Golden Bay / Mohua AMA 2 subzones: Stage 1 marine mammal monitoring summary

Cawthron Report 4192

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PROJECT NUMBER: 17288/07

ISSUE DATE: 17 October 2025

RECOMMENDED CITATION: Clement D, Floerl L, Brownlee A. 2025. Golden Bay / Mohua AMA 2 subzones: Stage 1 marine mammal monitoring summary. Cawthron Report 4192. Prepared for consent holders in subzones (l), (m), (n) and (o) in AMA 2, Golden Bay / Mohua.

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Golden Bay / Mohua AMA 2 subzones: Stage 1 marine mammal monitoring summary

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Prepared for consent holders in subzones (l), (m), (n) and (o) in AMA 2, Golden Bay / Mohua

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Executive summary

The consent holders in subzones (l), (m), (n) and (o) in Aquaculture Management Area 2 (AMA 2) in Golden Bay / Mohua (hereafter Golden Bay) were granted resource consents in 2019 to develop mussel farms. Earlier interim court decisions felt there was insufficient evidence on how development offshore of existing farms in AMA 2 might affect marine mammals, particularly in terms of pilot whale strandings and large baleen whale entanglements. Hence, as part of their consent conditions, and based on the previous Environment Court concerns, the consent holders were required to undertake a 5-year marine mammal monitoring programme while Stage 1 (50 ha within each subzone) was developed.

The criteria of this programme focused on understanding marine mammal stranding and entanglement rates within Golden Bay, and observing any interactions with the structures as the farms developed. For the latter, visual and acoustic methods were used to establish a baseline of which marine mammal species were sighted near or around the farms, and to track potential changes over time (Stage 1a) and once the subzones were fully developed (Stage 1b). This report evaluates the data gathered in relation to these criteria and summarises the Stage 1 monitoring programme findings.

At least 186 stranding events have occurred in Golden Bay waters since 1879, almost half of which were pilot whales and larger baleen whales. Stranding rates within Golden Bay were found to be consistent over the five decades reviewed, varying between 20 and 30 events per decade. A thorough review of these data found no evidence of any substantial difference in the proportions or types of species stranded over the various decades in Golden Bay, regardless of previous or current aquaculture development.

Stranding locations varied widely, but consistently half or more of all strandings each decade have occurred in the well-known 'notch' stranding region of Farewell Spit. The spatial review of stranding locations also found no subsequent evidence that the development of marine farms trapped animals along the southern coastline due to their block layout or forced them towards a particular region.

In non-stranding situations, the likelihood for entanglement in mussel farms is considered low. The lack of any entanglements (baleen whales or otherwise) in aquaculture gear to date in Golden Bay suggests that the current locations of marine farms have had little to no effect on entanglement risks to marine mammals, and nor have these risks increased in post-stranding circumstances.

Both visual and acoustic occurrence rates of marine mammals within the Zone of Effort suggested stable annual rates and strong seasonal trends in presence near farms. The most common species detected near the farms throughout Stage 1 were New Zealand fur seals / kekeno and Hector's dolphins / upokohue.

Sightings of both fur seals and Hector's dolphins increased through Stage 1a development and their presence continued through Stage 1b. While fur seals were the one species reported regularly interacting (physically touching, rubbing, etc.) with farm structures or lines, Hector's dolphins were observed travelling between farm lines and swimming around structures. Visual monitoring suggests that fur seals will be attracted to any new surface structures and continue to use them as convenient haul-out sites, despite the presence of farm vessels. Hector's dolphins initially seemed attracted to the farm vessels themselves, but as the farms developed, more sightings were in proximity to the farm structures.

Visual and some acoustic occurrence rates were generally lower over summer months, peaking instead during winter and spring. Several species migrate through Cook Strait waters over winter in search of warmer waters (e.g. dusky dolphins, several baleen whale species), while spring signals the start of the calving season for most marine mammals. Late winter and early spring are also the times in which fur seals pup leave the breeding colonies and set out on their own. These trends may account for the greater detection rates in the Zone of Effort over these seasons.

Despite individual farm vessels having highly variable sighting rates, visual monitoring still produced consistent estimates of marine mammal occurrences over the five monitoring years. This was achieved by having several vessels looking for marine mammals within the Zone of Effort.

While not as useful as visual methods for detecting pinnipeds and interaction occurrences, the one year of acoustic monitoring helped highlight that marine mammals were more likely to approach farm structures near the L-block in the middle of the bay than the more southern and inshore O-block. The continuous detection capability of acoustic method also revealed that both Hector's dolphins and orca / maki visited farm blocks more frequently overnight than during the day across most seasons.

As well as fulfilling the objectives of the consent conditions, monitoring results demonstrate how visual and acoustic findings can be used to inform expectations around further farm development. These datasets can also help assess the effectiveness of any mitigation actions and inform farm design to ensure that future interactions with marine mammals remain benign. Positive outcomes from this programme have included a new communication protocol with the Department of Conservation around stranding events, the development of a visual sighting app for farm vessels, and proof of the effectiveness of underwater acoustic technology for monitoring marine mammals near marine mussel farms in Golden Bay.

1. Introduction

1.1 Background

The SMW Consortium Ltd and Maara Moana Ltd (SMWMM) completed construction of their Stage 1 mussel farm developments in subzone (l), (m), (n) and (o) farm blocks within Aquaculture Management Area 2 (AMA 2) of Golden Bay / Mohua (hereafter Golden Bay; red zones in Figure 1) between May 2020 and January 2024. The subzone marine farm sites cover a combined area of 1,000 ha in the southern central Golden Bay area.

Based on concerns raised during the previous Environment Court hearing (started in 1999)[1] and highlighted in its interim decision report (2001),[2] Clement (2019) reviewed the national databases maintained by the Department of Conservation (DOC) for marine mammal sightings and incidents to determine which species may be affected by any further development of these marine farms. That report found a low likelihood of any potential impacts on marine mammal strandings or entanglements from further development of mussel farms into offshore areas. However, given the concerns expressed by the court regarding the proposed farms, Clement (2019) recommended several simple operational mitigations and monitoring as part of a marine mammal management plan (MMMP). The purpose of the monitoring was to establish a better baseline and understanding of marine mammal interactions (or lack of) with the farms as they are developed (Clement 2019).

In 2019, Tasman District Council (TDC) granted resource consents for the development of the subzones, but conditions limited initial development to a 50 ha area within each subzone, for a collective total of 200 ha (Stage 1). Stage 1a involved the initial development of the farm structures, while Stage 1b was fully operational mussel farms. Consent conditions also required an MMMP be developed. The final certified MMMP (Clement 2020) provided detailed management goals and criteria for a 5-year monitoring programme. This report summarises the data recorded during this monitoring and key findings.

1.2 MMMP goals

The goals and practices of the MMMP were to minimise the risk of any adverse effects on marine mammals within Golden Bay due to the farm development, which included:

- minimising exclusions from potential habitats
- minimising avoidance or attraction of marine wildlife to farms
- minimising entanglement risk, with the aim of zero mortality.

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1 1999 consent application to catch spat within AMA 2 subzones (l), (m), (n) and (o) by Golden Bay Aquaculture (NN990139), Marlborough Seafoods (NN990375), Westhaven Marketing NN990376 and Pakawau Trust (NN990374).

2 Interim Report and Findings to the Minister of Conservation, the Tasman District Council and the Referrers on an Inquiry into the Aquaculture References to the Tasman District Council's Proposed Resource Management Plan 2001. Decision No. W 42/2001.

The purpose of the monitoring programme itself was to answer questions related to understanding marine mammal presence around the farms (including refloated animals) through the following goals:

- quantify marine mammal occurrence rates (relative to effort) at the farm sites
- assess any spatial or temporal trends in marine mammal occurrence rates and locations
- assess whether any distinct temporal or spatial changes or trends in criteria occurred over the monitoring period relative to any previous database information.

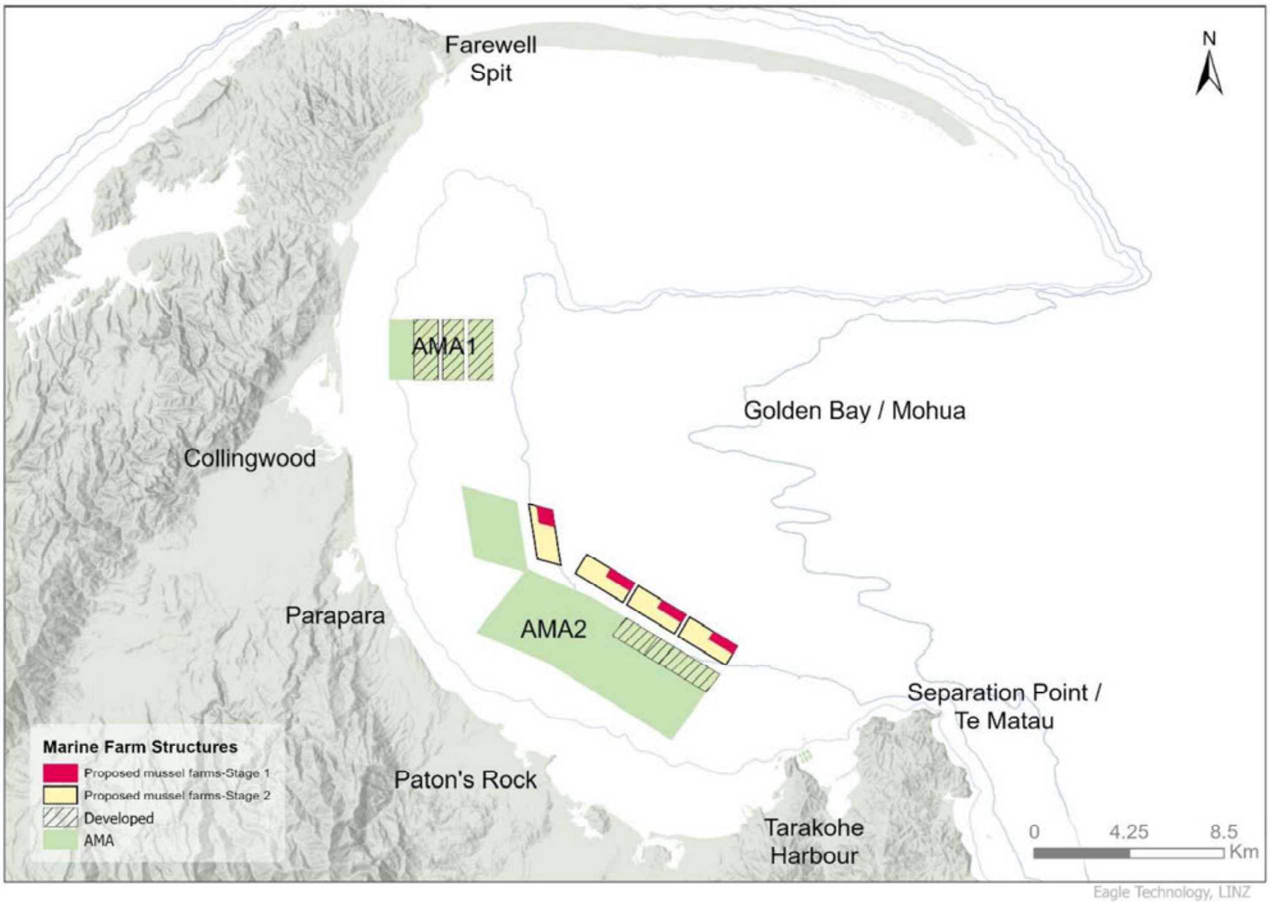

Figure 1. The aquaculture management areas (AMAs) in Golden Bay / Mohua (green), with the spatial location and area of the Stage 1 subzones indicated in red and subsequent Stage 2 mussel farm indicated in yellow.

2. MMMP monitoring programme

Based on recommendations from Clement (2019), the MMMP monitoring programme did not focus on effects-based monitoring, in that its aim was not to assess whether the farm development had an effect on a species' previous population abundance or distribution patterns. Instead, the monitoring focused on gathering information (i.e. an informative monitoring approach) on which marine mammal species interacted with the farms, how they interacted with the structures as the farms were being developed, and whether these interactions changed through time. Such information can help assess the effectiveness of any mitigation actions as well as inform how farms can be designed to ensure such interactions remain benign.

For this programme, and based on the earlier Environment Court considerations (2001), the criteria focused on:

- marine mammal stranding rates in Golden Bay (e.g. any additional information collected as part of DOC's national marine mammal incident database)
- marine mammal entanglement rates in Golden Bay (e.g. any additional information collected as part of the DOC's national marine mammal incident database)
- marine mammal occurrence rates and sighting locations (relative to effort).

Using these three criteria, the monitoring programme more specifically focused on gathering the additional data necessary to answer the following questions:

- What marine mammal species are observed near the farm sites?
- Are they mainly residents, visiting species or species with high stranding risks?
- Are marine mammals present near the farms on a regular basis or at certain times of year?
- How does this timing correspond to stranding events or other activities?
- Did any distinct temporal or spatial changes or trends in criteria occur over the monitoring period relative to any previous database information?

The monitoring time periods were:

- **Stage 1a – development of farms**: Monitoring during the building and development of the sites and structures (up to 2 years).
- **Stage 1b – farm structures in place and fully operational**: Monitoring for approximately 3 years once farms have been built and are in place.

2.1 Stranding methods

Following the methods used in Clement (2019), the Aotearoa New Zealand national marine mammal incident database[3] (Appendix 1) was examined to determine if there was any evidence of a notable change or trend(s) in stranding or entanglement events and /or their locations. Changes and trends

[3] Department of Conservation's New Zealand marine mammal incident database [accessed 30 May 2025].

were evaluated over the various decades since the court decision 20 years ago and prior to the new farm development (Stage 1), and more recently with the completion of the Stage 1 subzones (l), (m), (n) and (o) farm blocks. Specifically, the following questions were addressed:

- assess whether any distinct changes or trends in criteria occurred over time
- assess whether there were any obvious spatial changes or trends in criteria overall or over time
- compare how any changes or trends may correlate with subsequent marine farm development over the same time periods.

It should be emphasised that these comparisons are descriptive only, as the small sample size and lack of a systematic search process for strandings throughout Golden Bay precludes any robust statistical analyses.

Stranding rates

The 186 stranding events in Golden Bay were first filtered for: human-related causes of death (e.g. shot, caught in fishing net; n = 4), strandings on the Cook Strait side of the spit rather than in Golden Bay (n = 13), and any possible restranding events (i.e. same animal likely restranding within 1 week of original stranding, often noted in database; n = 23). These observations were removed, as including them would unfairly inflate stranding counts in the context of these comparisons. The filtered stranding data were then categorised by the decade in which they occurred (e.g. 1981–90, 1991–2000, 2001–10, 2011–20, 2021–25[4]) to obtain an adequate number of strandings for qualitative comparisons. The results for each time period were summed and displayed on a map alongside concurrent development of farming and spat-catching structures in AMA 1 and AMA 2 over the same time periods. Shellfish farming in Golden Bay has been under development, in some form, since the 1980s.

The species of interest for these comparisons were pilot whales and large baleen whales, and for some comparisons, small to medium-sized echolocating species. For the purposes of this report and in agreement with the national database categories, the following species have been categorised as small to medium-sized cetaceans: Hector's dolphin / upokohue, common dolphin / aihe, dusky and bottlenose dolphins / terehu, pilot whales, orca / maki and oceanic dolphins (e.g. *Stenella* sp., *Lissodelphis* sp., which occasionally strand). The proportions of the different categories of species stranded were compared to one another and across the various decades to assess for any temporal patterns or trends in strandings that may correlate with aquaculture development in the bay.

The proportion of strandings within particular regions of Golden Bay was also examined by decade to test the possibility that the layout and / or resulting underwater noise from existing farms may have increased the likelihood of animals being:

1. trapped against the southern shoreline by existing farms (AMA 2) and stranding
2. siphoned by the location of the farms into the Farewell Spit 'notch' and stranding.

4 The last stranding recorded in Golden Bay was January 2025.

The 'southern region' of the bay was defined by an arbitrary line at Parapara Inlet and extending east to Separation Point / Te Matau (hereafter Separation Point). The 'notch' region was determined as the area between Pākawau Inlet and the base of Farewell Spit, the eastern boundary of which is in line with the 10 m bathymetric contour on the eastern side of the 'notch' (these locations are shown in Figure 7).

Entanglement rates

Possible entanglement-related deaths were identified in the stranding dataset through cause of death and / or any additional descriptions or comments on the state of the stranded animal. The MMMP also put in place an incident reporting process for any entanglement, injuries or physical contact between marine mammals and the farm gear or farm vessels. This incident reporting was undertaken from farm vessels.

2.2 Occurrence methods

Visual monitoring

To quantify the species of marine mammals around farm blocks and the current level of their interactions with marine farms as they were developed, farm vessels recorded all visual sightings of marine mammals seen near the farms as well as those seen when travelling to and from the farms. These records included any interactions (e.g. touching, bumping, swimming within farms) between marine mammals and the vessel(s) or farms. Reporting sheets also included a place to note an absence of marine mammals during each trip, if applicable.

Effort protocol

Four different companies controlled operations on the relevant subzones. Up to 10 individual vessels, plus SMWMM's site coordinator, worked on the farms, some for a few to several days each month and others making only occasional visits during the year. Each vessel was asked to report trip effort manually using marine mammal effort log sheets that were provided. At a minimum, the necessary vessel information (date, time, location, etc.) was collected for every farm-related vessel trip. Overall effort was scaled to the number of daily visits to the L- and O-blocks, which included transiting from Tarakohe or Separation Point to work on these blocks. This area was termed the 'Zone of Effort' and is denoted as a 2 km × 2 km grid in Figure 2.

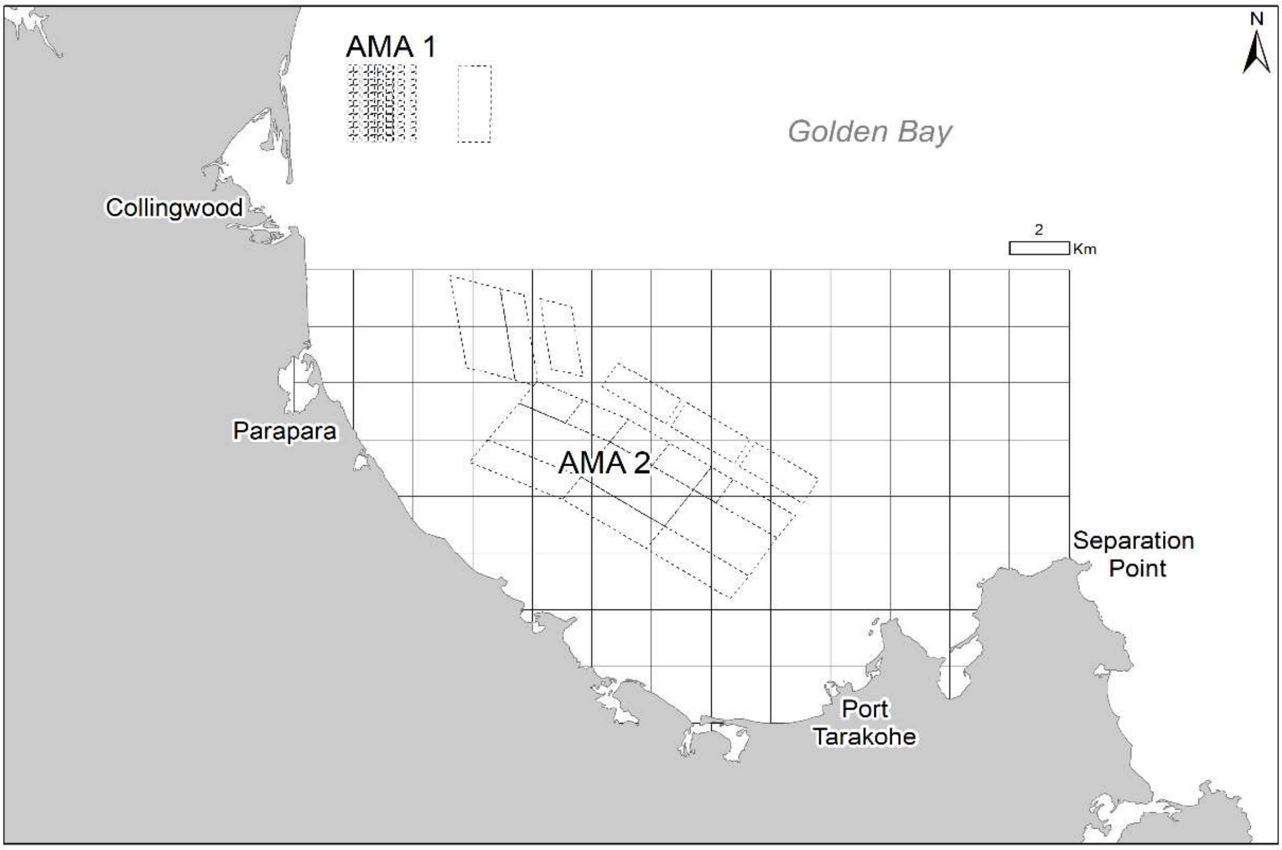

Figure 2. The Zone of Effort, shown by a 2 km × 2 km grid covering AMA 2 and relevant nearby regions in Golden Bay / Mohua. Vessel crew reported trips and sightings only when working on, or travelling to farm blocks.

Vessels owned by or working for MacLab NZ Ltd (MacLab) undertook a significant proportion of the operations on site and were responsible for 44–59% of all annual vessel trips over each of the 5 years of monitoring (Table 1). As the MacLab vessel *Vanguard* was responsible for 30–44% of all vessel trips undertaken annually, its automatic GPS tracking system was used to capture its actual track effort data for finer effort comparisons. *Vanguard*'s exact location was recorded at 5-minute intervals and collated for every trip the vessel undertook between September 2020 and May 2025. In September 2024, MacLab began GPS tracking another vessel, *Grey Heron*. With these data, the exact amount of time these particular vessel(s) spent within each grid was calculated and used to determine their effort (the total time the vessels spent in the Zone of Effort).

Visual sighting protocol

Any vessel(s) working on these farms had marine mammal sighting sheets on board (hard copy or electronic), and in the 2024–25 reporting year they also had access to an online report app (Survey123). All sightings within the Zone of Effort were manually recorded by vessel crew on these data sheets. Completed data sheets for all vessels were collated on a monthly or quarterly basis, along with vessel effort information. Total sightings from all vessels were collated and reported both seasonally and annually for qualitative temporal and spatial comparisons.

Table 1. Summary of vessel trips (effort) between March 2020 and 31 May 2025 reported by MacLab controlled vessels working on, or travelling to and from, L- and O-blocks. Note that sighting collection started in September 2020.

Dates	No. of trips	*Vanguard*	*Grey Heron*	*Aoraki / Sorcerer*	Controlled by MacLab
1 Mar 2020 – 31 Aug 2020	59	0	0	0	0%
1 Sep 2020 – 30 Nov 2020	70	25	10	0	50%
1 Dec 2020 – 28 Feb 2021	105	27	15	4	44%
1 Mar 2021 – 31 May 2021	93	46	13	5	69%
Year 1 total	**327**	**98**	**38**	**9**	**145**
(% Effort of total)		**(30%)**	**(12%)**	**(3%)**	**(44%)**
1 Jun 2021 – 31 Aug 2021	114	22	12	3	32%
1 Sep 2021 – 30 Nov 2021	91	33	13	9	60%
1 Dec 2021 – 28 Feb 2022	87	40	7	11	67%
1 Mar 2022 – 31 May 2022	122	47	10		47%
Year 2 total	**414**	**142**	**42**	**23**	**207**
(% Effort of total)		**(34%)**	**(10%)**	**(6%)**	**(50%)**
1 Jun 2022 – 31 Aug 2022	87	35	12	2	56%
1 Sep 2022 – 30 Nov 2023	121	39	18	7	53%
1 Dec 2022 – 28 Feb 2023	98	40	7	0	48%
1 Mar 2023 – 31 May 2023	81	57	7	6	86%
Year 3 total	**387**	**171**	**44**	**15**	**230**
(% Effort of total)		**(44%)**	**(11%)**	**(4%)**	**(59%)**
1 Jun 2023 – 31 Aug 2024	77	29	12	4	58%
1 Sep 2023 – 30 Nov 2024	100	42	18	0	60%
1 Dec 2023 – 28 Feb 2024	97	38	21	0	61%
1 Mar 2024 – 31 May 2024	124	45	18	0	51%
Year 4 total	**398**	**154**	**69**	**4**	**227**
(% Effort of total)		**(39%)**	**(17%)**	**(1%)**	**(57%)**
1 Jun 2024 – 31 Aug 2025	64	28	5	0	33
1 Sep 2024 – 30 Nov 2025	95	28	20	0	48
1 Dec 2024 – 28 Feb 2025	86	25	16	0	41
1 Mar 2025 – 31 May 2025	119	47	19	0	66
Year 5 Total	**364**	**128**	**60**	**0**	**188**
Effort % of total		**(35%)**	**(16%)**	**(0%)**	**(52%)**

When a marine mammal (e.g. cetacean or pinniped) was sighted, the following information was recorded on the log sheet:

- species (if possible); otherwise, indicate whether dolphin, whale or seal
- date and time
- vessel activities at the time (e.g. harvesting, checking lines, travel to / from site)
- approximate distance from animal
- vessel location (GPS coordinates) and description (farm and line numbers)
- observer / vessel name
- photographs and video footage, if collected.

Visual occurrence analyses

It was expected that those years or seasons in which vessels undertook more trips would have higher sighting rates compared to years or seasons with lower trip effort. Comparing these sighting counts would be biased and not representative of the actual numbers of marine mammals in the area. Hence, sighting data were first standardised for effort to allow for meaningful comparisons between years, seasons and grids. Annual and seasonal standardisation was done by summing all the sighting data with the relevant time periods and dividing this by the total number of daily vessel trips undertaken over the same period. The finer spatial scale sighting and effort data from the *Vanguard* (and later *Grey Heron*) were summed and similarly standardised for each grid. As these grid proportions were specific to a particular grid size (2 km × 2 km), they are considered to be marine mammal occurrence densities rather than rates.

Annual and seasonal sighting proportions were then transformed into percentages for statistical comparisons. To assess for any increasing trend in sightings with years, a simple linear regression was applied given the low sample size (n = 5). Non-normally distributed data are often associated with count data, as in this case. Hence, a X^2 test of independence was used to assess whether seasonal occurrence rates were significantly independent from one another.

Spatial and temporal trends in *Vanguard*'s sighting and effort data were explored using ArcGIS Pro's Space–Time Cube Analysis, which is based on the Mann–Kendall trend test (Mann 1945; Kendall and Gibbons 1990). This test was used to statistically assess if there is an upward or downward trend in sightings per grid over time. A monotonic upward (downward) trend means that the variable consistently increases (decreases) through time, but the trend may or may not be linear. As this test is a non-parametric (distribution-free) test, it can be used in place of a parametric linear regression analysis, to test if the slope of the estimated linear regression line is different from zero. Based on the variance for the values in the bin time-series, the number of ties (i.e. same value) and the number of time periods, the observed sum is compared to the expected sum (zero) to determine whether the difference is statistically significant.

The analysis can be done in two ways: with no-effort grid cells filled with zeros, or with no-effort grid cells filled by space–time neighbours. When filling empty bins with space–time neighbours, the tool estimates an empty bin based on its closest eight nearest neighbours. Temporal neighbours are used for each of those bins found to be spatial neighbours by going backwards and forwards one time-step. Using this option, a minimum of 13 space–time neighbours are required to fill the empty bin.

Depending on the results of the Mann–Kendall trend test, further analyses was considered using occupancy modelling (MacKenzie et al. 2017). Occupancy estimation and models are used to account for imperfect detection of animals during surveys, and help determine the probability of a species' true presence or absence and their estimated occupancy within the sampling area.

Visual monitoring with stranding event

When a stranding event(s) occurred within Golden Bay, all farm vessels were expected to be extra vigilant while monitoring around the farms for several days after the event to document any sightings of marine mammals (or lack of). This information was used to determine if there was evidence that the farms interfere with these animals' attempts to escape the bay once refloated. Following the MMMP protocol, staff or crew were on watch for any sighting of the stranded species, including live or dead refloated animals.

2.3 Underwater acoustic monitoring

Passive underwater acoustic monitoring was undertaken for 1 year once farms were fully developed and operations in a stable state (Stage 1b) – between February 2024 to February 2025. The aims of this monitoring were to:

1. verify the predicted visitation / presence of marine mammals as described in the assessment of ecological effects report (Clement 2019)
2. compare any acoustic detections (day or night) at the farms with information on relevant stranding events
3. assess how representative the visual sighting database is of the species observed and estimated occurrence rates.

Underwater acoustic protocol

Passive (i.e. collects and stores data) underwater acoustic moorings were placed in two locations along the northern edge of the subzone farm L- and O-blocks (Figure 3). SoundTrap High Frequency (ST500 HF) autonomous recorders were used to continuously sub-sample (every 5 minutes of 10 minutes) and record all sounds from these fixed locations. Moorings were custom-made to hang approximately halfway along the farms' warp lines to their fixed moorings using an insulated line to prevent noise contamination from the mooring or the connection to the mooring. Each recorder was positioned within a metal frame approximately 5 m off the seabed. Recorders were deployed on the same day at both moorings and generally left for 3 months (approximately 90 days) before redeployment. Recorders were set to detect a wide range of frequencies to capture sound from many species – very high frequency (e.g. Hector's dolphin), high frequency (e.g. common dolphin) and low frequency (e.g. southern right whale) – as well as sounds made by pinnipeds.

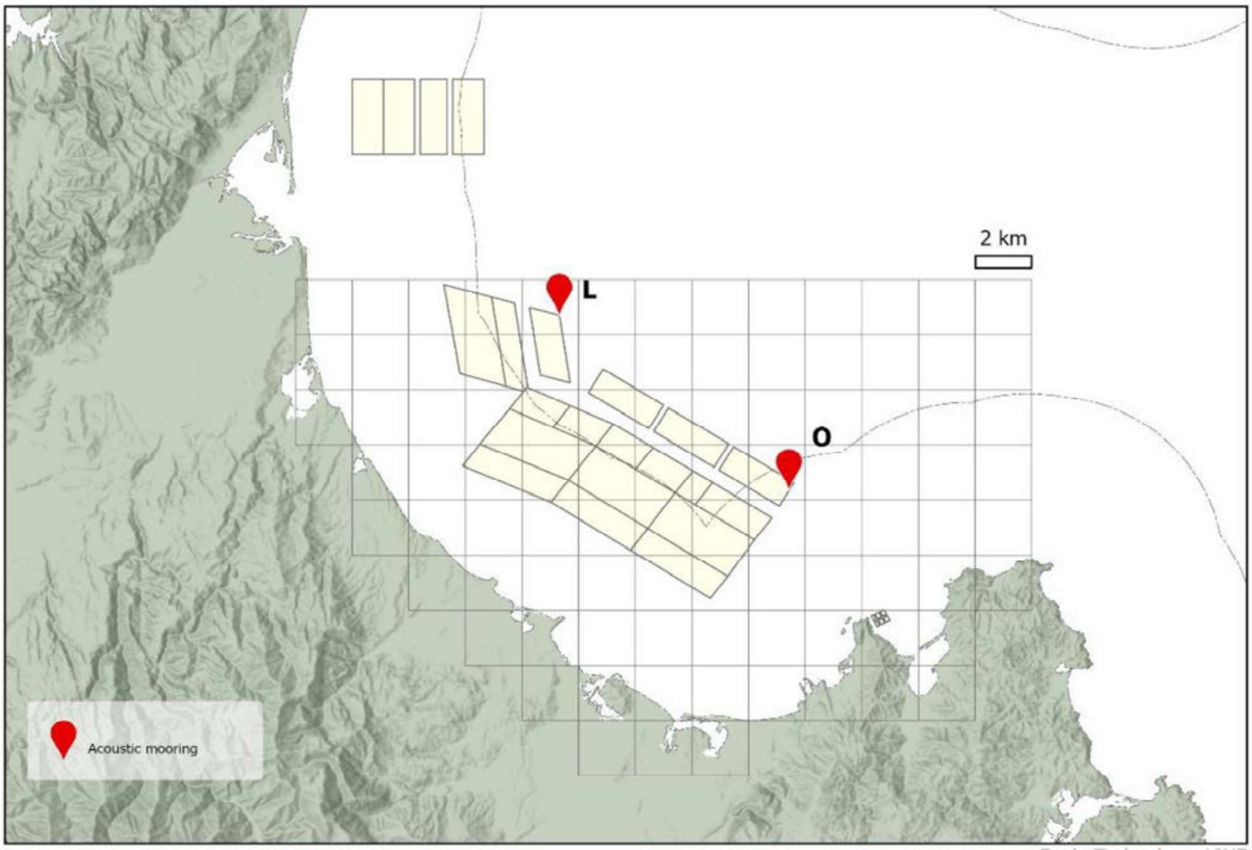

Figure 3. The location of acoustic recorders (SoundTraps) attached to L- and O-block farm mooring lines within the Zone of Effort.

The WAV files collected by the acoustic recorders were uploaded to the analysis software's (i.e. PAMScan, Ocean Acoustics Limited, Auckland) file directory and restructured into 1-minute time bins. The following analyses were undertaken:

- Power spectral densities (PSDs) and third octave levels (TOLs) were calculated for each 10-second time bin (50% overlap) and then averaged over 1-minute time, which was used to generate the time-averaged data for the long-term spectral average plot (LTSA).
- Statistical analyses of the PSDs (i.e. 1st, 5th, 25th, 50th, 75th, 90th and 99th percentiles), spectral probably densities (SPD) and TOLs (i.e. boxplots) were performed and plotted for general consideration of the SoundTrap's performance.
- Bandpass filters for four bands (i.e. 10–100 Hz, 100–1,000 Hz, 1–10 kHz and 10–32 kHz) plus broadband (i.e. 10–32 kHz) sound were applied to the raw waveform for each 1 minute of data.
- The bandpass filtered 1 min L_{eqs}[5] were then calculated for each time bin, generating a single mean value for each time bin and frequency band.

5 The equivalent sound pressure level with the same energy content as the measured varying acoustic signal over a sample period. This is the preferred metric for sound levels that vary over time because it takes into account the total sound energy over the time period of interest.

- The sound pressure level (SPL) data were then batch-processed into individual days (i.e. each 1-minute bin was time-stamped, determined in the file name of each recording), averaged over the daytime (so a single mean value for each day was obtained). The in-band energy contributions of each frequency band were calculated at the same time as the daily levels, except an additional algorithm was coded that took the daily acoustic energy in each frequency band, compared it to the total energy in the whole bandwidth, then multiplied it by 100 to generate a percentage.

Automated detectors for dolphins

The SoundTrap recorder data were processed in PAMScan. The primary vocalisation from dolphins for detecting their presence is echolocation clicks, with whistles as the secondary vocalisation. Echolocation clicks are the most reliable vocalisation for this purpose because dolphins rely heavily on their biosonar for sensing their environment and these clicks are more easily distinguishable from other ambient noise. However, an advantage of using PAMScan detectors is that they are trained on the spectrograms as images and provide a level of certainty in being able to detect dolphin presence from both clicks and whistles. PAMScan click detectors have been trained on thousands of detections from around Aotearoa New Zealand and overseas, and verification of detections is very quick, since each detection event is saved with a corresponding audio and image file.

For a detection to be flagged by the detectors, the inter-click intervals and amplitudes have to match the predetermined threshold requirements based on the click-train source. This allows dolphin-based clicks and whistles to be distinguished from other similar sources of noise in the environment. A single vocalisation is defined as one distinct unit of dolphin click-train, burst-pulse or whistle. For the purposes of this project, detection events were classified as either very high-frequency species (e.g. Hector's / Māui dolphins), high-frequency species (e.g. bottlenose, common or dusky dolphins, pilot whales), or mid- to high-frequency species (e.g. orca).

Detections were classified by sound frequency, rather than at species / individual level. While some species use unique frequencies or vocalisations (e.g. whistle inflections) that can identify them, others do not. For example, several dolphin species generate echolocation clicks within the same mid-frequency range. To differentiate between these species, a more detailed analysis is required to look for discerning acoustic signals of associated whistle structures in the recording, if these are present. This process requires large amounts of acoustic data for software training, covering the full vocal repertoire of each species. The same process is needed to identify individual dolphins within the same species – for example, bottlenose dolphins are known to have individually unique signature whistles. However, these signatures first need to be recorded and identified, and then later matched to any new detections – assuming the animal makes these whistles whenever it vocalises, which is unlikely.

Marine mammal detectors for whales

Scanning for low-frequency vocalisations from whales (southern right, fin, sei, minke, blue and humpback whales) was carried out using an automated detector, similar to that described by Hendricks et al. (2018), which produces sounds as spectrogram images. This was based on an adaptive entropy band detector that processed the SoundTrap data through batch-processing. However, some input parameters – such as the number of bands and filter bandwidths – were adapted based on this survey's location and the deployment method.

Acoustic occurrence analysis

Similar to visual sightings, acoustic detections needed to be standardised so they could be compared across seasons and between recorders. The number of detection events was standardised by the number of recording days for each recorder. Detections were also categorised into diurnal periods, daytime (between sunrise and sunset) and night-time (between sunset and sunrise) for comparisons. For each day, the sunrise and sunset times were calculated using the sun equation, which is based on the latitude and longitude position of the hydrophone, its elevation and the time zone.

As acoustic monitoring was carried out to verify visual findings and for comparisons with strandings, no statistical analyses were undertaken other than to qualitatively describe any trends or patterns.

3. Results and discussion

3.1 Strandings results

Temporal trends

A total of 186 stranding events (*n* = 144 filtered events) have been recorded in Golden Bay since records began in 1879 (Table 2, Figure 4). An additional 38 strandings (27 strandings after data filtering) were reported between 2018 and January 2025 in Golden Bay (Table 2), and since the original marine mammal assessment was undertaken by Clement (2019). Approximately 46% of all the 144 filtered strandings involved pilot whales and large baleen whales (e.g. minke, sei and fin whales; Table 2), the species of greatest stranding concern (Clement 2019). Approximately a quarter of all filtered strandings involved either local coastal species (e.g. Hector's dolphin, common dolphin), or rare deeper-water species (e.g. beaked whales, sperm whale, pygmy right whale).

Table 2. The total number of filtered stranding events* recorded in Golden Bay / Mohua waters between 1879 and January 2025, categorised by time period and groups of species.

Time period	Total strandings	Pilot whales	Baleen whales	Other cetaceans
1879–1960	6	2 (33%)	0 (0%)	4 (66%)
1961–1970	4	2 (50%)	1 (25%)	1 (25%)
1971–1980	15	4 (27%)	2 (13%)	9 (60%)
1981–1990	24	7 (29%)	3 (13%)	14 (58%)
1991–2000	20	8 (40%)	2 (10%)	10 (50%)
2001–2010	26	8 (31%)	1 (4%)	17 (65%)
2011–2020	29	10 (34%)	3 (10%)	16 (55%)
2021–2025	20	6 (30%)	7 (35%)	7 (35%)
Total	**144**	**47 (32%)**	**19 (13%)**	**78 (54%)**

* Each event refers to a stranding, whether it involves a single animal or a mass stranding. This dataset has been filtered for any potential restrandings, events that occurred from human intervention (e.g. fisheries entanglement, shooting), and any strandings that occurred on the northern side of Farewell Spit (outside of Golden Bay).

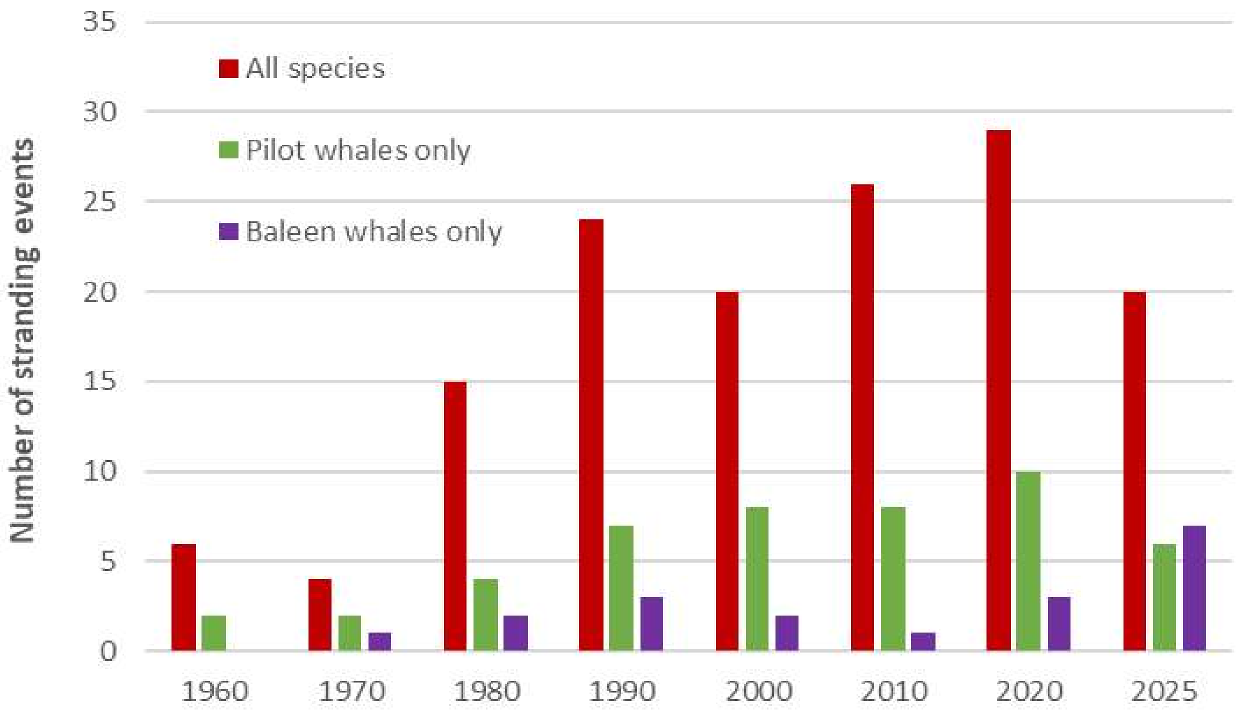

Figure 3. The frequency of marine mammal stranding events recorded in Golden Bay / Mohua waters between 1879 and 2025. Years are grouped by the preceding decade, with the exception of 1960, which includes all strandings from 1879 up to 1960. Note that early records are sporadic, as the Marine Mammal Protection Act was not introduced until 1978 and the national marine mammal incident database was not consolidated until 1988.

While the number of stranding events has varied from year to year, the general decadal total has fluctuated between 20 and 30 filtered stranding events since the 1990s. Based on the national marine mammal incident database, there is no evidence of a substantial difference between the proportion of small to medium-sized cetaceans, pilot whales or large baleen whales (Table 2, Figure 4) that have stranded over the various decades in Golden Bay. Over this same time period, pilot whale strandings have represented between 30% and 40% of all strandings.

Only within the most recent time period (a partial decade of only 4 years: 2021–25) is there a possible change evident. More large baleen whale stranding events have already occurred relative to other decades (Table 2). These events include a few species that have not previously been reported stranding in Golden Bay: humpback whale / paikea (n = 1), blue whale (n = 2) and Bryde's whale (n = 1). The first stranding of each of these species in Golden Bay was reported between 2022 and 2024.

As noted by Clement (2019), the timing of Golden Bay's strandings is highly seasonal, with most occurring between November and January (Figure 5). Pilot whales generally tend to occur in Cook Strait and nearby coastal waters during the warmer months, when upwellings and associated plumes of productivity are common in the South Taranaki Bight (e.g. Torres 2013). Strandings of large baleen whales occur either side of the species' migrations through Cook Strait to tropical breeding grounds (prior to and over winter), or on their way back to Southern Ocean feeding areas during and after spring (Figure 5; Brabyn 1990).

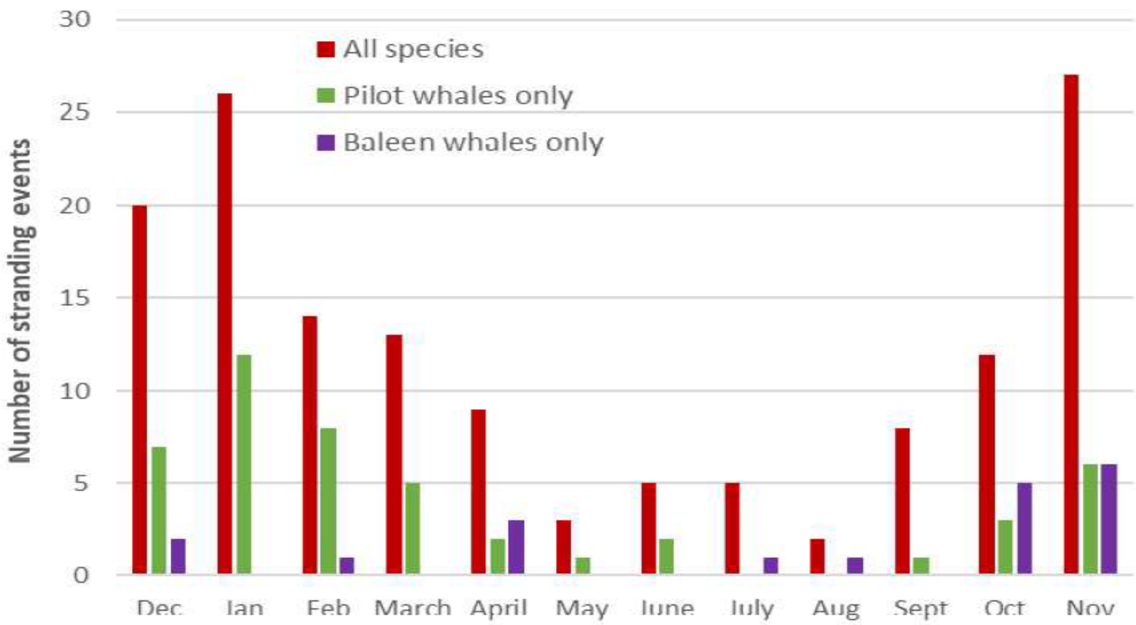

Figure 4.The monthly frequency of marine mammal stranding events in Golden Bay / Mohua waters between 1879 and 2025.

Spatial trends

The most recent stranding data (since 2018) are showing similar spatial spreads around Golden Bay to those of earlier decades, with the greatest proportion of strandings occurring in the 'notch' region of Farewell Spit (approximately 40–60%) and around 20% occurring in southern parts of the bay (Table 3, Appendix 2). At the same time, similar proportions of strandings of small to medium-sized species (which include pilot whales) have occurred over these decades (Table 3, Figure 6, Appendix 2).

Table 3. The total number of filtered stranding events* that have occurred in Golden Bay / Mohua waters since 1981, categorised by decade, the proportion that involved small to medium-sized cetaceans, and those that occurred along southern regions of the bay or within the 'notch' region of Farewell Spit.

Decade	Total strandings	Small / medium-sized species	Southern strandings	'Notch' strandings
1981–1990	24	16 (67%)	8 (33%)	7 (29%)
1991–2000	20	11 (55%)	3 (15%)	11 (55%)
2001–2010	26	18 (69%)	6 (23%)	12 (46%)
2011–2020	29	21 (72%)	6 (21%)	17 (59%)
2021–2025*	20	12 (60%)	4 (20%)	9 (45%)

* Not all coordinates were available for strandings from March 2024 onwards; instead, location descriptions provided were used.

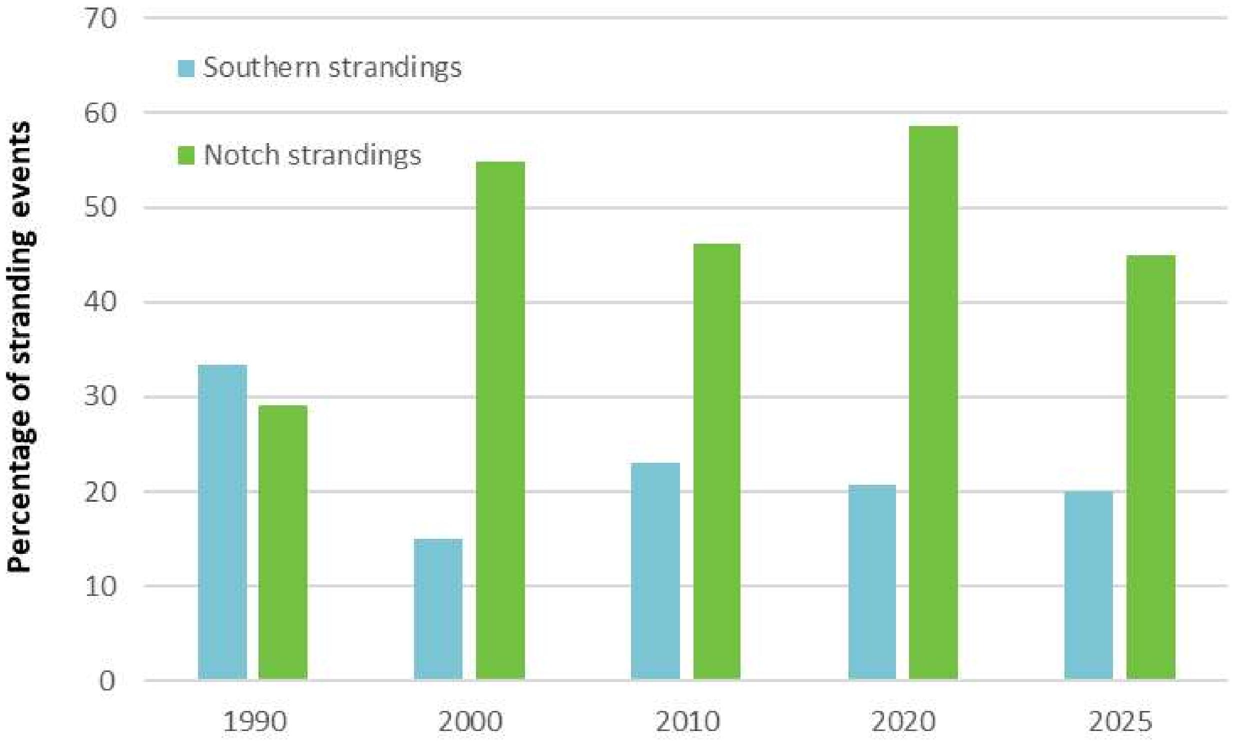

Figure 5. The proportion (by percentage) of stranding events in Golden Bay / Mohua that occurred along the southern coastline (blue columns) or within the 'notch' region of Farewell Spit (green columns). Sample sizes can be found in Table 3. Note that the national marine mammal incident database was not consolidated until 1988.

Since 2021, baleen whale strandings have been spread around Golden Bay, with several between Parapara (i.e. blue whale, humpback whale) and Collingwood (i.e. Bryde's whale, sei whale) up to Farewell Spit (i.e. sei whale), and others to the south around Tākaka (i.e. sperm whale) (Figure 7). Over the same period, mussel farm development was completed and went into production within AMA 2 at P-block and subzones (l), (m), (n) and (o), and AMA 1 C- and D-blocks. However, very little scallop and mussel spat collection has been undertaken over the last 3–4 years (J Wilson, pers. comm., 8 July 2025).

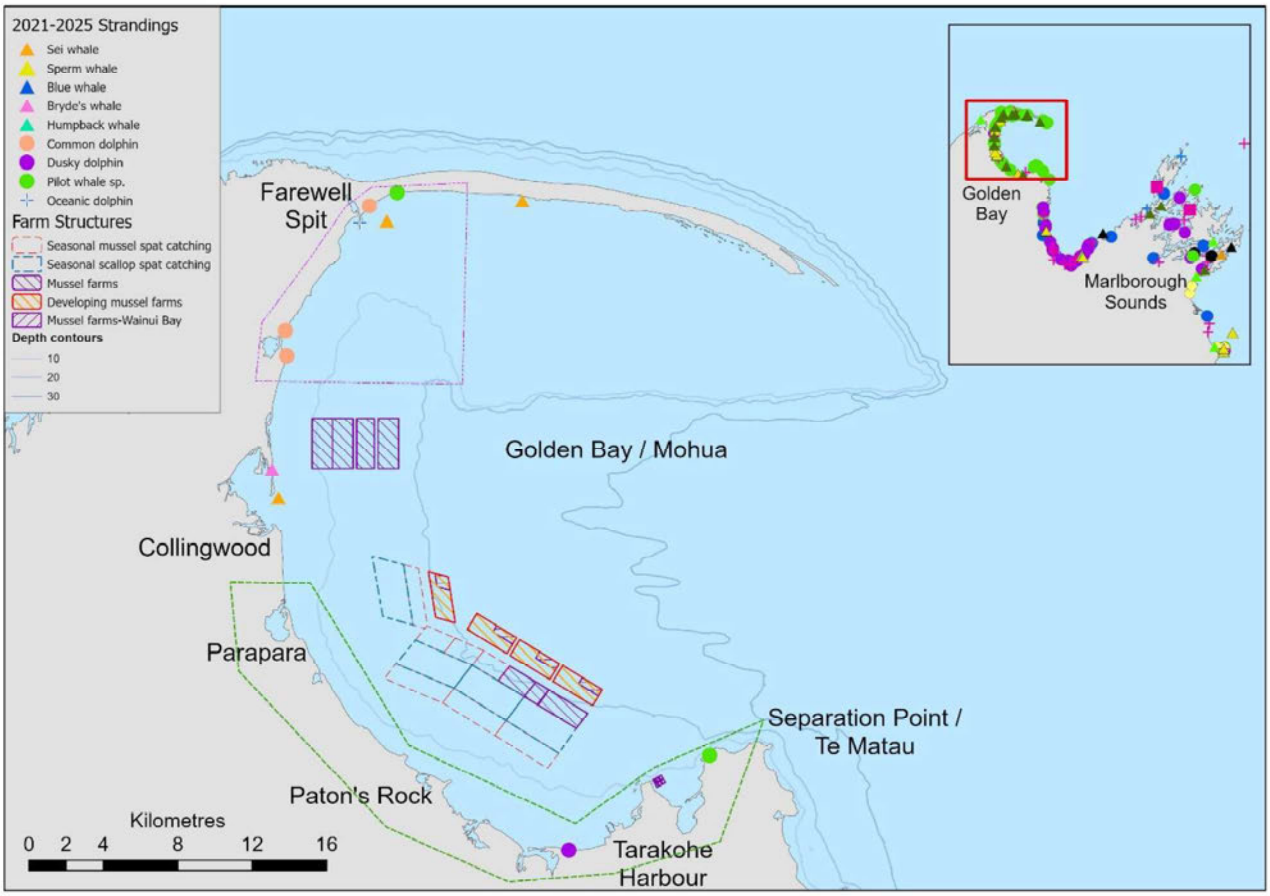

Figure 6. The spatial extent of the various marine mammal strandings that have been recorded in Golden Bay / Mohua from 2021 to 2025, with the associated development of existing marine farm structures during the same time period. The area outlined in purple indicates the Farewell Spit 'notch' stranding zone, while the green outline indicates the southern bay stranding area referred to in Table 3. Note that stranding coordinates were not available from March 2024 onwards. See Appendix 2 for previous years.

3.2 Entanglement results

Only three (and possibly four) of the 186 unfiltered stranding events reported in Golden Bay involved evidence suggesting entanglement as the cause of death. All of these single animal stranding events were attributed to fishing gear, not aquaculture lines, and involved small inshore dolphin species (*n* = 1 dusky dolphin; *n* = 3 common dolphin) found between 2006 and 2010.

Over the past 5 years of monitoring, no observed or accidental incidents of marine mammal entanglement or injury of marine involving farm structures or marine farm vessels were reported. Alister McDonald (Westhaven Shellfish, pers. comm., March 2019) noted a dead animal (which he believes may have been a pilot whale) floating in the bay that was eventually carried into AMA 2 farm structures but was not entangled. A total of three dead, floating pilot whales have been reported by vessel crew over the course of the monitoring period. One dead pilot whale was spotted by crew halfway between

AMA 1 and L-block on 25 February 2021, and was thought to have died and floated off the beach at Pūponga during high tide after stranding between 22 and 24 February. Around this time, Tasman District Council issued a 'warning to mariners' that several dead pilot whales were afloat in Golden Bay.

Another dead pilot whale was found floating within a marine farm at Collingwood (AMA 1) on 27 November 2023 (Figure 8). Crew photographed the whale and reported it to DOC staff, who said it was likely from a stranding on Farewell Spit on 25 November. The most recent record of a dead pilot whale was spotted north of L-block by crew on 21 January 2025. It had died during a mass stranding of 35 pilot whales on 18 January 2025 at Farewell Spit and likely floated off the stranding site with the tide. There were no signs that any of the dead pilot whales had been entangled.

Figure 7. Dead pilot whale found floating between mussel line floats in AMA 1 on 27 November 2023. Photo credit: *Vanguard* crew.

3.3 Occurrence rates

Vessel occurrence rates

Annual rates

From September 2020 to May 2025, all vessel crews reported 409 separate marine mammal sightings within the Zone of Effort (Table 4, Figure 9). This equates to a 22% marine mammal occurrence rate when standardised for the total number of reported trips made by all vessels in this area over the same time period (Table 4). Based on these results, any vessels working in the Zone of Effort would have a 22% chance of encountering a marine mammal on one of their trips. Annual occurrence rates tended to vary between 20% and 30% (with the exception of the first year of monitoring[6]), noting that the last three years had slightly greater sighting rates than the first two years of monitoring. However, there was no significant relationship between annual occurrence rate and monitoring year (p = 0.27; R^2 = 0.369).

Annual occurrence rates for the *Vanguard*, and later the *Grey Heron*, varied from year to year but were within similar ranges to the sighting rates from all the vessels combined (Figure 10). However, the annual trends in *Vanguard*'s occurrence rates did not always match the trends in the combined vessel rates, and nor were they correlated to the proportion of effort that the *Vanguard* (*Grey Heron*) undertook relative to the total trips (i.e. between 34% and 50%). These findings suggest that the combined annual occurrence rates were not necessarily driven by the vessel that undertook the most trips within the Zone of Effort each year. Instead, it is more likely that the consistency in reporting from any one vessel likely varied from year to year (and by different crew). However, by having several different reporting platforms, this variability between vessels was averaged into a more reliable estimate of occurrence.

The main marine mammal species sighted at the farms were New Zealand fur seal and Hector's dolphin (Figure 9). More than 67% of all sightings (n = 275) within the Zone of Effort were of fur seals, the majority of which were observed on and in the farms themselves. Fur seals were frequently observed feeding or playing with each other among the farm structures. Initially, annual occurrence rates of fur seals by the farm vessels indicated a potential increase from 9%[7] to 24% as the farms were developed over the first 3 years (Table 4). The MacLab vessel data also showed fur seal presence increasing around the subzone areas and peaking though 2022 (Figure 11, Appendix 3). However, feedback from vessel crews over the last few years of monitoring noted that if too many fur seals were around, crews did not always tend to report all sightings. Hence, while occurrence rates suggest there was an attraction to the new structures as they were being developed, the data may not be sufficient to determine if this attraction remained consistent over the last few years or whether it levelled out.

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6 Collection of standardised sighting data did not begin until September 2020.

7 Noting that the first year of monitoring did not begin until September 2020, excluding any winter data.

Table 4. Summary of vessel trips (effort) and marine mammal sightings over the five monitoring years as reported by vessels working on, or travelling to or from, L- and O-blocks. Occurrence rates and number of sightings standardised by trip effort are listed in brackets as a percentage.

Dates	Effort (no. of trips)	No. of sightings whales & dolphins (%)	No. of sightings pinnipeds (%)	Total sightings per effort %
1 Mar 2020 – 31 Aug 2020	59	0 (0%)	0 (0%)	0
1 Sep 2020 – 30 Nov 2020	70	2 (3%)	4 (6%)	9%
1 Dec 2020 – 28 Feb 2021	105	4 (4%)	3 (3%)	7%
1 Mar 2021 – 31 May 2021	93	6 (6%)	18 (19%)	26%
2020–2021 total	**268***	**12 (4%)***	**25 (9%)***	**14%***
1 Jun 2021 – 31 Aug 2021	114	2 (2%)	12 (11%)	12%
1 Sep 2021 – 30 Nov 2021	91	9 (10%)	15 (16%)	26%
1 Dec 2021 – 28 Feb 2022	87	1 (1%)	19 (22%)	23%
1 Mar 2022 – 31 May 2022	122	7 (6%)	15 (12%)	18%
2021–2022 total	**414**	**19 (5%)**	**61 (15%)**	**19%**
1 Jun 2022 – 31 Aug 2022	87	6 (7%)	18 (21%)	28%
1 Sep 2022 – 30 Nov 2022	121	8 (7%)	43 (36%)	42%
1 Dec 2022 – 28 Feb 2023	98	6 (6%)	20 (20%)	27%
1 Mar 2023 – 31 May 2023	81	5 (6%)	12 (15%)	21%
2022–2023 total	**387**	**25 (6%)**	**93 (24%)**	**30%**
1 Jun 2023 – 31 Aug 2023	77	14 (18%)	14 (18%)	36%
1 Sep 2023 – 30 Nov 2023	100	15 (15%)	7 (7%)	22%
1 Dec 2023 – 28 Feb 2024	97	1 (1%)	8 (8%)	9%
1 Mar 2024 – 31 May 2024	124	6 (5%)	17 (14%)	19%
2023–2024 total	**398**	**36 (9%)**	**46 (12%)**	**21%**
1 Jun 2024 – 31 Aug 2024	64	15 (23%)	13 (20%)	44%
1 Sep 2024 – 30 Nov 2024	95	5 (5%)	27 (28%)	34%
1 Dec 2024 – 28 Feb 2025	86	3 (3%)	7 (8%)	12%
1 Mar 2025 - 31 May 2025	119	2 (2%)	20 (17%)	18%
2024 –2025 total	**364**	**25 (7%)**	**67 (18%)**	**25%**
Grand total	**1,831**	**117 (6%)**	**292 (16%)**	**22%**

* Effort and sightings totals cover the period September 2020 to May 2021.

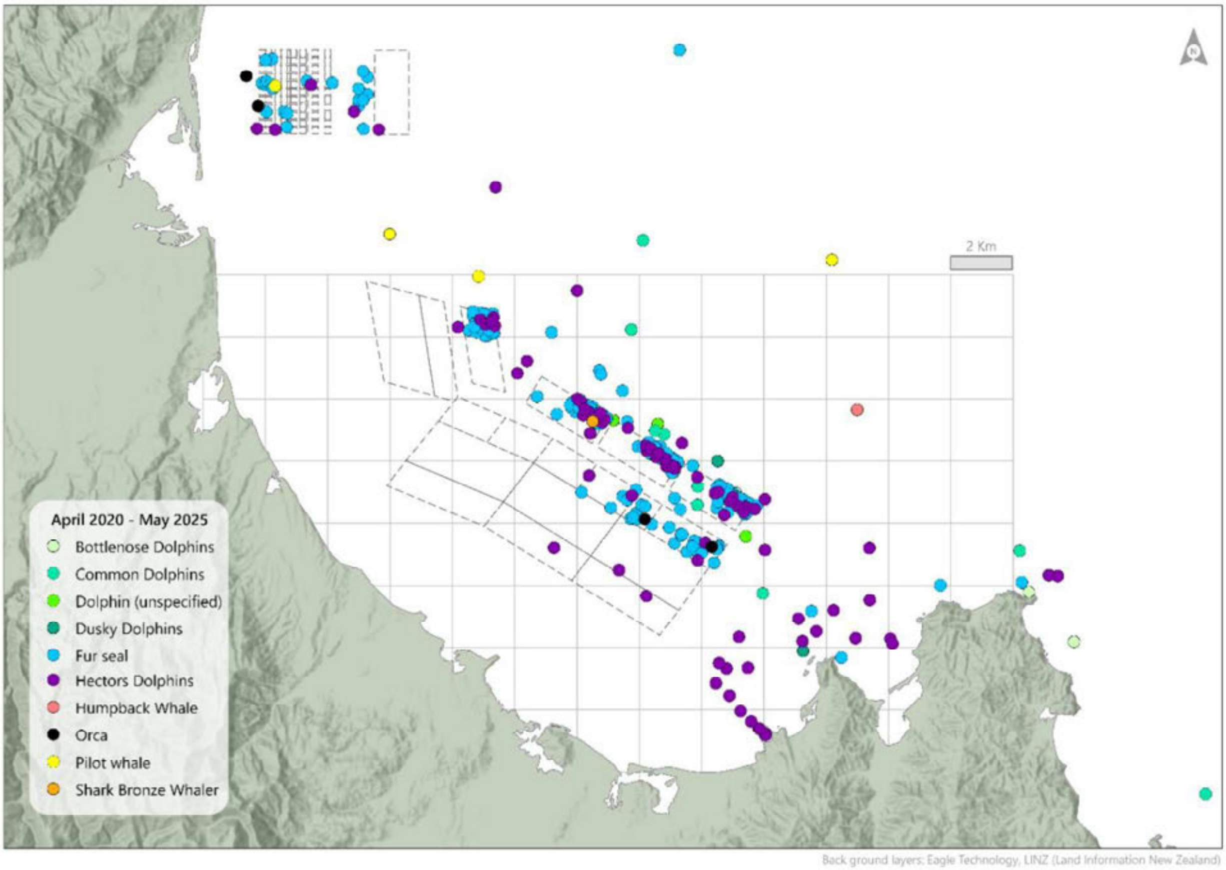

Figure 8. All reported marine mammal sightings from farm-related vessels working in the Zone of Effort (grid) and wider Golden Bay / Mohua area from April 2020 to May 2025. See Appendix 3 for annual sighting maps.

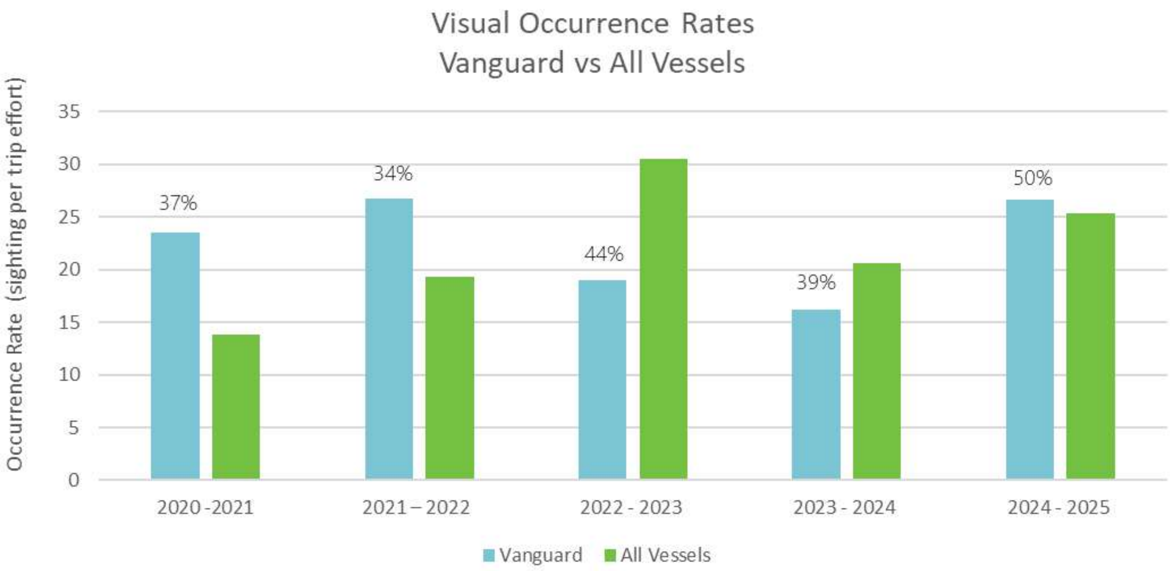

Figure 9. Comparison of marine mammal occurrence rates between only the *Vanguard* (and *Grey Heron* after September 2024) and all vessels combined. The percentage of the combined trips undertaken by just the *Vanguard* (*Grey Heron*) are listed above the blue columns.

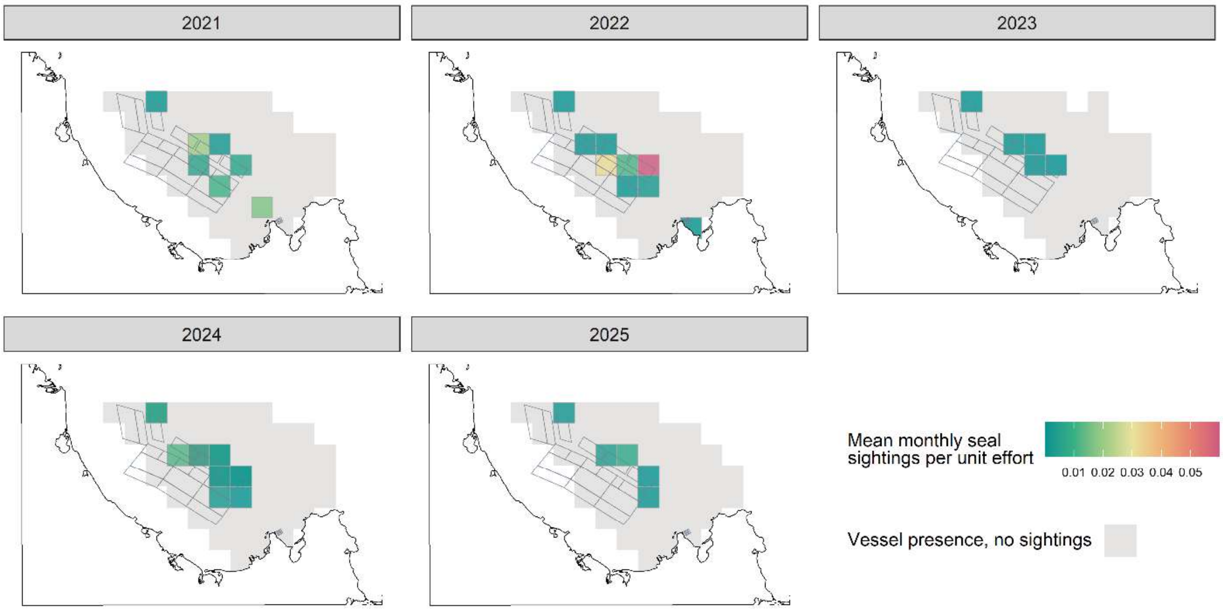

Figure 10. Annual densities of fur seal / kekeno observed by *Vanguard* and *Grey Heron* (from September 2024) in the Zone of Effort and corrected for effort (mean monthly sighting per vessel effort per grid).

Annual rates of cetacean (dolphins, toothed and baleen whales) sightings were low (less than 10%) across most monitoring years, with a slight increase in sightings over the first four monitoring years (Table 4, Appendix 3). Hector's dolphins accounted for 65% of all reported dolphin and whale sightings over the 5 years with a total of 75 sightings, typically in average groups of three, ranging from one to 20 individuals (Figure 9). During the first few years of monitoring, most sightings of Hector's dolphins by *Vanguard* occurred between Port Tarakohe and Separation Point and the farm block, where they were observed cruising, travelling or boat-riding around the boat (Figure 12). These reports indicate that there may have been some aspect of the marine farm vessels attracting these dolphins to the vessels. In general, Hector's dolphins are known for their curiosity, and specifically, for their attraction to nearby vessels moving at slow to medium speeds (Dawson et al. 2000). As the farms developed, sighting densities increased around them, with records noting Hector's dolphins swimming through the farms and between the lines (Figure 12). While no sightings of this species were reported by *Vanguard* or *Grey Heron* over the last 6 months of monitoring (2025), two sightings were made of other farm vessels over this period.

Other, less frequently sighted dolphin species within the Zone of Effort included bottlenose dolphins, common dolphins, dusky dolphins, orca and pilot whales (Figure 9). These animals were mainly reported in more open waters away from farms, often in larger groups of between 10 and 40 but up to 200 animals (Figure 13). Only occasional sightings of common dolphins or orca were reported between lines within the farms themselves. Baleen whales were the least sighted marine mammal, with only two sightings recorded by farm vessels over the 5 years of vessel monitoring (Figure 14).

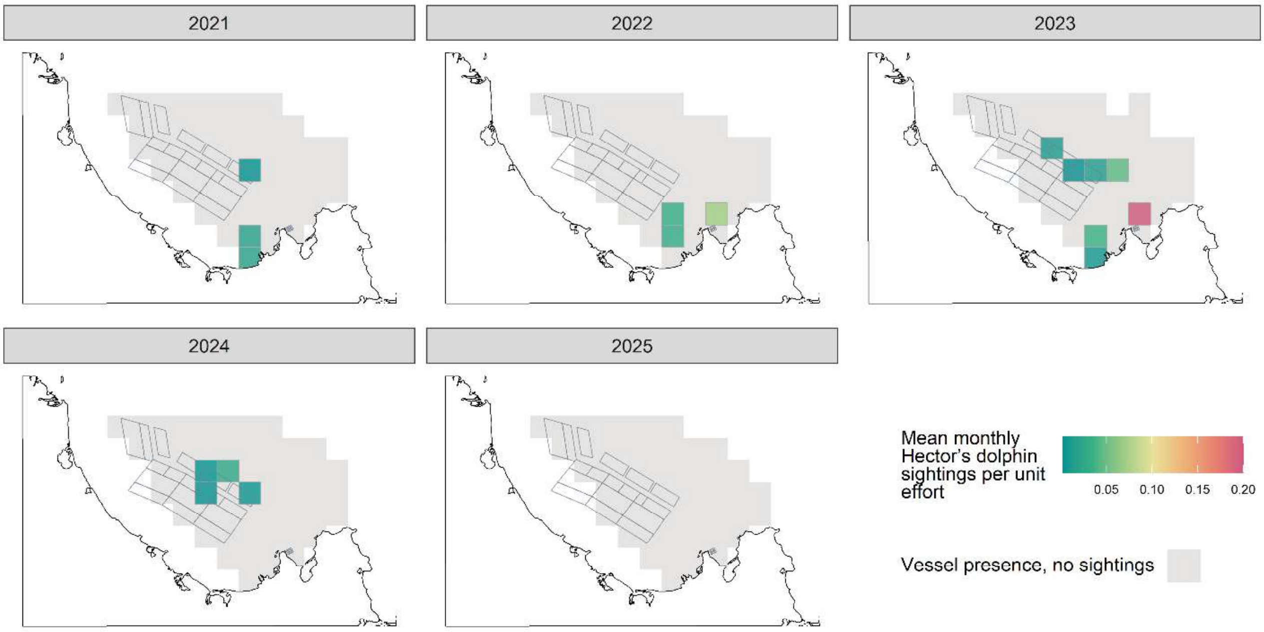

Figure 11. Annual densities of Hector's dolphin / upokohue observed by *Vanguard* and *Grey Heron* (from September 2024) in the Zone of Effort and corrected for effort (mean monthly sighting per vessel effort per grid).

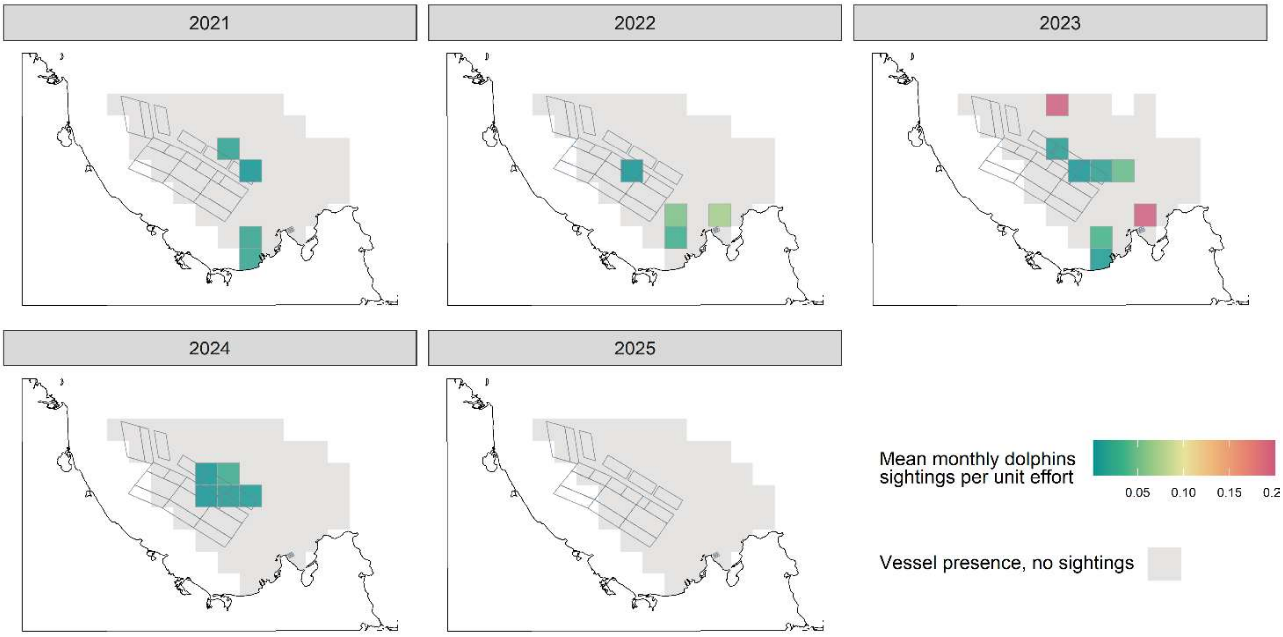

Figure 12. Annual densities of all dolphin species observed by *Vanguard* and *Grey Heron* (from September 2024) in the Zone of Effort and corrected for effort (mean monthly sighting per vessel effort per grid).

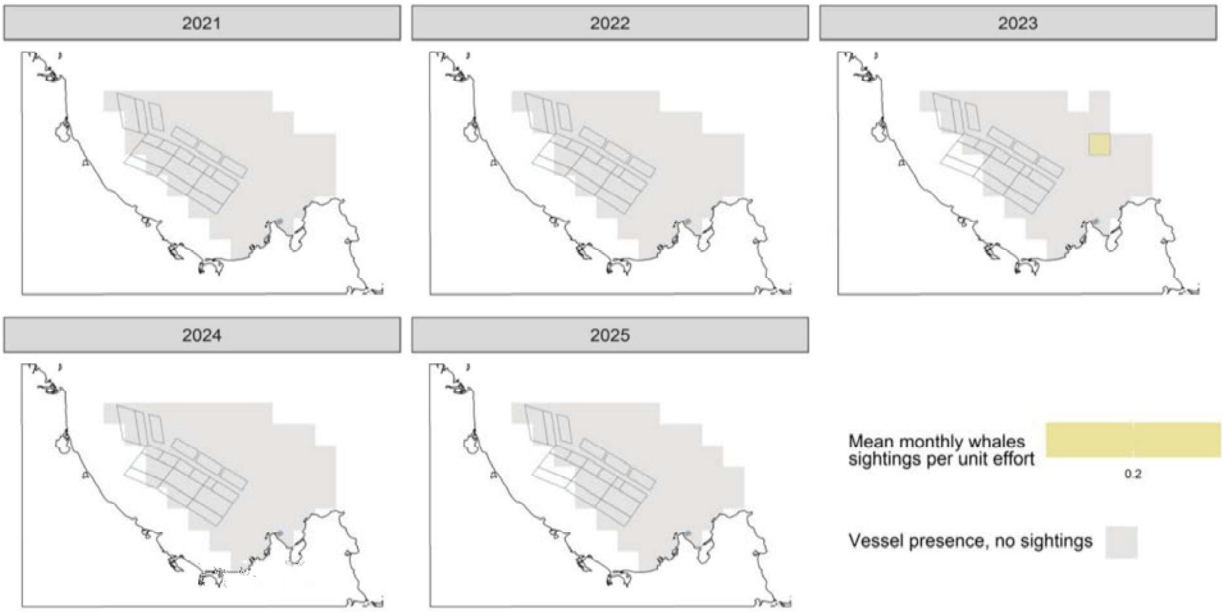

Figure 13. Annual densities of baleen whales observed by *Vanguard* and *Grey Heron* (from September 2024) in the Zone of Effort and corrected for effort (mean monthly sighting per vessel effort per grid).

Seasonal occurrence trends

Across the various seasons, farm vessels made more trips to the Zone of Effort during the autumn season and fewer trips over winter (Table 5).[8] However, once standardised for vessel effort, marine mammal occurrence was greater over both the winter and spring seasons (27% and 28%, respectively). While the lowest reported occurrence rates were in summer (15%), there was no statistical difference between seasons (X^2 = 5.49, p-value = 0.139, df = 3). The rates in visual sightings over spring were largely driven by the greater numbers of fur seals and groups of Hector's dolphins observed during this season (Table 5, Figure A4.1, Figure A4.2). Spring is when fur seal pups are weaned and set off on their own for the first time, and so visitations to the farms by weaned pups likely increase at this time. A known peak in fur seal sightings occurs each spring at salmon farms in the Marlborough Sounds (Clement and Elvines 2019). Spring is also when Hector's dolphins start calving and generally move back into shallower waters (Clement 2005). During this season, the dolphins appeared to cluster more in the subzone areas.

As predicted (Clement 2019), other species were seen only during certain seasons. Humpback whales, orca and dusky dolphins were more prevalent in Golden Bay waters over the colder months (Figure A4.3). Two humpback whales were sighted in August 2023 offshore from AMA 2 but within the Zone of Effort (Figure 9), and an unidentified baleen whale was recorded in August 2024 off L-block. Reports of humpback whales were also received from other sources around this time in Golden Bay (Mike Ogle, DOC ranger, pers. comm., 1 June 2024). Given the time of year, these animals were likely on their northern migration past Aotearoa New Zealand, transiting through Cook Strait and towards tropical waters. It is not unusual for humpbacks to rest in bays along their migration pathway (e.g. Dawbin 1956).

[8] Mainly due to lower effort over the first winter season.

Table 5. Summary of vessel trips (effort) and marine mammal sightings over the five monitoring years by season.

Season	Effort (no. of trips)	No. of sightings whales and dolphins (%)	No of sightings pinnipeds (%)	Total sightings per effort %
Winter	342	37 (11%)	57 (17%)	27%
Spring	477	39 (8%)	96 (20%)	28%
Summer	473	15 (3%)	57 (12%)	15%
Autumn	539	26 (5%)	82 (15%)	20%

Orca are transients across the top of the South Island and were mainly sighted within the Zone of Effort over the winter months, with a few sightings also in autumn (Figure A4.3). Two of the three Aotearoa New Zealand sub-populations of orca travel between / around the South Island, and in particular through Cook Strait. These animals tend to travel slowly across the top of the South Island coastal waters, hunting prey in estuaries and harbours, and do not spend a large amount of time in any one location (Visser 1999, 2000, 2007).

Dusky dolphins often frequent waters across the top of the South Island over winter (Davidson et al. 2011), with more spring observations in the Zone of Effort (Figure A4.3). They are seasonal visitors, sighted mainly over colder months, when animals from Kaikōura are thought to migrate north and around to the West Coast before returning to Kaikōura in spring (e.g. Markowitz et al. 2004).

Common dolphins are the most frequently observed species within the wider Cook Strait region, with smaller groups occurring within more coastal waters along the top of the South Island (Meakin 2014). This species was generally seen throughout the year in the Zone of Effort but sighted in greater numbers over summer months (Figure A4.3).

Pilot whales and bottlenose dolphins were mainly observed in the Zone of Effort during summer and spring months (Figure A4.3). Pilot whales were regularly observed in offshore waters of Cook Strait throughout the year. However, over the warmer months they move inshore and wander into shallower waters of Golden Bay while following the coastline (Brabyn 1991). Bottlenose dolphins also regularly and systematically move from one side of the Marlborough Sounds to the other, as well as through nearby regions such as Golden Bay and Te Koko-o-Kupe / Cloudy Bay, generally in groups of 30–40 animals (Merriman et al. 2009).

Spatial occurrence trends

Seasonal occurrence rates suggested that there may be some spatial patterns in use of the Zone of Effort by both fur seals and Hector's dolphins. Hence, vessel sighting data were initially analysed using the Space–Time Cube analyses, as described in Section 2.2. Both options for dealing with grid cells with no effort were used. However, preliminary tests found that only six grids had enough data for the Mann–Kendall trend test and no trends were detected within those grids. Hence, no further analyses using additional methods such as occupancy modelling (MacKenzie et al. 2017) were warranted. Instead, a qualitative description of spatial trends was undertaken.

Based on monthly density maps of *Vanguard* (and *Grey Heron*), fur seals appeared to spread themselves across farm development areas over most months of the year (Figure 15). Only during the colder months of June through August did there appear to be fewer seals and / or they were more concentrated in fewer locations.

Hector's dolphin use of the area appears to follow the species' well-known seasonal movement patterns from other locations. This species tends to occur close to shore in shallow water during the warmer months of spring, summer and / or autumn (Figure A4.2; Clement 2005). In this case, sightings were generally near Port Tarakohe and Separation Point over warmer months (Figure 16). During the colder months, however, Hector's dolphin were mainly sighted further from shore, near the deeper waters in the middle of the bay and around the farm subzones (Figure 16).

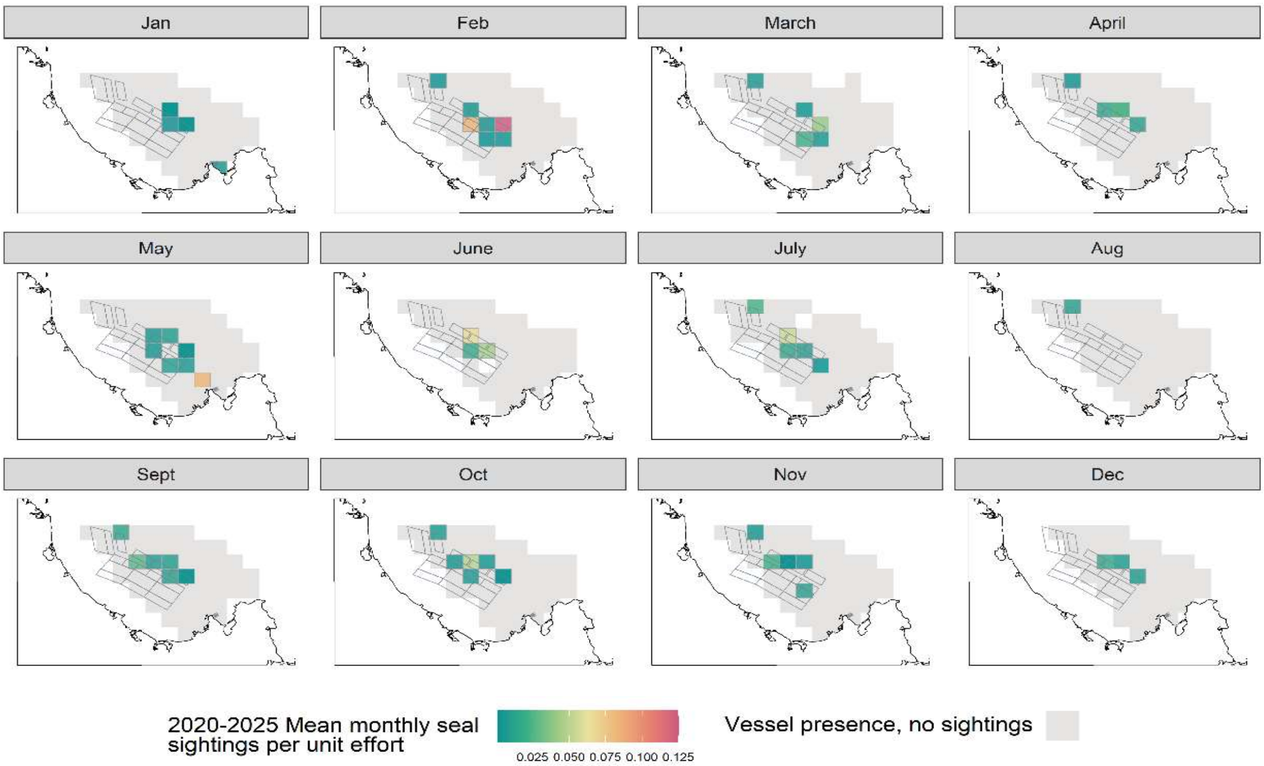

Figure 14. Monthly densities of fur seal / kekeno observed by *Vanguard* and *Grey Heron* (from September 2024) in the Zone of Effort and corrected for effort (mean monthly sighting per vessel effort per grid).

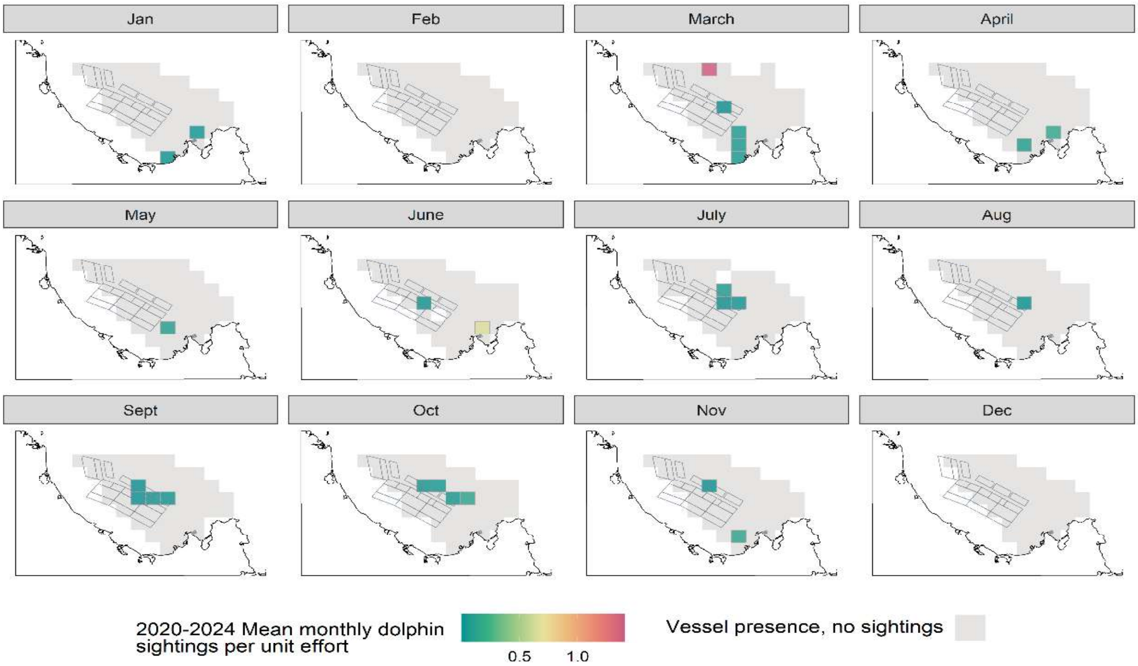

Figure 15. Monthly densities of Hector's dolphin / upokohue observed by *Vanguard* and *Grey Heron* (from September 2024) in the Zone of Effort and corrected for effort (mean monthly sighting per vessel effort per grid).

Acoustic occurrence rates

Two SoundTrap recorders were installed on the seaward side of the AMA 2 farms (one on L-block and one on O-block) between 13 February 2024 and 28 February 2025 (Figure 3). Over the 385-day monitoring period, a total of 1,782 and 3,648 individual cetacean acoustic detection events occurred at L-block and O-block moorings, respectively (Tables 6 and 7, Appendix 5). The effective detection distance of the SoundTraps for dolphin vocalisations is frequency-dependent, but generally less than 1 km and closer to several hundred metres. While multiple detections of a group could be recorded on the same day at one mooring, the same group would not have been detected at the other mooring at the same time given the distance between the moorings (approximately 10 km). Hence, the mooring locations are independent, to the extent that the Hector's dolphin, dolphin species and orca results do not reflect double-counting of the same event. That said, the same group may have visited both moorings at different times on the same day.

The case is different for baleen whale calls. Whale detections are likely received from a whale that is several kilometres and up to tens of kilometres away from the mooring because lower-frequency sounds travel further. The O-block mooring in particular was open to receiving whale calls from Cook Strait and the South Taranaki Bight (see Figure 3), a known year-round habitat for pygmy blue whales (Torres 2013). The L-block mooring was located more within an acoustic shadow of Farewell Spit. Sei, minke, fin and humpback whales, along with southern right whales, are known to pass through Cook Strait waters. Hence, the whale acoustic occurrence rates recorded by the moorings do not indicate that whales are physically near the farms, just in the wider Cook Strait region. Both moorings may have been able to record the same whale-call event, depending on the whale's location and strength of the call. As a result, whale events are not independent between the acoustic recorders.

Over the entire sampling year, acoustic recorders detected cetaceans around the farm subzones (and likely from parts of the South Taranaki Bight) on at least 261 (68%, L-block; Table 6) and 341 (89%, O-block; Table 7) of the recording days in 2024 and 2025 (Appendix 5). These acoustic occurrence rates were approximately 3–4 times greater than the visual occurrence rates, in which vessels observed marine mammals on 27% of their vessel trips over the same period. When the two moorings were compared, the L-block farm area was visited more often than the O-block farm area by all species except for baleen whales and across most seasons. The opposite was true of the visual occurrence patterns for the two farm blocks (Figure 9).

Seasonal acoustic occurrence trends

Seasonal comparisons between visual and acoustic occurrence rates found similar trends between all three monitoring sources, indicating relatively greater occurrences of baleen whales and orca over winter, and other dolphin species more common in spring (Figure 17). Hector's dolphin visual and acoustic occurrence rates at O-block were also greater over winter, while L-block had slightly greater occurrence rates over spring. These results suggest that visual monitoring by farm vessels could capture the general seasonal presence of most of these species in Golden Bay (Figure 17).

However, as with annual rates, the seasonal rates reported with the visual method were much lower than either of the acoustic mooring results, particularly for baleen whales and Hector's dolphin. This difference was less for other dolphin species and orca (Tables 6 and 7). These species seem less attracted to the farm structures when present (Figure 9, Figure A4.3), and farm vessel crew often sighted larger groups – i.e. those that might catch their attention better.

Table 6. Annual and seasonal summary of acoustic monitoring effort and acoustic detections listed by marine mammal categories near L-block farm from February 2024 to February 2025.

Species	Season	No. of sample days	No. of minutes detected	No. of events	No. days with detection	Detection rate (%)
Baleen whales	Autumn	94	1,857	208	55	59%
	Winter	92	9,147	458	71	77%
	Spring	91	1,207	160	61	67%
	Summer	108	966	91	39	36%
	Annual	**385**	**13,177**	**917**	**226**	**59%**
Dolphin spp.	Autumn	94	107	8	5	5%
	Winter	92	74	6	5	5%
	Spring	91	620	29	21	23%
	Summer	108	75	8	7	7%
	Annual	**385**	**876**	**51**	**38**	**10%**
Hector's dolphin	Autumn	94	2,106	217	68	72%
	Winter	92	1,813	235	67	73%
	Spring	91	2,418	222	71	78%
	Summer	108	504	115	55	51%
	Annual	**385**	**6,841**	**789**	**261**	**68%**
Orca	Autumn	94	59	1	1	1%
	Winter	92	522	21	5	5%
	Spring	91	68	1	1	1%
	Summer	108	51	2	1	1%
	Annual	**385**	**700**	**25**	**8**	**2%**

Table 7. Seasonal summary of acoustic monitoring days and marine mammal underwater acoustic detections near O-block farm from February 2024 to February 2025.

Species	Season	No. of sample days	No. of minutes detected	No. of events	No. days with a detection	Detection rate (%)
Baleen whales	Autumn	94	11,612	586	84	89%
	Winter	92	26,974	909	89	97%
	Spring	91	17,555	995	87	96%
	Summer	108	6,502	7,507	81	75%
	Annual	**385**	**62,643**	**2,997**	**341**	**89%**
Dolphin spp.	Autumn	94	143	7	6	6%
	Winter	92	9	2	2	2%
	Spring	91	92	9	8	9%
	Summer	108	113	12	8	7%
	Annual	**385**	**357**	**30**	**24**	**6%**
Hector's dolphin	Autumn	94	898	126	47	50%
	Winter	92	1,867	278	78	85%
	Spring	91	724	99	37	41%
	Summer	108	491	110	61	56%
	Annual	**385**	**3,980**	**613**	**223**	**58%**
Orca	Autumn	94	0	0	0	0%
	Winter	92	226	8	4	4%
	Spring	91	0	0	0	0%
	Summer	108	0	0	0	0%
	Annual	**385**	**226**	**8**	**4**	**1%**

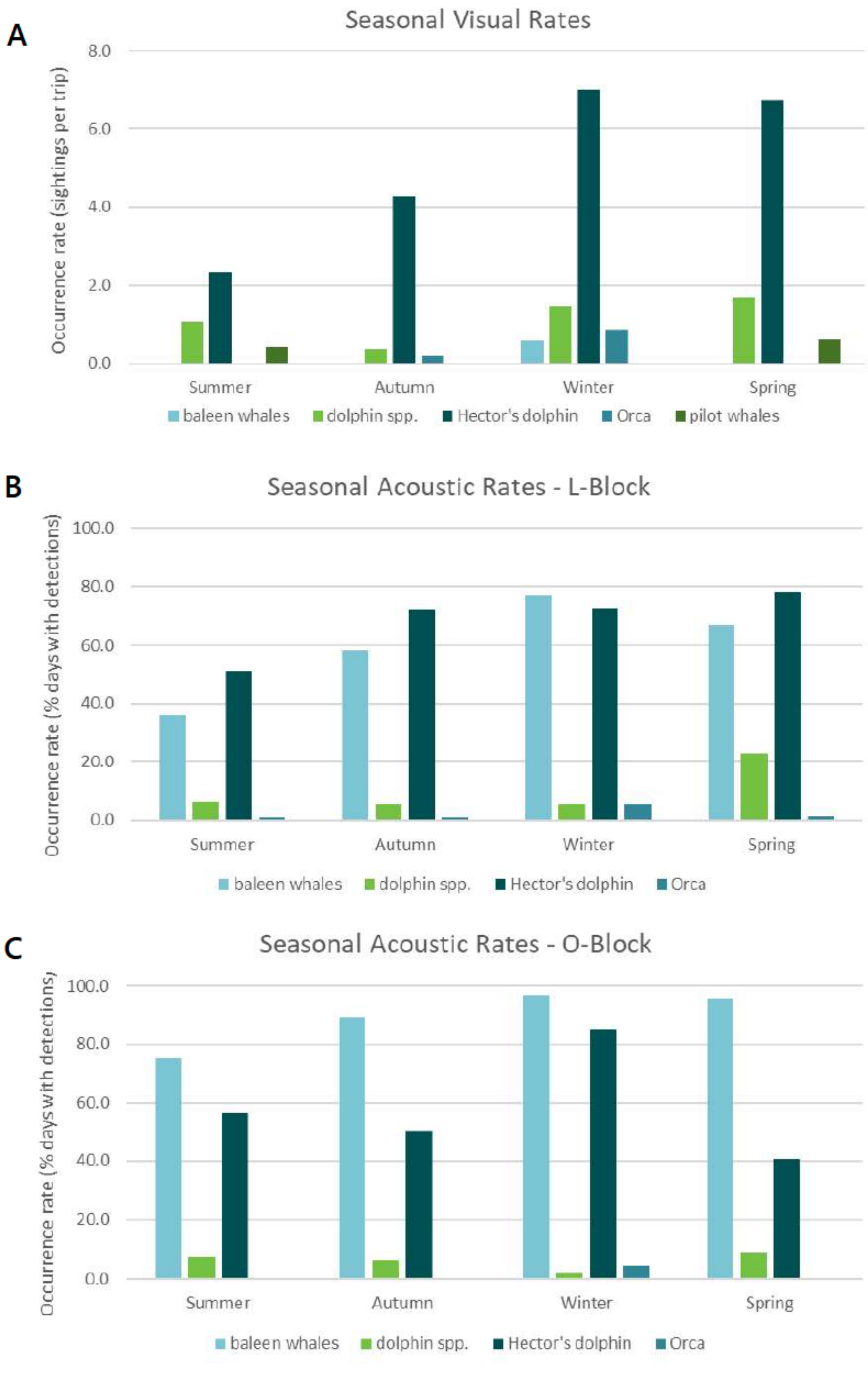

Figure 16. Seasonal occurrence rates of the marine mammal categories. (A) Vessel visual sightings. (B) Acoustic detections from L-block. (C) Acoustic detections from O-block.

Day versus night

The acoustic data were also used to determine whether there were any specific diurnal trends to species detections near or around farm structures, which may help explain differences with visual monitoring results. In general, most species were heard at O-block equally across both day and night (Figure 18). In contrast, Hector's dolphins were heard more frequently overnight at both moorings, while orca visited L-block almost exclusively overnight.

With the exception of baleen whales, winter was the season in which diurnal patterns seemed to differ slightly to those of other seasons (Figures 19 and 20). Various dolphin species were detected more often overnight during winter, perhaps due to the shorter days. However, the opposite trend was found with both Hector's dolphins and orca, which were detected slightly more often during daylight hours in winter relative to the other seasons (Figures 19 and 20). While these diurnal trends help explain lower visual sighting rates (which represented only daytime sightings), they do not fully account for the large differences between the two methods.

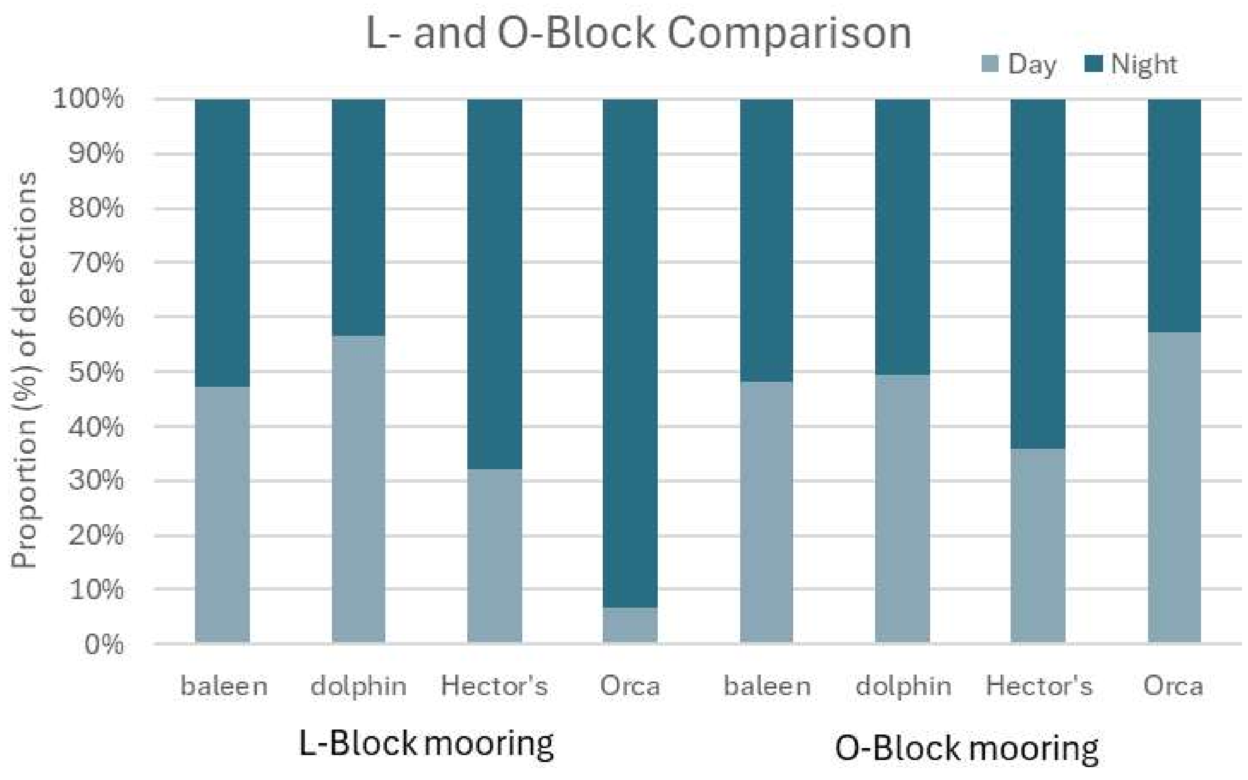

Figure 17. The proportion (%) of day and night acoustic detections recorded for each species category at both L-block and O-block moorings. Note that the dolphin species columns exclude Hector's dolphin.

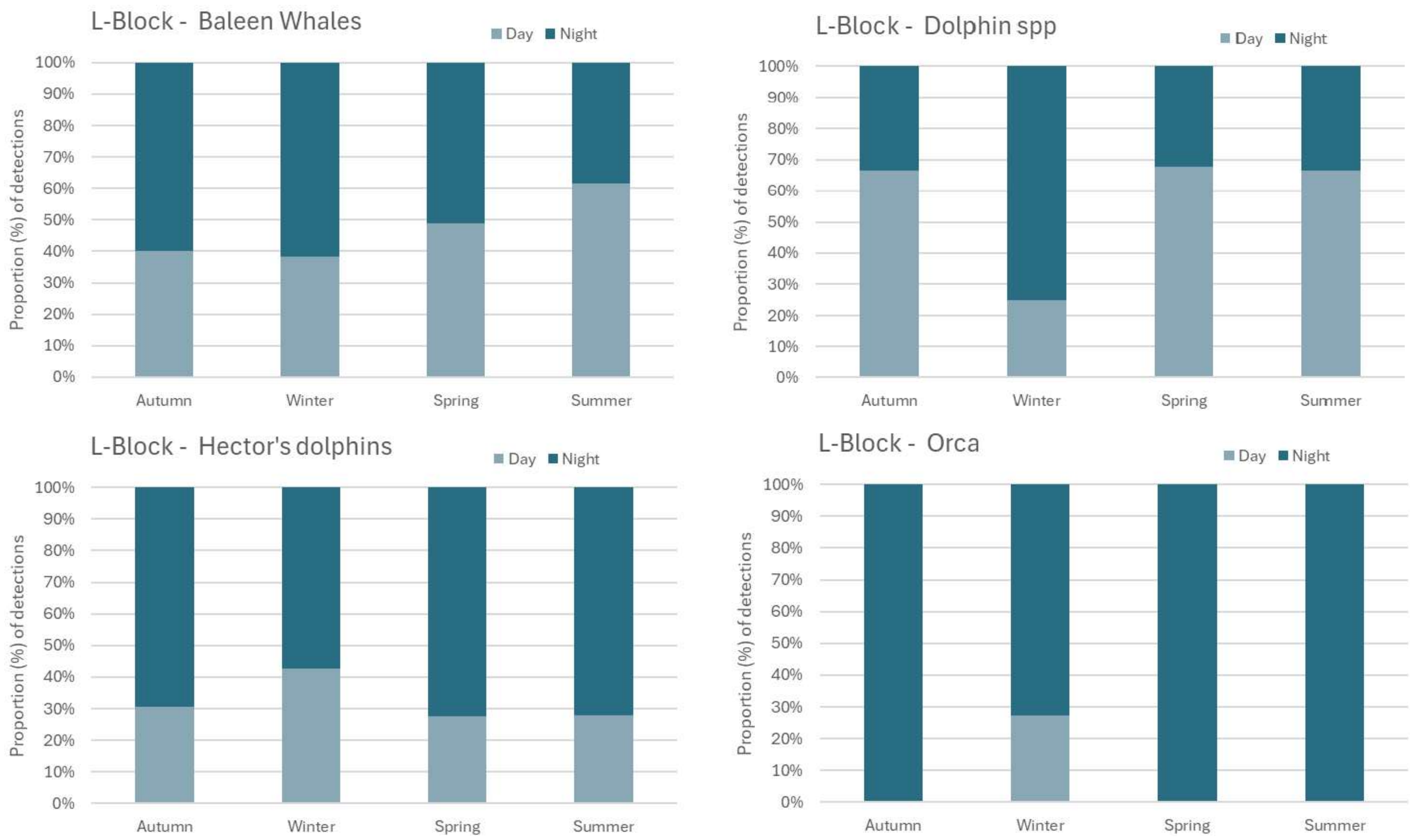

Figure 18. The proportion (%) of day and night acoustic detections recorded for each season at L-block mooring listed by species categories. Note that the dolphin species figure excludes Hector's dolphin.

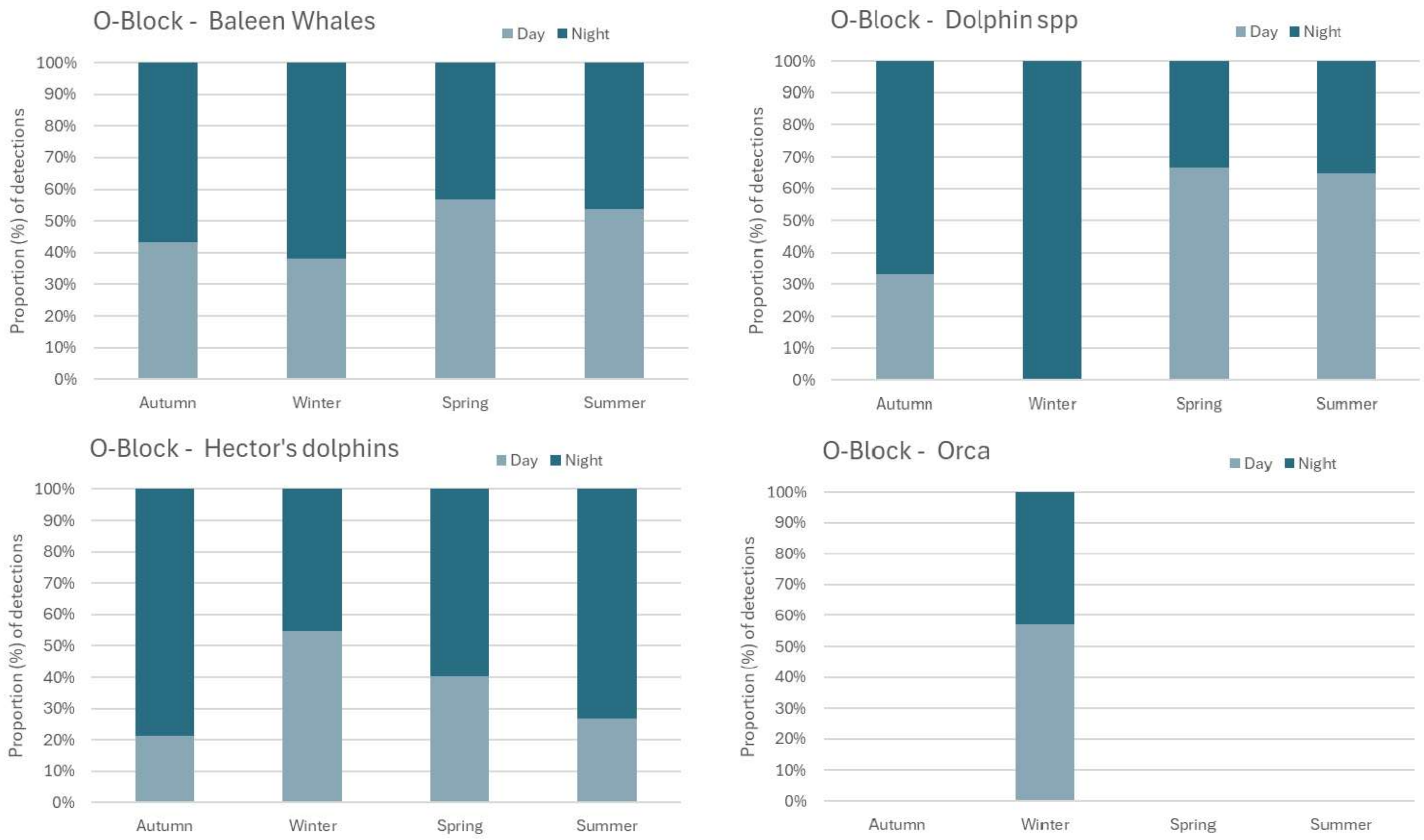

Figure 19. The proportion (%) of day and night acoustic detections recorded for each season at O-block mooring listed by species categories. Note that the dolphin species figure excludes Hector's dolphin.

Occurrence and strandings

Both acoustic and visual data were further explored for any evidence of unusual or prolonged interactions that coincided with stranding and / or refloating dates. This qualitative comparison looked for instances in which farm structures might possibly influence those species most susceptible to strandings (e.g. pilot whales, baleen whales) and their movements,

The acoustic data were examined to determine whether stranded animals may have been present around farm structures prior to stranding and any refloated animals trying to navigate their way out of Golden Bay may have ventured near farm structures. Of the 11 stranding events that occurred between February 2024 and February 2025, seven were small to medium-sized species (which include pilot whales), three were baleen whales and one sperm whale (see 'Spatial trends' in Section 3.1).

For periods of 1–4 days prior to four of the dolphin stranding events, acoustic detections of dolphin species (including pilot whales but excluding Hector's dolphin) were detected near farms (Table 8). Acoustic detections of dolphin species near farm structures were also recorded approximately 1–7 days after four of these stranding events. As it is difficult to distinguish the calls and whistles of different dolphin and pilot whale species from one another, we could not determine whether the detections were of the same species as those stranded. However, on most of these occasions the detection durations were generally brief, suggesting the animals did not remain around the farms for long.

During the 9 November 2024 event, two of the three common dolphins died soon after stranding, while one was refloated and not found again (Table 8). The single pilot whale that stranded on 15 November 2024 was a beachcast individual, which meant the animal likely died at sea and floated into the beach with the tide. Of the 10 pilot whales that stranded on 7 January 2025, eight animals were refloated. However, it is unknown whether these animals restranded or not. There was also no information in DOC's national marine mammal incident database about how many animals from the 18 January 2025 stranding were refloated and / or restranded.

Table 8. Comparisons of stranding events involving small to medium-sized species between February 2024 and February 2025 with acoustic detections of dolphin species (excluding Hector's dolphin) from L- and O-block farms both before and after stranding events.

Stranding date	Description	Pre-stranding detection location(s)	Pre-strandingdetection date(s)	Post-stranding detection location(s)	Post-stranding detection date(s)
9 Nov 2024	3 common dolphins	L- & O-blocks	5, 8 Nov / 6 Nov	L-block	12–14, 16 Nov
15 Nov 2024	1 pilot whale	L-block	12–14 Nov	L-block	16 Nov
4 Dec 2024	37 pilot whales	O-block	3 Dec	–	–
19 Dec 2024	18 pilot whales	–	–	–	–
19 Dec 2024	14 pilot whales	–	–	–	–
7 Jan 2025	10 pilot whales	L- & O-blocks	4 Jan / 6 Jan	O-block	13 Jan
18 Jan 2025	35 pilot whales	–	–	L-block	20 Jan

Multiple blue whale and humpback whale acoustic detections at both L- and O-blocks were recorded several days prior to, or on the days of, the stranding of two blue whales on 3 April and 26 April 2024, and of one humpback whale on 31 October 2024. In general, these species are expected to be in Cook Strait over these time periods. In these cases, stranding comments in the national marine mammal incident database noted that these whales were also beachcast and likely died at sea before washing ashore. Hence, the farms likely had no influence on the death or stranding locations in these instances. However, as we cannot triangulate the location of the baleen whales making the calls that were detected, we cannot determine if these species were inside or outside Golden Bay at the time of the strandings.

No visual sightings of stranded species were reported around the time of the stranding events or after, except for the floating dead pilot whale reported on 21 January 2025 near L-block. This animal was thought to a whale that died during the 18 January 2025 stranding event on Farewell Spit and then floated off the sand with the tide (see Section 3.2).

4. Summary

4.1 Stranding and entanglement findings

Golden Bay, and more precisely Farewell Spit, is recognised as a national hotspot for marine mammal strandings in Aotearoa New Zealand (Gaskin 1968; Baker 1981; Brabyn 1991). Brabyn (1990) highlighted that the bay accounts for a large proportion of live mass (also known as herd) strandings of offshore species: marine mammals that normally would be found in deeper ocean water, generally away from coastal regions, such as pilot whales. The author's review found that offshore species appear to herd strand more often on long, gently sloping sandy beaches with 'hooks' of protruding coastline, where the shallow or tidal coastal features are unfamiliar to them. The author found that the coastal configuration of Golden Bay is very similar to the configuration of overseas 'whale traps', such as Cape Cod in Massachusetts, USA. The first stranding recorded in Golden Bay was pre-1880 and they have continued to occur over all subsequent decades. Between 1879 and January 2025, approximately 186 stranding events of at least 20 different species have been reported in Golden Bay, mainly between the months of November and January.

Based on the review of DOC's national marine mammal incident database presented in this report, there is no evidence of a substantial difference across decades between the proportion of small to medium-sized cetaceans, pilot whales or large baleen whales that have stranded in Golden Bay. In addition, there is no relationship with previous or current aquaculture development. These results are also supported by the lack of any consistent increase across decades in the overall number of marine mammal strandings occurring in Golden Bay (n = 20–30 filtered events per decade).

An exception is the greater number of large baleen whales that have stranded over the last 4 years, including some whale species that have not been reported stranding in Golden Bay before 2022. However, more than half of these events are beachcast individuals of species known to be year-round residents or regular migrators through South Taranaki Bight / Cook Strait waters, suggesting they likely died at sea and floated into the bay. Brabyn (1990) examined several of the main theories for why Golden Bay is a 'whale trap' and concluded that it is likely due to a combination of local coastal topography, wind-derived circulation and, possibly, weather events. In addition, it should be noted that Cook Strait waters, as well as those of other regions around Aotearoa New Zealand, have also been experiencing more extreme water temperatures (known as marine heatwaves) over the last 5–10 years that may be adversely affecting marine wildlife, including whales. For example, Barlow et al. (2023) found reduced foraging calls of pygmy blue whales were correlated with marine heatwaves in the South Taranaki Bight. Torres et al. (2025) noted extreme differences in ecosystem conditions in the South Taranaki Bight between the summers of 2024 and 2025. Their 2024 surveys recorded no blue whale sightings and very little krill, while in the 2025 surveys they recorded more than 66 blue whale sightings, with most of these animals feeding on dense swarms of krill.

The fairly even spread of these more recent whale strandings around Golden Bay is also evidence that marine farms are not unduly affecting the navigation of the live whales and forcing them towards a particular region where they are then more prone to stranding. There is also little spatial evidence to suggest that the block layout of the farms has trapped animals (or any particular species) between the structures and the southern coastline, and resulted in more strandings in this region. Since the national marine mammal incident database was established in the late 1980s, stranding locations have been widely variable. However, consistently half or more of all strandings occurred in the 'notch' region of Farewell Spit and just under a third were reported along the southern part of the bay.

The continued lack of entanglements (of baleen whales or otherwise), or strandings with entanglement scars, suggests that the current locations of marine farms have had little to no effect on entanglement risks to marine mammals in Golden Bay. One outcome of this part of the monitoring programme has been the establishment of a new communication protocol between farms and DOC around stranding events. While staff changes (at both SMWMM and DOC) made it hard to maintain a direct line of communication, phone check-ins by the SMWMM's site coordinator with both DOC and council helped keep communications open. For instance, following notification or media reports of a stranding, vessel crews were asked to take extra care in their observations of marine mammals during and immediately after the stranding event. The reporting of the three separate dead pilot whales near the farms (Section 3.2) is clear evidence of the importance of this communication in avoiding incorrect assumptions of potential entanglement in farms in these situations.

4.2 Monitoring programme

Vessel occurrence rates

The marine mammal species observed by farm vessels and the generally slow to medium annual occurrence rates (approximately 22%) are in line with expectations from the assessment of effects from the farm development (Clement 2019). The majority of the 409 visual sightings by farm vessels were of New Zealand fur seal and Hector's dolphin, and these were the most common species observed around the farms themselves. While both species continued to be observed throughout the subzone development stage (initial 2+ years) and into full farming production over the last 2–3 years, sightings of other species varied from year to year as expected, these being seasonal and infrequent visitors. The occasional sightings of bottlenose dolphins, common dolphins, dusky dolphins, orca and pilot whales tended to occur across the Zone of Effort rather than only near the farms. Just two sightings of baleen whales were reported over the entire 5 years of monitoring: a pair of humpback whales and an unknown species of baleen whale. While Clement (2019) noted the expected presence of southern right whales, a species that prefers shallow coastal waters and has previously been sighted in Golden Bay waters, none were reported by farm vessels.

The most obvious trend in species occurrences near the farms was the steady increase in fur seal presence and the use of the farm structures by fur seals over the course of the Stage 1a development. This was followed by a levelling out of sighting rates when the farms became operational over Stage 1b. This species is regularly observed year-round within breeding colonies and / or near haul-out sites across the top of the South Island, including Farewell Spit and the Separation Point / Abel Tasman National Park region. While fur seals are known to haul out and rest on mussel buoys, this programme is the first to document their regular occurrence and feeding near mussel farm lines where the vessels were working. It appears, at least from these monitoring findings, that fur seals will be attracted to any new surface structures, and once the structures are fully established, will continue to use them as haul-out sites. These results also indicate that, regardless of vessel and crew presence, fur seals appear to be comfortable moving in and around mussel farm structures. Consistent fur seal presence around the farms also indicates that they are gaining some benefit from the farms. One probable advantage for individual fur seals is that the farms provide a place for them to rest at sea, closer to where they may feed or where they can take advantage of fish around the farms themselves.

The numbers of reported sighting of Hector's dolphin have steadily increased over the course of the monitoring work, perhaps because: (1) crews have become better at looking for and spotting this species, or (2) animals are visiting the area more often due to the presence of the farm vessels and / or a fully functioning farm. Hector's dolphin is known to be a curious species that is easily attracted to vessels and other on-water activities. These tendencies may explain the higher occurrence of Hector's dolphin sightings relative to other species near vessels working on the farms and also near Port Tarakohe. Regardless of the reason, it appears Hector's dolphins are not excluded by the farm blocks, as they were observed travelling through and within the developed farms. However, there were no reports of this species physically interacting (rubbing or touching) the farm structures or lines, at least as seen from the surface.

Seasonally, visual occurrence rates were greater over the spring and winter months once effort was taken into consideration. Within the Zone of Effort, fur seal sightings were fairly consistent across all seasons but tended to peak around spring. Larger groups of Hector's dolphins were also seen in the farm areas over this season. Generally, this species transitions from more offshore, stable winter waters over spring into shallower, warming waters like those in Golden Bay. This season also marks the start of calving season for Hector's dolphin and other dolphin species. Perhaps larger groups or clusters of groups around the farms are a consequence of nursing groups forming, or new feeding opportunities as several prey species also move inshore (Clement 2005; Miller et al. 2013). Larger group numbers of other species, including common and dusky dolphins, were also observed during spring. Several other species were either found to be more prevalent only over winter (e.g. baleen whales, orca) or summer (e.g. bottlenose dolphin, pilot whales).

Visual observations made from farm vessels provided good information on the different species that are likely to be present around the farms, and also the nature of their interactions with the farms. This dataset was also useful in indicating distinct seasonal trends of various species based on occurrence rates, as verified by the acoustic data. However, the caveat with this monitoring method was that several vessels needed to collect data simultaneously to capture enough information on these trends to average out the large variability in sighting numbers for any one vessel. It was expected that there would be some correlation between greater numbers of reported sightings and those vessels spending more time within the Zone of Effort relative to other company vessels. However, once effort was taken into account, it was apparent that vessels' sighting rates varied widely, with only a minor influence from trip numbers. Instead, the variability was likely due to a range of factors, including variability in species presence, differences in training and experience, crew / skipper changes, preferred reporting methods (app vs hard copy) and / or work tasks (regular maintenance vs harvesting).

Acoustic occurrence rates

Underwater acoustic recording methods are optimal at detecting vocalisations (e.g. whistles, songs, clicks) of most cetaceans (i.e. whale and dolphins). While they can capture vocalisation of pinnipeds (e.g. fur seals), these species do not rely on their vocalisations to the extent that cetaceans do. Hence, acoustic monitoring is not as useful for monitoring pinniped presence in farms and one of the reasons why visual monitoring was required throughout the 5 years of monitoring.

Hector's dolphins emit very high-frequency echolocation clicks that allow their acoustic calls to be easily distinguished from those of other dolphin species. The fairly localised range of these very high-frequency clicks (hundreds of metres), as well as the high-frequency calls of other dolphin species, indicate a dolphin must be near the recorders to be detected, making this method ideal for monitoring their presence close to farms. Alternatively, whales make low-frequency calls that travel further and can be heard across long distances (i.e. tens of kilometres). These variable detection ranges help explain why acoustic recorders in this study had such high detection results, with at least one marine mammal being detected on 68% and 89% of all recording days over the 2024–25 sampling year, relative to visual sighting results.

Acoustic monitoring was ideal for capturing finer-scale temporal and some spatial differences in the presence of cetaceans around the farm blocks. For instance, despite most visual sightings being reported around the M-, N- and O-blocks and nearby farms, L-block had far greater acoustic detections. These acoustic spatial results suggest marine mammals visiting Golden Bay were either entering the bay via deeper water to the east and northeast, and not passing near the southern and eastern farm blocks, or were coming around Separation Point and moving around these farm blocks (rather than through them) to the south or open waters to the north, before travelling past the northeast corner of L-block.

Acoustic methods also provided some key insights into diel use of the farm blocks by some species, such as Hector's dolphin and orca. Both species tended to visit farm block sites more frequently overnight than during the day across most seasons. Understanding the various species' diel patterns helped to validate and explain the visual occurrence rates. In this case, the much lower rate of visual sighting to acoustic detections of Hector's dolphin is likely because this species visited the farms mostly at night. This finding also suggests that Hector's dolphins are not just attracted to the farms when vessels are around or working, as suggested from the visual occurrence findings, but are also visiting farms for other reasons. Studies in Lyttelton Harbour / Whakaraupō have found that some local populations of Hector's dolphin tend to feed more during crepuscular time periods (i.e. before sunrise and after sunset; Clement et al. 2022), when prey species may be transiting between activity states. It may be that Hector's dolphins in Golden Bay are targeting prey that shelters within or under the farms during the night.

4.3 Recommendations

This is the first study in Golden Bay to document marine mammal presence around shellfish farms in comprehensive detail. By using long-term national databases on stranding information, it was evident that the general locations and rates of strandings have changed little over the last 50 years. As noted earlier, larger-scale drivers of climate are currently affecting South Taranaki Bight and Cook Strait waters. These changes will have flow-on effects to the marine mammals that use these regions, especially large baleen whales. Given the potential repercussions for the AMA farm blocks in Golden Bay (as well as more broadly), it would be prudent for farmers to maintain open communications with DOC over strandings, as well as continue farm vessel reporting and photographing of any dead or floating marine mammals that are observed.

Visual and acoustic monitoring provided evidence that fur seals and Hector's dolphins are regularly swimming among farm structures, and are likely making use of the habitat and any prey resources under and around the farms. With the knowledge that these species are likely present around farm structures, particular at the night, Golden Bay farm owners need to remain vigilant in their maintenance of farms, particularly regarding loose ropes and tensioning of lines. More importantly, long-term systematic data such as those used in this study can be used to quantify entanglement risk and aid in assessing the efficacy of current mitigation measures, but only if a measurement of effort is collected as part of the methodology. These data can also be used to inform the probability of such effects in relation to future farm development in the area.

5. Acknowledgements

Special thanks go to John Wilson (John Wilson Consulting Ltd), Scott Gillanders (MacLab) and Paula Callen (MacLab) for all their help in designing, preparing and successfully implementing the 5 years of farm vessel monitoring. Paula ensured all the paperwork and data were collated each month, Paula and Scott trained the vessel crews, and John transcribed all the vessel data. Thanks also go to all the vessel skippers and crew who gathered the visual sighting and effort data for the report, for their patience with the protocols and for their legible handwriting.

Mike Ogle and Hannah Hendriks of the Department of Conservation supplied the national marine mammal sighting and incident databases. Thanks go to both Lisa Floerl and Allison Brownlee (Cawthron Institute) for their mapping and spatial analysis skills and their help over the 5 years of this programme. Lisa helped collate and standardise all the vessel track data, and Allison trialled the various spatial and temporal analyses on the vessel sighting data.

Finally, Matt Pine (Ocean Acoustics Limited / Styles Group), Nick Scott (Cawthron Institute) and Dan Cairney (Ama Scientific Services Ltd) were all integral parts of the acoustic monitoring portion of the monitoring programme. Nick designed, tested and trialled the custom-made mooring for the SoundTraps to successfully hang on the mussel farm mooring lines. Both Nick and Dan helped deploy and retrieve all the SoundTraps over the year of monitoring. Matt Pine advised on the initial acoustic design and sampling rates. He also had the hard job of processing, deciphering, sampling and then analysing all the acoustic data.

6. Appendices

Appendix 1. Caveats and conditions of DOC's national marine mammal incident database

While providing the national marine mammal incident database, DOC asks that readers please consider the following caveats when analysing the database (M Ogle, DOC, pers. comm., 19 July 2024):

1. The data is limited to records received by the Department's National Office from a number of different sources and independent field offices and there are no guarantees that it is fully representative or accurate.
2. The quality and quantity of data collection has improved over time, particularly with the advancement of technology.
3. Processes for strandings and data collection have changed over time and have not necessarily been followed evenly around the country.

Note that the data is the property of the Department of Conservation and therefore we ask that you observe the following conditions with regard to its use:

4. The data shall only be used in the manner outlined in your submitted proposal, unless prior permission is granted from the Department of Conservation.
5. The Department is to be supplied with a copy of any reports, papers etc that result from your analysis of this data.
6. The Department is to be informed of the intention to publish any findings resulting from the analysis of this data prior to the draft being submitted to the chosen publication.
7. The Department of Conservation is to be appropriately acknowledged in any reports, publications etc that result from your analysis of the data provided.
8. The data shall not be supplied to any third party without prior written permission from the Department.
9. The data supplied shall not be made available on the internet or any other publicly available medium without prior permission from the Department.

Appendix 2. Spatial comparisons of marine mammal stranding data in Golden Bay

In the decade prior to and including 1990, the 24 recorded stranding events were spread fairly equally around the entire bay (Figure A2.1). Approximately 67% of these events involved small to medium-sized cetaceans. These species were found to strand in similar places to the larger species (i.e. baleen whales and sperm whales). During this time, only the small 16 ha Wainui farm was in place, having been established around 1984.

Between 1991 and 2000, approximately 20 recorded stranding events took place, with a larger proportion of these located north of Collingwood and along the base of Farewell Spit, while only three strandings were reported in the southern half of the bay (Figure A2.1). Just over half of all events (55%) consisted of small to medium-sized species (Table 3). In the most inshore block (a) of AMA 1, mussel farms were gradually developed over this decade and into the next. Scallop spat-catching structures began seasonal and rotational operations during 1991 and 1992, originally over three 500 ha blocks that were increased to four 500 ha blocks later in the decade. Seasonal and rotational mussel spat-catching blocks were developed in AMA 2 from approximately 1994 over six approximately 330 ha blocks, with two of these blocks permitted to be used in any one year. Importantly, seasonal scallop or mussel spat-catching blocks have all their structures removed when not in use (J Wilson, John Wilson Consulting Ltd., pers. comm., 8 July 2025).

Twenty-six stranding events were reported between 2001 and 2010, with small to medium-sized cetaceans accounting for 69% of these events (Table 3, Figure A2.1). Strandings occurred throughout the bay, but more events were recorded north of Collingwood and along most of Farewell Spit. During these years, mussel spat-catching and holding structures were developed as part of subzone (a) (52 ha) in AMA 1, and seasonal mussel spat-catching in subzone (k) (250 ha) in AMA 2. From approximately 2006 onwards, any additional mussel spat-catching has been confined to subzone (g). Staged development of mussel farm lines (approximately 100 ha) also began in the farm blocks in AMA 2 subzones (q) and (p).

From 2011 to 2020, 29 stranding events were recorded throughout most of Golden Bay. The vast majority of these occurred north of Collingwood, although there was a mix of larger whales and small to medium-sized species stranding in southern regions of the bay (Figure A2.1). Similar to previous decades, a large portion of all events (72%) consisted of small to medium-sized species (Table 3). Mussel farming extended to 330 ha in blocks in subzone (q) and part of subzone (p) of AMA 2 through staged development over this time period. In addition, mussel farming development continued in AMA 1 near Collingwood in subzone (b) and began in subzones (c) and (d). Development also began on the relevant subzones to this monitoring programme – AMA 2 subzones (l), (m), (n) and (o) – in 2020. During this decade, similar levels of seasonal (mainly summer) mussel spat-catching were maintained from the previous decade, although scallop spat-catching effort reduced.

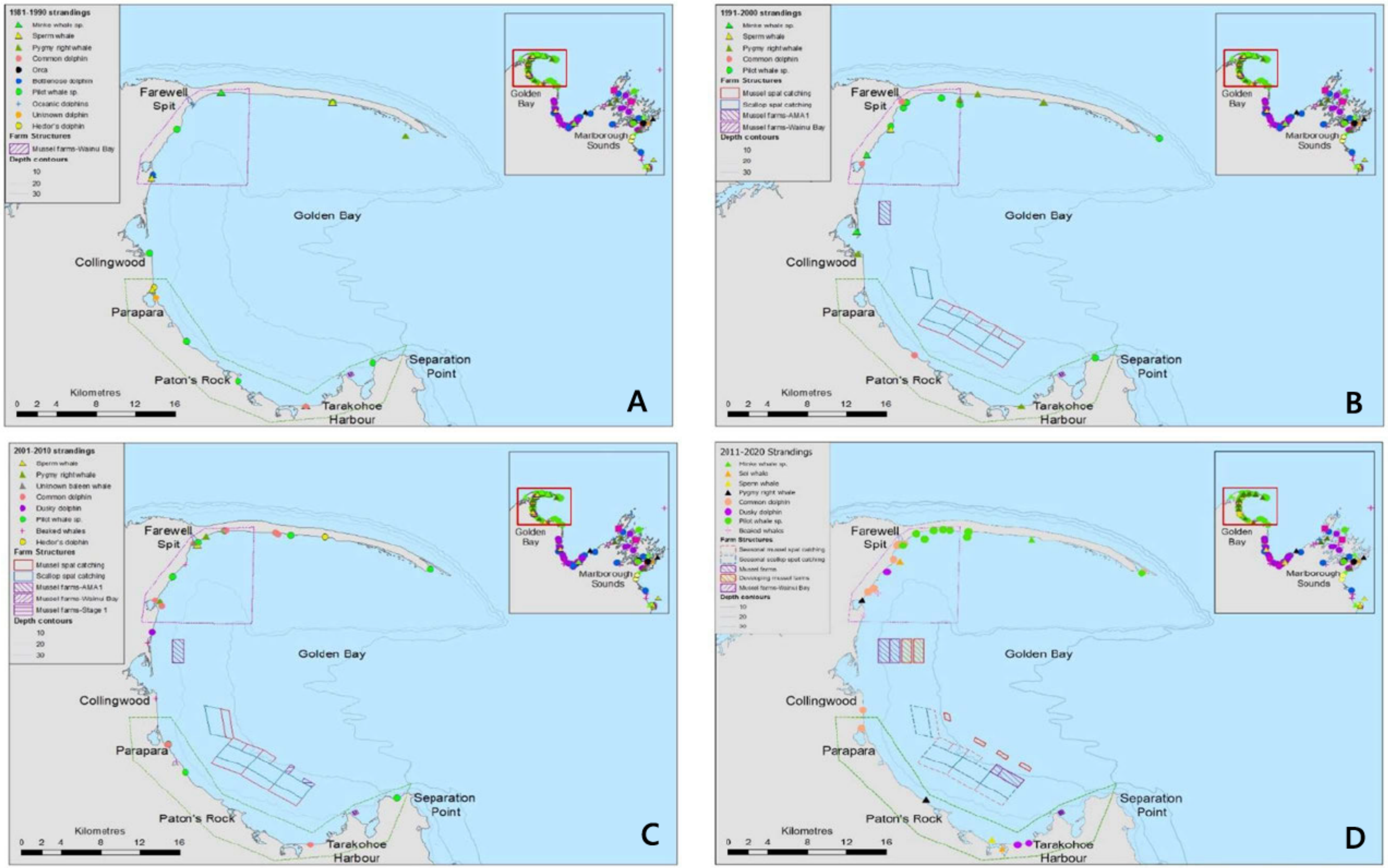

Figure A2.20. The spatial extent of the various marine mammal species that have stranded in Golden Bay / Mohua, with the associated development of existing marine farm structures during each period. (A) Between 1981 and 1990. (B) Between 1991 and 2000. (C) Between 2001 and 2010. (D) Between 2011 and 2020. The areas outlined in purple and green refer to the Farewell Spit 'notch' stranding zone and the southern stranding area referred to in Table 3.

Appendix 3. Annual reported marine mammal sightings from farm vessels

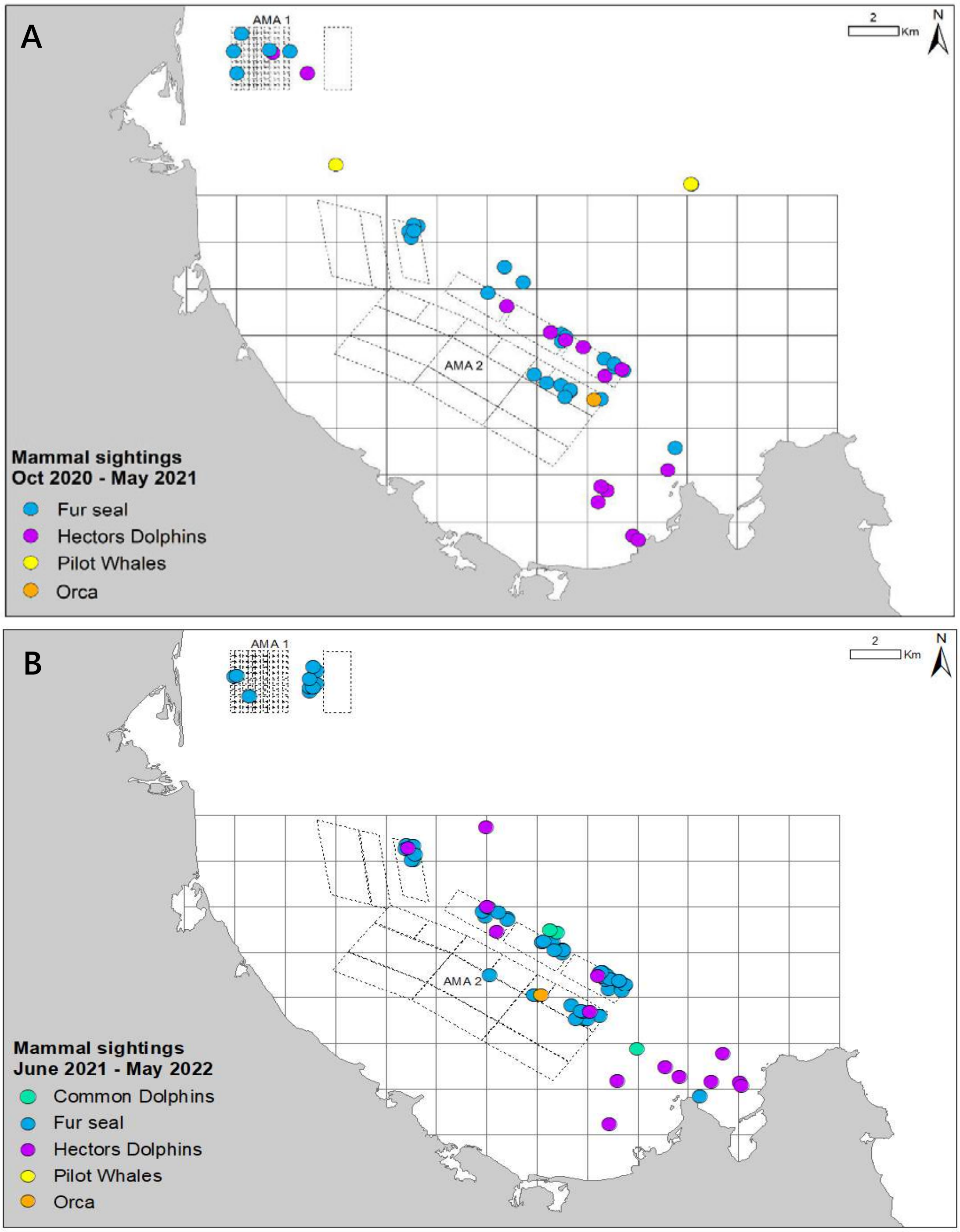

Figure A3.1. All reported marine mammal sightings from farm vessels working in the Zone of Effort (grid) and wider Golden Bay / Mohua area. (A) From October 2020 to May 2021. (B) From June 2021 to May 2022.

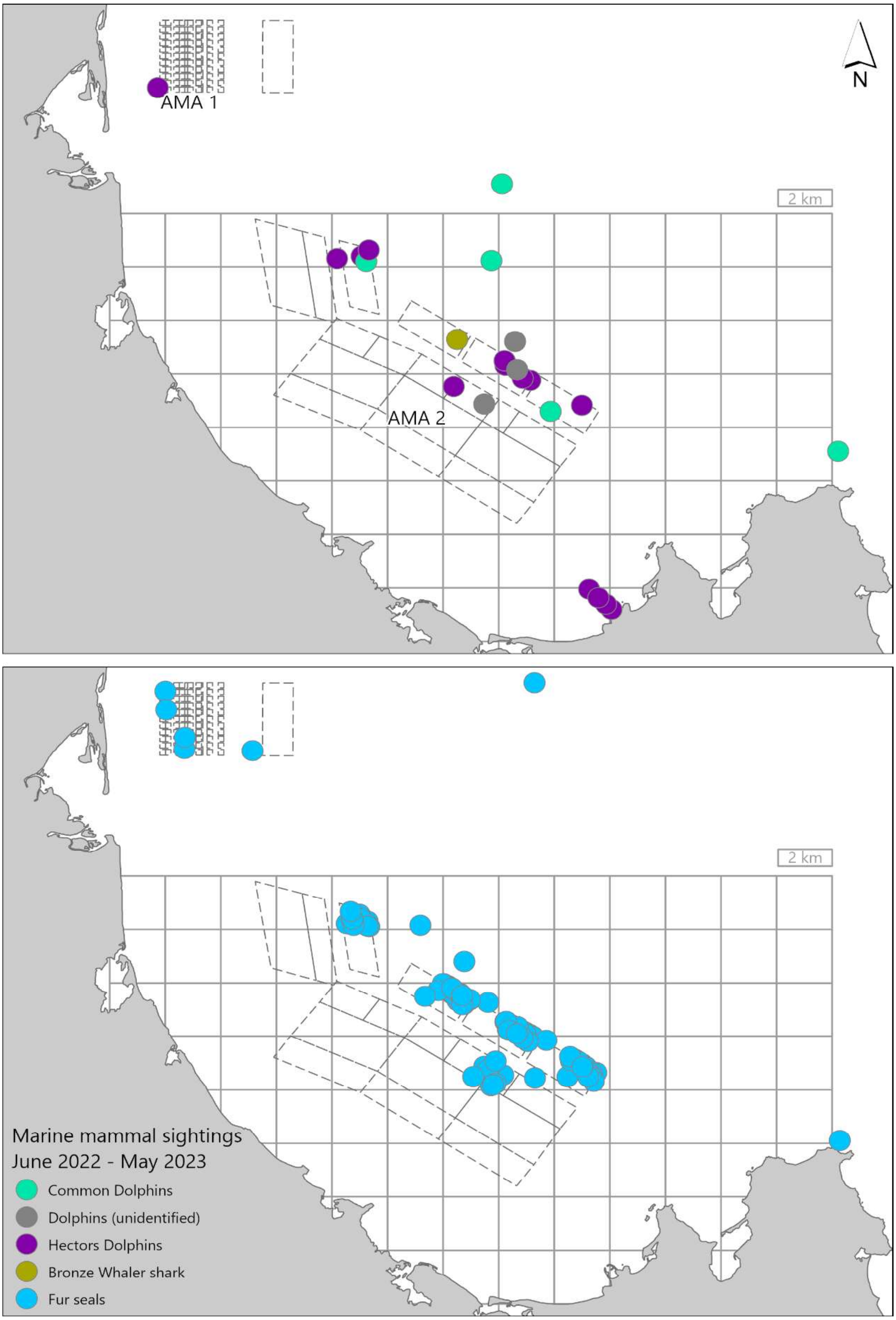

Figure A3.2. All reported marine mammal sightings from farm vessels working in the Zone of Effort (grid) and wider Golden Bay / Mohua area during the third monitoring year between June 2022 and May 2023.

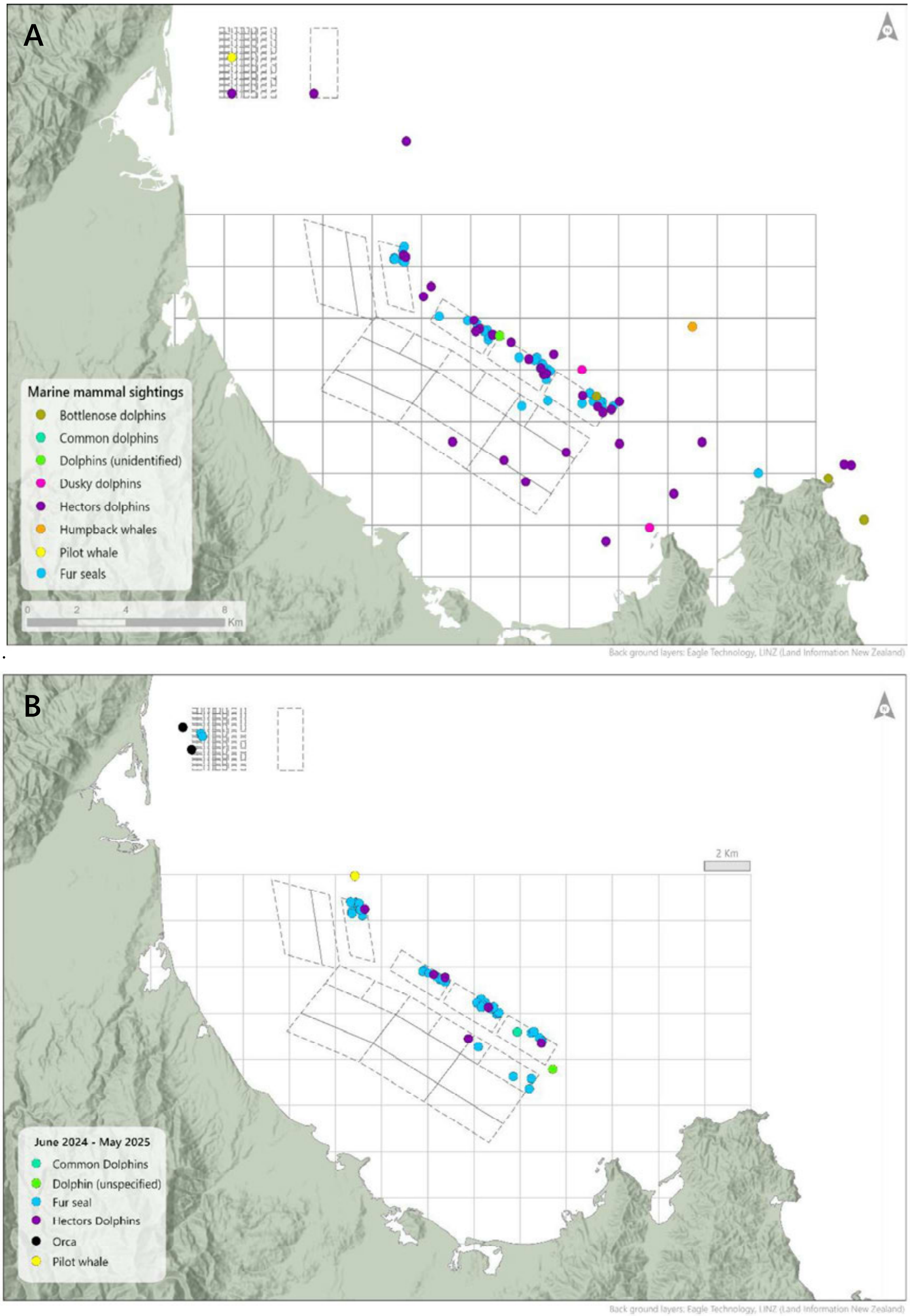

Figure A3.3. All reported marine mammal sightings from farm vessels working in the Zone of Effort (grid) and wider Golden Bay / Mohua area. (A) From June 2023 to May 2024. (B) From June 2024 to May 2025.

Appendix 4. Spatial and temporal trends in visual sighting data

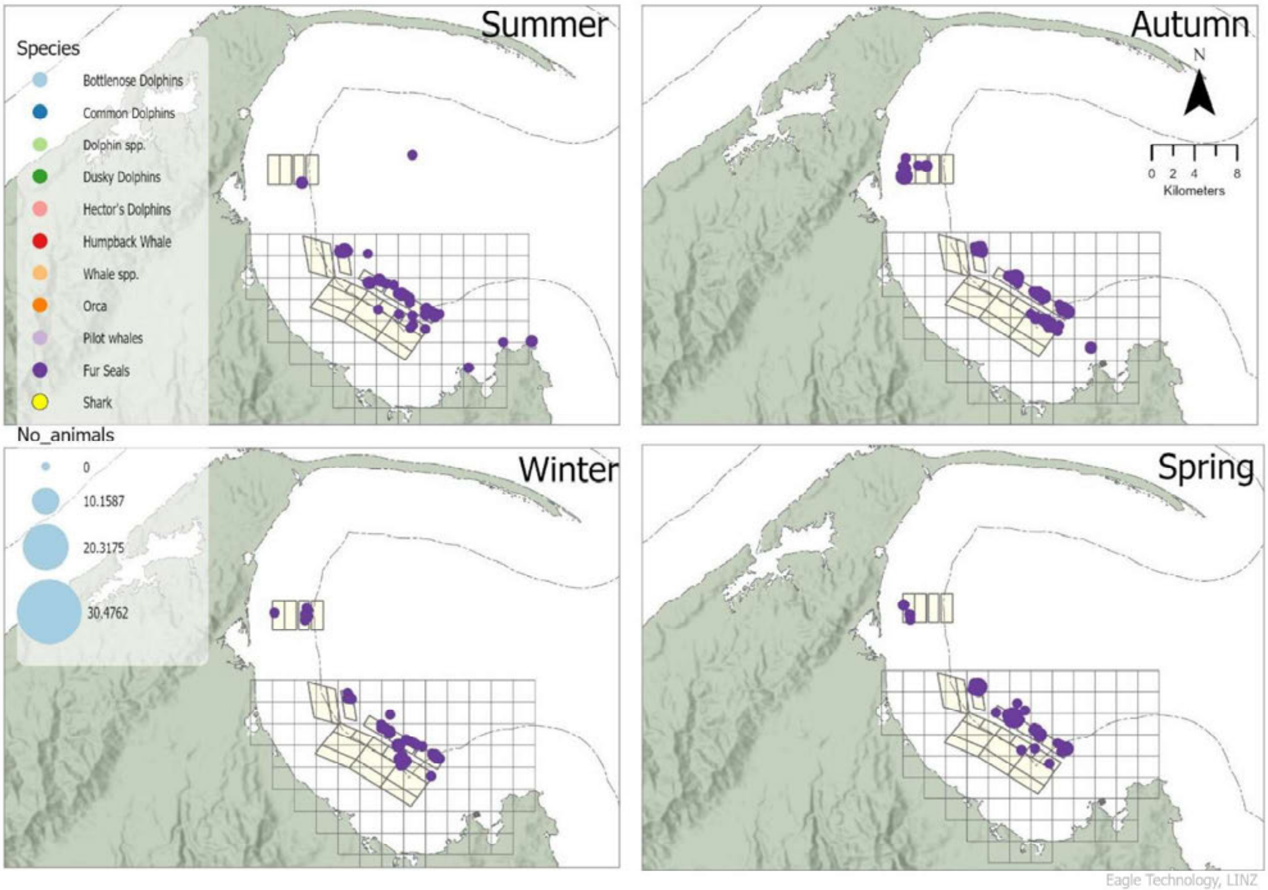

Figure A4.1. Seasonal sightings of New Zealand fur seals from farm vessels working in the Zone of Effort (grid) and wider Golden Bay / Mohua area from March 2020 to May 2025. The size of the circle relates to the number of animals sighted in the group.

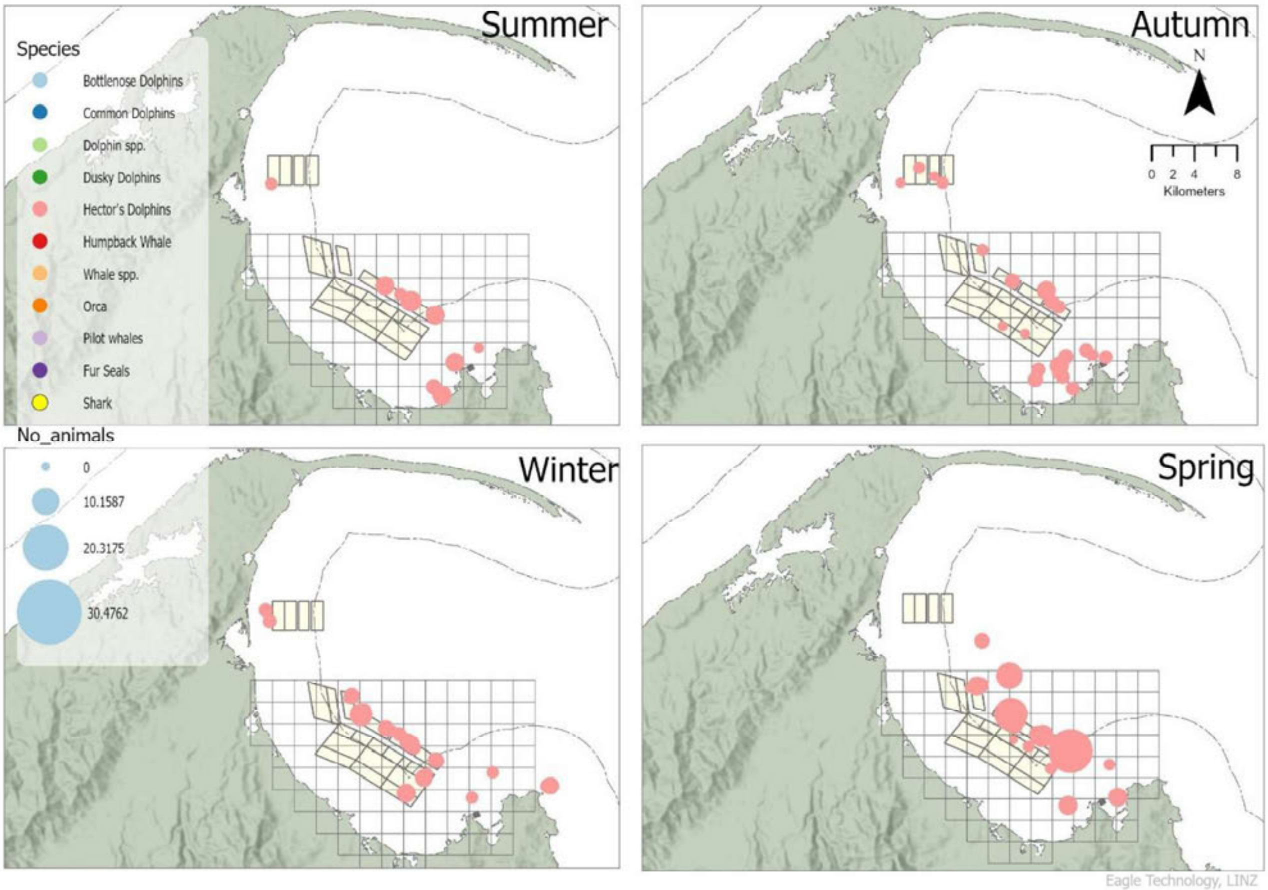

Figure A4.2. Seasonal sightings of Hector's dolphins from farm vessels working in the Zone of Effort (grid) and wider Golden Bay / Mohua area from March 2020 to May 2025. The size of the circle relates to the number of animals sighted in the group.

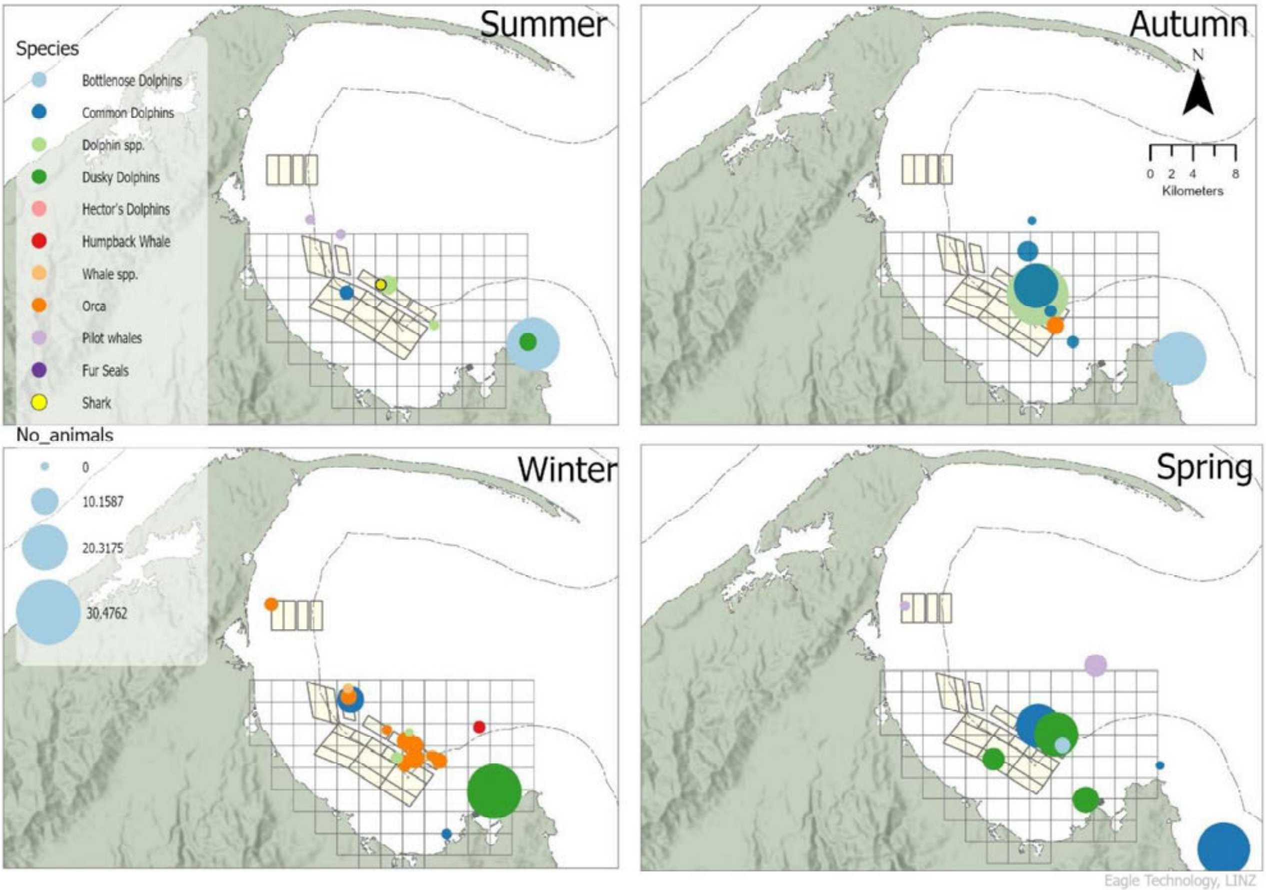

Figure A4.3. Seasonal sightings of marine mammals (excluding New Zealand fur seal and Hector's dolphin) from farm vessels working in the Zone of Effort (grid) and wider Golden Bay / Mohua area from March 2020 to May 2025. The size of the circle relates to the number of animals sighted in the group.

Appendix 5. Acoustic detections

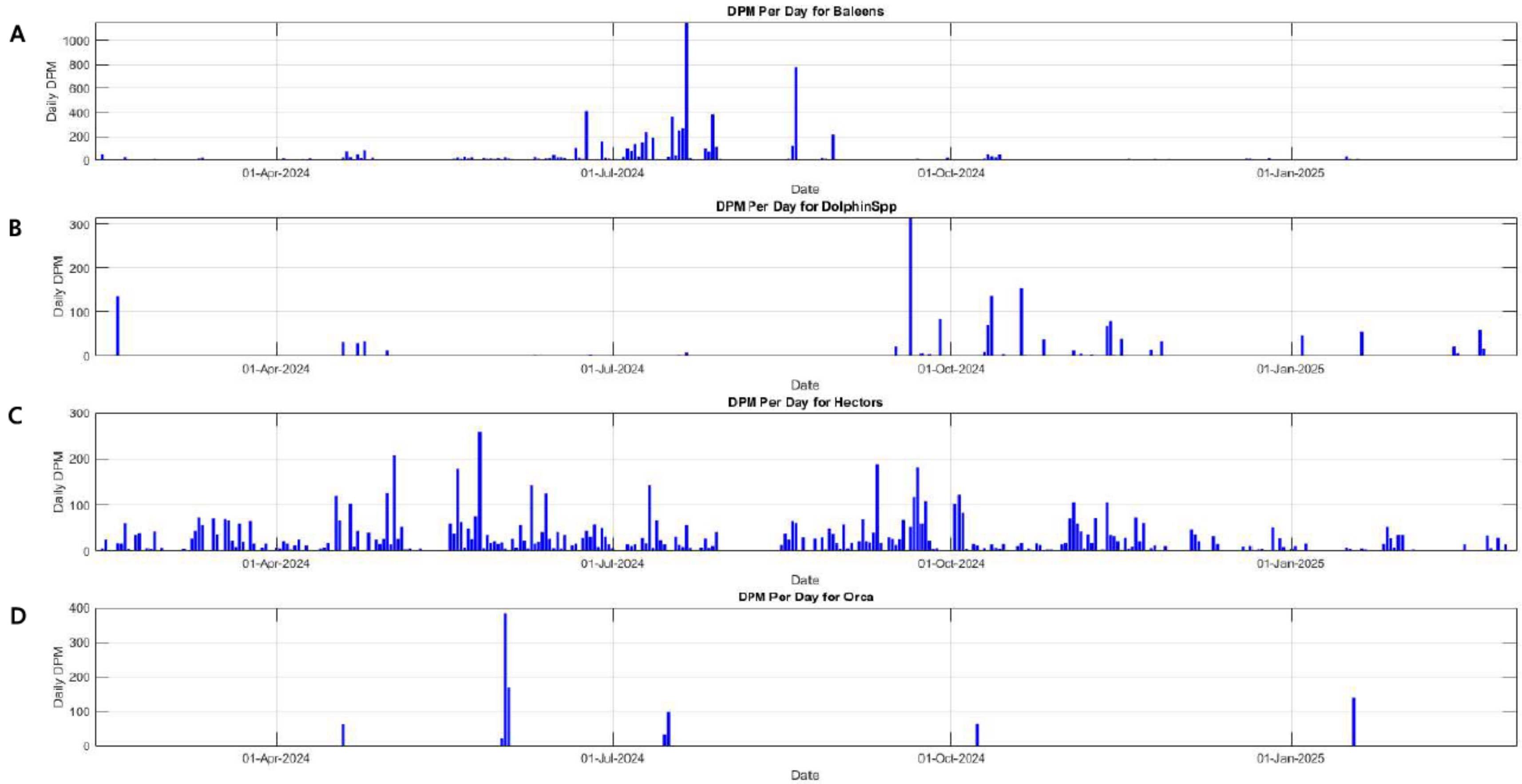

Figure A5.1. Daily summary of underwater acoustic detections per minute (DPM) recorded at L-block mooring between 13 February 2024 and 28 February 2025. (A) All baleen whale detections combined. (B) All dolphin species excluding Hector's dolphin. (C) Hector's dolphins. (D) Orca.

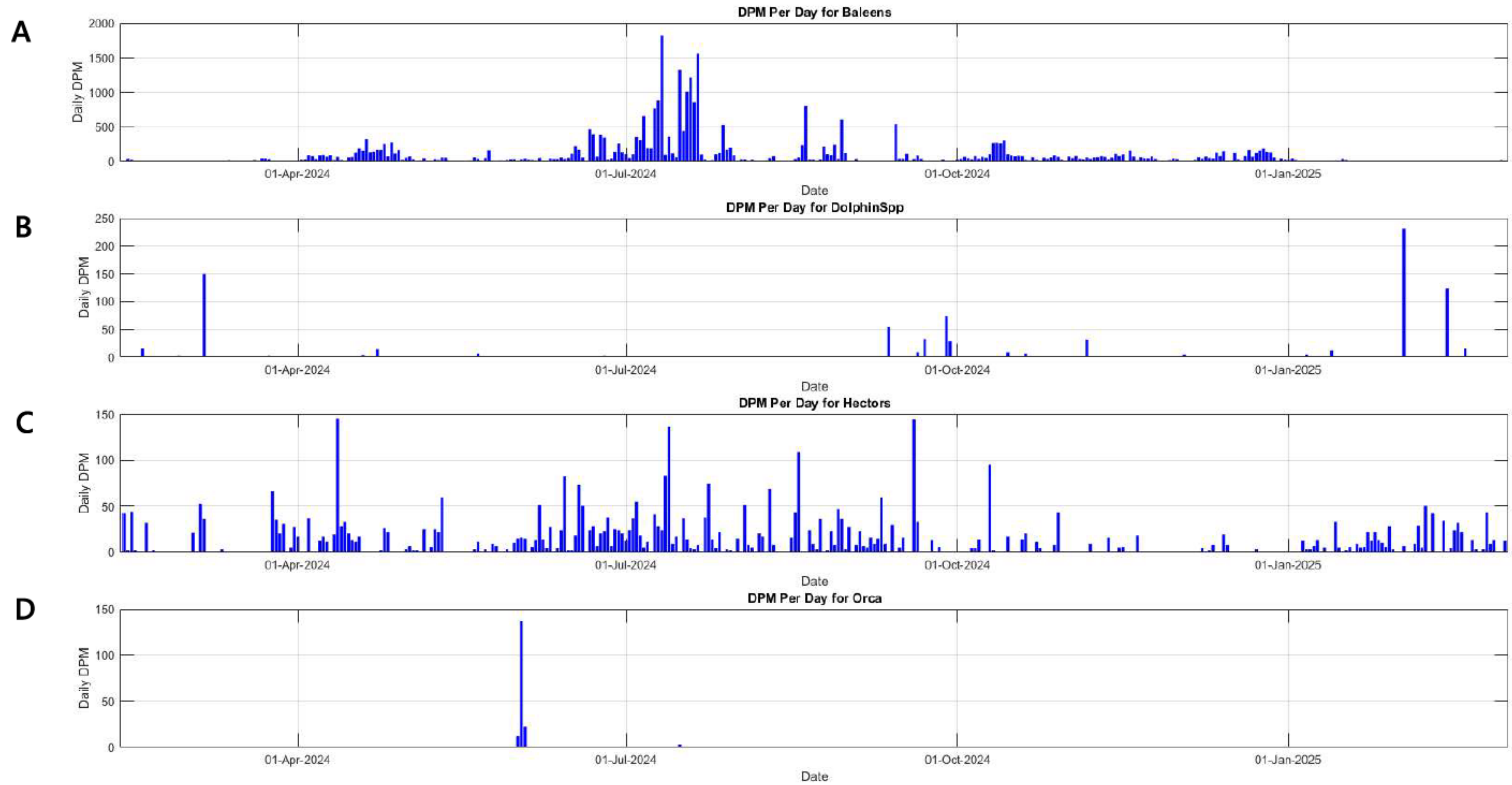

Figure A5.2. Daily summary of underwater acoustic detections per minute (DPM) recorded at O-block mooring between 13 February 2024 and 28 February 2025. The top figure denotes all baleen whale detections combined, the middle top figure show detections for all dolphin species (excluding Hector's dolphin), the second from bottom figure is detections of Hector's dolphins and the bottom figure shows detections of orca.

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