ASSESSMENT OF EFFECTS OF A PROPOSED MUSSEL SPAT-CATCHING/NURSERY OPERATION ALONG THE WESTERN WAIKATO COAST ON SEABIRDS

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ASSESSMENT OF EFFECTS OF A PROPOSED MUSSEL SPAT-CATCHING/NURSERY OPERATION ALONG THE WESTERN WAIKATO COAST ON SEABIRDS

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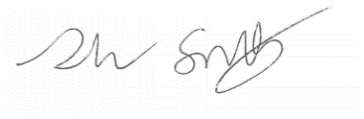

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1. INTRODUCTION

North Western Mussels Ltd is a joint venture between Gulf Mussel Farms, OP Columbia and Vela Fishing. North Western Mussels Ltd proposes to develop a large offshore spat-catching/nursery operation at four sites along the western Waikato coast. The four sites are located from Ruapuke Beach (Papanui Point) in the south to Pukerewa Road (Parikotuku Point) in the north (Figure 1, from the draft resource consent application, Kinetic Environmental November 2018). These sites have been chosen following several years of research on spat-catching/nursery viability along the Northland, Auckland, and Waikato coasts. The western Waikato spat-catching/nursery sites will capture spat larvae and relocate a proportion of that spat when it is a small size to the Hauraki Gulf. Other mussels will be grown to a final average seed size of 70 millimetres (range 50 to 90 mm) before being harvested before final seeding in the Hauraki Gulf. This is to try and use various strategies and locations to manage numerous risks (e.g. snapper predation of seed mussels).

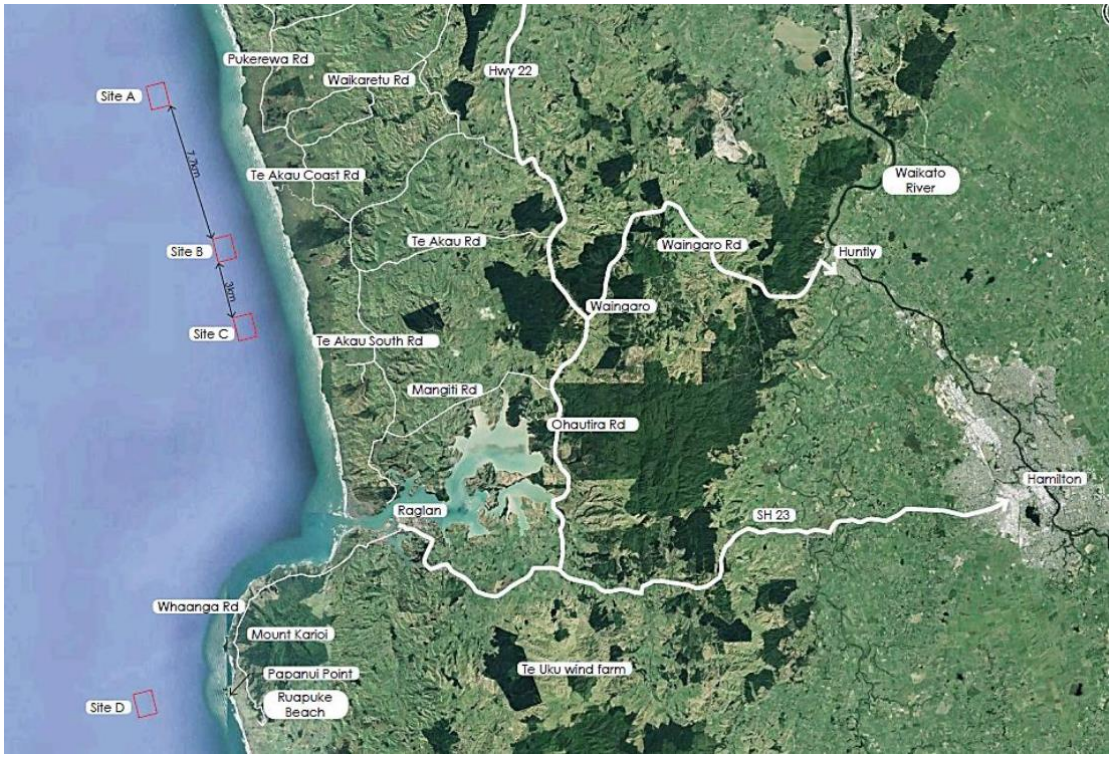

Figure 1: Proposed location of the four spat-catching/nursery sites, Waikato.

The proposed sites will each be approximately 3.1 kilometres from the coast in water 20-40 metres deep (Kinetic Environmental 2018). Three sites (Sites A, B, and C) will each cover an area of 2,000 metres by 1,500 metres, equalling a total of 180 hectares per site (including anchor and mooring lines, and unoccupied/non-consented space). Each site comprises three rows of 60 hectares of farmed space, each with paired or single lines anchored by screw anchors at 50 metre spacings. The southernmost site (Site D) will cover 160 hectares (2,000 metres by 1,200 metres), comprising two rows of 80 hectares of farmed space. The surface structures at Site D will occupy the exact

dimensions as sites A, B and C, but require longer anchor warps as the ocean is deeper at this site. The total consented area is 700 hectares.

The proposed spat-catch/nursery sites are separated as follows:

- 7.8 kilometres between A and B.
- 3.2 kilometres between B and C.
- 20.5 kilometres between C and D.

Backbone lines will be suspended approximately three metres below the sea surface. Dropper lines will be approximately eight metres long, and joined to the backbone in a continuous catching rope. The backbone lines will each be suspended using twenty 300 litre buoys. Orange buoys will be placed at each end of the backbone and one at the mid-point of the outside long-lines. Special marker buoys with yellow flashing lights will be placed 200 metres outwards of each corner of the spat-catching/nursery operation. Perimeter lights will be placed at each 950 metre intervals and 650 metre intervals along the length and width of each site, 100 metres outside of the edge of the spat-catching/nursery operation. The dropper lines consist of 60-80 millimetre 'hairy' or frayed-like rope onto which the microscopic free-swimming spat larvae will settle. The free-swimming larval settlement stage lasts approximately 3-5 weeks. Once attached, the metamorphosis from larval to adult form takes place, and an additional two weeks in situ is required before developing mussels can be seen by the naked eye. The droplines will be assessed at least once a week to determine rope capacity and suitable 'harvest' size. The spat will be caught from February to November and harvested as required.

The spat removal will consist of one of the following:

- Spat rope relocated when spat is just visible.
- Spat rope relocated when spat has grown up to 20 millimetres.
- Spat stripped and relocated up to an average of 70 millimetres.

The microscopic spat will be harvested over two days every two weeks between May and December. Maintenance will be undertaken mostly in the summer months and on an as-required basis. It will require two days per month to assess the structural integrity and rectify any wear and tear on lines, buoys, and lighting at each site.

The specialised mussel barge and support vessels will be moored at Raglan Harbour and will make their way to and from the spat-catching/nursery sites during harvesting and maintenance.

The proposed development will be implemented over two stages. Stage One will comprise of 50% of each site being constructed, followed by a period of assessment and monitoring before Stage Two is constructed.

Wildland Consultants have been asked to provide an ecological assessment of the potential effects of the farming operation on seabirds, particularly diving birds. The western Waikato coast is a known bird migration route for waders, and seabirds, including skuas, gannets, and terns.

2. METHODS

A desktop assessment was undertaken of seabird species distribution and abundance in the offshore western Waikato and coastal seabird populations along the Waikato coast. Sources of information include:

- Scientific papers, particularly those published in *Notornis* (the scientific publication of Birds New Zealand), and research on seabird tracking studies at sea.
- New Zealand Government fisheries observer data for seabirds attending fisheries vessels. Geographic Information System (GIS) analysis was used to select relevant western Waikato data from the national data set.
- eBird (http://ebird.org/content/newzealand/). The eBird website is a real-time, global online checklist programme where people submit bird observations, and now contains several hundred million bird records. Recent coastal and pelagic (offshore) species lists have been submitted for the Waikato Region. GIS was used to select relevant western Waikato data (coastal and at sea) from the global data set.
- The Atlas of Bird Distribution in New Zealand (https://ebird.org/atlasnz/explore). This publication also summarises the records of birds seen at sea within several kilometres of land.
- Unpublished data, for example, collected by the Department of Conservation and Birds New Zealand.
- Other assessments of potential and known effects of inshore and offshore mussel farming and spat-catching/nursery operations on seabird populations within New Zealand and internationally.
- The North Western Mussels Ltd resource consent application and AEE (Kinetic Environmental 2018).
- The monitoring framework for the Waikato coastal marine area: Report 2 – regional aquaculture monitoring priorities and guidance (Waikato Regional Council 2015).

  Information from the above sources was used to assess the likely effects of the proposed mussel spat-catch and nursery farms on birds using that utilise the Waikato coast. Potential controls, standards, and techniques for reducing any potential adverse effects and practices are recommended where appropriate, along with methods for monitoring seabird interactions with the spat farms.

Assessment of Effects

The New Zealand Coastal Policy Statement 2012 guidance note (NZCPS) - Policy 11: Indigenous biological diversity (Department of Conservation 2019) was assessed in relation to the At-Risk and Threatened taxa identified from the eBird and fisheries searches.

The ecological assessment of effects using the NZCPS guidance note outlines:

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 that species are at the limit of their natural range, or are naturally rare.
    v. Areas containing nationally significant examples of indigenous community types.
    vi. Areas set aside for full or partial protection of indigenous biological diversity under other legislation.

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 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 ecological corridors.
    vi. Ecological corridors, and areas important for linking or maintaining biological values identified under this policy.

In addition to assessing the above statutory criteria an assessment was also made using the Ecological Impact Assessment Guidelines prepared by the Environment Institute of Australia and New Zealand (Roper-Lindsay *et al.* 2018), hereafter referred to as the EIANZ guidelines. Although the guidelines are specifically designed to assess terrestrial and freshwater ecosystems, the application of the categories are used to provide an indication of potential effects on avifauna. The guidelines were also used to assess the potential ecological effects of the proposed spat-catching/nursery operation.

The ecological assessment of effects using the EIANZ guidelines involved the following steps:

a) Assigning ‘Ecological Value’ to species likely to be impacted within the spat-catching/nursery farm. The ‘Ecological Value’ of a species is scored on a scale of ‘Negligible’ to ‘Very High’ and is assessed in terms of national threat status (Table 1).

Table 1: Factors considered when assigning value to terrestrial species.

Determining Factors	Value
Nationally Threatened species, found in the Zone of Impact (ZOI) either permanently or seasonally.	Very High
Species listed as At Risk – Declining, found in the ZOI, either permanently or seasonally.	High
Species listed as any other category of At Risk, found in the ZOI either permanently or seasonally.	Moderate
Locally (Ecological District) uncommon or distinctive species.	Moderate
Nationally and locally common indigenous species	Low
Exotic species, including pests, species having recreational value.	Negligible

b) The 'Magnitude of Effect' of a proposed activity on the environment is assessed after all effects have been considered. The 'Magnitude of Effect' is a measure of the extent or scale of the effect of an activity and the predicted degree of change that it will cause. The 'Magnitude of Effect' is scored on a scale of ''Negligible'' to 'Very High' and is assessed in terms of:

(i) Level of confidence in understanding the expected effect.
(ii) Spatial scale of the effect.
(iii) Duration and timescale of the effect.
(iv) The relative permanence of the effect.
(v) Timing of the effect in respect of key ecological factors.

c) An overall level of residual effects that cannot be avoided or minimised for each habitat or species value is determined using a matrix approach that combines the 'Ecological Values' with the 'Magnitude of Effects' resulting from the activity. The matrix estimates an overall 'Level of Effect' on a scale from 'Negligible'' to 'Very High'.

3. SEABIRD FORAGING AND ROOSTING ON MUSSEL FARMS

Seabirds are bird species that spend part of their lifecycle feeding in the open sea. New Zealand is known as the seabird capital of the world, with more seabird species (some 80 taxa) breeding in New Zealand waters than in any other country (Forest and Bird 2014). Many of these species breed nowhere else, and most are Nationally Threatened or At Risk.

There are significant knowledge gaps concerning many seabird species in New Zealand. While the overall distribution of most species is well documented, detailed information on the time-specific distribution, abundance and critical habitats is lacking (Sagar, 2013). Several New Zealand and overseas publications discuss the potential ecological effects of shellfish aquaculture on seabird populations, but only a few studies have been undertaken (Roycroft *et al*. 2007; Wildlands 2020b).

A pilot study on kawau pāteketeke/king shag (*Leucocarbo carunculatus*, Threatened-Nationally Endangered), which is restricted to the Marlborough Sounds, was undertaken to understand the effect of mussel farming (Wildlands 2020b). The aim was to investigate if they avoid, prefer, or are indifferent to foraging in mussel farms in Pelorus Sound.

The method involved the manual observation of eight paired sites. Each site combination comprised of a mussel farm and a 'control' site of equal size. The control sites were approximately 200 metres from a mussel farm, of the same depth, and over suitable habitat for a mussel farm (benthic substrate mainly consisting of silt, sand and mud). Each paired site was observed for two days (approximately 14 hours), except for one paired site, which was only observed for one day, as a harvesting vessel arrived on the morning of the second day.

In addition to the observations of king shags using the farm and control sites, counts were made of other bird species present in the farm and control sites at 15-minute intervals throughout each two-day period. General notes were made on the behaviours of those bird species at the sites, for example, foraging between backbone ropes, feeding on algae and other biota associated with backbone ropes, roosting on buoys, and resting on the sea surface. It is the first study to attempt to describe the use of mussel farms by birds, and to compare it to an equivalent area of un-farmed marine space.

This study was based on mussel farms rather than spat-catching/nursery farms, and the farms are inshore (mostly within 50 metres of the coast) compared to the proposed spat-catching/nursery farms, which are much further from shore. However, many of the bird species that use inshore mussel farms will also forage out to sea (e.g., shags, gulls, and terns).

The spat-catching/nursery farm will provide similar potential food sources for birds as a mussel farm does, including algal and bivalve encrustations on buoys, backbone ropes and other mooring structures, and may attract wild fish.

In summary, the results of the Pelorus Sound pilot study included:

- Kawau/king shags were present at five of the eight farms, and four of the control sites. Birds were not observed at two of the eight paired sites. King shag roosted at five farms, and roosted and foraged at three farms.

- The pilot study indicates that almost all of the species use mussel farms significantly more than adjacent un-farmed coastal waters. There is an indication, therefore, for benefits to seabirds, in terms of providing a resting point and/or a food source. Consequently, they may be more attracted to mussel farms than spat-catching/nursery farms or areas with no farms. Nevertheless, any adverse effects on seabirds should be less than minor.

- Kawaupaka/little shag (*Microcarbo melanoleucos brevirostris*, At Risk-Relict) was the most commonly seen species at the mussel farms, with often more than one bird present on a farm at a time (a maximum of eight birds at one time). It was present at all eight farms and one control site. Little shags were mostly observed roosting on buoys, but occasionally they foraged within farms.

- Karoro/southern black-backed gull (*Larus dominicanus dominicanus*, Not Threatened) was also a very common species at the farms. The maximum seen at any one time was 10 individuals. The species was present at all eight farms and one control site. Birds roosted on buoys and rested on the water within farms. The gulls foraged on backbone ropes and on the water surface, and followed mussel boats working at farms.

- Tarāpunga/red-billed gulls (*Chroicocephalus novaehollandiae scopulinus*, At Risk-Declining) were present at approximately one-quarter of all counts at farms. The species was present at all farms and one control site. Red-billed gulls rested on buoys and the water at farm sites and foraged off the ropes and the water surface. Birds also followed mussel boats working at farms.

- Parekareka/spotted shag (*Stictocarbo punctatus punctatus*, Not Threatened) was also common at farms. It was observed at seven of the eight farms and one control site. Of the four shag species, it was the most likely to forage within farms.

- Kāruhiruhi/pied shags (*Phalacrocorax varius varius*, At Risk-Recovering) were observed at five of eight farms and one control site. Birds mainly roosted on farms. The exception was at Otatara Bay when at least five pied shags were seen repeatedly diving and surfacing behind a mussel boat as it was pulling up mussel lines.

- Taranui/Caspian tern (*Hydroprogne caspia*, Threatened-Nationally Vulnerable) were present at six of the eight farms but were not observed at any control sites. They were only observed roosting on buoys, and were not seen diving within farms. However, they were observed feeding near farms.

- Tara/white-fronted tern (*Sterna striata striata*, At Risk-Declining) were only seen at one farm, where two birds roosted on buoys, but were not seen feeding.

4. SEABIRD SPECIES WITHIN THE SPAT-CATCHING/NURSERY SITES

The seabird community along the west coast of the North Island is diverse. Comprising a combination of species nesting on the mainland, such as shags, gulls and terns. Species breeding on 'seabird islands', such as Karewa Gannet Island, and pelagic seabird species that breed as far away as the Subantarctic Islands and beyond, but forage in the region or pass through on route to different foraging grounds. These seabird species fall into three ‘orders’: albatrosses, shearwaters, petrels, and storm petrels (Procellariiformes), gannets and shags (Pelecaniformes), and gulls and terns (Charadriiformes).

Several key sources of information have been used to describe the seabird community, including terrestrial sightings and ‘at sea’ records, including:

- ‘Important Bird Area’ documents (BirdLife International/Forest & Bird).
- The eBird global database (Cornell Lab of Ornithology).
- Seabird observations obtained by fisheries observers (Ministry of Primary Industries).

These sources are described in the following paragraphs.

4.1 Important Bird Areas

The Important Bird Area (IBA) programme was developed by BirdLife International, and has been used for over 30 years. Over 12,000 IBAs have been identified worldwide, and Seabird IBAs in New Zealand were published in 2014 and 2015. Identifying an

IBA is based on a relatively simple set of criteria that can be applied in terrestrial and marine environments. Criteria for the identification of an IBA are:

- A1 - More than threshold numbers of one or more globally threatened species.
- A2 - More than threshold species complements of restricted-range species.
- A3 - More than threshold species complements of biome-restricted species.
- A4 - More than threshold numbers of one or more congregatory species, including:
  - A4i >1% of the biogeographic population of waterbirds.
  - A4ii >1% global population of seabirds.
  - A4iii >10,000 pairs, seabirds or 20,000 individuals, waterbirds.
  - A4iv > Threshold numbers at migration bottleneck sites.

The west coast of the North Island is part of an IBA for seabirds (NZ M003 West Coast Eastern North Island). This 'at sea' IBA covers an area of 14,993 km^2 and has been identified based on two seabird species (tākapu/Australasian gannet *Morus serrator*, Not Threatened and tara iti/New Zealand fairy tern *Sternula nereis davisae*, Threatened-Nationally Critical). The IBA criteria is A4ii. A map and details of the IBA are provided in Appendix 2. The application site falls within this large IBA. This IBA triggers Policy 11 (a)(vi) in the New Zealand Coastal Policy Statement 2010.

In addition, Karewa Gannet Island (NZ029, -37.972282 174.565973) has been identified as an IBA 'on land' based on the presence of thousands of pairs of Australasian gannets. Again, triggering the IBA criteria is A4ii. A map and details of the IBA are provided in Appendix 2. The proposed site D farm is approximately 18 kilometres northeast of Gannet Island. This IBA triggers Policy 11 (a)(vi) in the New Zealand Coastal Policy Statement 2010

4.2 eBird, Atlas of Bird Distribution in New Zealand and fisheries observation records

eBird is a citizen science, global database available online. Anyone can submit bird observations to the website. Observations include those of single birds through to checklists of all birds seen at a location or along a route. The database now holds hundreds of millions of records from around the world. The database has become an extremely valuable source of information on the presence and abundance of bird species around New Zealand. However, the data set has issues, limitations, and potential biases. These include species misidentification (potentially a significant issue with seabirds), bias towards locations that people regularly visit, reporting species 'of interest' rather than all species seen, and the accuracy of the map reference associated with the records. The data search was undertaken to assess seabirds and shorebirds observed between Karioitahi Beach to the Waikawau Tunnel beach and up to *c.*55 kilometres offshore from January 2019 to December 2021 (hereafter the study site, Table 2 and Appendix 1). The coastal area covers approximately 160 kilometres of coastline (Figure 2). Twelve pelagic surveys (11 October 2020) were undertaken offshore from Kawhia and are situated adjacent to or south of the proposed Site D (Table 2). Kawhia Harbour has significant conservation value for resident and frequenting endangered, rare, and threatened wading and coastal bird species (Waikato Regional Council 2012). One of the surveys assessed the birds at Gannet Island and within the adjacent ocean area (less than one kilometre) for the New Zealand eBird Atlas data set. The Atlas of Bird Distribution was also assessed for additional bird species, which were not recorded

on eBird (accessed 27 July 2022). The Atlas aims to identify bird species within every grid square (10 × 10 kilometres).

One species is classified as Threatened-Nationally Critical (toroa/Salvin's mollymawk *Thalassarche salvini*), one species is Threatened-Nationally Endangered (matuku moana/reef heron *Egretta sacra sacra*), three species are Threatened-Nationally Vulnerable (tāiko/black petrel *Procellaria parkinsoni*, taranui/Caspian tern, and toroa/northern royal albatross *Diomedea sanfordi*), one species is Threatened-Nationally Increasing (tūturiwhatu/northern New Zealand dotterel *Charadrius obscurus aquilonius*), eight species are At Risk-Declining (toroa/shy mollymawk *Thalassarche cauta steadi,* rako/Buller's shearwaters *Ardenna bulleri*, tītī/sooty shearwater *Ardenna griseus*, tarāpunga/red-billed gull, tara/white-fronted tern, kuaka/eastern bar-tailed godwit *Limosa lapponica baueri*, huahou/lesser knot *Calidris canutus rogersi*, and tōrea/South Island pied oystercatcher *Haematopus finschi*), two are At Risk-Naturally Uncommon (kawau tūī/little black shag *Phalacrocorax sulcirostris* and kōtuku-ngutupapa/royal spoonbill *Platalea regia*), four are At Risk-Recovering (totorore/North Island little shearwater *Puffinus assimilis haurakiensis,* pāngurunguru/northern giant petrel *Macronectes halli,* pied shag and tōrea pango/variable oystercatcher *Haematopus unicolor*), and six species are At Risk-Relict (toanui/flesh-footed shearwater *Ardenna carneipes* pakahā/fluttering shearwaters *Puffinus gavia*, takahikare/New Zealand storm petrel *Pelagodroma marina maoriana*, kuaka/northern diving petrels *Pelecanoides urinatrix urinatrix*k, tītī wainui/New Zealand fairy prion *Pachyptila turtur*, and māunga/black shag *Phalacrocorax carbo novaehollandiae*; Appendix 1). The species trigger Policy 11 (a)(i) in the New Zealand Coastal Policy Statement 2010 (NZCPS). Various species feature on the International Union for Conservation of Nature and Natural Resources (IUCN) Red List of Threatened Species (Red List) and thus trigger NZCPS Policy 11 (a)(ii). These include one 'endangered' species and three 'vulnerable' species (Appendix 1).

Fisheries observers are placed by the Ministry for Primary Industries on selected commercial fishing boats. The primary role of observers is to collect information on aspects of the quota management system, such as catch effort and bycatch data. Observers began collecting seabird abundance data for the Department of Conservation in 2004 and undertook analysis in 2019 (Richards *et al*. 2020). Data are publicly available. The accuracy of species identification is variable, and data are strongly biased towards species that are attracted to commercial fisheries vessels. However, the data set provides a different perspective of the seabird community present along the west coast of the North Island compared to the eBird data (Table 2).

Analysis of the data sets involved overlaying the eBird and fisheries observer databases with a map of the 'study area' to select relevant records. The study area was split into three zones for the analysis; the coastal zone within four kilometres of the coast, Gannet Island, and the sea zone – a zone with subjective boundaries set to include the pelagic bird surveys (Figure 2). The resulting eBird data set is summarised in Table 2, and the fisheries observer data set in Table 3.

Table 2: eBird records of seabird species along the coast and at-sea adjacent to the study site (between Karioitahi Beach to Waikawau Tunnel Beach) from January 2019 to December 2021. Their ecological value has been assessed using the EIANZ guidelines (Roper-Lindsay *et al.* 2018).

Common Name	Coastal Zone		Gannet Island		Sea Zone		Total Number of Observations	Total Number of Reports	Ecological Value
	Number of Birds	Number of Reports	Number of Birds	Number of Reports	Number of Birds	Number of Reports			
Albatrosses									
Northern royal albatross	2	2					2	2	Very High
Black-browed mollymawk	1	1					1	1	Moderate
Salvin's mollymawk	1	1					1	1	Very High
Shy mollymawk	23	8	1	1	24	6	48	15	High
Shearwaters, petrels, prions and fulmar									
Buller's shearwater	3	2	6	1	37	7	46	10	High
Flesh-footed shearwater	1	1	2	1	23	4	26	6	Moderate
Fluttering shearwater	151	6			54	5	205	11	Moderate
North Island little shearwater					6	3	6	3	Moderate
Shearwater sp.	20	1					20	1	
Sooty shearwater					26	6	26	6	High
Black petrel			3	1	1	1	4	2	Very High
Cape petrel	1	1					1	1	Moderate
Grey-faced petrel	17	7			2	2	19	9	Low
New Zealand white-faced storm petrel					4	3	4	3	Moderate
Northern diving petrel	1	1			14	5	15	6	Moderate
Northern giant petrel	8	5					8	5	Moderate
Fairy prion	5	1					5	1	Moderate
Prion sp.					1	1	1	1	
Northern fulmar	2	1					2	1	Moderate
Gannets and shags									
Australasian gannet	329	38	6,700	3	174	9	7,203	50	Low
Black shag	13	8			4	2	17	10	Moderate
Little black shag	5	3					5	3	Moderate
Little pied shag	6	3					6	3	Moderate

Common Name	Coastal Zone		Gannet Island		Sea Zone		Total Number of Observations	Total Number of Reports	Ecological Value
	Number of Birds	Number of Reports	Number of Birds	Number of Reports	Number of Birds	Number of Reports			
Pied shag	210	46			6	2	216	48	Moderate
Skuas, gulls and terns									
Pomarine skua	2	2					2	2	Moderate
Skua sp.					2	2	2	2	
Red-billed gull	164	48	31	4	154	2	349	54	High
Southern black-backed gull	890	105	54	4	144	7	1,088	116	Low
Caspian tern	115	47					115	47	Very High
Eastern little tern	4	1					4	1	Moderate
White-fronted tern	772	30	401	1			812	31	High
Grand Total	2,746	369	6,837	16	679	67	10,259	452	

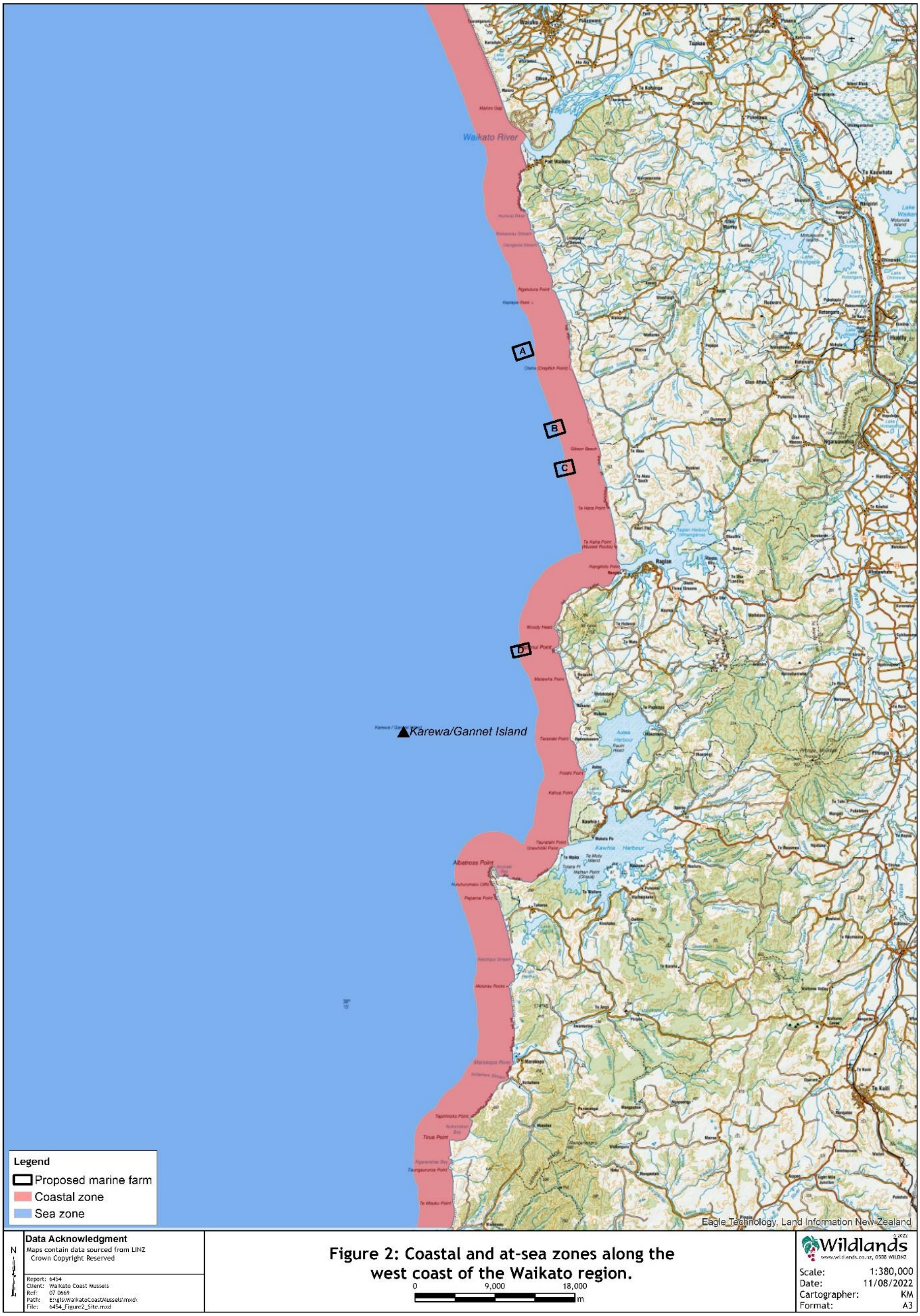

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Figure 2: Coastal and at-sea zones along the west coast of the Waikato region.

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Table 3: Fisheries observer records (nomad devices) of seabird species offshore of the study site from December 2009 to December 2017 (Richards *et al.* 2020). Their ecological value has been assessed using the EIANZ guidelines (Roper-Lindsay *et al.* 2018).

Common Name	Sea Zone		Ecological Value
	Total number of Birds	Total number of Reports	
Penguins			
Penguin spp.	6	3	
Albatrosses			
Albatross spp. large	866	96	
Albatross spp. small	799	47	
Antipodean and Gibson's albatross	3	2	Very High
Northern royal albatross	17	10	Very High
Southern royal albatross	21	12	Very High
Wandering albatross	47	11	Moderate
Black-browed mollymawk	667	75	Moderate
Buller's mollymawk	198	25	High
Campbell Island mollymawk	10	1	Moderate
Grey-headed mollymawk	10	1	Very High
Salvin's mollymawk	720	35	Very High
Shy mollymawk	11,499	663	High
Tasmanian mollymawk	390	20	Moderate
Shearwaters, petrels, and prions			
Buller's shearwater	17	16	High
Flesh-footed shearwater	2,143	267	Moderate
Fluttering shearwater	247	11	Moderate
Shearwater spp.	1,528	73	
Shearwater, prions, and petrels	1,916	60	
Sooty shearwater	375	28	High
Black petrel	685	58	Very High
Cape petrel	2,050	93	Moderate
Grey petrel	4	4	Moderate
Grey-faced petrel	1	1	Low
New Zealand fairy prion	1,115	34	Moderate
New Zealand white-faced storm petrel	286	9	Moderate
Northern diving petrel	128	11	Moderate
Petrel spp.	4,131	174	
Southern/northern giant petrel	446	142	Moderate
Storm petrel spp.	3817	70	
Westland petrel	934	64	Moderate
White-chinned petrel	698	31	Low
Prion spp.	4,642	112	
Gannets and shags			
Australasian gannet	972	149	Low
Boobies and gannets	11	2	
Shag spp.	5	1	
Skuas, gulls and terns			
Gull and tern spp.	48	12	
Red-billed gull	9	4	Moderate
Southern black-backed gull	2,311	468	Moderate
White-fronted tern	34	11	High
Unidentified			
Seabirds	193	13	
Total	43,999	2,919	

An overview of the results is discussed in the following paragraphs, concentrating on species that are Nationally Threatened or At Risk, rare in the region, or others that have the potential to be affected by the proposed farm. Specific comments on the potential for adverse effects are also discussed.

4.3 Albatrosses and mollymawks

Four large Procellariiformes species have been reported from the study area (toroa/ northern royal albatross; toroa/black-browed mollymawk *Thalassarche melanophris*, Non-resident Native-Coloniser; toroa/Salvin's mollymawk, and toroa/shy mollymawk). Overall, observations are rare (Table 1), which is not unexpected given that such species are likely to be present infrequently close to the coast. However, shy mollymawks were seen more often than the other species (23 coastal and 24 sea zone birds). The much higher numbers of albatrosses reported by fisheries observers in the region are most likely due to their strong attraction to commercial fisheries vessels bringing such species closer to shore (Table 3). They are very unlikely to be significantly affected by the proposed farm, given their preference for deeper, offshore waters.

4.4 Shearwaters, petrels, prions, storm petrels and fulmars

Eighteen species of the smaller Procellariiformes (petrels, shearwaters, prions, diving petrels, storm petrels, and fulmars) were recorded by eBird observers (Table 2), and a further three species by fisheries observers (Table 3). The Coastal observations are dominated by pakahā/fluttering shearwaters, followed by 20 unidentified shearwater species, ōi /grey-faced petrel (*Pterodroma macroptera gouldi*, Not Threatened) and pāngurunguru/northern giant petrel. The eBird data set indicates that all of these species are present within the coastal zone, four kilometres from shore.

Fluttering shearwaters are one of New Zealand's most common seabirds and were also the most commonly observed species in the four kilometre coastal zone (Table 2). Fluttering shearwaters often feed in immense flocks and undertake pursuit dives for prey, often schooling fish (Berg *et al*. 2019). They frequently forage with other seabird species, including Australasian gannet, tītī wainui/New Zealand fairy prion and rako/Buller's shearwaters. Fluttering shearwater predominately forage in coastal waters with an average ocean depth of 946 metres (Berg *et al*. 2019). However, eBird records clearly show that the foraging distributions of this species overlap with the proposed spat-catching/nursery farm locations.

The population of northern and pāngurunguru/southern giant petrel (*Macronectes giganteus*, Non-resident Native-Migrant) are estimated to be *c*.11,210 and 30,575 breeding pairs, respectively (Peterson *et al*. 2008). Both petrel species breed primarily on sub-Antarctic islands but forage over large areas of the southern hemisphere (Gonzalez-Solis *et al*. 2000). However, a population of northern giant petrel have been identified on the Auckland Island group (Parker *et al*. 2020). The breeding population is estimated as *c*.340 breeding pairs. This species interacts with fishing vessels and has been recorded as trawler by-catch (Richards *et al*. 2020, Table 2).

The population of toanui/flesh-footed shearwater in New Zealand is estimated to number less than 12,000 breeding pairs (Taylor 2013). The species also breeds in Australia, where it is much more common. Both populations are thought to be in decline due to interactions with fisheries vessels, and possible ingestion of plastics. It was the most common species reported by fisheries observers (Table 3), and had the highest number of eBird reports of the shearwater and petrel species (Table 2).

Flesh-footed shearwater breeding colony on Kauwahaia Island is approximately 78 kilometres north of the proposed farm, and is estimated to have approximately 20 breeding pairs (Waugh *et al*. 2014). A GPS tracking study analysed 58 loggers which were attached to breeding birds from New Zealand's two largest colonies on Titi Island in Cook Strait and Ohinau Island in the Bay of Plenty (Waugh *et al*. 2016). Individuals were seen to forage over the shelf and in deep oceanic waters up to 1,200 kilometres from their nesting sites. The observed foraging areas overlap with commercial fisheries and within waters of *c*.200-1,000 metres deep (Waugh *et al*. 2016). The species feeds on small fish, squid, and other soft-bodied species, usually taken in shallow dives. However, tracking devices have shown that flesh-footed shearwaters can dive deeper than 60 metres (Waugh *et al*. 2016).

Tāiko/black petrel is only known to breed on Hauturu/Little Barrier Island and Aotea/Great Barrier Island in the Hauraki Gulf, where it may number only a few thousand breeding pairs (Zhang *et al*. 2020). Along the study site, eBird records show that small numbers of black petrels were seen within the one-kilometre of Gannet Island and out to sea (Table 2). However, black petrel was commonly observed by fisheries observers (Table 3).

Black petrels are considered to be the seabird species at greatest risk from commercial fishing activity within New Zealand fisheries waters, following boats to take bait from lines (Richard and Abraham 2013). Natural prey includes squid and small fish. Recent tracking work indicates birds mostly feed by shallow diving but are capable of diving to much greater depths of 34 metres (Bell 2016). Most dives were made during the day, and only males were found to feed at night.

Tītī/sooty shearwater is a super-abundant seabird species. The population has been estimated at *c*.4.4 million pairs or up to 21 million birds, with at least 180 colonies located from the Three Kings in the north to the Subantarctic Islands (Newman *et al*. 2009). Around 53% of the breeding population is found on the Tītī Islands surrounding Rakiura (Stewart Island). However, local populations may be quite small, and the eBird records were recorded near Gannet Island (Table 2).

Like flesh-footed shearwater and black petrel, sooty shearwater has been killed through interactions with commercial fisheries vessels (Richards *et al*. 2020). In addition, extensive research has identified large-scale shifts in foraging distributions from the New Zealand coastal shelf to the Polar Frontal Zone (Shaffer *et al*. 2009). The prey of sooty shearwater includes fish, squid, and krill. Birds mostly feed by diving to depths less than about seven metres, but can reach average maximum depths of 69 metres (Dunphy *et al*. 2015).

Kuaka/northern diving petrels, New Zealand fairy prions and Buller's shearwater were also observed species in the four-kilometre coastal zone (Table 1). Diving petrels often feed in flocks and forage on krill, small fish, and squid (Rayner *et al*. 2017). Despite being a very small seabird (weighing around 130 grams), diving petrels can dive relatively deeply (mean maximum dives of 10.9 ± 6.1 metres and up to 22.2 metres, Taylor 2008). In contrast, fairy prions feed on or near the surface for zooplankton, molluscs, and small fish, but their foraging habits and at-sea distribution are poorly known (Jamieson *et al*. 2016). Buller's shearwater only breeds on the Poor Knights

Islands with an estimated population of *c*.78 thousand breeding pairs, and forages widely throughout the Pacific Ocean during the non-breeding season (Friesen *et al*. 2021). Nevertheless, eBird records clearly show that the foraging distributions of these three species overlap with the proposed spat-catching/nursery farm. Individual birds may be attracted to boat activity as fish may be brought to the surface through maintenance or spat harvesting activity. However, it is unlikely to have any significant affect on these species.

4.5 Gannets and shags

The tākapu/Australasian gannet breed on Karewa Gannet Island and 329 individuals were found within the coastal waters, and 6,874 eBird observations recorded gannets in the more expansive Gannet Island and sea zone areas (Table 2). This area has significant conservation values as an island wildlife sanctuary and is a major gannet breeding site (Waikato Regional Council 2012).

Gannets have extensive foraging ranges. For example, gannets at the Cape Kidnappers colony have been shown to forage a mean distance from the colony of 55.6 ±23.3 kilometres during the breeding season, with birds flying an average of 267.9 ±120.6 kilometres during each foraging trip (Machovsky-Capuska *et al*. 2014). Cape Kidnappers gannets undertake extensive non-breeding seasonal migrations, travelling to coastal waters of South Australia and Tasmania to overwinter, travelling up to 13,000 kilometres.

The species regularly attends 'boil-ups' of dense fish schools brought to the surface by dolphins and predatory fish. It feeds on a variety of fish and squid, usually diving to less than six metres deep (Machovsky-Capuska *et al*. 2014). If the spat-catching/nursery farm structures act as a fish aggregating device, dolphins and predatory fish forage within the area could positively affect tākapu/Australasian gannet.

Four shag species were present along the study site, and eBird records indicate that the most common is pied shag (Table 2). Population sizes are unknown, although numbers of pied shags in northern New Zealand are estimated to have been increasing (Bell 2013). A small number of māunga/black shag, kawau tūī/little black shag and kawaupaka/little pied shag (*Microcarbo melanoleucos melanoleucos*, Non-resident Native – Vagrant) were also observed along the coast. The eBird data suggests the feeding distributions of all four species overlap with the proposed spat-catching/nursery locations and are coastal foraging species (Powlesland *et al*. 2008). The buoys will provide suitable roosting structures and the potential for aggregating fish; this will positively affect shag species.

4.6 Gulls and terns

Red-billed gull, white-fronted tern and southern black-backed gull are common inshore species. The red-billed gull population in the northern North Island has undergone a significant decline over the last decades. One of the largest New Zealand colonies on the Mokohinau Islands (wider Hauraki Gulf) numbered from 2,000-6,500+ pairs in the 1940s, but a recent national survey of colonies only found 58 nests in the island group (Frost and Taylor 2016). Given the lack of introduced predators at this site, the implication is that the species is affected by at-sea food availability changes. During

the breeding season, the main food of the gulls is krill (*Nyctiphanes australis*), but the diet is more variable outside of this period. Colonies that coexist with introduced terrestrial mammalian predator populations are vulnerable to predation.

White-fronted terns breed in New Zealand and migrate to Australian coastal waters during adolescence or for the non-breeding season (Williams *et al*. 2016). This species roosts and nests on beaches, headlands and small offshore islands with gannets, gulls and other terns that over-winter in New Zealand. The species is in decline nationally, with predation by introduced predators thought to be the primary threat (Heather and Robertson 2015). Disturbance of breeding colonies by people may also be an issue.

Small numbers of tara teo/eastern little tern (*Sternula albifrons sinensis*, Non-resident Native-Migrant) and Caspian tern are present in the location of the proposed spat-catching/nursery farm (Table 2). Eastern little tern may be present from October to March and are mostly in non-breeding plumage (Heather and Robertson 2015). Small flocks or individual birds may be seen around the North Island and are mainly seen at estuaries and coastal lakes.

Caspian tern number as low as 1,300-1,400 pairs nationwide, but cosmopolitan in distribution. It nests in small colonies or as single pairs (Bell and Bell 2008). The species mainly forage on fish in estuaries, harbours, and other inshore locations but is not often seen further out to sea (Heather and Robertson 2015). The buoys may provide suitable roosting structures for white-fronted tern and southern black-backed gull. However, it is unlikely to have any significant affect on any gull or tern species.

5. POTENTIAL EFFECTS OF THE PROPOSED FARM/S

The potential effects of mussel farming (and other marine farming operations) on seabirds (and other biotas) have been assessed by the Department of Conservation (Butler 2003), Wildland Consultants (Wildlands 2020a, b), Pacific Coastal Ecology (White 2018), Cawthron Institute (Keeley *et al*. 2009), and National Institute of Water and Atmospheric Research (NIWA; Sagar 2013). The findings of these reports are summarised in Table 4 and discussed in the following paragraphs.

Table 4: The potential effects of mussel farming on seabirds (Sagar 2013, Keeley *et al*. 2009, and White 2018) and their magnitude of effect and level of adverse effect has been assessed using the EIANZ guidelines (Roper-Lindsay *et al*. 2018).

Potential Effects	Description	Magnitude of Effects	Level of Adverse Effects
Entanglement	Diving birds may become entangled in underwater ropes and other structures, leading to mortality.	Low	Low-Negligible
Habitat exclusion	Structures may deter birds from feeding on farms or inhibit movement within a farm.	Low	Negligible
Benthic habitat changes	The deposition of mussel shells and pseudofaeces changes the benthic fauna beneath a farm, which may include benthic and demersal fish.	Low	Low

Potential Effects	Description	Magnitude of Effects	Level of Adverse Effects
Changes in prey abundance	Epifaunal community on mussels has been recorded to consist of numerous different species. Ammonia excreted by mussels can lead to high productivity of seaweeds on ropes and lines. Fish may be attracted to the farm to feed on organisms growing on ropes, for shelter, or to prey on smaller fish. However, some prey species of seabirds may be reduced within a mussel farm. Mussels consume plankton; phytoplankton depletion may have flow-on effects on prey abundance.	High	Positive
Provision of roosting sites	Allows birds to rest close to foraging sites but away from potential predators.	High	Positive
Disturbance and noise	Presence of the farm and associated vessels may disturb breeding and feeding seabirds. Vessels may disturb breeding seabirds travelling to and from the farm.	Moderate	Low
Foreign debris – ingestion and entanglement	Birds can swallow plastics accidentally or become entangled in loose ropes, which can directly or indirectly impact survival.	High	Moderate
Attraction to lights	Lights can attract or disorientate seabirds, causing them to collide with structures.	Low	Low
Water pollution	For example, the result of an accidental collision of a larger boat with a farm releasing an oil spill. This is considered a low risk given the flexibility of mussel farm structures are unlikely to cause major damage to vessels.	High	Negligible

5.1 Entanglement in structures

Entanglement can injure or kill diving birds, and could affect the stability of vulnerable populations if species are particularly rare and/or mortality is frequent. However, no injuries or entanglements have been reported from New Zealand or overseas mussel farms. The entanglement risk within a mussel farm is very low given the thickness of ropes and structures associated with mussel farming as ropes are held under considerable tension and because of the lack of nets (Keeley *et al*. 2009, Lloyd 2003, Sagar 2013). A spat-catching/nursery farm may cover more of the water column than a mussel farm but should not pose a greater risk than a mussel farm (Butler 2003). The farm is proposed to consist of conventional longline structures. The backbone lines are below the surface (about three metres) and will be approximately 2,000 metres in length, with *c.*300 (Sites A, B and C) to 400 metres (Site D) between lines. The backbone lines will be supported by 20 300-litre buoys arranged along the sea surface. Spat-catching/nursery rope will be hung from the backbones to approximately eight metres in depth. The risk of seabirds becoming caught in these rope structures seems very low, and the potential effect is less than minor and probably negligible. Nevertheless, if a bird is entangled, all incidents, regardless of outcome (e.g. injury or mortality), must be reported to the Department of Conservation as outlined in the Waikato Regional Coastal Plan (Waikato Regional Council 2015).

5.2 Habitat exclusion

The presence of structures in the marine area may affect seabird species differently. Some species could potentially avoid foraging within or around farm structures (habitat exclusion), others may be unaffected by the presence of structures, and some species may be attracted to those structures (buoys as roosting sites, Wildland Consultants 2020a&b, Roycroft *et al*. 2007). Moving mussel farms offshore has the potential to affect a greater diversity of seabird species, given pelagic species, such as most petrels and shearwaters, will not be present in a coastal environment. However, these species generally have expansive foraging ranges, and the area of an offshore farm will comprise a very small proportion of their 'at sea' distribution.

Of the pelagic species, the most plentiful inshore populations are the locally abundant fluttering shearwater, fairy prion, and grey-faced petrel, whose distributions overlap with the proposed farm. It is not known whether these species may be less likely to forage within the structures of the marine farm. However, even if these species avoided foraging within the spat/nursery farm, this would represent a very small reduction in the species' foraging habitats and a less than minor effect. The other species listed in Table 2 are even less likely to be affected, given their lower use of the shallow waters compared to deeper, offshore waters.

During a pilot study to assess the use of mussel farms by king shag in the Marlborough Sounds, gannets were not observed diving in mussel farms or in the control sites Wildlands 2020b). However, gannets were regularly observed diving next to mussel farms, both study farms and adjacent farms, possibly benefitting from higher abundances of fish around the mussel farms. If gannets are deterred from diving within structures, this will have a negligible effect on the species, given its extensive foraging range in the area.

5.3 Benthic habitat change

Benthic habitat changes beneath mussel farms have been well studied, with a general increase in organic enrichment, increase in some seabed species assemblages and variable levels of shell drop from mussels (Keeley *et al*. 2009, Wong and O'Shea 2011). The sediment enrichment generally results in increased productivity and changes in composition of infauna, while changes in epifauna populations are less predictable. The benthic changes beneath the proposed spat-catching/nursery farm are predicted to be less than those beneath a mussel farm because the spat and nursery mussels are smaller than full-grown mussels, and the farm is offshore where currents may be stronger. As such, the limited benthic changes will have a minor effect on the use of the site by seabirds.

5.4 Prey abundance changes

The effects of mussel farms on fish have been assessed, and floating structures can often attract fish, particularly juveniles (Morrisey *et al*. 2006). The three-dimensional floating structures can act as fish aggregating devices. The effects of mussel farms on pelagic fish populations have been assessed in a paired study in Pelorus Sound, using an underwater camera to sample fish within 10 mussel farms and 50 metres from each mussel farm (Grange 2002). The results showed a greater diversity and abundance of

pelagic fish within mussel farms, although the differences between the unfarmed and farmed sites were not statistically significant.

In addition to fish, mussel farms may also provide food sources for seabirds by way of 'biofouling' of backbone ropes, buoys, and other associated structures (Roycroft *et al*. 2007). National and international studies indicate that this community can include seaweeds and attached filter-feeding invertebrates, with associated fauna such as polychaete worms and small crabs (see Keeley *et al*. 2009).

Within the Pelorus Sound paired study, a marked difference was observed in the use of mussel farms compared to adjacent un-farmed control sites by several different bird species (Wildlands 2002b). For example, little shag, spotted shag, red-billed gull and southern black-backed gull were much more likely to use a mussel farm than an adjacent un-farmed marine area. Little shag and spotted shag dived within the farm, while red-billed gull and southern black-backed gull foraged on mussel lines and from the surface of the water. All four species made use of buoys for roosting. The difference between their use of farmed versus unfarmed marine space may be due to greater availability of food resources within the farm, the presence of buoys which provide secure resting sites between foraging bouts, or a combination of the two.

The use of mussel farms as foraging sites is likely to have a positive impact or neutral impact on the above species, and possibly other seabird species, such as Caspian tern, may also utilise the farm. Birds may benefit from enhanced and possibly more predictable food resources and adjacent, secure resting sites. It seems likely that the proposed spat-catching/nursery farm, while further offshore, will also be used by many bird species for feeding and roosting.

5.5 Disturbance

Disturbance of foraging birds already occurs from recreational and commercial boat traffic entering or leaving Raglan Harbour and boating along the coastline. Vessel movements to and from the proposed spat-catching/nursery farm are unlikely to significantly increase the existing levels of boat disturbance of foraging birds in the area.

Disturbance of breeding birds is of greater concern. For example, boats approaching breeding colonies of shags, terns, and gulls may cause birds to abandon nests temporarily (Butler 2003, Lalas 1993). Frequent disturbance may cause eventual abandonment of the site. However, even temporary desertions lasting a few minutes can allow predatory birds, such as southern black-backed gull and skua species, to take eggs and chicks. Vessels that service the farm should use routes that avoid rock stacks, islets and islands used by shags, terns, and gulls for nesting by at least 100 metres. All vessels are required to maintain speeds of less than five knots within 200 metres of the shore (Maritime rules), which is also likely to reduce the risk of disturbance.

Vessel movements during the spat-catching/nursery farm construction and usual farm operations (maintenance and harvest vessels) will have a less than minor effect on seabirds if boats remain 100 metres offshore when transiting, and if boat speeds are less than five knots if approaching the shore or the spat-catching/nursery farm.

5.6 Noise

The primary source of noise at the proposed farm will be from the vessels that intermittently service the farm. For the most part, there will be no noise at the spat-catching/nursery farm. During the 18 days of observations for the mussel farm pilot study, vessels arrived to work on study farms on three occasions and were seen working on numerous adjacent farms (Wildland 2020b). Depending on the job, vessels were present for a few hours, up to a full day.

Different bird species reacted differently to the disturbance. For example, pied shags were only observed on farms when a harvesting vessel was pulling up lines, flying in to prey on small fish associated with the mussels. Red-billed gulls and southern black-backed gulls also followed harvesting vessels. Other species were disturbed by the boats and flew away. King shags often remained resting on buoys while boats worked in another part of the farm. One king shag flew into a study farm while two vessels were doing maintenance work and was observed undertaking a foraging dive. Another king shag foraged adjacent to a mussel farm where a boat was harvesting.

Overall, the occasional presence of noise from vessels will have a less than minor effect on birds. At most, it represents a short-term disturbance. After the boat has gone, birds will eventually resume their activities within and around the farm.

5.7 Ingestion of foreign debris

Marine waste, particularly plastics, can be consumed by seabirds and could cause death by dehydration, blockages, and release of toxins (Sagar 2013). For mussel farming, the management of debris resulting from mussel farming is overseen by a Sustainable Management Framework (SMF, Aquaculture New Zealand 2015). The SMF has set targets for 'marine debris' and includes reducing the amount of debris on beaches attributable to mussel farming and having all marine farm operators involved in beach clean-ups. As part of these beach clean-ups, the amount of farm waste is assessed against the total waste collected as a performance indicator. This aims to minimise the loss of waste such as mussel ties.

During maintenance and harvesting, all cordage, plastics, and general waste must be collected on-board and disposed of ashore. Any debris that does accidentally fall overboard must be retrieved as soon as possible. This will prevent entanglement, ingestion and pollution of the environment. This will have a minor effect on seabirds if well managed.

5.8 Lights causing attraction or disorientation

Some seabird species (e.g. petrels and shearwaters) can become disorientated or be attracted to lights, which can lead to injury or death through collision with structures or the inability to take flight (grounded on land, Cooper 2015). Navigation lighting and marks will be installed in accordance with Maritime New Zealand (2008, 2018) and Maritime Transport Act 1994. Where possible, the farm's navigation lights should be flashing or rotating lights rather than constant lights, as this can reduce the potential for disorientation of seabirds (Commonwealth of Australia 2020, Rebke *et al*. 2019).

All navigational lights are designed to shine horizontally; no discernible light is visible from the top of the lantern. Light that spills above the horizontal plane contributes directly to artificial sky glow and should be avoided to reduce effects on seabirds. In this regard, navigational lighting is less problematic than, for example, unshielded lights at marinas, ports, and other coastal areas.

The 'special markers' will be placed on buoys 200 metres outwards of each corner of the spat-catching/nursery operation, situated two metres above the water level and flash five times every 20 seconds. These markers will flash yellow lights and are less attractive to seabirds compared to violet/blue light (Commonwealth of Australia 2020).

The special markers light intensity allows them to be visible for five nautical miles. This is the maximum visible distance in clear weather conditions and equates to 9.26 kilometres. The coastline is within 3.1 kilometres, and illumination from the special markers will be visible to coastal nesting species. However, seabirds are most at risk of disorientation when weather conditions and visibility is poor. Consequently, this is when the reach of the special lights would be significantly reduced.

If seabirds were attracted to navigational lighting, the risk of collision is likely to be low given the small, low structures involved. Structures more commonly associated with light-induced injury or mortality are larger, more solid structures, such as lighthouses, buildings, fishing vessels and cruise ships (Commonwealth of Australia 2020). If disorientated birds landed on the water, they would be able to take off again, probably at daybreak, or when they had drifted away from the light. This differs from a seabird landing on or colliding with a vessel at sea or landing in an urban setting where it cannot take to the air again without human intervention. Because of these reasons, the potential effect of navigational lighting is considered to be less than minor.

5.9 Potential effects of non-seabird species

The proposed mussel spat-catching/nursery farm will not have any detectable effects on non-seabird species as it will be located 3.1 kilometres from the shore at its nearest point. However, this brief discussion assesses the potential effects on various shorebird species.

The main shorebird species present along the coastline of the study area are kuaka/eastern bar-tailed godwit, tūturiwhatu/northern New Zealand dotterel, tōrea/ South Island pied oystercatcher, and tōrea pango/variable oystercatcher, with occasional records of kōtuku-ngutupapa/royal spoonbill, matuku moana/reef heron, and a single huahou/lesser knot.

Eastern bar-tailed godwit is a migratory species that spends the non-breeding season in the southern hemisphere before flying back to Alaska (Battley *et al*. 2020). Godwits will fly long distances to reach their destination, and it is highly unlikely that a bar-tailed godwit would be attracted to the spat-catching/nursery farm during migration.

Variable oystercatchers were recorded at all eight mussel farms in the Pelorus Bay pilot study (Wildlands 2021b). Although difficult to observe, they were considered to be foraging on buoys and droplines. Unsurprisingly, the species was not observed in the paired controls as it is a wader and feeds from a solid surface. The study farms were all

within 100 metres of the coast. The proposed farm will be 3.1 kilometres from the coast, and it is unlikely that variable oystercatcher would fly out to sea to forage at the farm. However, if it did so, the farm could be considered beneficial to the species rather than a negative effect.

It is improbable that the dotterels, South Island pied oystercatcher, royal spoonbill, reef heron or lesser knot will fly out to the proposed spat-catching/nursery farms. However, if they did, the farm may provide food sources, such as mussel species and other encrusting organisms on ropes and buoys. If a bird did fly the 3.1 kilometres, the buoys would provide temporary roosting sites.

6. MITIGATION OF RISK

Seabirds may congregate around and within the spat-catching/nursery farm for roosting and foraging, including shags, gulls, and Australasian gannet (*Morus serrator*; Not Threatened). Foraging behaviour around farms may be greatest at times of harvesting when invertebrates and small fish are displaced from structures and dispersed in the water column. There is some potential risk of entanglement in marine farm ropes for diving birds, but such incidents are considered rare. Tāiko/black petrel (*Procellaria parkinsoni*, Threatened-Nationally Vulnerable) is the focus of conservation efforts by the Black Petrel Working Group comprised of fishing interests, iwi environmental groups and government agencies to aid the recovery of the bird from its threatened status in the Hauraki Gulf (Hauraki Gulf Forum 2020). The main risk to tāiko/black petrel in the Gulf is from recreational and commercial fishing, and there is no evidence of mortalities associated with mussel farming. Flesh-footed shearwater are also vulnerable to fishing bycatch, but aquaculture operations are not implicated as a threat. Overall, the effects on seabirds from the establishment of mussel spat-catching/nursery farm are considered to be less than minor if there are rigorous controls on plastic waste.

Monitoring should be undertaken to assess seabird interactions with the spat catching farm. Maintenance and harvesting team members should record seabird observations to monitor seabird behaviour while approaching (within 100 metres of the proposed farm site) and during spat farm catching activities. Observations should include if a bird is foraging, roosting on buoys or the water surface, and whether any birds have been found entangled.

To avoid the attraction of seabirds or migratory shorebirds to lights on vessels, it is recommended that all harvesting and maintenance operations are restricted to daylight hours.

7. CONCLUSION

The west coast of the North Island is part of an extensive ‘at sea’ IBA for seabirds. Karewa Gannet Island is an important site for Australasian gannets and other seabirds. This IBA triggers Policy 11 (a)(vi) in the New Zealand Coastal Policy Statement 2010.eBird data for the region further demonstrates the diversity and abundance of seabird species. Many of the bird species present are Nationally Threatened or At Risk

and trigger Policy 11 (a)(i) and 11 (a)(ii) in the New Zealand Coastal Policy Statement 2010.

The potential effects of a mussel spat farm and nursery on seabird species include:

- Entanglement in structures.
- Habitat exclusion.
- Benthic habitat changes.
- Prey abundance changes.
- Disturbance.
- Noise.
- Ingestion of foreign debris.
- Lights causing attraction or disorientation.

The potential effects of entanglement, habitat exclusion, benthic habitat changes, foreign debris, navigational lights, disturbance, and noise, all pose a very low risk to seabirds and are likely to have a less than minor or negligible effect on all species.

It is unknown if pelagic seabird species, such as shearwaters and petrels, will use a mussel spat-catching/nursery farm for foraging, including those frequently observed inshore species, such as fluttering shearwater and diving petrel. Some of these species may avoid feeding within the structures or forage less on the farm than in unfarmed areas. However, this will be a less than minor effect, as these species have large, sometimes vast, foraging distributions, and the proposed spat-catching/nursery farm will comprise a very small proportion of the available area for feeding.

Some species may benefit from the presence of the spat-catching/nursery farm from biota growing on structures, from roosting opportunities in between bouts of foraging, and if it supports increased fish abundances.

The potential for disturbance of surface-breeding seabirds should be addressed by examining proposed vessel routes and maintaining distances from known breeding colonies (mainland or at sea) of 100 metres or more. However, vessels are required to keep speeds below five knots within 200 metres of shore, reducing the risk of disturbance. The potential for seabirds to be attracted to vessels working at night will be avoided if work is only carried out only during daylight hours. Management of waste and debris should be addressed through a number of conditions, setting out best practices for maintenance and operation of the farm. Monitoring should be undertaken to ground truth that the mussel spat catching/nursery operation has less than minor adverse effects. The proposed spat-catching/nursery farm is likely to have an overall neutral effect on seabirds using the west coast of the North Island.

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APPENDIX 1

THREAT CLASSIFICATIONS FOR BIRD SPECIES MENTIONED IN TEXT

Threat classifications follow Robertson *et al*. 2021 and the International Union for Conservation of Nature and Natural Resources (IUCN) Red List of Threatened Species.

Common Name	Scientific Name	Threat Classification 2021	Red List
Albatrosses			
Northern royal albatross	*Diomedea sanfordi*	Threatened-Nationally Vulnerable	Endangered
Black-browed mollymawk	*Thalassarche melanophris*	Non-resident Native – Coloniser	Least Concern
Salvin's mollymawk	*Thalassarche salvini*	Threatened-Nationally Critical	Vulnerable
Shy mollymawk	*Thalassarche cauta steadi*	At Risk-Declining	Near Threatened
Shearwaters, petrels, prions and fulmar			
Buller's shearwater	*Ardenna bulleri*	At Risk-Declining	Vulnerable
Flesh-footed shearwater	*Ardenna carneipes*	At Risk-Relict	Near Threatened
Fluttering shearwater	*Puffinus gavia*	At Risk-Relict	Least Concern
North Island little shearwater	*Puffinus assimilis haurakiensis*	At Risk-Recovering	Least Concern
Shearwater sp.	*Puffinus* sp.		
Sooty shearwater	*Adrenna griseus*	At Risk-Declining	Near Threatened
Black petrel	*Procellaria parkinsoni*	Threatened-Nationally Vulnerable	Vulnerable
Cape petrel	*Daption capense capense*	Non-resident Native – Migrant	Least Concern
Grey-faced petrel	*Pterodroma macroptera gouldi*	Not Threatened	Least Concern
New Zealand white-faced storm petrel	*Pelagodroma marina maoriana*	At Risk-Relict	Least Concern
Northern diving petrel	*Pelecanoides urinatrix urinatrix*	At Risk-Relict	Least Concern
Northern giant petrel	*Macronectes halli*	At Risk-Recovering	Least Concern
Fairy prion	*Pachyptila turtur*	At Risk-Relict	Least Concern
Prion sp.	*Pachyptila* sp.		
Northern fulmar	*Fulmarus glacialis*	Non-resident Native – Vagrant	Least Concern
Gannets and shags			
Australasian gannet	*Morus serrator*	Not Threatened	Least Concern
Black shag	*Phalacrocorax carbo novaehollandiae*	At Risk-Relict	Least Concern
Little black shag	*Phalacrocorax sulcirostris*	At Risk-Naturally Uncommon	Least Concern
Little pied shag	*Microcarbo melanoleucos melanoleucos*	Non-resident Native – Vagrant	Least Concern
Pied shag	*Phalacrocorax varius varius*	At Risk-Recovering	Least Concern
Skuas, gulls and terns			
Pomarine skua	*Coprotheres pomarinus*	Non-resident Native – Migrant	Least Concern
Skua sp.	*Stercorarius* sp.		
Red-billed gull	*Larus novaehollandiae scopulinus*	At Risk-Declining	Least Concern
Southern Black-backed gull	*Larus dominicanus dominicanus*	Not Threatened	Least Concern
Caspian tern	*Hydroprogne caspia*	Threatened-Nationally Vulnerable	Least Concern
Eastern little tern	*Sternula albifrons sinensis*	Non-resident Native – Migrant	Least Concern
White-fronted tern	*Sterna striata striata*	At Risk-Declining	Least Concern
Other species			
Eastern bar-tailed godwit	*Limosa lapponica baueri*	At Risk-Declining	Near Threatened
Lesser knot	*Calidris canutus rogersi*	At Risk-Declining	Near Threatened
Northern New Zealand dotterel	*Charadrius obscurus aquilonius*	Threatened-Nationally Increasing	Near Threatened

Common Name	Scientific Name	Threat Classification 2021	Red List
Pied stilt	*Himantopus himantopus leucocephalus*	Not Threatened	Least Concern
Reef heron	*Egretta sacra sacra*	Threatened-Nationally Endangered	Least Concern
Royal spoonbill	*Platalea regia*	At Risk-Naturally Uncommon	Least Concern
South Island pied oystercatcher	*Haematopus finschi*	At Risk-Declining	Least Concern
Spur-winged plover	*Vanellus miles novaehollandiae*	Not Threatened	Least Concern
Variable oystercatcher	*Haematopus unicolor*	At Risk-Recovering	Least Concern
White-faced heron	*Egretta novaehollandiae*	Not Threatened	Least Concern

IMPORTANT BIRD AREAS

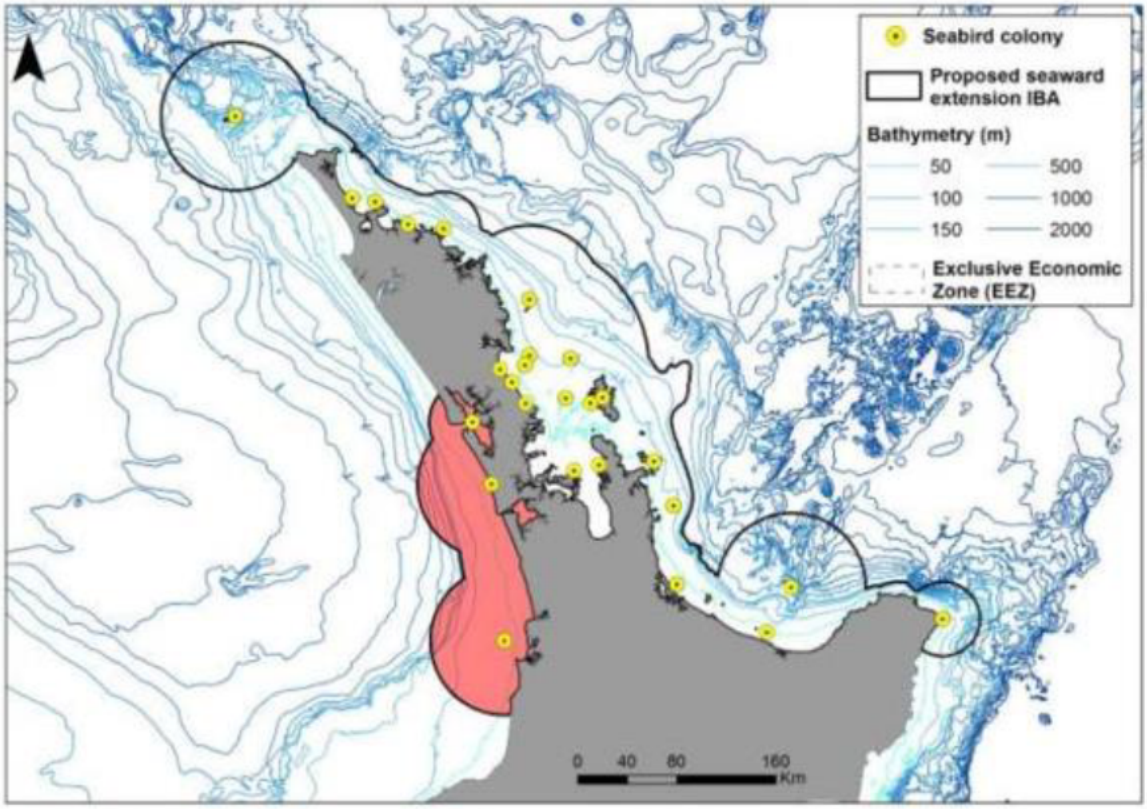
NZ M003	**West Coast North Island**

Location	New Zealand, west coast North island
IBA criteria (see page 14)	A4ii
Area	14,993 km²
Year of Assessment	2013

IBA trigger species:

Species	Tracking	Supporting data	Activity	IBA	IUCN
Australasian Gannet		Seaward extension (60km)	Foraging	A4ii	LC
NZ Fairy Tern [1]		Seaward extension (5km)	Foraging (in-shore)	A1, A4ii	VU

[1] Included in Papakanui Spit and Kaipara Harbour IBAs which include coastal waters.



Protected area	Designation	Area (km²)	Relationship with IBA
West Coast North Island	MPA Cable Zone	322	Protected area contained within site
West Coast North Island Sanctuary	Marine Mammal Protection	11,935	Protected area overlaps with site

NZ029	Karewa Gannet Island	Waikato West Coast

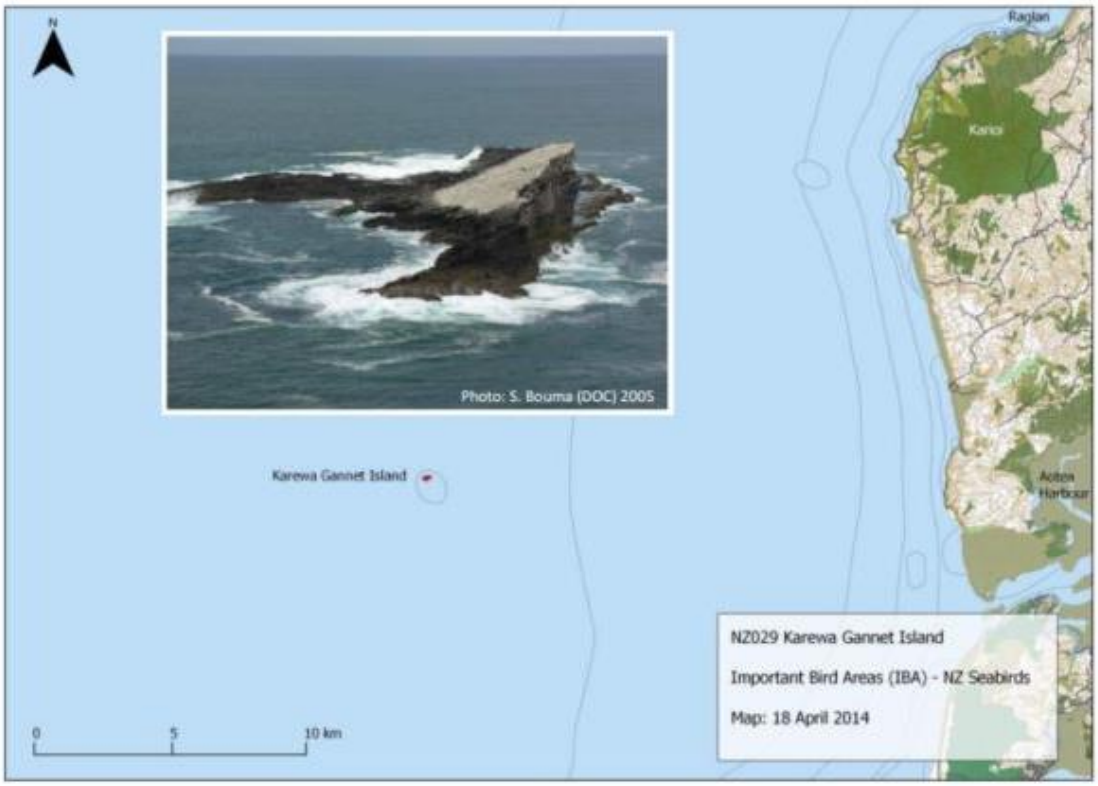
Location	New Zealand, Waikato West Coast
Central coordinates	37.972282°S, 174.565973°E
IBA criteria	(A4ii)
Area	2 ha
Altitude	0 - 13m
Year of Assessment	2013

Populations of IBA trigger species:

Species	Season	Year/ Period	Population estimate (pairs)	IBA crite-ria	IUCN cat.	NZ Threat Class.
Australasian Gannet	Breeding	1946-2007	5,910-8,003	A4ii	LC	Not Threatened

Ornithological information: More data is required for this site.

Protected area	Designation	Relationship with IBA
Nil		



IUCN Habitat	Habitat detail	Extent (% of site)
Marine Intertidal	Rocky shorelines, sand and boulder beaches	Major
Marine Coastal/Supratidal	Sea cliffs and rocky islets	Major
Rocky areas	Exposed rock , guano covered in colony area; no vascular plants	Major

Threats to the site (pressure) - IUCN Classifications

Threat Level	Notes	Timing	Scope	Severity
Invasive & other problematic species, genes & disease	Problematic native species - NZ Fur Seals invading gannet colony	Unknown	Unknown	Unknown
Recreational activities	The island is Maori owned and access restricted, however people climbing onto the island may disturb birds in the gannet colony during breeding.	Likely in short term (within 4 years)	Small area/few individuals (<10%)	Imperceptible deterioration

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