# Upper Mangatawhiri Shortjaw Kokopu Survey – 2011

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# Upper Mangatawhiri Shortjaw Kokopu Survey – 2011

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# Executive Summary

During 2008, a survey of the Mangatawhiri Reservoir and headwater streams recorded two shortjaw kokopu, with otolith microchemistry from one of the fish verifying it had a lacustrine life history. The presence of shortjaw kokopu above Mangatawhiri Dam is of particular significance as this species is the rarest of the five galaxiid species that comprise our whitebait fishery, and this was the first record of a potential land-locked (lacustrine) population for this species. To confirm the existence, and determine the size, of a self-sustaining lacustrine population of shortjaw kokopu upstream of the Mangatawhiri Dam, NIWA and Auckland Council undertook an extensive survey of the headwater tributaries during summer 2011.

The upper Mangatawhiri River, the reservoir's main tributary and the St Paul Stream were surveyed using electric fishing and fyke nets. In total 7.2 km of water was fished. Only three shortjaw kokopu were caught, all of which were captured in close proximity to one another (50 m). Despite large amounts of suitable habitat within the survey streams, the shortjaw kokopu population appears extremely rare. The present survey, however, may underestimate the abundance of shortjaw kokopu above Mangatawhiri Dam as it was not possible to undertake spotlighting, which is thought to be more effective for kokopu than electric fishing.

Otolith microchemistry on two of the three shortjaw kokopu captured established that both fish had a lacustrine life history, which confirms the shortjaw kokopu above the Mangatawhiri Dam are in fact part of a small lacustrine population. This population represents the only known land-locked shortjaw kokopu population within New Zealand.

Based on these findings, we recommend:

- Future surveys be carried out to ensure the shortjaw kokopu population does not decline to extinction.
- Future surveys should consist of both electric fishing and spotlighting to give a better estimate of population size.

To ensure the shortjaw kokopu population above Managatawhiri Dam is maintained, we recommend the following management options:

- Ensure an upstream Trap and Transfer programme is not implemented at this dam as it could disrupt the status quo.
- Consult with Auckland/Waikato Fish and Game regarding the necessity to maintain a trout fishery within the Mangatawhiri Reservoir. If the presence of a rainbow trout population above the Mangatawhiri Dam is deemed important, then stocking should continue at the current level as it appears sustainable with respect to the galaxiid populations. However, it is important that the current stocking rate is not increased, as adult trout are known to feed on galaxiids, and therefore have the potential to reduce the growth of the shortjaw kokopu population.
- Undertake stocking of shortjaw kokopu within the Mangatawhiri River catchment to determine if stocking of this species is a feasible option for population enhancement.

- As a conservation measure, consider translocating shortjaw kokopu above the Mangatangi Dam to form an additional self-recruiting lacustrine population.

# 1 Introduction

Watercare Services Limited own and operate four water supply reservoirs (Cosseys, Wairoa, Upper Mangatawhiri and Mangatangi) within the upper Hunua Ranges, which maintain the majority of Auckland's water supply. The four Hunua water supply dams were built between 1955 and 1977, but since construction no provision for fish passage has been made at any of the reservoirs.

Almost half of New Zealand's freshwater fish species are diadromous and therefore undergo migrations between fresh and salt water during their life cycle. It is well known that the construction of dams can impact heavily upon the distribution and abundance of freshwater fish species present in the headwater streams above the impoundments. Of the four Hunua dams, only the Mangatawhiri Reservoir has an external spillway that provides a potential pathway for native sea-run fish species like eels, banked kokopu, koaro and potentially shortjaw kokopu to recruit to the headwater streams.

During 2008, a survey of the Mangatawhiri Reservoir and headwater streams recorded six native fish species; longfin eels, shortfin eels, banded kokopu, koaro, shortjaw kokopu and Cran's bullies, and one introduced species; rainbow trout (Baker *et al.* 2008). Of all four reservoirs, Mangatawhiri had the highest diversity of fish species and was the only reservoir containing shortjaw kokopu. Shortjaw kokopu were however rare, with only two fish recorded during the survey (Baker *et al.* 2008). Otolith microchemistry from one of the fish verified it had a lacustrine life history.

The presence of shortjaw kokopu above Mangatawhiri Dam is of particular significance as this species is the rarest of the five galaxiid species that comprise our whitebait fishery and is classified as declining (Allibone *et al.* 2010). This is the first record of a potential land-locked (lacustrine) population for this species. To confirm the existence, and determine the size, of a self-sustaining lacustrine population of shortjaw kokopu upstream of the Mangatawhiri Dam, NIWA and Auckland Council (AC) (supported by the Department of Conservation (DOC)) undertook an extensive survey of the headwater tributaries during summer 2011.

# 2 Methods

## 2.1 Sampling sites

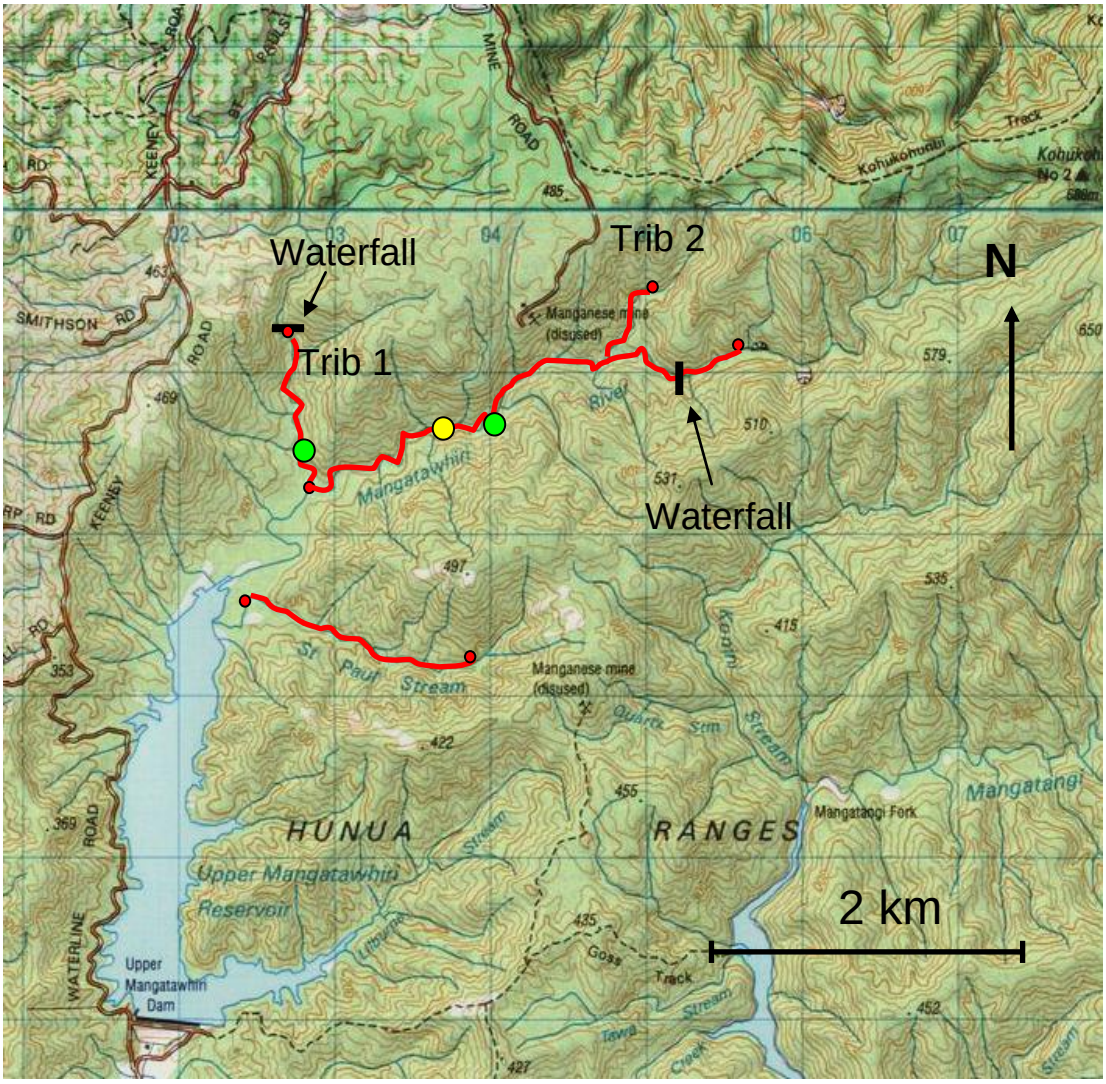
Based on the 2008 survey results, the Mangatawhiri River and its tributaries were targeted (Figure 1). This is where shortjaw kokopu were previously captured, and this river system was thought to provide the most suitable habitat for shortjaw kokopu within the catchment. St Paul Stream was also fished as it was also deemed to contain suitable shortjaw kokopu habitat, and only a small section of the stream was fished in 2008. The Lilburne was not fished as it is a smaller tributary whose habitat was considered less suitable for shortjaw kokopu than the larger waters of the Mangatawhiri River and St Paul Stream. The lower section of the mainstem of the Mangatawhiri River was not fished as most of this water was too deep to fish effectively with the electric fishing machine (Figure 1).

The main true right tributary (herein named Trib 1; Figure 1) was not fished above the 10 m waterfall as this was considered a barrier to upstream colonisation of galaxiids, and no galaxiids were found above this waterfall during the 2008 survey (Plate 1). Fishing was, however, continued above a series of waterfalls encountered on the upper mainstem of the Mangatawhiri River, as the largest fall was no more than 4 m high and galaxiids were found above the impediment, although in lower densities.

**Plate 1:**
10 m waterfall located on the mainstem of the lower unnamed true right tributary of the Mangatawhiri River (photo Callum Bourke, DOC).

**Figure 1:**

Area fished in the upper Mangatawhiri River plus tributaries and the St Paul stream. Red line signifies area covered by electric fishing (7.2 km), the yellow circle is where the three shortjaw kokopu were caught (2011), the green circles are where shortjaw kokopu were caught in 2008. The green circles also represent the upper limits of fyke netting starting from the confluence of the main true right tributary with the mainstem of the Mangatawhiri River.



## 2.2 Methodology

A combination of electric fishing and fyke netting was carried out over four days from the 28th February to 3rd March 2011. Two NIWA staff were supported by two AC staff, and one DOC staff member. Spot-lighting was unable to be carried out as permission to camp over-night in the catchment was declined, making the one and a half hour walk out over rugged terrain at night a health and safety hazard. The lower Mangatawhiri River, Trib 1, and St Paul Stream was accessed via Ernies track (off Waterline Road) and then following the Mangatawhiri River upstream. The upper reaches of the Mangatawhiri River and Trib 2 were accessed via Mine Road Track North (off Mine Road).

Two teams were utilised to maximise the area surveyed over the four day period. Each team used an EFM300 backpack electric fishing machine, set at 200 to 300 volts with a pulse width of 2 milliseconds and frequency of 60 Hz. Coarse mesh fyke nets (10 mm mesh) were also used. In total, 20 nets were set and left to fish overnight. Over three nights, 14 nets were set in the mainstem of the Mangatawhiri River, and 6 nets set within Trib 1. All nets were unbaited and contained excluders (75 mm) to keep larger eels from entering and deterring fish or feeding upon any galaxiids caught. Fyke nets were normally set with the cod end facing upstream (Plate 2).

**Plate 2:**
Example of a fyke net set in the mainstem of the Mangatawhiri River (photo Peter Hancock, AC).

Qualitative single-pass spot electric fishing (Plate 3) was undertaken throughout the survey area. For habitat that was identified as containing good cover for shortjaw kokopu (ie, larger boulders, debris dams, logs, undercut banks) fishing effort was increased with multiple passes undertaken. The survey concentrated on catching shortjaw kokopu, however, any other fish species captured were recorded as rare to abundant depending on numbers caught, with their length (total length) estimated. Any shortjaw kokopu caught were kept alive and held within flow-through plastic containers to enable their length (total length) to be measured and photos taken. A number of

photos and habitat measurements were also taken where the fish had been caught as well as the site coordinates being recorded with a handheld GPS unit.

Of the shortjaw captured, two fish were killed for life history analyses. Both fish were anaesthetised, and then fixed in 95% ethanol. Within the NIWA laboratory, the otoliths (ear bones) were removed from each fish, dried, and then embedded in an epoxy resin. To determine if the shortjaw kokopu were sea-run fish, an analysis of the strontium:calcium (Sr:Ca) ratio within the otoliths was performed at the Australian National University in Canberra using an inductively coupled plasma-mass spectrometer (ICP-MS). Sr:Ca ratios are higher when fish are reared in a marine environment compared to a freshwater environment (Tzeng 1996; Shen *et al.* 1998) and the ratios can be used as indicators of whether fish have a diadromous life cycle with larvae reared at sea, or if they have completed their life cycle in freshwater. All otoliths were drilled through along the shortest axis, using the spike in manganese to determine when the nucleus is hit. Sexing and gut analysis was also carried out on any fish kept.

A number of water quality measurements (temperature, conductivity, dissolved oxygen) were also taken using an YSI Professional Plus machine at regular intervals throughout the survey area. A temperature logger (Onset Hobo Pro) was also deployed overnight at the Trib 1 - Mangatawhiri River confluence, and also within the upper Mangatawhiri River (adjacent to Mine Road track) to record the diel fluctuation in water temperature during the survey.

**Plate 3:**

Electric fishing in the mainstem of the Mangatawhiri River (photo Peter Hancock, AC).

# 3 Results and Discussion

A total of 7.2 km of water was fished during the survey; 4.1 km within the mainstem of the Mangatawhiri River, 1.1 km within Trib 1, 0.6 km for Trib 2 and 1.4 km for St Paul Stream. Overall, six fish species and the freshwater crayfish (koura) were captured (Table 1). The community composition matched that recorded by Baker *et al.* (2008) during the 2008 survey of the upper Mangatawhiri Reservoir tributaries.

**Table 1:**

All species and their abundance caught during the March 2011 survey of the upper Mangatawhiri Reservoir tributaries.

| Species | Mainstem Mangatawhiri River below falls | Mainstem Mangatawhiri River above falls | Trib 1 | St Paul Stream |
|---|---|---|---|---|
| Shortjaw kokopu | rare | - | - | - |
| Banded kokopu | common | occasional | common | abundant |
| Koaro | abundant | common | abundant | abundant |
| Longfin eel | occasional | occasional | occasional | occasional |
| Cran's bully | common | - | abundant | abundant |
| Koura | occasional | occasional | occasional | common |
| Rainbow trout | occasional | - | occasional | occasional |

In total, only three shortjawed kokopu were captured, and all were caught within 50 m of each other in the middle of the fished section of the Mangatawhiri River (Figure 1 and Table 2). No shortjaw kokopu were caught in Trib 1, the site of the first shortjaw kokopu captured in 2008 (Figure 1), despite there being plenty of suitable habitat. Although shortjaw kokopu are solitary fish, they are found as discrete populations (Allibone *et al.* 2003; Charteris *et al.* 2003) so finding all three within close proximity to one another is not unusual. However, the two fish caught during 2008 were found over a more extensive range of the Mangatawhiri River (Figure 1). The two shortjaw kokopu sacrificed were ripe males (the third fish was returned alive to the pool of capture) indicating they may have been close to spawning, and therefore, a spawning migration could account for the close aggregation of fish in the present survey.

The three shortjaw kokopu captured were located approximately 500 m downstream of one fish caught in 2008. This habitat provided good cover and fish were found with a number of other species including koaro, banded kokopu and Cran's bullies (Table 2). The largest shortjaw kokopu (194mm) was found sharing its pool with a large longfin eel (900 mm) that would have been piscivorous. The shortjaw kokopu caught were in good condition with no signs of physical damage from predators (Plate 4). From gut analyses, both fish had been actively feeding prior to capture. A survey of banded kokopu and giant kokopu habitat use by Baker and Smith (2007) found both of these kokopu species also shared pool and cover habitat with large adult eels.

**Table 2:**

Habitat measurements, sex, and gut contents of shortjawed kokopu caught during the March 2011 survey of the upper Mangatawhiri Reservoir tributaries.

| Shortjaw kokopu | 1 | 2 | 3 |
|---|---|---|---|
| Date caught | 1 March 2011 | 1 March 2011 | 3 March 2011 |
| Gps co-oords | E2703651.2 N6458635.5 | E2703711.2 N6458650.4 | E2703717.2 N6458659.4 |
| Fish kept | Yes | Yes | No |
| Length (mm) | 194 | 150 | 125 |
| Weight (g) | 106.02 | 64.85 | Not sampled |
| Habitat | Under a boulder in a pool next to a riffle | Under boulders in a pool with a run upstream | Under a boulder in a run with a pool downstream |
| Substrate % | Boulder 25<br>Cobble 35<br>Gravel 40 | Boulder 40<br>Cobble 60<br>Gravel 0 | Boulder 60<br>Cobble 20<br>Gravel 20 |
| Cover | Undercut bank<br>Woody debris<br>Boulder | Undercut bank<br>Boulder (interstitial spaces between boulders) | Undercut bank<br>Boulder |
| Habitat width (m) | Pool 0.5 to 2 wide | Pool 1.2 to1.5 wide | Run 1.8 to 2.5 wide |
| Maximum Habitat depth (m) | 0.4 | 0.5 | 0.65 |
| Comments | Using the same cover as longfin eel (900mm), large BK and several smaller BK, koaro and bullies | Using same cover as BK, bullies and a few koaro | Caught 2m upstream from pool where SJK 2 was caught. In a run with several juvenile BK and koaro |
| Sex | Male (ripe) | Male (ripe) | Not sampled |
| Gut analysis | Terrestrial long-horn beetle x 1, terrestrial bettle x 1, ant x1, wasp x 1, Caddis fly – Hydropsychidae x 1, Caddis fly Aoteapsyche x 1 Mayfly – Zephlebia borealis x 2 | Terrestrial click beetle (elateridae family x 1 Pupae – Hydrobiosis x 1 Mayfly – Acanthophlebia cruentata x 2, Flatworm – Platyheminthes x 1 Caddis fly – Helicopsyche x 3 Costachorema xanthopterum x 1 Hydrobiosis parmbripennis x 1, unidentified terrestrial invertebrates x 3 | Not sampled |

In general, all shortjaw kokopu were found in habitats of similar dimensions (1-2 m wide, with max depth of c. 0.5 m), dominated by larger substrates, and containing undercut banks, woody debris and boulders as in-stream cover (Table 2). The maximum width and depth of the pools, and in-stream cover used by shortjaw kokopu is comparable to that found by Baker and Smith (2007) for pools utilised by both banded and giant kokopu within the Hakarimata Range. Of the five whitebait species, previous studies have found that shortjaw kokopu tend to be associated more with koaro and banded kokopu than giant kokopu (Allibone *et al.* 2003; Charteris *et al.* 2003) even though an overlap in habitat and cover choice occurs. The tendency for shortjaw kokopu to occur with banded kokopu and koaro over giant kokopu may relate to the location of suitable habitat with respect to elevation and gradient. Shortjaw kokopu have been found to prefer higher elevation forested streams with moderate

gradients often characterised by little fine sediment and good cover amongst cobbles and boulders (Allibone *et al.* 2003; Charteris *et al.* 2003). This was indeed evident in the present study, as shortjaw kokopu tended to be associated with larger cobble and boulder substrates. In comparison, giant kokopu are found at lower elevations than banded kokopu and their preferred habitat consists predominantly of finer cobble and gravel substrates (Baker and Smith 2007; Bonnett and Sykes 2002).

**Plate 4:**
Graham Surrey (AC) proudly displaying the first two shortjaw kokopu caught within 30m of each other, (photo: Peter Hancock, AC).

Overall, the present survey has determined that shortjaw kokopu are rare above the Mangatawhiri Dam even though large amounts of suitable habitat exist within much of the Mangatawhiri River, Trib 1 and parts of St Paul Stream. Most habitats deemed suitable for shortjaw kokopu (pools and runs with good in-stream cover) contained mostly banded kokopu and the occasional large longfin eel. Due to such low numbers being caught, the third shortjaw kokopu captured on the last day of sampling by repeat fishing of productive sites was returned alive to the river due to concerns about the population's survival.

It is more than likely that some fish were missed during the electric fishing survey, as the cryptic nature of shortjaw kokopu, paired with their habitat preferences, can make electric fishing ineffective. The in-stream cover chosen by shortjaw kokopu (large boulders, debris dams, undercut banks) allows fish to hide deep under cover, making it difficult to draw them out with the electric fishing machine. McDowall *et al.* (1996) also had problems capturing shortjaw kokopu in Jones Creek, on the West Coast of the South Island using electric fishing, as fish retreated amongst the substrate for cover. For species such as shortjaw kokopu, spotlighting has been shown to give greater capture efficiency over electric fishing (Allibone *et al.* 2003). As it was not possible to undertake spotlighting in the present survey, it is likely that the number of shortjaw kokopu within the survey areas was underestimated. That said, even with higher

efficiencies, it is likely that the total Mangatawhiri River population is small, and should be considered extremely rare and vulnerable.

No shortjaw kokopu were captured within any of the fyke nets. The only species captured were Cran's bully, koura, and banded kokopu. The fyke nets were set within pools considered too deep to fish effectively with the electric fishing machine, and the poor catches indicate that there were either no shortjaw kokopu frequenting these pools whilst out feeding overnight or that these fish were net shy. Given that shortjaw kokopu have been caught in fyke nets and small traps in South Westland (Main *et al.* 1985; Taylor and Main, 1987) it is likely that fish were absent from the habitat sampled or in such low numbers that none were captured. There could potentially be fish within these pools and spotlighting would be the best method to confirm this.

It was observed that the water in Trib 1 did not seem as clear as that in the mainstem of the Mangatawhiri River, however, water samples were not taken to confirm turbidity levels. A higher level of suspended solids within Trib 1 could be the result of the upper catchment housing an operational pine plantation. Presently, only inanga, banded kokopu and koaro have been tested for avoidance to suspended sediment (Boubee *et al.* 1997). Of the three galaxiid species, banded kokopu were extremely sensitive, avoiding waters with turbidity higher than c. 20 NTU, whereas koaro and inanga were relatively insensitive, requiring levels of 70 and 420 NTU, respectively, before an avoidance response was displayed (Boubee *et al.* 1997). Further investigation is necessary to determine if shortjaw kokopu are also sensitive to suspended solids, or whether the absence of this species from Trib 1 during the present survey is because of their low abundance within the catchment.

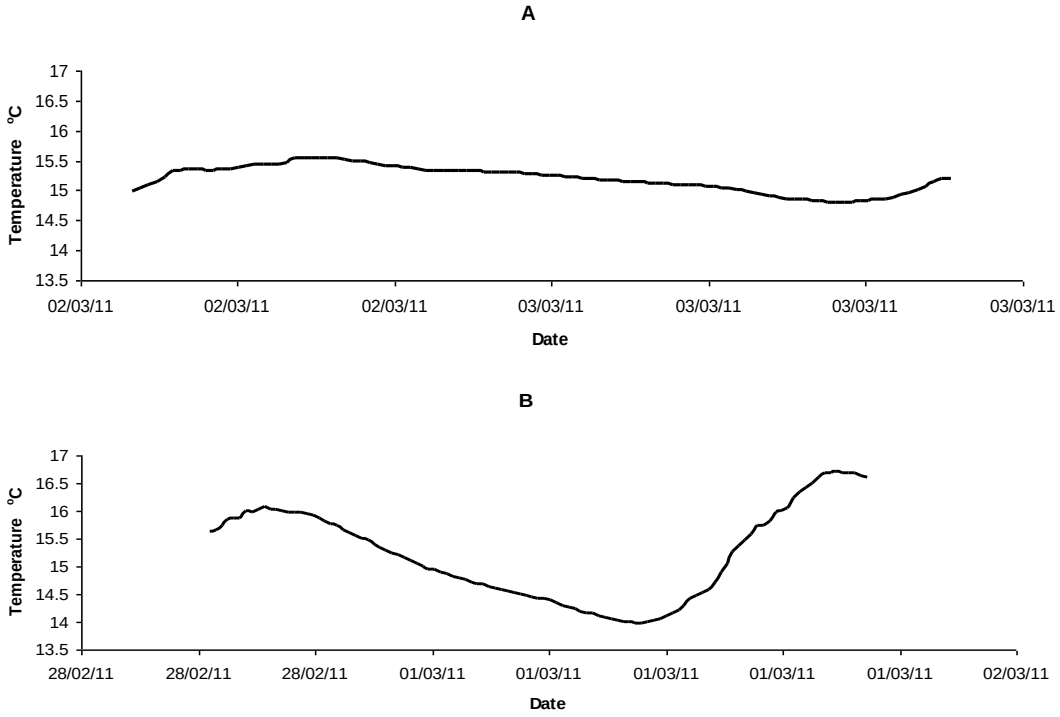
There was little difference between sites in the water quality parameters investigated (Table 3). However, differences in the diel range of water temperatures were found between two sites within the mainstem of the Mangatawhiri River (Figure 2). At the confluence with Trib 1, water temperature fluctuated by 2.7°C over a 24 hour period, whereas further upstream adjacent to the Mine Track, overnight water temperatures only dropped by 0.7°C from the daytime maximum (Figure 2). Although water temperature was only monitored over one 24 hour period, the difference in fluctuation between sites is likely to be due to higher levels of stream shading in the upper reaches of the Mangatawhiri River compared with more open reaches of lower river at the confluence with Trib 1. Whether water temperature fluctuation has an effect on shortjaw kokopu distribution is difficult to determine because of the small number of fish caught. However, given that they are associated with forested streams (Allibone *et al.* 2003; Charteris *et al.* 2003), it is likely they will be less frequently associated with open waters where larger temperature fluctuations are possible.

**Table 3:**

Water quality readings from four sites in the upper Mangatawhiri catchment.

| Site | Mainstem Mangatawhiri River by Mine Track | Mainstem Mangatawhiri River at confluence | Trib 1 above waterfall | St Paul Stream |
|---|---|---|---|---|
| Date | 2 March 2011 | 28 February 2011 | 3 March 2011 | 3 March 2011 |
| Temperature | 15.4 | 15.2 | 14.9 | 15.2 |
| DO % | 90.8 | 95 | 88.1 | 88 |
| DO mg/l | 9.04 | 9.51 | 8.99 | 8.84 |
| Conductivity | 91 | 85.8 | 70.2 | 103 |

**Figure 2:**
Diel temperatures at two sites within the Mangatawhiri River catchment. A, Mainstem of the Mangatawhiri River adjacent to Mine track over the 25 hour period 11.00am to 12pm, 2nd to 3rd March 2011. B, Mainstem of the Mangatawhiri River at the confluence with Trib 1 over the 27 hour period 3.00pm to 6.00pm, 28th February to 1st March 2011.

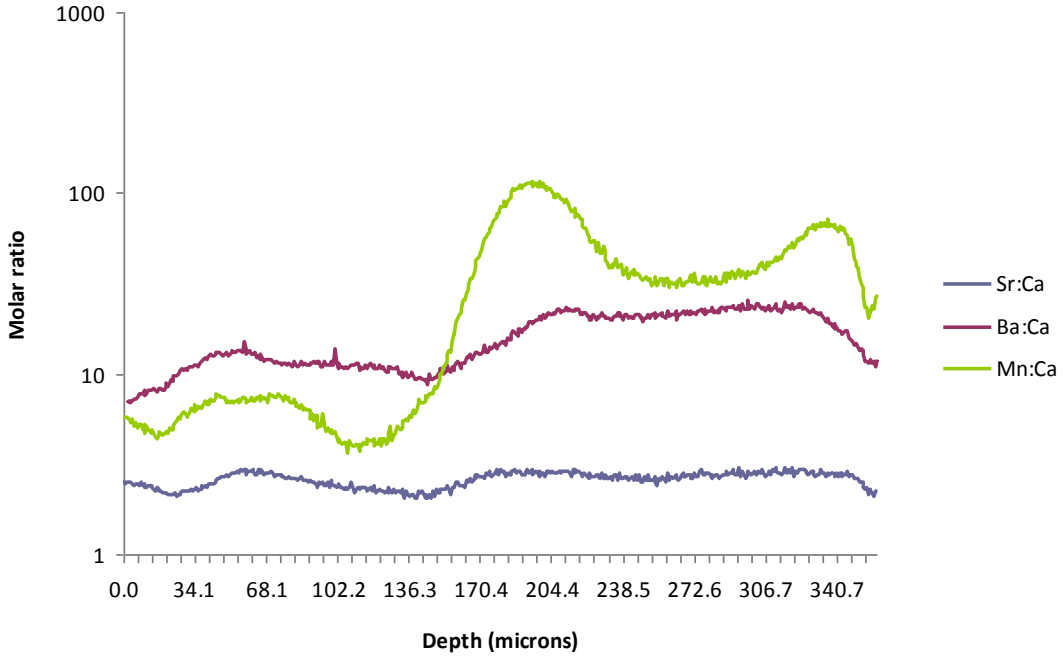



Analysis of the two shortjaw kokopu otoliths show both fish had a lacustrine life-history with no evidence of a marine phase. Representative ratios of isotopes are shown in Figure 3. For both fish, the Sr:Ca ratio was similar throughout their life history. Known sea-run inanga (*Galaxias maculatus*) and koaro show a Sr:Ca ratio of 8 to 12 mmol $mol^{-1}$ when in a marine environment (Baker and Hicks 2003; Hicks *et al.* 2005). Ba:Ca ratios were also similar throughout their life history, and barium abundance is known to be low in the sea compared to freshwater (Crook *et al.* 2006). For both otoliths and the shortjaw kokopu otolith processed in 2008, a peak in the Mn:Ca ratio was present which signifies sampling of the core.

Thus it is likely that the shortjaw kokopu population above Mangatawhiri Dam is lacustrine, with little to no recruitment past the dam by sea-run fish. Of the five diadromous galaxiid species, all species except shortjaw kokopu are known to form lacustrine populations within lake catchments, and this is the first conclusive evidence that shortjaw kokopu can also form a land-locked population. As banded kokopu and koaro are found at similar elevations to shortjaw kokopu (Allibone *et al.* 2003; Charteris *et al.* 2003), shortjaw kokopu should form land-locked populations alongside these species if present at the time access to the sea is inhibited. The absence of shortjaw kokopu lacustrine populations around New Zealand is most likely due to their scarcity in distribution compared to banded kokopu and koaro.

Given the rarity of land-locked shortjaw kokopu populations, the small population within the Mangatawhiri River catchment should be protected. Management options could include stocking to ensure this population continues. As a conservation measure, translocating shortjaw kokopu above the Mangatangi Dam could also be undertaken to form an additional self-recruiting lacustrine population. Baker *et al.* (2008) found the Mangatangi Reservoir and headwater streams to be the only Hunua dam devoid of galaxiids, with low densities of eels, rainbow trout and restricted populations of Cran's bullies the only fish species present. Mangatangi Reservoir is close to the Mangatawhiri Reservoir, and both dams feed into the Waikato River. Because of its high altitude, Mangatangi Reservoir has an almost entirely forested catchment, with many tributaries containing habitats preferred by shortjaw kokopu.

**Figure 3:**
Laser ablation transects through one of the shortjaw kokopu otoliths ( shortjaw number 1, 194 mm). Sr:Ca ratios given in mmol mol-1. Ba:Ca and Mn:Ca ratios given as µmol $mol^{-1}$.



# 4 Summary and Recommendations

Shortjaw kokopu are the rarest of the five galaxiid species that comprise our whitebait fishery, and the two fish caught within the upper Mangatawhiri catchment during 2008 were the first record of a potential land-locked population for this species. The results of the present survey have confirmed that the shortjaw kokopu in the upper Mangatawhiri River are in fact part of a small lacustrine population. This population represents the only known land-locked shortjaw kokopu population within New Zealand.

Despite large amounts of suitable habitat within the headwater streams of the Mangatawhiri Reservoir, the shortjaw kokopu population appears extremely rare, with only three fish captured over an intensive four day survey of 7.2 km of river. The present survey, however, may underestimate the abundance of shortjaw kokopu above Mangatawhiri Dam as it was not possible to undertake spotlighting, which is thought to be more effective for this species than electric fishing.

Based on these findings, we recommend:

- Future surveys be carried out to ensure the shortjaw kokopu population does not decline to extinction.
- Future surveys should consist of both electric fishing and spotlighting to give a better estimate of population size.

As outlined in Baker *et al.* (2008) preserving the shortjaw kokopu population within the Mangatawhiri Reservoir should be a priority. We recommend the following management options:

- Ensure an upstream Trap and Transfer programme is not implemented at this dam as it could disrupt the status quo.
- Consult with Auckland/Waikato Fish and Game regarding the necessity to maintain a trout fishery within the Mangatawhiri Reservoir. If the presence of a rainbow trout population above the Mangatawhiri Dam is deemed important, then stocking should continue at the current level as it appears sustainable with respect to the galaxiid populations. However, it is important that the current stocking rate is not increased, as adult trout are known to feed on galaxiids, and therefore have the potential to reduce the growth of the shortjaw kokopu population.
- Undertake stocking of shortjaw kokopu within the Mangatawhiri River catchment to determine if stocking of this species is a feasible option for population enhancement.
- As a conservation measure, consider translocating shortjaw kokopu above the Mangatangi Dam to form an additional self-recruiting lacustrine population.

# 5 Acknowledgements

We wish to thank Graham Surrey and Peter Hancock of Auckland Council and Callum Bourke of DOC, (Plate 5) for help in coordinating and carrying out the shortjaw kokopu survey, as well as Auckland Council Southern Sector Park rangers for providing accommodation in the Kokako House. We also thank Watercare Services Limited for enabling the survey to be undertaken by providing access to the catchment.

**Plate 5:**
Shortjaw kokopu sampling team 2011 from left to right Callum Bourke (DOC), Graham Surrey (AC), Brenda Bartels (NIWA), Josh Smith (NIWA), and Peter Hancock (AC).

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# 7 Appendix I – Site Co-ordinates

| Fykes unnamed trib | East | North |
|---|---|---|
| 1 | 2702848 | 6458282 |
| 2 | 2702822 | 6458305 |
| 3 | 2702875 | 6458352 |
| 4 | 2702780 | 6458387 |
| 5 | 2702717 | 6458505 |
| 6 | 2702756 | 6458631 |
| | | |
| Fykes main stem | | |
| 1 | 2703200.7 | 6458375.4 |
| 2 | 2702977.4 | 6458208.9 |
| 3 | 2702996.7 | 6458355.8 |
| 4 | 2703070.8 | 6458396.7 |
| 5 | 2703145.8 | 6458390.5 |
| 6 | 2703311.8 | 6458429.2 |
| 7 | 2703314.9 | 6458447.2 |
| 8 | 2703347.8 | 6458431.1 |
| 9 | 2703389.7 | 6458388.1 |
| 10 | 2703405.7 | 6458377 |
| 11 | 2702952.4 | 6458200.9 |
| 12 | 2702832.5 | 6458248.2 |
| 13 | 2703957.2 | 6458662.9 |
| 14 | 2703403.7 | 6458376 |
| | | |
| Shortjaw kokopu 2008 | | |
| 1 | 2702738 | 6458524 |
| 2 | 2704036 | 6458707 |
| | | |
| Shortjaw kokopu 2011 | | |
| 1 | 2703651.2 | 6458635.5 |
| 2 | 2703711.2 | 6458650.4 |
| 3 | 2703717.2 | 6458659.4 |
| | | |
| Main stem fishing | | |
| start | 2702848 | 6458282 |
| end | 2705597 | 6459112 |
| | | |
| Main tributary fishing | | |
| start | 2702848 | 6458282 |
| end | 2702710 | 6459154 |
| | | |
| Small tributary | | |
| start | 2704775 | 6459045 |
| end | 2705058 | 6459484 |
| | | |

| | East | North |
|---|---|---|
| St Paul stream | | |
| start | 2702506 | 6457571 |
| end | 2703669 | 6457117 |
| | | |
| Waterfall main tributary | 2702710 | 6459154 |
| | | |
| Waterfall main stem | 2705214 | 6458956 |

# 8 Appendix 2 – Freshwater Fish Database Forms

| FRESHWATER FISH DATABASE FORM | | | | | | | | | | 1 |
|---|---|---|---|---|---|---|---|---|---|---|
| Date | **1/3/2011** | River/Lake system | **Waikato River (mouth to Waipa River)** | | | | | Catchment number | **434.120** | |
| Time | **1100** | Sampling locality | **Upper Mangatawhiri River** | | | | | | | |
| Observer | **jps** | Access | | | | | | Altitude (m) | **200** | |
| Organisation | **niwa** | NZMS 260 Map no. | **s12** | Coord. | **2703651 6458635** | | | Distance inland (km) | **76** | |
| Fishing method | **efp** | Area fished (m2) or no. nets used | | Number of electric fishing passes | **1** | | | Tidal water | **n** | |

## HABITAT DATA

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Water | Colour | **u** | | | Clarity | **c** | | | Temp. **15.4** | pH | |
| | Average width (m) | **2.0** | Average depth (m) | **0.3** | Maximum depth (m) | **0.4** | | | Conductivity | | |
| Habitat type (%) | Still **0** | Back-water **0** | Pool **100** | | Run **0** | Riffle **0** | | | Rapid **0** | Casc. **0** | |
| Substrate type (%) | Mud **0** | Sand **0** | Fine gravel **0** | | Coarse gravel **40** | Cobble **35** | | | Boulder **25** | Bed-rock **0** | |
| Fish cover (y/n) | Macrophyte **n** | Instream debris **n** | Undercut bank **y** | | Bank veg. **n** | | | | | | |
| Catchment vegetation(%) | Native forest **100** | Exotic forest **0** | Farm **0** | | Urban zone **0** | Scrub **0** | | | Swamp land **0** | Other **0** | |
| Riparian vegetation(%) | Native forest **100** | Exotic forest **0** | Grass tussock **0** | | Exposed bed **0** | Scrub willow **0** | | | Raupo flax **0** | Other **0** | |

| Type of river/stream/lake | | | |
|---|---|---|---|
| Water level | Downstream barrier **y** | Pollution | |
| Large invertebrate fauna | Koura **o** | Paratya | Freshwater mussel |
| Bottom fauna abundance | Predominant species group | Permanent water | |

## FISH DATA

| Species | Abundance | Length | Habitat/Comments |
|---|---|---|---|
| **Galaxias postvectis Shortjaw kokopu** | **1 (r)** | **194** | **poo boulder cover** |

Comments **Ripe male, weight 106.02g**

# FRESHWATER FISH DATABASE FORM

2

| | | | | | |
|---|---|---|---|---|---|
| Date | **1/3/2011** | River/Lake system | **Waikato River (mouth to Waipa River)** | Catchment number | **434.120** |
| Time | **1200** | Sampling locality | **Upper Mangatawhiri River** | | |
| Observer | **jps** | Access | | Altitude (m) | **200** |
| Organisation | **niwa** | NZMS 260 Map no. | **s12** | Coord. **2703711 6458650** | Distance inland (km) **76** |
| Fishing method | **efp** | Area fished (m2) or no. nets used | | Number of electric fishing passes **1** | Tidal water **n** |

## HABITAT DATA

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Water | Colour | | | | **u** | Clarity | | **c** | Temp. **15.4** | | pH | |
| | Average width (m) | **1.3** | Average depth (m) | | **0.4** | Maximum depth (m) | | **0.5** | Conductivity | | | **91** |
| Habitat type (%) | Still | **0** | Back-water | **0** | Pool **100** | Run | **0** | Riffle **0** | Rapid | **0** | Casc. | **0** |
| Substrate type (%) | Mud | **0** | Sand | **0** | Fine gravel **0** | Coarse gravel | **0** | Cobble **60** | Boulder | **40** | Bed-rock | **0** |
| Fish cover (y/n) | Macrophyte | **n** | Instream debris | **n** | Undercut bank **y** | Bank veg. | **n** | | | | | |
| Catchment vegetation(%) | Native forest | **100** | Exotic forest | **0** | Farm **0** | Urban zone | **0** | Scrub **0** | Swamp land | **0** | Other | **0** |
| Riparian vegetation(%) | Native forest | **100** | Exotic forest | **0** | Grass tussock **0** | Exposed bed | **0** | Scrub willow **0** | Raupo flax | **0** | Other | **0** |

| | | | |
|---|---|---|---|
| Type of river/stream/lake | | | |
| Water level | Downstream barrier **y** | Pollution | |
| Large invertebrate fauna | Koura **o** | Paratya | Freshwater mussel |
| Bottom fauna abundance | Predominant species group | Permanent water | |

## FISH DATA

| Species | Abundance | Length | Habitat/Comments |
|---|---|---|---|
| **Galaxias postvectis Shortjaw kokopu** | **1 (r)** | **150** | **poo boulder cover** |

Comments **ripe male, weight 64.85g**

# FRESHWATER FISH DATABASE FORM

3

| | | | | | |
|---|---|---|---|---|---|
| Date | **1/3/2011** | River/Lake system | **Waikato River (mouth to Waipa River)** | Catchment number | **434.120** |
| Time | **1200** | Sampling locality | **Upper Mangatawhiri River** | | |
| Observer | **jps** | Access | | Altitude (m) | **200** |
| Organisation | **niwa** | NZMS 260 Map no. | **s12** | Coord. **2703717 6458659** | Distance inland (km) **76** |
| Fishing method | **efp** | Area fished (m2) or no. nets used | | Number of electric fishing passes **1** | Tidal water **n** |

## HABITAT DATA

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Water | Colour **u** | | | Clarity **c** | | Temp. **15.4** | pH | |
| | Average width (m) **2.1** | Average depth (m) **0.4** | | Maximum depth (m) **0.7** | | Conductivity **90** | | |
| Habitat type (%) | Still **0** | Back-water **0** | Pool **0** | Run **100** | Riffle **0** | Rapid **0** | Casc. **0** | |
| Substrate type (%) | Mud **0** | Sand **0** | Fine gravel **0** | Coarse gravel **20** | Cobble **20** | Boulder **60** | Bed-rock **0** | |
| Fish cover (y/n) | Macrophyte **n** | Instream debris **n** | Undercut bank **y** | Bank veg. **n** | | | | |
| Catchment vegetation(%) | Native forest **100** | Exotic forest **0** | Farm **0** | Urban zone **0** | Scrub **0** | Swamp land **0** | Other **0** | |
| Riparian vegetation(%) | Native forest **100** | Exotic forest **0** | Grass tussock **0** | Exposed bed **0** | Scrub willow **0** | Raupo flax **0** | Other **0** | |

Type of river/stream/lake

| | | | |
|---|---|---|---|
| Water level | Downstream barrier **y** | | Pollution |
| Large invertebrate fauna | Koura **o** | Paratya | Freshwater mussel |
| Bottom fauna abundance | Predominant species group | | Permanent water |

## FISH DATA

| Species | Abundance | Length | Habitat/Comments |
|---|---|---|---|
| **Galaxias postvectis Shortjaw kokopu** | **1 (r)** | **125** | **run boulder cover** |

Comments

# FRESHWATER FISH DATABASE FORM

4

| | | | | | |
|---|---|---|---|---|---|
| Date | **1/3/2011** | River/Lake system | **Waikato River (mouth to Waipa River)** | Catchment number | **434.120** |
| Time | **1000** | Sampling locality | **Upper Mangatawhiri River** | | |
| Observer | **jps** | Access | | Altitude (m) | **200** |
| Organisation | **niwa** | NZMS 260 Map no. | **s12** | Coord. **2702848 6458282** | Distance inland (km) **76** |
| Fishing method | **efp** | Area fished (m2) or no. nets used | | Number of electric fishing passes **1** | Tidal water **n** |

## HABITAT DATA

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Water | Colour | | | | **u** | Clarity | | **c** | Temp. **15.4** | | pH | |
| | Average width (m) | **2.5** | Average depth (m) | | **0.3** | Maximum depth (m) | | **1.6** | Conductivity | | | **90** |
| Habitat type (%) | Still | **0** | Back-water | **0** | Pool **20** | Run | **60** | Riffle **20** | Rapid | **0** | Casc. | **0** |
| Substrate type (%) | Mud | **0** | Sand | **0** | Fine gravel **20** | Coarse gravel | **30** | Cobble **30** | Boulder | **20** | Bed-rock | **0** |
| Fish cover (y/n) | Macrophyte | **n** | Instream debris | **n** | Undercut bank **y** | Bank veg. | **n** | | | | | |
| Catchment vegetation(%) | Native forest | **100** | Exotic forest | **0** | Farm **0** | Urban zone | **0** | Scrub **0** | Swamp land | **0** | Other | **0** |
| Riparian vegetation(%) | Native forest | **100** | Exotic forest | **0** | Grass tussock **0** | Exposed bed | **0** | Scrub willow **0** | Raupo flax | **0** | Other | **0** |

| | | | |
|---|---|---|---|
| Type of river/stream/lake | | | |
| Water level | Downstream barrier | | Pollution |
| Large invertebrate fauna | Koura **o** | Paratya | Freshwater mussel |
| Bottom fauna abundance | Predominant species group | | Permanent water |

## FISH DATA

| Species | | Abundance | Length | Habitat/Comments |
|---|---|---|---|---|
| **Galaxias postvectis** | **Shortjaw kokopu** | **3 (r)** | **125-194** | **gen boulder cover** |
| **Galaxias fasciatus** | **Banded kokopu** | **c** | **40-200** | **gen** |
| **Galaxias brevipinnis** | **Koaro** | **a** | **40-110** | **gen** |
| **Anguilla dieffenbachii** | **Longfin eel** | **o** | **600-1100** | **gen** |
| **Gobiomorphus basalis** | **Crans bully** | **c** | **b** | **gen** |
| **Oncorhynchus mykiss** | **Rainbow trout** | **o** | **a** | **gen** |

Comments **4.1 km spot fished lokking for shortjaw kokopu**

# FRESHWATER FISH DATABASE FORM

5

| | | | | | |
|---|---|---|---|---|---|
| Date | **1/3/2011** | River/Lake system | **Waikato River (mouth to Waipa River)** | Catchment number | **434.120** |
| Time | **1000** | Sampling locality | **Upper Mangatawhiri River Trib.** | | |
| Observer | **jps** | Access | | Altitude (m) | **200** |
| Organisation | **niwa** | NZMS 260 Map no. | **s12** | Coord. **2702848 6458282** | Distance inland (km) **76** |
| Fishing method | **efp** | Area fished (m2) or no. nets used | | Number of electric fishing passes **1** | Tidal water **n** |

## HABITAT DATA

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Water | Colour | | | | **u** | Clarity | | **c** | Temp. **15.0** | | pH | |
| | Average width (m) | **2.5** | Average depth (m) | | **0.3** | Maximum depth (m) | | **1.5** | Conductivity | | | **70** |
| Habitat type (%) | Still | **0** | Back-water | **5** | Pool **10** | Run | **60** | Riffle **20** | Rapid | **0** | Casc. | **5** |
| Substrate type (%) | Mud | **0** | Sand | **10** | Fine gravel **10** | Coarse gravel | **10** | Cobble **35** | Boulder | **30** | Bed-rock | **5** |
| Fish cover (y/n) | Macrophyte | **n** | Instream debris | **n** | Undercut bank **y** | Bank veg. | **n** | | | | | |
| Catchment vegetation(%) | Native forest | **50** | Exotic forest | **50** | Farm **0** | Urban zone | **0** | Scrub **0** | Swamp land | **0** | Other | **0** |
| Riparian vegetation(%) | Native forest | **100** | Exotic forest | **0** | Grass tussock **0** | Exposed bed | **0** | Scrub willow **0** | Raupo flax | **0** | Other | **0** |

| | | | |
|---|---|---|---|
| Type of river/stream/lake | | | |
| Water level | Downstream barrier | | Pollution |
| Large invertebrate fauna | Koura **o** | Paratya | Freshwater mussel |
| Bottom fauna abundance | Predominant species group | | Permanent water |

## FISH DATA

| Species | | Abundance | Length | Habitat/Comments |
|---|---|---|---|---|
| **Galaxias fasciatus** | **Banded kokopu** | **c** | **40-200** | **gen** |
| **Galaxias brevipinnis** | **Koaro** | **a** | **40-110** | **gen** |
| **Anguilla dieffenbachii** | **Longfin eel** | **o** | **600-1100** | **gen** |
| **Gobiomorphus basalis** | **Crans bully** | **a** | **b** | **gen** |
| **Oncorhynchus mykiss** | **Rainbow trout** | **o** | **b** | **gen** |

Comments **1.1 km spot fished up 10m waterfall**

# FRESHWATER FISH DATABASE FORM

6

| | | | | | |
|---|---|---|---|---|---|
| Date | **1/3/2011** | River/Lake system | **Waikato River (mouth to Waipa River)** | Catchment number | **434.120** |
| Time | **1200** | Sampling locality | **Upper Mangatawhiri River trib** | | |
| Observer | **jps** | Access | | Altitude (m) | **200** |
| Organisation | **niwa** | NZMS 260 Map no. | **s12** | Coord. **2704775 6459045** | Distance inland (km) **76** |
| Fishing method | **efp** | Area fished (m2) or no. nets used | | Number of electric fishing passes **1** | Tidal water **n** |

## HABITAT DATA

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Water | Colour **u** | | | Clarity **c** | | Temp. | pH | |
| | Average width (m) **1.0** | Average depth (m) **0.1** | | Maximum depth (m) **0.5** | | Conductivity | | |
| Habitat type (%) | Still **0** | Back-water **0** | Pool **20** | Run **60** | Riffle **20** | Rapid **0** | Casc. **0** | |
| Substrate type (%) | Mud **0** | Sand **0** | Fine gravel **0** | Coarse gravel **10** | Cobble **60** | Boulder **30** | Bed-rock **0** | |
| Fish cover (y/n) | Macrophyte **n** | Instream debris **n** | Undercut bank **y** | Bank veg. **n** | | | | |
| Catchment vegetation(%) | Native forest **100** | Exotic forest **0** | Farm **0** | Urban zone **0** | Scrub **0** | Swamp land **0** | Other **0** | |
| Riparian vegetation(%) | Native forest **100** | Exotic forest **0** | Grass tussock **0** | Exposed bed **0** | Scrub willow **0** | Raupo flax **0** | Other **0** | |

| | | | |
|---|---|---|---|
| Type of river/stream/lake | | | |
| Water level | Downstream barrier **y** | | Pollution |
| Large invertebrate fauna | Koura **r** | Paratya | Freshwater mussel |
| Bottom fauna abundance | Predominant species group | | Permanent water |

## FISH DATA

| Species | | Abundance | Length | Habitat/Comments |
|---|---|---|---|---|
| **Galaxias brevipinnis** | **Koaro** | **c** | **b** | **gen** |
| **Galaxias fasciatus** | **Banded kokopu** | **c** | **b** | **gen** |
| **Anguilla dieffenbachii** | **Longfin eel** | **o** | **a** | **gen** |

Comments **spot fished 600m up trib.**

# FRESHWATER FISH DATABASE FORM

7

| | | | | | |
|---|---|---|---|---|---|
| Date | **1/3/2011** | River/Lake system | **Waikato River (mouth to Waipa River)** | Catchment number | **434.120** |
| Time | **1200** | Sampling locality | **St Paul stream** | | |
| Observer | **jps** | Access | | Altitude (m) | **200** |
| Organisation | **niwa** | NZMS 260 Map no. | **s12** | Coord. **2702506 6457571** | Distance inland (km) **76** |
| Fishing method | **efp** | Area fished (m2) or no. nets used | | Number of electric fishing passes **1** | Tidal water **n** |

## HABITAT DATA

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Water | Colour | | | | | **u** | Clarity | **c** | Temp. | **15.2** | pH | |
| | Average width (m) | **1.2** | Average depth (m) | | **0.2** | | Maximum depth (m) | **0.7** | Conductivity | | | **100** |
| Habitat type (%) | Still | **0** | Back-water | **0** | Pool | **20** | Run | **70** | Riffle | **10** | Rapid **0** | Casc. **0** |
| Substrate type (%) | Mud | **0** | Sand | **0** | Fine gravel | **0** | Coarse gravel | **20** | Cobble | **60** | Boulder **20** | Bed-rock **0** |
| Fish cover (y/n) | Macrophyte | **n** | Instream debris | **n** | Undercut bank | **y** | Bank veg. | **n** | | | | |
| Catchment vegetation(%) | Native forest | **100** | Exotic forest | **0** | Farm | **0** | Urban zone | **0** | Scrub | **0** | Swamp land **0** | Other **0** |
| Riparian vegetation(%) | Native forest | **100** | Exotic forest | **0** | Grass tussock | **0** | Exposed bed | **0** | Scrub willow | **0** | Raupo flax **0** | Other **0** |

| | | | |
|---|---|---|---|
| Type of river/stream/lake | | | |
| Water level | Downstream barrier **y** | Pollution | |
| Large invertebrate fauna | Koura **c** | Paratya | Freshwater mussel |
| Bottom fauna abundance | Predominant species group | Permanent water | |

## FISH DATA

| Species | | Abundance | Length | Habitat/Comments |
|---|---|---|---|---|
| **Galaxias fasciatus** | **Banded kokopu** | **a** | **40-180** | **gen** |
| **Galaxias brevipinnis** | **Koaro** | **a** | **40-100** | **gen** |
| **Anguilla dieffenbachii** | **Longfin eel** | **o** | **a** | **gen** |
| **Gobiomorphus basalis** | **Crans bully** | **a** | **b** | **gen** |
| **Oncorhynchus mykiss** | **Rainbow trout** | **o** | **b** | **gen** |

Comments **spot fishing 1.4km up from mark**