MINUTE 16 OF THE EXPERT PANEL

Request for Information - Birds

Taranaki VTM Project [FTAA-2504-1048]

RESPONSE

Kororā Foraging, Dive Behaviour, and Breeding Performance

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1. Purpose

The purpose of this response is to provide **best-available information** on kororā / little penguins (*Eudyptula minor*) relevant to the proposed Taranaki VTM Project [FTAA-2504-1048], as requested by the Expert Panel in Minute 16.

This information is intended to **clarify** and **expand**, not duplicate, the evidence provided in our written comments and October 2025 Hāwera presentation.

Our response incorporates:

1. **Peer-reviewed evidence** of kororā using the **South Taranaki Bight (STB)** as a key foraging area;
2. **Expert-interpreted tracking and dive records** from breeding birds in **North Taranaki** (Port Taranaki & Urenui Beach);
3. **Breeding success data** from the kororā monitoring programme at Te Kāhui (Port Taranaki colony).

2. Context

2.1 Regional ecological connectivity (peer-reviewed evidence)

Kororā in central Aotearoa/New Zealand function as a **regional metapopulation** linked by shared oceanographic foraging systems. Peer-reviewed tracking (Mattern 2001, Poupart et al. 2017, see also Section 3A) has demonstrated that breeding kororā from the **Marlborough Sounds** routinely travel **>200 km** to forage in the STB during incubation, identifying the South Taranaki Bight as an **ecologically essential feeding area** for kororā from multiple regions (see Section 3A).

2.2 Local behavioural examples

Since 2021, NMMRS has collected high-resolution GPS and dive-profile data from breeding kororā at **Te Kāhui/Port Taranaki** and **Urenui Beach.**

Although these tracks show **limited direct overlap** with the Area Of Interest (AOI) due to breeding-range constraints and lack of monitoring further south (Figure 1), they provide **behavioural evidence** directly transferable to kororā breeding along the coastline of the STB.

All penguins forage on the same **shallow continental shelf system**, and therefore experience **the same functional constraints**, particularly reliance on **clear water within ~0-40 m depth**.

2.3 Requirement for expert interpretation

Raw tracking and dive data **cannot** be accurately interpreted without seabird-behaviour expertise. For example:

- Average dive depth does **not** indicate prey capture depth
- Commuting dives must be excluded to avoid misleading conclusions
- Foraging depth must be defined behaviourally
  (NMMRS methods in Section 3B)

Misinterpretation of raw, unfiltered datasets could lead to **underestimation of ecological exposure** and would fail the legal requirement that the Panel rely on the **best available information** and apply a **precautionary** decision-making approach.

2.4 Relevance to decision-making criteria (exposure pathway)

The mining project area, together with the broader zone predicted to be affected by the suspended-sediment plume, lies in approximately 20-40 m water depth on Pātea Shoals (NIWA 2015). NIWA's client report for TTR describes the hydrodynamic and sediment-transport models used to predict suspended-sediment plumes and deposition, including vertical-transect outputs for near-surface and near-bottom concentrations (median and 99th percentile) across the water column.

In short, the **plume is modelled within shallow shelf waters of the same order as kororā foraging depths**, with near-surface and near-bottom Suspended-Sediment Concentration (SSC) statistics reported and mapped for multiple cases (A/B source locations, seasons). This establishes a **credible depth-overlap** between the modelled turbidity effects and kororā's visually constrained, shallow foraging zone.

Any **reduction in mid-water light/visibility across ~0-40 m** would plausibly lengthen foraging trips and reduce provisioning efficiency and subsequently reproductive success for kororā, a mechanism consistent with (i) regional plume modelling, (ii) kororā reliance on visual prey detection in shallow water, and (iii) observed links between coastal turbidity and provisioning outcomes on this coast (see Section 3C).

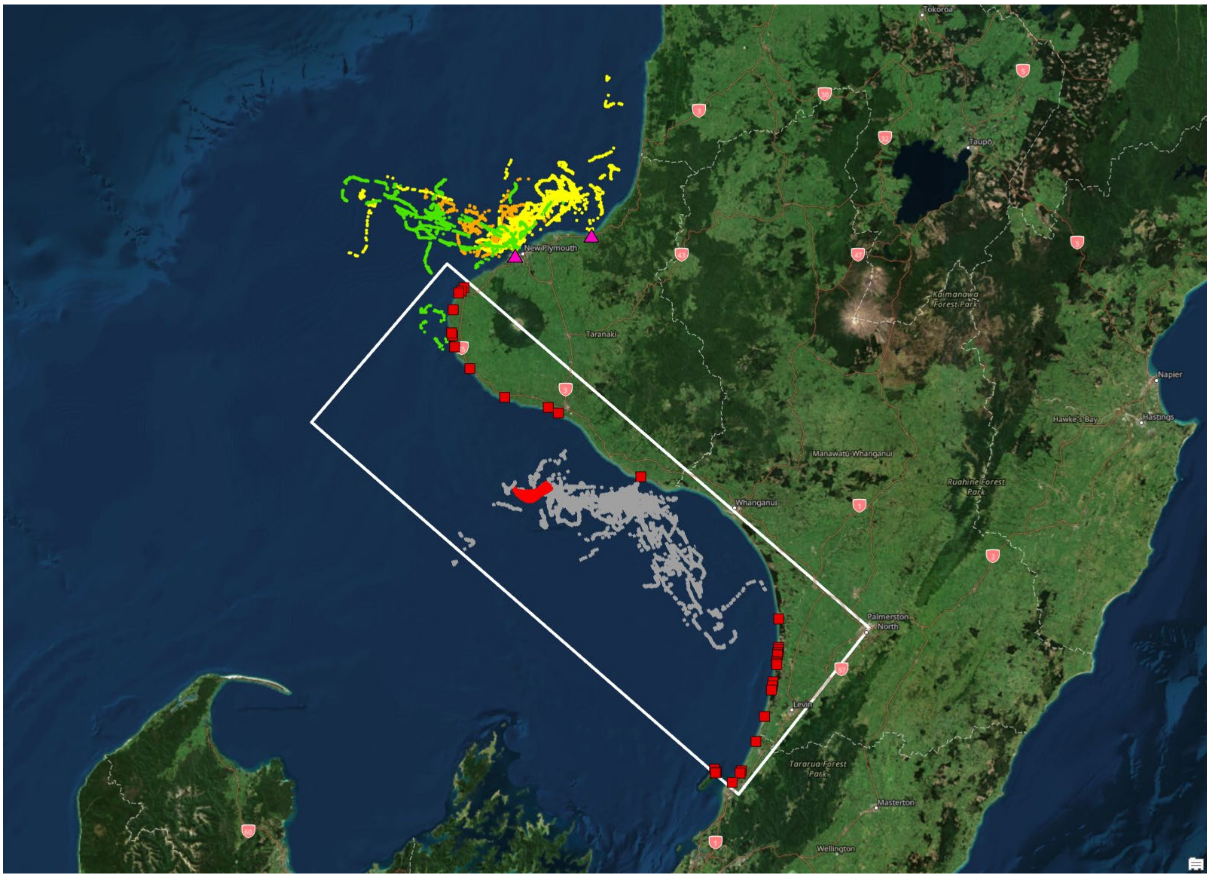

Figure 1. *Regional distribution of kororā records and tracking data in relation to the proposed mining Area of Interest (AOI). Red squares: public kororā sightings on land (iNaturalist). Purple triangles: North Taranaki study sites at Te Kāhui/Port Taranaki and Urenui Beach. Coloured points: GPS fixes from North Taranaki birds during incubation (yellow), guard (orange) and post-guard (green) stages. Grey points:* ***illustrative rotation*** *of the same data to show the type of foraging pattern likely for a South Taranaki colony. White polygon: AOI.*

3. Information Requested from Ngā Motu Marine Reserve Society

> *"Provide available data on kororā, including GPS tracks, dive profiles, and breeding data."* - Minute 16, Attachment: Information Requested

The following subsections provide the requested information in a **decision-ready format**.

Important interpretation note (to prevent misuse of raw data)

The provided figures and summaries are fit-for-purpose interpretations of specialist datasets. Raw, unfiltered files (GPS/dive time-series) require statistical processing and expert judgement to avoid artefacts (e.g., treating commuting depth as foraging depth, or extrapolating North Taranaki breeding-season ranges as absence from South Taranaki or non-breeding distribution). If the Panel desires raw files, we request that they be considered alongside this interpretation framework, or that we supply a limited-scope technical note to avoid misinterpretation.

3A. GPS Tracking Data (Te Kāhui/Port Taranaki 2021-2024, Motuara Island, 2011-2016)

Scope & methods:

Breeding adults were fitted with streamlined GPS dive loggers (±5 m GPS, ±0.1 m pressure, 1 Hz). Deployments in Aug-Dec of the years 2021-2024 yielded **63 complete trips** from **34 birds**, mean trip length ~21.7 h (range 7.2 h-3.6 d), maximum single-trip displacement up to ~170 km; mean distance from shore ~14.9 km (range 0.2-61.1 km). Tracks concentrate north to southwest of Port Taranaki during breeding, with occasional long excursions consistent with flexible foraging strategies (Figure 2).

In addition to the North Taranaki tracking data, the GPS data underlying the peer-reviewed publication by Poupart et al. (2017) and the numerous **kororā observations recorded on iNaturalist** show that penguins are widespread throughout Cook Strait and along the South Taranaki coastline (Figure 3). The concentration of recent sightings indicates a **substantial and regionally connected presence** likely to utilise the South Taranaki Bight as shared foraging habitat. Within this ecological context, the **Trans-Tasman Resources Area of Interest (AOI)** represents an **administrative boundary rather than a biological one**, positioned inside a continuous shallow-water system that kororā use extensively for foraging and transit. This reinforces that the foraging distributions depicted in Figures 1 and 2 are ecologically relevant to the project area, even though direct tracking from STB colonies is not yet available.

Comparable long-distance movements were recorded by **Mattern (2001)**, who used range-limited VHF telemetry to track kororā from Motuara Island. Even with the smaller detection range of that technology, birds were shown to travel widely within the South Taranaki Bight. These earlier findings confirm that the GPS trajectories reported by Poupart et al. (2017) represent a persistent behavioural pattern rather than an isolated event, underscoring the long-term ecological linkage between Cook Strait colonies and the STB.

Interpretation guidance:

The Te Kāhui/Port Taranaki tracking data represent movements of breeding birds constrained by regular nest attendance and therefore depict **minimum foraging ranges** during the breeding season. These data **should not be interpreted as absence from South Taranaki**, as kororā from southern colonies and off-season individuals are likely to use the South Taranaki Bight (see Figure 1 and Section 3B).

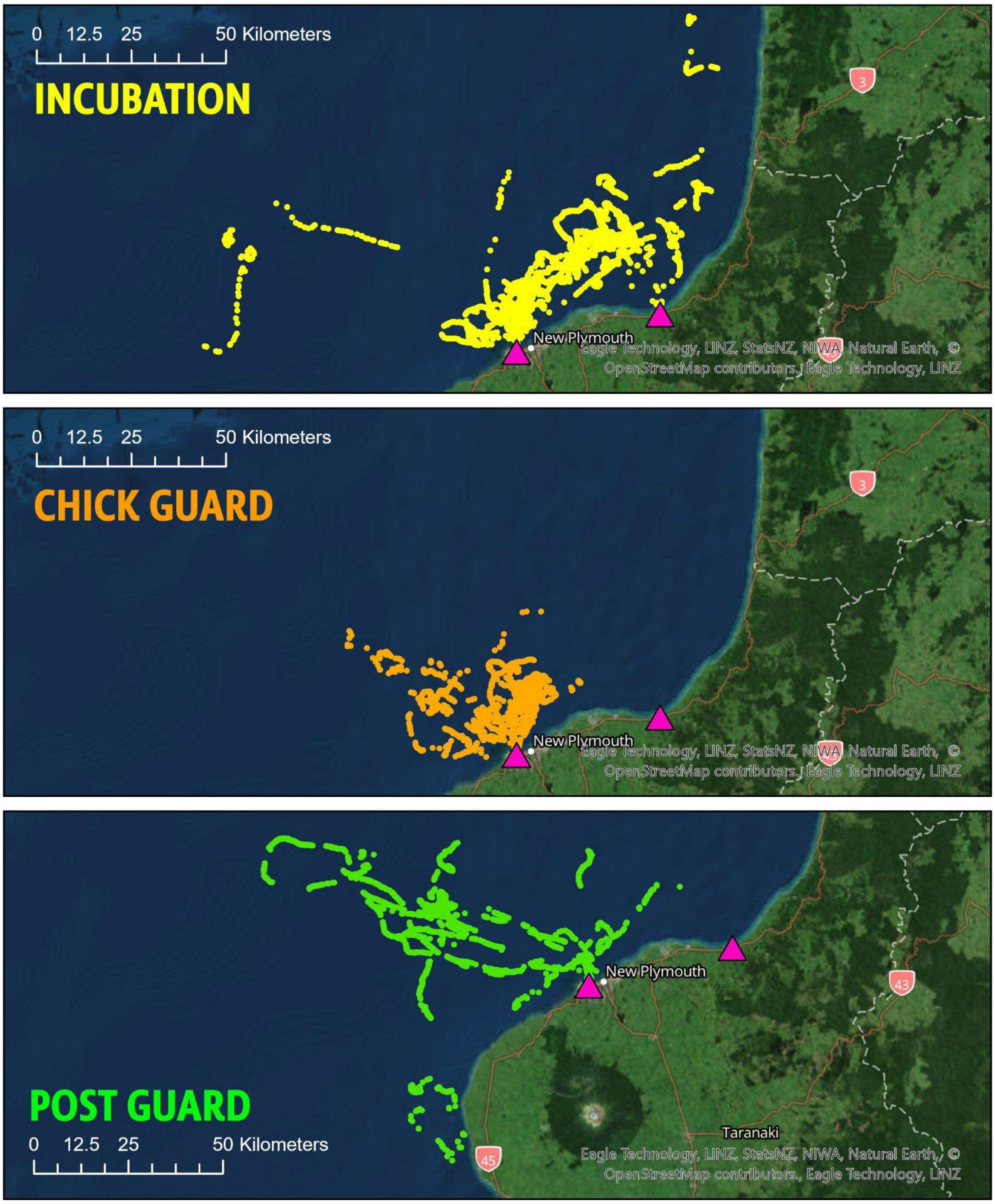

Figure 2. *Spatial distribution of GPS positions of breeding kororā tracked from Port Taranaki and Urenui Beach (purple triangles) during the 2021–2024 seasons, grouped by breeding stage. The top panel shows longer trips during the egg incubation (mean home range: 27.6 km). The middle panel (chick guard) represents the period immediately after hatching when adults alternate between nest attendance and are feeding young chicks on a daily basis (mean home range: 18 km). The bottom panel (post guard) depicts the stage when chicks are left unattended and adults undertake longer, more wide-ranging trips to offshore foraging areas (mean home range: 30.9 km). Each point represents a GPS fix.*

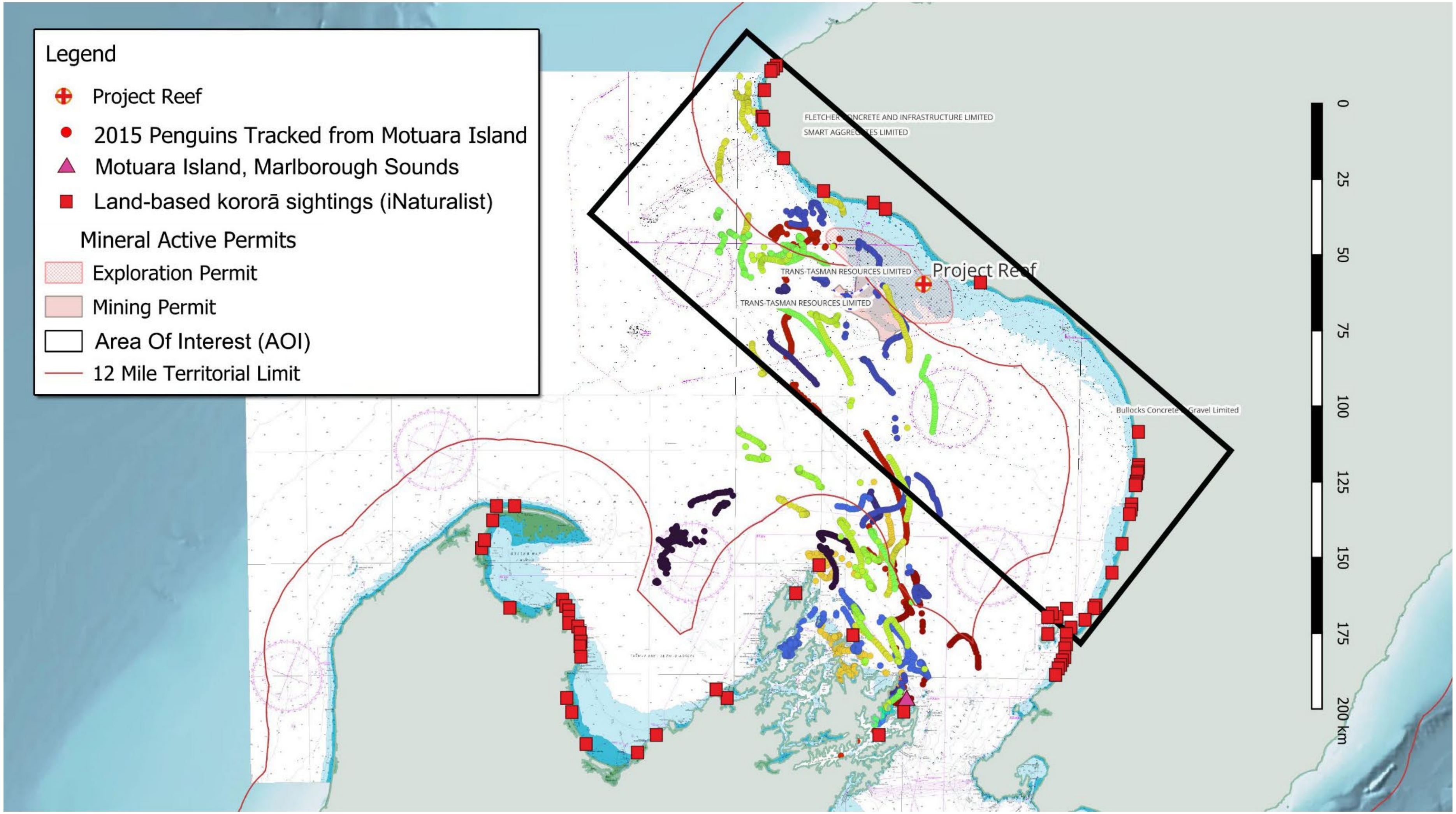

Figure 3. *Regional distribution of kororā foraging movements from Motuara Island (Poupart et al. 2017) and land-based kororā sightings (iNaturalist) in relation to the Trans-Tasman Resources Area of Interest (AOI). Tracks and sightings show kororā regularly using the wider Cook Strait–South Taranaki Bight system that encompasses the AOI.*

3B. Dive Profiles

Why classification matters:

Considering mean maximum depth across all dive events is misleading as an indicator of foraging depth, because kororā perform many short, shallow **commuting dives** that **bias the average towards lower depths**.

Therefore, dive data were behaviourally classified using three independent indicators of prey pursuit to distinguish **foraging** from **commuting** dives (Figure 4):

1. **Bottom-phase >3 "wiggles"** (number of vertical undulations),
2. **Mean wiggle amplitude (> 0.1 m),**
3. **Horizontal speed < 1 m/s**.

Result (filtered for foraging behaviour):

- Number of dives: **2524**
- Mean foraging depth: **10.5 m**
- Median: **10.2 m**
- Range: **2.5 - 49.7 m**

Ecological link:

This zone coincides with **NIWA's model domain and vertical statistics across the 0-40 m shelf** where the plume is assessed (near-surface and near-bottom SSC). Therefore, **visibility/light reductions across the upper water column directly intersect kororā prey-capture depths** (Figure 5).

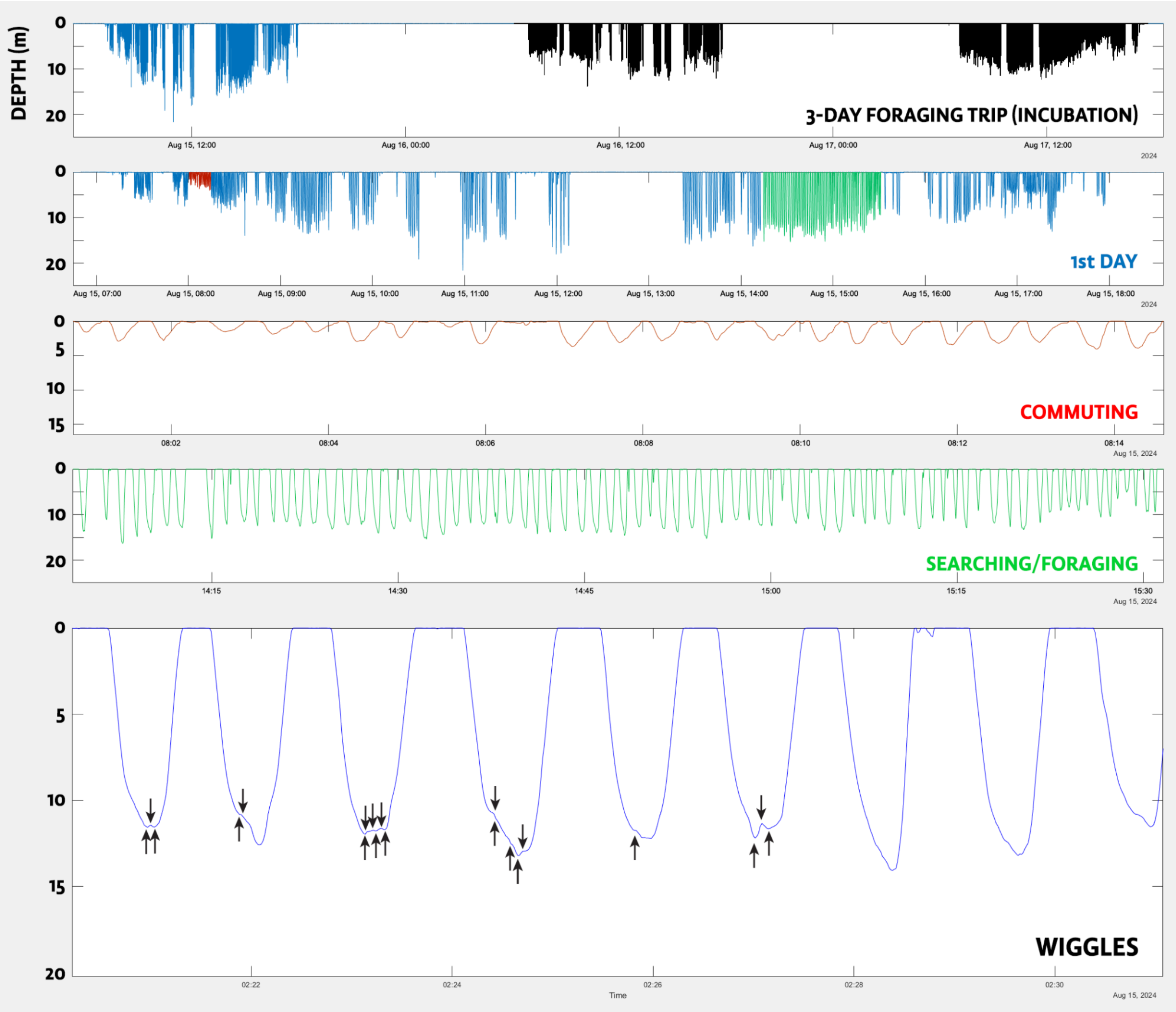

Figure 4. *Example dive-depth time series and behavioural classification for a three-day foraging trip by a breeding kororā during incubation. Panels 1-4 show successive magnifications of the same dataset to illustrate how foraging and commuting dives are distinguished. Panel 1 shows the full dive record; the first day of the trip is highlighted in blue, subsequent days in black. Panel 2 expands the first day, with blue dives segmented into red and green periods representing commuting and foraging behaviour, respectively. Panel 3 details the red segment, illustrating the shallow, regular profiles typical of commuting dives, whereas Panel 4 details the green segment, showing variable depths and bottom undulations characteristic of prey searching and pursuit behaviour. Panel 5 presents nine individual foraging dives, each annotated with small arrows indicating "wiggles" (vertical undulations) during the bottom phase that define prey searching/pursuit activity. Together the panels demonstrate how behavioural metrics (wiggle count, amplitude, and horizontal speed) are used to separate travel from foraging phases in kororā dive records.*

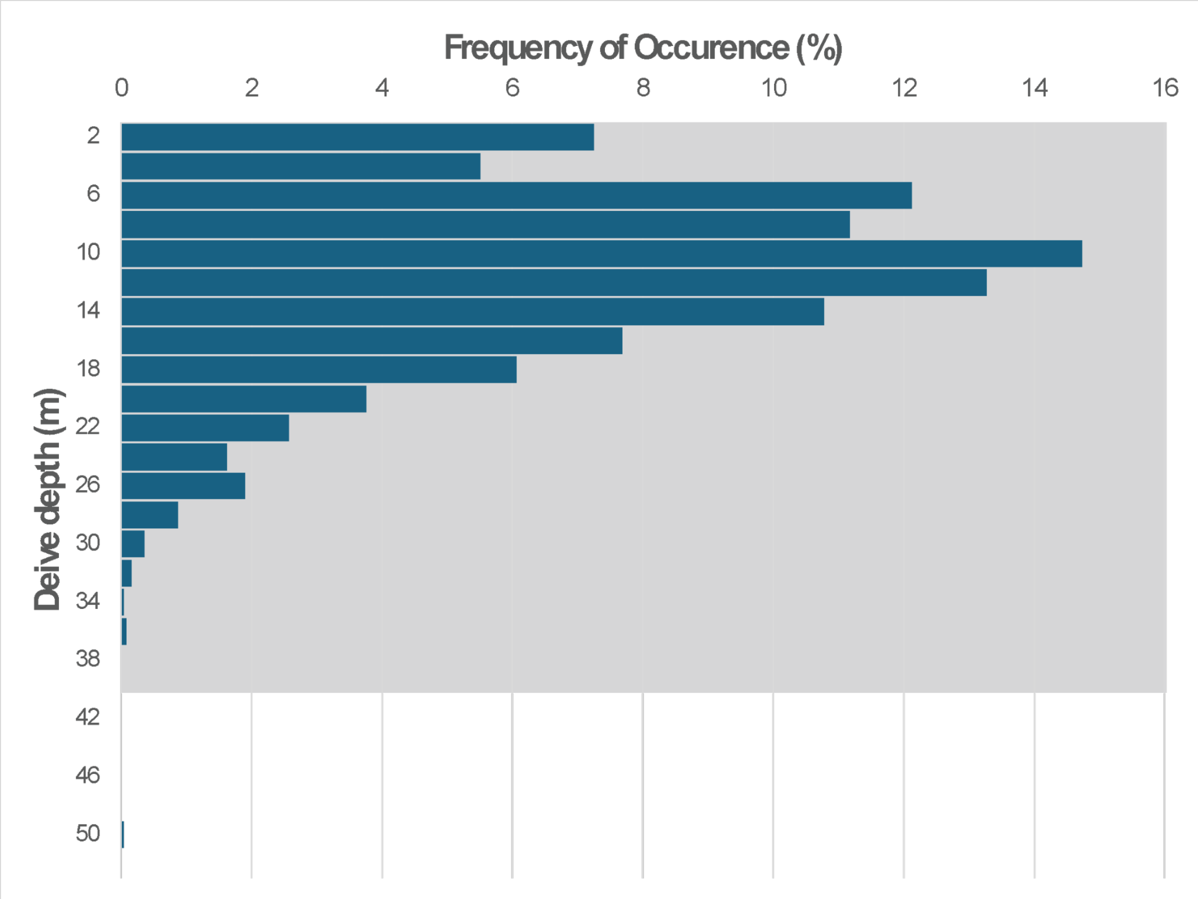

Figure 5. *Depth distribution of kororā foraging phases recorded on birds from Te Kāhui/Port Taranaki and Urenui Beach (2021-2024). Only dives identified as prey-pursuit behaviour are included. The histogram shows that nearly all foraging activity occurs within the upper 0-34 m of the water column (mean ≈ 10.5 m). The grey-shaded zone marks the 0-40 m depth band corresponding to the shallow, well-mixed layer predicted in sediment-plume modelling for the proposed mining operation (NIWA 2015), indicating a strong vertical overlap between penguin prey-capture depths and the depth range potentially affected by increased turbidity.*

3C. Breeding Data – Te Kāhui/Port Taranaki (Summary)

Monitoring:

Weekly nest checks since 2021 provide breeding success metrics for the Port Taranaki colony (pairs, eggs, chicks, fledglings) (Table 1, Figure 6). These data indicate that breeding performance depends on **frequent, efficient trips** and **adequate visual conditions** in shallow water during chick provisioning.

Rainfall-turbidity-productivity signal:

Years with **higher Aug-Dec rainfall** correspond to **lower chicks fledged per pair** at Te Kāhui, consistent with **river-driven sediment runoff** increasing coastal turbidity during the main breeding window (Figure 7). The mechanism is straightforward:

more suspended sediment → lower mid -water light in ~0-30 m → less efficient visual prey detection → longer trips → provisioning shortfalls → fewer fledglings .

This observation is consistent with plume modelling indicating mining-derived suspended sediments would become **well-mixed through shallow depths (~0-40 m)** - the **same depth band** where kororā conduct nearly all **prey-capture** behaviour (Figure 5). Visual-foraging impairment in this layer therefore represents a **credible mechanism** by which the proposed activity could adversely affect breeding performance.

Table 1. *Breeding success by year (Te Kāhui, Port Taranaki).*

Year	Nests	Eggs laid	Eggs hatched	Chicks fledged	Hatch success	Chick survival	Chicks / pair
2021	14	25	22	20	88%	90.9%	1.43
2022	16	31	16	15	51.6%	93.8%	0.94
2023	14	26	20	16	76.9%	80.0%	1.14
2024	13	26	21	20	80.8%	95.2%	1.54
2025*	13	24	19	15	79.2%	78.9%	1.15

* 2025 season ongoing at time of writing

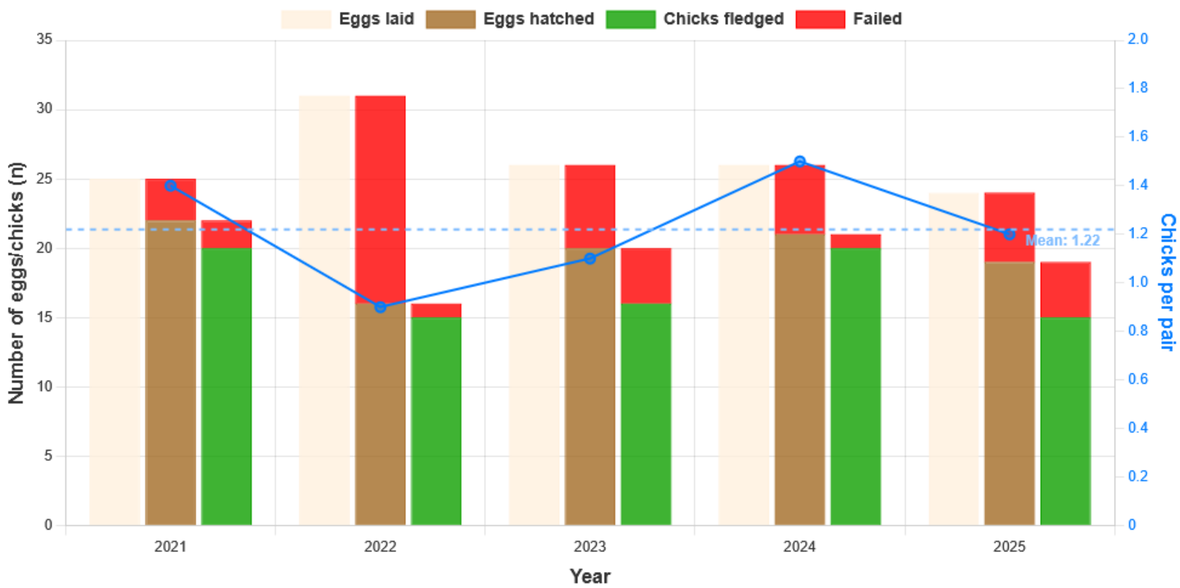

Figure 6*. Graphical representation of breeding success data by year. Blue line indicates annual breeding success as mean chicks per pair. Note that the 2025 season is ongoing at the time of writing.*

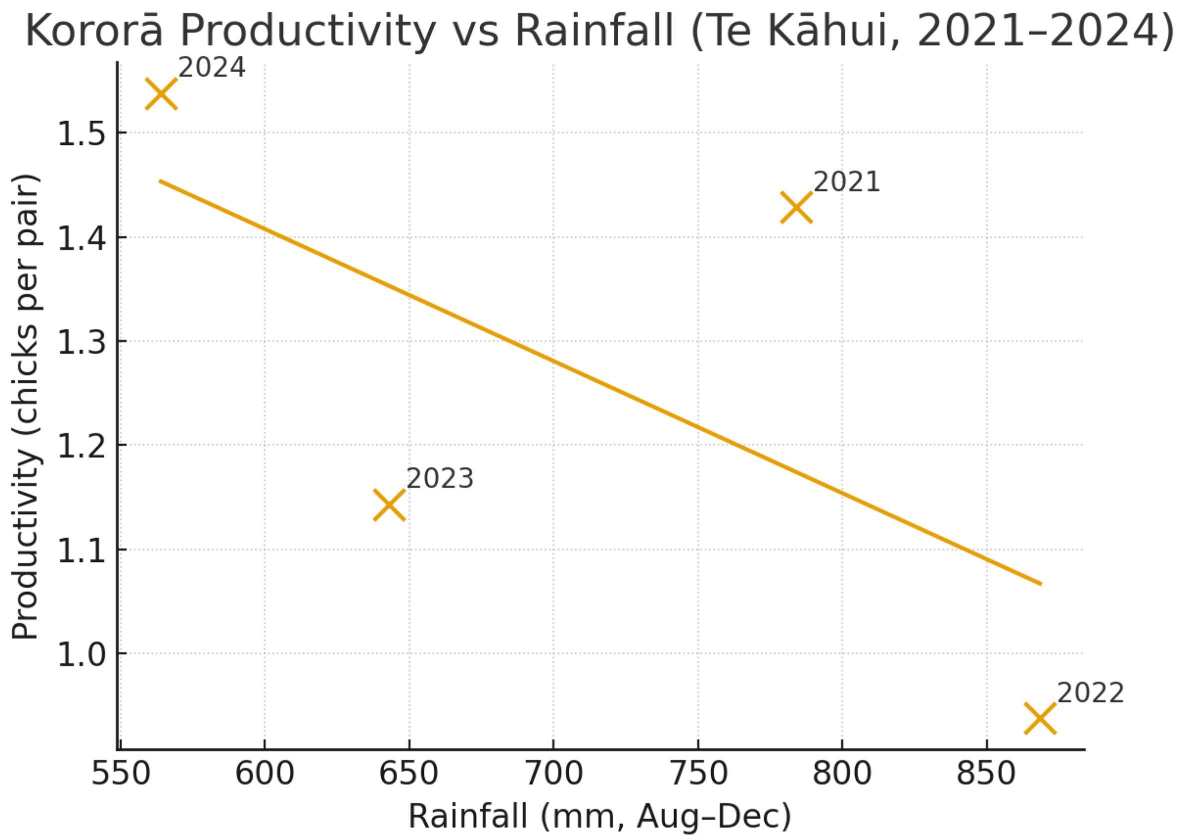

Figure 7. *Kororā breeding productivity (chicks per pair) at Te Kāhui shows a negative association with winter-spring rainfall, reflecting the impact of rainfall-driven turbidity on shallow-water visual foraging efficiency. This natural turbidity signal is consistent with the expected effects of a mining-induced sediment plume entering the same coastal foraging zone. Note: The monitoring series is still short; we present this as directional evidence with a plausible mechanism rather than a final statistical attribution.*

4. References

Mattern T. 2001. Foraging strategies and breeding success in the Little Penguin, *Eudyptula minor*: a comparative study between different habitats. Dunedin, New Zealand: University of Otago, Dunedin, New Zealand. URL: https://hdl.handle.net/10523/9557

NIWA 2015. *Sediment Plume Modelling. Prepared for Trans-Tasman Resources Ltd. October 2015.* Wellington, New Zealand: National Institute of Water & Atmosphere Research Ltd. URL: https://www.epa.govt.nz/assets/Uploads/Documents/Marine-Activities-EEZ/Activities/bbd197c6cc/4-NIWA-Sediment-Plume-Modelling-TTR16301-WLG2015-22-Redacted.pdf

Poupart TA, Waugh SM, Bost C, Bost C-A, Dennis T, Lane R, Rogers K, Sugishita J, Taylor GA, Wilson K-J, Zhang J, Arnould JPY. 2017. Variability in the foraging range of *Eudyptula minor* across breeding sites in central New Zealand. *New Zealand Journal of Zoology* 44:225–244. DOI: 10.1080/03014223.2017.1302970.