BEFORE THE FAST TRACK PANEL
AT WELLINGTON

I MUA I TE KŌTI TAIAO O AOTEAROA
TE WHANGANUI-A-TARA ROHE

UNDER	the Fast Track Approvals Act 2024 (the "**Act**")
IN THE MATTER	of an application by Trans-Tasman Resources Ltd for marine and discharge consents to undertake iron sand extraction in the South Taranaki Bight The 'Taranaki VTM Project' [**FTAA-2504-1048**]
BETWEEN	**TRANS-TASMAN RESOURCES LIMITED (TTRL)** *Applicant*
AND	**THE ENVIRONMENTAL PROTECTION AUTHORITY** *The EPA*

STATEMENT OF EVIDENCE OF Dr LEIGH GABRIELA TORRES (Marine Mammals)

FILED ON BEHALF OF KIWIS AGAINST SEABED MINING, GREENPEACE AOTEAROA LIMITED AND THE ROYAL FOREST & BIRD PROTECTION SOCIETY INCORPORATED

Dated 6 October 2025

[redacted]
Barrister
Globe Law
[redacted]

[redacted]
Barrister
Magdalene Chambers
[redacted]

STATEMENT OF EVIDENCE OF LEIGH GABRIELA TORRES

INTRODUCTION

1 I am an Associate Professor at Oregon State University and lead the Geospatial Ecology of Marine Megafauna (GEMM) Lab within the Marine Mammal Institute.

2 This statement of evidence considers the potential effects to marine mammals in the South Taranaki Bight from the proposed Taranaki VTM fast track application to mine approximately 50 million tonnes of seabed material a year for 20 years.

3 I have the following qualifications and experience relevant to this application:

I hold a PhD in Marine Ecology (Duke University, 2008), a Master's of Environmental Management (Duke University, 2001), and a Bachelor of Arts in Communication and Environmental Science (American University, 1997).

I am currently an Associate Professor in the Department of Fisheries, Wildlife and Conservation Sciences at Oregon State University (USA).

I lead the Geospatial Ecology of Marine Megafauna Laboratory (GEMM Lab[1]) within the Marine Mammal Institute. The GEMM Lab focuses on the ecology, behaviour and conservation of marine megafauna including cetaceans, pinnipeds, seabirds, and sharks. Our research is diverse and global, and we use advanced and innovative methods to describe the distribution, behaviour, health and ecological patterns of marine

---

[1] Geospatial Ecology of Marine Megafauna (GEMM) Lab, Marine Mammal Institute, Oregon State University, Hatfield Marine Science Center, Newport, Oregon
Webpage: https://mmi.oregonstate.edu/gemm-lab

megafauna to provide effective management options that will reduce space-use conflicts with human activities in the marine environment.

I have conducted research on the ecology of marine mammals since 1996. My expertise is in spatial ecology (understanding species distribution patterns and their environmental drivers) and foraging ecology (understanding feeding patterns and ecological correlates). I have applied my knowledge and skills to a variety of research projects on a diversity of species and habitats, including bottlenose dolphins in Florida, southern right whales and sperm whales in New Zealand, gray whales in the northeastern Pacific, bottlenose dolphins in New Zealand, and blue whales in New Zealand.

4 Since 2013, I have been conducting research on Pygmy Blue Whales (*Balaenoptera musculus brevicauda)* in the South Taranaki Bight (**STB**), working to document the population and understand their ecology and habitat use, and inform conservation management.

5 We conducted boat-based surveys in the STB during summers of 2014, 2016, 2017, and recently in 2024 and 2025 as part of the SAPPHIRE project, which stands for Synthesis of Acoustics, Physiology, Prey, and Habitat in a Rapidly changing Environment (see the recent SAPPHIRE Project report, **Appendix C**).

6 This research has included drone-based photogrammetry to assess whale body condition and pregnancy, collection and analyse of krill samples to understand prey availability, deployment and recovery of hydrophones to track whale vocalizations between 2016-2018 and 2024-2027, and gathering of tissue and faecal samples to study genetic population structure, and stress and reproductive hormones. The research is ongoing; in 2025, we collected and redeployed hydrophones, which will record vocalizations during this year 2025-2026 and we plan to return to undertake further field work in 2026.

7 We have thoroughly analysed this data leading to over 12 peer-reviewed scientific publications that describe the ecology of blue whales in the STB region.

SCOPE OF THIS STATEMENT

8 In this statement of evidence, I have been asked to undertake the following two tasks:

a. *Review of the 2025 Application:*
   i. Assess the 2025 fast track application of Trans-Tasman Resources to mine iron ore and vanadium in the STB;
   ii. Identify any differences between the present application and the previous applications, specifically in relation to potential adverse effects and risks to marine mammals.
   iii. Consider whether these differences affect the conclusions I reached in my earlier evidence.

b. *Update of my 2023 Evidence:*
   i. Review and update the evidence I provided in 2023.
   ii. Incorporate any new research or information that has become available since that time.

9 In my review of the Taranaki VTM Project, I note that the application is substantively the same as the earlier 2016 application, except for the duration of consent sought. The statements of evidence addressing marine mammals are the same statements of evidence prepared and filed by TTR as part of the 2016 application and the 2023 reconsideration hearing.

10 Rather than repeat my 2023 statement of evidence, which provides a detailed analysis of the 2016 substantive application and supporting material, this statement should be read in conjunction with that earlier evidence. Readers should begin with Appendix A, my 2023 statement of evidence, together with my oral presentation which is recorded in the transcript, Appendix C, before turning to this statement.

11 This statement adopts and relies on my 2023 statement of evidence. This statement confirms the key findings already made and provides additional commentary.

SUMMARY OF KEY FINDINGS IN MY EVIDENCE TO DATE

12 I have led extensive research over the past 12 years that has established the South Taranaki Bight (STB) as a critical year-round habitat for pygmy blue whales. This habitat supports many essential life functions, including foraging, breeding, and nursing. The STB population is genetically distinct, endemic to Aotearoa New Zealand, and very rarely recorded outside New Zealand waters.

13 This STB population of pygmy blue whales is vulnerable to climate-driven oceanographic changes and cumulative anthropogenic pressures, including vessel strikes, ocean noise, and impacts from sediment plume to be produced by mining on the quality, quantity and distribution of krill prey that blue whales rely on in the STB. These pressures pose significant risks to the long-term viability of the population.

14 The plume may disrupt krill populations, which are the whales' sole food source. Krill are filter feeders and sediment from the plume could interfere with krill filtration, reducing their abundance and nutritional value. This would diminish food availability and compromise the health of the blue whale population that relies on krill prey.

15 There is insufficient information to determine the degree of impact (a) of the mining operations on the turbidity in the water column that may impact krill and whale foraging efficiency, and (b) sediment plume extent under various oceanographic conditions.

16 Underwater noise also poses a risk to pygmy blue whales. The whales rely on low-frequency acoustic signals for essential behaviours including communication, navigation, and foraging. The introduction of sustained noise

into their habitat could interfere with these signals, leading to adverse effects such as displacement from preferred foraging areas and reduced feeding efficiency. Chronic noise exposure may trigger physiological stress responses, including elevated cortisol levels. The whales' documented year-round presence near the proposed mining site and their sensitivity to acoustic disturbance means the cumulative noise impacts may adversely affect the health and viability of the population.

17 The sediment and noise from mining operations may cause chronic physiological stress and behavioural disturbance, potentially displacing whales from critical habitat and impairing reproduction. The whales' regular presence within the vicinity of the proposed site means that, in addition to the existing pressures, pollution and noise from the mining operation could undermine the population's viability.

18 These risks are not adequately addressed. The proposed conditions of consent fail to demonstrate sufficient environmental protection or precaution.

19 The SAPPHIRE Project (**Appendix D**), based on fieldwork conducted in Aotearoa New Zealand between January and February 2024 and 2025, strengthens this understanding. It documents habitat use, reproduction, foraging behaviour, health, and responses to environmental variability, confirming that this population is highly sensitive to both climate-driven changes and additional sources of disturbance in the STB and wider New Zealand region.

20 I have previously assessed seabed mining proposals in this area. In 2017, our research was preliminary, but by 2023 we had developed robust analyses confirming the STB's importance for blue whale ecology. In my 2023 statement, I concluded that the TTR seabed mining proposal risked material harm to vulnerable marine mammal populations, particularly pygmy blue whales and Māui dolphins, and that the uncertainty of impacts was too great to proceed. I also noted at that time that "we now have much stronger and more complete knowledge of the marine mammal, particularly blue whale, ecology and distribution patterns in the STB region to support my previous evidence."

21 Having now reviewed the 2025 Fast-Track application for a 20-year consent (rather than the 35 years originally sought), my opinion is unchanged. The further research undertaken since 2023, including the SAPPHIRE findings, reaffirms that the STB is a critical habitat for this species. The proposed mining activity would introduce further stressors, compounding existing threats, and put at risk the ongoing viability of the STB as suitable habitat. The proposed consent conditions do not demonstrate sufficient environmental protection or precaution. Accordingly, I do not consider the proposal to be consistent with the requirement to favour caution and environmental protection.

22 Given the uncertainty associated with the lack of accurate noise estimates for this specific mining operation, the resulting insufficient estimation of the acoustic footprint of the TTR site, and the lack of data available on potential behavioural and physiological response of cetaceans to increased noise, I do not think there is sufficient evidence to conclude that there will be no material harm or no adverse effects caused by the proposed TTR mining operation and their is a significant risk that the proposal will result in the significant adverse impacts including the relocation of these mammals from the region altogether.

23 In my 2023 statement I also provide evidence on the impacts to other marine mammals including maui dolphins.

EVIDENCE PREVIOUSLY PROVIDED, 2016, 2017 AND 2023

24 I provided expert evidence to the environmental protection authority (EPA) in relation to the 2016 proposal by Trans-Tasman Resources limited to mine iron ore in the STB and the reconsideration hearings in 2023.

25 I provided the following statements of evidence and oral presentations:

2016/2017 EPA Hearings

a. A first statement of evidence dated 23rd of January 2016;
b. A rebuttal statement of evidence dated 15 February 2017;
c. A further statement of evidence (responding to further evidence filed by TTR expert Simon Childerhouse) dated 6 March 2017; and

d. A further statement of evidence filed in response to questions from the Decision Making Committee (DMC) dated 15 March 2017.

26 I did not participate in the Marine Mammals Joint Expert Conferencing in 2017, as I was not situated in Aotearoa/New Zealand at that time and was undertaking research at sea. However, I did take part in the Joint Witness Conferencing during the reconsideration hearings in 2023.

2023 Reconsideration Hearings:

a. Statement of evidence dated 6 October 2023. This statement of evidence was prepared in collaboration with Dr. Dawn Barlow at Oregon State University (OSU).
b. Signatory to the Joint Statement of Experts in the Field of Marine Mammals, dated 19 February 2024
c. Oral Presentation on Day 2, Thursday 14 March 2024.

27 **Attached** to this affidavit is:

a. My statement of evidence dated 6 October 2023, marked **Appendix A**.

b. A copy of joint witness statements on marine mammals, dated 2023 as **Appendix B**.

c. In my oral presentation to the Decision-Making Committee in 2024, I also reported on the field work undertaken in the South Taranaki Bight that year. The relevant portion of the transcript is attached as **Appendix C**.

d. I have also included the SAPPHIRE Report, which outlines the research conducted in 2025, as **Appendix D.**

28 Together, these four documents represent the most up-to-date and comprehensive evidence currently available on the pygmy blue whales in the STB.

CODE OF CONDUCT

29 I confirm that I have read the Code of Conduct for Expert Witnesses as contained in the Environment Court Practice Note dated 1 January 2023. I agree to comply with this Code. This evidence is within my area of expertise, except where I state that I am relying upon the specified evidence of another person. I have not omitted to consider material facts known to me that might alter or detract from the opinions that I express.

REVIEW OF THE 2025 FAST TRACK APPLICATION

30 In preparing this statement of evidence I have reviewed the application by Trans-Tasman Resources Limited for marine and discharge consents under the Fast Track Approvals Act 2024. I have specifically considered the following documents included in the substantive application document for the Taranaki VTM project (available online) including:

a. The Taranaki VTM application
b. Attachment 1- Proposed Marine consent conditions
c. Marine Mammal Locations of all Sightings and Incidents; and
d. Draft Marine Mammal Management Plan

31 And the following documents listed under Technical Reports:

a. The NIWA Habitat models of southern right whales, hectors dolphin and killer whales in New Zealand, Updated November 2015.
b. Further evidence - Mr Darran Humpheson further to Dr Simon Childerhouse - February 2024 Marine Mammals
c. Rebuttal evidence -Dr Simon Childerhouse - marine mammals - January 2024 Marine Mammals
d. Evidence Dr Simon Childerhouse - effects on marine mammals - May 2023 Marine Mammals
e. Martin Cawthorn Associates Ltd – Cetacean Monitoring Report – November 2015 Marine mammals.

32 When reviewing these materials I note:

a. The application document has been updated but has not substantively changed in relation to the effects on marine mammals. The only notable difference in the application as it relates to marine mammals is the term of consent which has changed from 35 years to 20 years.
b. The Proposed Marine consent conditions and the Draft Marine Mammal Management Plan are the same.
c. The Marine Mammal Locations of all Sightings and Incidents are the same.
d. I have previously reviewed all of the technical reports (a-e) above as part of the 2023 reconsideration application.
e. As far as I can tell, there is no new evidence (since 2016) relating to marine mammals as part of TTR's 2025 Fast-track application.

33 Included in the 2016 TTR documents and in the 2025 Fast Track Application is the 'NIWA Habitat Models of Southern Right Whales, Hector's dolphins, and killer Whales in New Zealand', updated in November 2015.[2] This is a report I co-authored on behalf of NIWA and was provided to the DMC by TTR in 2017. While this report is relevant, its focus is on habitats across all of Aotearoa/New Zealand and uses limited, opportunistic sightings data in models so should be interpreted with caution.

Response to Evidence of Dr Childerhouse

34 In my evidence dated 6 October 2023, **Appendix A**, I reviewed the evidence of Dr Simon Childerhouse dated May 2023. My response to this evidence is set out in paragraphs ([14]–[39] of my evidence dated 6 October 2023).

35 My comments from that review remain unchanged and therefore I have not repeated them here.

36 The only notable difference I have identified between the 2016 application and this one is the term of consent being reduced from 35 years to 20 years. However, this change is not reflected in the evidence of Dr Childerhouse whose

[2] Found at [https://www.fasttrack.govt.nz/__data/assets/pdf_file/0016/4273/Report-4-NIWA-Cetacean-Habitat-Models-Report-FINAL.pdf].

evidence (dated 2023) refers to the 35 year term. The term of the consent does not change my comments in my statement of evidence of 6 October 2023. I expect that impacts on blue whales and their habitat from the proposed mining will manifest within a year or two of project activity, so the change from 35 to 20 years term will not change expected impacts on whales, their prey or habitat, except that the mining activity would end sooner.

37 I have also reviewed the rebuttal evidence of Dr Simon Childerhouse (February 2024) which responded to my statement of evidence dated 6 October 2023. I provided oral rebuttal to this evidence in 2023 when presenting to the DMC, the full transcript of my oral evidence is set out at **Appendix D**.

38 My position as set out in oral evidence remains unchanged. I do however expand on some of this evidence below given the further research undertaken:

a. **Species distribution models**
   i. Dr. Childerhouse's models are too broad-scale and inappropriate for predicting local marine mammal presence at the TTR site.
   ii. These models are similar to using an annual, region-wide average temperature map to predict a single day's temperature in Wellington;
   iii. Marine mammal surveys are appropriate, affordable and should have been undertaken regularly to assess species abundance and presence in the region. They were not. No further evidence was provided by TTRL in 2023 nor in this application.

b. **Blue whale sensitivity to noise**
   i. Blue whales are extremely sensitive to low-frequency noise, which travels long distances underwater.
   ii. A hydrophone (in 2016-2017) placed 18.8 km from the TTR site recorded blue whale calls almost daily throughout the year, confirming the area's critical habitat.
   iii. Noise and sediment plumes can spread far beyond the mining site, creating disturbance for the full 20 year term of this mining activity.

iv. Continuous noise could displace whales from vital feeding and mating grounds — compared to “living next to a vacuum cleaner for 35 years.” Which is now “20 years” but this does not change the likely outcome.
v. Persistent, elevated noise exposure is correlated with increased cortisol stress levels in whales, which can cause negative long-term health and reproductive consequences.

c. Evidence of whale proximity

i. Three blue whales were observed 13.5 km from the TTR site in 2013, showing whales can occur very close to the proposed mining area.
ii. In 2017, we surveyed 1,678 sq km and recorded 32 blue whale sightings consisting of 68 individual whales. Most blue whale sightings were made north of Farewell Spit, in the plume of cold, upwelled water, yet we also observed 8 blue whales within 25 km of the proposed mining site.
iii. In 2024, we surveyed 1,583 sq km and observed no blue whale sightings in the STB, nor were any krill swarms detected. Rather, the STB was dominated by gelatinous salps. We did encounter one blue whale off the coast of Westport that was in poor nutritional health.
iv. In 2025, we surveyed 1,129 km and recorded 34 blue whale sightings of 66 individuals, including 5 mother-calf pairs. Blue whale foraging behaviour and dense krill swarms were frequently observed across the STB, including 9 blue whales within 40 km of the TTR consent area (ranging 31-38 km).
v. This variation in sighting rates and distribution patterns within and between years illustrates the sensitivity of blue whales to habitat change that impacts their ability to find and capture sufficient prey. Climate change and current human activities already impact the health and ecology of this blue whale population; added pressure from seabed mining could compound these negative consequences for the population.

d. **Sediment plume impact on krill**

   i. Sediment can clog krill's filtration systems, reducing their growth, nutrition, and survival rates. Blue whales are obligate krill feeders, meaning they only eat krill, so a reduction in krill abundance, size, quality, and biomass will have significant consequences to blue whales.

   ii. Over 20 years, a continuous sediment plume could spread across the Bight, degrading the krill population that blue whales depend on.

   iii. This could lead to food scarcity and declining health in the blue whale population.

e. **Overall concern**

   i. The combined effects of chronic noise, increased vessel traffic, and sediment disruption pose long-term, cumulative risks to blue whales and their ecosystem.

Response to Evidence of Primary evidence Darran Humpheson

39 In my evidence dated 6 October 2023, **Appendix A**, I review the evidence of Mr Darran Humpheson with regard to noise effects to marine mammals. My response to his evidence is set out in paragraphs ([19]-[22], [26]-[33]), where I discuss the impact of noise on marine mammals. In light of the proposed 2025 Fast Track application, my comments in response to this evidence remain the same.

40 I have also reviewed the rebuttal evidence of Dr Humphenson (February 2024) which responded to my statement of evidence dated 6 October 2023. I provided oral rebuttal to this evidence in 2023 when presenting to the DMC; the full transcript of my oral evidence is set out at **Appendix D**. My position as set out in oral evidence remains unchanged but can be summarised as: (1) the sound propagation model is fundamentally flawed due to a lack of relevant empirical data on the source levels of noise produced; (2) and the need to assess the

impacts of the mining operation across a more realistic range where sound and sediment plume will extend.

Response to Comments of Alison MacDiarmid

41 I have reviewed the transcript for day three of the hearing in 2023. There Dr. MacDiarmid commented on my evidence in pages 244 – 247[3].I make the following comments in response:

a. It is important to note the crisscross black lines in the figures in Stephenson et al 2021, which indicate areas of low predicted environmental coverage and thus depict areas with lower confidence in the predicted probability occurrence. This crisscross hatching mainly occurs beyond the shelf regions of New Zealand, and thus areas within the STB should not be compared to areas with hatching.
b. Dr. MacDiarmid notes that whales can travel long distances in search of food. While this is true, it does not mean that this is a healthy strategy. Travelling and searching for many kilometres and days takes significant energy. Furthermore, time spent travelling is time spent not eating. Blue whales rely on the STB region for predictable prey availability; It remains the only confirmed blue whale foraging ground in New Zealand. If the STB provides poor foraging opportunities, either due to environmental conditions or disturbance from human activities, then the whales need to work a lot harder to find food, causing reduced health and lower reproductive capacity.
c. While the Stephenson et al. 2020 model indicates that the northern coastal area of the STB has lower blue whale predicted probability of occurrence than the central region, our observations of blue whales close to the proposed TTR site (see Section C above) empirically show that blue whales can and do occur in this region. Models are based on the data underlying the model, so if the Stephenson et al. 2020 model did not include these sightings, which I don't think they did, then the model would not predict this area as having high probability of occurrence.

---

[3]https://www.epa.govt.nz/assets/Uploads/Documents/Marine-Activities-EEZ/Activities/EEZ000011-TTRL-Reconsideration/Hearing/EPA-TTRL-Reconsideration-Hearing-15-03-24.pdf

d. Dr. MacDiarmid's assertion that "there are canyon systems up and down the east coast and the west coast of the North Island, and in particular that are important alternative areas for blue whales" is based on thin, unconfirmed evidence. While the Stephenson et al. 2020 model predicts these regions to have moderate probability of blue whale occurrence, these predictions are not entirely reliable as indicated by the crisscross lines over these areas (see (a) above). Furthermore, no empirical evidence exists of blue whales using these areas regularly as foraging grounds.

e. Regarding Dr. MacDiarmid's comments on the potential for suspended sediment to clog-up the krill and cause mortality, the Fuentes et al. 2016 paper is the only known study to examine this effect of suspended sediment in krill. So, while the krill species examined in Fuentes et al. 2016 is different from the krill species found in the STB, it is biologically similar, as noted by Dr. MacDiarmid, and thus a useful analog to what can be expected in the STB with increased sedimentation rates from the proposed mining. Currents in the STB can vary based on tides (which are very strong through the Cook Strait), upwelling strength, and winds strength and direction. Thus, it should be expected that the sediment plume caused by the proposed mining will vary in flow direction and extent. Dr. MacDiarmid's assertion that the sediment will flow away from the krill in the STB is overly simplified. Krill do occur near the mining site, as seen in Report 9[4] and other studies on zooplankton in the STB, and they feed regularly; hence the krill will likely consume the sediment in the water column caused by the mining operation, which can cause mortality and lower food availability for blue whales.

f. Dr. MacDiarmid repeatedly states that the effects of the mining will be small in scale and thus have no population level consequences. I do not agree that the impacts will be small. Twenty years of daily mining operations will undoubtedly impact the ecosystem as a whole, and extend beyond the 10km radius currently assessed. New Zealand blue whales are already living on the edge, where their margins of survival,

[4] https://www.fasttrack.govt.nz/projects/taranaki-vtm/substantive-application

health and reproductive capacity are thin and driven by variable ocean conditions and human impacts. Adding another stressor on top of current threats does not seem like a wise choice if maintaining a sustainable blue whale population is desired.

g. Two small points of clarity based on Dr. MacDiarmid's testimony: (1) During our blue whale survey in the STB in 2024 when we found no blue whales and heaps of salps, the upwelling was strong and "turned on", contrary to her claim. Despite these strong upwelling conditions, the state of the STB ecosystem was disturbed with other drivers at play. The point being that many oceanographic patterns regulate ecosystem health. (2) I have never received $50-100 million in research funding, nor anywhere close to that. My budget used to assess the impacts of disturbance on whales in the US was $2 million over 5 years. With such a budget, it is certainly possible to conduct population surveys and assess response to disturbance.

Response to Comments of Mr Eggers

42 I have reviewed the transcript for the presentation of TTR on 2 September 2025[5] to the decision making panel. In that transcript Mr Eggers made a number of comments around whales in Namibia scratching their backs on the bottom of mining ships, implying that there was some sort of harmonious relationship between the mining and the whales in the area.

43 I am unclear how this information is relevant to the permit decision. This story is anecdotal, in another ecosystem, with different whale species, and is plagued by anthropomorphism. I doubt whales will enjoy the presence of increased ship traffic or mining operations in their STB foraging ground.

UPDATES TO MY EVIDENCE SINCE 2023

THE SAPPHIRE REPORT

[5] Not released yet- we will add it in once it has been released.

44 In my evidence dated 6 October 2023, I summarise what our research has taught us about blue whales in the STB in paragraphs [10]-[13]. The work undertaken through the SAPPHIRE project confirmed our previous findings.

45 The SAPPHIRE project, led by Oregon State University in partnership with the New Zealand Department of Conservation (DOC), investigates how climate-driven ocean changes affect the health and resilience of marine species—focusing on krill (*Nyctiphanes australis*) and pygmy blue whales (*Balaenoptera musculus brevicauda*).

46 The 2025 field season took place from 27 January to 17 February aboard the R/V *Star Keys*, continuing the project's three-year research campaign across Aotearoa's South Taranaki Bight (STB). The 2025 survey effort for blue whales covered 1,129 km.

47 During the survey, we sighted 34 sightings of pygmy blue whales and 66 individual whales, including five mother-calf pairs (which is a positive sign for population growth). The other cetaceans sighted during the survey included common dolphins (175), hectors dolphins (4), sperm whales (7), pilot whales (10) and humpback whales (1).

48 The survey confirmed that the South Taranaki Bight is a key foraging and nursing area for the pygmy blue whale.

49 The hydrophones deployed in the STB recorded blue whale songs and feeding calls over nearly a full year. With the retrieval of two long-term hydrophones that recorded over 10.5 terabytes of data on blue whale vocalizations, acoustic analyses were conducted that confirm that there is year round presence of the New Zealand blue whale population in the STB.

50 The aim of the project is to assess how environmental variation influences krill abundance and quality, and how these changes affect blue whale body condition, hormone profiles, foraging behavior, and reproduction. The team uses an integrated approach—combining drone-based photogrammetry, biopsy sampling, hydroacoustics, and oceanographic data—to develop Species Health

Models (SHMs). These models are designed to predict predator-prey responses to climate change and support the development of dynamic marine protected area (MPA) strategies.

51 The 2025 field season was highly successful. Researchers recorded 34 blue whale sightings (approximately 66 individuals), including five mother-calf pairs. Foraging behaviour, particularly surface lunge feeding on dense krill aggregations, was observed at nearly half of the sightings. Drone surveys captured video footage of 53 individual whales, enabling measurements of body length, condition, and potential pregnancy. A total of 26 tissue biopsy samples and two faecal samples were collected for genetic, dietary, and hormone analyses. Notably, the 2025 ecosystem conditions—with cool upwelling supporting high krill and whale presence—stood in stark contrast to 2024, when no whales and very little krill were observed.

52 Krill were sampled at ten locations using dip and ring nets, with individuals measured for size, dry mass, and biochemical content. Respiration experiments were conducted at four temperatures (14–20°C) to examine physiological sensitivity to warming seas. A new CTD-video device ("LOLA") was deployed 58 times to gather detailed data on zooplankton composition and water column structure.

53 Strong engagement with tangata whenua has been a cornerstone of the SAPPHIRE project. Between 2024 and 2025, the team held consultations with Ngāruahine, Te Kāhui o Rauru, Ngāti Mutunga, Ngāti Tama, and Tupoho, sharing research protocols and ensuring cultural values were reflected in sample handling and data use. A marae hui at Te Rangatapu prior to the expedition fostered deeper collaboration, and future engagements—including the naming of individual whales based on tikanga Māori—are planned.

54 The 2025 field season revealed encouraging signs of blue whale population recovery, with a high number of whales observed, including five mother-calf pairs. This represents a positive indicator for population growth and contrasts sharply with 2024, when no whales were sighted. The dramatic difference between years highlights the strong environmental variability in the South

Taranaki Bight (STB). In 2024, the ecosystem was dominated by gelatinous salps, with little krill available to support foraging whales. In 2025, however, cold-water upwelling events generated a krill-rich environment, creating ideal foraging conditions. Blue whales were observed clustering near these upwelling plumes, particularly to the north of Farewell Spit, which underscores the tight connection between oceanographic processes, prey availability, and whale distribution**.**

55 These observations provide the essential foundation for developing Species Health Models (SHM) that integrate prey abundance, whale health metrics, and environmental conditions. By linking these factors, the project aims to predict how climate-driven changes will impact krill and blue whale populations. This approach will ultimately help identify ecological thresholds and guide adaptive management to prevent population declines before they occur.

56 This further work has demonstrated the sensitivity of these species to environmental changes and highlights the significance of considering how the impacts of the proposed seabed mining proposal will add to the cumulative effects on the health, distribution and population viability of New Zealand blue whales.

CONDITIONS OF CONSENT

58. I have reviewed conditions 10, 11 and 12. And make the following comments:

A. Section 10a states that “no adverse effects as a result of the activities authorised” on blue whales or other threatened marine mammal species, yet no clarity is provided about how these effects will be monitored and evaluated. Given that this permit would be for 20 years, clear guidance on metrics and regularity of evaluation of effects should be clearly identified. Otherwise, the uncertainty in guidance will create opportunities for inadequate assessment of impacts that could cause populations to decline before detection is possible.

B. Observation effort from vessels will not avoid adverse effects caused by noise and sediment plume disturbance to animals that travel beyond line of sight.

Monitoring of impacts on marine mammals should cover a larger region than just where vessel traffic is near the mining site.

C. There is no certainty provided or available that the crawler can be built to the noise conditions specifications.

CONCLUSION ON POTENTIAL EFFECTS TO MARINE MAMMALS FROM SEABED MINING IN THE STB

57 My conclusions on the effects of the proposed seabed mining activities are set out at paragraphs [41]-[44] of my statement of evidence dated 6 October 2023:

> [41] I have considered the qualitative, temporal, quantitative and spatial effects to marine mammals, in particular the distinct population of pygmy blue whales that reside year-round in the STB region and Critically Endangered Maui dolphin, and the proposed conditions of consent. I consider that the proposal may result in material harm to these vulnerable marine mammal populations and consider the uncertainty of impacts to be too great to proceed. I do not consider that the potential effects of TTR's proposed activities will be addressed by the proposed conditions of consent. I do not consider that the proposal favours caution or environmental protection.
>
> [42] I have considered the whole period of harm and overall consider that there is potential for material harm and significant adverse effects to marine mammal populations that use the STB region for the following reasons: acoustic disturbance due to elevated noise that may cause animals to leave important habitat or cause increased physiological stress levels, reduced foraging success due to elevated turbidity and pollution that may impact individual foraging efficiency and quality of prey, and elevated risk of ship strike due to increased vessel traffic in the region. All these pathways of impacts can have significant adverse impacts on population viability through impacts on vital rates (e.g., reproductive rates and survival).

[43] There is insufficient evidence at this time to determine whether there will be material harm to marine mammal populations in the STB region caused by the noise and sediment plume impacts of the TTR mining operation.

[44] Given the high uncertainty about TTR activities and impacts on the environment, and the known presence of vulnerable, iconic cetacean populations in the nearby region, it would be misguided to permit activities.

58 This remains my opinion and can be applied to the 2025 Fast Track Act proposal for 20 years of operation.

59 I however would like to add the further comments

a. Cumulative effects – The proposed mining will add to the many threats and sources of disturbance that blue whales are already forced to tolerate or respond to, causing increased likelihood of negative population level consequences.
b. Still no mapping – Despite almost 2 decades of efforts by TTR to obtain marine consents associated with seabed mining, adequate surveys and assessments of the marine ecosystem (e.g., marine mammals, ambient noise levels) have not been conducted. Moreover, minimal concrete details have been provided about the operations (e.g., noise levels, sediment suspension rates), which make assessment of impacts challenging.
c. Location of the whales in comparison to the mining site: we have produced empirical evidence that blue whales occur in close proximity to the proposed mining area, through both acoustic and visual detections. Thus, there will likely be some level of impacts from the mining operations on blue whales. While it remains unclear what those impacts will be, the risks to this vulnerable population should be considered carefully.

Dated 6 October 2025

APPENDIX A

BEFORE THE ENVIRONMENT PROTECTION AUTHORITY
AT WELLINGTON

I MUA I TE KŌTI TAIAO O AOTEAROA
TE WHANGANUI-A-TARA ROHE

UNDER	the Exclusive Economic Zone and Continental Shelf (Environmental Effects) Act 2012
IN THE MATTER	of a reconsideration of evidence by a decision-making committee appointed to consider a marine consent application by Trans Tasman Resources Limited to undertake iron ore extraction from the seabed in the South Taranaki Bight
BETWEEN	**TRANS TASMAN RESOURCES LIMITED** Applicant
AND	**KIWI'S AGAINST SEABED MINING INCORPORATED** Submitter
AND	**GREENPEACE NEW ZEALAND LIMITED** Submitter

STATEMENT OF EVIDENCE OF LEIGH G TORRES ON BEHALF OF KASM AND GREENPEACE NZ
Dated 06 October 2023

Counsel Acting:
[redacted]
Barrister
Globelaw
Christchurch
[redacted]

[redacted]
Barrister
Magdalene Chambers
Whanganui
[redacted]

Introduction

1 My name is Leigh G. Torres.

2 I have the following qualifications and experience relevant to this application:

I hold a PhD in Marine Ecology (Duke University, 2008), a Master's of Environmental Management (Duke University, 2001), and a Bachelor of Arts in Communication and Environmental Science (American University, 1997).

I am currently an Associate Professor in the Department of Fisheries, Wildlife and Conservation Sciences at Oregon State University (USA). I lead the Geospatial Ecology of Marine Megafauna Laboratory (GEMM Lab) within the Marine Mammal Institute. The GEMM Lab focuses on the ecology, behaviour and conservation of marine megafauna including cetaceans, pinnipeds, seabirds, and sharks. Our research is diverse and global, and we use advanced and innovative methods to describe the distribution, behaviour, health and ecological patterns of marine megafauna to provide effective management options that will reduce space-use conflicts with human activities in the marine environment.

I have conducted research on the ecology marine mammals since 1996. My expertise is in spatial ecology (understanding species distribution patterns and their environmental drivers) and foraging ecology (understanding feeding patterns and ecological correlates). I have applied my knowledge and skills to a variety of research projects on a diversity of species and habitats, including bottlenose dolphins in Florida, southern right whales and sperm whales in New Zealand, gray whales in the northeastern Pacific, bottlenose dolphins in New Zealand, and blue whales in New Zealand.

I have published over 100 peer-reviewed scientific journal articles on the ecology and conservation of marine megafauna, including 15 articles focused on marine mammals in New Zealand waters (Maui and Hector's dolphins, bottlenose dolphins, blue whales, Bryde's whales, sperm whales, southern right whales).

3 I have studied blue whales in the South Taranaki Bight (STB) region of Aotearoa New Zealand since 2013, working to document the population, understand their ecology and habitat use, and inform conservation management. We conducted boat-based surveys in the STB during summers of 2014, 2016, and 2017, and used hydrophones to record the underwater soundscape between 2016-2018. We have thoroughly analysed these data leading to 10 peer-reviewed scientific publications that describe the ecology of blue whales in the STB region and support my evidence presented here.

4 My other experience relevant to this statement of evidence is produced in my original evidence dated 23 January 2016 from paragraph [5].

5 I provided evidence as part of the 2017 hearings before a Decision-making Committee (**DMC**) of this application. I have previously provided the following statements of evidence and oral presentations:

a. A first statement of evidence dated 23rd of January 2016;
b. A rebuttal statement of evidence dated 15 February 2017;
c. A further statement of evidence (responding to further evidence filed by TTR expert Simon Childerhouse) dated 6 March 2017; and
d. A further statement of evidence filed in response to questions from the Decision Making Committee (DMC) dated 15 March 2017.

6 I did not participate in the marine mammals joint expert conferencing as I was not situated in Aotearoa/New Zealand at the time and was also undertaking research at sea. Therefore, I am not a signatory to these statements.

7 This statement of evidence was prepared in collaboration with Dr. Dawn Barlow at Oregon State University (OSU). Dr. Barlow conducted her PhD thesis research on blue whale ecology in the STB under my supervision and is currently a post-doctoral scholar at OSU under my supervision Dr. Barlow's expertise is in spatial ecology and distribution modelling, and passive acoustic monitoring of marine mammals.

Code of Conduct

8 I confirm that I have read the Code of Conduct for Expert Witnesses as contained in the Environment Court Practice Note dated 1 January 2023. I agree to comply with this Code. This evidence is within my area of expertise, except where I state that I

am relying upon the specified evidence of another person. I have not omitted to consider material facts known to me that might alter or detract from the opinions that I express.

Scope of Evidence

9 I have been asked to:

a. Review and update the evidence I provided to the 2017 DMC given any further information that has become available;
b. Review the updated evidence provided by Trans-Tasman Resources Limited, dated 19 May 2023; and
c. Review and update my evidence in light of the directions set out in the decision of the Supreme Court in *Trans-Tasman Resources Ltd v Taranaki-Whanganui Conservation Board and Others* [2021] NZSC 127.

Further Information Available since 2017

10 I have reviewed the evidence I provided to the 2017 DMC and concur with my previous statements. In fact, we now have much stronger and more complete knowledge of marine mammal, particularly blue whale, ecology and distribution patterns in the STB region to support my previous evidence. **In 2017, our research results were preliminary, but since this time we have solidified our analyses and findings and produced 10 more peer-reviewed publications on blue whale ecology in the STB region**, which conclude that:

- Blue whales in Aotearoa are a unique population, genetically distinct from all other known blue whale populations in the Southern Hemisphere, with an estimated population size of 718 (95% CI = 279 – 1926) (Barlow et al. 2018).
- Blue whales reside in the STB region year-round, using the area for foraging, nursing and breeding (Barlow et al. 2018, Torres et al. 2020, Barlow et al. 2023), with blue whale vocalizations detected nearly every day of the year (Barlow et al. 2022b), including near the proposed TTR mining site.
- Wind-driven upwelling over Kahurangi shoals moves a plume of cold, nutrient-rich waters into the STB, supporting aggregations of krill, and thereby providing critical feeding opportunities for blue whales in spring and summer (Barlow et al. 2020, Barlow et al. 2021).

- Blue whales in the STB have variable health condition as measured by drone-based photogrammetry (Burnett et al. 2019) and skin condition (Barlow et al. 2019).
- Surface feeding by blue whales in the STB is an important component to their foraging ecology used to optimize their energetic efficiency, which puts them at increased risk of ship strike due to more time spent in surface waters (Torres et al. 2020).
- Blue whales in the STB do not respond to noise from episodic earthquakes in the region, indicating that they have potentially evolved tolerance for natural noise sources but not novel noise from anthropogenic origins (Barlow et al. 2022a).
- We developed predictive models to forecast blue whale distribution up to three weeks in advance, providing managers with a real-time tool in the form of a desktop application to produce daily forecast maps for dynamic management (Barlow & Torres 2021).
- During marine heatwaves, blue whale feeding activity was substantially reduced in the STB. Consequently, their breeding activity was also reduced in the following season. This finding indicates that shifting environmental conditions, such as marine heatwaves and climate change, may have consequences to the population (Barlow et al. 2023).

11 **In addition to this increased knowledge on blue whale ecology in the STB region since the 2017 hearings, there has also been increased knowledge and appreciation for the negative and unknown impacts of seabed mining on marine ecosystems** (Miller et al. 2018, Christiansen et al. 2020, Hitchin et al. 2023, Thompson et al. 2023, Washburn et al. 2023). In particular, Washburn et al. (2023) investigated the biological impacts on megafauna (animals > 1 cm) around a crust mining site 1 month before and 13 months after excavation and observed that mobile epifauna were less abundant in the deposition area following disturbance and highly mobile swimmers showed reduced densities after the test in both deposition and adjacent areas following disturbance. The authors conclude that highly mobile taxa (such as fish or marine mammals) may avoid areas outside plume deposition, possibly owing to the creation of suboptimal feeding patches resulting from deposition (Washburn et al. 2023). This result highlights the inadequacies of limiting assessment of the impacts from TTR activities to the immediate vicinity of the proposed consent area.

12 Additionally, Thompson et al. (2023) recognize the scant information available on the impacts of deep sea minerals extraction on cetaceans and call for more research on this knowledge gap prior to authorization for extraction activities. These authors note that an increase in anthropogenic noise caused by seabed mining activities that operate 24 hours a day is of particular concern for cetaceans, and that cetaceans are already facing numerous stressors, including climate change, and seabed mining is a potential additive stressor to their vulnerable populations (Thompson et al. 2023). These conclusions are also relevant to TTR's permit application, as TTR has not conducted an adequate assessment of noise generation and impacts from their proposed activities. Low frequency noise, which baleen whales like blue whales are sensitive to, travels vast distances in the ocean, beyond the boundaries of the proposed TTR consent area, and thus is likely to impact acoustically sensitive animals in the STB region, both within and beyond the TTR consent area.

13 Highlights from my previous evidence that should be emphasized again here are the potential for the proposed activities by TTR to impact the distribution, behaviour, health and population growth of blue whales in the STB region due to disturbance from elevated ocean noise, increased risk of ship strike due to increased vessel activity across the region, and impacts on the quality, quantity and distribution of the krill prey blue whale rely on in the STB.

Comments on the revised evidence of TTR, namely evidence submitted by Dr. Simon Childerhouse on behalf of TTR.

14 Dr. Childerhouse correctly recognizes the increased scientific knowledge of marine mammals in the STB region since 2017. Yet, I believe it is important to recognize that TTR did not contribute to this increased knowledge base, as all research Dr. Childerhouse refers to was conducted by outside research groups, not affiliated with TTR. In essence, TTR has not made any effort over the past six years to gain information on marine mammal occurrence or potential impacts of their proposed activities on marine mammals.

15 Dr. Childerhouse states "there is a low likelihood of marine mammals being present in the proposed TTR consent area and there is nothing to suggest that the mining area is of any significance to any marine mammal species." I disagree with this

statement and find the evidence Dr. Childerhouse uses to support this statement flawed for three main reasons.

A. Inappropriate interpretation of model predictions

16 While the TTR consent area may not be documented core habitat for marine mammals based on well-informed species distribution models (SDMs) produced by (Barlow & Torres 2021) for blue whales and (Derville et al. 2016) for Maui dolphins, these models do predict a probability of presence > 0. These model results indicate that there is still a likelihood that blue whales and Maui dolphins will occur in the consent area. Figure A4-1 from Dr. Childerhouse's evidence (Figure 1 in this document), which is taken from Barlow and Torres (2021), does illustrate lower probability of blue whale presence in the TTR consent area relative to the very high probability of presence in the main area of the upwelling plume in the STB. Also, this figure shows mean probability of presence across the full study period (2012-2019) based on 100 bootstrap iterations, thus it is incorrect to say this figure shows that the TTR consent area is never suitable habitat for blue whales. Furthermore, Figure 2 (reproduced from Derville et al. 2016) indicates that the coastal region near Hawera has high habitat suitability for Maui dolphin (> 80 km^2 area). This figure also shows low uncertainty of the predictions for this area. Additionally, this figure illustrates that a sighting of a Maui or Hector's dolphin was recorded very close to the TTR consent area (likely the same data point Dr. Childerhouse highlights in Table A2-2 as being within 10 km from the consent area.)

17 While Dr. Childerhouse relies on the opportunistic data compiled in the DOC Marine Mammal Sighting and Stranding database to describe spatial distribution patterns of marine mammals in the STB region, he also recognizes their limitations by stating, "… these data sets still retain the same limitations as previously noted, including that they are primarily collected in a non-systematic manner, are not necessarily representative of marine mammal diversity within either the proposed consent area or the wider STB region, and species identifications are generally not confirmed by experts." Dr. Childerhouse correctly emphasizes this point further in point 31, "It is important to note these new records do not necessarily reflect the most abundant or commonly found species in the STB region but rather other factors such as how much their distribution may overlap with people, active research and/or monitoring programmes (e.g., DOC encourage the public to report all sightings of Hector's and

Māui dolphins within the region and have an active reporting programme), and the interest of the public."

18 These same cetacean sightings data from the DOC database, with the same limitations, were implemented in the models generated by (Stephenson et al. 2020) that Dr. Childerhouse relies on to claim a low likelihood of cetacean presence in the TTR consent area. While use of these DOC sightings data in species distribution models can be insightful at coarse spatial (>50 km) and temporal (annual) scales, they are not reliable for fine-scale interpretation as Dr. Childerhouse has done in his evidence. The models produced by (Stephenson et al. 2020) are across the whole NZ Exclusive Economic Zone (EEZ), and thus do not capture the dynamic nature of the environment in the STB. In fact, the exclusion of the TTR consent area from "high probability" blue whale habitat seems to be driven in large part by static contour lines (distance to shore contributed 48.8% in the Stephenson et al. (2020) blue whale model, followed by distance to the 500 m isobath and bathymetry) that are relevant at a larger scale across the New Zealand EEZ, but not in the STB as demonstrated by the fine-scale models produced by (Barlow et al. 2020, Barlow & Torres 2021). These fine-scale models indicate how dynamic oceanographic characteristics such as thermocline depth and productivity are critical drivers of blue whale distribution in the STB, and how the propagation of the upwelling plume into the STB can lead to blue whale feeding opportunities in relatively shallow, nearshore waters compared to the rest of the EEZ (Barlow et al. 2021). Additionally, fine-scale models generated by Derville et al. (2016) indicate that temperature and turbidity are key dynamic factors driving the distribution of Maui dolphin. **In summary, the models produced by Stephenson et al. (2020) based on the opportunistic DOC sightings data and fit for the entire EEZ are inappropriate to be applied at this fine scale to describe the potential for cetacean occurrence near the TTR consent area.**

B. False assumption that the impacts from the proposed TTR mining activities, particularly elevated noise and increased turbidity and pollution from the sediment plume, will not be confined to the consent area.

19 **Evidence exists demonstrating that vulnerable cetacean populations, like blue whales and Maui/Hector's dolphins, do occur near the TTR consent area,** including blue whales that have year-round presence in the area and rely on the region for multiple critical life history functions (i.e., both feeding and breeding).

20 It is likely that these impacts from the TTR mining activities will expand beyond the consent site (up to 25 km for noise based on the estimates supplied on behalf of TTR by Humpheson (2017). Dr. Childerhouse limits his assessment of marine mammal presence to within the TTR consent area or within a 10 km buffer of the consent area. There is no barrier around the TTR consent area, so all noise, pollution and sediment plume generated by TTR activities will extend beyond the consent boundaries. Therefore, it is incomplete to only assess marine mammal sightings or probability of occurrence patterns to within 10 km of the consent area. TTR application seeks consent to conduct mining activities up to 24 hours a day, every day of the year, for 35 years. The accumulation of noise, pollution and sediment from this massive seabed mining activity will almost certainly impact (1) the hearing sensitivity of blue whales that they rely on to find mates and food, (2) the turbidity of the water column that may impact whale foraging efficiency, and (3) sediment plume, deposition and pollution that may impact the health and productivity of the krill prey of blue whales and blue whales themselves. Therefore, **it is necessary to consider the presence of vulnerable cetacean populations that use the STB region, like blue whales and Maui/Hector's dolphins, across a larger spatial area than just 10 km from the proposed consent area.**

21 Evidence exists that both blue whales and Maui/Hector's dolphins occur near the proposed TTR consent area. In point 32, Dr. Childerhouse points out that within the last six years one Maui/Hector's dolphin and one blue whale were recorded between 5 and 10 km from the consent area, and two blue whales within 30 km of the consent area. Additionally, as reported in my previous evidence in 2017, "One blue whale sighting has been reported in close proximity to the proposed mining area (in purple circle in Fig. 2 [of 2017 evidence]). This sighting was of **three blue whales, in 79 m deep water, is 13.5 km from the boundary of TTR's mining area**, and was reported by a fishing vessel on 19-Sep-2013."

22 Further evidence that blue whales occur regularly within close proximity to the proposed TTR consent area comes from two years of acoustic recording data from **a hydrophone we deployed 18.8 km from the boundary of TTR's proposed mining site**, in 67 m of water (MARU 2; see Figure 3). As seen in Figure 3 taken from (Barlow et al. 2023), **blue whale vocalizations were detected on every day of the year and with high detection rates across seasons at the MARU 2 hydrophone (as well as the other four hydrophones across the STB).** While the exact location of these vocalizing whales relative to the hydrophone and the TTR

consent area is unknown, the mean estimated detection range of blue whale vocalizations at this hydrophone location (MARU 2) across our two-year recording period is 86.0 km for song, and 71.8 km for D calls (Barlow et al. 2023). These results indicate that the detection range of the MARU2 hydrophone overlaps with the TTR consent area where high occurrence rates of blue whale calls were recorded year-round (Barlow et al. 2022b). Therefore, it can be assumed that blue whales within this area will be impacted by the noise and sediment plume generated by the TTR mining activities.

23 Note that in paragraph 42 of Dr. Childerhouse's evidence, the detection ranges are misreported: Australian and Antarctic detection ranges are switched.

C. Impacts from the plume are uncertain

24 I have read the evidence of Mr Greer and Mr John Luick dated 06 October 2023.

At paragraph [15] of Mr Greer's statement, he states:

> "….insufficient caution has been included in the 'worst-case scenario' for the plume modelling",

And at his paragraph [19] he states:

> "I disagree that the plume model or the worst case model is fit for purpose for the reasons I have described above. I do not consider that the worst case model favours caution and environmental protection."

Mr John Luick at [15](d) states the following in regard to fine fractions in the plume:

> "….the finest fraction may remain in suspension for years, accumulating in the mid-Bight over long periods, potentially to a level where they pose a threat to marine mammals".

25 There is insufficient information to determine the degree of impact to (a) the turbidity of the water column that may impact whale foraging efficiency, and (b) sediment plume, deposition and pollution that may impact the health and productivity of the krill prey of blue whales and blue whales themselves.

D. *TTR's estimation of noise expected to be generated by the mining activities is highly speculative and flawed, leading to great uncertainty of impacts on acoustically sensitive cetaceans.*

26 Although Dr. Childerhouse revised his evidence regarding noise impacts of the proposed TTR activities on marine mammals in his current evidence relative to his prior evidence in 2017, including the addition of several revised sound propagation model estimates, the foundation of his conclusions is fundamentally flawed due to (1) a lack of relevant empirical data on the source levels of noise produced, and (2) inconsistencies within the evidence supplied by TTR regarding the modelled sound exposure levels from the mining operation.

27 Documented responses of blue whales to acoustic disturbance include changes in behavior state such as halting feeding or increasing swim speeds (Goldbogen et al. 2013), increased calling activity (Di Iorio & Clark 2010), changes in call loudness (Melcon et al. 2012), and cessation of calling (Melcon et al. 2012). These behavioral changes may bear physiological consequences that have subsequent impacts on population health (Pirotta et al. 2019). For the blue whale population that is present in the vicinity of the TTR consent area year-round and relies on the STB region for both feeding and breeding (Barlow et al. 2023), and for critically endangered Maui dolphins whose habitat range encompasses the TTR consent area, the potential population-level consequences due to acoustic disturbance should be carefully evaluated. In order to make an informed assessment of whether there will be material harm caused by the TTR mining operation due to noise impacts on acoustically sensitive cetacean species, critical components include current, rigorous noise measurements for the proposed mining operation and all related activities (e.g., the crawler, IMV, support vessels, and increased vessel traffic to and from the TTR consent area), robust sound propagation models to adequately estimate the acoustic impact of the mining operations, and data on behavioural responses of cetaceans to noise in the region. **Presently, the noise estimates (which, in turn, impact the propagation model outputs) and information on behavioural response are insufficient to make an informed assessment of risk to cetaceans.** I respond to the evidence supplied by Dr. Childerhouse below, provide supporting evidence, and refer to aspects of my previous testimony that remain relevant.

28 Dr. Childerhouse states in paragraph 82 of his evidence, “there are still no available estimates for the specific underwater noise generated by this proposal.” This data gap is highly problematic, as all subsequent sound propagation models and noise exposure estimates—while they have been revised—are based on the De Beers mining operation in Namibia, which took place in the 1990s. As sound propagation properties vary substantially with water column properties (e.g., temperature, salinity, stratification), water depth, bathymetry, benthic substrate, and ambient noise (Zimmer 2011), the environment of the De Beers mining operation is likely not comparable to the environment of the STB. Furthermore, the technology used in the De Beers operation is likely not comparable to the technology that would be used by TTR in the STB, decades later. Dr. Childerhouse relies heavily on the report prepared by Humpheson (2017) (Appendix 3 and 4 supplied to the DMC by Dr. Childerhouse on 2 May 2017), which modelled potential noise impacts of the proposed TTR mining operation. While the Humpheson (2017) report evaluates different propagation models and improves on previous estimates by incorporating additional considerations regarding the propagation of sound (e.g., bathymetry), the source levels used in the models that are meant to approximate the potential noise production by the TTR mining operation are out-dated and from a different region and entirely different operation. Therefore, the foundation of all subsequent noise propagation estimates is based on incomparable source level estimates.

29 In addition to the lack of empirical noise estimates for the proposed TTR mining operation, the evidence supplied by TTR demonstrates that the noise caused by the operation will exceed background noise levels in the already noisy STB environment and extend beyond the TTR consent area boundary (Humpheson 2017). The STB region is regularly exposed to noise from vessel traffic (notably fishing vessels), and seismic survey operations for oil and gas exploration, meaning that cetaceans in the STB are already exposed to high levels of anthropogenic noise (Warren et al. 2021). Humpheson (2017) reports that under very quiet conditions, the noise signature of the TTR mining operation would be audible up to 120 km from the source, and that even in the typical background noise conditions, the TTR operations would be audible 25 km from the source.

30 I note an important discrepancy in Dr. Childerhouse’ evidence where he refers to the Humpheson (2017) report. In Table 2 in Dr. Childerhouse’ evidence, which reports on Sound Exposure Levels (SEL) and Sound Pressure Levels (SPL) estimated for the TTR mining operation at different distances and exposure times, the right-most

column that indicate sound exposure levels over a 24-hour period contains values that are 9 dB re 1μPa^2.s below what is reported in evidence submitted by Humpheson (2017). Considering that dB measurements are on a log scale, this discrepancy is substantial. Furthermore, this discrepancy is particularly concerning, as the higher SEL over 24-hour exposure reported in the Humpheson (2017) report would indicate that low frequency cetaceans (e.g., blue whales) and high frequency cetaceans would be exposed to SEL in the category of temporary threshold shift (TTS) onset, and very high frequency (VHF) cetaceans (e.g., Maui/Hector's dolphins) would be exposed to noise levels higher than both TTS and permanent threshold shift (PTS) onset thresholds, according to Table 3 of Dr. Childerhouse' evidence (reproduced from Southall et al. 2019). Therefore, even if the DMC is to rely on the noise estimates supplied by TTR, it appears that there is evidence for potential impacts to all cetacean hearing groups based on broadband sound exposure over 24 hours (noting that TTR operations would be 24 hours/day, i.e., a continuous, 100% duty cycle).

31 Dr. Childerhouse refers to new research on acoustic impacts to marine mammals that has emerged since the last hearings, specifically Southall et al. (2021). In particular, he emphasizes that the best practices from the previous hearing, and the previously established thresholds for TTS and PTS that I refer to above, are subject to revision based on the hearing range of the species in question. Dr. Childerhouse provides revised calculations for VHF cetaceans using revised, m-weighted noise level estimates. However, this process was not followed for low frequency or high frequency cetaceans, nor was it conducted using the SEL values supplied for 24-hour exposure in the Humpheson (2017) report.

32 Below, I refer to sections of my previous testimony regarding potential noise impacts of the proposed TTR mining operation. These concerns and shortcomings remain true, four years later, with little to no effort to address these flaws through further data collection to obtain more accurate noise estimates from the mining operation, or to address the potential consequences of elevated noise to acoustically sensitive cetaceans.

- Paragraph 39 of my evidence submitted 23 January 2016: "*Hegley (2015) relies entirely on information derived from Reports 36 and 38, which are based on a study conducted prior to 1995 (actual dates not given) and presumably not with the equipment that will be used by TTR considering technology advancement over the past 20+ years. An on-site assessment* *of the noise levels to be produced by the equipment that will actually be used by TTR, such as the crawler (or SSED), FPSO, tug, and gas turbine generator, were not conducted and therefore the actual noise levels to be expected in the proposed mining site have not been evaluated or described adequately.*" While my previous evidence refers to Hegley (2015), the same data from the De Beers mining operation in Namibia underlie the Humpheson (2017) report referred to by Dr. Childerhouse. As it stands, the substantial concerns regarding actual noise levels produced by the TTR operation have not been adequately addressed in the recent evidence prepared by Dr. Childerhouse on behalf of TTR.

- Paragraph 41: "*The limited information of the sound source levels of the equipment and activities expected at the proposed mining site provided by Hegley (2015) is presumably from Report 38 (though not actually referenced in Hegley 2015). Table 1 in Report 38 provides noise levels from a variety of machinery tested prior to 1995, which produced sounds between 145 and 155 dB that are in the low frequency range that directly overlaps the hearing and communication range of blue whales (See Fig. 8 and Table 2). Report 38 does provide frequency spectrums of drills, crawler and chains, all of which also show that the highest noise levels (dB) will be in the low frequency range where blue whales hear and communicate. So, while TTR purport minimal noise contribution by their mining equipment based on an unreliable study, the IA does acknowledge that noise will be produced and elevated in the low frequency band used by blue whales.*" While Humpheson (2017) supports the use of the De Beers noise estimates and improves on the noise propagation modeling efforts, the fact remains that **the noise produced by the TTR operation will very likely overlap with the hearing and communication range of blue whales.**
- Paragraph 49: "*In addition to behavioral responses to ocean noise, there is rising evidence of physiological impacts of ocean noise on baleen whales. Evidence has shown that many mammal species, including humans, show physiological stress responses to chronically noisy environments, and these responses can impact health and susceptibility to illness (Evans et al. 1998, Stansfeld and Matheson 2003, Ising and Kruppa 2004). Through the analysis of fecal hormone levels, it has been demonstrated that northern right whales have a significant correlation in stress response with increased ambient ocean noise levels (Rolland et al.*

2012). Therefore, we must be vigilant regarding added noise in the ocean environment because each increase contributes to the behavioral and physical consequences to ocean animals, including blue whales." The body of evidence regarding the physiological impacts of elevated ocean noise on cetaceans has grown since my previous testimony (e.g., Lemos et al. 2022), emphasizing that this is a critical consideration in terms of potential consequences of the TTR mining operation.

33 Given the uncertainty associated with the lack of accurate noise estimates for this specific mining operation, the resulting insufficient estimation of the acoustic footprint of the TTR site, and the lack of data available on potential behavioural and physiological response of cetaceans to increased noise, I do not think there is sufficient evidence to conclude that there will be no material harm or no adverse effects caused by the proposed TTR mining operation.

Conservation considerations

Blue whales:

34 Dr. Childerhouse presents information on the most recent threat status for the marine mammal populations that regularly occur in the STB region (Table 1). The current threat classification for pygmy blue whales in NZ is indeed Data Deficient, but ironically, this change in status to "data deficient" is based on a wealth of new data. Furthermore, more recently published data (since 2019 NZTCS revision) shows that NZ blues likely breed in the STB (Barlow et al. 2023; as well as forage and raise calves), meaning that the area is used for multiple life history stages and can be recognized as a resident population in NZ, with a another change in status at the next NZTCS revision.

35 Dr. Childerhouse describes the Important Marine Mammal Area (IMMA) designated by the IUCN for the STB region, which was largely based on the significance of this area to blue whales. Dr. Childerhouse claims that the small size of the TTR consent area relative to the size of the STB IMMA indicates that insignificance of potential disturbance, yet it is critical to recognize that the TTR consent area falls 100% within the IMMA boundary. Therefore, permitting TTR activities in this consent area would

disregard the goals and ethos of the IUCN IMMA to protect important marine mammal habitats and global ocean biodiversity.

Maui dolphin:

36 The Maui dolphin population is a mere fraction of the size of its historic abundance, with its current abundance estimate between 21 and 67 individuals (Constantine et al. 2021). Thus, with dedicated conservation efforts currently underway in New Zealand, we should expect and encourage range expansion of this vulnerable population into areas where sightings may not currently be regular but models and data anticipate Maui dolphin to occur (Derville et al. 2016). The low likelihood of Maui dolphin occurrence near the TTR area, as indicated by Paragraph 54 by Childerhouse, is due to low abundance and prevalence, and not due to poor habitat suitability for Maui dolphin near the TTR consent area. Moreover, given the extremely low abundance of the Critically Endangered Maui dolphin, the disturbance to or loss of just one individual can have significant impacts on the population and its chances of recovery.

Monitoring as prescribed in Appendix 2 to the 2017 Marine Consent Decision on TTR's application under Marine Consent Conditions

37 In paragraphs 102 through 113, Dr. Childerhouse criticizes the Conditions laid out to monitor marine mammals in the vicinity of the TTR consent area. Overall, Dr. Childerhouse claims the Conditions are too challenging to achieve and therefore should not be required. I disagree because I believe these data can be collected and analysed to provide needed information to assess impacts on marine mammals. For instance, I currently lead a multidisciplinary study of gray whales in Oregon, USA that monitors their distribution, ecology and health through a combination of non-invasive methods that include hydrophones for acoustic monitoring of the soundscape, drone-based photogrammetry of whale body condition to assess their nutritional status, faecal hormone collection to determine stress levels and reproductive condition, and photo-identification and distribution analysis to assess spatial response to disturbance. Through this project, called Gray whale Response to Ambient Noise Informed by Technology and Ecology (GRANITE), we have demonstrated that the stress hormone levels of gray whales increases with increased ambient ocean noise levels. Please visit this website to read more about the project and learn about the feasibility of monitoring whale health and ecology.

38 Furthermore, in Paragraph 111 Dr. Childerhouse claims that two years of monitoring prior to commencement of seabed extraction would be sufficient. We have learned that the oceanography of the STB region is very dynamic and has incurred multiple heat waves within the past 7 years that influences the feeding behaviour and breeding of blue whales in the area (Barlow et al. 2020, Barlow et al. 2023). Therefore, if the monitoring occurs in these anomalous conditions, as is entirely possible under global climate change, it is possible these data will not be representative of blue whale use of the region and response to TTR activities. Blue whales are very long-lived animals, so two years is a mere snapshot in their lives, necessitating longer monitoring to actually understand their ecology and response to anthropogenic activities.

Uncertainty and inconsistencies in evidence:

39 There are a number of places in Dr. Childerhouse evidence that present contradictory statements, which I consider to illustrate shortcomings in interpretation of data and model outputs and demonstrate the uncertainty that exists in our understanding of the potential harm to marine mammals in the STB region.

a. Paragraph 75 (b) states that the TTR consent area is "highly unlikely to be an area of any special biological significance to blue whales. These model results are also consistent with data from acoustic monitoring which demonstrates that blue whales are in the STB region almost year-round."
   - Response: The acoustic evidence from (Barlow et al. 2022b, Barlow et al. 2023) shows that the area near the TTR consent area is frequently used by blue whales and important area for multiple life history process.

b. Paragraph 71 states "my previous statements that recognise the STB as an important area for marine mammals while noting that the proposed consent area represents only a tiny part of the whole region and that the specific location for the consent does not appear to be an area of any significance for any marine mammal species."
   - Response: The TTR consent area is fully within the STB and the IMMA, thus it is indeed an area of significance for marine mammals.

c. The previously noted discrepancy between SEL estimates from Childerhouse evidence and the Humpheson (2017) report is of significant concern because the values presented in the Childerhouse evidence are much lower and thus have very different implications for cetacean noise exposure and harm (see noise evidence above).

d. Paragraph 79 states, "There has been less new information about marine mammal population numbers in the region but I would argue that this is an extremely difficult task to address given the variety and sheer number of species, the large area over which they range and the logistical, financial and scientific challenges with estimating abundance of marine mammals."
   - Response: if the data do not exist, then it is not possible to reasonably claim that there will be no material harm caused by the proposed TTR operation.

e. Paragraph 106: states, it is "My reason for this is that monitoring and determining compliance with such a Condition would be extremely difficult as it would require robust, complex and very expensive monitoring to… I believe it would be almost impossible to collect the data required to make this assessment".
   - Response: Scientific data collection on marine mammals is always a challenge. However, this is a critically necessary challenge to overcome, as data are needed to robustly assess the potential impacts. I provide an example illustrating how these necessary data collection steps are feasible and practical, and could be conducted in the STB with the appropriate investment of time and resources.

f. Paragraph 114: states "While I acknowledge that there were some information gaps and uncertainties in the information provided, I believe that most of these gaps would be impossible to fill given their complexity and the significant difficulties in actually collecting the required data (e.g., robust abundance estimates and distribution maps for all marine mammals in the region). In addition, I believe that where there was uncertainty in the available data, it could be and was addressed through a comprehensive and precautionary set of consent conditions ensuring that if the consent did proceed, there would be no material harm on marine mammals."

- Response: Given Dr. Childerhouse recognition of knowledge gaps and uncertainties regarding marine mammal ecology near the TTR consent area and impacts on mining activities on these marine mammals, it is evident that the uncertainty is too great to say with any confidence that there will be no material harm from TTR's proposed activities. Furthermore, if there have been no assessments of impacts to the population and it is "too hard" to do so, then there is not enough evidence to show there will be no material harm.

Changes to your evidence

40 I have no changes to my previously submitted evidence. I support my previous statements and add more evidence here to further support those statements.

Conclusion

41 I have considered the qualitative, temporal, quantitative and spatial effects to marine mammals, in particular blue whales that reside year-round in the STB region and Critically Endangered Maui dolphin, and the proposed conditions of consent. I consider that the proposal may result in material harm to these vulnerable marine mammal populations and consider the uncertainty of impacts to be too great to proceed. I do not consider that the potential effects of TTR's proposed activities will be addressed by the proposed conditions of consent. I do not consider that the proposal favours caution or environmental protection.

42 I have considered the whole period of harm and overall consider that there is potential for material harm and significant adverse effects to marine mammal populations that use the STB region for the following reasons: acoustic disturbance due to elevated noise that may cause animals to leave important habitat or cause increased physiological stress levels, reduced foraging success due to elevated turbidity and pollution that may impact individual foraging efficiency and quality of prey, and elevated risk of ship strike due to increased vessel traffic in the region. All these pathways of impacts can have significant adverse impacts on population viability through impacts on vital rates (e.g., reproductive rates and survival).

43 There is insufficient evidence at this time to determine whether there will be material harm to marine mammal populations in the STB region caused by the noise and sediment plume impacts of the TTR mining operation.

44 **Given the high uncertainty about TTR activities and impacts on the environment, and the known presence of vulnerable, iconic cetacean populations in the nearby region, it would be misguided to permit activities. In particular, I believe there is potential for material harm from the proposed activities in the TTR consent area on blue whales and Maui dolphins.**

06 October 2023

References

Barlow, DR, Bernard, KS, Escobar-Flores, P, Palacios, DM, Torres, LG (2020) Links in the trophic chain: Modeling functional relationships between in situ oceanography, krill, and blue whale distribution under different oceanographic regimes. Mar Ecol Prog Ser 642 207-225

Barlow, DR, Estrada Jorge, M, Klinck, H, Torres, LG (2022a) Shaken, not stirred: blue whales show no acoustic response to earthquake events. Royal Society Open Science 9:220242

Barlow, DR, Klinck, H, Ponirakis, D, Branch, TA, Torres, LG (2023) Environmental conditions and marine heatwaves influence blue whale foraging and reproductive effort. Ecology and Evolution 13:e9770

Barlow, DR, Klinck, H, Ponirakis, D, Garvey, C, Torres, LG (2021) Temporal and spatial lags between wind, coastal upwelling, and blue whale occurrence. Sci Rep 11:6915

Barlow, DR, Klinck, H, Ponirakis, D, Holt Colberg, M, Torres, LG (2022b) Temporal occurrence of three blue whale populations in New Zealand waters from passive acoustic monitoring. J Mammal

Barlow, DR, Pepper, AL, Torres, LG (2019) Skin Deep: An Assessment of New Zealand Blue Whale Skin Condition. Front Mar Sci 6

Barlow, DR, Torres, LG (2021) Planning ahead: dynamic models forecast blue whale distribution with applications for spatial management. J Appl Ecol 58:2493-2504

Barlow, DR, Torres, LG, Hodge, KB, Steel, D, Baker, CS, Chandler, TE, Bott, N, Constantine, R, Double, MC, Gill, P, Glasgow, D, Hamner, RM, Lilley, C, Ogle, M, Olson, PA, Peters, C, Stockin, KA, Tessaglia-Hymes, CT, Klinck, H (2018) Documentation of a New Zealand blue whale population based on multiple lines of evidence. Endang Species Res 36:27-40

Burnett, JD, Lemos, L, Barlow, D, Wing, MG, Chandler, T, Torres, LG (2019) Estimating morphometric attributes of baleen whales with photogrammetry from small UASs: A case study with blue and gray whales. Mar Mamm Sci 35:108-139

Christiansen, B, Denda, A, Christiansen, S (2020) Potential effects of deep seabed mining on pelagic and benthopelagic biota. Mar Policy 114:103442

Constantine, R, Steel, DD-S, Carroll, E, Hamner, RM, Hansen, C, Hickman, G, Hillock, KA, Ogle, M, Tukua, P, Baker, CS (2021) Estimating the Abundance and Effective Population Size of Māui Dolphins (Cephalorhynchus Hectori Maui) in 2020-2021 Using Microsatellite Genotypes, with Retrospective Matching to 2001. Creative Services Team, Department of Conservation

Derville, S, Constantine, R, Baker, CS, Oremus, M, Torres, LG (2016) Environmental correlates of nearshore habitat distribution by the Critically Endangered Māui dolphin. Mar Ecol Prog Ser 551:261-275

Di lorio, L, Clark, CW (2010) Exposure to seismic survey alters blue whale acoustic communication. Biol Letters 6:51-54

Goldbogen, JA, Southall, BL, DeRuiter, SL, Calambokidis, J, Friedlaender, AS, Hazen, EL, Falcone, EA, Schorr, GS, Douglas, A, Moretti, DJ, Kyburg, C, McKenna, MF, Tyack, PL (2013) Blue whales respond to simulated mid-frequency military sonar. Proc R Soc Lond B 280:20130657

Hitchin, B, Smith, S, Kröger, K, Jones, DOB, Jaeckel, A, Mestre, NC, Ardron, J, Escobar, E, van der Grient, J, Amaro, T (2023) Thresholds in deep-seabed mining: A primer for their development. Mar Policy 149:105505

Humpheson, D (2017) Trans-Tasman Resources - Acoustic Modelling. AECOM New Zealand Limited, Christchurch, New Zealand. https://www.epa.govt.nz/assets/FileAPI/proposal/EEZ000011/Evidence/aa5ae488ce/Childerhouse-Response-to-DMC-Questions-Appendix-3-and-4.pdf

Lemos, LS, Haxel, JH, Olsen, A, Burnett, JD, Smith, A, Chandler, TE, Nieukirk, SL, Larson, SE, Hunt, KE, Torres, LG (2022) Effects of vessel traffic and ocean noise on gray whale stress hormones. Sci Rep 12:18580

Melcon, ML, Cummins, AJ, Kerosky, SM, Roche, LK, Wiggins, SM, Hildebrand, JA (2012) Blue Whales Respond to Anthropogenic Noise. PLoS ONE 7:e32681, 32681-32686

Miller, KA, Thompson, KF, Johnston, P, Santillo, D (2018) An Overview of Seabed Mining Including the Current State of Development, Environmental Impacts, and Knowledge Gaps. Front Mar Sci 4

Pirotta, E, Mangel, M, Costa, DP, Goldbogen, J, Harwood, J, Hin, V, Irvine, LM, Mate, BR, McHuron, EA, Palacios, DM, Schwarz, LK, New, L (2019) Anthropogenic disturbance in a changing environment: modelling lifetime reproductive success to predict the consequences of multiple stressors on a migratory population. Oikos 128:1340-1357

Southall, BL, Finneran, JJ, Reichmuth, C, Nachtigall, PE, Ketten, DR, Bowles, AE, Ellison, WT, Nowacek, DP, Tyack, PL (2019) Marine mammal noise exposure criteria: Updated scientific recommendations for residual hearing effects. Aquat Mamm 45:125-232

Southall, BL, Nowacek, DP, Bowles, AE, Senigaglia, V, Bejder, L, Tyack, PL (2021) Marine mammal noise exposure criteria: assessing the severity of marine mammal behavioral responses to human noise. Aquat Mamm 47:421-464

Stephenson, F, Goetz, K, Sharp, BR, Mouton, TL, Beets, FL, Roberts, J, MacDiarmid, AB, Constantine, R, Lundquist, CJ (2020) Modelling the spatial distribution of cetaceans in New Zealand waters. Divers Distrib 4:495-516

Thompson, KF, Miller, KA, Wacker, J, Derville, S, Laing, C, Santillo, D, Johnston, P (2023) Urgent assessment needed to evaluate potential impacts on cetaceans from deep seabed mining. Front Mar Sci 10

Torres, LG, Barlow, DR, Chandler, TE, Burnett, JD (2020) Insight into the kinematics of blue whale surface foraging through drone observations and prey data. PeerJ 8:e8906

Warren, VE, McPherson, C, Giorli, G, Goetz, KT, Radford, CA (2021) Marine soundscape variation reveals insights into baleen whales and their environment: a case study in central New Zealand. Royal Society Open Science 8:201503

Washburn, TW, Simon-Lledó, E, Soong, GY, Suzuki, A (2023) Seamount mining test provides evidence of ecological impacts beyond deposition. Curr Biol

Zimmer, WM (2011) Passive acoustic monitoring of cetaceans. Cambridge University Press

Figures

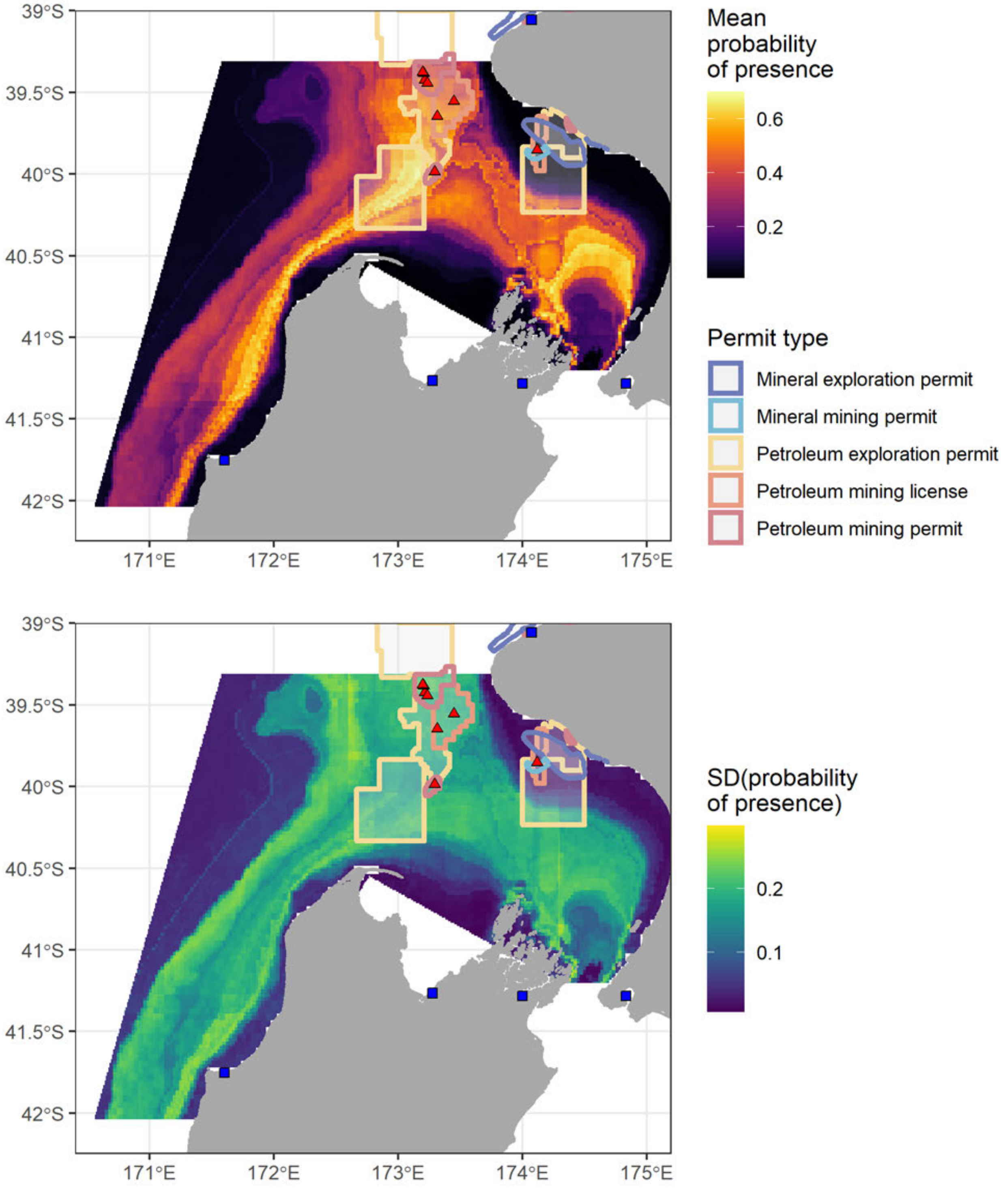


Figure 1. Top panel: mean probability of blue whale presence predicted by the BRTwhale model, calculated across 100 bootstrap runs. Lower panel: spatial variation in predicted probability of presence across bootstrap runs (standard deviation: SD). Anthropogenic pressures are overlaid, including petroleum and mineral permit areas (as of May 2021), ports (blue squares) and active oil rigs (red triangles). Figure and caption reproduced from Barlow & Torres (2021).

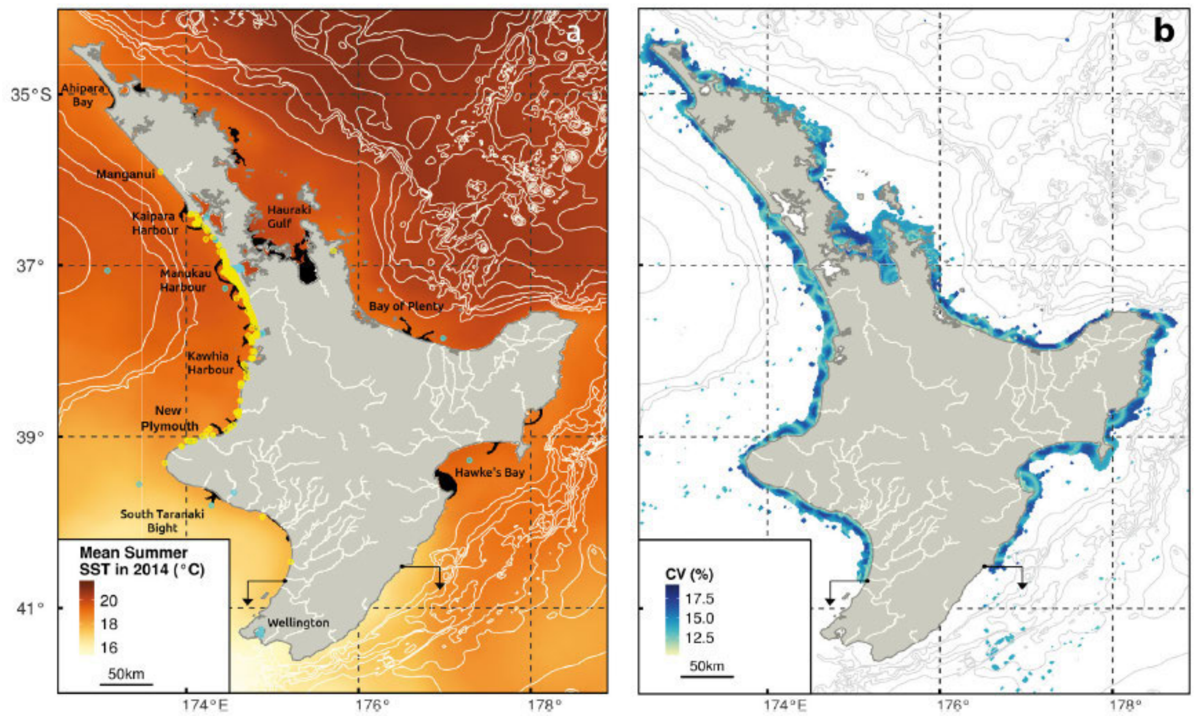


Figure 2. Predictions of habitat suitability for Maui dolphins and historical sightings of Maui and Hector's dolphins in North Island, New Zealand. (a) Mean predicted patches of high habitat suitability. Black zones show areas of high habitat suitability with surface area greater than 80 km^2 . Historical sightings of Maui and Hector's dolphins included within (yellow) and outside (blue) our prediction range are shown. Background shows SST average values for December 2013 to April 2014. Although obscured by many sightings, the area between Kaipara Harbour and Kawhia Harbour is covered by several patches of high habitat suitability. (b) CV of the predicted habitat suitability. The coefficient is calculated over 1000 BRT model runs using a bootstrap resampling approach. It ranges from 10 to 19% and provides a spatial measure of uncertainty for our predictions. Areas in white were excluded from our predictions because they are outside the data calibration range (i.e. offshore waters in general, harbours and nearshore waters of the Wellington region). Light grey lines represent isobaths from depth 100 to 10 000 m, with a 400 m increment. Black arrows indicate the latitudinal limit under which no predictions were made. Figure and caption reproduced from Derville et al. (2016).

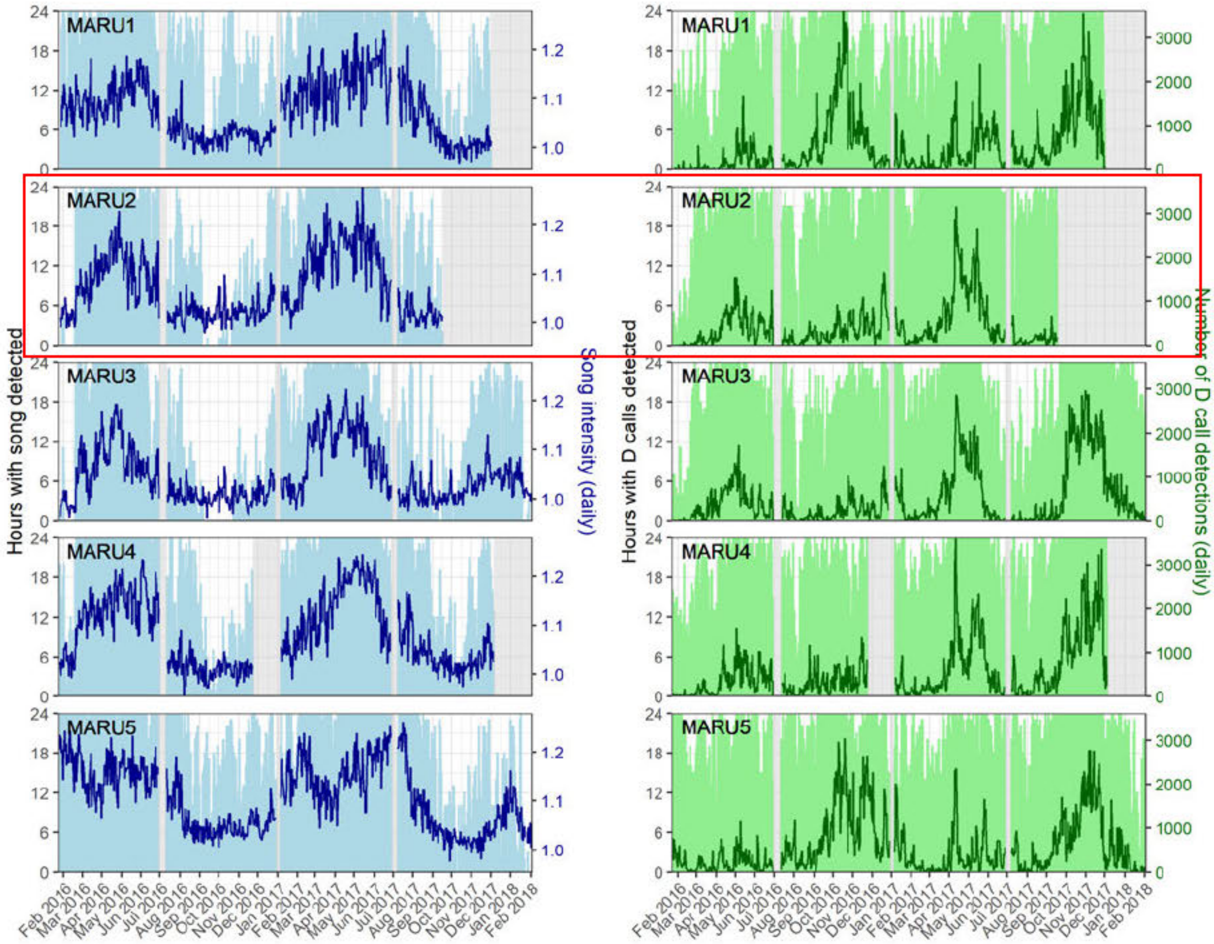


Figure 3. Occurrence patterns of song and D calls. Left panels: number of hours per day with song detected (light blue bars) and daily song intensity index (dark blue lines) for each hydrophone (MARU 1–5) over the entire recording period. Right panels: number of hours per day with D calls detected (light green bars) and number of D call detections per day (dark green lines) for each hydrophone over the entire recording period. The hydrophone is listed at the top of each panel, corresponding to map locations in Figure 1. Periods with light gray shading indicate gaps in recording due to hydrophone refurbishment. Figure and caption reproduced from Barlow et al. 2023. Note: the MARU2 location (inside red box) is 18.8 km from the TTR consent area boundary.

APPENDIX B

BEFORE THE ENVIRONMENTAL PROTECTION AUTHORITY

IN THE MATTER	of the Exclusive Economic Zone and Continental Shelf (Environmental Effects) Act 2012
AND	
IN THE MATTER	of a Reconsideration of Applications by Trans-Tasman Resources Limited (TTRL)

JOINT STATEMENT OF EXPERTS IN THE FIELD OF EFFECTS ON MARINE MAMMALS

Dated 19 February 2024

INTRODUCTION

1. Expert caucusing on the topic of effects on marine mammals took place via videoconference on 19 February 2024.
2. The conference was attended by the following experts:
   a) Simon Childerhouse (TTRL)
   b) Alison MacDiarmid (TTRL)
   c) Darran Humpheson (TTRL), noting that DH is an expert in underwater acoustics rather than marine mammals
   d) Elisabeth Slooten (KASM and Greenpeace)
   e) Leigh Torres (KASM and Greenpeace)
   f) Greg Barbara (Fishers)
3. Chris Simmons (ChanceryGreen) acted as facilitator.
4. Jessie Richardson (EPA) acted as scribe.

CODE OF CONDUCT

5. The experts confirm that we have read the Environment Court Code of Conduct 2023 and agree to comply with it. We confirm that the issues addressed in this Joint Statement are within our area of expertise, unless stated otherwise.

SCOPE OF STATEMENT

6. In accordance with DMC Minute and Directions 10:
   a) The Joint Statement on effects on marine mammals dated 3 March 2017 ("2017 Joint Statement") has formed the starting point for the caucusing session.
   b) We have endeavored to:
      (i) comment on whether there is any new or updating evidence that changes the previous positions; and
      (ii) if so, identify what the evidence is and how it changes the positions.
7. We record that LT and DH were not signatories to the 2017 Joint Statement.
8. A broad summary of the process adopted is set out in **Appendix A**.
9. In this Joint Statement we report the outcome of our discussions in relation to each issue (below) by reference to points of agreement and disagreement relating to facts, assumptions, uncertainties, and expert opinions. We have noted where each of us is relying on the opinion or advice of other experts. Where we are not agreed in relation to any issue, we have set out the nature and basis of that disagreement.
10. DH spoke to additional information around noise modelling. There was some discussion amongst the group on this issue. The matter was parked so that LT,

GB and ES has sufficient time to review the new information, including seeking acoustic expert review if appropriate.

11. LT spoke to new findings and results on blue whale observations and population estimates including based on acoustic survey.
12. LT raised a recent paper by Fuentes et al regarding effects of sedimentation and turbidity on krill.

ISSUES FROM 2017 JOINT STATEMENT; AND CURRENT POSITIONS

SC1[1]

Question #	Question	Response from Childerhouse or MacDiarmid	Areas of agreement and disagreement
SC1	The focus for assessing potential impacts to marine mammals has been on cetaceans. However, of all marine mammals documented within the STB and PPA, New Zealand fur seals are the most frequently sighted species. Seals are an indicator species of the health of a fishery, and are also known to be opportunistic exploiters of human activities. Do you think it would be prudent to obtain baseline information about the numbers and health of seals in and around TTR's proposed operations to enable monitoring of any potential changes in their health?	• Childerhouse notes that it would be useful to have some additional information on seals, given that they are apparently occur in small numbers in the PPA, that the nearest haul out or breeding sites are >75km away, and that the nature of the mining operation means that there are unlikely to be any direct impacts on seals, this should be a low priority.	• **All the experts agreed** that fur seals are found in the PPA and that additional pre- and post-mining monitoring would be useful to investigate potential impacts.

13. All participants agree with the position recorded in the "areas of agreement and disagreement" column in the 2017 Joint Statement, except DH because it is outside his area of expertise.

SC2

SC2	Why were no further marine mammal surveys undertaken?	• Childerhouse noted that he had not been asked by TTR to undertake any additional surveys and directed the question to TTR	• **All the experts agreed** that additional marine mammal surveys would have provided valuable information for the DMC on marine mammals in the area affected by noise and ecological impacts from the proposed mining operation.

14. All participants agree with the position recorded in the "areas of agreement and disagreement" column in the 2017 Joint Statement, except DH because it is outside his area of expertise.

[1] The issue headings are as per the 2017 Joint Statement.

SC3

Question #	Question	Response from Childerhouse or MacDiarmid	Areas of agreement and disagreement
SC3	Do you accept that the information provided by TTR includes a population survey which is inadequate for the purpose, and some habitat modelling based on anecdotal information (Slooten para 13)? Do you accept that problems include the small size of the area covered and a lack of data on sighting probability? (Slooten para 13)	• Childerhouse noted that the aerial survey by Cawthorn for TTR was not designed to estimate abundance but rather to determine the presence/absence of marine mammals in the PPA and their spatial extent. Therefore, he believes that the Cawthorn survey met its stated purpose and was adequate for the purpose of identifying cetacean occurrence in the area. • He agreed that the habitat modelling was based on the incidental sightings data from the public and ships officers, and sightings by MPI fisheries observers • He noted that the aerial survey covered the entire PPA and also the waters inshore of the PPA. Obviously, the larger area that the survey covers, the more useful it is likely to be • Childerhouse agrees that there are no data on sighting probability however this survey was not designed to estimate abundance and therefore sighting probability was not required to meet the stated objective. However, it would have been a useful addition to aid in interpretation of the results.	• **All the experts agreed** that the modelling was based on incidental sightings data limited to DOC, Cawthorn and MPI datasets • **There was disagreement** about the suitability of the existing survey and modelling in describing marine mammal fauna occurrence in the PPA and the wider area that would be affected by the proposed mining operation (e.g. through noise and ecological impacts). While MacDiarmid and Childerhouse thought they were sufficient, Slooten and van Helden said that there were severe deficiencies in their design that negated the value of their findings. Barbara agreed. It was noted that Torres also pointed out these deficiencies in her evidence. For example, sighting probability should have been estimated, regardless of whether the purpose of the survey was to estimate the number of individual marine mammals in the area (abundance) or the number of species (presence/absence). Slooten, van Helden and Barbara consider that because only two very common species (common dolphin and fur seal) where sighted, this indicates that the survey had a very low probability of seeing even relatively common marine mammal species. Childerhouse and MacDiarmid consider that despite the apparent limitations of the survey the fact that two smaller members of the marine mammal community were sighted suggests it is unlikely that larger fauna such as blue whales would have been missed along the survey lines, if present. • Slooten, van Helden and Barbara consider that independent data, from other research projects (e.g.research by Torres), marine mammal observers on seismic surveys, the strandings record and other data show that a much larger number of marine mammal species use the area, as indicated in the evidence of all the marine mammal experts contributing to this process. They consider the Cawthorn survey was not adequate for concluding that species that were not seen were therefore absent from or present in low numbers in the survey area. • Childerhouse and MacDiarmid both accept the evidence of Torres about blue whale occurrence in the STB but have reservations about using strandings data to inform cetacean use of the PPA or adjacent waters as dead or dying individuals on the seashore may originate from over a very wide area.

15. All participants agree with the position recorded in the first bullet point in the “areas of agreement and disagreement” column in the 2017 Joint Statement, except DH because it is outside his area of expertise. Participants note that the reference to the Cawthorn dataset does not include the Cawthorn South Taranaki Bight STB survey data.
16. All participants are of the same view of the areas of disagreement recorded in the subsequent bullet points in the “areas of agreement and disagreement” column in the 2017 Joint Statement.
17. The participants noted that there are some new spatial modelling data available

since 2017. The participants differ in their views as to the usefulness of this data.

18. LT, ES and GB consider that the findings from Stephenson et al should not be relied on for fine scale species occurrence in the proposed mining area.
19. There was agreement that while spatial models can be useful, they must be considered in the context of their potential limitations including data inputs, model structure and assumptions. There was disagreement about the exact utility of the new spatial modelling data, including the appropriateness of model interpretation at fine versus large spatial scales.

SC4

SC4	In para 3 you say "If noise levels of the dredge are comparable to those of shipping as the literature suggests "	• This question appears to be incomplete • As stated in Childerhouse's primary evidence, he believes that the likely noise levels from the operation are comparable to shipping noise.	• **All the experts agreed** that the noise levels and frequencies from the proposed mining operation are currently unknown and that relevant data need to be gathered from other marine mining operations (e.g. recordings of de Beers mining operation, using modern, broadband equipment). • **All the experts agreed** that a. Information on background intensities and frequencies of underwater noise at the mining area should be obtained by TTR over a period of a least 1 year before mining starts. It was noted that NIWA is collecting broadband underwater noise information from the STB and analysis of these data would help to define existing background noise levels and therefore cumulative noise impacts. b. The lack of information on the noise signatures (frequency and intensity) of individual operational components and the resultant operational noise profiles at various stages of operations has not been adequately described at this time. • **There was disagreement** about whether the sound produced from the TTR operation would or would not be comparable to shipping noise.

20. All participants agree with the position recorded in the "areas of agreement and disagreement" column in the 2017 Joint Statement.

SC5

SC5	In para 10 you say that you have not undertaken any field studies in relation to this proposal. Why not?	• Childerhouse was not asked to undertake any field studies by TTR. The baseline survey was undertaken by Martin Cawthorn Associates and Childerhouse was only asked to review it by TTR and directed the question to TTR.	• **All the experts agreed** that additional marine mammal surveys would have provided valuable information for the DMC on marine mammals in the area affected by noise and ecological impacts from the proposed mining operation.

21. All participants agree with the position recorded in the "areas of agreement and disagreement" column in the 2017 Joint Statement, except DH because it is outside his area of expertise.

SC6

Question #	Question	Response from Childerhouse or MacDiarmid	Areas of agreement and disagreement
SC6	Do you accept that noise produced by the mining operations may directly disrupt blue whale foraging, cause blue whales to move out of important feeding areas, interfere with blue whale communication causing loss of feeding or mating opportunities, cause changes in vocal behaviour patterns with subsequent energetic consequences, and induce increased physiological stress that compromises blue whale health? (Torres para 9)	• Childerhouse does not agree with this very broad statement. • In his primary evidence, he undertakes an assessment of potential noise impacts (e.g. Table 2) and conclude that behavioural, rather than physiological effects (e.g. Temporary or Permanent Threshold Shift in hearing) are likely to be of more concern for blue whales. Overall, while the risk of behavioural disturbance is low to moderate, this effect will only be evident in the area immediately around (e.g. ~2km) the operation • Childerhouse also noted that if TTR Condition 12 was accepted, then there is unlikely to be any impacts on blues whales outside the immediate operational area.	• **There was disagreement** on this issue as there was a range of views on the likely impacts from noise. • **The experts agreed** that one of the potential impacts of the proposed mining operation is displacement of blue whales and other species from areas that may be important for feeding, breeding or other critical activities. • Van Helden and Slooten summarised data from research on the behavioural and other impacts of noise on whales and dolphins. It is noted that Torres also included relevant research in her evidence.

22. All participants agree with the position recorded in the "areas of agreement and disagreement" column in the 2017 Joint Statement, except DH because it is outside his area of expertise, including that physiological responses may also occur in addition to behavioral responses to disturbance.

SC7

Question #	Question	Response from Childerhouse or MacDiarmid	Areas of agreement and disagreement
SC7	Do you accept that the expected sediment plume from the mining operations may impact the distribution and availability of *N. Australis* (krill), thus reducing the foraging ability and efficiency of blue whales (Torres para 9)?	• Childerhouse noted that he was not an expert on krill and sediment plumes and referred to the information provided in MacDiarmid et al. (2015b) which reported that there should be negligible effects of mining 50 Mt per annum according to standard evaluation criteria. This is principally because the scale of the mined area and the areas of elevated suspended sediment concentrations are small compared to the area used by the populations of these species. Consequently, they are likely to be displaced from, or experience a decrease in prey abundance or availability over a very small part of their distribution. Furthermore, marine mammals are highly mobile and have ample opportunity to avoid the discharge plume. • This issue is also covered by MacDiarmid in her response to questions AM28 and AM29 below	• **All the experts agreed** that it isn't known if the area impacted by the sediment plume is a preferential area for marine mammal foraging and therefore it would be useful to investigate this. • **There wasn't agreement** on the likely impact on krill and therefore blue whale foraging from the expected sediment plume. MacDiarmid and Barbara did not think there would be significant impacts on krill abundance due to the plume.

23. All participants agree with the position recorded in the "areas of agreement and disagreement" column in the 2017 Joint Statement, except DH because it is outside his area of expertise, but we encourage a review of Fuentes et al 2016,[2] which relates to impacts of sedimentation and turbidity on krill survival.

SC8

Question #	Question	Response from Childerhouse or MacDiarmid	Areas of agreement and disagreement
SC8	Do you accept that the STB is an important habitat and foraging area for blue whales?	• Yes. Childerhouse agreed that some parts of the STB are an important habitat and foraging area for blue whales.	• **All the experts agreed** with this statement.

24. All participants agree with the position recorded in the "areas of agreement and disagreement" column in the 2017 Joint Statement, except DH because it is outside

[2] *Sci Rep* **6**, 27234 (2016). https://doi.org/10.1038/srep27234

his area of expertise.

SC9

SC9	Do you accept that Blue whales have extreme energy demands, and each disturbance to their feeding opportunities and success rate can impact their viability and reproductive capacity. Added noise, habitat impacts, prey disturbance and vessel density in the STB by the mining operation would add physiological and behavioural consequences and burdens to blue whales already living within an impacted and compromised ecosystem? (Torres para 9)	• Childerhouse doesn't agree that blue whales have extreme energy demands but rather that they have energy demands consistent with normal biological process such as growth and reproduction. They do require large amounts of krill to eat but are highly adapted to efficiently find, catch, and consume large amounts of krill to meet these needs. • He agrees that any disturbance to foraging efficiency could result in negative impacts for blue whales and that any increase in cumulative impacts needs to carefully considered. However, for the reasons provided above for question SC7 the impact of the proposed mining operations on foraging opportunities and thus on energy supplies and reproductive capacity is likely to be negligible. • Childerhouse noted that the STB ecosystem is certainly already impacted by a number of human activities. The degree to which it is compromised is unclear.	• **All the experts agreed** that any new activity has the potential to have an effect on a species or population. However, an impact has to be significant before it will have negative effect on that species or population. Several individual impacts which are insignificant on their own, may add up to a significant cumulative impact. • **All the experts agreed** that Antarctic blue whales are endangered and pygmy blue whales are classed as data deficient by the IUCN and therefore require careful consideration of effects. If the mining operation impacts a relatively small part of their habitat/foraging area, then any effect may be acceptable. However, if the mining operation impacts a large proportion or important area of their habitat/foraging range, then it is likely to lead to significant impacts.

25. All participants agree with the position recorded in the "areas of agreement and disagreement" column in the 2017 Joint Statement, except DH because it is outside his area of expertise, noting that the IUCN classifications may have been updated since the 2017 Joint Statement.

SC10

Question #	Question	Response from Childerhouse or MacDiarmid	Areas of agreement and disagreement
SC10	Do you accept that with every increase in anthropogenic activity in the STB region, the risk of vessel strike of a blue whale increases? (Torres para. 33)	• Yes Childerhouse agrees in that adding even one additional vessel will increase the risk of vessel strike. However, the additional amount of expected vessel traffic from the TTR operation is negligible compared with existing traffic levels transiting the region.	• **All the experts agreed** that as vessel speed increases, the risk of vessel strike to marine mammals increases and therefore vessel speed should be reduced wherever possible. For example, modelling has demonstrated that if vessel speed is reduced to 10 knots, this will significantly reduce both the risk and mortality rate of vessel strike. • **All the experts agreed** that consideration should be given to including vessel strike issues in the EMMP.

26. All participants agree with the position recorded in the "areas of agreement and disagreement" column in the 2017 Joint Statement, except DH because it is outside his area of expertise. GB suggests that the 10 knots speed limit has been updated to 6 knots within 300 meters of marine mammals.

SC11

SC11	Do you accept that the conservation status and cumulative impacts for Māui dolphin are of serious concern? (Slooten para. 18.1) Do you accept that there is still considerable overlap between Māui dolphins and fisheries in the area, which is likely to be exacerbated by the mining and the sediment plume resulting from the mining. (Slooten 18.1)	• Yes – Childerhouse agrees that cumulative impacts are of significant concern for Māui dolphins. • He also agrees that there is significant overlap between fisheries and Māui dolphins across most of their range but believe that the inshore waters of the STB are at the limit of the southern range of Māui dolphin and that Māui dolphins are present in extremely low numbers (e.g. Currey et al. (2012) reported that Māui dolphin density was less than 0.0005 Māui dolphin per square nautical mile inshore of the proposed mining area).	• **All the experts agreed** that the STB is an important area linking Māui and Hectors dolphin habitat. • **All the experts agreed** that any additional impact on Māui dolphins will be unsustainable and therefore should be avoided. • **There was no agreement** on the density and likely abundance of Māui dolphins in the STB. • There is a very high level of uncertainty about Māui dolphin distribution, due to the very low population size of Māui dolphins and therefore it would be extremely difficult to robustly describe their distribution.

27. All participants agree with the position recorded in the “areas of agreement and disagreement” column in the 2017 Joint Statement, except DH because it is outside his area of expertise.

SC12

SC12	Do you accept that a detailed assessment of the conservation implications of the proposed mining, including cumulative impacts, will be essential in order to provide the DMC with enough information to make a science-based appraisal of the potential impacts of the proposed mining on marine mammals, in particular for Māui dolphins which are already at an extremely high risk of extinction (Slooten 18.1)	• Yes – Childerhouse agreed that it is important to carefully consider cumulative impacts of any activity, especially for species at high risk of extinction. • He believed that there is sufficient information available presently to make a science based assessment of the scale of the impact of the proposed operations on marine mammals, including Māui dolphins.	• **All the experts agreed** that it is important to carefully consider cumulative impacts of any activity, especially for species at high risk of extinction. • **There was no agreement** about whether there is sufficient information available presently to make a science based assessment of the scale of the impact of the proposed operations on marine mammals, including Māui dolphins.

28. All participants agree with the position recorded in the “areas of agreement and disagreement” column in the 2017 Joint Statement, except DH because it is outside his area of expertise.

SC13

SC13	Do you accept that TTR have failed to provide either measurements of the noise made by the proposed mining operation (ships, generator and dredge to be used) or measurements of the background “ambient” noise off Taranaki? (Slooten para. 15)	• Yes – Childerhouse agrees that there are no actual measurements of the noise likely to be produced from the mining operation nor of ambient noise for the proposed PPA.	• **All the experts agreed** that there are no actual measurements of the noise likely to be produced from the mining operation nor of baseline ambient noise for the proposed PPA.

29. All participants agree with the position recorded in the “areas of agreement and disagreement” column in the 2017 Joint Statement, with the following wording change “…no actual measurements of the noise available from the proposed mining operation…”.

SC14

SC14	Why did TTR perform no actual assessment of the ambient noise levels at the mining site? (Torres para 37) rather only of Lyttelton Port for only 15 minutes? Do you accept that the Lyttelton recorded sound is surprisingly high (Slooten para. 15.8)?	• Childerhouse noted that he had not been asked by TTR to undertake ambient noise measurements but that he understood that Hegley had attempted it at the PPA and directed the question to TTR.	• **All the experts agreed** that there is no relevance of acoustic data collected from Lyttelton Harbour to the PPA.

30. All participants agree with the position recorded in the “areas of agreement and disagreement” column in the 2017 Joint Statement.

SC15

SC15	Do you accept that ambient ocean noise is highly site specific, as well as variable temporally? (Torres para 37, Slooten para 15.7))	• Yes - Childerhouse agrees.	• **All the experts agreed** that ambient ocean noise varies substantially from location to location and from time to time .

31. All participants agree with the position recorded in the “areas of agreement and disagreement” column in the 2017 Joint Statement.

SC16

SC16	Do you accept that there is no information on local sound propagation conditions that will impact the distance sound will travel (because these local conditions were never measured) (Torres para 42) And do you accept that sound propagation depends strongly on underwater topography, benthic substrate and water temperature (Slooten para. 15.7)	• Yes - Childerhouse agrees.	• **All the experts agreed** with this statement.

32. All participants agree with the position recorded in the "areas of agreement and disagreement" column in the 2017 Joint Statement. DH clarifies that while the existing propagation model uses data including salinity, bathymetry, and temperature collected from the region, however there is no empirical measurements of these variables from within the permit area.

SC17

SC17	Do you accept that each sound increase contributes to the behavioural and physical consequences to ocean animals, including blue whales (Torres para 49)?	• Childerhouse noted that not all increases in sound will necessarily lead to an impact on marine mammals. Only those increases that lead to overall levels of noise passing a certain threshold will have a significant effect. This applies to both single and cumulative effects.	• **All the experts agreed** that increases in sound contribute to behavioural and physical consequences for marine mammals, including blue whales, and to the overall cumulative effects of human activities on these species.

33. All participants agree with the position recorded in the "areas of agreement and disagreement" column in the 2017 Joint Statement, except DH because it is outside his area of expertise.

SC18

Question #	Question	Response from Childerhouse or MacDiarmid	Areas of agreement and disagreement
SC18	You have not estimated sound levels and frequencies at various distances have you? And do you accept without this information and without marine mammal surveys, you are unable to predict effects on specific marine mammal species at different distances?	• Childerhouse undertook analysis of estimated sound levels at various distances from the source in Table 2 of my primary evidence. I did not undertake an analysis of the frequency spectra by distance but instead took the conservative approach and assumed that the broadband level was the same for all frequencies (e.g. non-weighting of frequency species impacts). • As noted in Childerhouse's primary evidence, there are very few species-specific thresholds for noise impacts available and therefore I followed the approach of Southall et al. (2007) who assessed impact by group for low, medium and high frequency cetaceans rather than for specific species as the data is simply not available for 95% of species. • Table 2 of Childerhouse's primary evidence provides estimates of received sound levels at increasing distances from the source and an assessment of the likely impact on marine mammals at that distance based on published criteria for threshold based on Southall et al. (2007).	• **All the experts agreed** that some species (e.g. beaked whales, porpoises) have a higher sensitivity to anthropogenic noise than others and so these species should be considered separately. • **There was disagreement** on the likely impact of noise on marine mammals. • Van Helden and Slooten reported on recent literature showing harbour porpoise responding to noise up to 50 km from the source of the noise, data on stress levels in cetaceans due to noise and other impacts of noise on marine mammals. • **All the experts agreed** that the lack of information on the intensity and frequency range of the noise from the proposed mining operation means it is not possible to determine the likely impacts on marine mammals, including physical and behavioural effects.

34. All participants agree with the position recorded in the first three bullet points in the "areas of agreement and disagreement" column in the 2017 Joint Statement.
35. All the participants agreed that the fourth bullet point be amended to instead record that "without information on the intensity and frequency range of the noise

from the proposed mining operation it is not possible to determine the likely impacts on marine mammals, including physical and behavioral effects".

36. There was disagreement as to whether there was adequate information currently available.

SC19

SC19	Do you accept that the plume will cause impacts on ecosystem productivity through reduced light penetration and subsequent change to the zooplankton community, including *Nyctiphanes australis* (krill), the target prey item of blue whales in the region? (Torres para 51) And do you accept that that with increased sediment in the water column dense patches of *N. australis* – needed by blue whales to survive – may be less numerous, more difficult to detect, and occur in unusual areas that reduce availability to whales (Torres para 51)?	• Childerhouse noted that he was not an expert on krill and sediment plumes and referred to the information provided in MacDiarmid et al. (2015b) which is summarised above under question SC7. • Krill have been found throughout the STB and its distribution is likely to be highly variable within seasons and among years. For this reason, it is reasonable to assume the foraging area for blue whales includes the whole of the STB. On this basis, MacDiarmid et al. (2015) concluded that the area of the STB occupied by the plume that may affect krill and therefore blue whales was negligible. • This issue is also covered by MacDiarmid in her response to questions AM28 and AM29 below	• **All the experts agreed** that the sediment plume is likely to have ecological impacts, some of which will affect marine mammals using the area. • **There was no agreement** on the impact of the sediment plume on blue whale foraging.

37. All participants agree with the position recorded in the "areas of agreement and disagreement" column in the 2017 Joint Statement, except DH because it is outside his area of expertise, but we encourage a review of Fuentes et al 2016,[3] which relates to impacts of sedimentation and turbidity on krill survival.

SC20

Question #	Question	Response from Childerhouse or MacDiarmid	Areas of agreement and disagreement
SC20	Do you accept that there is an important biomass of N. australis in the STB with an unknown distribution (spatially or seasonally), yet the studies that do exist show increasing abundance toward the proposed mining site, and therefore, habitat disturbance that impacts prey availability for blue whales in this area should be considered and avoided? (Torres para 53)	• Childerhouse noted that he was not an expert on krill and sediment plumes and referred to the information provided in MacDiarmid et al. (2015b) which is summarised above under question SC7. • Childerhouse agrees that impacts in the foraging area of blue whales should be avoided wherever possible.	• **All the experts agreed** that impacts on the foraging area of blue whales should be avoided.

38. All participants agree with the position recorded in the "areas of agreement and disagreement" column in the 2017 Joint Statement, except DH because it is outside his area of expertise.

---

[3] *Sci Rep* **6**, 27234 (2016). https://doi.org/10.1038/srep27234

SC21

Question #	Question	Response from Childerhouse or MacDiarmid	Areas of agreement and disagreement
SC21	Do you accept that in conclusion, "it is naive to think that a 35 year mining project within the STB region will not impact this population of blue whales, through elevated noise within their frequency range, habitat displacement, vessel impacts, and prey disturbance." (Torres para 58). And do you accept that the absence of credible, scientifically robust data on background noise and the noise produced by the mining operation mean that it is not possible to determine the impact of the noise from the proposed mining operation on marine mammals, nor to develop conditions relating to noise (Slooten 15.9)	• Childerhouse does not believe that there will be any significant impact on blue whales from any of these issues for the following reasons: a. TTR condition 12 will limit noise from the operation to levels that minimise any impact on blue whales b. While the possibility of habitat displacement exists, if it occurs it is likely to only be around the immediate area (e.g. within 2km) of the operational activity which represents only a very small part of the total foraging area of blue whales in the region, and c. There is unlikely to be significant prey disturbance, and if it does occur, it is likely to only be around the immediate area (e.g. within 2km) of the operational activity which represents only a very small part of the total foraging area of blue whales in the region. • He noted that information on noise and ambient levels are not required for an assessment of impact as Condition 12 sets a maximum allowable level of noise from the operation. Therefore, the operation must comply with this condition and no louder noise will be permitted. The noise level specified in Condition 12 has been set to minimise impacts on marine mammals based on published international studies (e.g. Southall et al. (2007).	• **All the experts agreed** that the proposed number of acoustic recorders inside and outside the PPA was insufficient to provide baseline information on the range of species potentially present in the area. Data from a more extensive array of acoustic recorders would be extremely valuable to the DMC in their decisions on whether to approve or decline the application for resource consent. • **The experts did not agree on whether** Condition 12 would be an effective mitigation tool. Problems with condition 12 were discussed, including: The threshold level is arbitrary and very high. The method proposed for monitoring noise is inadequate. The sighting probability of marine mammal observers is typically very low which means that some (unknown number of) marine mammals would be exposed to levels between 135 and 188 dB. • **There was disagreement** on the likelihood and nature of impact from noise for the operation. • van Helden, Slooten and Barbara noted that a consent that calls for an agreed level is problematic. The level set at 135 dB and considered "conservative" by Childerhouse, is not conservative by international standards. The level was set by expert conferencing at the previous application by TTR for this consent. There is considerable new information and papers on such levels and the responses of marine mammals to anthropogenic noise. An independent conferencing by marine mammal acousticians would be helpful to provide the DMC with an up to date understanding of these impacts. As it stands the 135 dB is over a ten-fold increase on levels used by NOAA at 120dB. There are also considerable issues with how and where the sound would be measured. There are multiple noise sources and so there is difficulty in determining where the sound should be measured. The current proposal of condition 12 calls for a measurement at a nominal 10m depth rather than maximum over depth that could only be derived from full spectrum modelling.

39. All participants agree with the position recorded in the "areas of agreement and disagreement" column in the 2017 Joint Statement. DH to clarify the maximum predicted sound level as recorded in the second bullet point.

AM27

Question #	Question	Response from Childerhouse or MacDiarmid	Areas of agreement and disagreement
AM27	In paragraph 107 (d) on Māui's dolphins you are relying on modelling, correct? Not on surveys? Why were no surveys undertaken? Does your conclusion stand that "mining 50 Mt per annum is likely to have negligible effects on this species" if one Māui's dolphin is killed or displaced or reproduction is affected by mining?	• Yes, Childerhouse agrees that the assessment relies on modelling the distribution of Hector's and Māui dolphins based on incidental sightings by the public, ships officers and MPI observer sightings. • He noted that a survey by Martin Cawthorn Associates Ltd (2013) was undertaken. • MacDiarmid stated her understanding that Māui is a sub-species (i.e. very closely related to southern populations called Hectors dolphin). If a single Māui dolphin was killed through displacement or changes in the availability of abundance of prey, then her assessment of risk to this population would increase. However, given the available information about Māui distribution and its use of turbid water the likelihood of a death from the mining activities is very unlikely.	• **All the experts agreed** that it will be very difficult to ascribe ultimate cause of death from a dead beach cast marine mammal and so the occurrence of a dead marine mammal near the mining area may not provide much insight into causation. Nonetheless, **all the experts agreed** that every dead marine mammal should be formally autopsied to provide possible indications of cause of death, tissue samples taken for genetic and ecotoxicological analysis, and analysis of sound reception capability. • **All the experts agreed** that any additional impact on Māui dolphins will be unsustainable and therefore should be avoided. The likelihood of impact on Māuidolphins is very poorly known. This is partly because it is very difficult to determine the number of Māui dolphins using the area that would be affected by the proposed mining operation, and partly because the potential impacts of the proposed mining operation are very poorly known (e.g. lack of relevant data on noise, uncertainty about impacts from sedimentation). Even if it could be established that the number of Māui dolphins in the area affected by mining were low, this would still result in a situation of low probability of impact but very serious consequences of any impact that does occur. Potential mining impacts (e.g. direct impacts such as noise and ship strike or indirect impacts such as displacement or ecological impacts) could push the Critically Endangered Māui dolphin beyond the point of no return.

40. All participants agree with the position recorded in the "areas of agreement and disagreement" column in the 2017 Joint Statement, except (i) DH because it is outside his area of expertise, (ii) That the second bullet be amended to read "…The likelihood of impact on Māui dolphins is ~~very poorly known~~ highly uncertain. This is…".
41. SC suggests that there is new information provided since 2017 that can be used to explore both the likelihood and uncertainty.

AM28

AM28	In paragraph 107 (a) you discuss blue whales. Do you accept Dr Torres findings that the STB is an important habitat and foraging area for blue whales? (Torres para 9)	• Yes, MacDiarmid cites Torres in MacDiarmid et al. (2015).	• **All the experts agreed** that the STB is an important habitat and foraging area for blue whales and note their previous agreement for question SC8.

42. All participants agree with the position recorded in the "areas of agreement and disagreement" column in the 2017 Joint Statement, except DH because it is outside his area of expertise. Participants also agree that the STB is used by blue whales for courting and mating in addition to foraging, and that calves have been observed in the STB.

AM29

AM29	Do you accept that the mining may affect *Nyctiphanes australis* (krill) and therefore blue whales? (Torres para 9)	• This issue is also addressed in question SC7 and SC9 above. • MacDiarmid noted that krill have been found throughout the STB and its distribution is likely to be highly variable within seasons and among years. For this reason, it is reasonable to assume the foraging area for blue whales includes the whole of the STB. On this basis, MacDiarmid et al (2015) concluded that the area of the STB occupied by the plume that may affect krill and therefore blue whales was negligible.	• **There was disagreement** on the impact of the plume on blue whale foraging.

43. All participants agree with the position recorded in the “areas of agreement and disagreement” column in the 2017 Joint Statement, except DH because it is outside his area of expertise. Participants encourage a review of Fuentes et al 2016,[4] which relates to impacts of sedimentation and turbidity on krill survival.

AM30

Question #	Question	Response from Childerhouse or MacDiarmid	Areas of agreement and disagreement
AM30	Is your finding of negligible impacts affected if one blue whale was known to forage in the “in the vicinity of the proposed mining areas”?	• MacDiarmid’s assessment assumed that blue whales forage over the whole of the STB, including the PPA, thus my assessment would not alter if a single blue whale was observed to forage in the area affected by mining. The natural variability in the availability of krill in the area is known and expected and is likely to have a much bigger impact on where blue whales forage than the impact of the proposed mining.	• **There was no agreement** with the statement that the availability of krill in the area is likely to have a bigger impact on where blue whales forage than the impact of the proposed mining. • **All the experts agreed** that the potential impacts of the mining (including noise and sedimentation) would affect a much larger area than the PPA.

44. All participants agree with the position recorded in the “areas of agreement and disagreement” column in the 2017 Joint Statement, except DH because it is outside his area of expertise.

AM31

AM31	At paragraph 108 f you discuss cumulative impacts. Do you accept that noise can be a cumulative impact? Why did you not measure it?	• Yes - MacDiarmid agrees noise can be an impact. • She noted that NIWA was not commissioned by TTR to undertake assessments of underwater noise. This question is best addressed to TTR.	• **All the experts agreed** that noise can be an impact on its own and by contributing to the cumulative impact

45. All participants agree with the position recorded in the “areas of agreement and disagreement” column in the 2017 Joint Statement, except DH because it is outside his area of expertise.

[4] *Sci Rep* **6**, 27234 (2016). https://doi.org/10.1038/srep27234

AM32

AM32	How about other disruption by ship activities? You do not discuss ocean acidification. Can this be a cumulative impact?	• MacDiarmid noted that the likelihood of vessel strikes can be mitigated by reductions in vessels speeds. • For vessel noise see responses by Dr Childerhouse above. • MacDiarmid noted other possible vessel activities that could cause disruption to marine mammals (e.g. rubbish, discharges, oil spills) are addressed by other TTR witnesses. • MacDiarmid discusses the potential impacts of ocean acidification and cumulative impacts in paragraphs 108-110 of my evidence.	• **All the experts agreed** that the effects of the proposed mining operation should be evaluated in terms of how they add to cumulative impacts already affecting marine mammals in the area (including noise and ship strikes from existing shipping, fishing and other existing impacts).

46. All participants agree with the position recorded in the “areas of agreement and disagreement” column in the 2017 Joint Statement, except DH because it is outside his area of expertise.

SIGNATURES OF EXPERTS

Simon Childerhouse (TTRL)

Alison MacDiarmid (TTRL)

Elisabeth Slooten (KASM and Greenpeace)

Leigh Torres (KASM and Greenpeace)

Greg Barabara (Fishers)

Darran Humpheson (TTRL)

Appendix A: Overview of process adopted in caucusing

1. Review of previously agreed statements in 2017 Joint Statement:
   (a) Review statement – review experts' reconsideration of 2017 Joint Statement agreements
   (b) Review any new data relevant to specific statement
   (c) Confirm agreement with previous statement. If no longer agreement, then add to list of items to consider as unagreed statements

2. Review of previously unagreed statements in 2017 Joint Statement:
   (a) Review statement
   (b) Review any new data relevant to specific statement
   (c) Develop agreement where possible. Note areas of disagreement.

3. Review any new material (if not considered under items above) or issues:
   (a) Underwater noise – m-weighting using new work prepared by Mr Humpheson (e.g. Appendix 1 of Childerhouse Rebuttal Statement, new work presented)
   (b) New data to be provided by Dr Leigh Torres
   (c) Other

APPENDIX C

MS HAAZEN: She's available, or she's thinking that she's going to be on at 4 pm at the moment, but I can let her know that 10 to is preferable.

CHAIR: And if you could let the staff know that she is available and then we can get her evidence underway.

MS HAAZEN: Will do, sir. Thank you.

CHAIR: Great. Thank you very much. We'll adjourn for now.

ADJOURNED **[3.33 pm]**

RESUMED **[3.56 pm]**

(Dr Torres affirmed)

CHAIR: Thank you very much for joining us this afternoon. We're most grateful that you were agreeable to be interposed.

DR TORRES: Yes, of course. Happy to be here. Thanks for having me.

MS HAAZEN: Dr Torres, Ms Haazen here. Can you just confirm that you are Dr Leigh Torres?

DR TORRES: Yes, I'm Dr Leigh Torres.

MS HAAZEN: And you produced statements of evidence as part of the 2017 hearing and a statement of evidence as part of this rehearing dated 6th of October?

DR TORRES: Yes.

MS HAAZEN: And that you also participated in the marine mammals joint witness conferencing?

DR TORRES: Yes.

MS HAAZEN: Thank you. Can you answer any questions from the DMC?

DR TORRES: Yes.

MS HAAZEN: Sorry, sir, Dr Torres doesn't have any present PowerPoint presentation.

CHAIR: No, no, it's not essential by any means so that's not a problem.

DR TORRES: Yes, perhaps I'm opening statements or remarks, and then…

CHAIR: Oh, that would be most helpful. Yes, I didn't appreciate that you-- I wasn't aware whether you were going to do a PowerPoint or how you would like to present. It's entirely a matter for you and your counsel.

DR TORRES: Yes, that's fine. I'm ready to speak when is appropriate.

CHAIR: Good, well, is there anything you would like to say by way of opening or summary or how you would like to get your message across?

<u>DR LEIGH TORRES PRESENTING</u>

DR TORRES: Yes, certainly. So, I'll start just by introducing myself a little bit. I am a professor at Oregon State University in the States. So, you might be wondering why I'm an expert witness here, but I did live and work in New Zealand for a while where I first discovered and documented this blue whale foraging ground and population in Aotearoa waters of New Zealand. And I've continued that work since moving to Oregon about ten years ago. So, when I testified back in 2017, we had literally just finished a field season -- I think I stepped off the boat that day and gone to the hearing -- so, it's been a while now since we collected that data. We collected data during a survey in 2014, 2016, and 2017. But since that time in 2017, we've had an opportunity to analyse all that data and it's been really productive. We've produced ten peer reviewed papers all about blue whale ecology and distribution and health, particularly in the South Taranaki Bight.

[4.00 pm]

So, my testimony today, what I just would like to do is sort of go over what was in my evidence briefly, hit the high points about what we've learned about blue whales, particularly in the South Taranaki Bight, and then a little bit about my comments on Dr Childerhouse's evidence and then just closing with some emphasis and discussion about the potential for impacts from the mining operation on blue whales.

So, in particular, I want to emphasise that this blue whale population is really a New Zealand blue whale population. So, from our surveys we collected photographs of all the blue whales that we observed, and we compared all those individuals-- so, from the photographs we can look at markings and identify individuals over and over, it's like a fingerprint. And we compare those images or compare those images to photos of blue whales taken in Australian waters as well as Antarctic waters, and there was never any match, which means that these whales, the New Zealand blue whales, haven't been seen outside of New Zealand waters. Likewise, we collected little skin tissue samples from the whales that we did genetic analysis on, and that genetic analysis showed that they are genetically distinct from all other blue whale populations in the Southern Hemisphere and the Northern Hemisphere.

So, they also had really low haplotype diversity, which means that they're, again, a very small New Zealand population. They don't mix with other neighbouring populations of blue whales around Australia or Antarctica.

And then also we had five hydrophones down throughout the South Taranaki Bight for two years, and those hydrophones recorded daily, constantly, and the data that we recorded was very interesting because it showed blue whale presence at each one of those hydrophones across the Taranaki Bight every day of the year. So, very high presence across the whole region across all of the years, which is really quite surprising -- most baleen whales migrate through -- but really these animals are relying on the Taranaki Bight for feeding opportunities. So, in the spring and summer when there's upwelling and bringing productivity in, that creates food for the whales in the form of krill. And then we've also documented calves in the area, which means that the mothers are bringing their calves back to this region to teach them that the South Taranaki Bight is an important area for their livelihood, for them to live. So, we've documented nursing between a mother and a calf in the Taranaki Bight, and also recently we've had documented likely breeding behaviour in the Taranaki Bight in the breeding months between May and August, there's elevated, very, very high rates of their mating call. So, blue whales make two types of calls, essentially; they make a foraging call and then a mating call. And we have recorded high, very high rates of that mating call during that mating season. So really the area shouldn't just be thought of as a foraging ground for these blue whales but rather an important part of their whole life history. So, from feeding to nursing to breeding and raising their calves.

We also use drones to fly over the whales and measure their body condition. And what we've noticed is that there is high variability in how skinny or fat they are, which just shows that they are prone to different availability in food for them and that can certainly impact their health. We also have documented that these particular blue whales in the South Taranaki Bight, they do a lot of surface feeding as opposed to blue whales maybe off the coast of California, or in Antarctica, or in Australia, where they feed more at depth. These whales feed more at the surface, which puts them at risk from ship strike, from different vessels that are moving more quickly through the surface waters. So, that's just another vulnerability that they have.

[4.05 pm]

And then one of the very interesting things that we documented was -- so, in 2016 when we did the survey, there was a marine heat wave in the area as opposed to in 2017 when we did our survey in the Taranaki Bight, which was more typical environmental conditions, so cooler waters. And there was quite a distinct difference in the distribution of the whales between those two years and then the availability of their food: krill. So, in that heat wave year we found less whales in the area and less krill. But when we looked at the acoustic data comparing between those two years, it was really interesting because we detected less of that foraging call, that D call, during the marine heat wave year compared to the more typical year in 2017. And that was kind of to be expected because we knew there was less prey around, so seeing less foraging calls was kind of, okay, that made sense.

But what was particularly interesting was the following reproductive season in that period between May, June, July, there was much reduced rates of that breeding call after that marine heat wave foraging season than during the breeding season following the more typical year. And what that means is that when there are anomalous conditions that impact their foraging success, that not only impacts their foraging success then but also their breeding capacity later. So, population dynamics, the ability of this population to have calves and continue growing and surviving. So, it's an important thing to keep in mind when we think about their vulnerability, the vulnerability of this population to environmental change coming with climate change, from all the other aspects of impacts that they might be facing within the Taranaki Bight and the wider New Zealand region.

So, I think all -- I believe in our caucusing of the expert witness, everybody agreed that it's important to consider the cumulative impacts that these populations might face. That's not just the impacts from the seabed mining, but that's those impacts on top of what they're already experiencing from dramatic impacts of climate change to having vessel traffic through their area to oil and gas exploration in the area. It's just important to keep those in mind that there are numerous stressors that these whales are facing already and then adding seabed mining on top of that will be an additive stressor that we should try to really avoid for these vulnerable populations.

I do want to touch on some of Dr Childerhouse's evidence where he presented model outputs for species distribution in the South Taranaki Bight. So, the particularly the models by Stephenson et al. that used opportunistic sightings that had been reported to DOC of cetaceans across all of Aotearoa waters, and while those models are good, they are at a very broad scale, and much too broad to be applied to understand the potential occurrence patterns within the various small scale TTR study area or even that region of the Northern Taranaki Bight. So, what I mean here is that those models are made at an annual basis. So, it's one map per species per year and at a very large spatial scale. So, they're appropriate for interpretation of a 50 square kilometre area whether we expect to maybe see species in that area, but really, it's inappropriate to interpret those model outputs in the way that Dr

Childerhouse, I believe, has for potential for these species to occur in the TTR areas. It's like seeing a mean temperature map for all of the North Island for a year and then using that to try and predict what the temperature might be in Wellington on a certain day, the two different types of data aren't compatible for their application. So while those species distribution outputs can be useful, they're useful at a broad scale and, really, I don't think are appropriate to be applied to understand the potential occurrence of species at risk within the Taranaki Bight.

CHAIR: Just referring to the geography of these blue whales, you said earlier that they represent a New Zealand blue whale, as opposed to ones that are being seen in Antarctica and ones that have been sighted in Australia, where do these New Zealand blue whales range to and from?

DR TORRES: Well, we don't fully know. We have sightings data from images, again we make can make photographic matches of individuals, and we've made matches from whales we've seen in the Taranaki Bight up to the northern tip of the North Island to down south. How far they go beyond that really, we don't know, there's just not good monitoring. There are hydrophones in Australia that have rarely picked up the New Zealand call. So these New Zealand blue whales have a distinct dialect, so they actually sound different than the Australian calls or the Antarctic blue whales.

[4.10 pm]

But really for the amount of hydrophones outside New Zealand in the water, they really have rarely ever never picked up the New Zealand call. So I really do think that the blue whales do likely wander around all of New Zealand, I don't think they're constantly in the Taranaki Bight, but I do think the Taranaki Bight represents a very important place for them, and at the moment it's the only foraging ground that we know of for them.

CHAIR: Thank you. Please continue with your presentation. There's a bit of a delay in in the audio.

DR TORES: Well, I am many time zones apart, so I appreciate you being patient with it.

I did want to touch on another aspect of the evidence that's been presented, which I feel the perspective is quite narrow for the potential for the impacts of the mining operations. So the evidence is presented that the noise won't go beyond 10 km from the mining area or that the sediment plume that's generated won't advance very far. I think that's a narrow perspective and an inappropriate one for understanding that these animals, blue whales, are very low frequency hearing and they're very sensitive to noise, and that the sound that this operation will generate is in that low frequency band which can travel quite far across the ocean.

In fact, I want to emphasise that one of the hydrophones we had down for two years was only 18.8 km away from the TTR site, so that's pretty close, actually. That hydrophone recorded blue whale calls, again, almost every day of the year. So that means that within our detection range of about 50 km from that hydrophone, which includes the TTR site, there were blue whales calling almost every day of the year. So I think it's really important to understand that even though the maximum noise level or the maximum sediment plume might be highest right in that TTR site, it will disperse far beyond that and will have a good potential to impact blue whale hearing, they will hear it and it might not cause permanent threshold shift, but it will be a disturbance that they'll have to live with for 35 years.

Because the South Taranaki Bight is such an important area for them, it's not like they can easily go someplace else for the same life history needs, for the food or mating opportunities. So if this is it for them, if this is very important, being displaced from that habitat because of this constant racket, imagine living for 35 years next to a vacuum cleaner, that that could cause stress to you.

I also want to point out that there was an observation of three blue whales in 2013 only 13.5 km from the TTR site. So, again, there is evidence that blue whales do occur quite close to the proposed mining site. I also want to touch on the potential of the sediment plume to disturb their krill foraging base. So there is another study on a different species of krill down in Antarctica, but yet also krill that shows that these large quantities of sediment in the water can have significant negative impacts on krill feeding and their growth and mortality because that sediment clogs their filtration system.

[4.15 pm]

So I do think that there is a lot of potential for that sediment plume, again, over 35 years is constant to spread throughout the Bight into where the krill are that the blue whales are so dependent on, and can cause the krill to, to be less nutritious, to not grow, to have higher mortality rates, which would clearly affect the blue whales and their health.

QUESTIONS

DR BYROM: Excuse me, Dr Torres, it's Andrea Byrom here, I'm on the Decision-making Committee. Could I just check you on that point? I'll just keep it really broad and general at the moment, but my understanding, based on the sediment plume modelling that we've seen so far, is that it's going to be going into the coastal marine area a lot of the time, which is to the north-east or east of the mining operation. Broadly speaking, again, that most of the whale occupancy of the South Taranaki Bight would be more into the deep water area beyond the coastal marine area and sort of in the opposite direction to where that sediment plume might go. You've made some good points around the food chain effects around krill, for example, but I'm just trying to reconcile those two spatial differences in my mind, at a broad level at this stage, please.

DR TORRES: I think you have a good point, but I think it's important to understand that the ocean is highly dynamic, and those models may show that that's the primary pathway for the sediment plume, nut I think there's a lot of evidence that shows that the plume can move, that the krill can move, that the whales can move, and it all has the potential, I think, to mix quite a lot. Again, it's not a static system, so the whales will go where the krill goes and the krill will go where the nutrients are, and if that interacts with where the sediment plume is, I think that that's where the potential for harm is.

DR BYROM: Thank you. Please continue.

DR TORRES: Certainly. So I think those are the points I wanted to make there. I think I'll just close by sort of emphasising the potential for the seabed mining activity to impact a few different aspects of blue whales. So we've talked a lot about the noise, that it might cause this background noise that they'll have to deal with, which can cause them to either call louder or call more often. And that's an energetic cost to these animals, potentially they can't find each other for mating opportunities or foraging opportunities. There's evidence from other areas that when there is noise disturbance that blue whales will call louder or call more often or cease calling. So all of those behavioural responses are possible.

There's also the potential for physiological impacts. So here in Oregon I lead a big project where we look at the impacts of noise on grey whale physiology, particularly their stress levels, And we've found that with increased noise from vessel traffic, the whales show an increase in their cortisol stress hormones, and that's also correlated with noise in the environment. So that's a really interesting result to show that these animals are still occupying the area, they're not moving, but yet they do show a physiological response to that elevated vessel traffic on noise in the environment.

So I think it's important to consider both the behavioural and physiological impacts of this mining operation on blue whales, and in fact, again, all the expert witnesses in our caucusing agreed that that is a really important thing to consider. I think those were the main points I wanted to make before moving on, so I'll leave it at that and answer any more of your questions.

DR DE LUCA: We heard from Dr Childerhouse that his assessment has been updated with about 50 new publications from 2017 and his work refers to Stevenson et al 2020, which you referred to, Roberts et al, 2019, Barlow et al, 2022 and 2023. Do you agree that all of this published research indicates the proposed mining area shows a low habitat suitability for marine mammals?

[4.20 pm]

DR TORRES: No, not quite, and this goes back to, to the point I was trying to make that Stevenson and that Roberts' paper are both at quite a different scale, spatial and temporal. So I don't think that those are appropriate to apply in this sense. **(**several inaudible words - video buffers)

Our composite map of, again, a mean of over a year of blue whale distribution. So there is variability, and that's what I was trying to emphasise with stating about that, that one sighting 13.5 kilometres from the TTR site. The whales do occur there. It may not be the core of their habitat, but when the conditions are right and that's where the food is, that's where they want to be. And if the food isn't someplace else, then they will be disturbed. They won't be able to access that food, or the food will be diminished in quality because of the sediment plume. So, I hope that clarifies my answer.

DR DE LUCA: Yes, it does a bit. We also heard from the underwater acoustics expert that the sound isn't really going to get anywhere near where the whales are going to be. It's going to be of low level below the PTS levels and not really affect the mammals?

DR TORRES: No, I would again disagree. So, PTS is permanent threshold shift. That's like hearing damage, so permanent hearing damage. And then there's TTS, which is temporary hearing damage. But there's still just that low-level noise in the environment and that will spread far and wide. That's what I was trying to make that analogy to living next to a vacuum cleaner for 35 years. That will have an impact on the animals over time, either choosing not to use this habitat or be near there, or that physiological stress increase. Having increased physiological stress has other health impacts; there are many studies in many mammals, including humans, that show that when we're stressed out, we have higher rates of disease, higher rates of heart failure or heart complications, and so forth. So, having higher levels of stress is not a good thing.

DR DE LUCA: We also heard from the acoustic expert and also Dr Childerhouse that mammals become acclimated or used to or adapted to low-level noise. I think the similarity was humans living next to a railway track or something like that. That they get used to a certain low-level noise. What do you think about that?

DR TORRES: There are theories that animals can or do acclimate or become accustomed to it. That doesn't mean it doesn't impact them. In fact, there's no evidence that they have -- I don't know of -- that they've become acclimatised. It's all background noise and then there can be punctuated louder noise on top of that. But that doesn't mean, starting at your baseline, that that's a good place to be. I wouldn't use that -- you know, the potential for these animals to become acclimatised to the noise -- as a reason that it's okay to put the noise in the water. There's already enough noise in the ocean from human and natural sources, that adding something on top of it doesn't just mean, “Oh, get used to it and that’s fine.” I don't think that's a good way to look at it.

DR DE LUCA: I don't think that Dr Childerhouse or Dr Humpheson talked about punctuated noise. I think it was just more of a background low hum, I suppose. That was my interpretation of what they said.

DR TORRES: I think that's probably -- yes, will be what the mining noise is, but it is an elevation in the current soundscape of the environment and, on that note, I don't think the current soundscape of that area was adequately measured. The JASCO hydrophone that I think they're using is from much closer to the Cook Strait than the TTR site. So it would kick up a lot more vessel traffic, which would elevate their current rates of background noise, where I think where the site is at the moment, it doesn't have that. So, adding this loud, constant noise would be a significant new contribution to the soundscape that the whales would have to live with for a long time.

[4.25 pm]

DR DE LUCA: Do you know what is proposed for pre-commencement monitoring? For the mammals and for the underwater noise.

DR TORRES: You mean from the conditions?

DR DE LUCA: Yes.

DR TORRES: Like, the thresholds for what noise can be emitted? Is that …

DR DE LUCA: That's one aspect, yes. But there's also two years of marine mammal monitoring, themselves, and also acoustic monitoring. Do you --

DR TORRES: Yes, no I'm aware that that is part of the condition.

DR DE LUCA: Do you think that that’s appropriate or sufficient or not?

DR TORRES: Well, I wish they had done it before. Then we'd have a lot more certainty to some of this guesswork that we're doing based on, you know, either lack of data or data from other places. Will it be enough? I think that the scale of it needs to be increased. So, a wider spatial scale. Again, thinking more broadly about where the impacts of the operation will stand too. I think that two years -- I would say it should be larger.

Like I tried to demonstrate in that one example, we had quite different distribution of blue whales and a marine heatwave year versus a more typical year. And this year, I'll tell you -- I was just down there a month ago -- was again a very strange year, very different in terms of the distribution of the blue whales. I've done four surveys now and basically every year has been slightly different than the others in terms of where the animals are, and the krill are. That just again shows you how dynamic the ocean is and how hard it is to predict and to rely on two years of data is really, I would say, far too little to be confident about what your baseline and your normal to be expected in the area is.

DR DE LUCA: We did talk to Dr Childerhouse about maybe extending that to three years so that there would be at least three annual surveys or seasonal surveys within each year. Also, you said you were monitoring earlier this year for blue whale. Did you find any in the South Taranaki Bight?

DR TORRES: We didn't, which is actually quite scary to be honest. The environment was very different. We didn't find any krill either, really. It was full of salps, which are these little jellies. Again, these animals are already dealing with a lot of environmental impacts just from climate change, to be honest, so adding in this other stressor I think is quite risky.

DR DE LUCA: Thank you.

DR BYRON: Kia ora anō. Dr Torres, it’s Andrea Byrom here again. I'd just like you to comment on the removal of the words “population level effect” from the conditions. I apologise, I've just looked through the joint witness statement and I can't find it, so I'm sorry if you've already made a comment on this in the joint witness statement, but could I just get you to articulate your opinion on that, whether you agree or disagree with removing those words, and if you disagree with that, why do you?

DR TORRES: Could you be specific about which numbered comment that was?

DR BYROM: The marine mammal condition is condition 10, which is on page 281 of the conditions. And it's 10 a.

DR TORRES: I’m looking at different document but…

DR BYROM: That's okay. I can read it out to you.

DR TORRES: Okay, I see it.

"There are no adverse effects at a population level on blue whales."

Yes, okay. So, the removal of the word "population level", is that what the question is?

[4.30 pm]

DR BYROM: Yes. And you may have already addressed that in the joint witness -- in the conferencing -- and I can't find it, sorry, just at short notice. So, I was going to ask you to comment on that, please. The proposal to remove those words "at a population level" from the conditions.

The point was made yesterday that it's really too hard to attribute the impact of this mining operation at a population level, given all the other cumulative stressors in the environment that you've just described. So I just wondered about your expert opinion on that.

DR TORRES: Okay, thank you for that clarity. Again, I say, "No, it's not impossible. It's not too hard." I'll echo back to this grey whale project that I have going here in Oregon. That is actually funded by the Office of Naval Research here, that are interested in how sound may affect the population consequences on marine mammals, particularly large whales. What we're doing there is collecting the faecal samples to look at stress levels, body condition data with drones, sightings, behaviour and folding it all into what's called a "population consequences of multiple stressors model". Essentially that's looking at how multiple stressors -- so, noise, vessel traffic, environmental conditions -- can impact animals over a lifetime. Looking at their vital rates, response, the number of births in each year of this study, the mortality rates and so forth.

So, it's not impossible. It does take an investment of data collection. I would say, four or five years at minimum to do it, but it's not impossible to do. Especially if this project is going to go on for 35 years, it's certainly something that should and could be monitored over that period to look at population-level consequences of this effort. That's also what I was trying to get at before with that example of how there was reduced breeding calls after that marine heat wave. So there's certainly ways to monitor their reproductive effort and whether the populations are growing or shrinking or remaining the same.

DR BYROM: Okay, so in your opinion it is possible to build a model that would help us understand this particular threatening process as an overall stressor in relation to a number of other stressors?

DR TORRES: Yes. I think there's examples in the literature of these population consequences of disturbance models. You have to collect the data and invest in that, but it's certainly possible to do.

DR BYROM: I'm just reading through my notes very quickly to see if I've got any other questions for you, so I apologise for the pause.

DR TORRES: No worries.

CHAIR: While that's happening, I have a question about the conditions. You were referred to condition 10 regarding marine mammals, and we also had a presentation not long ago from Mr Humpheson, particularly addressing condition 11, and there are others. But how closely have you examined the content of those conditions?

DR TORRES: Not that closely, in all honesty. I'm not an acoustician by trade. I mean, I do understand the impacts of noise and frequencies and decibel levels. I did review them, so I'll say that and what I gather from them is that all these conditions are about things very close to the site 500 metres and so forth. So, I do think that needs to be expanded.

[4.35 pm]

CHAIR: All right. I'm speaking about the possibility of your looking critically at the current draft. Now it may be -- I don't know, we don't know -- the amended conditions may be proffered along the way, but if you were to examine critically at least condition 10 and condition 11, and the ones following, it might help us if you could provide us with any suggested amendments that would pick up on the concerns that you have expressed in your evidence.

DR TORRES: Yes, I can certainly do that for section 10.

CHAIR: You might be-- on the basis of your expertise not extending to acoustic? That's fine.

DR TORRES: Yes, I think a marine mammal acoustician should probably have more say in that.

CHAIR: Thank you. Well, that's most helpful. And through your counsel, you might be able to provide any extra commentary that you had on that, picking up on the discussion that you've heard, today, Ms Byrom, do you have any more questions?

DR BYROM: Yes, I do. I do. Okay, so, this is a question from TTRL to you and I should say, by the way, that some of the questions we've asked, we've paraphrased because we had similar questions to TTRL, but we have picked up on a number of other ones that they had for you. This one reads: the figure on page 20 of Mr Humpheson's 16 February statement shows the noise contours from his old model. If you are able to look at the equivalent figures from the new model which is on pages 16, 17 and 18. Now if you can't find that, just to let you know that what the new results indicate and what we've heard today is that the area of underwater noise propagation is significantly smaller than what the old model showed. And I just wonder if you could comment on that please?

DR TORRES: Are you able to summarise what they changed in the model to make the area shrink?

CHAIR: Well, it's maybe that she's not an expert on acoustics, so it's potentially an unfair question.

DR TORRES: Well, I mean --

DR BYROM: The question is in relation to the impact of noise on marine mammals, and so the shrinkage- - basically what the new model shows is a much smaller area of significant noise propagation around the mining site, compared to what was modelled originally. I think I've paraphrased that correctly.

DR TORRES: Well, if I'm understanding correctly, it's the new model that Humpheson produced just like a day before our caucusing. Is that correct? And I think we agreed that it was submitted too late for us, the other expert witnesses to fully evaluate so, again, I feel like an acoustic modeller, somebody that understands the nuances -- acoustic modelling is a very mathematically intense field so somebody that understands the changes that they did to their model to why those contours shrunk I think is really important here.

DR BYROM: Okay. Thank you. Moving on, I acknowledge that your expertise is clearly around the larger whale species, but I do wonder if you might be able to comment on Māui dolphins. So, the question is do you agree with the statement that the impact on Māui dolphins, which are a highly threatened, if not endangered, species here is highly uncertain at this point in time?

DR TORRES: Yes, it is uncertain clearly. There's historic evidence that Māui dolphin and Hector's dolphin used that coastline, and certainly the hope is that Māui dolphin extend their distribution and that would be a prime area that they would go. And so, I think putting an operation that might disturb them or impact their habitat right there is risky and not beneficial to the recovery of that endangered population.

[4.40 pm]

DR BYROM: Okay. Thank you. I really only have one further question which again is sort of a general question. I think what I've interpreted from your evidence is very much that you are wanting to have us understand that this environment is all connected and that there isn't-- just having a single-- focusing on a single point source is not helpful in interpreting the wider population level implications for some of these marine mammal species in the South Taranaki Bight, in terms of food and breeding and some of those other factors, that there are ecosystem interconnections there. Do you agree with that? Is that sort of your general thesis?

DR TORRES: Yes, I think that that's a good synthesis of it. You know, we can't put a fence around the TTR mining area, and so, I think the impacts will spread beyond there. We should expect that over 35 years. Conditions will change and the ocean there dramatically changing right before our eyes at an incredible pace. And these animals are vulnerable already and again, they're trying to make a living in this changing environment and adding another threat on top of that is just highly risky.

DR BYROM: Okay. And so, if you were to prioritise how we would better understand the ecosystem as a whole -- which is a very hard question, but I'm going to pose it to you anyway -- how would we go about understanding how this ecosystem works and what the mining impact would be overall at an ecosystem level? And I know it's hard but have a crack.

DR TORRES: You mean the methodology?

DR BYROM: Not so much the methodology, but what's your top priority for really understanding how the system works in order to better understand the impact of mining?

DR TORRES: Well, yes. Okay. A lot of the ecosystem, it's a wind driven upwelling system that comes from the Kahurangi Shoals and that plume, that upwelling plume flows into the Taranaki Bight, but it's highly variable where it goes, its intensity, how much nutrients it has in it. And like the summer, like I mentioned, there was an upwelling plume, there was cool water, it looked like it was going to be a good season, but it wasn't. At all. And so, I think understanding those dynamics, period. And then when you throw in this added disturbance source in all the ways that you all have been hearing about noise, sediment plume, pollutants, so forth, I think that can be put on top of those sort of more natural variability that's happening.

And one thing we know about climate change is that there is no normal anymore, which is making all of this predictive ability really hard.

Ecosystems are oscillating all over the place in terms of their response to dynamic and new and novel environmental conditions. Climate change is causing temperature ranges and current flows and things that we've never seen before, so it's getting a better grasp, but there has been very little oceanographic or biological sampling in the Taranaki Bight. So, I've been very surprised by that. When I first thought that there might be blue whales in the region, I was like, okay, well, I'll go look at the literature to see what's known in the area. And there's basically -- prior to me -- there were 3 or 4 studies in the 80s about the zooplankton or the oceanography of the region. So, we know very little already about the area. And so, enhancing that knowledge, would be primary.

DR BYROM: Okay. Thank you. I mean, our challenge as a Decision-making Committee, of course, is bringing it back to material harm. We have to weigh and consider whether this operation will cause material harm to some of the species that you've been talking about. And so, I'm just trying to get a that ecosystem context. Thank you. It's appreciated.

DR TORRES: Yes.

CHAIR: If I could just add to that. As well as focusing on material harm, we must also focus on the conditions as to what extent they might mitigate or remove the material harm. So that's why we expressed our interest in the conditions around your area of expertise and whether the condition relating to marine mammals is fit for purpose and at a best practice level. So it might be important when you provide your response to the earlier question, when you've had a closer look at the condition, to bear that in mind.

[4.45 pm]

DR TORRES: Certainly, and that is clear. It's a hard thing to do. Marine mammals live a long time, and they have many behaviours and they do things for different reasons, so that's why short-term monitoring can be quite challenging, short-term and short scale, to draw any conclusive inferences from. I will certainly keep that in mind when I review the conditions.

DR BYROM: Nothing further.

CHAIR: Nothing further. My colleague who's coming in by Zoom, Ms Lovell, has some questions for you, so just stand by.

MS LOVELL: Kia ora, Dr Torres. Can you hear me?

DR TORRES: Yes, I can. Kia ora.

MS LOVELL: Kia ora. So I just wanted to follow on and sort of work my way through some of the discussion around the Māui dolphin, as an example. My colleague has already raised the question of condition 10, which contemplates no adverse effects on species classified as threatened, which is the Māui dolphin and, of course, that's reflective of the fact that they are utilising the South Taranaki Bight. As I read the condition, it's no adverse effects on species that are utilising the bight, so that becomes very relevant, the utilisation of the South Taranaki Bight.

It does, I note, also reference the possibility of strike and entanglement of Māui and m the need to report, et cetera, to DOC. You may not be able to tell me, but given I did note your introduction and the work that you do, including around conservation of marine cetaceans, given the small number of Māui, I think it's 63-odd known, what would the impact or effect be of losing one to a species of that size? Can you give me any insight into that given your experience?

DR TORRES: With small populations like that, the loss of one individual can be quite dramatic, particularly if it's a female, that's a loss of a reproductive animal that can increase your population size. The loss of one individual can also really reduce your genetic diversity, which obviously is really important for small species to resist, basically, becoming inbred, which can cause other issues. So the loss of one individual to a population of 63 can be highly deleterious to that population's recovery.

MS LOVELL: Do you have a number, in your experience, where it's too high, there's a number where if we lose that number the species is absolutely threatened?

DR TORRES: Well, it depends on the population size. So here in the States for each one of our stocks we calculate something known as potential biological removal, which I think is what you're sort of getting at.

MS LOVELL: In layman's terms, yes.

DR TORRES: The calculation of that is based on the population size, so the estimates and a recovery factor, and it's the population's growth. Basically those three terms. From that, you get this population of potential biological removal, PBR we call it, and that's that number. So it can be 0.13 for highly endangered populations, so right now our southern resident killer whales have a PBR of 0.13, that means you can kill that many killer whales a year in the population will be all right, but clearly that's less than one individual. So I would imagine that the Māui dolphin would be in that range as well. The southern resident killer whale population size right now I think is in the 70s, so that's highly similar to that 63 number you said for the Māui dolphin. So it's definitely less than one for Māui per year of the number that can be killed by anthropogenic impacts and still have the population recover.

[4.50 pm]

MS LOVELL: I know you've got homework, as referred to, if you could provide - I can't write that fast and I'm not that understanding as a layperson of what you're talking about. So if you could provide us with that scale that you're talking about that would be helpful.

DR TORRRES: A description of PBR, sure.

MS LOVELL: Now, Dr Childerhouse took the view that there were very few sightings of Māui in the TTR site, possibly due to the lack of quality of that area, you noted that it was more likely the low number of species. I note that tangata whenua evidence actually refers to Māui as being in the area. Noting your comments, I think in your evidence at paragraph 36 re D'Urville et al, and models and data anticipating Māui in the area, is there anywhere or anything you can point to in terms of evidence or sightings or information that contrasts with Dr Childerhouse's evidence at 54 and 55 of his evidence?

I just note that your 36 doesn't provide me with a bit more detail in terms of what 54 and 55 speaks to, which is, there's an extremely low likelihood of dolphins being in the proposed area and speaks to the right and Tregenza summary of acoustics, et cetera. I know you've covered this all, but is there anything else that you would refer to in terms of documentation in terms of Māui being in the area or is it just the stuff we've got?

DR TORRES: So you have that that D'Urville et al paper, which is essentially we modelled the habitat preferences of Māui dolphin in the known range and then tried to extrapolate that beyond, and that coastline was potential prime habitat for them to expand into. I do recall that there have been sightings of Hector's/Māui dolphin along that Taranaki coast, like down by I think Kapiti in the last few years, so animals are traversing through that area probably.

These animals, Hector's and Māui dolphins, they like shallow waters, so it's much more likely that animals sort of traverse the shallow portion of the coastline rather than cut across the deep waters of the Taranaki Bight. I'm guessing we really don't know, but based on their habitat use patterns around the rest of the country, that would be true. So I think the fact that there have been Hector's or Māui dolphin sightings in other areas along that Taranaki Bight coastline, it points to the fact that they are likely to traverse through or pass the mining site.

MS LOVELL: Just noting your comment, I guess in recognising the applicants or the application, recognising that there are low numbers and your point about them preferring the shallows, and also I guess your observation around recent surveys where you were concerned about the absence of krill and the absence of whale sound, for example, I guess I'm wondering really, on the balance, how likely it is that the likes of Māui will actually be in that area?

I mean, I take your point that you want to actually provide for as much area as possible for Māui, but equally it just seems like if the area is not looking great at the moment and the Māui are more likely to go into the shallows, isn't it reasonable to take Dr Childerhouse's comment that, at least in terms of Māui, it's extremely unlikely or there's a low likelihood that they will go there.

[4.55 pm]

DR TORRES: Yeah. I mean, I think just based on the sheer numbers of animals, that there's only 63 animals, and that this is outside their core range, it is a low likelihood that they will be there. But it's, again, a matter of how much risk people want to take for these endemic, iconic animals of Aotearoa, and how much - it's all a trade-off, ocean use. So at some points there are hard decisions to be made about whether you want to give Māui dolphin a chance to expand their habitat or risk it.

MS LOVELL: Thank you. That's been very helpful. No more questions, Chair.

CHAIR: Any further questions? Yes, Ms Byrom.

DR BYROM: I just have one more question for you. You just said something that really pricked up my ears, Dr Torres, which was that talking about the potential for recovery of a population into a particular area, like Māui dolphins, where we actually create good habitat for a species like that that's so endangered that its population has shrunk, and there are probably a number of other species in the South Taranaki Bight like that where populations have shrunk. Another tough question, but what kind of an impact might the mining operation here have on the ability of some of these populations to not just survive, but thrive in the South Taranaki Bight? In other words, to recover and rehabilitate.

CHAIR: Can you hear us? You're back.

DR TORRES: Yes, I did hear the question, the video froze for a moment, but I did hear the question, so hopefully you can hear me all right.

CHAIR: Yes. Thank you.

DR TORRES: I was just saying it is a challenging question, and its probably species specific, what aspect of the mining might impact species? So if it's impacting their food source, animals need to get enough energy to be able to get pregnant, hold their pregnancy, bring that to term, and then for the calf to survive, all of that takes healthy animals and whether they're being disturbed or displaced or they can't find enough food or their food isn't good quality, all of that can impact animals ability to thrive, for sure. So I think there are a number of different mechanisms that need to be paid attention to in terms of how the mining operation can impact vulnerable marine mammal populations, there's a number of pathways.

DR BYROM: Thank you. No more questions from me.

CHAIR: Would it be fair to say that your evidence of concern about material harm for the species you've spoken about depends significantly on the modelling of the sedimentary plume? Just in terms of effects from the mining.

DR TORRES: Yeah, that as well as the noise are my major concerns. I think ship strike is also another issue of concern, but I think that is easier to mitigate as long as the vessels go slowly and you have observers on board, I think the other two are very hard to monitor, and even with objective goals those can be overshot, even unintentionally, with some serious harm.

CHAIR: Well, thank you very much indeed for your evidence today, and this evening your time, we appreciate that we were able to meet your time availability, and thank you for presenting and answering the questions, and also being willing to do a bit of homework. So we will liaise with your counsel as to how that will be made available to the panel.

DR TORRES: Yes. Well, thank you for having me Zoom in virtually and present my evidence, and thank you for your time.

CHAIR: Thank you. Good evening. Yes?

(witness excused)

MS HAAZEN(?): Sorry, I just wanted to add in terms of those last questions around Māui dolphins, they can also be put to Professor Slooten who will be coming later on in the hearing.

CHAIR: Of course, yes. No, we have that on our radar. Just check with you, Mr Slyfield?

[5.00 pm]

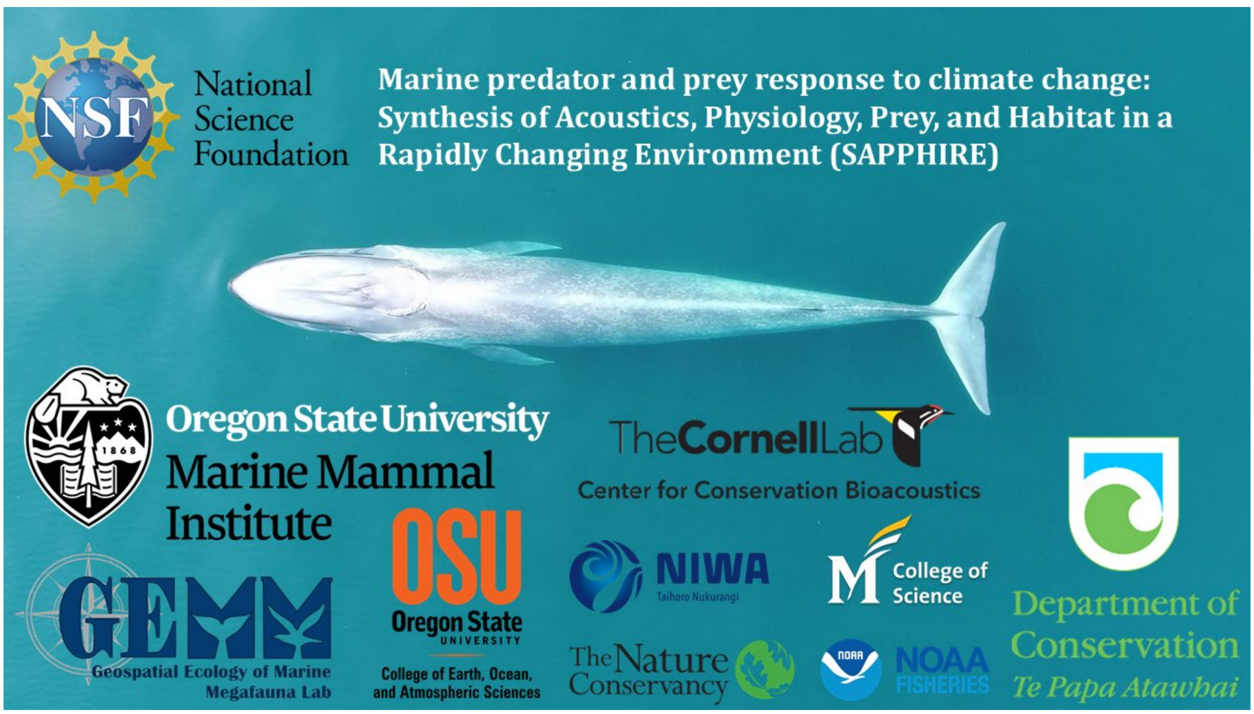
MR SLYFIELD: Yes, one procedural comment and question from me, and it's really picking up on the exchanges that we've been listening to today between the panel and various witnesses and homework that has come out of

APPENDIX D

Report of field work in Aotearoa New Zealand

January-February 2025

As part of the SAPPHIRE project



Prepared April 2025

Report prepared by:

Dr. Leigh Torres*[1], Dr. Kim Bernard[2], Dr. Dawn Barlow[1], Dr. KC Bierlich[1,3], Mike Ogle[4]

[1] Geospatial Ecology of Marine Megafauna (GEMM) Lab, Marine Mammal Institute, Oregon State University, Hatfield Marine Science Center, Newport, Oregon

Webpage: http://mmi.oregonstate.edu/gemm-lab

Instagram: @gemm_lab

[2] Zooplankton Ecology Lab, College of Earth, Ocean, and Atmospheric Sciences, Oregon State University, Corvallis, Oregon

Webpage: https://www.krillseekerlab.com/

Instagram: @psycho_kriller

[3] Center of Drone Excellence (CODEX), Marine Mammal Institute, Oregon State University, Hatfield Marine Science Center, Newport, Oregon

Webpage: https://mmi.oregonstate.edu/centers-excellence/codex

[4] Marine Species Team, New Zealand Department of Conservation (DOC)

Webpage: https://www.doc.govt.nz/nature/native-animals/marine-mammals/

*Contact Details

2030 SE Marine Science Drive

Newport, OR 97365, U.S.A.

+1-541-867-0895; leigh.torres@oregonstate.edu

Project Collaborators and Partners:

Holger Klinck[5], Philip Sutton[6], Svenja Halfte[6], C. Scott Baker[7], Debbie Steel[7], Kathleen Hunt[8], Emma Carroll[9], Nick Kellar[10], Nick Wolff[11]

[5] K. Lisa Yang Center for Conservation Bioacoustics, Cornell University

[6] National Institute of Water and Atmospheric Research, Ltd. (NIWA), Wellington, New Zealand

[7] Cetacean Conservation and Genomics Laboratory (CCGL), Marine Mammal Institute, Oregon State University

[8] Smithsonian-Mason School of Conservation, Biology Department, George Mason University

[9] School of Biological Sciences, University of Auckland

[10] Marine Mammal and Turtle Division, Southwest Fisheries Science Center

[11] Climate Change, The Nature Conservancy

Funding and logistical support provided by:

The United States National Science Foundation, The New Zealand Department of Conservation, The Marine Mammal Institute at Oregon State University, and The Thompson Foundation.

Permits

All data on blue whales collected under New Zealand Department of Conservation permit 107462-MAR, with animal ethics approval from the NMIT Animal Ethics Committee (AEC-2023-OREG-01) and Oregon State University (IACUC-2023-0388).

Project Summary

In the face of global climate change, it is critical to understand how rapid environmental change will impact the availability and quality of prey species, and consequently how these changes will impact predator health and population resilience. Furthermore, ocean ecosystems are experiencing significant impacts of climate change, yet the effects on marine organisms remain largely unknown, particularly physiological consequences such as nutrition and reproductive rates. The goal of this project is to identify and describe the impacts of environmental variation on the physiology of a crucial marine prey species (krill) and a model marine predator (blue whale). The project will examine how changing ocean conditions affect the availability and quality of krill, and impact blue whale body condition, endocrinology (i.e., hormone levels), foraging behavior, and reproductive effort. The focus on prey and predator physiology and fitness will inform the development of novel Species Health Models (SHM), which will advance our understanding of prey-predator co-responses to novel climatic conditions and the influence of species health on population resilience. SHM will provide a transformative way to monitor and predict species response to climate change by shifting the focus of management efforts toward thresholds based on health, which could enable mitigation measures before population-level declines occur. Furthermore, understanding krill response to variable environmental conditions will inform management of marine prey and predator response to climate change broadly, while public attention on the iconic blue whale can enhance societal awareness and motivate behavioral change. [See SAPPHIRE project schematic in Figure 1.]

Technical Approach

Species' resilience to climate change over shorter timescales will be determined by fitness and fecundity of individuals mediated through behavioral and physiological response pathways. This project aims to describe the co-response of marine prey (krill; *Nyctiphanes australis*) and predator (blue whale; *Balaenoptera musculus brevicauda*) health to environmental variation at individual and population levels, enabling a comprehensive understanding of impacts on species fitness under climate change conditions. Data is collected on krill and blue whale ecology and physiology in Aotearoa New Zealand during three consecutive years (2024-2026). Controlled experiments will determine effects of temperature on krill metabolic rates, energy requirements, and body condition (bioenergetic and biochemical responses). The availability of prey to foraging blue whales is assessed through net tows and active acoustics to determine krill energetic content, distribution, and density. Impacts of changes in prey and environmental conditions on individual whale physiology is quantified through Unoccupied Aircraft Systems (UAS; drone) assessments of body condition to document nutritive state, and biopsy sampling of skin and blubber tissue to quantify stress (glucocorticoids), nutrition (thyroid, leptin) and reproductive (progesterone, testosterone) hormone levels. At the population level, hydrophones record blue whale vocalizations to quantify changes in foraging and breeding effort relative to changes in prey and environmental conditions. These data streams will be integrated through multivariate analyses and development of Species Health Models to understand prey and predator co-response to environmental change, predict species health impacts and fitness consequences, and identify thresholds in prey and predator population resilience.

Engagement and Impact

Through the SAPPHIRE project, we will develop our understanding of the health impacts of environmental change on krill and blue whales in Aotearoa New Zealand. Given that blue whales are taonga (treasured), careful and informed management of this unique population in Aotearoa waters is critical, especially as impacts of climate change on our oceans continue to manifest. We frequently engage with both tangata whenua (people of the land) and DOC environmental managers throughout the SAPPHIRE project to learn about cultural and local values, knowledge, and concerns, and share our knowledge gained through our research. Through this knowledge sharing, findings about how changing ocean conditions will affect the health and reproduction of blue whales can be most effectively and appropriately applied by local communities to protect and conserve these taonga animals and their critical habitat in Aotearoa New Zealand.

SAPPHIRE is particularly well-suited to support development of a dynamic Marine Protected Area (MPA) framework to guide management decisions on anticipated impacts of climate change on vulnerable species and ecosystems. Our integrated SHM approach will identify robust thresholds of environmental conditions and prey and predator health to trigger adaptive mitigation measures. We continue to work with DOC managers to develop, implement, and test dynamic MPA design options based on organismal health indicators.

In addition to scientific publications, the SAPPHIRE project emphasizes broader scientific communication through multiple channels including blogs, a regularly updated research project webpage, social media, public media, public seminars, and K-12 public engagement events. Whales frequently act as a gateway to awareness of marine science, and we can use this lure to engage diverse groups to learn, care and act to protect vulnerable marine organisms and ecosystems. Furthermore, with SAPPHIRE's focus on species health, particularly of the iconic blue whale, our project can spark emotional connections between humans and climate change, leading to motivation for behavioral change.

Specific Project Objectives:

A. Assess variation in krill quality and quantity relative to rising temperatures and different ocean conditions,

B. Document how blue whale body condition and hormone profiles change relative to variable environmental and prey conditions,

C. Understand how environmental conditions impact blue whale foraging and reproductive behavior, and

D. Integrate these components to develop novel Species Health Models to predict krill and blue whale population responses to rapid environmental change.

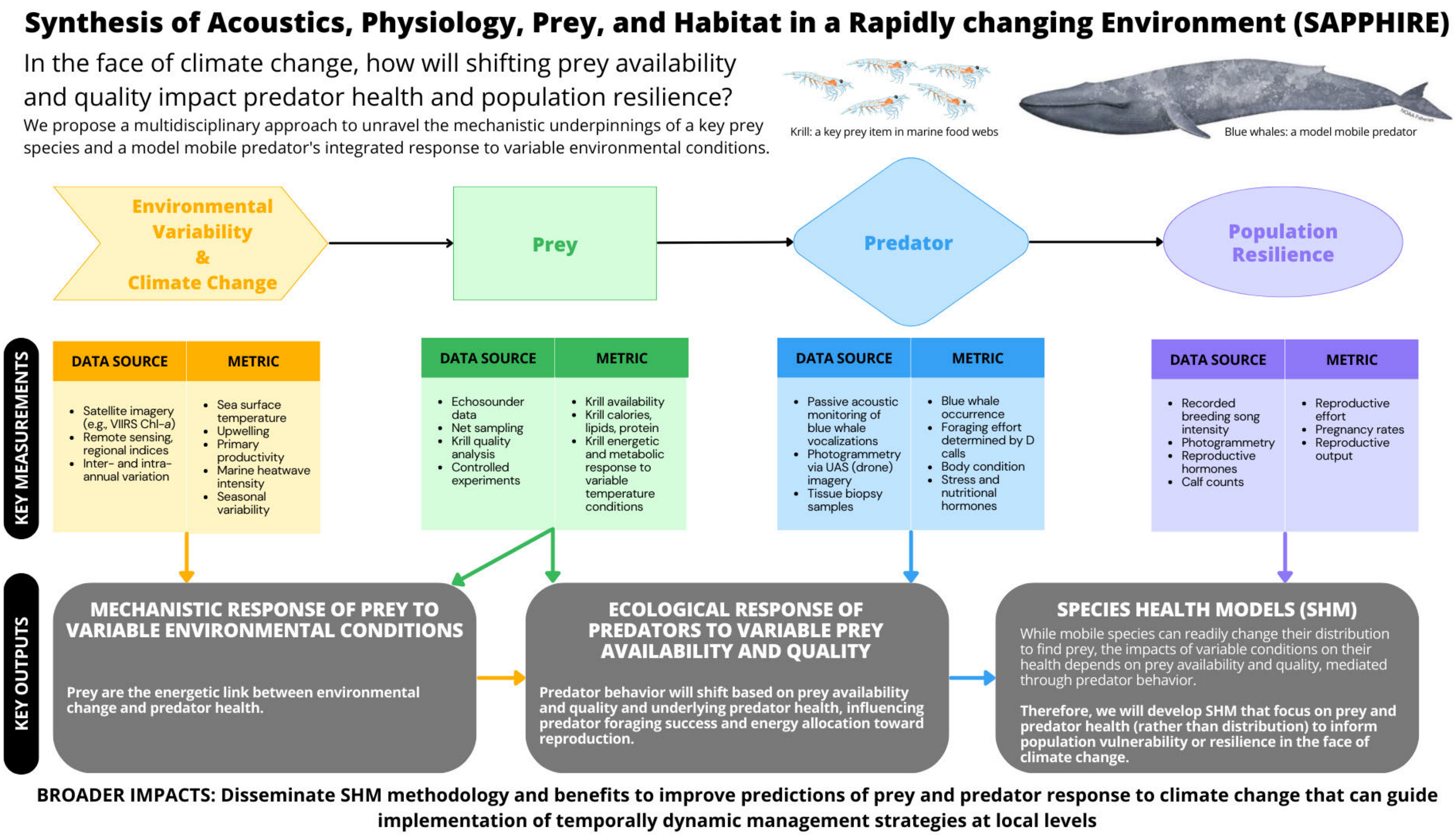


Figure 1. SAPPHIRE project schematic illustrating the overarching objectives, primary data inputs, and key outputs and impacts.

Overview of SAPPHIRE Field Work 2025

Field work in the South Taranaki Bight (STB) of Aotearoa New Zealand for the SAPPHIRE project was conducted in 2025 between 27 January and 17 February aboard the *R/V Star Keys* (operated by Western Workboats, Ltd.). The science party on board was Leigh Torres, Kim Bernard, KC Bierlich and Dawn Barlow from Oregon State University, and Mike Ogle or Rosalind Cole from the New Zealand Department of Conservation (DoC). The three crew members were Josh Fowden (Captain), Dave Futter, and Jordan Maiden-Drum.

During these three weeks, we conducted 1,129 km (610 nm) of survey effort during which time we recorded 34 blue whale sightings of an estimated 66 individual blue whales. At most of these sightings, active foraging behavior was documented, specifically on dense swarms of krill using a feeding tactic called surface lunge feeding. We also observed five mother-calf pairs, which is a positive sign for population growth. Our survey effort covered a broad area from the west coast of the South Island off Kahurangi Shoals, to the Cook Strait and canyons toward the east, and through the northern central STB region. Interestingly, the blue whales were highly clustered in the area north of Farewell Spit and toward the northeast from there, where surface swarms of krill were frequently observed.

During these sightings we collected 16,688 photographs of whales to identify individual blue whales through photo-identification (photo-ID) methods, recorded 850 minutes (14.17 hrs) of drone video to measure each blue whale's length, body condition, and pregnancy status, and collected 26 minimally invasive tissue biopsy samples (skin and blubber) to analyze the whale's genetic makeup, hormone levels, and stable isotope characteristics. While on survey and at each blue whale sighting, we assessed the oceanographic conditions through 58 water column profiles that measured depth, temperature, and salinity through the water column. This oceanographic instrument was paired with a GoPro camera and lights to record and identify zooplankton species. We used a scientific echosounder to map the distribution and density of prey in the water column while on survey, to link whale presence or absence with prey abundance and type. We also used nets to collect krill for on-board respiration experiments to assess their response to warmer water temperatures, and many krill were frozen for later measurements of length, weight, and caloric, lipid, and protein content. Finally, we also recovered two hydrophones that recorded blue whale calls during the past year and replaced them with two different hydrophones that will record vocalizations during this year.

Overall, data collection efforts during the 2025 SAPPHIRE field season were very successful. The ecosystem conditions and abundance of life observed in the STB in 2025 lie in stark contrast to 2024 conditions, when no blue whales were observed and very little krill were detected in the STB, with dense swarms of gelatinous salps in the water column instead. This contrast of ecosystem states between 2024 and 2025 is remarkable and emphasizes the value of the SAPPHIRE project that aims to utilize these data collected during contrasting conditions to understand how environmental variation influences the health, distribution, behavior and reproduction of marine prey (krill) and predators (blue whales). We are now underway with analyses of these data to uncover some answers, which will help communities in Aotearoa and across the world understand and conserve marine ecosystems and life as ocean conditions continue to change.

Stakeholder Engagement

Between March 2024 and January 2025, Leigh Torres and Mike Ogle engaged in ten consultations with multiple iwi over Zoom/video conference. These iwi consultations included Ngāruahine, Te Kaahui o Rauru, Ngāti Mutunga Iwi, Ngāti Tama Iwi, and Tupoho/Whanganui. These discussions were excellent knowledge sharing opportunities where we described our past and current research efforts and findings about blue whales in Aotearoa New Zealand, and iwi representatives asked pertinent questions, shared their tikanga of tohorā, expressed concerns about handling of biopsy tissue samples, and recognized the value of the research being conducted.

To ensure tissue samples collected from blue whales were handled appropriately, we developed and shared a clear protocol explaining all steps in the process from on board collection, to storage and transport, to analysis. In brief, each tissue sample is sub-sampled into 3 parts: (1) skin for genetic analysis and archiving at the University of Auckland and the New Zealand Cetacean Tissue Archive, (2) skin for stable isotope analysis to describe diet of the whales, stored and conducted at NIWA in Wellington, and (3) blubber, which is frozen and hand carried with appropriate permits by Leigh Torres back to Oregon for hormone analyses to describe each whale's stress, nutritional, and reproductive state.

In an incredible show of generosity and partnership, Ngāruahine invited our research team to hui (meet) at the beautiful Te Rangatapu Marae on 24 January 2025 prior to our departure on the research vessel. We were honored to be welcomed with a pōwhiri, which was followed by a useful, informative, and transparent wananga (Q&A). We discussed our research efforts and findings, listened and learned about Māori connections to the ocean and their role as perennial keepers of knowledge, and discussed ways to connect our research with iwi more directly going forward, including tangible approaches that we are currently following up on. This hui was a deeply meaningful and important step to building trust and partnerships with iwi as we continue to learn about and protect these tohorā and their habitat.

Leigh Torres delivered a remote presentation about blue whales of Aotearoa at the Ngāruahine Alternative Energy Wananga on 29 March 2025, and the research team has been invited back to hui again in 2026 when names of tohorā will be chosen based on tikanga Māori. Our team is thrilled about our growing relationship and looking forward to learning more about Māori practices, knowledge, and traditions.

The Oregon State University team also worked closely with environmental managers at the New Zealand Department of Conservation (DoC) to ensure our research is supported and aligned with information needs of the Marine Species Team tasked with conserving biodiversity in the ocean of Aotearoa. Through many meetings, emails, and phone calls, we are in close contact about research plans and findings.

Additionally, we work transparently with fellow scientists and colleagues across Aotearoa, the region, and globally, to ensure our work is shared and informed by the expertise of others. In particular, we are grateful for the logistical and scientific contributions of Phil Sutton, Alain de Verneil, Sarah Bury, Svenja Halfter, and Pablo Escobar at NIWA, Emma Carroll at the University of Auckland, and Deanna Clement at the Cawthron Institute.

SAPPHIRE blogs and Instagram posts

During the field season our research team made three posts on Instagram (@gemm_lab and @psycho_kriller), which have received over 2,500 views. Additionally, at the end of the field season we wrote a blog re-capping the data collection effort, which has received 463 reads: https://blogs.oregonstate.edu/gemmlab/2025/02/24/the-blues-are-back-in-town-recap-of-the-sapphire-2025-field-season/

Visual Survey Effort

Surveys were conducted aboard the *R/V Star Keys*, a 19.2 m vessel operated by Western Workboats, Ltd (Fig. 2). The *R/V Star Keys* is equipped with a flying bridge that is well-suited for marine mammal visual surveys. During visual survey effort, one observer scanned between the bow and the beam on the port side, another on the starboard side, and a third, center observer scanned forward of the vessel and was responsible for data entry (Fig. 3). Any additional observers present on the flying bridge scanned the entire area. Surveys were conducted at a vessel speed of 8 kt, with occasional surveys at faster speeds (10-12 kt) during excellent conditions. Weather conditions were recorded continuously during survey effort. When conditions were suitable, an EK80 scientific echosounder with 120 kHz and 38 kHz transducers was deployed to continuously map the available prey field during our blue whale survey. Effort was paused approximately every hour to conduct a water column profile (see oceanographic sampling section below) for concurrent oceanographic information.

Figure 2. The R/V Star Keys (left) and the Brig launched at blue whale sightings for closer approach, when conditions permitted (right).

When a marine mammal sighting was made, the observers recorded the distance and bearing from the vessel to the observation along with the species, group size, and behavior. All survey and observation details were entered into the software program Seascribe on an iPad. If the sighting was a blue whale, an unknown species, or a sighting of particular interest, the vessel diverted from the trackline to approach the sighting for additional data collection, and visual search effort was halted until the end of the sighting. If conditions permitted, a small rigid hull inflatable boat (Brig; Fig. 2) was launched from the *R/V Star Keys*, to enable a more efficient, maneuverable, and less invasive approach for photo collection and biopsy sampling.

Figure 3. Marine mammal observers survey from the flying bridge of the R/V Star Keys.

Between 26 January and 16 February, we conducted 1,129 km (610 nm) of survey effort during 13 days of workable weather conditions. Our coverage was mainly focused in the South Taranaki Bight, between the Heaphy River off the West Coast of the South Island and the Cook Strait (Fig 4). A minimum of six cetacean species were observed during survey effort (Table 1, Fig. 4). Blue whales were the most frequently observed species, with most sightings concentrated north of Farewell Spit, where a blue whale aggregation persisted for much of the field season. Additionally, blue whales were observed further north in the central region of the South Taranaki Bight.

Table 1. All cetacean sightings recorded during the 2025 field season. The Total Sightings column is the sum of the number of sightings of each species, and the Total Individuals column is the sum of the group size recorded at all sightings for that species.

Species	**Total Sightings**	**Total Individuals**
Blue Whale	34	66
Common Dolphin	21	175
Hector's Dolphin	1	4
Humpback Whale	1	1
Pilot Whale	2	10
Sperm Whale	6	7
Unidentified Baleen Whale	10	12
Unidentified Dolphin	2	20

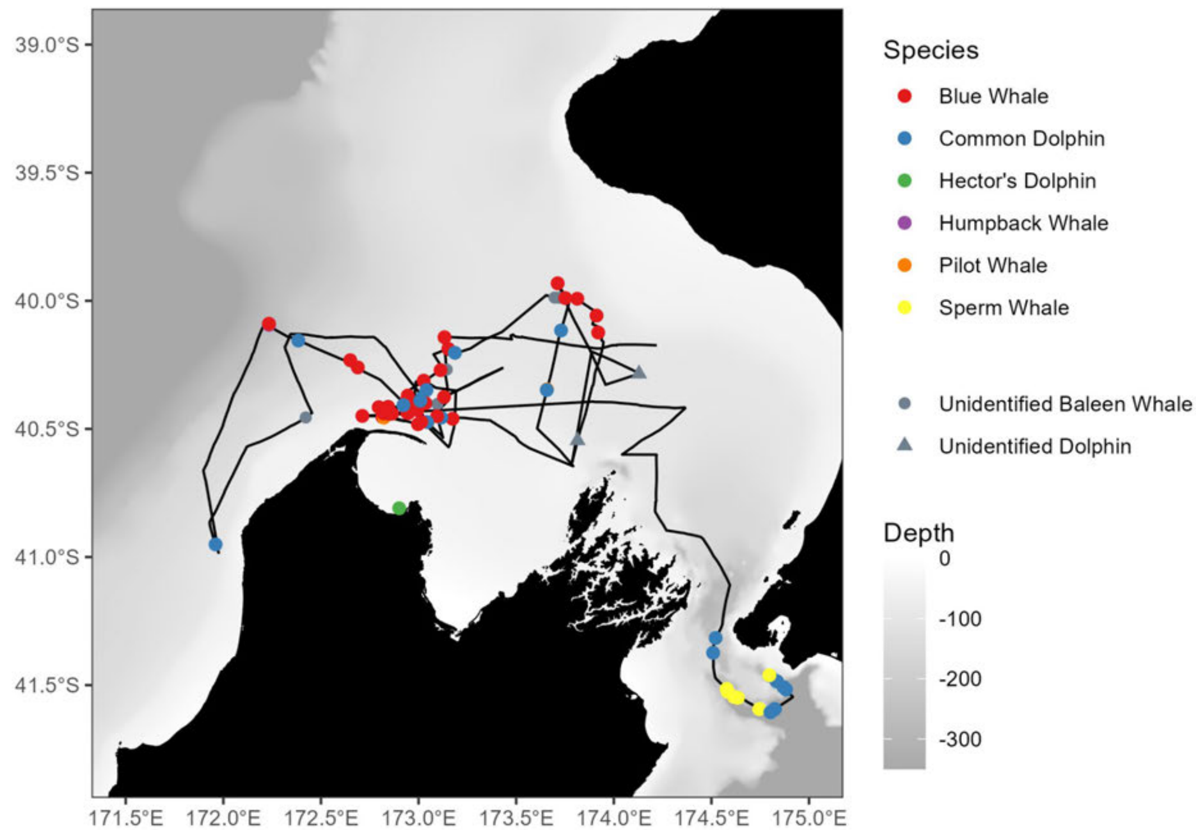


Figure 4. All cetacean observations recorded during visual survey effort. Survey tracklines are shown by the black lines. Cetacean observation locations are colored by species.

Ocean temperatures were unusually warm off the west coast of the South Island prior to the start of our field season. However, near the beginning of our survey effort, wind generated an upwelling plume originating near Kahurangi Shoals that moved into the STB, following closely to the north of Farewell Spit. This cool water plume persisted for most of our field season (Figs. 5 and 6).

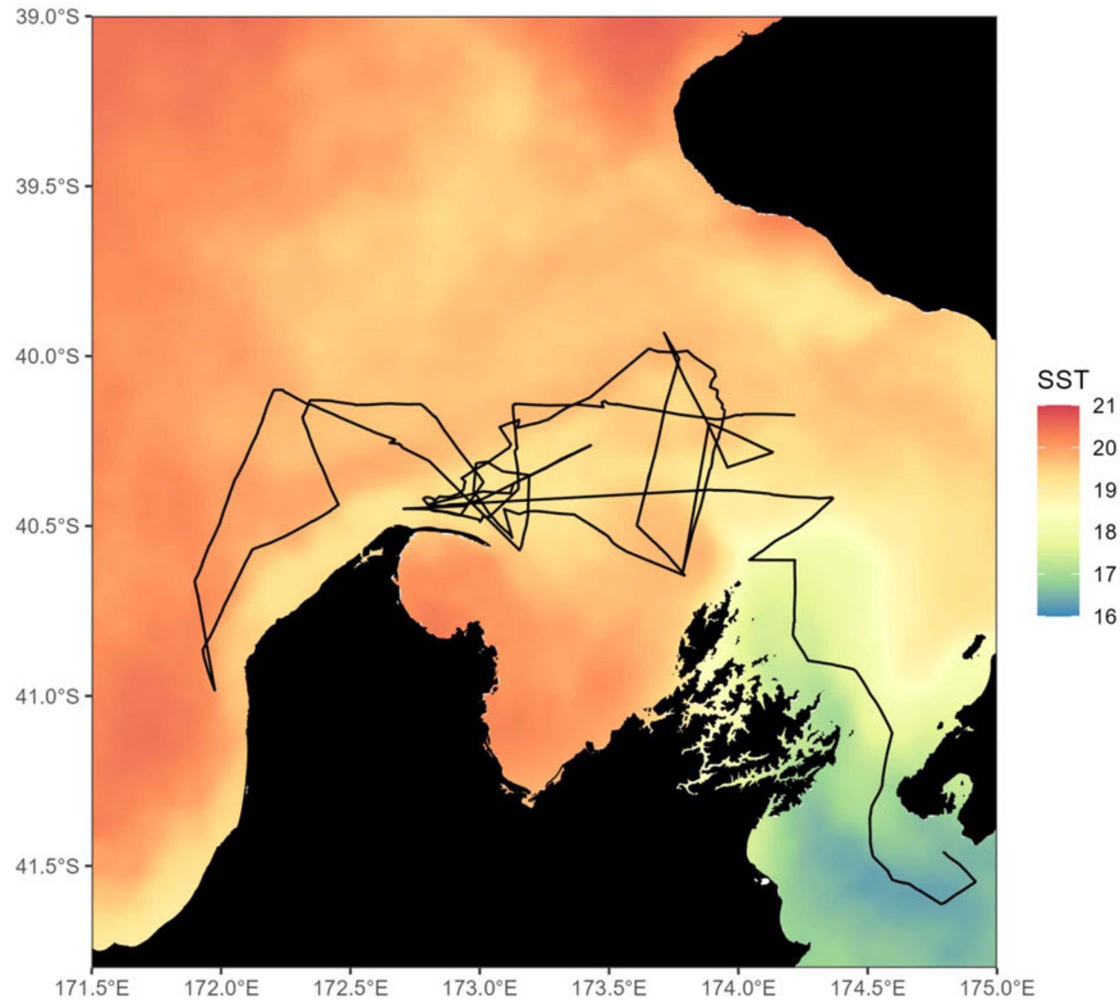


Figure 5. Mean daily sea surface temperature (SST) across all of our survey days from the MUR satellite, overlaid with survey effort (black tracklines).

Figure 6. A blue whale mother and calf pair surface off Wharariki, west of Farewell Spit, where a blue whale sighting aggregation persisted for much of the 2025 field season.

Blue whale sightings and behavior

Blue whale group sizes ranged between one and seven individuals (Fig. 7), including five mother and calf pairs. Foraging behavior was observed at 44% of sightings, most of which included observations of several surface lunge feeding events (Fig. 8). Social behavior, which included nursing and tactile interaction between mother and calf pairs and fast-paced racing behavior, was observed at 9% of sightings. Directed travel was observed at 3% of sightings, and the behavior state was unknown at 47% of sightings.

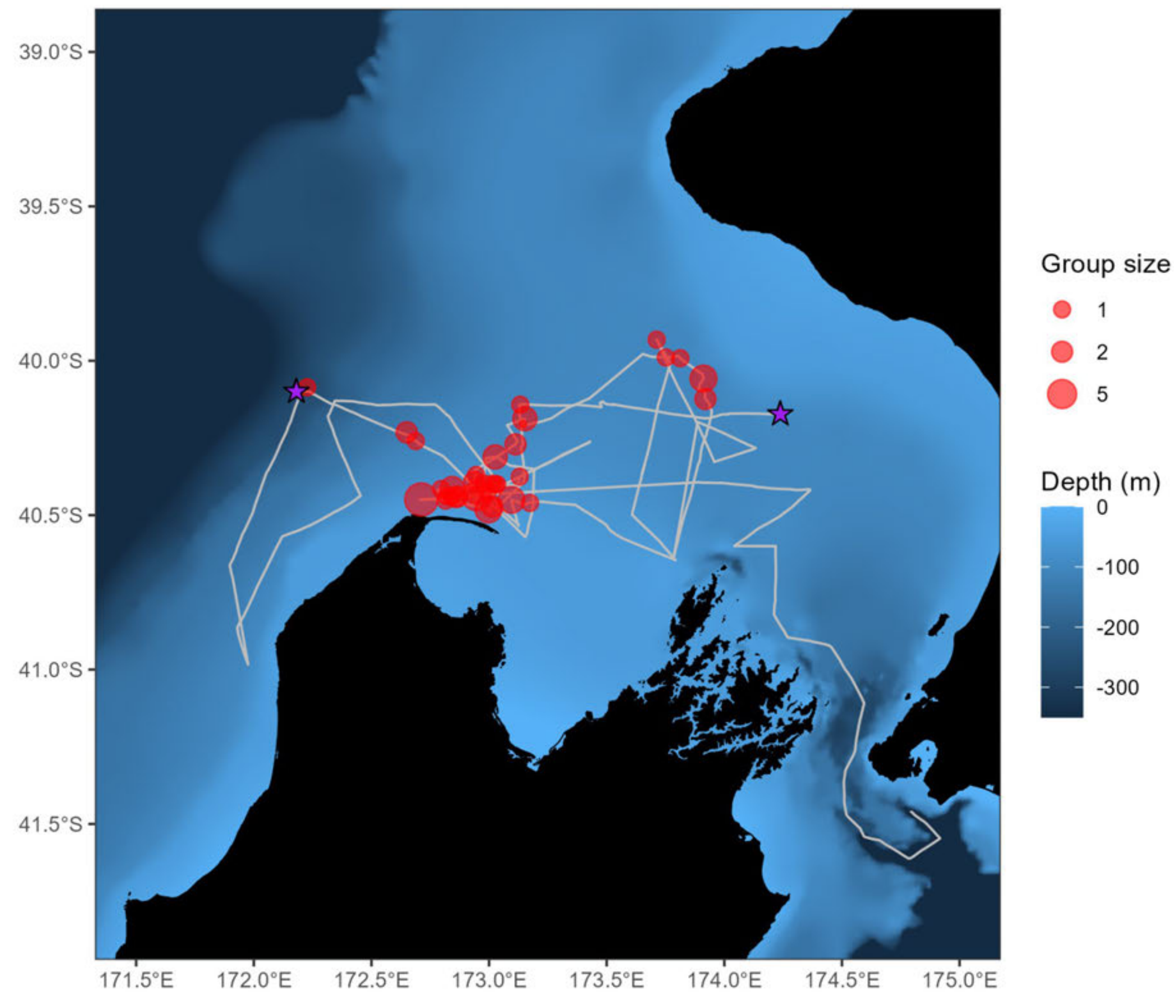


Figure 7. Map of survey effort and blue whale sightings for the 2025 field season. Visual survey tracklines are shown in gray. Blue whale sighting locations are depicted by the red circles, scaled by the number of individuals at the sighting (group size). Purple stars denote the hydrophone deployment locations.

Foraging was the most commonly observed behavior, including surface lunge feeding, sub-surface lunging and filtration observed from the drone, and repeated fluke-out dives in the same location. Dense aggregations of krill were frequently observed from the surface during blue whale foraging observations, and often groups of seabirds (e.g., fluttering shearwaters), and baitballs of fish and fish predators (e.g., gannets) were observed in the areas where blue whale feeding behavior occurred.

Figure 8. Photographs of surface lunge feeding behavior. Ventral grooves are visibly expanded as the whales engulf krill and water during a surface lunge.

Tissue sample collection

Sampling was undertaken by a skilled and experienced Department of Conservation staff member (Mike Ogle or Rosalind Cole), following the New Zealand Department of Conservation standard operating procedure “SOP for Remote Biopsy of Cetaceans” (DOC-3207548). Biopsy sampling effort was conducted from the bow of the *R/V Star Keys* or from the small boat tender (Brig) launched from the main vessel, depending on the conditions. We were fortunate to have good weather during many survey effort days, which allowed us to launch the Brig that enabled close approach (5 - 20 m) to whales for efficient and effective collection of tissue biopsy samples with accompanying photos to link each sample with the individual whale.

Skin and blubber biopsy samples were collected using a lightweight biopsy dart (cutting head size ~7 mm diameter, 20 mm length) fired from a PAXARMS biopsy rifle. We collected 26 biopsy samples from blue whales, and one from a humpback whale (Fig. 9). Of the 26 samples from blue whales, 22 samples included blubber for hormone analysis; the other four samples only contained skin. All samples were divided into sub-samples, placed into sterile tubes, and frozen in liquid nitrogen for the duration of the research cruise.

Each tissue sample was sub-sampled into three parts: (1) Skin for genetic analysis and archiving at the University of Auckland and the New Zealand Cetacean Tissue Archive. These samples were placed in sterile tubes with 99% ethanol after the cruise and then handed off to Dr. Emma Carroll at the University of Auckland on 20 February 2025 who will lead the genetic analyses and archiving. (2) Skin for stable isotope analysis to describe diet of the whales, which will be led by collaborator Dr. Sarah Bury at NIWA in Wellington. After the cruise these samples were stored in a -80 freezer at NIWA in Wellington, to await analysis. (3) Blubber samples were placed in a -80 freezer at NIWA in Wellington after the cruise until 21 February when they were transferred to a small polystyrene cooler with TechniIce to keep the samples frozen during transport to the United States. This cooler was hand-carried with appropriate permits by Leigh Torres back to Oregon where hormone analyses will be conducted to describe each whale's stress, nutritional, and reproductive state.

Additionally, two faecal samples were opportunistically collected from two different blue whales after defecations were observed. These samples were frozen in a -20 freezer on board the vessel. After the cruise, the faecal samples were included in the small polystyrene cooler with TechniIce and transported to the United States for hormone analyses.

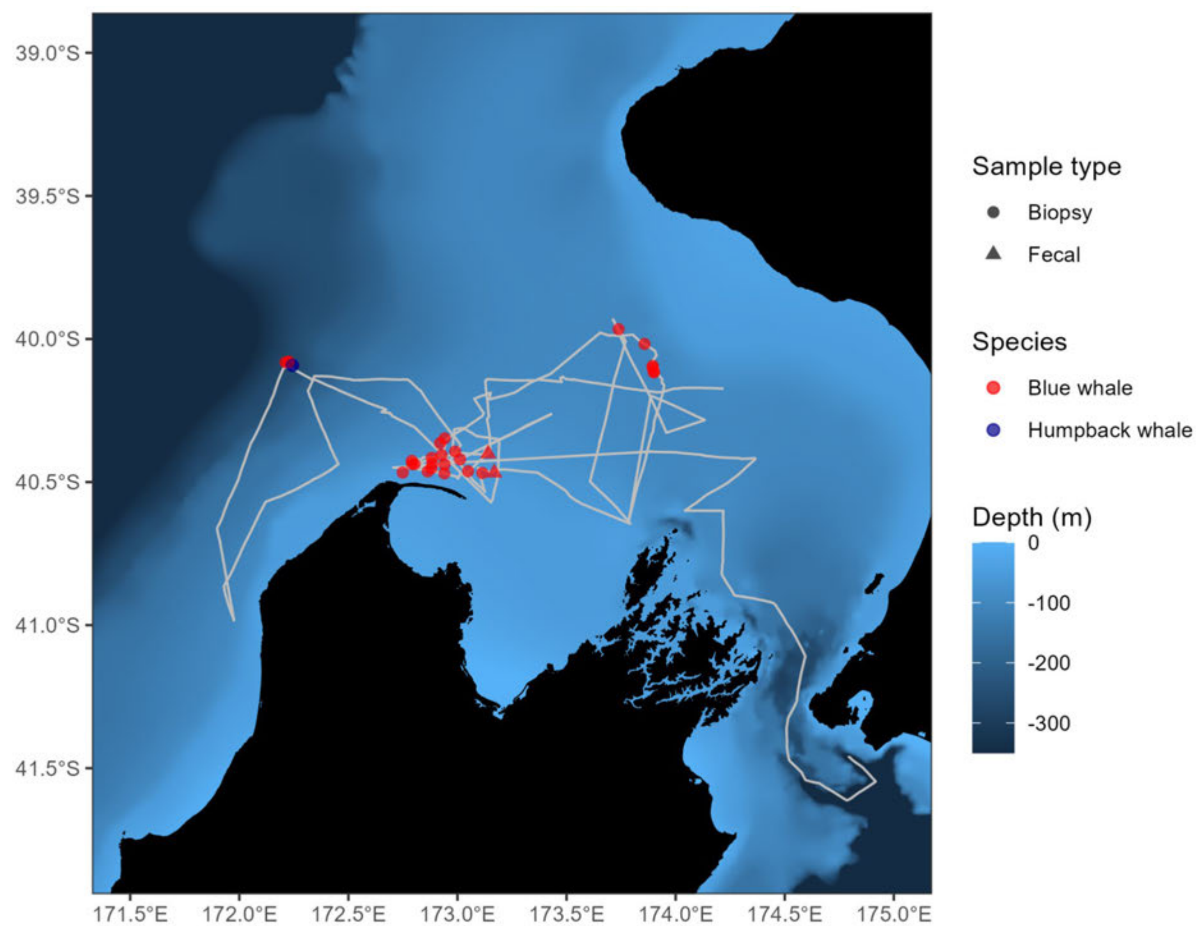


Figure 9. Locations of biopsy and faecal sample collection from blue and humpback whales in 2025. The gray line indicates our survey trackline.

Hydrophone deployment/recovery

Underwater acoustic recorders (hydrophones) are deployed at two different locations as part of the SAPPHIRE project, selected to record blue whale calls, other marine mammal vocalizations, and the ambient soundscape over the three-year duration of our study. The hydrophones are "Rockhopper" units designed by the K. Lisa Yang Center for Conservation Bioacoustics at Cornell University. The Rockhopper is a digital audio recording system contained in a positively buoyant 43 cm glass sphere, which is deployed on the seafloor using an iron weight anchor. A hydrophone mounted to the Rockhopper records acoustic data, which is stored on internal electronic storage media. To enable year-long deployments, the units record on a duty cycle to maximize battery and data storage capacity. The duty cycle was set to 15 minutes on/12 minutes off, with an archival rate of nine minutes and a sampling rate of 197,368 Hz. After a year-long deployment, each Rockhopper is sent an acoustic command from the research vessel to release itself from the anchor and float to the surface for recovery.

Two hydrophones were deployed during the 2024 field season and were recovered during the 2025 field season (Fig. 7). The RH-east unit, which is located inside the STB in 90 m water depth, was recovered on 28 January. The RH-east hydrophone recorded for 316 days, which is ~six weeks less than the intended recording period. The RH-west unit, which is located offshore to the west in 255 m water depth, was recovered on 1 February after recording for the full 361 days since deployment. In total, the two units recorded 10.5 Tb of acoustic data. The duty cycle was programmed the same way for the 2025 deployment as it was in 2024, and the engineering team at Cornell University is investigating what led to the shorter than expected recording duration for the RH-east hydrophone. Immediately following each hydrophone recovery, a replacement Rockhopper was deployed in the same location. In January 2026, we will recover the newly deployed units to retrieve the acoustic data and replace them with two different Rockhoppers.

Next steps for analysis of the recorded passive acoustic data collected in 2024 include the development and application of automated detectors to identify blue whale song (reproductive) and D-call (social/feeding) vocalizations.

Drone-based photogrammetry

One of the goals of the SAPPHIRE project is to collect body condition measurements of blue whales using drone-based photogrammetry. We used a DJI Mavic 3 Classic with an attached LiDAR altimeter to improve accuracy of altitude recordings. We hand-launched and recovered the drone from the back deck of the *R/V Star Keys*. We collected videos of each whale at an altitude between 19 and 80 m. This field season we flew over a total of 53 blue whales, consisting of over 40 unique individuals. We observed and recorded surface lunge feeding in eight flights (10 whales, Fig. 10) and nursing behavior in two flights from two separate mother and calf pairs (Fig. 11).

We are using VLC Media Player to collect snapshots of the whale in a flat body position at the surface with minimal obstruction of the edge of the body from waves, refraction, or glare. We use MorphoMetriX v2 open-source photogrammetry software to measure the total length (TL, tip of rostrum to fluke notch) and body widths (in 5% increments of TL) of each whale in the snapshots (Fig. 12). We will use the TL of each whale to help determine if they are a juvenile or adult, i.e., a juvenile if their length is <19.2 m, which is the average length at sexual maturity. We are calculating body condition as the Body Area Index (BAI), a scale-invariant, unitless metric with high precision and low uncertainty. BAI is calculated as the surface area standardized by the length of the body region known for lipid storage, which for blue whales is body widths between 20-90% (Fig. 13). We will use the R package 'Xcertainty', which was created by the Marine Mammal Institute's Center of Drone Excellence (CODEX), to incorporate photogrammetric uncertainty so that measurements from all years of data collection are comparable.

Figure 10. Example of an Aotearoa New Zealand Pygmy blue whale surface lunge feeding observed with a drone.

Figure 11. Example of nursing behavior of an Aotearoa New Zealand Pygmy blue whale mother and calf pair observed with a drone.

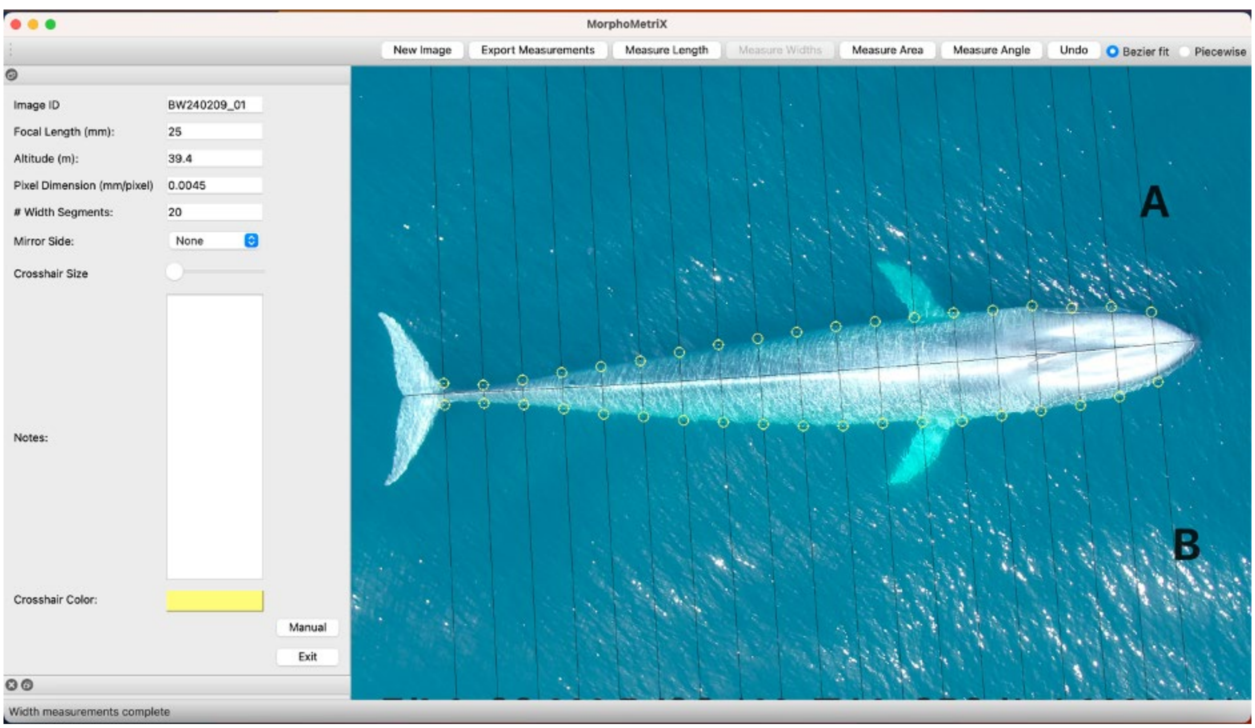


Figure 12. An example of an Aotearoa New Zealand Pygmy blue whale being measured in MorphoMetriX v2, open-source photogrammetry software.

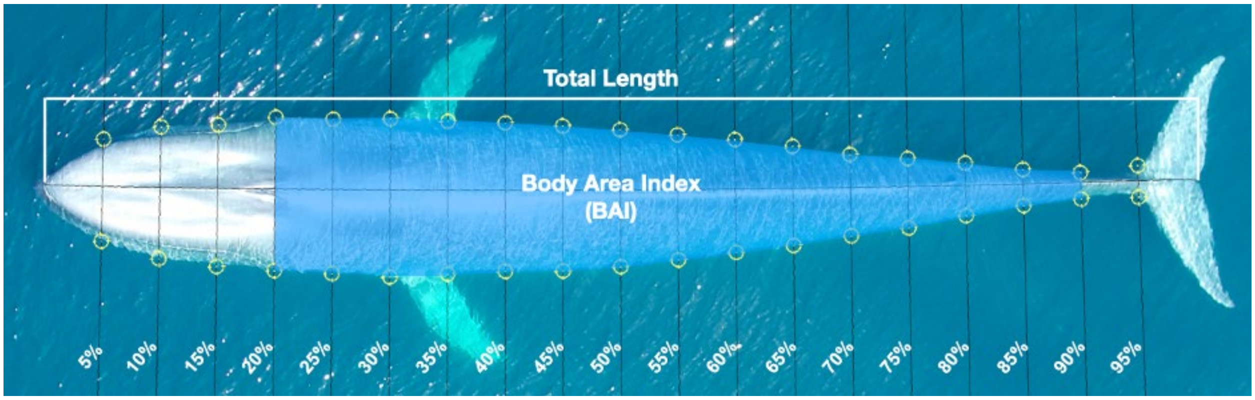


Figure 13. A schematic of the total length and the body region (between widths 20-90%) used to calculate Body Area Index (BAI), shaded in blue, of an Aotearoa New Zealand Pygmy blue whale.

Krill Acoustics and Oceanographic Sampling

Hydroacoustic backscatter data were collected using a pole-mounted Simrad EK80 echosounder, configured with calibrated 38 kHz and 120 kHz split-beam transducers and a WBT mini transceiver connected to a laptop and GPS receiver. We collected acoustic data during every day of visual survey effort. When conditions were rough or we elected to survey at a faster speed (> 8 kt), the pole was raised out of the water and acoustic data collection was halted. Following all blue whale sightings, we re-deployed the pole to map the prey field in the vicinity of the whale. Next, the data will be processed using Echoview software to identify krill aggregations and measure attributes such as their density as well as the depth, thickness, and length of the aggregations.

In order to validate acoustic backscatter and attribute it to krill or non-krill targets, this year we included a drop-camera system integrated to our oceanographic sampling. "LOLA" (Lowered Oceanography with Lights and Action) is a custom-built device consisting of an RBR Concierto3 conductivity, temperature, and depth (CTD) sensor configured with two Keldan Video 4x 10,000 lumen lights and a GoPro HERO12 Black in an Isotta underwater housing. Both the lights and camera housing are rated to 200 m depth, limiting the depth of LOLA deployments to no greater than 200 m. LOLA was deployed 58 times during our field season, with an average of 4.8 casts (range 0-7) conducted per day of visual survey effort. Preliminary analysis of video footage collected during LOLA deployments successfully identified krill as well as other zooplankton (e.g., amphipods, salps, and jellyfish) and larval fish.

We collected 58 water column profiles with the CTD sensor attached to the LOLA device (Fig. 14). These included measurements of the temperature and salinity collected at a high-resolution (8 Hz) sampling rate as the CTD is lowered, and allow for re-construction of water column characteristics, such as the depth and temperature of the mixed layer, and the strength of the thermocline, which may impact krill availability and blue whale foraging. Additionally, these water column profiles will be compared to CTD casts collected in 2014, 2016, 2017, and 2024 using similar methods, to increase our understanding of the inter-annual variability in the oceanography of the STB region.

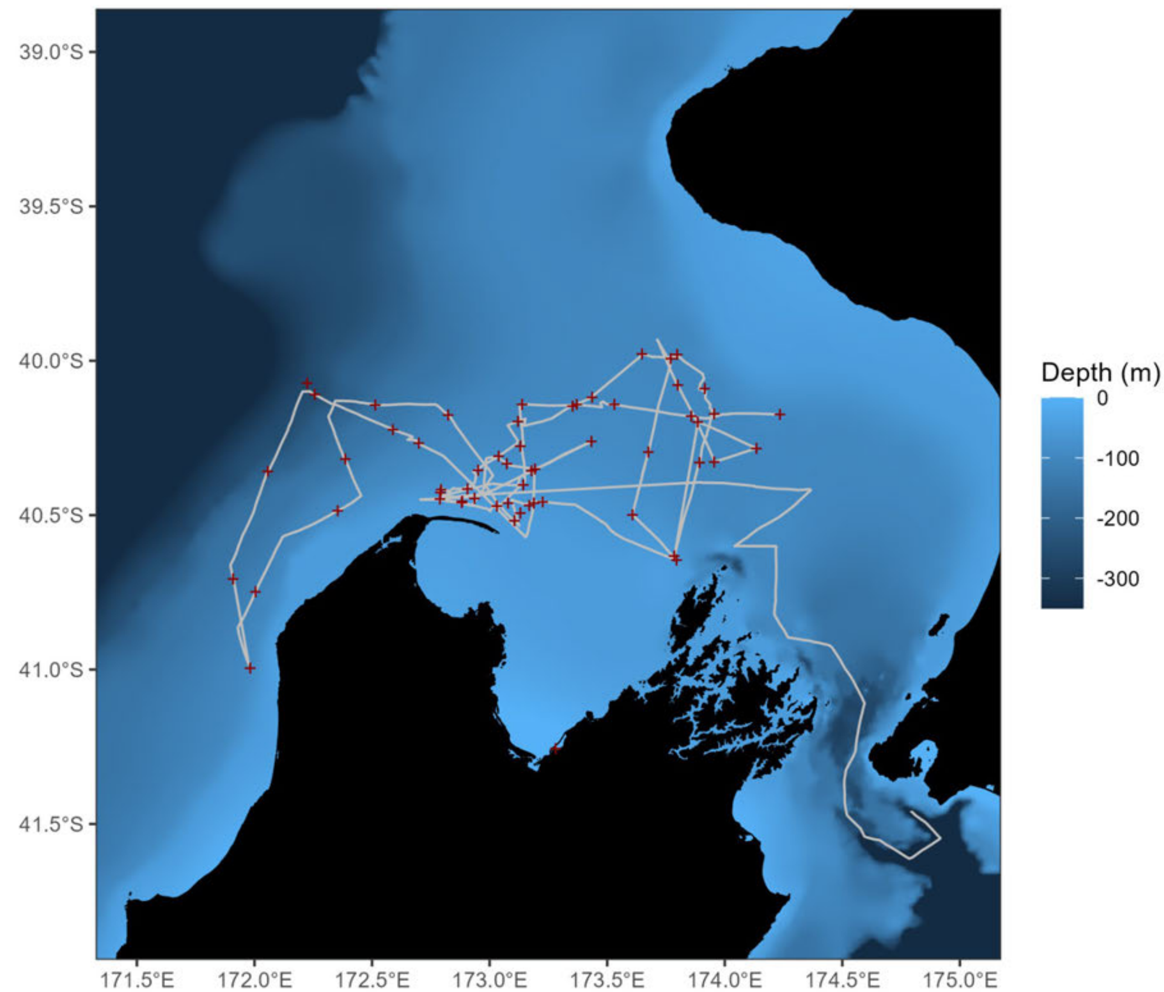


Figure 14. Oceanographic sampling locations (red crosses) during the 2025 survey. Visual survey tracklines are shown in gray, and CTD/LOLA cast locations are depicted by the dark red crosses.

Krill collection

Krill were collected at seven locations in the South Taranaki Bight (Table 2, Fig. 15).

Table 2. Details of krill collections, including date, waypoint number, GPS coordinates and collection method. Dip netting was done from the side of the vessel. The ring net was provided by NIWA and was one half of a Bongo net. This was towed near the surface behind the vessel using the crane to hold the wire out to port. The two dip nets associated with waypoints 884 and 887 were carried out from the Brig in the vicinity of blue whales.

Date	Waypoint	Longitude	Latitude	Collection Type
5-Feb-25	96	172.793385	-40.430234	Dip net
10-Feb-25	184	173.177669	-40.459268	Ring net
10-Feb-25	201	173.059642	-40.453804	Dip net
10-Feb-25	202	173.067157	-40.454268	Dip net
12-Feb-25	884	172.931532	-40.473441	Dip net
12-Feb-25	887	172.941362	-40.468739	Dip net
13-Feb-25	229	172.882361	-40.45912	Dip net
13-Feb-25	233	172.787929	-40.446734	Dip net
14-Feb-25	270	173.296263	-40.311197	Ring net
14-Feb-25	280	173.147116	-40.396397	Dip net

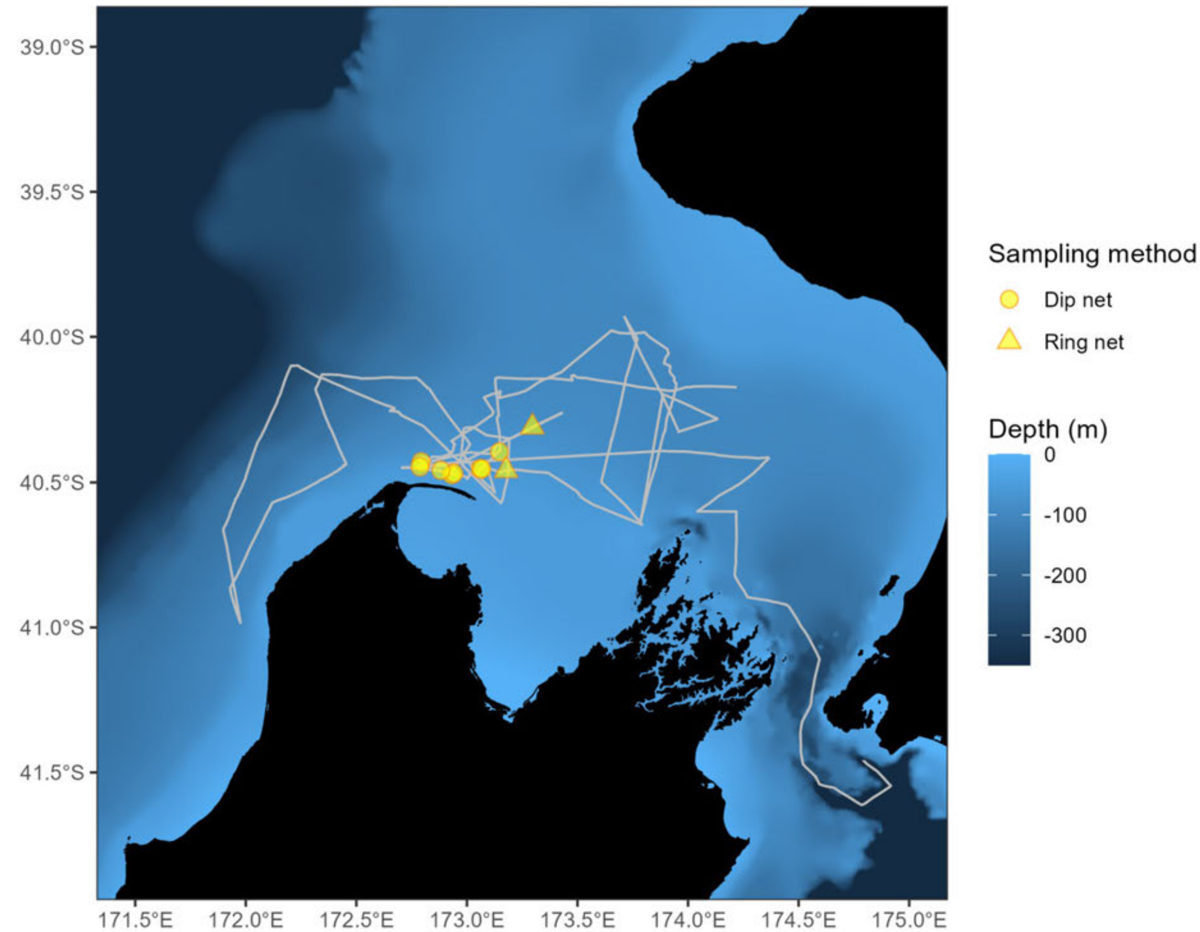


Figure 15. Krill sampling locations during the 2025 field season. Visual survey tracklines are shown in gray, and krill collection locations are shown in yellow, with the collection method denoted by the shape.

At each collection site, all or a subset of the krill were placed into 2 mL cryovials and immediately flash-frozen in liquid nitrogen, where they were stored until sorting back in the laboratory at NIWA. In the laboratory, vials of krill were thawed out and a subset of individuals from each collection site were measured for length (front of the eyes to end of the uropod). A further subset of measured krill were individually freeze-dried and their dry mass measured on an analytical balance. The remaining measured krill were freeze-dried in batches of ~10 individuals and transported back to the United States for later analysis of caloric and protein content. A subset of the individual measured and weighed krill were left at NIWA with Dr. Sarah Bury for stable isotope analysis and total lipid measurements.

Krill lengths ranged from 7.33 mm to 17.46 mm (mean = 12.70 mm; standard deviation = 1.98 mm; n = 942). Dry mass of individual krill ranged from 1.33 mg to 9.10 mg (mean = 4.30 mg; standard deviation = 2.00 mg; n = 84 to date).

Krill experiments

Three sets of respiration rate experiments were conducted on krill collected during our survey (Table 3). Data will be analyzed in the coming months to assess how krill respiration rates change with different water temperatures.

Table 3. Overview of respiration experiments.

		Number of krill used at each temperature			
Date	**Waypoint**	**14˚C**	**16˚C**	**18˚C**	**20˚C**
5-Feb-25	96		3	11	
13-Feb-25	229	3		11	
14-Feb-25	270		3		11