Hon. Kit Toogood

Panel Chair

C/- The Environmental Protection Agency

Dear Hon. Kit Toogood,

REVIEW OF INFORMATION ON FINFISH[1] AND FISHERIES RELEVANT TO THE TARANAKI VTM PROJECT (FTAA-2504-1048)

Dated: 12 January, 2026

EXECUTIVE SUMMARY

This report is prepared for the Expert Panel as an independent technical review of the information before it on potential effects of the proposed iron sand extraction and processing activities on finfish (including sharks) and on commercial and recreational fisheries in the South Taranaki Bight (STB). It is a review of existing material only. I have not undertaken field investigations, new modelling, or laboratory analyses. My role is to assist the Panel by identifying plausible effects pathways, testing the applicant's key assertions against the available evidence and scientific literature, and clearly distinguishing between matters that can be concluded with confidence and those that remain subject to material uncertainty.

The review focuses on four principal pathways by which the proposed activity could plausibly affect finfish and fisheries outcomes:

1. **Suspended sediment concentration (SSC) and turbidity exposure**, including direct physiological and behavioural effects on fish and indirect effects mediated through habitat quality.
2. **Optical effects**, including plume-induced reductions in light penetration and euphotic depth, and the implications for reef macroalgae productivity and associated nursery function.
3. **Underwater noise**, particularly sustained operational noise and its potential to cause avoidance, masking, or redistribution of fish at spatial scales relevant to fisheries.
4. **Benthic habitat disturbance and recovery**, including the adequacy of evidence supporting claims of rapid recovery following excavation.

The assessment explicitly considers fisheries outcomes, not only fish responses, recognising that fisheries effects are mediated by regulatory, spatial, and operational constraints, including Fishstock/QMA boundaries, closures, and ACE availability.

I have also reviewed the proposed consent conditions insofar as they are relied on to manage fisheries-relevant risk, including baseline characterisation, monitoring and trigger frameworks, governance arrangements, and noise criteria. Where the evidence record does not yet describe

[1] Finfish is a term that distinguishes swimming fish (e.g. snapper, tuna) from other organisms that are "fished" (e.g. pipis, paua, crayfish). Finfish includes teleosts or bony fish (e.g., snapper, tuna) and elasmobranchs or cartilaginous/non-bony fish i.e. sharks and rays. For simplicity, 'fish' and 'finfish' are interchangeable for the remainder of this document and both carry the meaning referred to above. Any reference to non-finfish fished organisms will be clarified as necessary.

exposure magnitude and duration in a fisheries-relevant way, or where enforceability and attribution present difficulties, that uncertainty is stated plainly.

Overall, while the evidence does not demonstrate stock-scale sustainability impacts, it does not support the level of confidence implied by the applicant's characterisation of "no more than minor" effects. Several pathways present credible risk of localised changes in fish distribution, habitat function, and catchability, with consequences that may be material for some commercial and recreational fisheries, particularly where flexibility to absorb displacement is constrained.

KEY CONCLUSIONS

1. **Noise – behaviour – fisheries pathway**: On the evidence reviewed, it is plausible that sustained operational underwater noise from mining activities could cause avoidance and redistribution of some finfish over spatial scales of relevance to fisheries, with consequent changes in local catchability and fishing efficiency. The magnitude, duration, and spatial extent of such effects remain uncertain and are not yet expressed in a way that enables firm conclusions for this project.
2. **SSC exposure – fish response**: Elevated suspended sediment concentrations can plausibly affect finfish through gill irritation, impaired feeding, growth effects, and avoidance behaviour. However, fisheries-relevant outcomes depend on exposure magnitude and duration, which are not currently characterised with sufficient specificity to allow confident assessment of effect thresholds.
3. **Optical effects – reef productivity – nursery function**: Modelled reductions in euphotic depth in the vicinity of Pātea Shoals and Graham Bank raise a credible risk to reef macroalgal productivity and associated nursery habitat function, including the documented juvenile blue cod nursery at Site V. The spatial extent and biological significance of this risk remain uncertain.
4. **Benthic habitat recovery claims**: Statements in the application regarding rapid benthic recovery following excavation are not adequately supported by traceable expert evidence in the material reviewed and should not be treated as established.
5. **Fisheries displacement constraints**: Where fish redistribution occurs, fisheries impacts will be mediated by Fishstock/QMA boundaries, regulatory closures, and ACE availability (including settlement quota constraints). These constraints materially affect whether displacement is a practical or legally available mechanism for absorbing effects.
6. **Reliance on conditions**: The proposed conditions place significant reliance on baseline characterisation, percentile-based limits, monitoring, and adaptive management. Whether those mechanisms are sufficient to manage the identified risks depends on whether exposure regimes (SSC, optical effects, noise) can in practice be kept below ecologically relevant thresholds and whether triggers are enforceable in a naturally variable environment.

Given the level of uncertainty and therefore the reliance of the application on monitoring, adaptation and compliance limits to manage fisheries risk, I suggest that the Panel examines carefully if the conditions framework will be effective. In particular, I suggest examining:

(a) whether the SSC limits and triggers are **ecologically protective**, not merely statistically derived from "background variability", for the identified vulnerable pathways (reef productivity/nursery and fisheries catchability/distribution);

(b) how a "direct causative link" will be demonstrated at the Response Limit **in real time**, and what occurs if causation cannot be shown but exposure is increasing;

(c) whether the monitoring suite includes the right endpoints for **optical effects at reefs** (light attenuation/euphotic depth), rather than relying on SSC as a proxy for a light-driven habitat function risk;

(d) whether the "cease extraction" rule is operationally enforceable and timely, given the exceedance definition and natural plume variability;

(e) whether the underwater noise conditions are grounded in **project-specific empirical data** early enough to support reliance on predicted spatial contours and effect assumptions; and

(f) whether the Kaimoana Monitoring Programme's triggers and "desired actions" are framed so they **compel operational response**, rather than functioning as reporting channels without binding decision rules.

INTRODUCTION

Personal Statement

1. My name is Paul Robert Taylor. I hold the degrees of MSc Hons in Zoology, MPhil in Statistics, and BSc in Biological Sciences, all from the University of Waikato.

2. I have worked in fisheries research since 1986, mostly in the area of pelagic fish. Since leaving NIWA in 2011 and starting Statfishtics Ltd., I have provided advice in the form of reports to salmon farm companies on the effects of farms on wild fish, and methods to mitigate these effects. I have also provided advice on the effects of salmon farms on various seabird species including shags and yellow-eye penguin.

3. I have been engaged here by the Environmental Protection Agency (EPA) to act as an independent expert to provide a technical review of information addressing effects on fish, sharks, and fisheries (commercial and non-commercial) generated by the proposed iron sand extraction and processing activities in the South Taranaki Bight (STB) associated with the Taranaki VTM Project.

4. I confirm that, in my capacity as author of this report, I have read and abided by the Environment Court of New Zealand's Code of Conduct for Expert Witnesses Practice Note 2023.

Purpose and scope

5. The purpose of this review is to assist the Panel to understand whether the application documents provide a sufficient and reliable basis for understanding the effects of concern and associated risks on wild and fished finfish species present within the proposed project area (PPA) and the surrounding environment, and the commercial and non-commercial fisheries targeting those species.

6. This review is confined to finfish (including sharks) and fisheries pathways and does not provide planning conclusions. Where information is uncertain or incomplete, I identify the uncertainty, explain why it matters to the risk profile, and indicate how that should affect confidence in effects conclusions and any reliance on adaptive management.

7. I have also been instructed to focus on the effects of concern, key disagreements among experts/other parties concerning effects on finfish, including sharks, and the fisheries for them in the STB, as well as highlighting key uncertainties (e.g., lack of data, modelling assumptions, natural variability, unknowns in species/habitat sensitivity).

8. This brief also includes assessing the quality of the information supplied (survey data, modelling, literature, local ecological knowledge, fisheries catch information) is sufficiently comprehensive and up to date to constitute the best available information. I am also asked to note important gaps and weaknesses.

9. I am to provide advice on whether any effects of concern that are identified can be effectively avoided, remedied, or mitigated, including the feasibility of monitoring; and to comment on any limitations in the proposed mitigation/management framework (consent conditions).

10. I have reviewed the documents suggested by the EPA that are relevant to the proposal. These are listed in Appendix I. I have also referenced documents from the scientific literature to resolve points of uncertainty and support the position I have taken. Any of these that I have cited are included within the review document as footnotes where they are first cited. Further reference to them in the text is often simply marked by the footnote number of the original citing.

Other issues

11. There has been recent concern about a reported sighting of juvenile great white shark (*Carcharodon carcharias*) spending time in the STB with the suggestion that this might be evidence of a nursery area for this listed species. There is no previous information of this occurring. The source of the reported sighting would require confirmation.

POTENTIAL EFFECTS OF THE MINING ON FINFISH

Statements about effects on fish in the application document[2]

12. Trans-Tasman Resources Ltd (TTR) is applying for consents for iron sand extraction in the South Taranaki Bight (STB). The proposed project area (PPA) is located within the STB in an area of seabed known as the “Rolling Grounds” and adjacent to an area of seabed known as “Pātea Shoals”, approximately 25-40 km offshore in water depths of 25-45 m.

13. The following is stated in the Executive Summary to the TTR application document (p. x) (emphasis added): “The scientific data collated to inform the Project demonstrates the overall effects on fish species and populations **will generally be no more than minor**, and that there will be **no effect on either the abundance or health of the commercial or recreational fisheries** in the STB”.

14. On the information reviewed, I am not satisfied this statement is supported to the level of confidence implied, because key effects pathways are not fully anchored to exposure thresholds, duration, and evidence of species and habitat sensitivity, and some important uncertainties remain unresolved. Those uncertainties mean the application’s “no effect” characterisation should be treated with caution. At a minimum, it is reasonably foreseeable that mining-related disturbance (including noise and plume/deposition processes) will alter fish distribution and/or catchability at a local scale, which may in turn affect the reliability of fishing for some operators in or near the PPA (even if wider stock-scale effects are not demonstrated on the current record). Mining induced ecological events

[2] Trans-Tasman Resources Ltd (TTR) Taranaki VTM Project Fast-Track Act Application document (2025) (TTR application/application document). Trans-Tasman Resources Ltd, *Taranaki VTM Project Fast-track Application* and supplementary fisheries material (as filed).

15. The immediate effects of the mining operation on finfish will, in its earliest phase, take the form of four relatively sudden ecological events: (1)underwater noise generated mining machinery[3] (2) artificial lighting associated with vessels and machinery, (3) physical alteration of benthic habitat within the mined footprint and (4) changes to the pelagic environment associated with the formation of the suspended sediment plume (and associated deposition).

16. Three of the ecological events introduce potential effects of concern for finfish, which are likely to impact them both directly and indirectly. The fourth (artificial light) may influence attraction and aggregation for some species, although any such effect may be moderated or outweighed by avoidance behaviour associated with noise and activity.

17. Fish habitats beyond the excavation will also be affected by the suspended sediment plume: (1) its physical presence as elevated SSC in the water column, (2) changes to optical properties (i.e., reduced light penetration and altered water colour) and (3) deposition of suspended material on benthic habitats from the plume occurs. The extent, frequency, and duration of these exposures (and their biological significance) are central uncertainties that require clearer linkage to thresholds and effects pathways.

18. As mining proceeds, these disturbance pathways will continue to impact the local environment to an increasing degree. The plume is expected to develop in the manner described in the application and the modelling reports. Associated changes in optical properties (including reduced light penetration expressed as light availability and euphotic zone depth) are described in the application (see p.154). The following paragraph is quoted from the application document (p. 142; emphasis added).

19. "The sediment plume model outputs have been used to refine and model the impacts on optical properties of the water column. The changes of potential concern in terms of water column and seabed ecology are underwater visibility for visual feeders and light attenuation for primary producers (i.e. water column and seabed micro-algae and seabed and reef macroalgae). **As for the sediment plume, there is considerable background variability in optical properties and the effects of the project are likely to be highly variable in time and space - depending on prevailing conditions**."

Noise

20. No substantive discussion is provided by TTR regarding the effects of ongoing operational underwater noise on finfish inhabiting the zone that includes or is influenced by the excavation site. While underwater noise is discussed extensively with reference to marine mammals, the application makes only a brief reference to fish in the context of "noise sources" (Section 5.6.1, p. 188) and that reference is treated as something fish would simply move away from. In my opinion, that is not a sufficient basis for the categorical fisheries-level conclusions expressed elsewhere in the application.

21. Fish are vulnerable to elevated ambient underwater sound because of the various ways they utilise sound. This includes sound reception and emission for communication with conspecifics, (including warning/alerting sounds), perceiving predators and as a strategy for startling them. Sound communication is also common in courtship and breeding. However, a limitation of fish communication is that they largely communicate using low frequency (<1 kHz) sound[4] and

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[3] M.K. Pine (2025). Review of Information on Underwater Generated Noise from the Taranaki VTM Project (FTAA-2504-1048). 17 pp.

[4] Ladich, F. (2019), Ecology of sound communication in fishes. Fish & Fisheries. 20:552–563. https://

unlike other animals have limited ability alter the loudness or frequency in their calls[5]. Consequently, fish proven maximum communication distances are approximately 10m and much less on average.

22. Ambient noise can affect fish sound communication in several ways[6]. Masking is an immediate effect where a biologically relevant sound is drowned out or confused by a simultaneous ambient noise of overlapping frequency. The immediate result is that the effect raises the hearing threshold of the fish so the sound is more difficult to detect while the noise persists. Once the masking noise ceases detectability may return to baseline (subject to whether other noise-related impacts, such as threshold shift, have occurred).

23. Temporary threshold shift (**TTS**), has been demonstrated in multiple fish species (including across non-related taxa) (see[6]). In contrast to masking, TTS is a temporary hearing loss that occurs following exposure to a sound that is intense or prolonged enough to cause physiological fatigue or minor, reversible damage to the sensory hair cells of the fish's inner ear. In this case the hearing threshold remains elevated after exposure to the sound has ceased, returning to baseline over a period that is intensity-duration dependent and can range from minutes to days or weeks.

24. Where exposure is more intense or prolonged, irreversible damage can occur causing permanent threshold shift (PTS), usually through damage to their sensory hair cells.

25. A review of the effects of loud noise on fish[7] compiled information from multiple studies and reported results from a field study[8,] where sonar mapping and fishing trials (trawls and longlines) were used with seismic shooting in a 7, 5, 5 days before, during, and following (respectively) found that, for the entire 5,500 km^2 study area seismic shooting severely affected fish distribution, abundance and catch rate. Trawl catch of both haddock *Melanogrammus aeglefinus* (L.) and Atlantic cod *Gadus morhua* L. and longline catch of haddock dropped 50% following shooting, with the longline catch of cod reducing by 21%. Catch rate reductions occurred 33 km from the seismic shooting area and abundance and catch rates did not return to pre-survey levels within the five days after use of seismic airguns for geologic exploration had ceased.

26. Properties of the seismic airgun from this study were not included in the review, but in a repeat of the study[9] they were reported as 140-191 dB *re* 1 μPa. Reporting of this second study was similar in some regards but was more detailed and investigated additional factors making it difficult to summarise here.

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doi.org/10.1111/faf.12368.

[5] Amorim, M.C.P. 2006. "Diversity of sound production in fish," In: Ladich, F., Collin, S.P., Moller, P., and Kapoor, B.G. (Eds.). Communication in Fishes. Enfield: Science Publishers 1: 71–104.

[6] Ladich, F. (2013). Effects of noise on sound detection and acoustic communication in fishes. In H. Brumm (Ed.), *Animal Communication and Noise* (pp. 65–90). Berlin, Heidelberg: Springer-Verlag. https://link.springer.com/chapter/10.1007/978-3-642-41494-7_4

[7] Weilgart, L. (2018) The Impact of Ocean Noise Pollution on Fish and Invertebrates. Report for OceanCare, Switzerland. 34 pp.

[8] Engas, A., Løkkeborg, S., Ona, E. & Soldal, A. V. (1996). Effects of seismic shooting on local abundance and catch rates of cod (*Gadus morhua*) and haddock (*Melanogrammus aeglefinus*). *Canadian Journal of Fisheries and Aquatic Science* **53,** 2238–2249.

[9] Lokkeborg, S., Ona, E., Vold, A., and Salthaug, A. 2012. Sounds from seismic air guns: gear-and species-specific effects on catch rates and fish distribution. Can. J. Fish. Aquat. Sci. 69 (8): 1278-1291.

27. The same review[7] also reported[10] several pelagic species including blue whiting (*Micromestisius poutassou*) and Norwegian spring spawning herring (*Clupea harengus* L.) in which investigators found that with the use of seismic air guns the abundance of fish increased 30–50 km away from the ensonification, suggesting that migrating fish would not enter the zone of seismic activity.

28. The two studies above provide indicative evidence that repeated anthropogenic noise can elicit behavioural responses in fish, including redistribution and changes in catchability, although direct transfer of magnitude to the STB/TTR context is uncertain. Although the sound category is continuous in the STB/TTR case and therefore dissimilar to the intermittent/impulsive category of the examples, the relevant concern in the present context is that sustained exposure of fish to operational noise from mining machinery could cause masking and/or injury-related effects (where exposure levels are sufficiently high), leading to avoidance and altered habitat use. Such responses could, depending on the received level, frequency content and duty cycle of the source, translate into local reductions in catchability within the PPA and potentially redistribution beyond the PPA. At present, the material reviewed does not provide sufficient specificity to confirm whether the Schedule 7 120 dB contour is an appropriate proxy for the spatial extent of fish behavioural response in this context. Accordingly, further information is required to: (i) define the relevant acoustic metric used for the contour (e.g., SPL/SEL and averaging period);(ii) confirm source characteristics and propagation modelling inputs; (iii) test the contour against empirical measurements; and (iv) identify the behavioural threshold(s) being protected. If the concerns raised by Dr M K Pine regarding the underwater noise assessment materially affect contour derivation or metric selection, the 120 dB contour may require revision before it can be relied on for effects assessment and conditions compliance**.**

29. Underwater noise caused by the mining excavations may induce movement of fish away from an extended zone. The effect on fish distributions of largely continuous noise from ongoing mining over a period of up to 35 years, the proposed time intended for the TTR project, is unknown.

30. In the event of sustained disturbance, a fish is not constrained and can, of course, swim away from the sound's source. As in the first study described above, this could result in localised reductions in catch rate with the potential for corresponding increases elsewhere. The result from the second study reduces some of the uncertainty related to the distance over which the movement of fish into the loud noise zone might be affected, however, how this may apply to the project area is unknown and therefore does not allow for a confident inference.

Artificial lights

31. It is difficult to predict the effects of artificial lights on fish in this context. Attraction of fish to artificial lights is well documented and is used operationally as a method for luring fish. However, in the present setting the potential attraction effect may be outweighed by avoidance responses to noise and physical disturbance associated with excavation and plume formation.

32. From Thomson 2013[11]: "For fish and squid, any effects of the iron sands extraction vessel as a source of artificial nocturnal light are likely to be very localised and centred on the vessel itself: some species of both groups could potentially aggregate in the water column close to the

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[10] Slotte, A., Kansen, K., Dalen, J. & Ona, E. (2004). Acoustic mapping of pelagic fish distribution and abundance in relation to a seismic shooting area off the Norwegian west coast. *Fisheries Research* **67,** 143–150.

[11] Thompson, D. 2013. "Effect of ships lights on fish, squid, and seabirds". NIWA Client Report WLG2013-16. Updated November 2015.

vessel, but these effects are highly unlikely to have any measurable population level impact on the attracted species".

Habitat degradation/sensitivity

33. The STB contains a number of finfish habitats that may be vulnerable to change under activities associated with the proposal (including excavation, plume exposure, optical change, and deposition), and those changes have the potential to affect local fisheries through altered habitat function, fish distribution, and catchability. The degree of impact will depend on (at a minimum) the spatial extent and duration of habitat alteration, the sensitivity of affected habitats (including any reef-associated features), and the extent to which affected fisheries can practicably adjust to given spatial constraints.

Within the PPA

34. According to NIWA's[12] analysis of the relatively recent period between fishing year 2007-08[13] and 2022-23 (inclusive), the PPA has produced a fishery dominated by bottom trawl and set net target activity throughout the period.

35. Bottom trawling has been the most important commercial fishing method making 235 (55.2%) of the total 425 fishing events in the PPA. However the number of events for this method have decreased gradually following a peak of 50 events in 2011, to an extreme low during the last three years of the series with zero, two and six events respectively. Set net has been the second most important method with 163 events throughout the period, but declining from 2017 to 2021 and a resurgence to 16 and 14 events respective to the last two years of the series. The other three contributing methods were bottom longline, hand line and purse seine with total events of 14, 8 and 5 respectively throughout the period but with them only registering catch in a total of 5, 4 and 3 years of the series respectively.

36. This summary for the PPA is part of an overall summary for all five subareas of the main area of interest related to the proposed mining that also includes the median SSC and 99th percentile areas associated to the mining A and B sites. In referring to the overall summary for all subareas, the NIWA report[12]provides the additional information that "the number of commercial fishing events summarised here underestimates those from a number of smaller vessels working in the STB, as for most of the time-period they were not required to report at the level of individual fishing events. Only since the 2019/20 fishing year have smaller vessels begun to report at this resolution with the introduction of the Electronic Reporting System (ERS) across the entire New Zealand fishing fleet regardless of vessel size or fishing method".

37. The Minister[14] has commented on the underestimation with a summary of more recent information provided to Fisheries New Zealand (FNZ) through the electronic (catch and position) reporting, commenting that this system "supports a better understanding of vessel and catch within the relevant stock boundaries (Quota Management Areas/QMAs). The summary provided by The Minister stated that in 2023-24, 14 commercial vessels fished in the potentially affected area and that although the catch volume was small, three fishers caught more than 40% of their catch volume between 2019 and 2023 in the area.

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[12] MacDiarmid et al. (2024). South Taranaki Bight Fishing. NIWA Client Report No: 2024053WN
[13] I have assumed that reference is made to fishing years in all cases in the NIWA report although it is not used consistently in the text and varies between formats.
[14] AM25-0827 (Minister for Oceans and Fisheries) (8 October 2025), response to FNZ feedback 11 (June 2025) on Treaty Settlements and other obligations (Section 18).

38. Although the PPA is only a portion of the total area referred to, the underestimation will also apply to the landings there. And although it is only the PPA that will be affected directly by the excavation, the four additional subareas relate to four variations on the extent of the suspended sediment plume which will potentially affect fishing beyond the PPA.

39. Results of seabed sampling by NIWA[15] for TTR noted that: "The PPA comprised two seabed habitats and benthic community types: rippled sands supporting a relatively depauperate macrobenthic assemblage, and wormfield communities, dominated *Euchone* sp A". Domination of the area by wormfields of this species, although patchy, is a major feature of the area, providing stability to the benthos and a well-developed basis for a functioning fish community.

40. Although the recent data have shown declines, the area still continues to produce catch levels that support some fisheries operators and loss of this particular habitat type is considered a major reduction in productive habitat throughout NZ waters. Note also that the reduction in leatherjacket targeting apparent from the NIWA summaries does not mean that catch of the species has similarly disappeared.

41. With respect to leatherjacket; the following note was published in the May 2024 plenary document for leatherjacket[16]: 'Leatherjacket are landed in fisheries targeting RCO, BAR, FLA, ELE, TAR, WAR, and GUR, but are most commonly caught in FLA, GUR, and ELE target bottom trawl tows. Some concerns have been raised about catch being taken in "hay paddocks"; these are polychaete worm beds that are biologically sensitive, habitat forming areas, which appear to be diminishing in areal extent as a consequence of disturbance from bottom trawling'. This context reinforces that changes in recorded targeting may reflect evolving management and habitat considerations rather than absence of fisheries reliance on the broader area.

42. Two sections from the evidence of Dr. Tara Anderson[17] are, in their entirety, relevant here: Section 25) **Recovery of functional benthic habitats**, in which she discusses the uncertainty in regaining stability of extensive sediment-stabilising bedforms from the recovery of the *Euchone* Sp A wormfields; and Section 26) **Cumulative effects,** where she discusses unknown factors related to cumulative effects of the mining and how they may work additively or synergistically along with stressors such as land runoff to reduce recovery rate of slow-growing, longer-lived benthic species. The final sentence carries an important message: "The long-term ecological consequences of these combined stressors **are highly uncertain or are simply not known**".

43. Also important here is a recent publication regarding long-term impacts of deep-sea mining and first signs of biological recovery [18]. According to the authors: "In this study, we define 'recovery' as a return to the original state of the ecosystem stated in terms of the parameter assessed, which includes a range of physical and biological characteristics, such as substratum composition and biological abundance. It does not indicate a full return of the ecosystem and its

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[15] Beaumont, J., Anderson, T.J., MacDiarmid, A.B. (2015). Benthic flora and fauna of the Pātea Shoals region, South Taranaki Bight. Unpublished NIWA Client Report WLG2012-55 prepared for Trans-Tasman Resources Ltd. 200 p.

[16] Anon (2024). Leatherjacket (LEA). In *Fisheries Assessment Plenary, May 2024: stock assessments and stock status – Volume 2*, Fisheries New Zealand, 798-808.

[17] Anderson, T.J. (6 October 2025) Statement of evidence of Dr Tara Julie Anderson filed on behalf of Kiwis Against Seabed Mining and Greenpeace Aotearoa Limited. In the Matter of an application by Trans-Tasman Resources for marine and discharge consents to undertake iron sand extraction in the South Taranaki Bight.

[18] Jones, D.O.B. et al (2025). Long-term impact and biological recovery in a deep-sea mining track. *Nature* 642, 112–118.

diversity to predisturbance conditions, which does not always occur in any environment[19] and may be impossible with nodule removal[20]".

Outside the PPA

Importance of habitats in the Pātea Shoals for fish in the STB

44. Of potential concern for a range of finfish species in the STB is the possibility of habitat degradation and loss, including important nursery areas, that could result from the close proximity of the PPA in association with the flow-direction of the suspended sediment plume, to what has recently been described as an extensive area of rocky reefs within the Pātea Shoals[21]. Reduced downward radiance in the water column has the potential to impact on primary production affecting plant growth, which may in turn affect the availability of forage for herbivorous fish, and the availability of prey for predatory fish.

45. Pātea Shoals is the area of rocky reef habitats that were identified using a multibeam sonar mapping route in 2020. According to the report's executive summary, "Numerous reefs were revealed across the entire survey area, ranging from small knolls and patches, through to extensive linear ridges several kilometres long". They were identified using Benthic Terrain Modelling to be nine feature classes interpreted to be reefs. Collectively these features covered 9.3%" of the 61.5 km^2 total seafloor mapped (= 5.72km^2).

46. Sampling of 14 of these features in 2021 using a towed video camera system revealed "a diverse landscape of reef and reef-associated species". In addition to the macroalgae dominating the habitat cover, "including narrow *Ecklonia radiata* (kelp) forests running for potentially kilometres along the reef ridgelines, and extensive meadows of the fleshy green algae *Caulerpa flexilis*" covering several different reef features such that the assemblages observed were described as unusual in the regional context rather than "that have not been seen elsewhere" … and … "sponge-rich habitat clusters were present on the boundaries of some reefs, as patches in association with rock tells (limited rock just at or before sediment surface) and as a relatively large patchy sponge garden at the deepest site surveyed (30–33 metres)" .

47. "This deeper site also held high densities of juvenile blue cod, consistent with it providing important nursery habitat for this species. Several other smaller nursery habitat areas were discovered on the edges of some reefs." The observed distribution is consistent with hypotheses that deeper reef-associated habitats may provide a combination of refuge and foraging opportunity for juveniles.

48. It has been shown in a study on blue cod nursery areas in the Marlborough Sounds[22] that nursery areas situated at reef edges can be associated with result in higher growth rates than in other habitats, with juveniles there consuming more prey items. Further evidence[23] has been provided with regards to ideal blue cod nursery area, showing that the key is in **complex** habitats, "habitats that provide shelter, food, nesting and nursery sites allowing for high

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[19] Vos, M. et al. The Asymmetric Response Concept explains ecological consequences of multiple stressor exposure and release. *Sci. Total Environ.* 872, 162196 (2023).

[20] Van Dover, C. L. et al (2017). Biodiversity loss from deep-sea mining. *Nat. Geosci.* 10, 464–465.

[21] Morrison et al (2022). Offshore subtidal rocky reef habitats on Pātea Bank, South Taranaki. NIWA Client Report, September 2022.

[22] Chang, A.X. (2021). Assessing the quality and value of *Parapercis colias* nurseries in the Marlborough Sounds, New Zealand. MSc Thesis, University of Victoria, Wellington NZ. 81 pp.

[23] Wade, Baylee L., Anna Carolina Resende, Danielle Willis-Kaio, and Alice Rogers. (2024). Exploring the consequences of complex habitat loss for the New Zealand blue cod, *Parapercis colias*. *Ecosphere* 16(3): e70233. **https://doi.org/10.1002/ecs2.70233**

biodiversity and productivity that supports valuable economic, cultural, and recreational services".

49. The authors of the rocky reef study[21] refer to "the very strong 0+/larger juvenile blue cod associations with the sponge garden of Site V" and contrast the high quality and value of the nursery area with the results from a comparatively lower quality nursery area elsewhere: "The Site V sponge garden was in waters 11–21 metres deeper than those of Pariokariwa Reef [in north Taranaki], and much further offshore, with clear waters and coarse bottom sediments suggesting low terrestrial run-off inputs". In contrast to the high juvenile blue cod nursery value at Site V was the "small populations of juvenile blue cod" for Pariokariwa Reef noted in a previous study report prepared for the Department of Conservation[24].

50. The authors also wrote: "One of the objectives of the science outreach from the NIWA Juvenile fish habitat bottlenecks programme to the South Taranaki coast, was to see if 0+ blue cod habitats/nurseries could be found, what they were, and compare and contrast then to other regions such as the Marlborough Sounds. Data from the 14 sites (absences as much as presences) will help answer these questions, with the strong nursery values of the sponge garden and low reef habitat of Site V **being a particularly valuable discovery**".

51. Also, the presence of nursery areas in the rocky reef study[21] was not relevant to blue cod alone: "Scarlet wrasse and leatherjacket juveniles ((not formally separated from adults in the counts)) also showed clear habitat preferences at sites where they were common (e.g., juvenile scarlet wrasse with some *Caulerpa* meadows, sponge clusters and gardens; juvenile leatherjacket with *Ecklonia* forest).

52. A total of 30 fish species were present across the reefs, with blue cod dominating the fish assemblage and accompanied by abundant scarlet wrasse, butterfly perch, leatherjacket, and tarakihi. Although mobile invertebrates were uncommon, kina were relatively abundant at two sites, where they formed urchin barrens. Also mentioned were other fisheries species (e.g., snapper, trevally, kingfish, and kahawai) that are likely to be common.

53. The report's executive summary[21] closes with: "The unusual distance of these reef systems from shore, occurring on a wide shallow continental shelf, makes them relatively unique in the New Zealand context, and may have protected them (in part) from land-based impacts seen elsewhere around New Zealand. The authors note these characteristics as relevant considerations for regional management and governance entities.

Action of the suspended sediment plume on the fish and fish habitats of the Pātea Banks areas

54. The suspended sediment plume can affect the fish habitats of the Pātea Shoals area in three ways: 1) through its presence in the water column causing variable sediment density exposure to the pelagic and demersal fish habitats, 2) through redeposition of sediment from the plume itself and 3) by affecting the passage of light through the water column, thereby altering its optical character.

55. Given the results presented in the 2017 suspended sediment plume modelling report[25], the plume will encroach on the Pātea Shoals area in several ways. Sometimes this encroachment will coincide with naturally occurring plumes which will increase the concentration of suspended sediment in the water column with values provided/plotted for median near-surface concentration, 99th percentile near-surface concentration, median near-bottom concentration,

[24] Battershill, C.N., Page M.K. (1996) Preliminary survey of Pariokariwa Reef North Taranaki. Report prepared for Department of Conservation, Whanganui. 15 p. + Appendices.

[25] Macdonald, H.S and Hadfield, M.G. (2017). South Taranaki Bight Sediment Plume Modelling, Worst Case Scenario, 51 p.

and 99th percentile near-bottom concentrations of suspended sediment, which also inform assessment of optical effects.

Suspended sediment concentration (SSC)

56. For fish, suspended sediments at sufficient concentrations can cause gill damage, induce impaired feeding, impact growth rates, and, at particular concentrations, can elicit certain behavioural responses such as avoidance of areas with elevated SSC. It has been known for some time that exposure duration is an important factor in such effects on fish (see[26]), as is particle characteristics, variations between species, temperature and salinity, and the ecologically relevant *habitat context*. The review[27], discusses the effect of both particle effects and the turbidity caused by SS including the effect of the latter resulting in reduced spawning success.

57. It is also known[27] that sediments can serve as a vector of many metals and toxic compounds such as Pb, Cd, Zn, Cu, Al, Fe, Mn, Cr, and Ni (see e.g.,[28, 29]) which can have a range of additional effects on fish.

58. Recent discussion in the literature has concerned the need for the science behind understanding the effects of SSC to broaden its approach. While there is much information about the thresholds that cause specific responses in fish, such as the threshold-avoidance discussed by Page (2014)[30] in terms of the very comprehensive list of published threshold concentrations (Table 3-2[30]) referenced by TTR (p. 189[2]), defining the interactions between the factors listed above are considered necessary for predicting useful outcomes[31], without which there is a high level of uncertainty around the simple approach. Until more is available about multiple stressor interactions the implication is that risks associated with these areas of concern should be treated with caution.

Plume induced light reduction

59. Creation of the suspended sediment plume represents multiple interacting pathways of effect, including changes to optical quality of the water column in addition to its physical presence in the pelagic/demersal habitats and the deposition of its coarser sediment fractions onto the seabed and other habitat features in the denser portion of its range.

60. Finfish respond to the marine environment in a variety of ways. In most species, vision is the dominant sensory link with the environment and is central to fundamental behaviours such as prey capture and predator evasion. In addition to its role in vision, ambient light controls

[26] Wilber, D.H., Clarke, D.G. (2001). Biological Effects of Suspended Sediments: A Review of Suspended Sediment Impacts on Fish and Shellfish with Relation to Dredging Activities in Estuaries.

[27] Kjelland, M.E., Woodley, C.M., Swannack, T.M., Smith, D.L. (2015). A review of the potential effects of suspended sediment on fishes: potential dredging-related physiological, behavioural, and transgenerational implications. Environment Systems and Decisions (2015) 35:334–350. DOI 10.1007/s10669-015-9557-2

[28] Novotny V, Chesters G (1989) Delivery of sediment and pollutants from nonpoint sources: a water quality perspective. J Soil Water Conserv 44:568–576

[29] Kundell J, Rasmussen T (1995) Recommendations of the Georgia board of regents scientific panel on evaluating the erosion measurement standard defined by the Georgia erosion and sedimentation act. Proceedings 1995 Georgia water resources conference. University of Georgia, Athens, Georgia, pp 211–217.

[30] Page, M. (2014). Effects of total suspended solids on marine fish: pelagic, demersal and bottom fish species avoidance of TSS on the Chatham Rise. NIWA Client Report No:WLG2014-7, 25 p.

[31] Park, S.Y., Lee, J., Byeon, Y., Khim, J.S. (2025). Systematic review of suspended sediment effects on aquatic organisms across taxa, developmental stages, and endpoints. Marine Pollution Bulletin 221, 1-10.

circadian rhythm, stress, growth, feeding, reproduction, and migration, through both the visual system and the pineal organ, and in some species through other photoreceptors in the skin.

The effect of a reduced euphotic depth on the habitat of fish populations downstream of the mining sites

61. Results from the assessment of optical effects[32] show that TTR's proposed mining will, through the presence of the suspended sediment plume, cause a reduction in the euphotic zone depth (see Section 6.2), the euphotic zone depth being the depth at which the downwelling radiance has fallen to 1% of its value at the surface. Results of the optical modelling show that for Site A, the mining reduces the amount of light reaching the seabed in the area of the west-east and south-north transects (see Fig. 6-1[32]). For the present discussion relating to the effect of the suspended sediment plume on fish and fish habitat in the area of the Pātea Shoals, the west-east transect is more relevant. The peak of the effect on the west-east transect is at Site A (see Fig 6.4[32]) and remains significant at station 6 on the transect, which appears to **about** coincide with Graham Bank. Site V in the NIWA rocky reefs study[21] is located on the south-east side of Graham Bank.

62. An interesting feature of Figure 2.4[32] is that, at station 6 the natural euphotic zone depth coincides with the bottom depth of approximately 25 m or more. This makes sense given that Graham Bank itself appears, from various maps included in documents relating to the TTR application, to be mostly about 11-15m depth, with surrounding waters on the inshore side some 23-30m depth. What this means is that according to the optical modelling report, mining at Site A will reduce the euphotic depth in the vicinity of Graham Bank by about 8-10m, from the 25m estimate above to about16m. Site V in the NIWA rocky reefs study[21] is located on the south-east side of Graham Bank. A large reduction in euphotic depth could plausibly affect the current health and productivity of the blue cod nursery area at Site V.

63. Although it does not include the natural euphotic depth coinciding with the seafloor anywhere else on the transect (Figure 2.4), plume-alteration of the euphotic depth at stations 4 and 5 is also significant and raises concerns for other habitats through that area. It must be kept in mind that although there is uncertainty associated with it, conditions on the transect will continue for some distance perpendicular to the transect although this spatial extent is not explicitly resolved in the available modelling.

64. Note that the effect is less for mining Site B (see Fig 2-5[32]). The explanation for this, given in the text of the optical modelling report, is that mining site B is much further away from the west-east transect than mining site A. However, there is still an appreciable reduction in the euphotic zone depth at station 6 for mining Site B, with the depth being reduced by about 5m from the approximately 25m of the seabed to about 20m. It is therefore reasonable to suggest that as an approximation, the reduced euphotic zone depth at Graham Bank will follow an approximately linear succession between approximately 5m, as a result of mining at Site B, and approximately 8-10m, as a result of mining at Site A.

65. Ultimately, the effect of any reduction in euphotic zone depth is to reduce the depth to which sunlight penetrates the water column. When this becomes advanced in terms of affecting plant growth the continued effective functioning of the habitat is threatened. If conditions reach a

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[32] Pinkerton, M. (2017). Optical effects of an iron-sand mining plume in the South Taranaki Bight region – worst case update. 47 pp.

point that could be described as adverse, this could have an adverse effect on fish occupying the habitat.

The effect of reduced light on the fish visual system

66. The visual systems of fish vary widely on what is generally a common theme, with specialisations for feeding mode (predatory, herbivory), habitat position in the water column (benthic, demersal, pelagic), and activity period (night, twilight, diurnal), and often changing throughout life as different habitats with different lighting levels become dominant and are vacated/occupied during different life history stages. The specific light environments different species inhabit include low, medium or high light, which has been identified as variations in the ocular morphology of a range of shallow marine teleosts from New Zealand[33]. For those specialised for mixed light levels, either ontogenetically or within their adult phase, the ocular morphology has been shown in the same study to vary accordingly, a result that has become well known since that study was published and developed further[34]. The ability to see within low light conditions is termed scotopic vision.

67. Ocular morphology was determined in the study referred to above using eye size, pupil shape, theoretical sensitivity and acuity based on retinal morphology, and regional distribution of photoreceptors within the retina.

68. With the aim of determining the possible effects on fish of the reductions in light given in the optical effects report[32] for TTR, these results were considered with reference to those species included in the eye study that are known from the predicted area of the suspended sediment plume. This approach is an approximation because no estimated instantaneous irradiance levels for depths under and along the length of the plume were given in the optical modelling report, and the estimates of scotopic sensitivity for the fish examined in the fish study are, to some extent, themselves approximations. It is also limited in that not all fish species from the predicted area of the plume were examined. Nevertheless, for some species it provides a reasonably definitive answer.

69. Generally, it is reasonable to suggest that those species that have a component of low light in their activities and the associated ocular structures to allow them to be active there, will have the visual ability to function within the reduced light mode that will likely accompany the presence of the plume. It is equally reasonable to suggest that the species most likely to be limited by the light reduction are those that do not have the visual ability to compensate. For the latter, depending on the degree of light reduction that occurs within their familiar territory/habitat, the most likely strategy may be to move to an area where the light level is acceptable.

70. Some results from the study were initially surprising but were considered by the investigators ultimately understandable in view of known behaviours of the subject species. For example, the three pelagic predators, kingfish, trevally and golden mackerel, which are diurnally active and would be expected to have a retinal structure that reflected that, were in fact shown in results from the fish vision study to have high scotopic sensitivity. This unexpected result was explained by their tendency during feeding to make frequent vertical excursions which probably take them into lower light levels than are experienced by reef fish species. Also, kingfish, for example, are known to be active in the early morning, which is likely to be within the twilight period and

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[33] Pankhurst, N.W. (1989). The relationship of ocular morphology to feeding modes and activity periods in shallow marine teleosts from New Zealand. Environmental Biology of Fishes 26: 201-211.

[34] Fogg LG, Chung W-S, Justin Marshall N, Cortesi F, de Busserolles F. (2023). Multiple rod layers increase the speed and sensitivity of vision in nocturnal reef fishes. Proc. R. Soc. B 290

therefore they have likely developed a level of scotopic sensitivity to deal with this period when prey species like the golden mackerel are active.

71. The scotopic vision ranking system used in the fish vision study indicated that most of the nocturnally active and twilight active species had high scotopic sensitivity, whereas most diurnal species had low to average sensitivity. There were, however, a number of exceptions and the authors concluded that "mismatch of theoretical sensitivity and activity period would result if activity periods were incorrectly identified , non-visual senses operated, or the ranking criteria did not reflect changes in visual function".

72. This study on fish vision includes information for 31 species, 21 of which are known from the area of interest. All species were graded by the researchers with either a scotopic vision rank of either 3-5 (low sensitivity), 6-8 (average sensitivity) or 9-12 (high sensitivity). In several cases listing of the scotopic rank was presented as a set representing demersal fishes as a group which prevented definitive ranking of several species for the purposes I was considering.

73. The species that were included are as follows. 1) **with high scotopic sensitivity**: golden mackerel, blue cod, kingfish, trevally, kahawai, blue mackerel, bigeye, slender roughy, goatfish, conger eel; **with average sensitivity**: piper, butterfly perch, sweep, blue maomao, red gurnard; **with low-average sensitivity**: snapper, leatherjacket, john dory, spotty, red moki.

74. The species in the high scotopic sensitivity category are well adapted to low light; those in the average category are somewhat less adapted to low light. The demersal species are placed in the low-average category but are not identified to species because of the way the data are tabulated. All are defined as demersal species[35] by the investigators and therefore occupy a habitat that includes activity at both the seabed level and higher within the water column for which some level of scotopic vision would be required. Although it is unclear as to which of the demersal species examined in the study the ranks apply, two of them are ranked as low sensitivity (rank 5) and the remainder are ranked as average (6 to 8). Consequently, all of these species are adapted to being active at some degree of low light level, but two of them have a low scotopic sensitivity which suggests a higher level of uncertainty with regards to their ability to function effectively within an area of reduced euphotic depth.

75. The final outcome from this determination of how finfish in the path of the suspended sediment plume might be affected by altered optical properties of the water column is that, for those that a score can be gathered from the fish vision study, all species exhibit a level of adaptation for reduced light. However, as is discussed in the previous section, the results of the optical modeling report show that, as a result of the plume's presence, a mean decrease in euphotic depth of anything up to 8-10m for mining Site A, to anything up to 5m for mining Site B can be expected for at least some of the habitats of the Pātea rocky reefs area. And although there are no data provided for irradiance levels in the water column beneath the plume, the definition of euphotic depth is depth at which irradiance is at 1% irradiance at the surface. Given that the mean modelled euphotic depth is well above the seabed depth at station 6 in figures 6-4 and 6-5, it is reasonable to suggest uncertainty regarding functional performance for at least the two demersal species and perhaps for others as well. The degree of sensitivity for the demersal group carries a higher level of uncertainty with two species included in the low category ranking.

76. Given the amount of variation in the examined species and the degree of uncertainty associated with that, it is not possible to apply any general rule to the species that were not examined.

[35] Spotty, banded wrasse, leatherjacket, porae, red moki, john dory, snapper.

Potential effects of the TTR mining on fisheries

77. Two main areas of concern arising from the proposed seabed mining by TTR relate to fisheries in the area: the possible effect of factors related to the actual mining activity (noise and light) and those related to the suspended sediment plume.

Recent status of fisheries in the area of interest

Commercial fisheries

78. TTR[2] defines an area of the northern STB, as their "*sediment modelled domain"* (SMD), which "covers approximately half of the STB (approximately 13,300km^2) and covers the area where any potentially significant impacts from sediment discharged by the project could occur". The STB lies within Fisheries Management Area FMA8. Well within the SMD lies the main area of interest related to the proposed mining, which comprises five subareas: the PPA as well as the median SSC and 99th percentile areas related to the mining A and B sites. The SMD is a modelling construct and does not represent a fisheries management unit or an area of uniform fishing activity.

79. The predominant commercial fishery in the STB is a mixed bottom trawl fishery for trevally, leatherjacket, red gurnard and snapper which occurs within the Rolling Ground, a large area of fishing ground. Second in importance is a setnet fishery targeting rig, school shark and blue warehou. These fisheries are spatially structured and method-dependent, with effort concentrated on particular trawlable or nettable grounds rather than evenly distributed across the wider STB.

80. A summary in the form of tabulated numbers of commercial fishing events within the five subareas of the main area of interest is available from the 2024 NIWA report for TTR[12]. Data covers the period from fishing year 2007-08 to 2022-23. Fishing methods include bottom trawl, setnet, bottom longline, handline, purse seine, cod potting, and in one case for each, dredge and midwater trawl on bottom. These datasets are aggregated and indicative and are subject to confidentiality suppression and spatial allocation limitations.

81. Examination of these table summaries relative to fishing method or target species shows a recurring pattern that comprises a peak value often early in the series followed in most cases by a decline and, in some cases a later, secondary peak occurs. The second peak is usually lower than the first, is followed by a second decline and, in some cases, there is increase for some 1-3 years at the end of the series. In a number of cases the early peak value occurs at fishing year 2010-11.

82. This pattern, with its variations, can be seen in both the series for fishing method and for target species. In many cases there are years with no data in the series. The presence of zero or low values should not be interpreted as absence of fishing effort without regard to reporting thresholds, confidentiality suppression, and changes in fleet behaviour.

83. Of the five species that appear for all subareas, leatherjacket shows the most years of no data. There have been no events registered for this species in any subarea since 2013-14, with final years in the series occurring in 2012-13 for three subareas and once each in 2011-12 and 2013-14 for the other two. This pattern indicates a cessation of leatherjacket being recorded as a primary target species within the subareas but does not demonstrate absence of leatherjacket catch as bycatch or a lack of ongoing fisheries reliance at a broader spatial scale.

84. School shark mostly follow the pattern described above with some minor variations. For all subareas school shark shows the resurgence in the last two or three years of the series. Rig follows the pattern above most strongly in the Mining A and B 99th percentile is least evident in the PPA based on recorded event data. Based on NIWA event summaries, rig fishing events are most evident in the Mining A and B 99th percentile areas and are least evident in the PPA. No rig fishing events are recorded in the Mining B median area in the NIWA event summaries for the years reported. These patterns are derived from event-level summaries and are not assessed or confirmed at the stock level in the Fisheries New Zealand rig plenary.

85. The pattern suggests that there are other factors influencing the data, such as the number of fishers or perhaps regulatory closure rules or something similar. The consistency of these patterns across fishing methods supports an inference that regulatory, management, or access-related factors are likely contributors to observed changes, rather than changes in stock abundance alone. Overall, the data suggest a general decline in the fishery. However, there is something of an upturn in the most recent years, particularly for school shark, which coincides with regulatory changes affecting fishing methods and areas within FMA 8 and is consistent with redistribution of effort rather than a simple recovery in underlying stock abundance [36].

86. This context reinforces that changes in recorded targeting may reflect evolving management and habitat considerations rather than absence of fisheries reliance on the broader area.

Recreational fisheries

Value of the Pātea Shoals to local recreational fishing

87. The Pātea Shoals are known to local fishing clubs as "a mixed habitat sand area and rocky structure supporting snapper, gurnard, cod, scallops, kahawai, grey shark, and kingfish", a description that suggests knowledge of the rocky reef system described recently in the scientific literature[21].

Recreational catch at Pātea Shoals and the wider STB

88. Tabulated summaries of recreational fishing catch by NIWA[12] were summarised further as part of my review here to determine the relative levels between local recreational fishing reporting areas as a rough indicator of productivity for the Pātea Shoals area. The recreational fishing reporting area PTE (Pātea) is closest to Pātea Shoals, which are frequently accessed from the Pātea River mouth[37]. The summaries showed that recreational catch since 2005 in area PTE reflects a productive area with a total number of different finfish species possibly exceeding 27, including 6 species of shark and an undefined number of skate species.

89. By contrast, catch immediately to the north of PTE in area HWR (Hawera) over the same period recorded 12 finfish species including 4 sharks and no skate species, although in area WVL (Waverly) immediately to the south of PTE, 29 finfish species including 4 of sharks and an unknown number of skate species were recorded since 2005.

90. The PTE catch was achieved using 6 fishing methods, and those of HWR and WVL with 3 and 8 methods respectively. A major contrast is evident in the data for WNG (Whanganui), the area immediately south of WVL, where a total of 15 fishing methods were used over the same period to capture a total of 37 finfish species (including 5 shark species) along with an extra unknown number of species recorded as unknown shark, flatfish, stargazer, stingray, skate, sole, freshwater eel, moray eel and jack mackerel. Whether the higher values for WNG relate to the

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[36] Anon (2024). Seafood New Zealand comments on TTR's application under FTAA 2024. Seafood New Zealand, 36 pp.

[37] Comments by Wanganui-Manawatu Sea Fishing Club, The Patea & Districts Boating Club, and other clubs

larger recreational fisher population likely in Whanganui is unknown, but no data were presented on number of trips/events or whether such were available from the Fisheries NZ *rec_data* database.

91. Furthermore, recreational fishing catch data are collected occasionally from boat ramp surveys, fisher logbooks, ad hoc samples, and one-off surveys. It is likely that there is uncertainty in the data, particularly for boat-ramp surveys where trips may include visits to other areas that are not easily represented at data collection time or are overlooked. Given the attractive nature of the Pātea Shoals as a recreational fishing area, some data collected in areas other than Pātea could be for fish taken in the Pātea Shoals area.

92. Generally, then, based on available evidence, the rocky features of the Pātea Shoals are extensive, highly productive and provide a highly varied set of habitats for a wide range of finfish species. Any reduction in productivity from increased suspended sediment levels caused by a mining-induced plume, especially when combined with 'natural' levels of suspended sediments from sources such as the relatively large Pātea River (see Table 2-1[38]), could well reduce this productivity to some unknown level.

Potential effects of the proposed mining on local fisheries

93. It is widely known that assessment of adverse effects on fisheries first requires examination of how the effects impact the fish species landed from the fishery, followed by further assessment to determine how those effects impact the fisheries of interest.

Commercial fisheries

94. For commercial fishing, the most important effect of concern is displacement or redistribution of target fish from their current distribution. The most consequential plausible scenario involves displacement outside the current Fishstock although less extensive movements also increase the need for additional search time and hence costs. If, in the present context, the extent of movements were large enough to make it difficult or impossible for fishers targeting within the Fishstock encompassing the PPA to fill their ACE, they would need to fish outside that Fishstock to meet their required volumes of the target species. This would require them to either purchase ACE for another Fishstock, or to pay the deemed value penalty for any volume they take there. However, the latter is discouraged and is a non-solution considering the high cost, with rates increasing significantly for over-catches. The problem that could well occur for ACE holders is that either there is no ACE available in neighbouring QMAs or, if they hold settlement quota, they are ineligible to buy ACE in the neighbouring QMA.

95. In the event of ongoing loud noise, a fish is not constrained and can, as was discussed previously, swim away from the sound's source. However, this could result in localised reductions in catch rate with corresponding increases elsewhere. There is uncertainty here with regards to the distance fish might move, whether the movement will affect local catch rates, and whether this could affect the movement of numbers of certain fish species over Fish Stock boundaries, particularly when considered in combination with the possible habitat loss represented by removal of extensive areas of seabed in the PPA.

96. As was discussed above, high levels of underwater noise have been shown to affect the behaviour of fish over a distance of 30-50 km. Given that the project area is approximately 22–36 km offshore, the southern boundary of FMA 8 lies within a distance range that has been identified as relevant in some noise studies. However, the applicability of those distances to continuous operational mining noise in this setting is uncertain. As was observed in one of the field studies above, investigators concluded that fish were interrupted or halted from moving

[38] Hadfield, M.G. and Macdonald, H.S. (2015). Sediment Plume Modelling 117 p.

towards the source of the noise by the occurrence of loud noise. The distance of noise effects arising from the mining activity may be less but is unknown.

97. In the other field study discussed above, reductions in catch rates occurred up to 33 km from the source of noise. Although there was discussion in further studies included in the review[7] that there was evidence that fish might escape from the sound vertically (into deeper water) rather than horizontally (over distance), the resulting reduced catch rate was measured in both the trawl fishery as well as the longline fishery, suggesting that in this case fish did not necessarily choose increased depth. These studies provide indicative evidence of possible behavioural response pathways but do not establish the magnitude, duration, or likelihood of effects in the present project context.

98. In addition to the effect of fish movements within or over the QMA boundary, it is also possible that fish movements away from the mining area could work together with regulatory closures to effectively remove fish from the fishery within the area of the Fishstock. Losing fish into a closed area would require the same solution for fishers if available volumes were otherwise unavailable, that of fishing outside the QMA to maintain their required volumes of the target species. Regulatory closures in the STB prevent certain commercial fishing in certain areas, which can limit the availability to fishers of particular species that might redistribute into the closed area in response to stressors such as the noise and SSC associated with the TTR mining. This interaction does not of itself establish a fisheries effect but may amplify the consequences of redistribution where it occurs. A discussion of the cumulative effect of regulatory closures is presented in the Fathom attachment[39] to the Seafood NZ document[36].

99. The species discussed under commercial fisheries in the previous section (current status) were caught in the PPA, mostly within the bottom trawl and setnet fisheries, and are therefore potentially those that will be most immediately vulnerable to any mining activity under the proposed project in the form of loud noise from the mining machinery, as well as presence of suspended sediment in the water column and loss of benthic habitat from the excavating.

100. Fisheries for other species could be affected by the impact of the plume on the rocky reef habitats of the Pātea Shoals. For example, target events for blue cod in the NIWA summary (Table 2-6[12]) for the Site A 99th percentile SSC area, represented 11.3% of the total number of events over the period 2007-08 to 2022-23. The potential damaging effect of the plume on the blue cod nursery area at Graham Bank, along with any other so far undiscovered, could be far reaching for the blue cod target fishery in this area.

101. From Fathom (2025)[39] p.8. "Although reasonable catches of school shark are taken within the TTR project area, these catches are only a small proportion of total SCH 8 catch, with a maximum of 2.46% in 2020/21. In all other years the percentage of total SCH 8 and SPO 8 catch taken from within the TTR project area was less than 1%. However, in most of the last five fishing years more than 40% of the catch of both SCH 8 and SPO 8 was taken from within the affected area, with a maximum of 65.62% for SPO 8 in 2019/20. This indicates that the set net fishery would be significantly affected by the proposed mining activity if adverse effects on fish or fishing are experienced in the affected area".

Recreational fisheries

102. The major potential effect from the proposed TTR mining on the recreational fishery is from the suspended sediment plume and its possible effect on the reef areas of the Pātea Shoals. This effect has been discussed previously in this review, particularly in terms of changes to the

[39] Anon (2025). Commercial fisheries in the vicinity of TTR's proposed mining site. Attachment 1 to Seafood New Zealand comments on TTR's application under the FTAA 2024. Seafood New Zealand. 36 pp.

euphotic depth and the potential effect on fish nursery areas. The concern is not limited to nursery areas but includes consideration in a more general sense where reduced light levels can impact the primary production, thus affecting herbivorous fish directly and predatory fish more indirectly. Reductions in available fish will affect the current productivity of the recreational fishery discussed in the previous section.

KEY UNCERTAINTIES

103. Two main uncertainties became evident during this review. They were both related to variations in the SS plume

104. The first relates to the lack of information on spatial variations in the plume which makes it difficult to determine the effects on fish and fish habitats. One must instead assume steady state which is unreasonable for an entity that is obviously dynamic.

105. There was no information regarding the depth of the euphotic zone in the area between the transect relating to mining Site A and the transect relating to mining Site B. Because of the absence of information a linear succession between the two is assumed, which may be the best approximation.

DISAGREEMENTS/CONTESTED EVIDENCE

Overview of the Applicant's position[2]

106. The applicant's fisheries case proceeds on the basis that the proposed mining activities will not result in material adverse effects on commercial or customary fisheries. In summary, the applicant contends that:
    a. the proposed mining footprint and modelled sediment plume affect only a small proportion of fishing activity when assessed at FMA 8 / QMA scale;
    b. finfish are mobile and will avoid stressors such as elevated suspended sediment and underwater noise, with redistribution occurring over limited spatial and temporal scales;
    c. commercial fishing effort is similarly mobile and can adapt by shifting effort within the wider South Taranaki Bight;
    d. stock abundance, sustainability, and overall fisheries productivity will not be affected;
    e. any localised displacement effects are temporary and operationally manageable; and
    f. proposed consent conditions, including monitoring and adaptive management, are sufficient to address residual uncertainty.

107. These positions are advanced principally through the application documents, NIWA fisheries analyses, and applicant-commissioned ecological, economic and cultural evidence.

Seafood New Zealand and Fathom Consulting (sector-wide industry position)[40]

108. Seafood New Zealand contests the applicant's characterisation of fisheries effects, relying principally on the Fathom Consulting report dated 25 November 2025 ("Fathom 25"), supported by associated submissions and evidence.

[40] Seafood New Zealand submissions and evidence.

109. The core disagreement concerns what Seafood NZ describes as **a conflation of fish behaviour with fisheries outcomes.** While accepting that fish may redistribute in response to stressors such as noise or elevated suspended sediment, Fathom 25 emphasises that commercial fishers operate within regulatory, spatial and economic constraints, including QMA and Fishstock boundaries, regulatory closures, gear restrictions, and ACE availability. On that basis, Seafood NZ contends that localised changes in fish distribution, productivity or catchability can translate into adverse effects on commercial fishing operations, even where stock sustainability at a wider scale is not affected.

110. Fathom 25 further disputes the applicant's treatment of spatial displacement. It submits that displacement analyses relied on by the applicant are outdated and do not reflect post-2019 changes in fishing patterns, regulatory settings, or the improved resolution of electronic reporting data. In particular, Fathom 25 criticises the expression of displaced catch as a proportion of a "study area" spanning multiple QMAs, noting that for most affected stocks fishers cannot lawfully or practically shift effort into neighbouring QMAs.

111. Seafood NZ also places weight on **cumulative spatial displacement**, arguing that existing regulatory closures, including Māui dolphin measures implemented in 2020, have already constrained flexibility for trawl and set-net fisheries in FMA 8. On this view, even modest additional displacement could exacerbate existing pressures.

112. In response, the applicant does not accept that these constraints materially alter the assessment of significance. The applicant maintains that fishing effort remains adaptable at the scale of FMA 8, that closures are an established feature of fisheries management, and that the proportion of fishing activity potentially affected by the Project remains small in regional terms. The applicant further contends that changes in targeting patterns, including cessation of targeting of some species within parts of the Project area, reduce sensitivity to displacement.

113. These opposing positions reflect a fundamental disagreement as to the appropriate spatial, regulatory, and operational frame for assessing fisheries effects.

Individual commercial operator perspectives (Talley's, Moana, Brooks)[41]

114. The sector-wide position advanced by Seafood New Zealand and Fathom 25 is reinforced, and in some respects elaborated, by evidence from individual commercial operators active in the South Taranaki Bight, including Talley's Group Ltd, Moana New Zealand Ltd, and Brooks Seafood Ltd. While their emphases differ, their evidence is consistent in challenging the applicant's assumptions regarding mobility, substitution, and operational neutrality.

115. **Talley's Group Ltd** focuses on operational scale and cumulative constraint. Its evidence emphasises that commercial efficiency depends on repeat use of known productive grounds, predictable catch rates, and weather windows, rather than theoretical access to alternative areas. Talley's disputes the assumption that effort can readily be redeployed without cost, pointing to increased steaming time, reduced trip efficiency, and planning uncertainty, particularly in a context of existing closures and regulatory limits. Talley's does not assert stock-level depletion but contests the proposition that localised disruption would be operationally neutral.

116. **Moana New Zealand Ltd** frames its evidence through the lens of Māori commercial fisheries and settlement asset utility. Moana emphasises that settlement quota and ACE are not

[41] Talley's Group Ltd, evidence and submissions on fisheries effects. Moana New Zealand Ltd, evidence on Māori commercial fisheries and settlement impacts (as by Te Ohu Kaimoana filed).Brooks Seafood Ltd, evidence on set-net fisheries and operational constraints.

abstract entitlements, but assets whose value depends on practical access to productive fishing grounds. Displacement is characterised not merely as an operational inconvenience, but as a potential erosion of the practical utility of settlement redress where access becomes uncertain or more costly.

117. **Brooks Seafood Ltd** provides a perspective from a smaller operator engaged primarily in set-net fisheries. Its evidence highlights limited flexibility due to vessel size, method constraints, safety considerations, fuel costs, and weather exposure. Brooks disputes the applicant's suggestion that reduced recorded activity equates to reduced reliance, noting that changes in targeting or reporting do not necessarily reflect diminished economic dependence. On this view, incremental displacement, even if modest in spatial terms, may have material viability implications for smaller operators.

MPI / Fisheries New Zealand[42]

118. MPI and Fisheries New Zealand do not adopt the applicant's characterisation of fisheries effects as necessarily minor or readily managed. Their advice and evidence identify constraints on displacement arising from Fishstock boundaries, regulatory closures, gear-specific access, and ACE availability, and caution against reliance on coarse spatial metrics that may mask concentrated use of particular grounds. MPI also notes limitations in the resolution of fisheries and customary datasets, particularly for small-vessel activity and finer-scale spatial use and advises that uncertainty should be treated cautiously when assessing existing interests.

119. MPI does not advance a definitive conclusion on significance, but its material challenges the applicant's reliance on mobility and substitution as a complete answer to fisheries effects.

Summary of contested position

120. The principal disagreements do not turn on whether fishing occurs in the Project area, but on:
   a. the appropriate spatial scale for assessing effects;
   b. the realism of displacement and substitution assumptions in light of regulatory and operational constraints;
   c. the weight to be given to cumulative closures and existing pressures; and
   d. how uncertainty should be treated where fisheries reliance is spatially concentrated and flexibility is limited.

121. The applicant maintains that effects are localised, temporary, and manageable. MPI, Seafood New Zealand (through Fathom 25), and individual commercial operators contest that proposition, contending that constrained displacement capacity, cumulative pressures, and unresolved uncertainty mean that fisheries effects may be materially understated on the applicant's analysis.

CONDITIONS ANALYSIS

Conditions and monitoring framework: relevance to finfish and fisheries

122. This review identifies where the proposed consent conditions are expected to carry the main risk-management load for fisheries outcomes, particularly where compliance depends on

[42] Response to RFI from the Minister for Oceans and Fisheries.

baseline characterisation and limit-setting, monitoring design and governance processes, fisheries/kaimoana monitoring programmes, and underwater noise criteria.

How the conditions are intended to manage fisheries-relevant risk

123. The conditions adopt a "monitor–validate–respond" model in which pre-commencement data are used to characterise "background" conditions, then translated into operational limits and triggers that are intended to prevent effects from exceeding acceptable exposure regimes.

124. Baseline characterisation and limit setting (SSC). Pre-commencement monitoring is required for a minimum of two years for a broad set of environmental components, including biological/seafood resources and commercial and recreational fishing. The pre-commencement monitoring is implemented through a certified Pre-Commencement Environmental Monitoring Plan (**PCEMP**), which is peer reviewed, provided to the Technical Review Group (**TRG**) for confirmation against the PCEMP purposes, and then submitted to EPA for certification. The TRG is tasked to provide technical advice and is to be established by the consent holder at least six months prior to commencement of the PCEMP.

125. Following completion of the pre-commencement monitoring, the consent holder must review the numerical values of the SSC Limits in Schedule 2 using the Schedule 3 methodology, submit that review to the TRG, and then to EPA for certification. If the updated SSC limits differ from the Schedule 2 values, the updated values supersede Schedule 2 for the purposes of the consents. Schedule 3 also states that any updated SSC limits must represent "background" conditions and not be influenced by extraction activity (actual or model-simulated).

126. Operational triggers and stop rules. The operational control point in the conditions is a "cease extraction" requirement if SSC Limits are exceeded by more than 10% along the PPA boundary for 30 minutes or longer (with ongoing monitoring required until SSC returns within limits).

127. Monitoring governance and the ability to adapt. The TRG has an explicit function to review monitoring results against baseline, identify trends, consider mitigation/management effectiveness, and recommend changes. The conditions also allow for additional monitoring parameters to be required where a new parameter is identified (including a requirement to consult and to incorporate the parameter into monitoring).

128. Noise criteria. Underwater noise is addressed through a source-level cap for the combined crawler/IMV noise (177 dB re 1 µPa RMS @ 1 m) and a modelled 120 dB contour that must be based on empirical noise data. These conditions matter for fisheries outcomes because the plausible pathway is sustained noise contributing to avoidance/redistribution and altered local catchability at meaningful spatial scales.

Where the framework is likely to be fragile

129. The core issue is not whether conditions exist, but whether the project can be managed "as conditioned" so that exposure levels (SSC/optical/noise) remain below effect thresholds for the vulnerable pathways, given natural variability and the feasibility/attribution limits of monitoring and enforcement.

130. On the material reviewed, the main fragilities are:

    a. Reliance on background-percentile limits does not automatically equal protection of sensitive habitats. The application's monitoring framework treats SSC as the "primary driver" and uses baseline monitoring and plume modelling to derive Response and Compliance limits (80th and 95th percentiles of natural variability at "sensitive sites"). That may be administratively neat, but biologically it is only as good as the assumption that "natural variability" is a defensible proxy for "tolerable exposure" for reef productivity/nursery pathways and fish behaviour. This is particularly important where the report identifies material uncertainty about exposure magnitude/duration in a fisheries-relevant way.

b. The Response Limit is conditional on proving causation, which is a practical enforcement choke point. The monitoring plan states that an Operational Response is mandatory at the Compliance Limit, but at the Response Limit it is only required if a "direct causative link" to the project can be made. In a naturally variable system with naturally occurring plumes, "direct causation" is exactly the sort of thing that becomes disputed while the exposure continues.

c. Optical effects are not obviously managed "as experienced" at reefs. The report's key conclusions flag a credible risk pathway from plume-driven light reduction to reef macroalgae productivity and associated nursery function (including the Site V juvenile blue cod association), with uncertainty around magnitude and spatial extent. The conditions framework (as drafted) is heavily SSC-centred; the Panel should test whether the monitoring/trigger suite actually measures and manages the optical endpoint that matters (light attenuation/euphotic depth at reef habitats), rather than assuming SSC limits will necessarily prevent ecologically meaningful light reduction.

d. Governance helps, but it does not remove the structural problem: conditions are only as strong as the decision rules. The TRG role is substantial (reviewing monitoring, trends, mitigation effectiveness, and recommending changes). But the condition structure still leaves room for disagreement about whether evidence is sufficient to trigger operational change (especially where causation is contested), and for "process compliance" to substitute for outcome protection.

Fisheries-specific conditions: what they do and what they do not do

131. The conditions include two fisheries-facing mechanisms:

a. Kaimoana Monitoring Programme. The consent holder must develop and implement a Kaimoana Monitoring Programme that includes identification of indicators, trigger points/thresholds, and "desired actions", as well as an engagement approach (ie: it is meant to be actionable, not just descriptive).

b. Commercial Fishing Liaison Group. A Commercial Fishing Liaison Group must be established with specified membership and meeting requirements, including within one month of commencement and then quarterly and annually (with at least one meeting prior to extraction).

132. These mechanisms are useful for information flow and dispute visibility, but they are not, by themselves, a substitute for enforceable exposure controls. They do not resolve the central fisheries risk in this review: whether the project can be operated so that SSC/optical/noise exposure regimes remain below effect thresholds at the habitats and spatial scales that matter for fish distribution, catchability, and nursery function.

Matters the Panel should consider testing if relying on conditions

133. If the Panel proposes to rely on the condition's framework as the primary mechanism for managing fisheries effects, the following practical questions could in my view be considered:

   a. Are SSC limits/triggers ecologically protective for reef productivity/nursery and fisheries catchability pathways, not just statistically derived from background variability?
   b. How will a "direct causative link" be established at the Response Limit in real time, and what occurs where attribution is contested but exposure is increasing?
   c. Does the monitoring suite measure the correct reef endpoints for optical effects (light attenuation/euphotic depth), rather than assuming SSC is a sufficient proxy?
   d. Is the cease-extraction rule enforceable and timely, given exceedance definitions and natural plume variability?
   e. Are underwater noise contours and limits grounded in project-specific empirical data early enough to support behavioural/catchability inferences?
   f. Do Kaimoana programme triggers/desired actions compel response, rather than operating primarily as reporting and engagement mechanisms?

CONCLUSIONS

134. This review does not conclude that the proposed mining will cause stock-scale depletion of finfish or collapse of fisheries in the South Taranaki Bight. However, the evidence provided does not support the applicant's characterisation that effects on finfish and fisheries will "generally be no more than minor" with the level of confidence implied.

135. Finfish responses to disturbance are expected to include avoidance and redistribution in response to noise, suspended sediment, and altered optical conditions. While such responses may be adaptive at an individual level, they are not neutral from a fisheries perspective. Localised changes in distribution, catchability, and habitat function may have adverse effects on commercial and recreational fishing where flexibility to absorb displacement is constrained by regulatory, spatial, cultural, or operational factors.

136. The most credible fisheries-relevant risk pathways identified in this review are:
   a. sustained operational noise contributing to redistribution and altered catchability;
   b. plume-induced reductions in light penetration affecting reef productivity and nursery habitat function; and
   c. loss and uncertain recovery of benthic habitat within the mined footprint.

137. The proposed consent conditions provide a framework for monitoring and adaptive management, but they also carry much of the risk-management burden. Their effectiveness depends on whether the parameters being monitored are biologically meaningful for fisheries outcomes, whether triggers are enforceable in practice, and whether response mechanisms operate in a timely and precautionary manner when attribution is contested.

138. In my opinion, the Panel should treat the identified uncertainties as material. Any reliance on conditions as the primary means of managing fisheries effects should be accompanied by clear findings on whether those conditions are capable, in practice, of preventing or adequately responding to ecologically and fisheries-relevant harm.

Appendix 1: Documents reviewed

Applicant Documents

1. The Trans-Tasman Resources Ltd (TTR) Taranaki VTM Project Fast-Track Act Application document (2025) (TTR application/application document).
2. Proposed consent conditions (relevant conditions 47, 54, 60, 77, 78, 86).
3. MacDiarmid et al. (2024). South Taranaki Bight Fishing.
4. MacDiarmid et al. (2013 Updated 2015). South Taranaki Bight Fish and Fisheries.
5. MacDiarmid and Ballara. (2016). South Taranaki Bight Commercial Fisheries.
6. Thompson (2015). Effects of ships lights on fish, squid and seabirds.
7. Gibbs (2013). South Taranaki Bight iron sand mining proposal assessment of potential impacts on commercial fishing.
8. Page (2014). Effects of total suspended solids on marine fish: Pelagic, demersal and bottom fish species avoidance of TSS on the Chatham Rise.

Documents provided by other parties

9. Comments by the Minister for Oceans and Fisheries.
10. Comments by Dr Tara Anderson for KASM and Greenpeace on blue cod.
11. Comments by Seafood NZ.
12. Comments on the Taranaki VTM Project from the Ngā Motu Marine Reserve Society (October 2025).
13. Comments by Brooks Seafood Ltd in relation to patterns in fish use of the area.

Documents provided in response to RFIs

14. RFI to the Minister for Oceans and Fisheries
15. Response from the Minister for Oceans and Fisheries.
16. Minute 17.
17. Response documents provided under heading 'Response to Minute 17'.

Other documents

Throughout the review I have cited many of the documents listed here and referenced many other documents, including those from the scientific literature. Referenced documents appear as footnotes on the page they are first cited. In most cases further reference to them in the text is marked by the footnote number of the original citing, although sometimes they are included each time they are referenced further to avoid certain difficulties that can arise with the word processing software.