Before the Expert Fast-track Panel

FTAA-2511-1150

Under	the Fast-track Approvals Act 2024 (**FTAA**)
And	
In the Matter	of an application for approvals by **MCCALLUM BROTHERS LIMITED** for the Te Ākau Bream Bay Sand Extraction Project located at Te Ākau Bream Bay, Northland

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Evidence of Matthew K. Pine on behalf of McCallum Brothers Limited in Response to Invited Comments

(Underwater Noise)

Dated 12 August 2026

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Introduction

1. My name is Matthew K. Pine.

2. I am a Principal at Styles Group Acoustics and Vibration Consultants and Honorary Research Fellow at the Institute of Earth & Life Sciences at Heriot-Watt University. I hold a Ph.D. in Marine Science, a BSc in Biological Sciences, and have completed two Postdoctoral Fellowships at the Institute of Hydrobiology, Chinese Academy of Sciences in Beijing (2 years) and the Department of Biology at the University of Victoria in British Columbia, Canada (3 years).

3. These degrees and fellowships were in the prediction of noise effects on marine life due to changing environments (both acute, such as construction activities and chronic, such as shipping and climate change) using advanced propagation modelling, passive acoustic monitoring, soundscape analyses and automated detection and classification of sound in the marine environment.

4. I have 15 years' experience as an underwater acoustics scientist. In that time, I have led research projects involving advanced underwater noise modelling, development of masking effects metrics on marine mammals and fishes (the listening space reduction metric) and researching dolphin and whale vocalisations for developing automated detection and classification algorithms to analyse recordings from both subsea recorders and real-time edge processing devices.

5. This evidence is provided as part of McCallum Brothers Limited's (**MBL**) response to comments from invited persons on the Te Ākau Bream Bay Sand Extraction Project (the **Project**).

6. I prepared the Report titled *Assessment of Underwater Noise Levels for Proposed Sand Extraction: Te Ākau Bream Bay* dated 10 April 2025 included as Appendix 11 to the Substantive Application.

Scope of Evidence

7. My evidence responses to specific comments received on the Project:

    a. Omitting detection events less than one minute in duration (raised by Mr Jochen Zaeschmar (for the Department of Conservation (DOC)) and Dr Tom Brough (Ngātiwai Trust Board and Te Patuharakeke Te Iwi Trust Board)).

    b. Winter-only marine mammal detections (raised by Mr Zaeschmar).

    c. Baseline PAM of the existing soundscape before operations begin (Dr Brough & Mr Zaeschmar).

    d. Foraging behaviours within the Extraction Area (Dr Brough & Mr Zaeschmar).

Code of Conduct

8. Although this is not a hearing before the Environment Court, I confirm that:

    a. I have read and am familiar with the Environment Court's Code of Conduct for Expert Witnesses as specified in the Environment Court's Practice Note 2023 (**Code**); and

    b. My report lodged with the Substantive application and this evidence:

        i. Are within my area of expertise (except where I state that I rely upon the technical reports of other expert witnesses);

        ii. Have been prepared in accordance with the Code; and

    c. I have not omitted to consider any material facts known to me that might alter or detract from the opinions expressed.

Response to Comments

9. Underwater noise effects was a commonly identified area of concern for several of the invited parties. Many of these comments were stating, or

agreeing, with the Applicant's assessment conclusion that underwater noise requires careful consideration as one of the primary effects on the marine environment. Consequently, they say, a precautionary approach is warranted. I agree with this sentiment, and this is reflected in the comprehensive assessment that I have prepared to quantify the expected underwater noise from the proposed extraction activity and the ranges within which some effect may occur.

10. The comments received addressed a range of issues covering both my own assessment on underwater noise and the ecological assessment of underwater noise contained in the Marine Mammal Impact Assessment report from marine mammal expert Ms McConnell. The comments and issues overlap between my expertise and Ms McConnell's, and in some cases considerably.

11. Ms McConnell and I have had many conversations during the preparation of our original assessments and our evidence in response to comments.

12. This evidence relates to only those issues covering my own assessment on underwater noise. Issues relating to the ecological effects on Te Ākau Bream Bay's marine mammal species are addressed by Ms McConnell.

Matters agreed

13. Aside from the one minor matter I discuss in the next section, there were no concerns that related to the outputs of the technical measurement and modelling work that I have undertaken. The underwater noise assessment was found to be technically robust and suitable for the purposes of establishing underwater noise effects ranges on marine life in Te Ākau Bream Bay.

14. I consider that the following matters are agreed:

    a. The international criteria and selection of guidance and peer-reviewed studies that I have adopted to assess the effects on marine fauna.

    b. The range of species that I have included in the effects assessment.

c. The calculation methods, procedures and modelling algorithms used to predict the underwater noise and level of effects.

d. The physiological, behavioural, auditory masking and audibility ranges I have predicted across Te Ākau Bream Bay.

Matter not agreed

15. There is one minor matter raised by Mr Jochen Zaeschmar (for the Department of Conservation (**DOC**)) and Dr Tom Brough (Ngātiwai Trust Board and Te Patuharakeke Te Iwi Trust Board).

Omitting detection events less than one minute in duration

16. Dr Brough[1] and Mr Zaeschmar[2] have said that acoustic detections less than one minute in duration were omitted from the marine mammal Passive Acoustic Monitoring (**PAM**) dataset. They are concerned that this may materially underestimate the overall presence of dolphin species, including killer whales, inside the Extraction Area.

17. Nowhere in the Substantive Application, or my Underwater Noise Assessment, does it say that acoustic detections less than one minute in duration were omitted from the marine mammal PAM dataset.

18. However, some filtering of the PAM data was required when defining true detection events and was undertaken. As stated within the Substantive Application[3], detection events were defined as *three or more vocalisations within 20 minutes of each other.*[4] This is used to prevent excessive false positives from the dataset.

19. The application of this definition does mean that events with fewer than 3 vocalisations (i.e., just 1 or 2 during that 20 minute period) were filtered out

[1] Paragraph 3.2 of Dr Brough's Evidence dated 19 May 2026.

[2] Paragraph 30 of Mr Zaeschmar's Evidence dated 21 May 2026.

[3] In the Underwater Noise Assessment (Attachment 11, page 40), the pre-lodgement consultation summary (Attachment 5, Response ID 9 on page 34/35) and the Marine Mammal Environmental Impact Assessment (Attachment 14, Section 3.2.1, page 22).

[4] Attachment 11 of the Substantive Application.

from the dataset (i.e., the detector did not isolate those events for human verification).

20. It is common when grouping raw detections into certain events or true encounters to apply ‘context-related’ thresholds, whether it be for species classification of whistles, signature whistles, or echolocation signals (Oswald et al. 2016; Kershenbaum et al., 2025). This is because isolated signals are often very difficult to confidently distinguish from ambient environmental noise, anthropogenic sounds or other biological sounds, particularly if the target vocalisations are not highly stereotyped (Fleishman et al. 2023).

21. Because the ocean is naturally noisy and hydrophones are highly sensitive instruments, there are instances when certain extraneous noise sources trigger a detector. For example, sediment or bubble entrainment, mooring-related noise from an isolated ‘squeak’ of a rope on metal, distant sounds from passing vessels or biological sounds from invertebrates and fish.

22. The context surrounding the detected acoustic signal is therefore incorporated to rule out very isolated signals that occur randomly. For example, snapping shrimp produce loud clicks that can closely mimic some recorded echolocation clicks from dolphins, but snapping shrimp clicks are random through space and time whereas dolphin echolocation click trains are always coherent. The number of repeated echolocation clicks is what gives researchers the confidence that they are detecting echolocation (i.e., a true encounter) and not snapping shrimp (for example).

23. Similarly, when dolphins move through an area, they are highly vocal animals that use sound as their primary sensory cue. They show very high vocalisation rates, producing echolocation click trains, burst pulses/buzzes, and whistles and they use those sounds to maintain near constant acoustic contact or continued sensory information about their environment. These behaviours mean that true detection events of dolphins can be reliably characterised as involving more than 2 vocalisations over the 20 minute period. That context is a reliable way of immediately reducing false positive events for a human to go through, while maintaining a very high probability for localising true detection events of dolphins.

24. The requirement of 3 or more vocalisations has been fine-tuned based on over 10 years experience processing over a million hours from large PAM datasets for High Frequency cetaceans in the Pacific, Tasman Sea, South China Sea, Atlantic, Arctic and Antarctic, as well as extensive acoustic monitoring of marine mammals around New Zealand.

25. If the event definition did happen to exclude an acoustic encounter of a dolphin instead of a false positive, I consider that it would be uncommon, and it would likely be detecting a dolphin that is a significant distance away, and so far away that its sound was only just detectable.

26. I consider that it only has the potential to underestimate the presence of dolphins in the area by a tiny fraction of the overall detections.

27. Therefore, I consider that the overall presence of dolphins inside the Extraction Area is not being materially underestimated due to the context filtering in the detection event definition.

28. I consider that there is a minor limitation in the PAM method in that it will not detect an animal that is not vocalising. I expect that it would be unusual for an animal to be inside the detection range for any meaningful period of time and not vocalise at all. However, it is common for sleeping individuals to not vocalise, and therefore those individuals would be missed if they managed to move through the Extraction Area/detection range of the hydrophone while asleep. I expect that this would be highly unusual.

29. Therefore, it is possible that a very small number of animals may have been present in the Extraction Area over the monitoring period than my results show.

30. For the reasons above, I consider that the PAM results are robust and have been appropriately curated using the methods I have described. If there is any uncertainty in the event definition, it would result in the possibility that there were a very small number of actual animal vocalisations that were not reported. If this had occured, I consider that that the number of missed detections would comprise only a very small fraction of the total detections.

New Information

31. Dr Brough and Mr Zaeschmar both make comments that I consider require new information for either myself or Ms McConnell to address. I do not consider that these matters are disagreements.

32. The matters are:

    a. Winter-only marine mammal detections.

    b. Baseline PAM of the existing soundscape before operations begin.

    c. Investigating dolphin foraging occupancy within the Extraction Area.

Matter 1 - Winter-only marine mammal detections

33. Mr Zaeschmar says:

…the limited temporal scope of the acoustic data collection may under-represent the presence of some species…Given that acoustic monitoring was only carried out in winter, it is likely that detections of these species will be even greater during warmer months.[5]

34. The ongoing acoustic monitoring (described in the next section of my evidence) that is being undertaken within southern Te Ākau Bream Bay (approximately 2km from shore near Waipu) addresses this matter.

35. These new data demonstrate that Te Ākau Bream Bay is highly frequented by dolphin species at all times of the year (winter and summer).

Matter 2 - Baseline PAM of the existing soundscape before operations begin.

36. Mr Zaeschmar states, "*To enable a meaningful assessment of the long-term effects of the Project, it is important that baseline data [is] collected prior to the commencement of the Project".*[6]

37. Dr Brough states he "*…considers it important to obtain validation of the soundscape change validation before the approval of the activity…"*[7]

[5] Paragraph 31 of Mr Zaeschmar's Evidence dated 21 May 2026

[6] Paragraph 78 of Mr Zaechmar's Evidence dated 21 May 2026

[7] Paragraph 7.2 of Dr Brough's Evidence dated 19 May 2021

38. While the 3dB increase limit appears to be agreed with, the concern raised is around the baseline data required to quantify the baseline for determining the change in soundscape after the commencement of the activity.

39. The 3dB increase limit to existing noise levels outside the Extraction Area and across Te Ākau Bream Bay is specifically designed to protect against cumulative noise effects on the soundscape and mitigate noise effects in areas well away from the Extraction Area.

40. As an analogy, parts of Te Ākau Bream Bay, such as the southern inshore environment, could be compared to an area of bush some distance from an urban area and that is dominated by natural sounds, like bird song. There may be some anthropogenic noise like an occasional car passing or aircraft overhead in the same way that Te Ākau Bream Bay is sometimes exposed to noise from commercial and recreational vessel traffic. I consider that the anthropogenic noise level in southern Te Ākau Bream Bay is relatively low, and the existing environment to be relatively quiet (i.e., compared to other nearshore environments, such as in the Hauraki Gulf Marine Park).

41. The 3dB noise limit is designed to protect this.

42. As correctly identified by Dr Brough and Mr Zaeschmar (and others), understanding baseline conditions are essential for that limit to be meaningful and monitorable.

43. The Applicant commissioned baseline PAM in southern Te Ākau Bream Bay in 2025, approximately 2km off the coast at Waipu (Mark 2 in the proposed Environmental Management Plan[8]) (**Figure 1**). The recorder was installed 7 July 2025 and is ongoing, with the recorder's batteries and storage being swapped out every 2-3 months. There is no hydrophone located at Mark 1.

[8] Section 7.2 of Attachment 29 (Environmental Monitoring Management Plan).

Figure 1: Map showing the locations of the baseline soundscape monitoring locations in the EMMP.

44. The location of that recorder was chosen as it is an area of Te Ākau Bream Bay that the soundscape modelling showed minimal influence from AIS traffic in Perry Channel, so has little anthropogenic noise. Additionally, the monitoring at that site avoids commercial fishing which threatens the security of the instruments.

45. Limiting a soundscape change to no more than three decibels at this location therefore affords protection to marine life against appreciable cumulative noise effects across the wider Te Ākau Bream Bay.

46. The baseline data acquisition follows the same methods as in the Underwater Noise Assessment[9], with the exception that the sampling rate was set at 96kHz instead of 192kHz. This change was made to maximize the recorder's onboard storage and battery consumption between services after earlier surveys confirmed minimal natural sound energy above 48kHz. Sampling rates of 96kHz is a widely used sampling rate for general soundscape monitoring in scientific publications, both internationally and around New Zealand.

[9] Attachment 11 of the Substantive Application, Appendix B

47. It is also important to note that the noise associated from the *William Fraser* extracting sand has been measured and does not emit any appreciable energy above 48kHz.

48. The primary purpose of the baseline monitoring is to characterise the existing soundscape in a quiet part of Te Ākau Bream Bay before the sand extraction begins, so to robustly measure any soundscape changes in an area that is expected to remain relatively undisturbed from a noise perspective.

49. Acoustic data from this monitoring site has been successfully collected and processed up until the most recent service date of 22 June 2026. The hydrophone remains active, but being a recording device instead of a real-time device, the data is not obtainable without physical retrieval. The next service is scheduled to occur September 2026.

50. Data were not available from the monitoring site between 24 January and 18 February 2026 due to damage to the instrument.

51. I have attached these data to my evidence as **Attachment 1**. Despite the data gap between 24 January and 18 February, these data show that the southern Te Ākau Bream Bay is relatively undisturbed by anthropogenic noise. Across all recorded hours, the highest hourly-averaged ambient noise level was raised by ~1 dB re 1 µPa due to passing recreational vessels. I have attached these plots as **Attachment 2.**

52. These baseline data also demonstrate evidence that whales and dolphins are very frequent in southern Te Ākau Bream Bay. I have attached those data as **Attachment 3**.

53. The collection of these ambient soundscape data, as well as the continuation of doing so by MBL, contribute towards filling this data gap and ensures any soundscape change from the activity at the monitoring location can be quantified and the cumulative increase limit enforced. Given the ongoing data collection by MBL, should consent be granted later in 2026, it is likely that 12 months of data will be available from the monitoring site.

Matter 3 - Investigating dolphin foraging occupancy within the Extraction Area.

54. Dr Brough opines that it is "...*important to ... undertake an analysis of the distribution of foraging activity and nursing behaviour in bottlenose dolphins."*[10] Mr Zaeschmar agrees.[11]

55. Such fine-scale analyses are not typical of underwater noise assessments or marine mammal impact assessments in New Zealand, as instead the mere presence of marine mammals is sufficient as a proxy to general habitat use. Foraging is assumed to occur at any time within those detection events by default.

56. I am not aware of any underwater noise assessments in the past that includes foraging behaviour analyses as part of baseline surveys.

57. It is not possible to robustly determine nursing behaviours using PAM technology.

58. It is possible to robustly determine foraging behaviours using PAM technology and has been done in a substantial number of academic investigations. I have extensive experience at detecting and classifying vocalisations associated with foraging behaviours from PAM datasets in my previous and current academic roles.

59. Foraging behaviour in dolphin species (and other odontocetes) can be acoustically detected because of how dolphins use echolocation to search for and capture prey. In simple terms, dolphin echolocation used for foraging has distinct characteristics that are unique to that behaviour. For example, when searching for prey, the echolocating predator emits high amplitude clicks that are evenly spaced apart so that the 'gaps' between clicks (called the inter-click intervals, or **ICI**s) allow enough time for the return echo to be received and processed by the predator's brain. When the predator detects a target of interest (i.e., potential prey item), their acoustic 'gaze' is focused on that target as they quickly move towards it while steadily decreasing the ICI in their echolocation click trains (providing them continued sensory information).

[10] Paragraph 7.2 of Dr Brough's Evidence to the Expert Consenting Panel dated 19 May 2026

[11] Paragraph 80 of Mr Zaeschmar's Evidence dated 21 May 2026.

Once they start getting close enough to capture the prey, the click rate spikes (often >100 clicks per second) and the ICIs plummet to well below 10ms, producing what is known as a 'terminal buzz', just before prey capture. Those echolocation phases can be mathematically characterised, and as a result, PAM is widely used to investigate spatiotemporal patterns in foraging activity in odontocetes.

60. To illustrate what this looks like with real data from Te Ākau Bream Bay, I have attached an example of this in **Figure 2**.

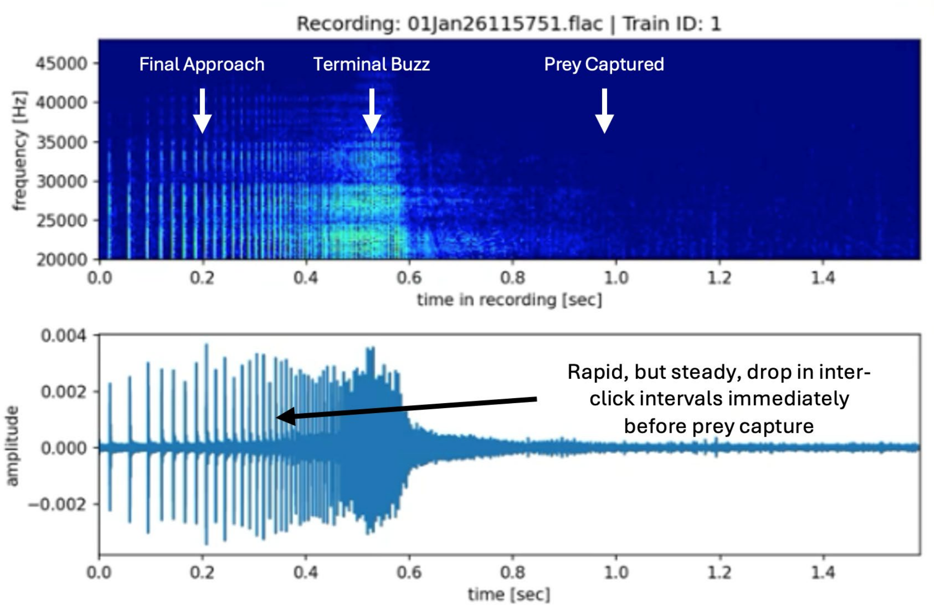

Figure 2: Example of a foraging terminal buzz with preceding click train, recorded from southern Te Ākau Bream Bay.

61. All PAM data collected to date from Te Ākau Bream Bay were run through an analysis pipeline that combines deep-learning models (a type of AI) with traditional mathematical models and algorithms to categorise dolphin detection events as either:

a. Containing at least 1 confirmed foraging-related vocalisation anywhere inside the detection event,

or,

b. No foraging-related vocalisations were confirmed to be present anywhere inside a detection event.

62. I have pooled foraging buzzes in two categories – those that are immediately preceded by click trains associated with the approach phase (shown in Figure 1) and those that are not. I consider that this is a conservative approach that is unlikely to be underestimating true foraging occurrences.

63. The results of that analysis are provided in **Figure 2 and Figure 3** below. Figure 2 shows the results from within the Extraction Area, based on the PAM data collected as part of the underwater noise assessment. Figure 3 shows the results from the monitoring site in southern Te Ākau Bream Bay.

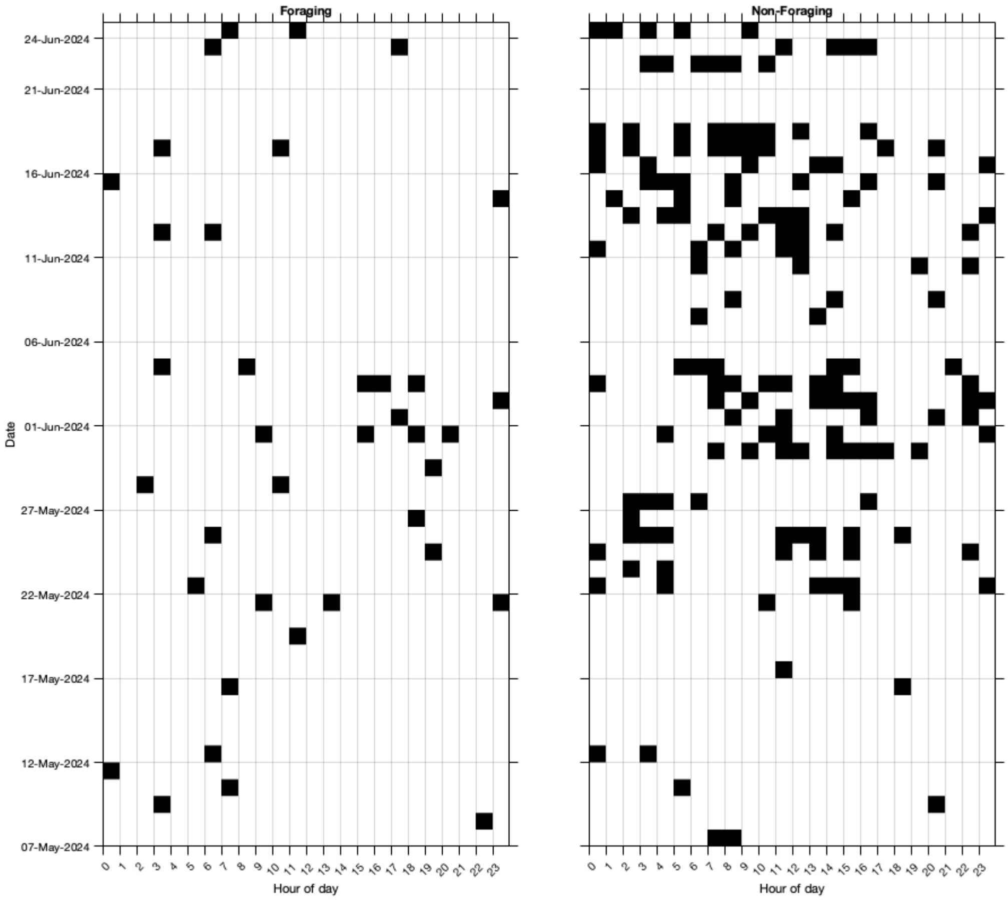

Figure 2: Detection events of dolphins that contained at least one foraging-related vocalisation (left panel), and those events that did not (right), as observed inside the proposed Extraction Area.

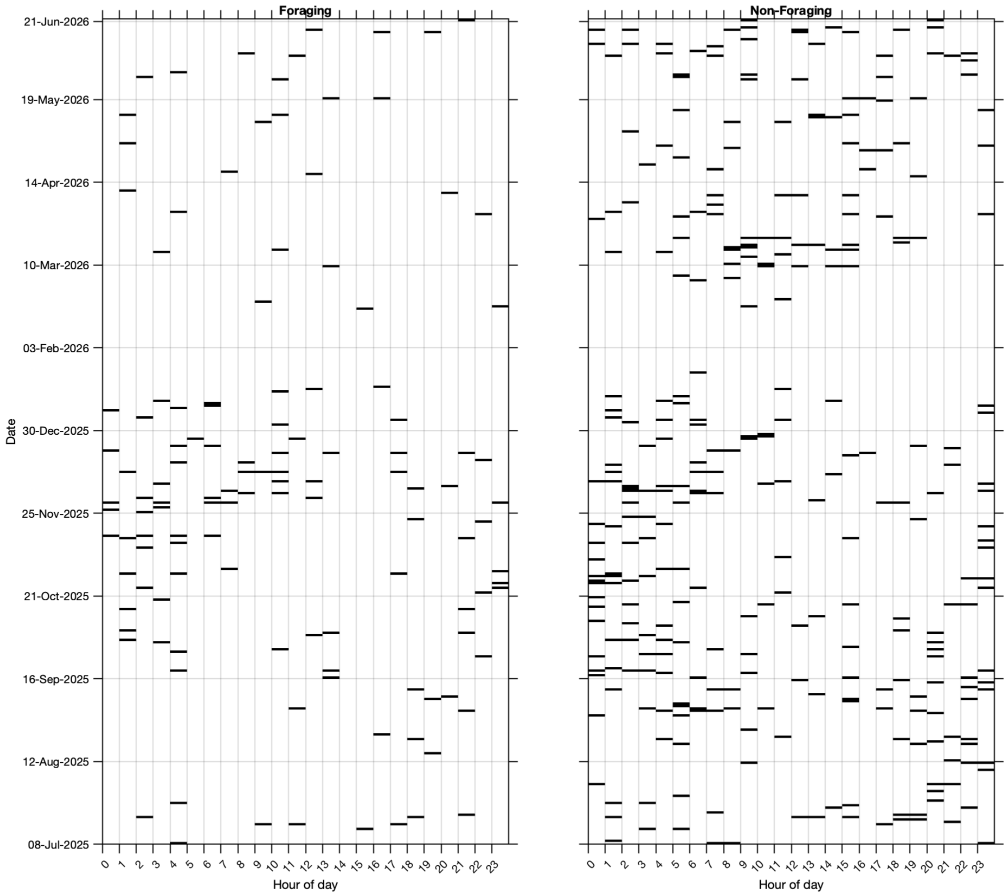

Figure 3: Detection events of dolphins that contained at least one foraging-related vocalisation (left panel), and those events that did not (right), as observed from the southern Te Ākau Bream Bay site.

64. These data reveal that:

    a. foraging behaviours were observed in at least 19% of detection events recorded between 8 May and 24 June 2024 within the Extraction Area,

    b. foraging behaviours were observed in at least 28% of all detection events recorded between 7 July 2025 and 22 June 2026 (excl. 17 Jan – 18 Feb 2026) in the southern Te Ākau Bream Bay site.

65. Being different years, sites, months and sampling efforts, care should be taken if comparing between the two figures.

66. I have attached to my evidence a detailed description of the foraging detection methods as **Attachment 4**.

67. The interpretation of these results in the context of Te Ākau Bream Bay's marine mammal ecology has been provided by Ms Helen McConnell in her reply evidence.

Conclusion

68. Underwater noise was a commonly listed concern among the invited parties. The majority of those comments were either stating a generalised concern regarding underwater noise effects on marine life that the comprehensive underwater noise assessment itself addresses.

69. Comments received from DOC and Ngātiwai Trust Board and Te Patuharakeke Te Iwi Trust Board were more specific and technical and warranted specific replies to assist the Expert Consenting Panel. Those revealed one minor matter of disagreement around detection events of less than one minute duration.

70. The comments also raised three matters that I have addressed with new information.

71. In summary:

    a. **One minute filtering of PAM data –** Detection events were not filtered by removing detection events less than one minute long. Instead, detection events were defined as requiring a minimum of 3 or more vocalisations anywhere inside a 20 minute period. This was made clear in my assessment lodged with the Substantive Application. The general use 'context filtering' in encounter definitions is commonly applied when defining true acoustic events in very large PAM datasets. Such filtering does not lead to meanngful under representation of delphinid presence inside Te Ākau Bream Bay.

    b. **Winter-only marine mammal detections –** The assessment of winter-only marine mammal presence in the Substantive Application has been supplemented with data that has been acquired since mid-2025 and that is ongoing. These new data demonstrate that Te Ākau Bream Bay is highly frequented by dolphin species at all times of the year (winter and summer).

c. **Baseline PAM of the existing soundscape before operations begin –** Since July 2025 there has been a long-term recorder installed within southern Te Ākau Bream Bay (Mark 2 in Figure 1) for the collection of baseline soundscape data. The data collected from this recorder enables a comprehensive assessment of the existing soundscape before operations begin.

d. **Investigating dolphin foraging occupancy within the Extraction Area –** Such in-depth analyses are not typical in underwater noise assessments, as habitat use in general (as indicated by presence) is assumed to include foraging. However, that information can be extracted from the PAM data and I have done so, presenting that new information in this evidence. These data reveal that:

    i. foraging behaviours were observed in at least 19% of detection events recorded between 8 May and 24 June 2024 within the Extraction Area,

    ii. foraging behaviours were observed in at least 28% of all detection events recorded between 7 July 2025 and 22 June 2026 (excl. 17 Jan – 18 Feb 2026) in the southern Te Ākau Bream Bay site.

72. I maintain the views and conclusions set out in my original assessment.

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Dr Matthew K. Pine,

BSc, PGDipSci (Dist.), PhD, MASNZ.

12 August 2026

References

Fleishman, E., Cholewiak, D., Gillespie, D., Helble, T., Klinck, H., Nosal, E.-M., & Roch, M. A. (2023). Ecological inferences about marine mammals from passive acoustic data. *Biological Reviews*, 98, 1633–1647. https://doi.org/10.1111/brv.12969

Kershenbaum, A., Akçay, Ç., Babu-Saheer, L., Barnhill, A., Best, P., Cauzinille, J., Clink, D., Dassow, A., Dufourq, E., Growcott, J., Markham, A., Marti-Domken, B., Marxer, R., Muir, J., Reynolds, S., Root-Gutteridge, H., Sadhukhan, S., Schindler, L., Smith, B. R., … Dunn, J. C. (2025). Automatic detection for bioacoustic research: a practical guide from and for biologists and computer scientists. *Biological Reviews*, 100, 620–646. https://doi.org/10.1111/brv.13155

Oswald, J. N., Walker, R., Hom-Weaver, C., & Norris, T. F. (2016). Manual and automated Atlantic whistle classifiers: Improvement, testing and application (Draft Final Report). Prepared by Bio-Waves, Inc. for HDR Environmental, Operations and Construction, Inc

ATTACHMENT 1

Baseline PAM of the existing soundscape before operations begin.

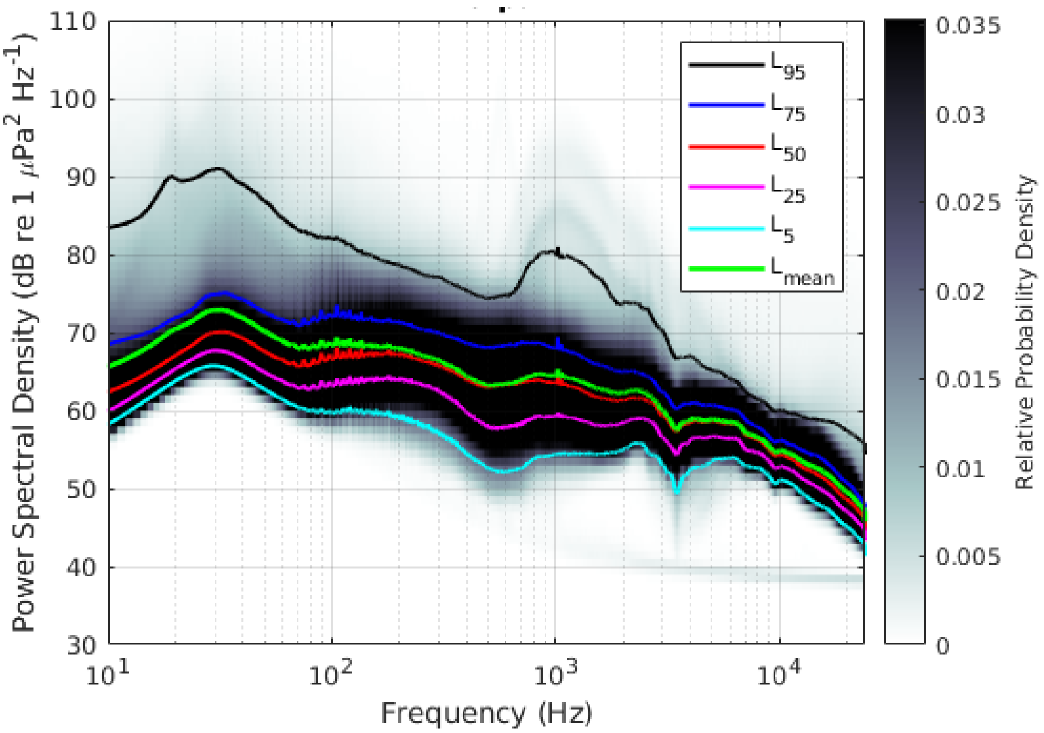

Figure A1.1: Power spectral densities and spectral probability densities from the southern Te Ākau Bream Bay monitoring site between 7 July 2025 and 22 June 2026 (excluding between 24 January and 18 February 2026 due to technical difficulties with the recorder).

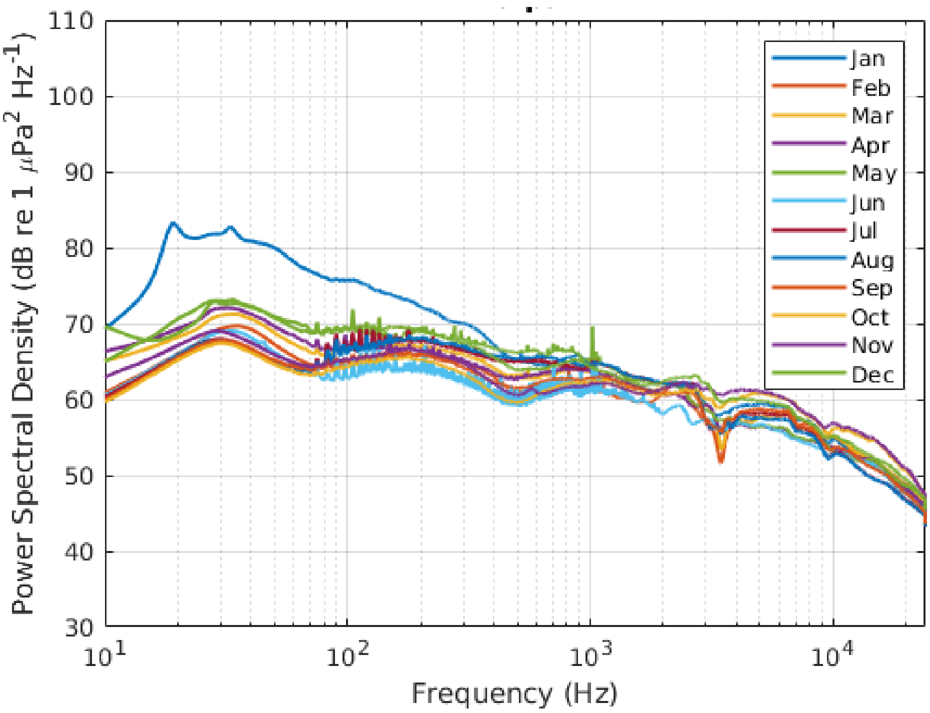

Figure A1.2: Monthly power spectral densities from the southern Te Ākau Bream Bay monitoring site. Note no data were collected between 24 January and 18 February 2026 due to technical difficulties with the recorder, so those months are undersampled.

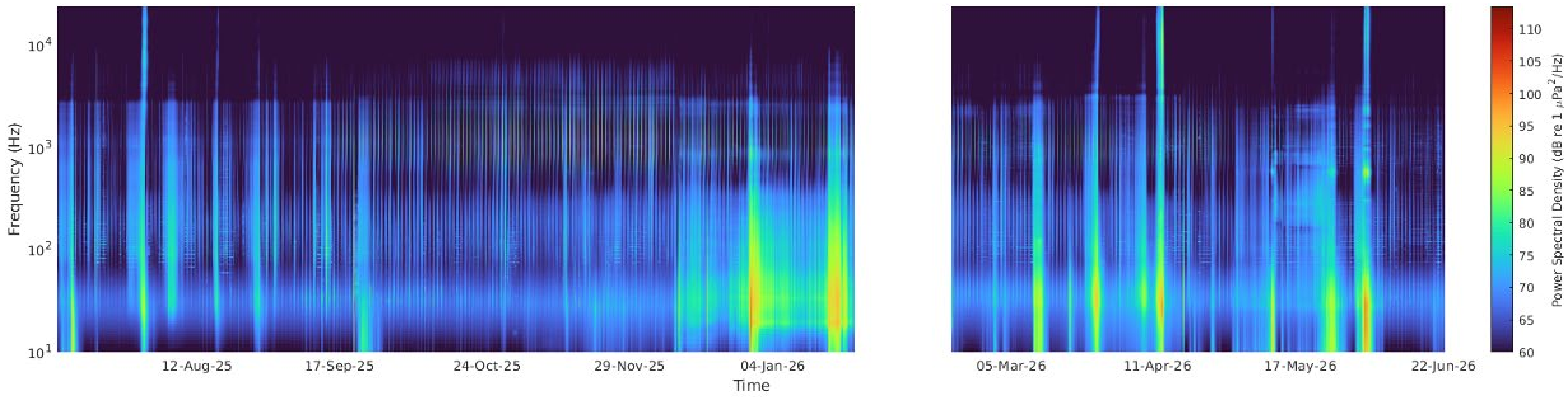

Figure A1.3: Long term spectral average (LTSA, calculated from the hybrid millidecade scale (Martin et al. 2021)) from the southern Te Ākau Bream Bay monitoring site. The blank block between 24 January and 18 February 2026 represents the period when no data were collected due to technical difficulties with the recorder.

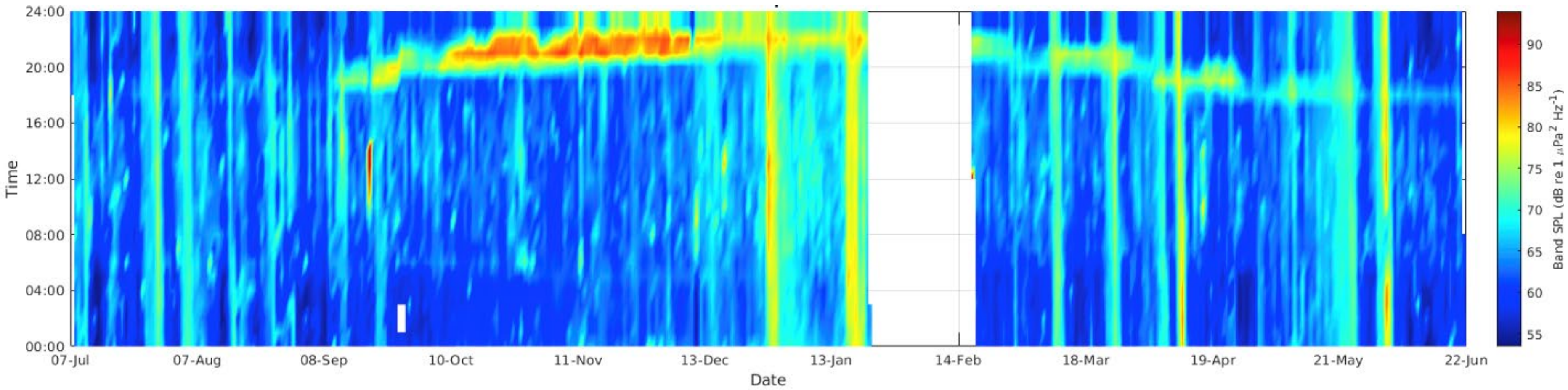

Figure A1.4: Diel plot showing the temporal variation in broadband ambient sound levels (10Hz – 24kHz, hybrid millidecade scale (**Martin et al. 2021**) across time of day (y axis) and date (x axis) at the southern Te Ākau Bream Bay monitoring site. The blank block between 24 January and 18 February 2026 represents the period when no data were collected due to technical difficulties with the recorder.

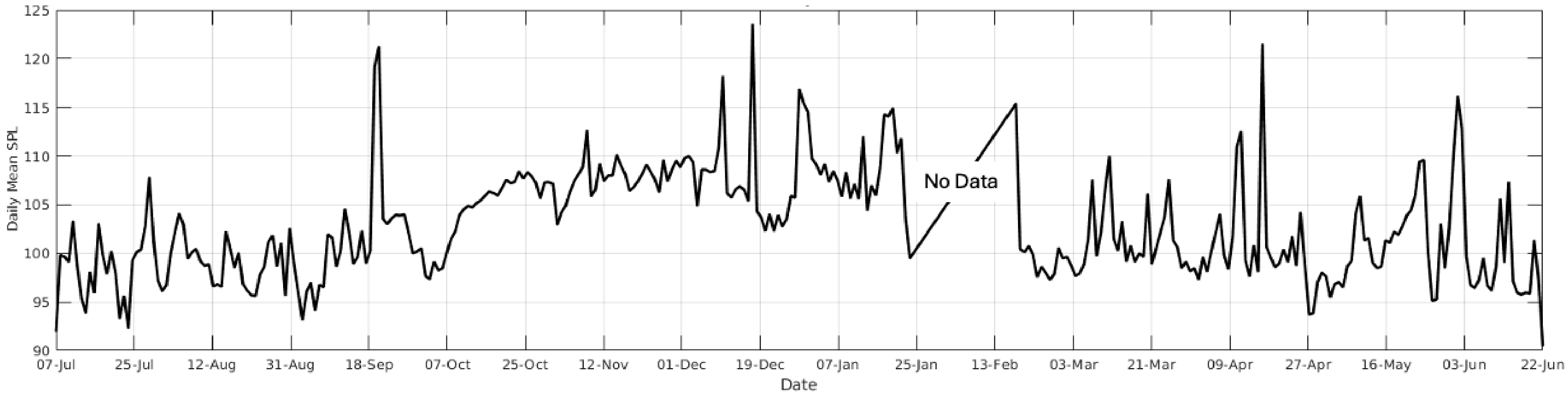

Figure A1.5: Daily broadband sound pressure levels (dB re 1 µPa) from the southern Te Ākau Bream Bay monitoring site. No data were collected between 24 January and 18 February 2026 due to technical difficulties with the recorder.

ATTACHMENT 2

Excess noise & listening space reductions from existing non-AIS vessel traffic

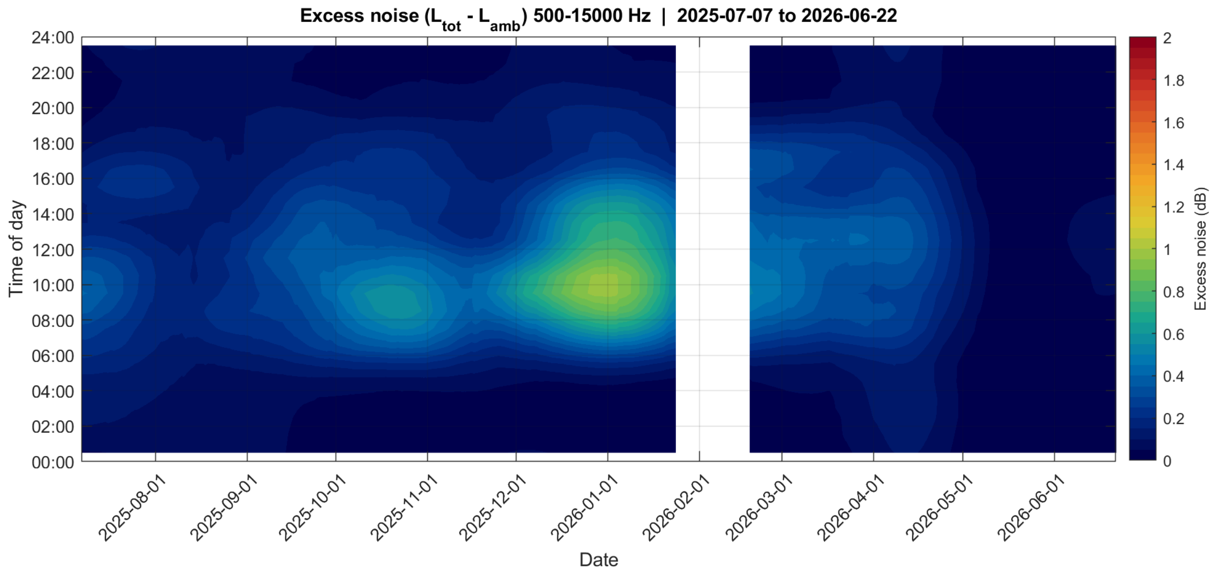

Figure A2.1: Plots showing temporal variation of observed dB increases over ambient levels directly from passing vessels as recorded from the monitoring site in southern Te Ākau Bream Bay.

The methods used to produce this plot generally followed Hendricks et al. (2025) with the following exceptions:

a) The analysis applied Gaussian smoothing over 1 hour and 12 days (i.e., [gaussSigma = [1 12] in the code).

b) Used a deep-learning detector for the vessel noise detection instead of entropy alone (adapted from Pine et al. 2021).

Analysis targeted boats within distinctive passby behaviours and was capable of detecting vessels over a range of distances and behaviours (examples provided in **Figure A2.2** below).

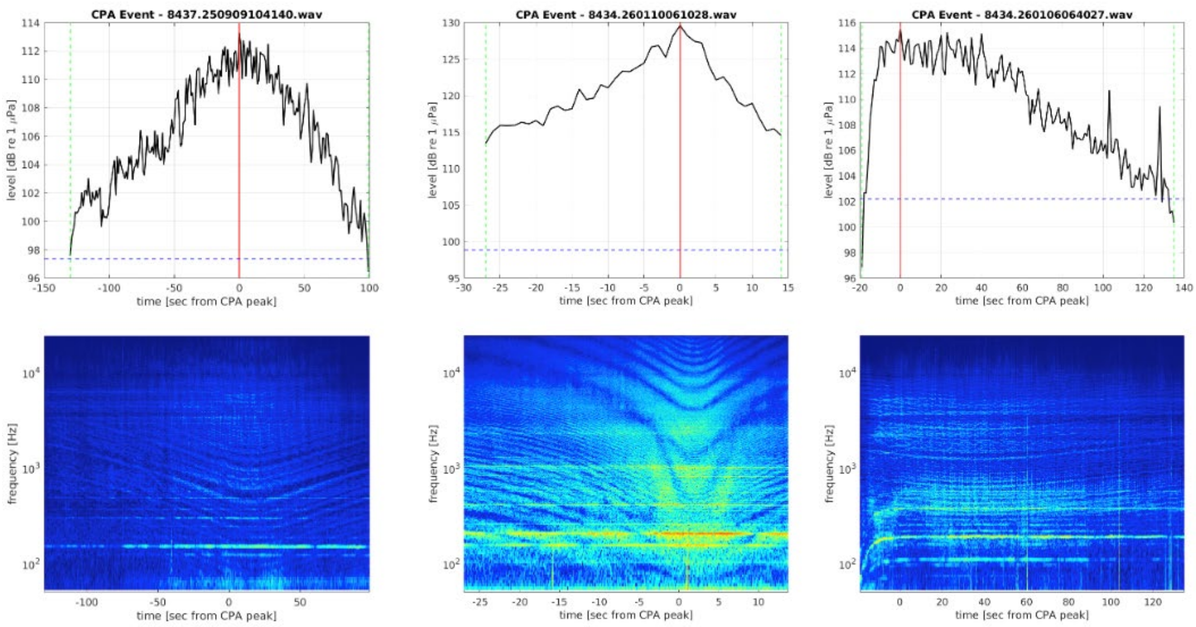

Figure A2.2: Example detections of small boat passbys from the vessel detector. The left panel shows a distant passby (indicated by the low received sound pressure levels of ~113 dB re 1µPa), the middle panel is a more proximate passby, while the right panel shows a boat starting its engine and leaving.

References

Hendricks, B., Pine, M. K., Baer, G., Welton, M., Symonds, H. K., Dakin, D. T., Alidina, H. M., Picard, C. R., & Wray, J. (2025). Quantifying vessel noise and acoustic habitat loss in marine soundscapes. *Marine Pollution Bulletin*, *219*, Article 118150

ATTACHMENT 3

Marine Mammal (Cetaceans) Acoustic Survey Results

New Information from southern Te Ākau Bream Bay

Table A3.1: Summary table of detection events for general delphinids (DolphinSpp) and orca (Orca) recorded between 7 July 2025 and 22 June 2026, excluding between 24 January and 18 February 2026. No data were collected between 24 January and 18 February 2026 due to technical difficulties on the recorder.

Group	Number of Detection Events	Average Detection Positive Minutes (DPM)	Minimum Detection Positive Minutes (DPM)	Maximum Detection Positive Minutes (DPM)
DolphinSpp	440	32.13	1	347
Orca	26	28.54	1	121

Table A3.2: Total detection positive minutes (DPM) and number of detection events within each season. Note that varying sampling efforts within seasons have not been controlled for, so this table is only descriptive.

Season	Total DPM	Total # detection events
DolphinSpp		
Summer (Dec-Feb)	4877	96
Autumn (Mar-May)	2236	94
Winter (Jun-Aug)	2199	92
Spring (Sep-Nov)	4823	158
Orca		
Summer (Dec-Feb)	239	5
Autumn (Mar-May)	60	2
Winter (Jun-Aug)	185	10
Spring (Sep-Nov)	258	9

Table A3.3: Summary table showing the proportion of detection events occurring during daytime hours vs nighttime hours. Day/night time periods are defined using sunrise and sunset time for each day.

Month	Proportion of detection events during daytime hours	Proportion of detection events during nighttime hours
DolphinSpp		
January	40.7	59.3
February	80.0	20.0
March	75.0	25.0
April	50.0	50.0
May	57.1	42.9
June	40.0	60.0
July	32.4	67.6
August	17.4	82.6
September	37.7	62.3
October	21.8	78.2
November	26.2	73.8
December	57.8	42.2
Orca		
January	0.0	100.0
February	0.0	0.0
March	0.0	100.0
April	0.0	0.0
May	0.0	100.0
June	0.0	0.0
July	33.3	66.7
August	75.0	25.0
September	40.0	60.0
October	0.0	0.0
November	75.0	25.0
December	0.0	0.0

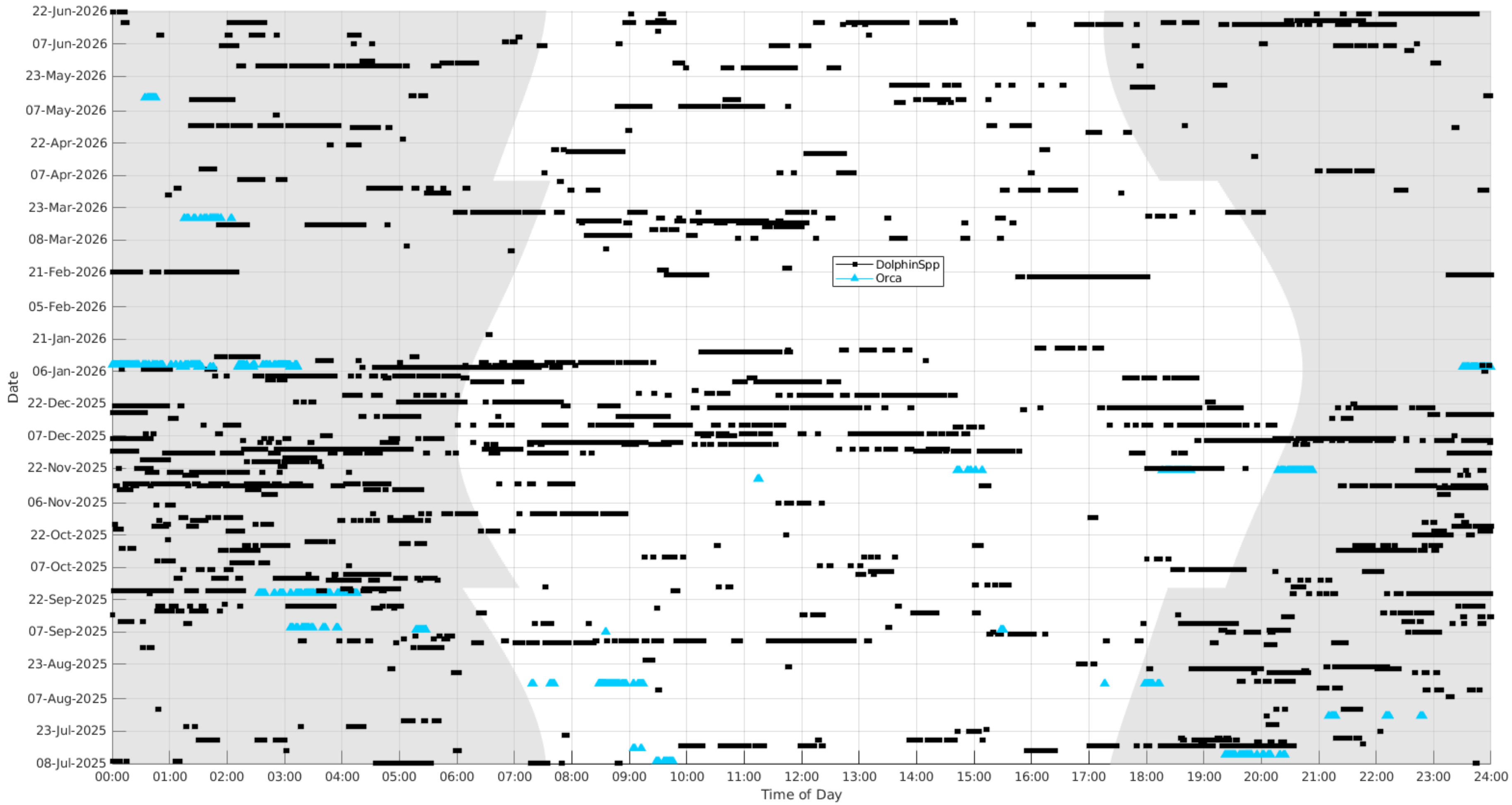

Figure A3.1: Actogram showing of dolphin species (DolphinSpp, represented by the black squares) and orca (Orca, represented by the blue triangles) at the monitoring site in southern Te Ākau Bream Bay.

Table A3.4: Summary table of acoustic detections of mysticete vocalisations recorded between 7 July 2025 and 22 June 2026, excluding between 24 January and 22 June 2026. No data were collected between 24 January and 18 February 2026 due to technical difficulties on the recorder.

Species	Number of Detection Events	Average Detection Positive Minutes (DPM)	Minimum Detection Positive Minutes (DPM)	Maximum Detection Positive Minutes (DPM)
Brydes Whale	73	15.36	1	127
Humpback whale (HBW)	15	5.07	1	37
Pygmy Blue Whale	1	34	34	34
Southern Right Whale (SRW)	1	88	88	88
Sei Whale	7	2.86	1	11

Table A3.5: Total detection positive minutes (DPM) and number of days within each season with a detection. Note that varying sampling efforts within seasons have not been controlled for, so this table is only descriptive.

Season	Total DPM	Total days with detections
Brydes Whale		
Summer (Dec-Feb)	5	5
Autumn (Mar-May)	63	7
Winter (Jun-Aug)	268	10
Spring (Sep-Nov)	785	18
Humpback whale (HBW)		
Summer (Dec-Feb)	0	0
Autumn (Mar-May)	2	2
Winter (Jun-Aug)	36	4
Spring (Sep-Nov)	38	1
Pygmy Blue Whale		
Summer (Dec-Feb)	0	0
Autumn (Mar-May)	0	0
Winter (Jun-Aug)	34	1
Spring (Sep-Nov)	0	0
Southern Right Whale (SRW)		
Summer (Dec-Feb)	0	0
Autumn (Mar-May)	0	0
Winter (Jun-Aug)	0	0
Spring (Sep-Nov)	88	1
Sei Whale		
Summer (Dec-Feb)	2	2
Autumn (Mar-May)	0	0
Winter (Jun-Aug)	12	1
Spring (Sep-Nov)	6	2

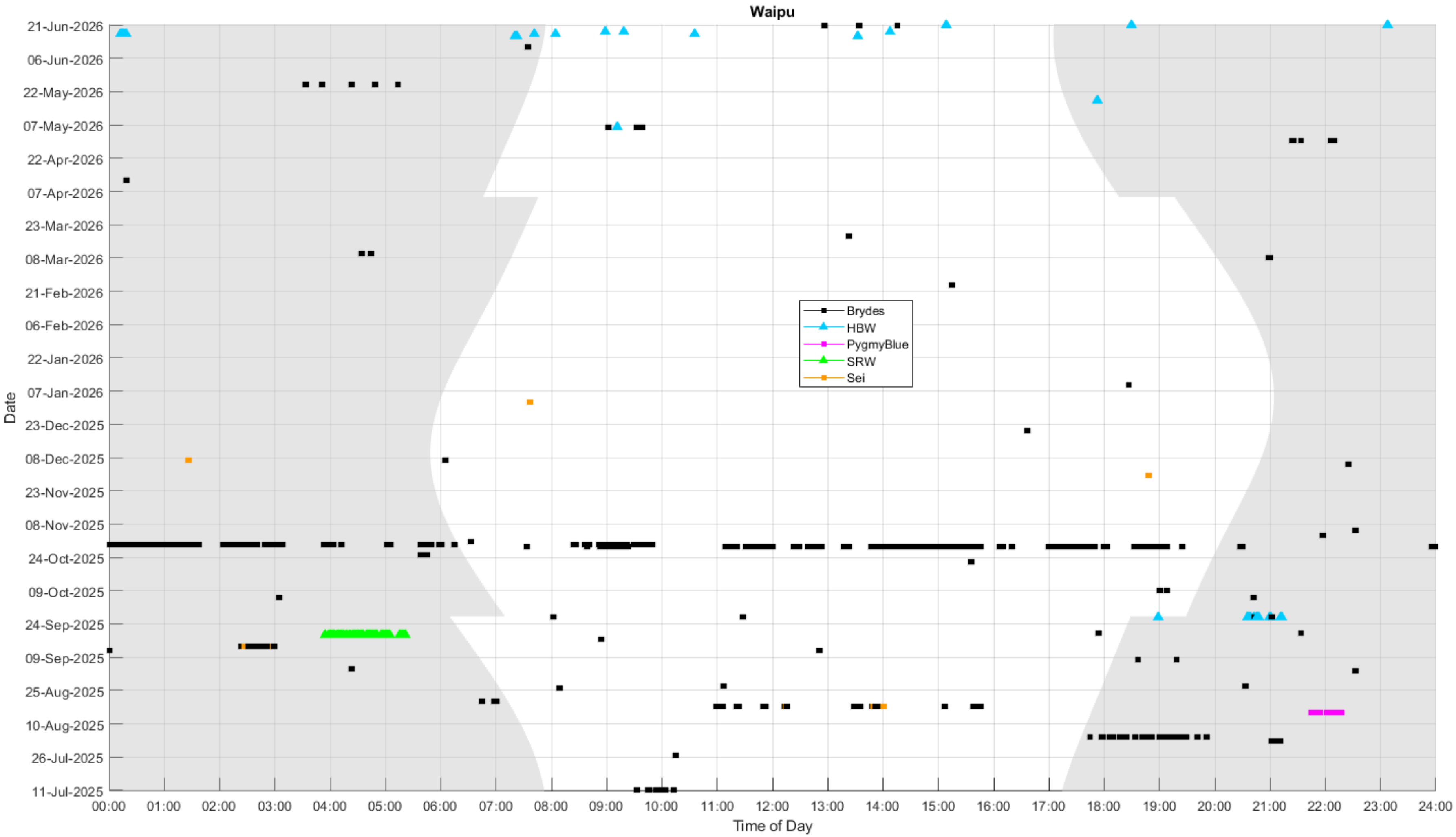

Figure A3.1: Actogram showing the temporal variation in detected whale sounds at the monitoring site in southern Te Ākau Bream Bay.

ATTACHMENT 4

Investigating dolphin foraging occupancy

1. Foraging behaviours were quantified by determining the presence of burst pulses/buzzes in the raw audio recordings. A simplified overview of the analysis pipeline is provided in Figure A4.1 below.

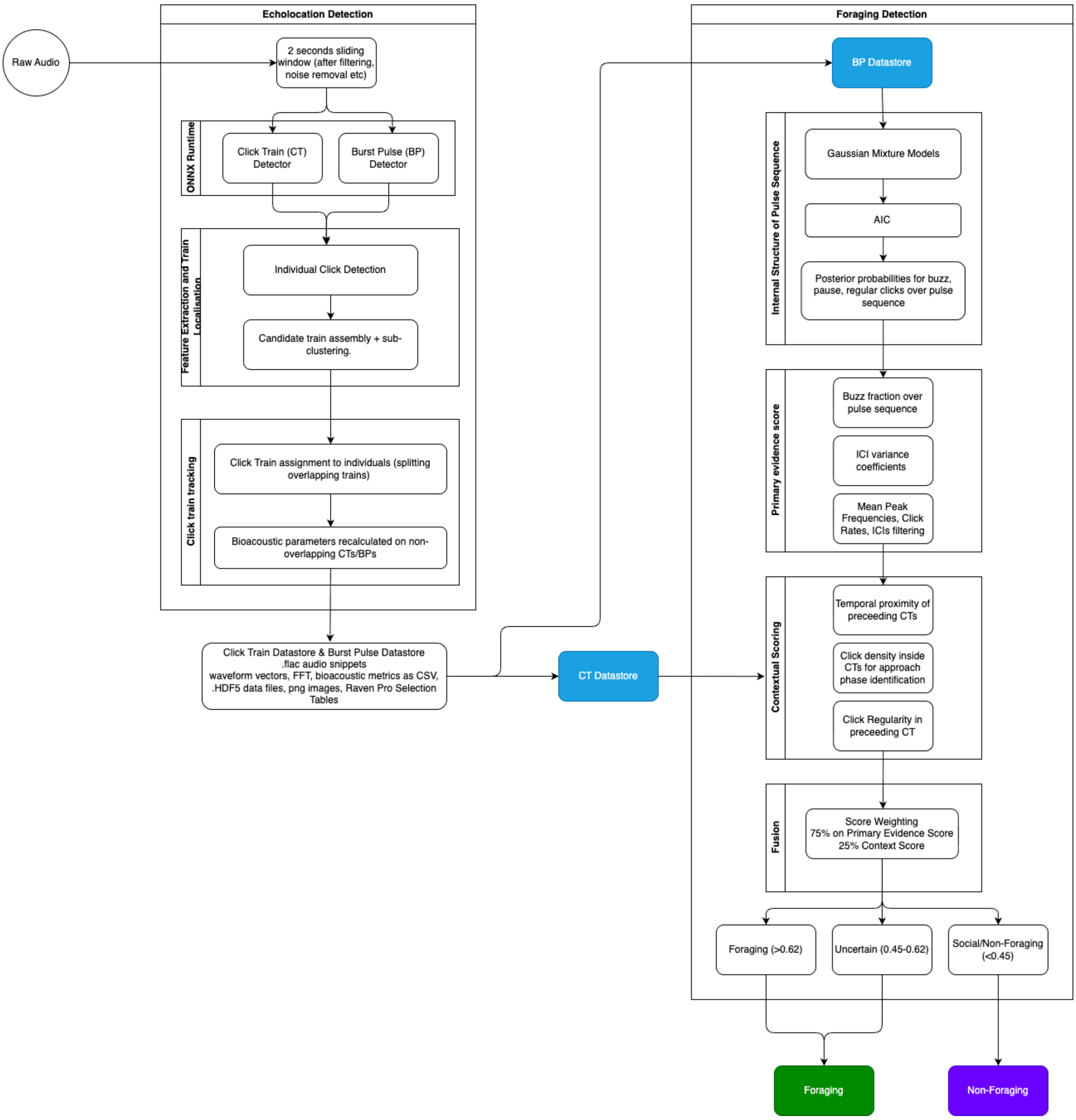

Figure A4.1: A simplified overview of the analysis pipeline used to detect and classify foraging behaviours within the acoustic recordings.

2. Separate ONNX models allowed for different signal-processing frontends that could be customised for their specific target signals. This significantly improved detector performance (approximately 0.96 precision, 0.9 recall). Both of those AI models were trained on hundreds of thousands of recordings from overseas and around New Zealand, on pooled data from a wide range of odontocetes (including bottlenose dolphins, false killer whales, orca, pilot whales etc).

3. Detections from the ONNX inference were passed to the rest of the analysis pipeline (Echolocation Detection container in Figure A4.1), which was largely based on functions and principles described by Zimmer (2011).

4. The Echolocation Detection phase outputted two separate datastores, one for Click Trains and one for Burst Pulses/buzzes. Each datastore contained audio snippets, spectrograms, FFTs, Raven Pro Selection Tables and the bioacoustics parameters including inter-click intervals, various bandwidth properties, durations, click rates, etc inside hdf5 and csv files, indexed according to the Train ID (an integer flag used to track individual click trains/burst pulses within a datastore).

5. Those datastores were fed into the Foraging Detection phase (see Figure A4.1) that ultimately classified detected burst pulses as either foraging or social buzzes. The foraging detector consisted of a primary foraging locator and a context layer that uses the click train datastore to provide important context when classifying buzzes as foraging or social buzzes. For Te Ākau Bream Bay, the foraging buzzes were parameterised using the values set in Table A4.1.

Table A4.1: Input parameters for defining foraging-related burst pulses.

Criterion	Configured Value
Hard rules/constraints (global)	
Minimum Mean Click Rate	50 Hz
Maximum ICI within burst	10ms
Minimum Peak Frequency	15kHz
Temporal dynamics (affecting foraging pulse score)	
Sequence duration limits	0.1 – 5.0sec
Target Onset Click Rate	100Hz
Internal structure (GMM Classification)	
Minimum buzz fraction (min. % of ICIs that must be classified by the GMM as fastest buzz component)	55%
Consecutive buzz run (Min. uninterrupted sequence of extremely fast buzz clicks).	5

ICI Coefficient Variation	0.03 – 0.35
Spectral properties	
Target Peak Frequency	10 – [fs/2] kHz
Final scoring & fusion	
Primary evidence score (based on temporal + spectral check passes)	60%
Combined weighted score to pass as foraging end classification.	>0.45 for Te Ākau Bream Bay. Typically set at >0.62 for foraging (combined weighting of 75% for primary evidence score + 25% weighting on surrounding contextual click trains). Scores of 0.45 < x > 0.62 are classed as 'uncertain' and below 0.45 classed as social burst pulses.

6. The foraging locator uses Gaussian Mixture Models (GMM) following Pirotta et al. (2014; 2015) and the Akaike Information Criterion (AIC) to set the component selection parameter in the GMM. The context layer was based on Arranz et al. (2016) which essentially uses the detected echolocation click train datastore to differentiate a sensory foraging buzz from a communicative/social burst pulse. This was achieved by evaluating any 'approach phase' clicks leading up to the burst pulse, since true foraging buzzes are preceded by regular echolocation click trains with coherent decreases in ICIs, while social buzzes typically occur in isolation (Arranz et al., 2016).

7. The foraging detector also integrates well-established minimums based on Carlström (2005) and Todd et al. (2009), which was that at least 5 consecutive clicks with ICIs below 10ms and a max ICI below 10ms required for a foraging buzz.

8. Mr Zaeschmar (DOC) states in his evidence[12] that benthic foraging may occur in species within Te Ākau Bream Bay. Consequently, classified foraging buzzes with low context scores were pooled with the 'forgaging' class to increase the conservativeness of the results. This was considered appropriate because the context layer, based on Arranz et al. (2016), was designed to detect pelagic feeding with distinctive target searching, acoustic gaze narrowing and agile prey capture phases. While this can be true when hunting benthic/demersal prey, by including uncertain foraging buzzes in the results (i.e., those witih low context scores), the detection model remains sensitivite to foraging buzzes associated when hunting stationary institital prey. It also increases

[12] Paragraph 45 of his Evidence to the Expert Consenting Panel, dated 21 May 2026

the conservativeness of the analysis by reducing the probability of significantly under-reporting true foraging occupancy in the detection event dataset.

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