both benthic habitat, by removal and disturbance, and generates sediment plumes that temporarily elevate turbidity in the water column. The potential ecological consequences include:

- Reduced light availability for phytoplankton and benthic microalgae
- Impaired feeding efficiency for visual planktivorous fish
- Elevated suspended sediment can also cause physiological stress (gill clogging) in sensitive life stages (Lowe, *et al.,* 2015, Wilber, *et al.*, 2021).
- Reductions in phytoplankton and benthic macroalgae (primary production) have the potential to affect the base of the marine food web.

However, the time and area over which turbidity will be raised in Te Ākau Bream Bay is limited. Plume monitoring in Pākiri indicates that elevated turbidity is confined to a footprint approximately the width of the vessel and up to 2 km behind the vessel. This represents a small proportion of the proposed extraction area and the wider Te Ākau Bream Bay. The monitoring also showed that turbidity reduced to background levels in as little as 26 minutes and certainly within one hour (Wilson, 2025).

The magnitude of effects of the proposed activity on water quality has been assessed to be **Negligible** and localised to the area being extracted. The Te Ākau Bream Bay marine environment is considered to have a '*good capacity to absorb proposed changes*'; any effects are highly likely to be very short-term/temporary, the increases in TSS only will return to ambient levels within an hour of the activity ceasing. In addition, it is likely there will be 'No discernible change' relative to the wider open coastal waters after reasonable mixing, and as assessed over a 12-month period (as per the NRC Policy H.3.3 Coastal water quality standards).

Given the high assimilative capacity of Te Ākau Bream Bay, the effects of turbidity on the water column are assessed to be **negligible**. Consequently, the effects of elevated turbidity on phytoplankton growth are expected to be similarly **negligible**. These findings are consistent with the coastal water quality standards set out in NRC's Policy H.3.3, and it is highly unlikely these would be breached.

2.1.2 Seabed disturbance and habitat alteration

Prepared by: Simon West, Bioresearches

Under the proposed sand-extraction regime, disturbance of the seabed is spatially and temporally constrained relative to the wider Te Ākau Bream Bay embayment. The consent area is 15.4 km^2 (7 km alongshore by 2.2 km across-shore), located at least 4.7 kilometres offshore (West, 2025). Each extraction trip creates a single dredge track approximately 13 km long, 1.6 m wide and about 0.1 m deep, so that one pass disturbs ~0.021 km^2 of seabed, equivalent to ~0.14% of the extraction area (West, 2025). At the lower extraction rate (150,000 $m^3\ yr^{-1}$; ~160 trips yr^{-1}), the cumulative area physically disturbed by dredge tracks in a year is on the order of 3 - 4 km^2, or roughly 20 - 25% of the 15.4 km^2 consent area. At the higher rate (250,000 $m^3\ yr^{-1}$; ~270 trips yr^{-1}), the disturbed area increases to ~5 - 6 $km^2\ yr^{-1}$, or around one-third of the extraction area, assuming tracks are laid out to minimise overlap in accordance with MBL's Sand Extraction Operational Plan and monitoring programme.

Te Ākau Bream Bay itself is a large open-coast embayment extending approximately 22 km from Bream Head to Bream Tail. Bounded by the shore and a line from Bream Head to Bream Tail the subtidal soft-sediment zone, the wider embayment is in the order of a few hundred square kilometres of sandy seabed. On that basis, the annual dredge-track footprint (3 - 6 $km^2\ yr^{-1}$) represents only about 1 - 3% of the soft-sediment seabed in Te Ākau Bream Bay, whereas the consent area itself accounts for a larger fraction of that soft-sediment habitat but is still only a small proportion of the regional coastal shelf.

Within the dredge tracks, most infaunal macroinvertebrates and sessile epifauna in the upper 10 cm of sediment will be removed, so that a high proportion of the benthic biota within the disturbed footprint is directly affected in any given year. However, all larger biota will be returned to the sea, with an expected loss of approximately 7%. This pattern is consistent with empirical studies of aggregate dredging on mobile sandy sediments, which report substantial reductions in macrofaunal abundance, biomass and species richness within dredged lanes immediately after extraction (Dernie *et al*,. 2003). Effects on community composition and biomass are typically strongest within the dredged area and diminish rapidly beyond tens to hundreds of metres from the dredge tracks, with little or no detectable change in macrofaunal structure outside the extraction zone (Newell *et al.*, 2004). Recovery trajectories depend on sediment type, depth of removal and the frequency of re-disturbance, but for shallow, high-energy sand habitats, soft-sediment communities frequently return to near-reference conditions within approximately 1 - 3 years once disturbance ceases or is infrequent (Dernie *et al*,. 2003). Under the proposed lane rotation rules (no reworking of individual lanes within at least 12 months), this implies that, although a substantial fraction of the benthic community within the consent area experiences direct physical disturbance over a year (on the order of 20 - 35% of the area), only a small fraction of the wider Te Ākau Bream Bay seabed (1 - 3%) is in an early post dredge recovery state at any one time.

2.1.3 Altered energy flow

Prepared by: Simon West, Bioresearches

Benthic - pelagic coupling refers to the exchange of energy, mass and nutrients between the seabed (benthic system) and the overlying water column or pelagic system (Griffiths *et al.,* 2017). Organic matter produced in the water column (e.g., phytoplankton) settles to the seabed, where it is processed by benthic invertebrates and microbes through feeding, bioturbation and remineralisation. In turn, these processes regenerate dissolved nutrients (e.g., ammonium, nitrate, phosphate) and influence oxygen fluxes back to the water column, sustaining pelagic primary production and higher trophic level food webs (Griffiths *et al.,* 2017). Benthic - pelagic coupling is therefore a key mechanism linking primary production, nutrient cycling and secondary production in coastal ecosystems, particularly on shallow continental shelves.

Temporary removal of benthic biota by sand extraction alters benthic - pelagic coupling locally by:

(i) Reducing the standing biomass of suspension feeders and deposit feeders that filter, ingest and repackage organic particles,
(ii) Disrupting bioturbation and bioirrigation that ventilate and mix the sediment, and
(iii) Modifying sediment texture and permeability, which in turn influence porewater exchange and nutrient fluxes (Goedefroo *et al.*, 2023).

Trait-based analyses from high intensity sand extraction sites in the southern North Sea show that annual extraction can depress macrofaunal secondary production in recently disturbed areas, while persistent disturbance favours opportunistic deposit feeding and burrowing taxa and alters the community's contributions to carbon and nutrient cycling (Goedefroo *et al.*, 2023). However, these studies also indicate that in naturally dynamic, permeable sands, benthic communities and their functional properties often exhibit substantial spatial heterogeneity and can recover much of their functional capacity once disturbance frequency decreases and sediment conditions stabilise (Goedefroo *et al.*, 2023, Robinson *et al.*, 2005, Dernie *et al.*, 2003).

Applied to Te Ākau Bream Bay, this evidence suggests that benthic - pelagic coupling will be weakened within active and recently dredged tracks, through a short to medium term reduction in benthic filtration, mixing and remineralisation capacity. At the scale of the whole extraction area, these effects are moderated by

a) Spatial rotation of dredge lanes, which limits repeat disturbance of the same patch within a year, and
b) The high-energy, sandy nature of the habitat, which promotes relatively rapid physical infilling and biological recolonisation.

At the scale of the wider Te Ākau Bream Bay embayment, the fraction of seabed experiencing recent dredging at any one time is small relative to the total soft sediment area (of order a few percent), so **the net effect on bay wide nutrient recycling and carbon processing is expected to be minor compared with natural variability** driven by hydrodynamics, primary production and other anthropogenic pressures (e.g., fishing, catchment inputs) (Griffiths *et al.,* 2017, Ehrnsten *et al.*, 2019, Robinson *et al.*, 2005).

2.1.4 Noise and disturbance

Prepared by: Simon West, Bioresearches

Underwater noise from the proposed sand extraction will primarily arise from the TSHD *William Fraser* as it transits and extracts sand in 20 - 30 m water depths in the sand extraction area. Acoustic modelling for this project shows that the dredge produces continuous, low frequency noise typical of commercial vessels, and that sound levels were evaluated in the context of existing AIS tracked shipping noise in the bay. The modelling indicates that changes to the wider Te Ākau Bream Bay soundscape are modest and largely confined to the extraction area and its immediate surroundings, with no expectation of injury level exposures to fishes or invertebrates.

Effects on pelagic fish in the extraction area

Pelagic fishes in Te Ākau Bream Bay include schooling species such as anchovy, pilchard, juvenile tāmure (snapper), kahawai, trevally and other small shoaling fish that form a key mid trophic link in the local food web. Like other marine fishes, these species detect and use sound (mainly particle motion at low frequencies) for orientation, predator avoidance, schooling and potentially for communication. Reviews of experimental and field studies show that exposure to anthropogenic noise can cause:

- Startle responses and short term changes in swimming speed and direction,
- Temporary displacement from noisy areas,
- Altered schooling behaviour and feeding efficiency,
- Sub lethal physiological stress responses at high or prolonged exposures (Normandeau, 2012, ABPmer., 2025, Hawkins & Popper, 2014, Hawkins & Popper, 2017).

For continuous, vessel like sources (including dredges), studies generally report behavioural changes and small scale redistribution of fish within tens - hundreds of metres of the source, rather than mortality or large scale population effects, provided sound levels remain well below injury thresholds (Normandeau, 2012, McQueen *et al.*, 2018, Hawkins & Popper, 2017, Barnett, 2020).

In Te Ākau Bream Bay, the Styles Group assessment concluded that for fishes and invertebrates the main potential effect from the *William Fraser* is auditory masking and behavioural response (e.g. temporary avoidance) within a local zone around the vessel, with effects graded by distance. Noise levels were modelled using measured source spectra from the *William Fraser* and propagated across the extraction area, then compared with ambient conditions dominated by existing vessel traffic. Predicted listening space reduction and audibility distances for representative fish and invertebrate species were limited to the vicinity of the dredge track, with sound levels merging into the range of existing background noise over broader parts of the bay.

Because extraction is restricted to a maximum of 3.5 hours per day within a rotating cell-based footprint, individual schools of pelagic fish are expected to experience only short duration exposures as the vessel passes, after which conditions return to the prevailing shipping dominated soundscape. International syntheses similarly emphasise that, for continuous industrial noise sources such as shipping and dredging, the primary pathway of impact on fish is localised behavioural change rather than direct mortality or long term population suppression. (Duarte *et al.*, 2021, ABPmer., 2025, El-Dairi *et al.*, 2024)

Overall, the best interpretation for Te Ākau Bream Bay is that pelagic fish may temporarily avoid the immediate vicinity of the dredge or alter their schooling behaviour while it is operating, but that these responses will be spatially restricted to a small proportion of the extraction area at any one time and will relax rapidly once the vessel moves away or ceases extraction.

Effects on pelagic fish in the wider Te Ākau Bream Bay area
The proposed extraction area is a small part of the wider Te Ākau Bream Bay coastal ecosystem, and offshore pelagic fish schools are distributed throughout the bay and adjacent coastal waters. Fisheries analyses and food web synthesis for this project show that pelagic species use a wide range of habitats (reefs, open-water shoaling zones, nearshore areas and estuarine mouths), and that the extraction area does not constitute a unique or irreplaceable pelagic habitat.

The underwater noise modelling compared monthly and daily sound exposure levels from the *William Fraser* with those from all AIS-tracked commercial shipping in the region. This analysis showed that:

- Existing commercial shipping already provides the dominant contribution to continuous low frequency noise in much of the bay; and
- Adding one additional dredge operating for a few hours per day produces only modest incremental increases in average sound levels, largely confined to the extraction area and its immediate surrounds.

Given this context, any redistribution of pelagic fish away from the dredge track is expected to be small relative to the spatial extent of available habitat and the natural variability driven by tides, prey patches and predator presence. International reviews emphasise that, although anthropogenic noise can clearly affect individual fish and local aggregations, convincing evidence for large scale population declines driven solely by continuous noise sources (such as dredges and ships) is limited, particularly where exposure is intermittent and sources are few relative to the size of the habitat (Duarte *et al.*, 2021, ABPmer., 2025, Hawkins & Popper, 2017).

On this basis, the effects of sand extraction noise on pelagic fish populations in the wider Te Ākau Bream Bay area are assessed as very small, with no plausible mechanism for a significant reduction in overall pelagic fish biomass at the scale relevant to predators.

2.2 Implications for small pelagic fish in Te Ākau Bream Bay

Prepared by: Rick Boyd, Independent Fisheries Expert
Planktivorous species (anchovy, pilchard, sprat, smelt, yellow-eye mullet, koheru, juvenile jack and blue mackerels): Effects are expected to be indirect, temporary and minor. Turbidity plumes **may temporarily** (very short term 4.5 hours, small footprint) reduce feeding efficiency, and **chronic** (not suggested by the project) habitat alteration could affect prey availability. This is not considered a concern for the project, as any effects are expected to be indirect, short-lived, and minor in nature. Plankton-eating pelagic fishes show diel vertical movement linked to light levels that affect plankton visibility to predators and the plankton's own feeding and hiding behaviours. Plankton move up to shallower depths at night, and the pelagic fish move with them. At daybreak, this vertical movement is reversed and they descend. All of the pelagic fish species are highly mobile and their presence at any location is ephemeral as the shoals (schools) of each species constantly move along the coast, evading or escaping predators.

Larval and juvenile stages: These life stages are more sensitive to suspended sediments. Sediments released from sand exaction could reduce egg or larval survival (Wilber *et al.*, 2021) but turbidity plumes generated by the dredge will be localised and temporary (Wilson, 2025). The eggs and larvae of coastal fishes are typically dispersed over relatively large areas and drift over time from the effects of coastal and wind driven currents (see Crossland 1981 on the distribution of fish eggs and larvae of the Hauraki Gulf, Crossland 1980 on snapper eggs and larvae). Spawning of many coastal species, including pelagic fishes occurs from early spring into mid-late summer (so the larvae have the benefit of the increase in phytoplankton abundance as the water warms), although some species spawn in winter. Water temperature is a key driver of spawning time and spawning location which may vary from year to year within the wider habitat occupied by each species.

The scale of impacts depends on dredging intensity, frequency, and timing relative to spawning, as well as the hydrodynamic regime of Te Ākau Bream Bay, which governs plume dispersion and habitat recovery.

The reality is that eggs and larvae of all fish species in Te Ākau Bream Bay (demersal and pelagic) are theoretically equally at risk from high suspended sediment levels. However, that issue has largely already been addressed in the existing fish and ecology reports - essentially relying on the low water quality effects, the mobility of fishes and the very wide distribution of most coastal fishes. While empirical evidence in Te Ākau Bream Bay is very limited, the study by Crossland (1981) on fish eggs and larvae of the Hauraki Gulf (and his earlier more detailed study on the distribution of snapper eggs and larvae (1980) provides a good picture of the overall pattern. I.e., Specific spawning locations (based on highest egg number) vary from year to year and there may be multiple spawnings at multiple locations. All are pelagic/midwater spawners, the eggs are neutrally or slightly positively buoyant. Spawning is often triggered by rising temperature to a trigger point - temperatures can vary at any given area from year-to-year so spawning locations may change from as water temperature patterns change due to weather and wind. Eggs and larvae drift and are relatively rapidly dispersed over time. They may drift for a month or two as they develop. While the majority of species spawn in spring/summer, some spawn in winter.

2.3 Food web implications for marine mammals

Prepared by: Helen McConnell, SLR Consulting New Zealand
The waters of the northeast coast of New Zealand are used by over 30 marine mammal species; however, only seven of these commonly visit Te Ākau Bream Bay (bottlenose dolphins, common dolphins, killer whales, false killer whales, pilot whales, Bryde's whales, and New Zealand fur seals). The foraging ecology of these common visitors varies widely and with the exception of Bryde's whales, typically include both demersal and pelagic prey (primarily fish and squid, see the summary of foraging ecology for marine mammals presented in Table 12 of McConnell (2025): the marine mammal assessment report). In particular, demersal fish and pelagic planktivorous fish are important contributors to the diet of some marine mammals, including the semi-resident population of bottlenose dolphins in Te Ākau Bream Bay.

As discussed in the sections above, while temporary elevations of turbidity and suspended sediment from the proposed activities could theoretically affect primary production, which could have flow-on effects for planktivorous fish, elevations in turbidity associated with the project will be:

1) Spatially limited (to a footprint approximately the width of the vessel and up to 2 km from the vessel),
2) Temporally limited (with turbidity reducing to background levels within about 30 minutes).

For these reasons, the magnitude of effects of the proposed activity on water quality and turbidity have been assessed as **negligible**. It follows that turbidity effects on primary production will also be **negligible**. Hence, effects of the project on pelagic planktivorous fish populations that contribute to the diet of some marine mammals, are expected to be minimal.

In addition, West (2025) concluded that at most the proposed sand extraction would result in a low magnitude of effects on fish, and that fish would not be adversely affected through loss of benthic prey associated with seabed disturbance that will occur during the proposed sand extraction.

On the basis of the information presented above:

- Detectable flow-on effects to marine mammals that target pelagic fish are highly unlikely; and
- Detectable flow-on effects to marine mammals that target demersal fish are also highly unlikely.

Furthermore, all marine mammal species expected in and around Te Ākau Bream Bay are highly mobile and have home-ranges that are very large compared to the area that will be subject to disturbance and have alternative foraging habitat readily available.

2.4 Food web implications for seabirds

Prepared by: David Thompson, NIWA
The marine environment to the northeast of New Zealand supports a diverse seabird assemblage. Conservatively, a total of approximately 20 species utilise Te Ākau Bream Bay for feeding from time to time, many of which are classified as 'Threatened' or 'At Risk' under the New Zealand Threat Classification System (see Robertson *et al*. 2021). Brough *et al*. (2024) recorded at least 23 species (but not including tara iti New Zealand fairy tern) in a recent structed and systematic survey of Te Ākau Bream Bay. While detailed, quantitative knowledge of the diets of seabirds is incomplete, it is very likely that seabird prey will comprise primarily fish, cephalopods and crustaceans in some proportion.

The proposed sand extraction will result in increased suspended sediment concentrations and turbidity in the water column, which have the potential to affect primary productivity and the abundance and availability of seabird prey. However, and as noted above, the scales of any such effects, both temporally and spatially, will be relatively small: elevated turbidity levels will return to ambient levels within about 30 minutes and will be constrained to a narrow area extending out up to 2 km from the stern of the extraction vessel. On this basis, proposed sand extraction has been assessed as having a negligible effect on water quality. It would seem reasonable to conclude that on this basis turbidity effects will also be negligible on marine productivity and hence on the prey species exploited by seabirds.

Given the mobile nature of prey species targeted by seabirds, and of seabirds themselves, temporary displacement from the relatively small area of elevated turbidity during extraction activities is likely to be inconsequential.

Overall, and on the basis of the information presented above, the effects of sand extraction on the marine food web supporting seabirds will be **negligible**.

For the reasons outlined above, this statement applies to all seabird taxa that utilise Te Ākau Bream Bay, including those with elevated threat classifications (e.g., tara iti New Zealand fairy tern) or those known to feed within the Bay (e.g., kororā northern little penguin, pakahā fluttering shearwater).

In the case of tara iti New Zealand fairy tern, work by Ismar *et al*. (2014) showed that at Mangawhai feeding by terns occurred predominantly in very shallow water habitats of the nearby estuary and along the adjacent shallow coastal fringe of the harbour's sand spit. Gobies *Favonigobius* sp., juvenile flounder *Rhombosolea* sp. and (possibly) small shrimp (amphipods) comprised the bulk of the diet by mass in juvenile tara iti New Zealand fairy tern based on stable isotope analyses of chick feathers. Stable isotope values of feathers reflect the chicks' diet over the period of feather growth during the breeding season, effectively integrating dietary information over this time period. Ismar *et al*. (2014) did not find any evidence for a substantive marine component in chicks' diet based on isotope data. The findings of Ismar *et al*. (2014) indicated that tara iti New Zealand fairy tern is closely linked to the productivity of the shallow harbour and mangrove forest that lie inside the Mangawhai sand spit, where they nest and roost, and to the shallow coastal fringe on the seaward side of the spit. The diet and primary feeding habitat of tara iti New Zealand fairy tern during the breeding season appear largely dependent on ecosystem services and foods of shallow harbours, estuaries and associated mangrove forests. Any direct or indirect impact on their food cycle from the proposed sand extraction in the central area of Te Ākau Bream Bay is extremely remote.

3 Conclusion

Sand dredging in shallow sandy habitats such as Te Ākau Bream Bay has minimal, if any, potential effects on small pelagic fish populations from **indirect (food-web mediated)** and **direct (habitat disturbance)** pathways. The small pelagic species in the region are primarily planktivorous, and thus influenced indirectly via changes in plankton availability which in turn is primarily influenced by nutrients and sunlight generating primary production. While small pelagic fishes are important to many seabirds, predatory fishes such as kahawai, tunas and kingfish, and some marine mammals, they are not directly linked to the known diet, feeding behaviour or feeding habitat of tara iti.

In addition, any turbidity or habitat disturbance generated by the proposed sand extraction will be highly localised, short-lived, and negligible relative to the spatial scale of pelagic fish habitat and the natural variability in coastal productivity. The mobility and broad distribution of small pelagic species further reduce the likelihood of any detectable ecological effect. Consequently, there is no plausible pathway by which the proposed activity could alter the availability of prey to higher predators or influence the foraging ecology of tara iti.

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