Kanakana in the Taiari catchment

Results from the 2023 survey campaign

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Cover: Tumai Cassidy deploys a POCIS sampler in the Waipōuri. *Photo: Chris Kavazos (DOC)*

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1 Introduction

The Taiari (Taieri) River catchment covers an area of more than 5,700 km^2 and includes the open rolling tussock-covered hills that are typical of Central Otago. The river is 288 km in length – the fourth longest in Aotearoa New Zealand. The river and associated lakes and wetlands host a diverse fauna and flora and are associated with over 40 taoka species, hundreds of mahika kai sites, and fortified, permanent and seasonal settlements. Hāpu from Te Rūnaka o Ōtākou and Kāti Huirapa Rūnaka ki Puketeraki are mana whenua of the catchment.

Today, many of the native ecosystems of the Taiari catchment are heavily modified and do not provide adequate habitat for native fishes. In 2020, the Department of Conservation published a report summarising the conservation values, issues and priorities for action in the Taiari catchment[1]. This report informs Te Mana o Taiari, a collaborative project to restore freshwater habitats in the Taiari[2].

Lamprey are an ancient family of jawless, boneless fish which has existed for around 450 million years[3]. There are currently 44 known lamprey species worldwide, 5 of which inhabit the Southern Hemisphere, but only *Geotria australis* (kanakana, piharau or pouched lamprey) are found throughout Aotearoa (Figure 1). Kanakana move between fresh and saltwater to complete their lifecycle and are likely to spend most of their lives in freshwater, only moving into saltwater to grow. Larvae and juveniles are filter feeders that live buried in the soft sediments of waterways for up to 4 years. Juveniles remain in freshwater systems for 3–4 years before migrating to the sea as adults approximately 15 cm in length. At sea, adults parasitise fish, sharks and whales by sucking onto their host and consuming their body fluids and tissues. After 4–5 years, adult kanakana (now 40–60cm in length) migrate back up rivers in New Zealand, Chile and Australia to spawn.

Kanakana are secretive and can be very hard to find and study, so relatively little is known about the species and the habitats they require. Adults are often hidden during the day, only venturing out at night to continue their migration. Kanakana use their powerful sucking mouths to climb steep waterfalls while searching for suitable nesting sites. Nesting sites are concealed in cavities beneath boulders, bedrock and within rock-lined stream walls.

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[1] Ryder 2020: Review of values, freshwater restoration programmes and research needs within the Taieri catchment: https://www.doc.govt.nz/globalassets/documents/our-work/nga-awa-river-restoration/taiari-river-review.pdf

[2] Ngā Awa river restoration programme, Taiari River: https://www.doc.govt.nz/our-work/freshwater-restoration/nga-awa/taiari-river-restoration/

[3] Piharau: What does science tell us about New Zealand lamprey? https://niwa.co.nz/te-kuwaha/piharau (Provides detailed information about the biology and ecology of kanakana.)

Figure 1: An adult kanakana captured in Three O'clock Stream December 2023

The upstream migration of adult kanakana is likely to be initiated by the increased discharge of rivers during spring. Waterway selection by migrating adults is thought to be driven by pheromone cues released by larvae and adults upstream.

Kanakana are a taoka and a mahika kai species for Māori that support an important traditional fishery. In the past, these fish were abundant in many New Zealand rivers and were harvested using various methods. Today, little is known about the distribution of kanakana throughout the Taiari catchment and the areas of important habitat for the species. Only 21 records for kanakana in the Taiari River exist in the New Zealand Freshwater Fish Database (NZFFD), most of which are located in the Taiari Plains, with 11 recorded from the lower Silver Stream. Other records are from the Taiari mainstem at Outram, Sutton, Middlemarch and Waipiata, Cullen's Creek (Lake Waihora tributary) and lower Sutton Stream. These observations were made using a mixture of spotlighting and electric fishing techniques.

The aim of this survey was to re-assess the distributions of kanakana in the Taiari using environmental DNA (eDNA) sampling and kanakana pheromone detection techniques. This data will help inform management of critical habitats required for kanakana and delineate priority catchments for future annual monitoring.

2 Survey methods

Two rounds of sampling were undertaken by staff from the Department of Conservation and Te Nukuroa o Matamata (Figure 2). The first round used eDNA techniques to identify the specific catchments important for kanakana, while a second round of pheromone sampling was undertaken to quantitively assess the importance of specific reaches within those catchments.

Figure 2: Staff from the Department of Conservation and Te Nukuroa o Matamata conducting the kanakana survey in the Taiari River from April 2022 to February 2023.

2.1 Environmental DNA

Organisms living in waterways shed waste and cellular material that becomes incorporated in the water column. This waste material often contains DNA and is referred to as eDNA. By analysing eDNA in water samples, it is possible to identify the different species inhabiting a waterway. Environmental DNA analysis is especially useful for detecting the presence of species that are difficult to observe using normal surveying techniques because they are nocturnal, cryptic or rare.

Two surveys of the catchment were undertaken using eDNA. Passive eDNA kits were purchased from Wilderlab Ltd (Wellington). A comprehensive survey was completed in March–April 2022 followed by a smaller survey in November–December 2022 (Figure 4). The first survey consisted of 63 sites with triplicate passive samplers deployed at each site for 24 hours. This survey included sites where kanakana had been recorded previously, but also included most major tributaries and subcatchments of the Taiari. The second survey of 13 sites used the same methods but incorporated additional subcatchments thought to be important for kanakana.

Field protocols for deploying and collecting the eDNA passive samples followed the instructions provided by Wilderlab Ltd[4]. There were three configurations of passive samplers that included passive bag design (discontinued) and the pods either inserted directly into the substrate or in a mount mid-water column (Figure 3). In shallow waterways, the pegs were deployed directly into the sediment, but in deeper waters, the peg mounts were inserted into an aluminium frame capable of holding up to six replicates. Effort was made to insert the samplers into parts of the waterways where the flow was constricted to ensure a representative sample was collected.

[4] eDNA passive sampler directions https://www.wilderlab.co.nz/directions#passive

Figure 3: The three passive eDNA samplers used in this study include the bag design (left), pods mounted to a mount (middle) and pods mounted directly into the sediment (right).

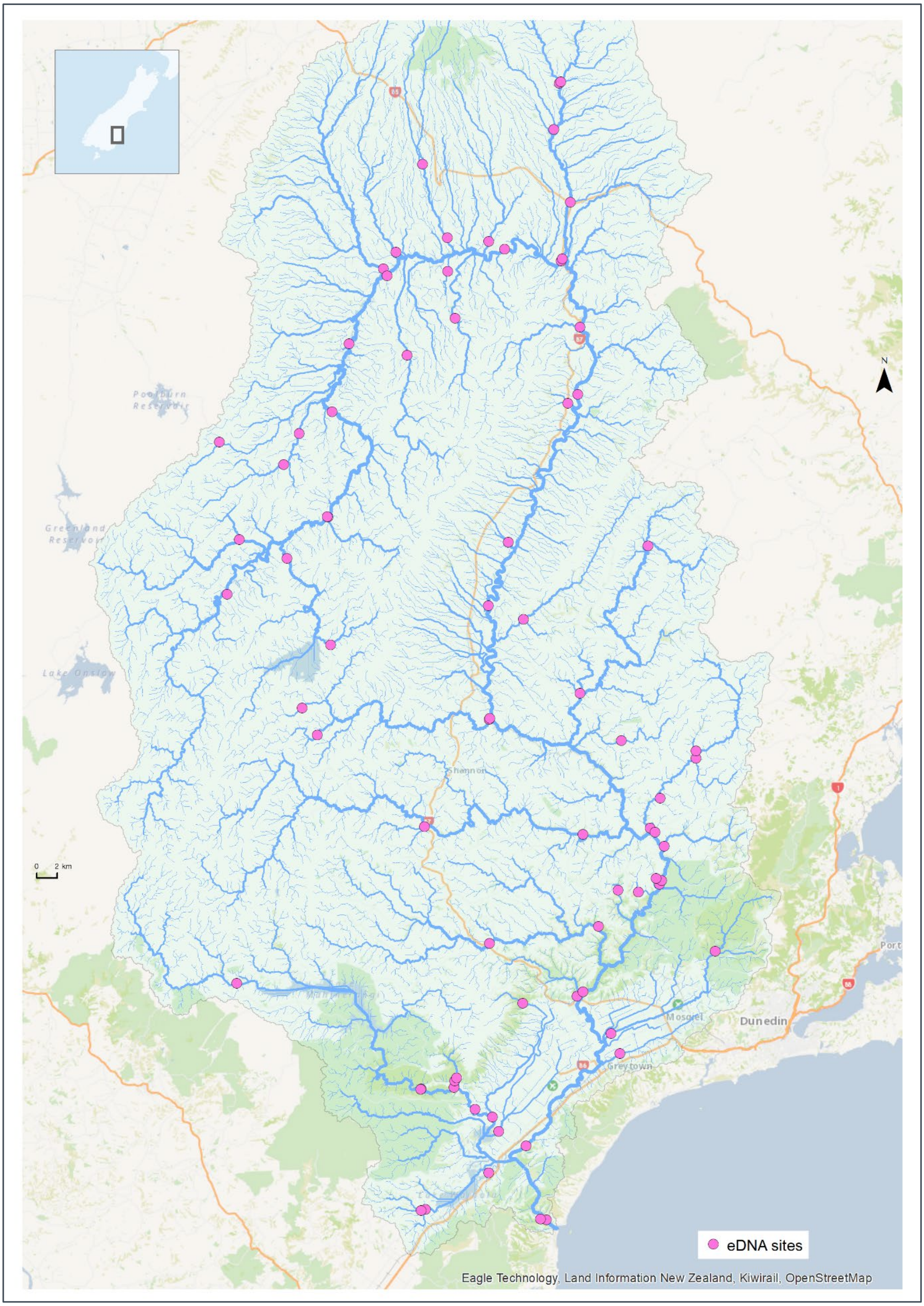

Figure 4: Map of eDNA sampling sites in the Taiari catchment in 2022.

2.2 Pheromone sampling

The pheromone petromyzonol sulphate (PS) is released primarily by kanakana larvae as a metabolic byproduct during feeding. Adult kanakana have been shown to choose waterways with a high PS signal during preferencing experiments. The concentration of PS in waterways is therefore a good proxy for predicting streams that are used by adult and larval kanakana to complete their lifecycles. Polar Organic Chemical Integrated Samplers (POCIS) developed by NIWA[5] absorb and accumulate PS over time, and can be used to provide a crude estimate of larval kanakana abundance upstream of the sampling point. In addition, because adult kanakana are thought to select spawning streams based on larvae presence and abundance, the identification of streams containing high pheromone concentrations can be used to predict where important nesting and spawning areas may be located.

Based on the eDNA results, 28 POCIS were deployed at strategic locations for a 3 weeks between 30 January and 23 February 2023 to quantitatively determine the importance of reaches for kanakana (Figure 5). POCIS units were attached to waratahs following the guidelines from NIWA[6]. The samplers were positioned in areas with an estimated flow of <1 m/s. In some catchments, a series of samplers were deployed to delineate upstream limits. Samplers were also deployed at major confluences to compare the PS cues in each tributary (Figure 6).

Figure 5: POCIS attached to waratah and deployed in the mainstem of Three O'clock Stream.

[5] Stewart, M., Baker, C. 2012: A sensitive analytical method for quantifying petromyzonol sulfate in water as a potential tool for population monitoring of the southern pouched lamprey, *Geotria australis*, in New Zealand streams. *Journal of Chemical Ecology 38*: 135–144.

[6] NIWA 2021: Locating lamprey – guidelines for passive monitoring and identification of spawning streams. Prepared for the Department of Conservation.

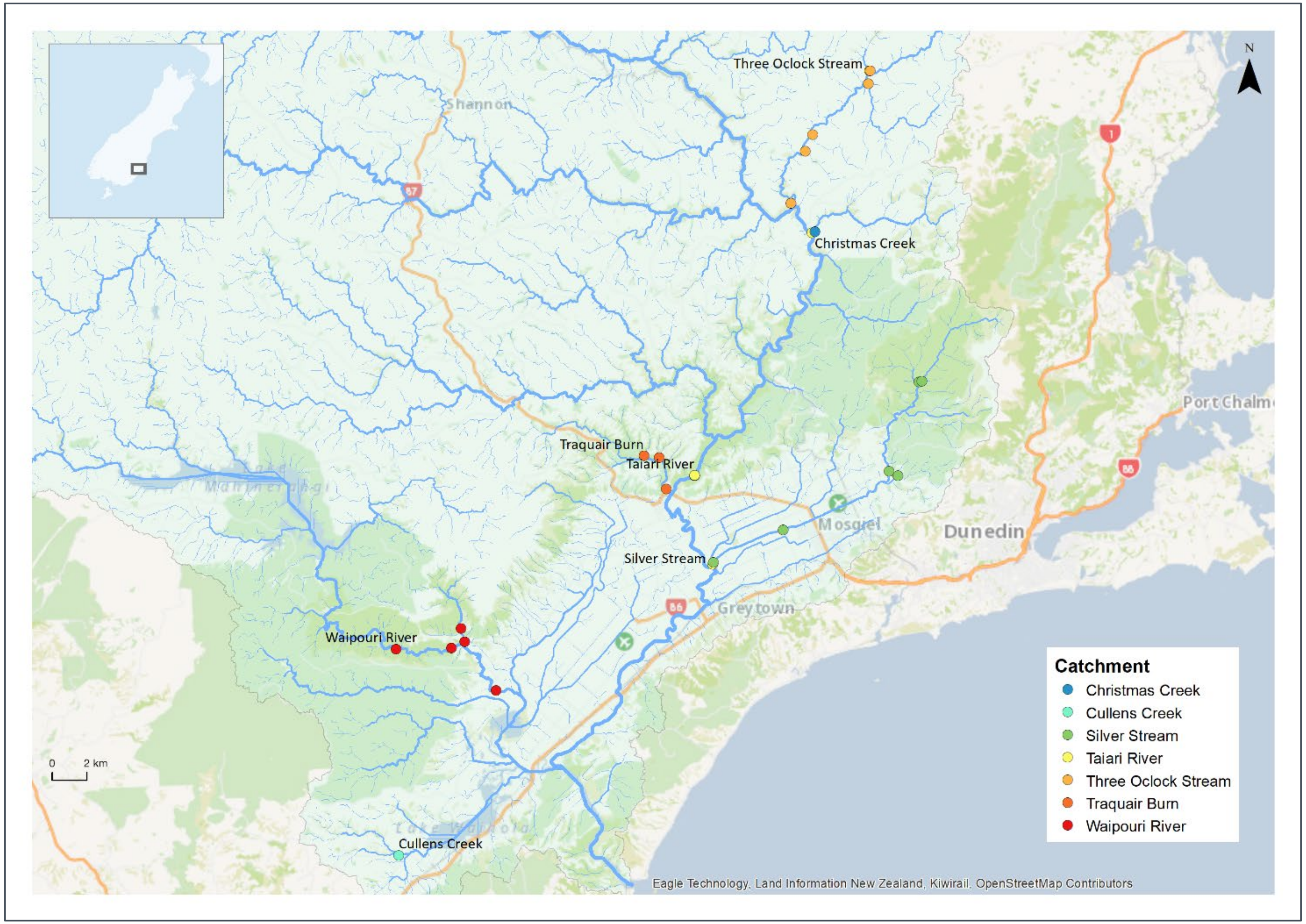

Figure 6: Map of pheromone sampling sites in the Taiari catchment in 2023 showiung the different catchments targetted with POCIS.

3 Results and discussion

3.1 Environmental DNA

In this survey[7], eDNA belonging to kanakana was detected at 10 sites (Figure 7). In the mainstem of the Taiari, kanakana eDNA was detected at Outram and Hindon. These results verify previous observations from Outram but are the first records for the Hindon area. Kanakana eDNA was also detected in five different tributaries of the Taiari. These subcatchments include Three O'clock Stream, Christmas Creek, Traquair Burn, Silver Stream and the Waipōuri (including Cullen's Creek and Mill Creek). These were all new records for the subcatchments except for Cullen's Creek in the Waipōuri and Silver Stream.

Many historical observations in the Taiari were not verified in this study, particularly for Sutton Stream, Deep Stream and Lee Stream. A juvenile kanakana was captured in the Middlemarch region of the Taiari River in May 2022 (Matt Dale pers. obs.) suggesting the fish still occupy the mid reaches of the catchment despite not being detected in this survey.

3.2 Pheromone sampling

The POCIS results supported the eDNA results in confirming the presence of kanakana in all the catchments where DNA was detected, albeit in varying abundances (Figure 8 & Appendix 1). One sampler failed (Waipōuri 2), whilst 5 samplers did not record pheromone concentrations above the detectable limits. These results suggest kanakana are absent or in very low abundance in those reaches. The upper limits to kanakana distributions were identified in Three O'clock Stream, Silver Stream and Waipōuri.

In the Taiari mainstem, the results show moderate to very high abundance of kanakana at the Hindon and Outram sites, but low to moderate abundance further downstream near the confluence with Silver Stream. This suggests that juvenile kanakana are utilising habitats in the mainstem.

Paired POCIS at confluences with the Taiari mainstem quantified the importance of tributaries during the upstream migration of adult kanakana (Figure 9). Nearly equal PS concentrations were detected at the confluence of the Taiari and Silver Stream, suggesting kanakana may not be strongly select one waterway over another. Further upstream, only a weak PS signal was recorded from Traquair Burn compared to the mainstem, suggesting few adults favour that waterway. However, further upstream, Christmas Creek and Three O'clock Stream both have greater PS concentrations than the mainstem, suggesting migrating kanakana are strongly associated with those subcatchments. This is particularly the case for Three O'clock stream given the PS signal at the confluence was greater than any of the other tributaries flowing into the mainstem.

[7] Data can be viewed by searching for job number 602811 at https://www.wilderlab.co.nz/explore.

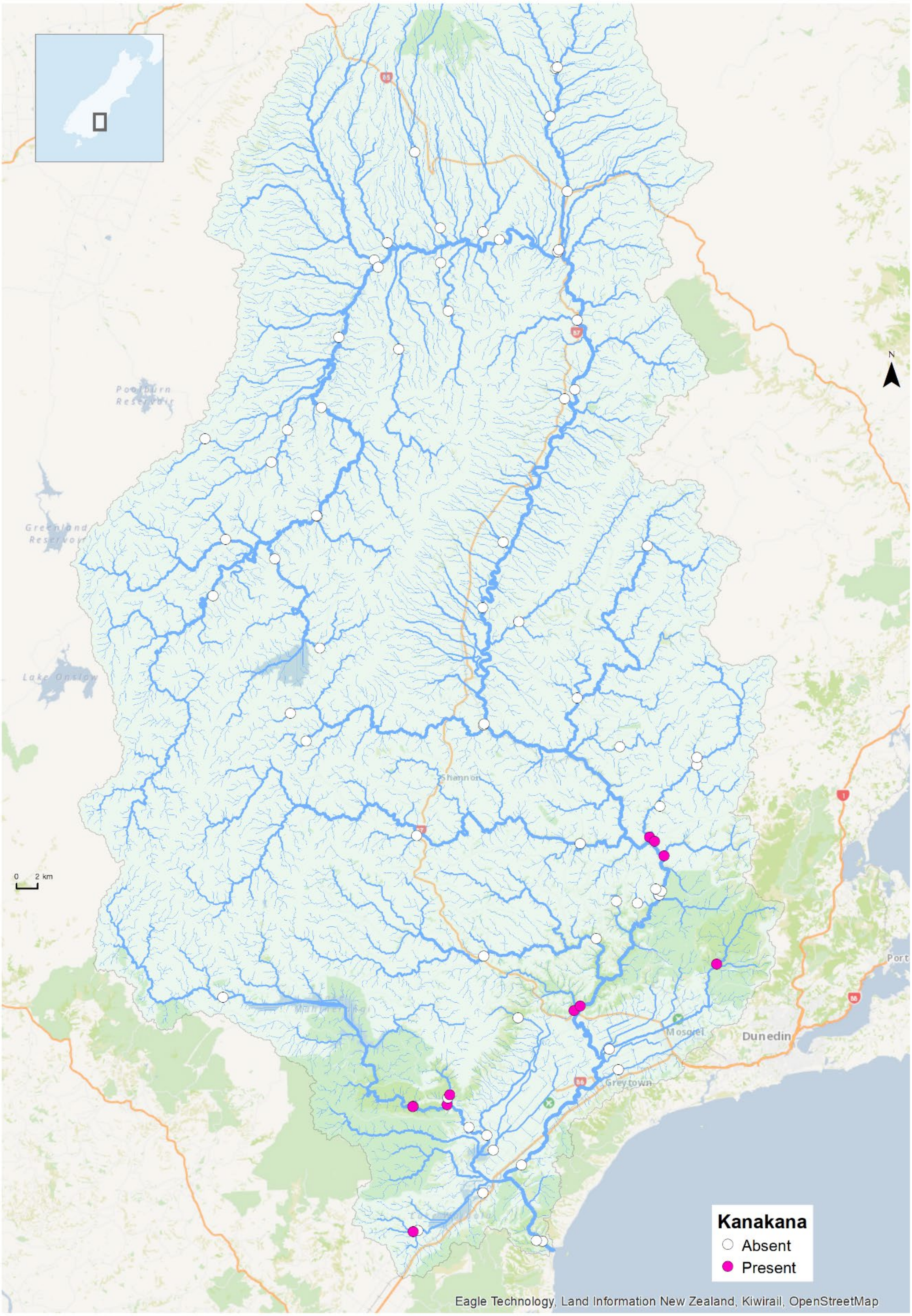

Figure 7: Map of sites with positive eDNA results for kanakana in the Taiari catchment in 2022.

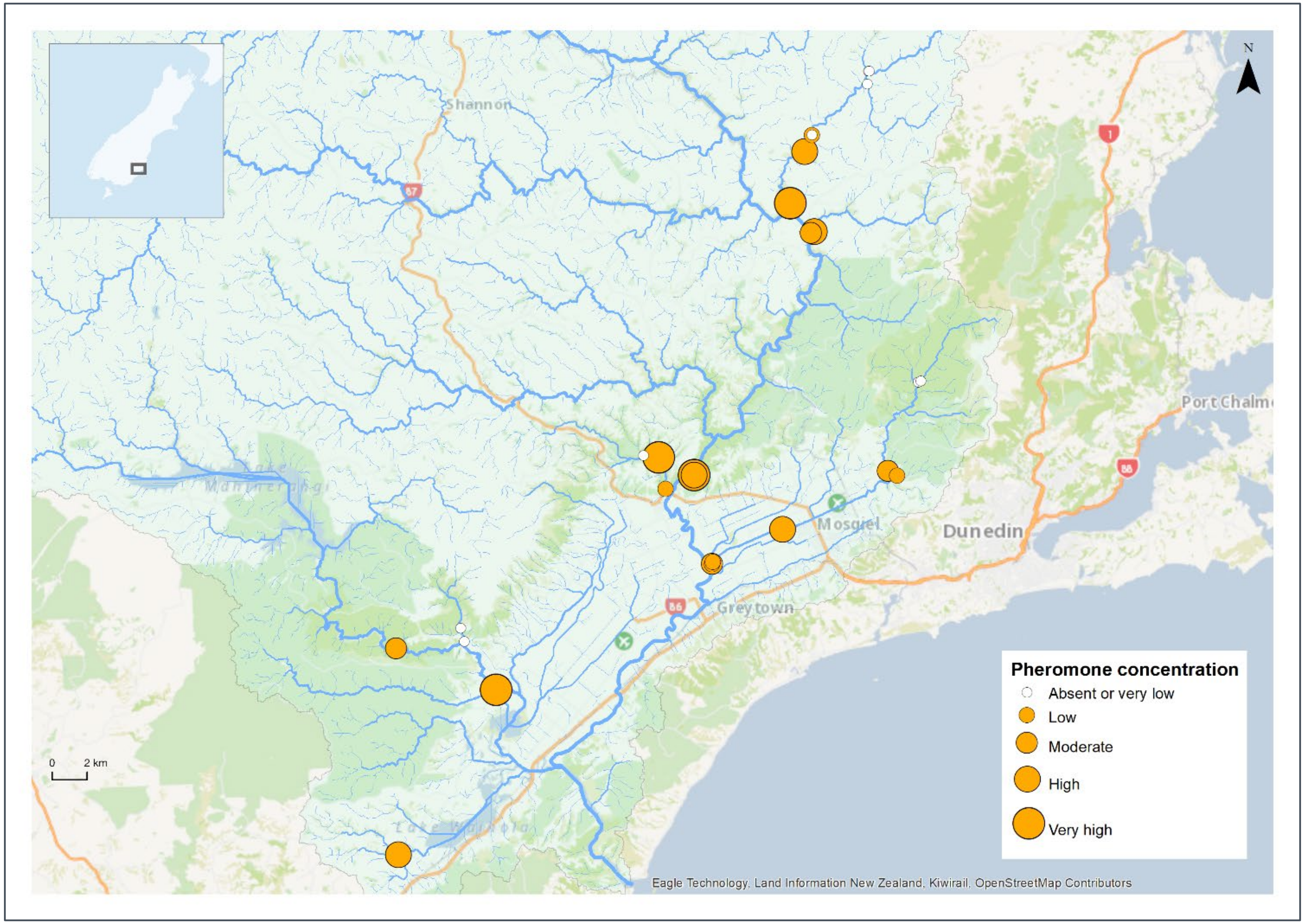

Figure 8: Map of kanakana pheromone concentration levels in the Taiari catchment in 2023. The size of the circle reflects the pheromone concentration, a proxy for kanakana abundance.

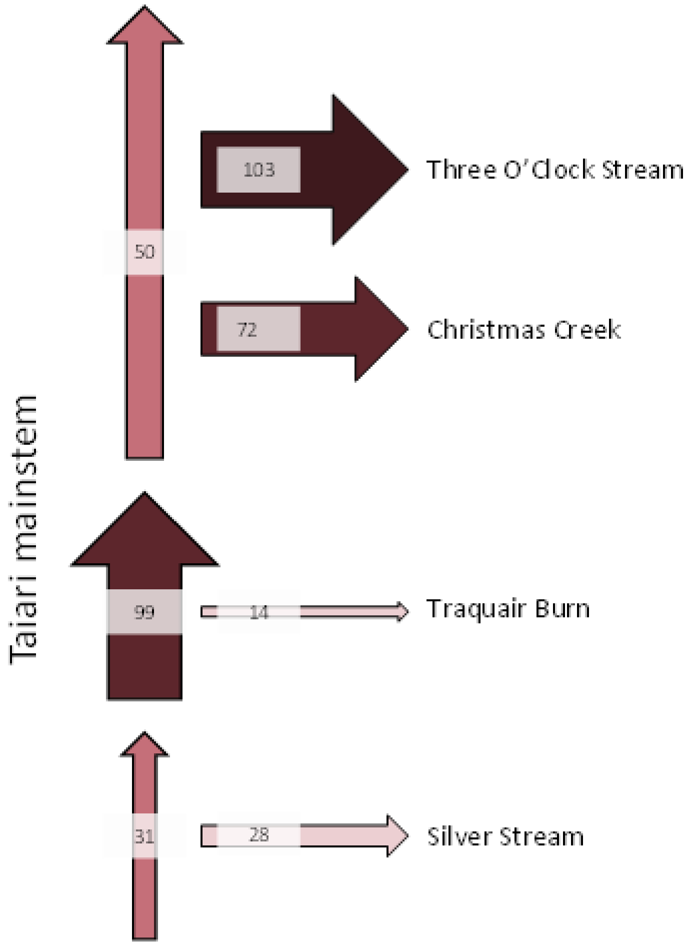

Figure 9: Lamprey pheromone, petromyzonol sulphate (PS), concentrations at four confluences along the Taiari mainstem. The values are time weighted average concentrations in femtomolar (fmolar). The size and colour of the arrow is proportional to the molar concentration of PS at each confluence. Arrows are pointing in the direction of migration (upstream).

Results from Three O'clock Stream show very high PS concentrations in the lower reaches, with a drop between site 2 and 1, and no PS detected in either 2 O'clock Stream or Orbells Stream. This suggests that larval kanakana are mostly utilising the lower reaches of the catchment and are very abundant in this region (sites 3 and 4). During the POCIS survey, a swimming adult female kanakana was captured in Three O'clock Stream in the vicinity of site 2.

Traquair Burn had a weak PS signal at the confluence with the Taiari compared to the Taiari mainstem. However, a tributary in the catchment reported very high abundances of kanakana, suggesting some reaches or tributaries in this subcatchment are important habitat for juveniles. No PS was detected at Smugglers Creek, suggesting that the waterfall is a significant barrier to kanakana migration.

The middle reaches of Silver Stream, particularly the reach around Mosgiel township, recorded PS concentrations that suggest high kanakana abundance. This result supports historical observations in this catchment. However, kanakana presence was detected upstream of Mosgiel and in Flagstaff Creek, suggesting the distribution is much broader than previously thought. No PS was detected higher in the catchment, indicating larval kanakana are confined to the lower to middle reaches.

POCIS results show that high abundances of kanakana are inhabiting Cullen's Creek. Future work is required to delineate the upper limit for kanakana in this catchment. It would be particularly interesting to understand if kanakana are migrating above a waterfall located in the middle of the catchment. This waterway supports a large amount of suitable kanakana habitat (pers. obs.), and given the prior restoration works completed by Te Nukuroa o Matamata and the landowner, presents an opportunity for electrofishing monitoring to understand the long-term population dynamics. This study confirms the important contribution made by this waterway to the biodiversity of the Taiari catchment as it also supports populations of Eldon's galaxias, giant kōkopu, banded kōkopu, tuna (eels) and kākahi (freshwater mussels).

Kanakana are likely to be utilising the entire reach of the Waipōuri River between Mahinerangi dam and Lake Waipōuri. The POCIS results generally show very high abundance in the middle reach of this waterway, but moderate abundance further upstream. It is unlikely that Mill Creek provides significant habitat for kanakana, based on these results. Despite a weak positive eDNA result (only 1 of 3 samples detected kanakana DNA), no PS was detected by POCIS.

4 Next steps

These results provide the basis for future work to increase the understanding of the distribution of important kanakana habitats and their population dynamics. Understanding their distribution in the Taiari catchment will help inform future restoration activities. Future work is summarised in Table 1.

Kanakana are confined to the lower reaches of the surveyed waterways (such as Three O'clock Stream and Silver Stream). These tributaries present an opportunity for annual monitoring to track population dynamics and recruitment over time. Further surveys of other significant tributaries in their lower reaches are also justified, such as the confluences of Deep Stream and Lee Stream with the Taiari mainstem. The eDNA sampling sites in these catchments were limited to more easily accessed reaches further upstream and therefore did not capture potential habitats closer to the confluence with the Taiari.

Deploying POCIS along the Taiari mainstem would identify the upstream limit of kanakana in the catchment. Historical observations for kanakana have been recorded as far upstream as Taiari Lake and although eDNA failed to detect any populations beyond Hindon, POCIS may be sensitive enough to quantify the abundance of kanakana along the mainstem. Similarly, further POCIS surveys are warranted for Traquair Burn and Cullen's Creek to delineate the upper limit of kanakana and assess the importance of specific tributaries.

Future surveys should focus on waterways that were missed in this study. These waterways include tributaries around Lakes Waihora and Waipōuri, particularly the Meggat Burn and the lower reaches of Contour Channel and Lee Creek. Given the proximity of these tributaries to the coast, and the fact that Cullen's Creek and the Waipōuri support important habitats, it is likely that other waterways in this area will be important for kanakana.

Given the limited habitat available to kanakana along the Waipōuri River, due to the Mahinerangi dam preventing fish passage further upstream, this catchment may provide a unique opportunity to identify nesting locations. This could be achieved by tagging migrating adults and tracking their movements[8]. Other remote sensing technology, such as

[8] Baker *et al.* (2017) First observations of spawning nests in the pouched lamprey (*Geotria australis*). *Canadian Journal of Fisheries and Aquatic Sciences 4*: 1603–1611.

cameras and sonar, could be employed to assess the number of migrating adults and the timing of migration.

Table 1: Recommended next steps for eDNA, POCIS or electrofishing monitoring in Taiari subcatchments.

Catchment	eDNA	POCIS	Monitoring	Comments
Mainstem		X		Delineate upstream distribution limit
Cullen's Creek		X	X	Monitor lower reach. Assess upstream limit
Meggat Burn.	X	X		Baseline survey to determine if kanakana present
Waipōuri River			X	Monitor lower reaches, survey nesting habitats and determine migration period
Lee Creek/Contour Channel		X		Determine importance of drainage network for kanakana
Silver Stream			X	Annual juvenile monitoring to understand recruitment and population dynamics
Traquair Burn		X	X	Delineate upstream distribution and important tributaries and monitor larval habitats
Lee Stream	X	X		Determine kanakana presence in lower reaches near Taiari confluence
Christmas Creek			X	Annual juvenile monitoring to understand recruitment and population dynamics
Three O'clock Stream			X	Annual juvenile monitoring to understand recruitment and population dynamics
Deep Stream	X	X		Determine kanakana presence in lower reaches near Taiari confluence

5 Conclusions

This survey provides an update on the distribution of habitats used by kanakana in the Taiari River catchment. It utilised a combination of eDNA and POCIS passive techniques. These results highlight the important subcatchments being utilised by kanakana to complete their lifecycle and points to reaches where more detailed monitoring should be undertaken. Results from subcatchments such as Three O'clock Stream, Christmas Creek, Silver Stream, Cullen's Creek and the Waipōuri River provide an opportunity to develop an annual monitoring strategy to track population dynamics over time. Other catchments require more survey work to delineate distributions. All the survey work will direct future restoration projects for this important taoka species.

6 Acknowledgments

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Figure 10: Looking down at the upper sites of Three O'clock Stream from the true right.

Appendix 1: POCIS data for each site showing location, duration and PS concentration for PS samplers deployed in January–February 2023.

Catchment	Site	Coordinates	Time deployed (days)	Petromyzinol sulfate (ng/sampler)	Time weighted concentration (fmol)	Estimated abundance
Mainstem	1	-45.7199, 170.3505	20	0.11	49.5	Moderate
	2 A	-45.8433, 170.2577	19	0.25	118.3	Very High
	2 B	-45.8434, 170.2578	19	0.17	80.5	High
	3 A	-45.8896, 170.2689	19	0.08	37.9	Moderate
	3 B	-45.8896, 170.2689	19	0.05	23.7	Low
Cullen's Creek	1	-46.0344, 170.0279	20	0.15	67.5	High
Waipōuri	1	-45.9276, 170.0319	20	0.09	40.5	Moderate
	2	-45.9282, 170.0729	20	FAILED		
	3	-45.9509, 170.1049	18	0.30	149.9	Very High
	Mill 1	-45.9182, 170.0805	20	<0.02	BDL	Absent
	Mill 2	-45.9252, 170.0829	20	<0.02	BDL	Absent
Silver Stream	1	-45.7984, 170.4283	18	<0.02	BDL	Absent
	2	-45.8446, 170.4017	20	0.11	49.5	Moderate
	3	-45.8730, 170.3219	19	0.11	52.1	High
	4	-45.8886, 170.2694	19	0.06	28.4	Low
	Flagstaff	-45.8470, 170.4083	20	0.06	27.0	Low
	Powder	-45.7989, 170.4261	18	<0.02	BDL	Absent
Traquair Burn	1	-45.8498, 170.2364	20	0.03	13.5	Low
	Tributary	-45.8335, 170.2317	20	1.33	598.1	Very High
	Smugglers	-45.8322, 170.2208	20	<0.02	BDL	Absent
Christmas Creek	1	-45.7192, 170.3528	20	0.16	72.0	High
Three O'clock Stream	1	-45.6370, 170.3974	24	<0.02	BDL	Absent
	2 A	-45.6691, 170.3535	20	0.03	13.5	Low
	2 B	-45.6691, 170.3535	20	<0.02	BDL	Absent
	3	-45.6775, 170.3476	20	0.15	67.5	High
	4	-45.7041, 170.3358	20	0.23	103.4	Very High
	Two O'clock	-45.6370, 170.3968	24	<0.02	BDL	Absent
	Orbells	-45.6436, 170.3958	24	<0.02	BDL	Absent