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EXECUTIVE SUMMARY

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Freshwater elver migrations were assessed by monitoring elver trapping and transfer operations at 11 sites around the country. The study was undertaken for the Ministry of Fisheries project EEL2008/01, which is scheduled to cover four seasons (2008–09 to 2011–12). This report includes data from the 2008–09 elver migration season which was added to data collected in previous seasons.

Elver catch and transfer data from four main sites (Karapiro, Matahina, Waitaki, and Arnold dams) and seven supplementary sites (Wairere Falls Power Station, Mokauiti Power Station, Patea Dam, Piripaua Power Station, Mangorei Power Station, Motukawa Power Station, and Mararoa Weir) were collated and analysed for the 2008–09 migration season (spring–autumn) so that trends in elver recruitment could be examined and established.

Standardised monitoring and operating instructions were distributed to 7 of the 11 monitoring sites. NIWA carried out or supervised monitoring at the four main sites, but information for the supplementary sites was obtained from the power station operators.

In the North Island, elver migrations lasted about 10–12 weeks, from early December 2008 to late March 2009. In the South Island, the migrations were shorter (6–8 weeks), from early January to late February 2009.

At the sites where temperature was reliably measured, migration activity began and ended when the average daily water temperature was 16–19 °C. Unusually high temperatures in February 2009 did not influence the timing and magnitude of elver migrations.

The total catch from the monitored sites for the 2008–09 season was the largest ever recorded (7.9 million elvers; 7800 kg), which was attributable to the largest ever catch at Matahina. North Island sites accounted for 97% of the total elver catch.

The shortfin elver catch (6.2 million elvers) was also the largest ever recorded, mainly due to the Matahina catch which was 1.3 million shortfin elvers more than the previous highest. About 98% of the total shortfin catch was captured at North Island sites, and 94% were captured at Karapiro and Matahina. In the 2008–09 season shortfin elvers were recorded in a relatively large quantity at Waitaki Dam for the first time.

The 2008–09 longfin elver catch (1 million elvers) is the second highest since elver catches were first monitored, but about half of the 2007–08 catch. About 81% of the longfins were captured at Karapiro and Matahina, and 17% of the longfins were captured at the three South Island sites.

Elver recruitment trends were analysed by standardising seasonal totals relative to the long-term average for each site. Data from Karapiro and Matahina show a significant increase in recruitment since the mid 1990s, due mainly to increasing numbers of shortfin elvers. There are also shorter-term trends at some supplementary sites suggesting 3–4 year recruitment cycles.

1. INTRODUCTION

Electricity generation using hydro-electric impounding reservoirs was first introduced into New Zealand at Reefton in 1886. Major schemes using large dams did not begin operation until 1914, and construction of large-scale schemes continued until the 1970s (Natusch 1987). Dams were constructed on many of the major rivers, such as the Tongariro, Waitaki, and Waikato for hydro-electric development, flood control, and water supply. Many of these schemes blocked migration of introduced and indigenous fish (Jowett 1987).

The 1947 Fishpass Regulations gave fisheries authorities the right to require a fish pass on any dam or weir built on rivers where trout or salmon did or could exist. Requirements for the passage of indigenous species were not included. Fisheries managers at that time advocated exclusion of elvers and eels from upstream populations of introduced trout (Boubée 2001). The 1983 Freshwater Fisheries Regulations introduced requirements for the passage of indigenous fish species for new structures, and the Resource Management Act (1991) also provided statutory protection for indigenous fish.

By the early 1980s, eight fish passes had been built for trout and salmon at the 33 or so major power, water, and flood control dams throughout New Zealand (Boubée 2001). In the elver migration season (spring–autumn) masses of elvers were seen attempting to climb the face the Karapiro Dam (Hayward 1992). A fish pass was installed at the Arnold Dam in 1932, but was closed in 1938 to reduce the eel population and improve the trout fishery upstream (Jowett 1987). In the 1970s, thousands of elvers frequently invaded the Arnold River powerhouse and were unable to migrate past the dam (Des Sweeney, Kaimata, pers. comm.).

In pre-European times, Maori undertook trapping and transfer of elvers to upstream habitats to enhance poorly productive areas (Best 1929). Since at least the early 1980s, fish passes and trapping and transfer of migrating elvers have been used on an ad hoc basis by electricity generating companies to mitigate impediments to upstream migration at hydro-electric dams, both in New Zealand and overseas, to enhance eel populations and increase productivity upstream of the dams (e.g., Beentjes et al. 1997, Knights & White 1998). More recently, statutory requirements for dam operators to facilitate upstream elver migrations have been included in resource consents.

Eel Research Plans for the North and South Islands propose ongoing monitoring of elver recruitment (Ministry of Fisheries 2008, 2009). Monitoring elver catches at sites where trapping and transfers are undertaken are an opportunity to establish long-term data sets on the relative abundance of elvers in New Zealand. Provided data are collected in a consistent manner each year, the data can be used to determine overall trends in recruitment, and may provide information which will indicate over time the relative status of each eel stock.

Since the 1990s, NIWA has developed standard methods for the trapping and transfer of elvers and recording of the catches (Martin et al. 2007). Although there are records of elver transfers at some locations for over 20 years, data obtained from before the standardised methods were developed and introduced have year to year variability in fishing effort, unreliable species identification, and inconsistent trapping methods which render much of the data unreliable for establishing long-term recruitment trends. Including the 2007–08 season, the longest reliable time series available (Karapiro Dam) has 13 records, and shows that the magnitude of the elver migration is highly variable (Martin et al. 2009).

Research projects funded by the Ministry of Fisheries (EEL2004/01 and EEL2006/01) over the past six years (Martin et al. 2007, 2008) have established a time-series of reliable data on the relative abundance of elvers at selected locations. This study (EEL2008/01) is a continuation of the previous research and will add to the existing dataset and move towards a reliable long-term record of elver recruitment.

2. METHODS

2.1 Data collection and reporting

During the 2008–09 season, detailed information regarding the fishing effort, catch, and species composition was collected at four main sites by NIWA contracted and trained operators. The are two main sites in the North Island (Karapiro Dam on the Waikato River and Matahina Dam on the Rangitaiki River) and two in the South Island (Arnold Dam on the Arnold River and Waitaki Dam on the Waitaki River) (Figure 1).

In addition, seasonal catch records and limited species compositions were obtained from the operators of six other supplementary North Island sites (Wairere Falls Power Station on the Mokau River, Mokauiti Power Station on the Mokauiti Stream, Patea Dam on the Patea River, Piripaua Power Station in the Wairoa River catchment, Mangorei Power Station on the Waiwakaiho River, and Motukawa Power Station in the Waitara River catchment), as well as from one supplementary site in the South Island (Mararoa Weir on the Waiau River) (Figure 1). Catch records have not yet been received from two North Island supplementary sites (Wilson's Dam on the Waiwarawara Stream and Morrinsville water supply dam on the Topehaehae Stream) and one South Island supplementary site (Waihopai Dam on the Waihopai River) (Figure 1).

Standard monitoring protocols and recording forms were developed by NIWA in 2001–02 (Martin et al. 2007), and were supplied to the operators at Karapiro, Matahina, Piripaua, Patea, Arnold, Waitaki, and Mararoa. These protocols formed the basis of monitoring undertaken during the 2008–09 season. Operators and NIWA personnel not familiar with the procedures were given training in data collection, species identification, and recording methods. Monitoring equipment was also provided. Site visits by NIWA staff were made at regular intervals through out the season to the four main sites.

Representative subsamples of at least 100 elvers were collected by taking a grab sample from the trap or the holding tank. At the four main sites, subsamples were collected at least weekly, and analysed for species composition and average weight by NIWA staff or trained operators. At the supplementary sites, subsamples were collected and preserved or analysed less frequently than at the main sites (Wairere, Mokauiti, Piripaua, Patea, Mangorei). No samples were collected from Motukawa. Where species composition could not be done by the operators, samples of about 100 elvers were frozen, and dispatched to NIWA Hamilton for analysis at the conclusion of the season.

Rainfall information, where available, was obtained from either the NIWA National Climate Database (http://cliflo.niwa.co.nz/) or from the power station records. Water temperatures were monitored using a HOBO water temp pro V2® temperature logger provided by NIWA at the start of the season. The loggers were deployed at least 1 metre underwater in flowing water of the tailraces or the downstream rivers adjacent to the elver traps, and recorded water temperature at 60 minute intervals. The records were then used to calculate average daily temperatures.

Estimates of the total weight and numbers of elvers, the average elver weights, and the species composition of the catches were determined using the methods described by Martin et al. (2007). For days where the average elver weight was not measured, the closest available record was used. The catch results for each location are expressed as total catch and average daily catch. Average daily catch was calculated by dividing the weight or number of elvers obtained for each collection by the number of days since the traps were last cleared.

Timing of the elver migration was established using total catch records (i.e., including dead elvers). However, when total catch data were not available, the number of elvers transferred was used. From these data, the time to 50% and 95% of the total cumulative catch was calculated for the total elver catch, and for the estimated shortfin and longfin elver catch (when reliable species composition information was available). Comparison with historical migration timing records were made, but it is important to note that the dates of the start and end of monitoring as well as methodology may have differed between years and between sites.

Details of the sites monitored (Figure 1) and procedures in place at each location have previously been described by Martin et al. (2007, 2008) and any changes or additions are included below.

Karapiro Dam

A video camera was installed on the lift trap at the start of the season, permitting the trap operators and NIWA staff to remotely monitor the trap and prevent overloading and mortality that have occurred occasionally during past seasons during the peaks of the elver migration.

Mokauiti Dam

The power station was commissioned in 1963, and is operated by King Country Energy. The power station is situated on the side of the Mokauiti Stream, which is a tributary of the Mokau River, and downstream of the Wairere Falls power station. The Mokauiti dam is 1 km upstream from the power station (NZMG (RF71nj) N629800 E2681700). There are two Horizontal Francis turbines at the power station, with a 42.7 m head. The power station has a mean output of 7 GWh.

For the 2008–09 season, a temporary fish pass was constructed as part of a fish passage trial required by Environment Waikato Resource Consent 961114 (Condition 12a). The fish pass consisted of a wetted channel from the base of the spillway to a ramp and holding tank which were situated at headrace height.

Elvers ascend through the wetted channel and climb up the ramp into the holding tank at the top of the ramp. Water was provided by a pipe and pump system from the headrace to the spillway side of the dam. Water passed into a header tank or directly into the fishway channel. Water from the header tank maintained a wetted surface on the ramp and provided water for the holding tank. Any excess water passed through an overflow pipe to the channel as attractant flow.

A remote video camera was positioned over the ramp to monitor the ramp, and analysis of the images may provide an estimate of the number of elvers accessing the fish pass. Data from analysis of the video images is not yet available.

Wairere Falls

At Wairere Falls, two ramp and trap systems are in operation, and are named ‘Trap 2' and 'Trap 3’.

At the top of the falls there is a weir which overflows during floods. An elver ladder has been installed on the true right of the spillway and a spray of water provided over the weir on the left. These passage points are not monitored, but a video camera was added over the ladder in late 2008 to monitor the number of elvers using it. The camera operated every 15 minutes and captured 5–6 seconds of video. Data from analysis of the video images are not yet available.

Arnold Dam

A land slip occurred on the true right bank of the Arnold Dam during the winter of 2008, which destroyed the trapping facilities used in 2007–08. Slip debris also filled the pool behind the flow gauging weir which had been used to trap elvers in previous seasons (Martin et al. 2008).

For the 2008–09 season the elver traps were reinstated in a slightly different configuration compared to past seasons. The new configuration consisted of two ramp and trap systems. The lower trap was installed to capture elvers below the flow gauging weir. Water for this trap was provided from the V-notch in the weir, with the elver ramp entry at the base of the weir.

The second system (upper trap) was located upstream of the flow gauging weir and was used to captured elvers that moved past the flow measuring weir. A header tank and pump was installed to provide water for the upper trap. Another small slip at the end of December 2008 damaged this trap yet again, so a new header tank was added and the trap relocated further away from the slip debris area.

Waitaki Dam

For the 2008–09 season, the existing elver ladder (a pipe structure on the spillway edge) was decommissioned and reconfigured to assist elvers to reach the base of Trap 1 (previously called auxiliary trap). Modifications were also made to pipework to provide a better attractant flow for the

access ramp of Trap 1. In addition, a sharp angle at the top of the ramp, was rounded to give elvers easier passage over the ramp

At Trap 3, the outflow from the holding tank that previously discharged onto the ramp was redirected to the base of the ramp.

The "floating" trap in the tailrace of unit 3 during 2008–09 had no buoyancy and became submerged when ever tailrace water levels increased. Consequently this trap was decommissioned.

3. RESULTS

3.1 North Island main sites

Karapiro Dam

Trap and transfer operation at this site were undertaken by the Eel Enhancement Company (EECo) who provided all the records for this site. All species compositions were made on site by Mr John Jeffcote of EECo. NIWA staff from Hamilton visited the site on four occasions during the season.

The lift and stoplog traps were deployed on 29 November 2008, and the first catch (14.42 kg) was processed the following morning. Trapping ceased after 125 days on 3 April 2009 (Figure 2). Maintenance at the power station prevented the lift trap being raised from the river from 27 February to 2 March. On 9 March the main water supply for the stoplog trap was damaged during power station maintenance, and the trap was not operational for the rest of the season. The traps were cleared daily until mid March, when they were cleared every two days.

The species composition and average elver weights of the elver catches were determined by EECo staff on 32 occasions during the season. Based on the total weight and number of elvers examined during the season, the average weights of shortfin and longfin elvers were estimated at 0.89 g (n = 3144) and 1.44 g (n = 423), respectively.

During the monitoring period, about 2.3 million elvers (2187 kg) were captured and transferred to the upstream reservoirs. We estimate about 2 million shortfins and 299 000 longfins were captured (Table 1). There was no mortality recorded for the entire season. In addition, about 361 kg of juvenile eels were also captured. The bycatch recorded by EECo included at least 4500 shrimps, 886 koaro, 945 common bullies, and 82 smelt.

Water temperature was measured near the lift trap. The average daily temperature through the season varied from 17.7 °C to 23.6 °C. Elver catches tended to increase as water temperature rose in early summer, and declined when temperatures fell in late summer (Figure 2). The greatest daily catch of elvers (70.2 kg) was made on 24 December. However, when based on the number of elvers, the greatest daily catch was on 3 December (72 960 elvers). Peak catches occurred in early and late December, and mid and late January, due mainly to increases of shortfin elvers. These migration peaks occurred well before the maximum water temperature for the season occurred (Figure 2). Peak longfin catches occurred late December and about mid–late January. The catches generally declined from late January, although small numbers of elvers continued to be captured through to early April 2009 (Figure 2).

Trapping and transfer of elvers at Karapiro Dam are regulated by a Ministry of Fisheries permit held by EECo. Permitted transfer limits are as follows: Lake Karapiro, no limit; Lake Arapuni, 550 kg; Lake Waipapa, 100 kg; Lake Maraetai, 250 kg; Lake Whakamaru, 450 kg; Lake Atiamuri, 140 kg; Lake Ohakuri, 750 kg.

Transfers of the catch from the Waikato hydro-electric reservoirs were undertaken every 3–7 days throughout the season. Lake Ohakuri, which has the higher permitted transfer, received the greatest proportion (20%) of the catch (Table 2). Transfers to Lake Maraetai (374 kg) and Lake Atiamuri (255 kg) exceeded the permitted limits.

Matahina

Trap and transfer operations at this site were undertaken by the Kokopu Trust who provided all the records. NIWA staff from Rotorua analysed the species composition and average elver weights on-site during regular visits.

Elver trapping began on 1 December 2008, and the first catch occurred on 3 December and continued for 93 days until 3 March 2009. No elver mortalities were recorded. At the beginning and end of the season, when relatively few elvers were present, the trap was checked every 2–3 days, but from mid December to late February the trap was usually checked and cleared daily (occasionally more than once each day).

A representative sample of about 100 elvers was examined for species composition and the average weight determined by NIWA staff on 13 occasions during the season. Based on these analyses, about 4.3 million elvers (4370 kg) were estimated to have been captured through the season (Table 3). The catch consisted of almost 3.8 million shortfins and 516 000 longfins (12%). The average shortfin weight was 0.94 g (range 1.03–0.79 g; n = 1777) and the average longfin weight was 1.64 g (range 2.02–1.18 g; n = 226).

The greatest single daily catch (209 kg) was recorded on 23 January, and the migration also peaked around that time (Figure 3). The catch declined markedly from mid February and trapping ceased in early March. The proportion of longfins in the catch increased in early January to a maximum in mid January (23%). In mid February, the proportion of longfins also increased, and the number of shortfins showed at least seven peaks during the season (Figure 3).

The tailrace water temperature logger was deployed on 2 December. The average daily water temperature ranged from 17.2 to 20.2 °C (Figure 3). The first elver catch occurred when the average daily water temperature was about 18 °C. The maximum average water temperature was recorded on 14 February 2009. Elver catches declined rapidly in late February when the average river temperature was falling (Figure 3).

The entire catch was transferred to locations upstream. Most of the catch (3500 kg or 81%) was transferred above the Aniwhenua Dam (Table 4). We estimate that at least 12.5 million and 2.2 million elvers have been transferred to Lake Aniwhenua and Lake Matahina respectively since transfers were first initiated in 1982.

In addition to elvers, 429 galaxiids were transferred until 14 December, when monitoring of the bycatch was discontinued.

3.2 North Island supplementary sites

Piripaua Power Station

Trap and transfer operations at this site were made by Margaret Tipuna under contract to Genesis. NIWA staff from Hamilton and Rotorua analysed the species composition and determined average elver weights on-site under contract to Genesis.

The elver trap was operational for 115 days, from 28 November 2008 until 23 March 2009. The first catch (44 elvers) was made on 1 December 2008 (Figure 4).

The species composition of the catch and the average elver weights were determined on seven occasions during the season by NIWA staff (Figure 4). However, the two samples in March were fewer than 40 elvers, and may not be an accurate representation of the catch composition. There was a high proportion of longfin elvers in the catch in both December and early February. The proportion of longfin elvers for the 2008–09 season (23%) is the highest since regular monitoring began at Piripaua in the 1996–97 season (Table 5).

The mean weight of the elvers from the seven samples examined was 1.16 g (n = 419) for shortfins and 1.94 g (n = 122) for longfins, which are about the same as the median of seasonal average elver weights since the 2001–02 season (1.91 g and 1.16 g respectively; n = 8).

The total catch was about 9500 elvers (12.7 kg) and at least 79 small eels (Table 5). Elver catches were relatively low in December, but increased through January, and most of the catch was made in January and February. The largest daily catch (1.1 kg) occurred on 28 January (Figure 4).

Longfins catches showed several peaks from early December to early February. The maximum average daily catch of longfins was made in late January (Figure 4). Shortfin catches also fluctuated markedly through the season and peaked on 28 January (Figure 4).

The start and end of the migration occurred at an average daily tailrace temperature of about 16 ^{o}C. Increases in the daily catch tended to coincide with water temperature increases (Figure 4).

Based on the catch samples analysed, we estimate that about 9500 elvers were captured and successfully transferred to the upstream catchment during the season. All of the catch was transferred to the Mangaone Stream. The catch consisted of about 7300 shortfin and 2200 longfin elvers.

Mokauiti Power Station

Trap and transfer operations at Mokauiti were made by King Country Energy (KCE) staff.

Elvers were monitored at this site from 14 October 2008 to 7 April 2009 (172 days). The first elvers (61 individuals) were recorded on 2 December. KCE staff cleared the trap 81 times during the season.

At the start of the season, monitoring consisted of weighing the total catch (i.e., both elvers and shrimps) and visually estimating the percentage of shrimps (by weight). However, from February onwards, elvers and shrimps were weighed separately. The total elver catch over the season was 68.9 kg, with 69.2 kg (43.8 kg weighed and 25.4 kg estimated) of shrimp also caught. Catches of elvers were highest in February, with moderate catches made in January and March. The largest daily catch was made on 17 February when 5.58 kg of elvers were obtained (Figure 5). All elvers and shrimps were released upstream of Mokauiti Dam. Apart from shrimps no other bycatch was recorded.

The species composition of the catch and average elver weights were determined during a site visit on 20 January 2009 by NIWA staff. The proportion of longfins in the sample was 2%, which is similar to the proportion of longfins that has been captured further upstream at Wairere Falls Power Station in previous years. The mean weight of elvers in the sample was 0.97 g (n = 100) for shortfins and 1.0 g (n = 2) for longfins.

Although an accurate estimate cannot be made from the single sample that was analysed for species composition and average elver weight, we estimate that about 82 000 elvers (77 500 shortfin elvers, 4500 longfin elvers) were captured and transferred upstream of the Mokauiti Dam through the season (Table 6).

Wairere Falls Power Station

As for the nearby Mokauiti site, trap and transfer operations at Wairere Falls were made by King Country Energy (KCE) staff.

Both traps were operating from 13 October 2008 until 3 April 2009 (172 days), and elvers were first captured on 14 November. The trap was checked 68 times by King Country Energy (KCE) staff during the season. Monitoring consisted of weighing the total catch (e.g. both elvers and shrimps) and visually estimating the percentage of shrimps (by weight).

The mean weight of elvers in a subsample examined by NIWA staff on 20 January was 0.73 g for shortfins (n = 199) and 0.88 g for longfins (n = 16). Shortfins were dominant in the subsample, about 93% of the 215 elvers examined.

A total of 159.6 kg (191 214) elvers and 22.7 kg of freshwater shrimps were recorded at Wairere Falls (Table 6). Catches peaked in January (one month before catches peaked at nearby Mokauiti) and catches in February were greater than those obtained in December (Figure 5). After weighing, all elvers and shrimps were released upstream of the dam. No elvers were recorded at Wairere after 21 March 2009. Apart from shrimps, no other bycatch was recorded.

Based upon the single sub-sample analysed, we estimate about 216 000 elvers (200 000 shortfins and 16 000 longfins) were caught at Wairere Falls (Table 6).

The elver ladder at the top of the falls was monitored on 20 January by placing a 'wet sock' over the end of the ladder. No elvers were captured on that occasion, but the video images obtained from the ramp indicate that a few elvers successfully used the ladder. Elvers have also been recorded ascending the weir wall where a spray of water has been provided.

Patea Dam

Trap and transfer operations at this site were made by TrustPower contractors and staff.

The trap was in operation from 1 December 2008 to 11 March 2009. The first elvers were captured on 4 December (Figure 6). The trap was checked 94 times during the 101 day period that it was operating.

Six subsamples of the daily elver catch were collected by Trustpower staff and frozen for examination at a later date by NIWA staff. The samples have been received at NIWA, Hamilton, but have not yet been examined.

The total catch of elvers was 364.7 kg and about 450 juvenile eels (over 20 g). There were several migration peaks throughout the season, and the maximum daily catch (8.56 kg) occurred on 27 December. Catches declined from about late January, and few elvers were captured in March (Figure 6). The catch was transferred to Lake Rotorangi immediately upstream of the dam.

An interim estimate of the number of shortfin and longfin elvers was made using the average elver weights for the 2007–08 season (Martin et al. 2009). We estimate that the total catch could be about 664 000 elvers for the 2008–09 season (Table 6). In addition, 663 whitebait and other indigenous fish species (i.e., koaro, banded kokopu, inanga, koura, bullies, and torrentfish), 470 smelt, 3 koura and 1635 shrimp were also captured in the trap.

Mangorei

Trap and transfer operations at this site were made by TrustPower staff.

Monitoring began on 1 December 2008 and continued until 19 March 2009, a total of 109 days. The trap was checked 23 times during the season, at 3 to 7 day intervals (Figure 6). The first elvers were captured on 2 December. A total of 31.7 kg of elvers and 0.31 kg of shrimps were caught in the trap (Table 6). One koura was also captured.

The largest catch (2.85 kg) occurred on 19 January 2009, and the catch peaked in mid-late January (Figure 6).

No subsamples were taken for species composition analysis during the migration season. However, Taranaki Regional Council (TRC) did one analysis during the season, and found that there were 1030 elvers/kg. Based on this analysis, we estimate that about 32 000 elvers were captured and transferred to the Waiwhakaiho River upstream of the power station through the season (Table 6).

Motukawa

Trap and transfer operations at this site are undertaken by TrustPower staff.

Monitoring began on 1 December 2008 and the trap operated for 110 days before closing on 20 March 2009 (Figure 6). The trap was checked 29 times during the trapping period. In general, the trap was checked every 3–7 days. The total catch of elvers was 60.1 kg.

Subsamples of the catch were not collected. Based on the last analysis of the average elver weight in 2005–06 (925 elvers/kg) (Martin et al. 2008), we estimate that about 56 000 elvers were captured and transferred upstream of the Motukawa Dam into the Manganui River during the season (Table 6).

3.3 South Island Main Sites

Arnold Dam

Trap and transfer operations at this site were made TrustPower under an arrangement with a nearby resident. NIWA staff carried out all the species composition and average weight assessments on site.

The traps were operational from 31 October 2008 until 16 March 2009, a total of 137 days (Figure 7). The first elvers were caught in the lower trap on 26 December. Elver migration began in earnest on 1 January (Figure 7).

Unfortunately, the start of the elver run coincided with another slip adjacent to the dam, which damaged the tank supplying water to the upper trap. Heavy rainfall encouraged elvers to continue to enter the trap but the subsequent lack of water in the holding tank resulted in the loss of 4.2 kg of elvers,.

The lower trap did not appear to be as effective as the upper trap, with 99% of the total elver catch captured in the upper trap. Nevertheless, 166 koaro, 25 bullies, and 1 lamprey were caught in the lower trap during the 2008–09 season.

Eleven subsamples were collected and examined by NIWA staff during the season. The average weight of shortfin elvers was 0.99 g (n = 741), and for longfins 1.62 g (n = 537). The proportion of longfins increased throughout the season to a peak in early March, when 83% of the sample examined was longfins (Figure 7). The largest average daily catch for longfins (3927 elvers) was in mid February, and for shortfins in late January (5830 elvers) (Figure 7).

A total of 232.2 kg of elvers and 1.8 kg of juvenile eels (over 20 g) were captured from the two traps (Table 6). The total weight of elvers transferred was 228 kg, with 1.8 kg of juvenile eels also relocated upstream of the dam. The greatest daily catch occurred on 30 January, when 11.6 kg of elvers were caught in the upper trap (Figure 7).

Based upon the subsamples examined, we estimate that about 87 000 longfin elvers and 92 000 shortfin elvers were captured and transferred to the Arnold River immediately upstream of the dam during the 2008–09 season (Table 7).

Waitaki Dam

Trap and transfer operations at this site were made under an arrangement between Graeme Hughes and Meridian Energy. Graeme carried out the species composition and average elver weight assessments on site with the help of NIWA staff.

At Waitaki, trapping began on 27 October 2008 and ceased on 22 March 2009 after 146 days operation (Figure 8). At the start of the season, traps were checked at 3 day intervals but towards the end of the season the traps were checked every 14 days. The first elvers were observed on 2 December, and a few elvers were also seen in the trap later in December, but not collected. Greater numbers of elvers were observed on 1 January. Transfers of elvers and eels began in earnest on 19 January 2009 (Figure 8).

Samples of the catch were collected and examined on six occasions. Longfins were the dominant species, but about 26% of the catch was shortfins. This relatively high proportion of shortfins is in contrast to past years when the catch had been estimated by the previous operators to be entirely longfins. It is possible that this is a relatively recent change in the composition of elvers at this site but a single sample of 36 elvers examined by NIWA staff at the end of the 2007–08 season (March 15 2008) did contain 12 shortfin elvers (Martin et al. 2009).

The average weight of longfin elvers for the 2008–09 season was 12.3 g (n = 791), and for shortfins 4.1 g (n = 304).The maximum proportion of longfin elvers (100%) occurred on 23 January. The greatest proportion of shortfins occurred on 2 February (Figure 8).

The total catch of elvers for the 2008–09 season was 42.9 kg (4701 elvers) and 32.5 kg of juvenile eels (over 20 g) (Table 8). Trap 3 caught 76% of the total elver catch. The largest average daily catch (577 elvers) occurred on 23 January. Peak catches were made from late January to early February. Based on the subsamples examined during the season, we estimate that 1237 shortfins and 3464 longfins were captured (Table 8).

About 93% (4215 elvers) of the captured elvers were transferred to the headwaters of Lake Benmore, and the rest of the catch (7%; 486 elvers) was transferred into Lake Waitaki.

3.4 South Island Supplementary Sites

Mararoa Weir

Trap and transfer operations as well as species composition and size analysis for this site were made by Meridian Energy contractors.

High flows and spilling from the control gates severely limited trap operations through the season, but trapping was nevertheless made on five occasions. Catches were made on four of these visits but no elvers were captured in March (Figure 9).

Each time the trap was checked, a subsample of elvers was examined for species composition, and the average weight determined. For all 16 subsamples, the catch was found to consist entirely of longfin elvers. The mean weight of the 279 elvers examined was 2.3 g (range 0.7–6.0 g) and mean length 128.5 mm (range 90–180 mm).

The traps were operated for 16 nights, and 181.4 kg (about 82 000 elvers) were captured (see Table 6). In addition, at least 278 juvenile eels (over 20 g) were also caught. The largest catch (52.5 kg) was made on 29 January (Figure 9).

About 62% (50 120 elvers) were transferred into the Lake Te Anau catchment, with the remainder being transferred to Lake Manapouri (32%) and the Mararoa River catchment (6%).

3.5 Nationwide catch

During the 2008–09 season, we estimate that 7803 kg (about 7.9 million elvers) were captured from all the monitored sites and transferred to upstream habitats. The catch consisted of 6.2 million shortfin (5607 kg) and 1 million longfin elvers (1649 kg) (see Table 6).

The total catch from the monitored sites for the 2008–09 season was the largest since monitoring began in 1982–83 (see Figure 10). Karapiro and Matahina yielded 83% of the elvers captured, and while the catch at Karapiro was about 440 000 elvers less than in the previous best season (2007–08), the catch at Matahina was 930 000 elvers greater than the previous best (also 2007–08). Thus, the much greater catch at Matahina this season accounted for most of the increase nationally (Table 9).

The shortfin elver catch, like the total catch was the largest ever recorded mainly due to the Matahina catch, which was 1.3 million shortfin elvers more than the previous highest catch (Table 10). Over 6 million shortfin elvers were captured in 2008–09, with about 98% captured at North Island sites, and 94% were captured at Karapiro and Matahina. Shortfin elvers were recorded in a relatively large quantity at Waitaki Dam for the first time in 2008–09 (Table 10). The species composition for Patea Dam has not yet been analysed, but we expect the total shortfin catch to increase further once these data are included.

The longfin catch for the 2008–09 season (1 million elvers) was about half of the 2007–08 catch (see Figure 10). Longfin catches generally decreased at the North Island sites, although there was an increase at Arnold Dam compared to 2007–08). The 2008–09 longfin elver catch is nevertheless still the second highest on record (Table 11). About 81% of the longfins were captured at Karapiro and Matahina, and 17% of the longfins were captured at the three monitored South Island sites.

4. DISCUSSION

4.1 Migration timing

The dates when 50% of the elver catch occurs provide an indication of the relative timing of the migration peaks and the start of the migration between sites and seasons. Furthermore, the dates when 95% of the catch is obtained provides a measure of the length of the season.

At the main North Island sites (Karapiro and Matahina), the elver migration began in early December 2008, before the main South Island sites (Arnold and Waitaki) (Figure 11). The peaks of the shortfin and longfin migrations occurred from mid to early January at the North Island sites, about in the middle of the range of dates recorded in past seasons (Table 12). The North Island sites reached the 50% catch earlier than the South Island sites (Figure 11).

At the South Island sites, the 50% catches at Arnold and Waitaki were also in the middle of the range of dates from previous seasons (Table 12).

The duration of the migrations at Waitaki and Arnold were shorter than for Matahina and Karapiro (Figure 11). At Karapiro and Matahina the migration continued for about 10–12 weeks (i.e., from early December 2008 to the end of February 2009, Figure 11). At Arnold and Waitaki, the duration of migration was about 6–8 weeks but the shortfin migration at Waitaki continued for only about 2–3 weeks (Figure 11).

Conclusions – migration timing

- North Island peak catches occur before those of the South Island.
- Timing of peak catches in 2008–09 was intermediate.
- North Island migration occurs over 10–12 weeks.
- South Island migration occurs over 6–8 weeks.

4.2 Environmental factors

Relationships between elver migration and environmental factors such as water temperature and rainfall are difficult to establish, due to possible interactions among a variety of factors that may affect migration (Knights & White 1998). In England, elver migration above tidal limits is largely dependent on water temperature, but the timing of glass eel runs into estuaries may also influence elver migration patterns (Knights & White 1998, Tesch 2003). In New Zealand, water temperature may also be the dominant factor influencing the timing of the elver runs. In the 2006–07 and 2007–08 seasons migration began when water temperature was about 17–18 °C, and maximum activity mostly occurred when water temperature peaked for the season (Martin et al. 2009).

Rainfall

In 2008–09 we were able to obtain rainfall records for Mokauiti, Wairere Falls, and Piripaua power stations, but there were no obvious relationship between elver catches and rainfall at these three sites (Figure 12).

Temperature

For the 2008–09 season, we have water temperature records from nine sites (Karapiro, Matahina, Wairere, Mokauiti, Piripaua, Patea, Waitaki, Arnold, and Mararoa). Data from Patea were inconsistent and indicate that the logger was probably not deployed correctly. Records from Mararoa are a single daily measurement on days the trap was deployed and is highly variable. At Karapiro, the first catch of elvers was made the same evening that the trap was deployed, and the water temperature was about 19 °C. Migratory activity at this site had probably began before trapping started.

At Matahina, Piripaua, Wairere, Arnold, and Waitaki we have reliable and accurate data from loggers that were deployed correctly before migration activity began. Elver migration generally started at these sites when the average daily water temperatures were about 16–18 °C. At the end of the season, catches ceased when the average daily temperature declined below about 16–19 °C (see Figures 3, 4, 6, 7, 8).

The peak catch for each site was estimated as the date when 50% of the total catch was obtained. At the North Island sites the peak catches occurred about 3–4 weeks before the maximum average daily water temperature occurred (Table 9). This apparent delay was not evident in the South Island. At Arnold, the 50% catch was obtained only about 8 days before the maximum average daily water temperature occurred, while at Waitaki the difference was one day (Table 12).

The occurrence of the migration peak well before water temperature reaches its maximum is in contrast with records from the previous two seasons when the peak catches occurred at about the same time as the maximum water temperature (Martin et al. 2009). However, the 2008–09 migration peaks generally occurred in about the middle of the range of peak catches from previous seasons (Table 12). Heatwave conditions were experienced over much of New Zealand from 7 to 12 February 2009 when air temperatures of 34 °C or more occurred at several locations (NIWA 2009). These

extreme conditions probably caused the water temperature to reach a maximum after the elver migration peak, but exerted little influence on the timing and magnitude of the elver migrations.

We have reliable downstream river or tailrace average daily water temperature records for several seasons from Karapiro (7 seasons), Matahina (4 seasons), and Arnold (5 seasons). At Matahina and Karapiro in 2008–09 the water temperatures at the start and throughout the migration season were relatively high compared to previous seasons, and relatively greater elver catches occurred during those two seasons (Figure 13). Low elver catches occurred at Karapiro in 2004–05 and 2006–07, when the early season water temperatures were relatively low (Figure 13). However, relationships between total catches and rates of temperature change at the start of the migration, or between the timing of the peak catches and temperature, are not statistically significant.

Conclusions – environmental factors

- Rainfall did not appear to directly influence migration at Wairere, Mokauiti, and Piripaua.
- Migration at most sites commenced at water temperatures of about 16–19 °C.
- In the North Island, the bulk of the elver migrations occurred well before water temperature peaked.
- Extremely hot weather occurred in February 2009 after the elver migration had peaked.

4.3 Total catch

In two of the Waikato hydro reservoirs (Maraetai and Atiamuri) transfers exceeded Ministry of Fisheries permit limits, but lower numbers than permitted were released into the other reservoirs (see Table 2). The effects, if any, the number of elvers released has had on eel populations and eventual harvest is unknown, but so far commercial eel fishers appear disappointed with their catches. The lower than expected commercial catches may be because transferred elvers have not yet reached harvestable size and the fast growth rates reported during the early part of the programme (Beentjes et al. 1997) have not continued. Although catches may be small for individual fishers, collectively the total catch from the Waikato hydro-reservoirs may be significant. We recommend that a study of the effects of elver transfers and eel populations in the Waikato hydro-reservoirs be considered in the near future.

The 183 000 elvers captured at the Arnold Dam in 2008–09 was similar to the numbers obtained in 2007–08, even though the traps were damaged at the start of the season (Table 9), and indicates that reconfiguration of the traps has not markedly affected the catch at this site. Nevertheless, in the 1970s about 1 million elvers were captured for an export trial (Des Sweeney, Kaimata, pers. comm). The catch suggests that either the existing traps are relatively ineffective or recruitment has declined markedly since the 1970s.

The elver traps at Waitaki Dam were altered slightly for the 2008–09 season, but the elver catch has remained similar to that obtained in the previous four seasons (Table 9). For consistency, we have made a small change to the way the 2007–08 catch was calculated. For 2007–08 much of the catch probably included small eels, and the catch has been adjusted to include only true elvers (i.e., under 2.0 g). This procedure will continue for 2008–09 and future catches. Shortfin elvers were recorded in a relatively large quantity at Waitaki Dam for the first time in 2008–09.

Conclusions – total catch

- Transfers to two Waikato hydro-reservoirs exceeded permitted limits.
- Reconfiguration of the traps at Arnold and Waitaki do not appear to have affected the catches in the last two seasons.
- A significant proportion of elvers captured at Waitaki in 2008–09 were shortfins.

4.4 Elver recruitment

Analysis of recruitment trends has been hindered by a lack of accurate long-term data at the monitored sites and large variations between seasons (Martin et al. 2009). Analysis of European and North American recruitment has been undertaken using datasets spanning several decades (Moriarty 1990, Moriarty & Tesch 1996, Knights 2003, Durif et al. 2008). However, the longest record of New Zealand elver catches is from Karapiro Dam, which has reliable and consistent data for 14 seasons (see Table 9).

The median catch from Karapiro is 1 465 000 elvers, but there is a 3.5-fold variation (range 2 728 000 – 782 000). Similarly, most of the monitored sites also have large variations (Table 13). Some of the variation at the supplementary sites may be due to inconsistent fishing effort, or inaccurate recording of catches. Consequently, these sites were not used to examine recruitment trends.

A large variability of seasonal catches within and between sites has also been recorded for European and North American catches, and data have been standardised using methods such as the Den Oever Index (DOI), which represents annual variation from the long-term mean catch (e.g. Knights 2003, Durif et al. 2008). For the purpose of this report we have standardised catch records using the method described by Durif et al. (2008) namely:

$$\mathbf{X}_{i,j} = (\mathbf{x}_{i,j} - \boldsymbol{\mu}_j)/\boldsymbol{\sigma}_j$$

where:

X_{ij} = recruitment index for a season at a site
$x_{i,j}$ = elver catch for a season
μ_j = mean elver catch at a site for all seasons
σ_j = standard deviation of elver catch at a site for all seasons

At Arnold and Waitaki dams we consider that there has been inconsistent fishing effort over the length of the records, due to frequent changes to trap designs and locations, and we have not standardised these data from these sites. However, records from the two main North Island sites (Karapiro and Matahina) and four supplementary sites (Patea, Wairere Falls, Piripaua, and Mararoa) have been derived from consistent fishing efforts since 1995.

Overall, there is no consistent long-term trend across the six standardised sites (Figure 14). However, recruitment at Karapiro and Matahina has generally increased since the 1995–96 season (Figure 14). At Matahina, both shortfins and longfins have increased markedly, particularly in 2007–08 and 2008–09 (Figure 15). At Karapiro, increasing recruitment appears to be largely caused by an increase of shortfins (Figure 15).

There are possibly also some short-term recruitment trends at some of the standardised sites. For example, recruitment at Piripaua has been increasing in the previous three seasons, and this trend has continued into 2008–09 season (Figure 14). The increase is mostly attributable to greater numbers of longfin elvers (Figure 15). Wairere, Patea, and Mararoa may have a 3–4 year recruitment cycle (Figure 14).

Conclusions – recruitment

- Large variability in recruitment has been found between and within sites.
- Significant increase in total elver catches have been found at Matahina and Karapiro.
- The increase in elver recruitment at Karapiro and Matahina is largely caused by an increase in the number of shortfins.
- Relatively recent longfin recruitment increases have occurred at Matahina and Piripaua.
- Short-term recruitment cycles may be occurring at Wairere, Mararoa, and Patea.

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Table 1: Estimated total number of elvers (in 1000s) captured at Karapiro Dam for 1995–96 to 2008–09 seasons. Date when 50% and 95% of total catch was made is also shown. Note that the total includes dead elvers in the traps (LF, longfin elvers; SF, shortfin elvers).

	1995–96[a]	1996–97	1997–98[b]	1998–99	1999–00	2000–01	2001–02	2002–03	2-03–04	2-04–05	2005-06	2006-07
Total elvers	1 155	1 220	2 039	1 097	892	782	1 596	1 942	2 131	1 333	2 177	1 296
50% catch	20–22 Jan	26-Jan	6-Jan	14-Jan	29 Jan–3 Feb	14-Jan	28-Jan	19-Jan	21-Jan	5-Feb	1-Feb	9-Feb
95% catch	1–5 Mar	6-Mar	26-Feb	10-Mar	5–10 Mar	28-Feb	25-Feb	9-Mar	27-Feb	22-Mar	24-Feb	14-Mar
Estimated SF	822	974	1 529	756	798	627	1 351	1 766	1 931	1201	1695	1 117
50% of SF	25-Jan	27-Jan	9-Jan	19-Jan	3–8 Feb	11-Jan	26-Jan	21-Jan	21-Jan	6-Feb	5-Feb	12-Feb
95% of SF	1–5 Mar	6-Mar	28-Feb	16-Mar	5–10 Mar	22-Mar	3-Mar	11-Mar	29 Feb	23-Mar	27-Feb	15-Mar
Estimated LF	333	246	510	341	94	155	245	176	200	132	482	179
50% of LF	13–15 Jan	22-Jan	4-Jan	11-Jan	7–11 Jan	14-Jan	28-Jan	7-Jan	25-Jan	3-Feb	20-Jan	31-Jan
95% of LF	9–12 Feb	10-Feb	23-Feb	9-Feb	12–19 Feb	9-Feb	13-Feb	6-Feb	9-Feb	24-Feb	5-Feb	18-Feb
% LF	29	20	25	31	11	20	15	9	9	10	22	14

	2007-08	2008-09	Total
Total elvers	2 728	2 288	22 676
50% catch	17-Jan	17-Jan	
95% catch	25-Feb	3-Mar	
Estimated SF	2 027	1 990	18 584
50% of SF	20-Jan	18-Jan	
95% of SF	29-Feb	3-Mar	
Estimated LF	701	298	4 092
50% of LF	11-Jan	11-Jan	
95% of LF	4-Feb	14-Feb	
% LF	26	13	18

[a] Transferred elvers only as total catch data not recorded
[b] 1997–98 data revised – see Appendix 3 for details

Table 2: **Estimated total weight and number of elvers transferred from the Karapiro Dam traps to the Waikato hydro-electric lake reservoirs in the 2008–09 season (bold indicates non-compliance with Ministry of Fisheries transfer permit quantities).**

	Estimated weight transferred kg			Limits kg	Estimated number transferred			Percentage transferred based on kg		
	Longfin	Shortfin	Total		Longfin	Shortfin	Total	Longfin	Shortfin	Total
Karapiro	73.7	293.0	366.8	no limit	56 505	320 098	376 603	17	17	17
Arapuni	74.5	312.5	387.0	550	51 263	389 192	440 455	17	18	18
Waipapa	0.8	68.7	69.5	100	593	72 367	72 960	0.2	4	3
Maraetai	42.2	332.1	**374.3**	250	33 732	384 125	417 857	10	19	17
Whakamaru	76.4	220.7	297.1	450	54 596	245 957	300 553	18	13	14
Atiamuri	47.8	207.5	**255.4**	140	37 301	224 940	262 240	11	12	12
Ohakuri	115.7	320.9	436.5	750	64 487	353 216	417 703	27	18	20
Total	431.2	1 755.4	2 186.6		298 476	1 989 896	2 288 372			

Table 3: **Estimated total number of elvers (in 1000s) captured at Matahina Dam for 1998–99 to 2008–09 seasons. The date when 50% and 95% of the total catch was made is also shown. Years with accurate records for most of the season are in italics (– no records available; LF, longfin; SF, shortfin).**

	1996–97[a]	*1997–98*[b]	1998–99	1999–00[c]	2000–01[c]	*2001–02*	*2002–03*	*2003–04*	*2004–05*	*2005-06*	*2006-07*
Total elvers	14	*615*	1 002	2 001	2 054	*619*	*1 484*	*945*	*1 117*	*1 193*	*485*
50% catch	7–10 Feb	*30-Jan*	–	–	–	*8-Jan*	*10-Jan*	*19-Dec*	*3-Feb*	*28-Jan*	*30-Jan*
95% catch	10–13 Mar	*23-Feb*	–	–	–	*16-Feb*	*19-Feb*	*28-Jan*	*24-Feb*	*19-Feb*	*1-Mar*
Estimated SF	10	*478*	–	–	–	*592*	*1 360*	*881*	*1 102*	*965*	*326*
50% of SF	12–16 Feb	*23-Feb*	–	–	–	*8-Jan*	*10-Jan*	*19-Dec*	*3-Feb*	*28-Jan*	*4-Feb*
95% of SF	10–13 Mar	*26-Feb*	–	–	–	*16-Feb*	*19-Feb*	*28-Jan*	*24-Feb*	*19-Feb*	*1-Mar*
Estimated LF	4	*136*	–	–	–	*27*	*124*	*64*	*15*	*228*	*159*
50% of LF	3–7 Feb	*5-Jan*	–	–	–	*24-Dec*	*12-Jan*	*20-Dec*	*29-Jan*	*27-Jan*	*23-Jan*
95% of LF	28 Feb–3 Mar	*13-Feb*	–	–	–	*6-Feb*	*13-Feb*	*5-Jan*	*17-Feb*	*15-Feb*	*22-Feb*
% LF	29	*22*	–	–	–	*4*	*8*	*7*	*1*	*19*	*33*

	2007-08	*2008-09*	Total
Total elvers	*3 379*	*4 307*	19 215
50% catch	*11-Jan*	*20-Jan*	
95% catch	*7-Feb*	*15-Feb*	
Estimated SF	*2 450*	*3 791*	11 955
50% of SF	*11-Jan*	*20-Jan*	
95% of SF	*7-Feb*	*16-Jan*	
Estimated LF	*928*	*516*	2 201
50% of LF	*12-Jan*	*20-Jan*	
95% of LF	*3-Feb*	*15-Feb*	
% LF	*27*	*12*	11

[a] An additional 84.5 kg of eels and elvers were caught but proportions were not recorded and data omitted.
[b] A further 107 kg of elvers and eels were caught but proportions were not recorded and data omitted.
[c] Kokopu Charitable Trust Inc. reported catching 2001 kg of elvers in 1999–2000 and 2045 kg in 2001 (Bill Kerrison, Murupara, pers. comm.). Estimated number shown is based on an average weight of 1 g. It is possible that the catches include juvenile eels.

Table 4: Estimated total weight and number of elvers transferred from Matahina Dam elver trap to the upper Rangitaiki catchment during the 2008–09 season.

		Weight of elvers kg			Number of elvers			Percentage transferred based on kg		
	Location	Longfin	Shortfin	Total	Longfin	Shortfin	Total	Longfin	Shortfin	Total
Lake Matahina	Lake Matahina	131.5	703.6	835.1	82 565	744 399	826 964	16	20	19
Lake Aniwhenua	Aniwhenua at Dam	120.2	554.7	674.9	72 616	598 141	670 757	14	16	15
	Upper Rangitaiki River	114.3	378.6	492.8	71 980	421 028	493 008	14	11	11
	Aniwhenua at Kopuriki	297.1	1 222.7	1 519.8	180 622	1 314 493	1 495 115	36	35	35
	Mid Rangitaiki	12.0	70.6	82.6	7 552	74 984	82 536	1	2	2
	Whirinaki	118.1	463.3	581.4	75 418	491 635	567 053	14	13	13
	Pokereiti	43.1	140.9	184.0	25 779	146 185	171 964	5	4	4
	Total	836.3	3 534.3	4 370.6	516 532	3 790 865	4 307 397	100	100	100

Table 5: **Estimated total number (in 1000s) of elver catch at Piripaua Power Station for 1998–99 to 2008–09 seasons. The date when 50% and 95% of the total catch was made is also shown. Years with accurate records for the most of season are in italics (–; no species composition or elver weights available; LF, longfin elvers; SF, shortfin elvers).**

	1996–97	1997–98[a]	1998–99	*1999–00*	*2000–01*[b]	*2001–02*	*2002–03*[c]	*2003–04*[d]	*2004-05*	*2005-06*	*2006-07*
Total elvers	2 100	7 339	3 141	*2 577*	*5 656*	*4 084*	*10 185*	*4 886*	*8 127*	*2 760*	*4 180*
50% catch	26-Feb	5-Feb	19-Jan	*21–28 Jan*	*21–28 Jan*	*21-Jan*	*3-Feb*	*10-Jan*	*4-Feb*	*30-Jan*	*26-Jan*
95% catch	11-Mar	18-Mar	18-Mar	*21–25 Feb*	*24-Feb*	*27-Mar*	*4-Mar*	*20-Feb*	*28-Feb*	*22-Feb*	*24-Feb*
Estimated SF	2 100	–	2 732	*2 529*	*5 432*	*3 656*	*10 001*	*4 685*	*7 669*	*2 613*	*3 832*
50% of SF	26-Feb		19-Jan	*21–28 Jan*	*21–28 Jan*	*21-Jan*				*30-Jan*	*24-Jan*
95% of SF	11-Mar		18-Mar	*21–25 Feb*	*22-Feb*	*4-Apr*				*2-Mar*	*21-Feb*
Estimated LF	0	–	409	*48*	*224*	*428*	*184*	*201*	*458*	*147*	*348*
50% of LF	–		19-Jan	*14–21 Jan*	*19-Feb*	*14-Jan*				*3-Feb*	*7-Feb*
95% of LF	–		7-Feb	*21–28 Jan*	*7-Mar*	*8-Mar*				*7-Mar*	*7-Mar*
% LF	0	6	13	*1.9*	*3.7*	*10.4*	*1.8*	*4.1*	*5.6*	*5.3*	*8.3*

	2007-08	*2008-09*	Total
Total elvers	*5 736*	*9 472*	70 243
50% catch	*17-Jan*	*28-Jan*	
95% catch	*16-Feb*	*28-Feb*	
Estimated SF	*4 685*	*7 319*	57 253
50% of SF	*15-Jan*	*30-Jan*	
95% of SF	*14-Feb*	*28-Feb*	
Estimated LF	*1051*	*2153*	5 651
50% of LF	*21-Jan*	*26-Jan*	
95% of LF	*2-Mar*	*9-Feb*	
% LF	*18.3*	*23.0*	8.0

[a] Species composition information available for transferred catch only.
[b] Dates for shortfin and longfin elvers not included as only 3 subsamples analysed over entire season.
[c] Dates for shortfin and longfin elvers not included as traps were closed intermittently through the season.
[d] Dates for shortfin and longfin elvers not included as only 5 subsamples analysed over entire season.

Table 6: Estimated elver catches at the monitored sites for the 2008–09 season.

	Shortfin elvers		Longfin elvers		Total	
Site	Number	Weight (kg)	Number	Weight (kg)	Number	Weight (kg)
Karapiro	1 989 896	1 755.4	298 476	431.2	2 288 372	2 186.6
Matahina	3 790 865	3 534.3	516 532	836.4	4 307 397	4 370.7
Wairere Falls	199 967	145.7	16 078	14.1	216 045	159.8
Mokauiti	77 608	64.4	4 579	4.3	82 187	68.7
Piripaua	7 319	8.7	2153	4.0	9 472	12.7
Patea					663 572	364.6
Mangorei					32 651	31.7
Motukawa					56 101	60.7
Arnold	96 217	95.1	86 900	137.1	183 117	323.2
Waitaki	1237	2.85	3 464	40.1	4 701	43.0
Mararoa Weir			81397	181.4	81 397	181.4
Total	6 163 109	5 606.5	1 009 579	1 648.5	7 925 012	7 803.0

Table 7: Estimated total weight and numbers of elvers caught at Arnold Dam for the 2008–09 season. Date to 50% and 95% of total catch also shown. All years have accurate records for most of season (LF, longfin; SF, shortfin).

	2004–05	2005–06	2006–07	2007–08	2008–09	Total
Total elvers	27 516	14 510	107 100	186 153	183 117	518 396
50% of catch	10-Feb	26-Jan	21-Feb	24-Jan	1-Feb	
95% of catch	18-Feb	10-Feb	12-Mar	17-Feb	24-Feb	
Estimated SF	20 385	6 218	55 242	107 743	96 217	285 805
50% of SF	10-Feb	2-Feb	21-Feb	20-Jan	29-Jan	
95% of SF	18-Feb	10-Feb	16-Mar	8-Feb	22-Feb	
Estimated LF	7 131	8 292	51 858	78 410	86 900	232 591
50% of LF	10-Feb	3-Jan	21-Feb	31-Jan	7-Feb	
95% of LF	18-Feb	7-Feb	7-Mar	21-Feb	26-Feb	
%LF	26	57	48	42	48	45

Table 8: **Estimated total number of elvers caught at Waitaki Dam for 1999–2000 to the 2008–09 seasons. Date to 50% and 95% of total catch also shown. Years with accurate records for most of season are in italics (LF, longfin; SF, shortfin; >, greater than).**

	2000–01	2001–02	*2002–03*[c]	*2003–04*	*2004–05*	*2005–06*[d]	*2006–07*	2007–08[e]	*2008–09*	Total
Total elvers	2 061[a]	65 kg[b]	*56*	*4 652*	*1 559*	*4 683*	*3 252*	4 140[f]	*4 701*	25 104
50% of catch	30-Jan	–	*3-Feb*	*31-Jan*	*14-Feb*	*31-Jan*	*14-Feb*	17-Jan	*26-Jan*	
95% of catch			*13-Feb*	*27-Feb*	*3-Mar*	*18-Feb*	*18-Mar*		*13-Feb*	
Estimated SF	–	–	*0*	*9*	*0*	*0*	*0*	0	*1 237*	1 246
50% of SF				*6-Jan*					*26-Jan–2-Feb*	
95% of SF	–	–		*7-Jan*					*2-Feb*	
Estimated LF	–	–	*56*	*4 643*	*1 559*	*4 683*	*3 252*	4 140[f]	*3 464*	>21 797
50% of LF	–	–	*3-Feb*	*31-Jan*	*14-Feb*	*31-Jan*	*14-Feb*	17-Jan	*23-Jan*	
95% of LF	–	–	*13-Feb*	*27-Feb*	*3-Mar*	*18-Feb*	*18-Mar*	15-Feb	*13-Feb*	
%LF			*100*	*99.8*	*100*	*100*	*100*	100	*74*	>87

[a] Mostly juvenile eels (>20g).
[b] Catch was 65 kg, but full season records not available, and most of the catch was juvenile eels (>20 g).
[c] Traps altered, including change of substrate on ramps.
[d] An additional floating trap installed in tailrace.
[e] Floating trap replaced by fixed ramp in 2007–08. Mostly large elvers (93% of elvers were > 2g).
[f] Amended to true elvers as catch reported by Martin et al. (2009) probably included many small eels.

Table 9: Summary of the estimated total number (1000s) of elvers captured each season at monitored sites. Italicised regions are records we consider to be representative of the elver run and where control over the quality of the data has been maintained.

		82–83	83–84	84–85	85–86	86–87	87–88	88–89	89–90	90–91	91–92	92–93	93–94	94–95	95–96
North Island	Karapiro											92	518	282	1155
	Matahina	20	21	23	6	19		18	46		>24	>32	>215	>39	>144
South Island	Waitaki														
	Roxburgh														
	Mararoa Weir														
	Total	20	21	23	6	19		18	46		>24	>124	>733	>321	>1299

		96–97	97–98	98–99	99–00	00–01	01–02	02–03	03–04	04–05	05–06	06–07	07–08	08–09	Total
North Island	Karapiro	*1 220*	*2 040*	*1 097*	*892*	*782*	*1 596*	*1 942*	*2 131*	*1 333*	*2 178*	*1 296*	*2 728*	*2 288*	23 570
	Lake Waikare	540						256	175	–	–	–	–	–	971
	Wairere Falls				166	191	130	289	330	*155*	*163*	294.2	204	216	2 138
	Mokauiti													82.2	
	Matahina	14	*615*	1 002	2 001	2 054	*619*	*1 484*	*945*	*1 117*	*1 193*	*485.4*	*3 378*	*4 307*	19 821
	Wilson's									*<0.1*	*0.5*	0.5	–	–	1.0
	Morrinsville										*0.4*	0.06	–	–	0.5
	Piripaua	2.1	7.3	3.1	*2.6*	*6*	*4.1*	*10.2*	*4.9*	*8.1*	*2.8*	*4.2*	*5.7*	*9.5*	71
	Patea				461	*495*	*754*	*380*	*391*	450	562	896	*857*	*664*	5 910
	Mangorei							18	19.6	10	20.2	24	32.8	32.6	157
	Motukawa							45.5	64.4	94	57.8	21	45	56.1	384
South Island	Arnold Dam									*27.5*	*14.5*	*107*	*186.2*	*183.1*	518
	Waitaki					–[a]		<0.1	*4.6*	*1.5*	*4.7*	*3.3*	4.3[b]	*4.7*	23
	Roxburgh	0.3	11	7.4			*1*	*0.1*	*1.4*	–	–	–	–	–	21
	Mararoa Weir			43.7	90	28		36	97.8	*64.1*	*46*	*118*	*133.5*	*81.4*	739
	Waihopai											12.7	2.7	–	15
	Total	1 776	2 673	2 153	3 613	3 556	3 104	4 141	4 081	3 260	4 243	3 262	7 577	7 925	54 340

[a] 2061 elvers not included as they were mostly small eels.
[b] Amended to true elvers as catch reported in Martin et al. (2009) probably included many small eels.

Table 10: **Summary of estimated number (in 1000s) of shortfin elvers captured each season at monitored sites. Italicised regions are records we consider to be representative of the elver run and where control over the quality of the data has been maintained.**

		82–83	83–84	84–85	85–86	86–87	87–88	88–89	89–90	90–91	91–92	92–93	93–94	94-95	95-96
North Island	Karapiro											61	342	186	822
	Matahina	–	11	18	5	8		16	–	–	>17	>30	–		
South Island	Arnold Dam														
	Waitaki														
	Roxburgh														
	Mararoa Weir														
	Total	0	11	18	5	8	0	16	0	0	17	91	342	186	822
		96–97	97–98	98–99	99–00	00–01	01–02	02–03	03–04	04–05	05–06	06–07	07–08	08-09	Total
North Island	Karapiro	*974*	*1529*	*756*	*798*	*627*	*1 351*	*1 766*	*1 931*	*1 201*	*1 695*	*1 117*	*2 027.0*	*1 990*	19 173
	Lake Waikare	108							173	–	–	–	–	–	281
	Wairere Falls				–	–	–	268	–	*144*	*135*	*269.1*	*147.0*	200	1 163
	Mokauiti													77.6	78
	Matahina	10	*479*	–	–	–	*592*	*1 360*	*881*	*1 102*	*965*	*325.9*	*2 450.0*	*3 791*	12 061
	Piripaua	2.1	–	2.7	*2.5*	*5.4*	*3.7*	*10*	*4.7*	*7.7*	*2.6*	*3.8*	*4.7*	*7.3*	57
	Patea					–	*707*	*372*	*390*	–	*475*	843.3	759.0		3 546
South Island	Arnold Dam									20.4	*6.2*	*55.2*	*107.7*	*96.2*	285.7
	Waitaki							*0*	<0.1	*0*	0	0	0	1.3	0.1
	Roxburgh	0	0	0			*0*	*0*	*0*	–	–	–	–	–	0
	Mararoa Weir			1.1				0	0	*0*	*0*	*0*	*0*	*0*	1.1
	Waihopai											4.3			4.3
	Total	1 094	2 008	760	801	632	2 654	3 776	3 380	2 475	3 279	2 619	5 495	6 163	36 650

Table 11: Summary of estimated number (in 1000s) of longfin elvers captured each season at monitored sites. Italicised regions are records we consider to be representative of the elver run and where control over the quality of the data has been maintained.

		82–83	83–84	84–85	85–86	86–87	87–88	88–89	89–90	90–91	91–92	92–93	93–94	94–95	95–96
North Island	Karapiro											31	176	96	333
	Matahina	–	10	5	1	11	–	2	–	–	>7	>2	–	–	–
South Island	Arnold Dam														
	Waitaki														
	Roxburgh														
	Mararoa Weir														
	Total	0	10	5	1	11	0	2	0	0	7	33	176	96	333
		96–97	97–98	98–99	99–00	00–01	01–02	02–03	03–04	04–05	05–06	06–07	07–08	08–09	Total
North Island	Karapiro	*246*	*510*	*341*	*94*	*155*	*246*	*176*	*200*	*132*	*483*	*178.9*	*700.7*	*298*	4 397
	Lake Waikare	431							2	–	–	–	–		433.0
	Wairere Falls				–	–	–	22	–	13.4	*28*	*25.1*	*57*	16.1	161.6
	Mokauiti													4.6	4.6
	Matahina	4	*136*	–	–	–	*27*	*124*	*64*	*15.2*	*228*	*159.5*	*928.5*	*517*	2 241.2
	Piripaua	0	–	0.4	<0.1	0.2	*0.4*	*0.2*	*0.2*	*0.5*	*0.15*	*0.35*	*1.1*	*2.2*	5.7
	Patea					–	*48*	*8*	*1*	*0.7*	*87*	52.7	98		295.4
South Island	Arnold Dam									*7.1*	*8.3*	*51.9*	*78.4*	*86.9*	232.6
	Waitaki					–[a]		<0.1	*4.6*	*1.5*	*4.7*	*3.3*	4.3[b]	*3.5*	21.9
	Roxburgh	0.3	11	7.4			*1*	*0.1*	*1.4*	–	–	–	–		21.2
	Mararoa Weir			42.6	90	28		36	97.8	*64.1*	*46.1*	*118*	*133.5*	*81.4*	737.5
	Waihopai											8.4			8.4
	Total	681	657	391	184	183	322	366	371	235	885	598	2 002	1 010	8 559.7

[a] 2061 elvers not included as they were mostly small eels.
[b] Amended to true elvers as catch reported by Martin et al. (2009) probably included many small eels.

Table 12: Dates of estimated peak catch (50%) and maximum water temperature for 2008–09 and previous seasons.

			50% catch	Max temperature 2008–09		Difference[a]
	Past records	N	2008–09	° C	Date	Days
Karapiro	14-Jan–9-Feb	11	17-Jan	23.2	11-Feb	25
Matahina	19-Dec–3-Feb	8	20-Jan	20.2	14-Feb	24
Piripaua	10-Jan–4-Feb	11	28-Jan	19.1	13-Feb	16
Wairere	3-Jan–2-Feb	11	19-Jan	22.6	9-Feb	21
Patea	2-Jan–3-Feb	9	14-Jan	24.0	10-Feb	27
Arnold	24-Jan–10-Feb	5	1-Feb	21.5	9-Feb	8
Waitaki	17-Jan–14-Feb	8	26-Jan	18.0	25-Jan	-1

[a] Number of days from 50% catch to maximum average daily river or tailrace temperature.

Table 13: Median elver catches for main and supplementary sites with reliable data.

	Median elver catches (max-min) x1000			
	Total	SF	LF	N
Karapiro	1 465(2728–782)	1 276(2027–627)	246(701–94)	14
Wairere Falls	198(330–130)			10
Matahina	1 117(4307–14)	923(3791–10)	130(928–4)	13[a]
Piripaua	4.9(10.2–2.1)	4.3(10.0–2.1)	0.3(2.1–0)	12
Patea	528.5(896–380)			10
Arnold Dam	117.2(186.2–14.5)	71.4(107.7–6.2)	45.8(86.9–7.1)	5
Waitaki	3.7(4.7–0.1)	1.2	3.4(4.7–0.1)	8[b]
Mararoa Weir	72.7(133.5–28)	no shortfins	72.7(133.5–28)	10

[a] N = 10 for longfin and shortfin catches.
[b] N = 1 (2008–09 season) for shortfin catches.

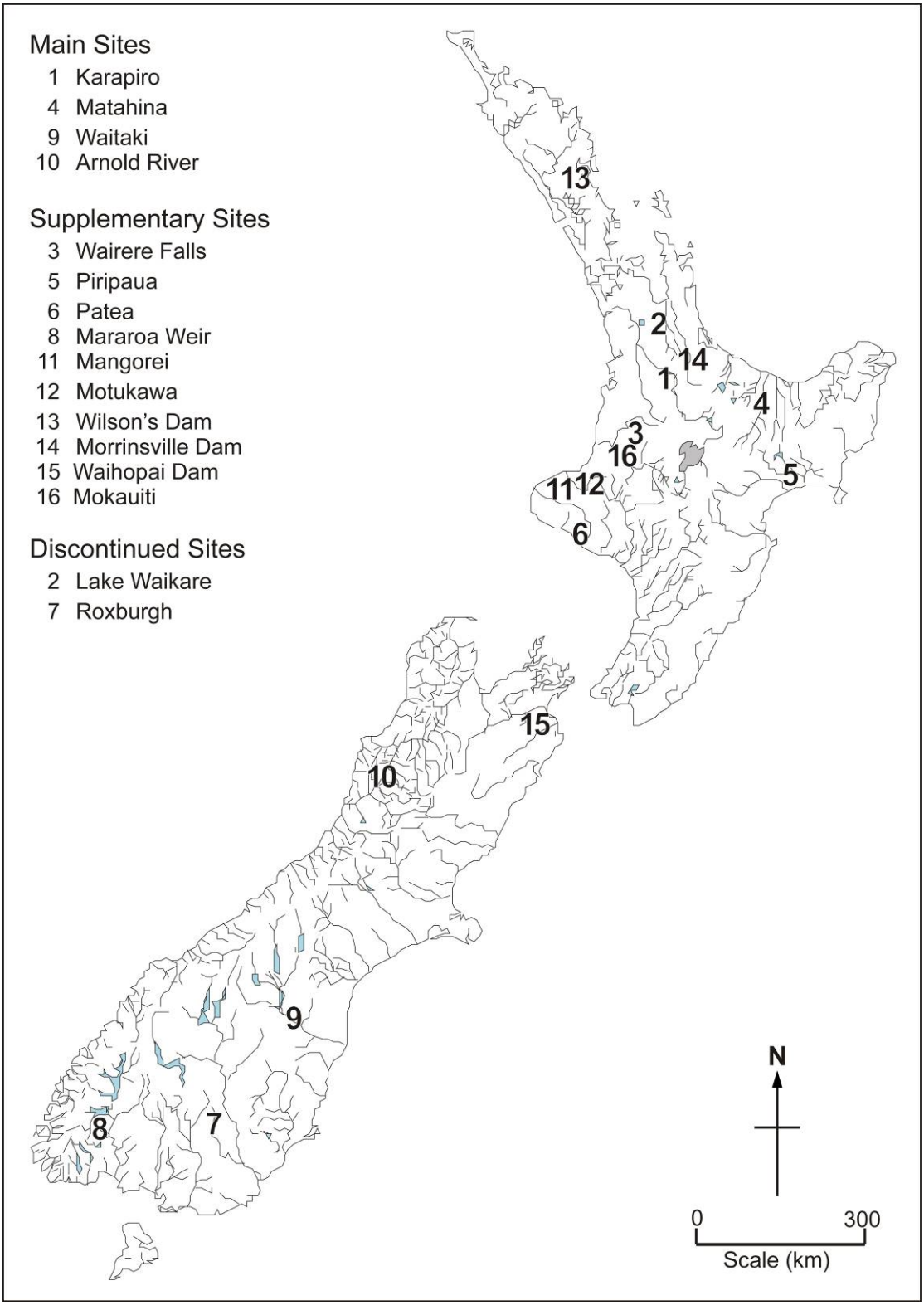

Figure 1: Location of the monitored elver catch and transfer sites for the 1982 – 2009 elver migration seasons (some sites discontinued).

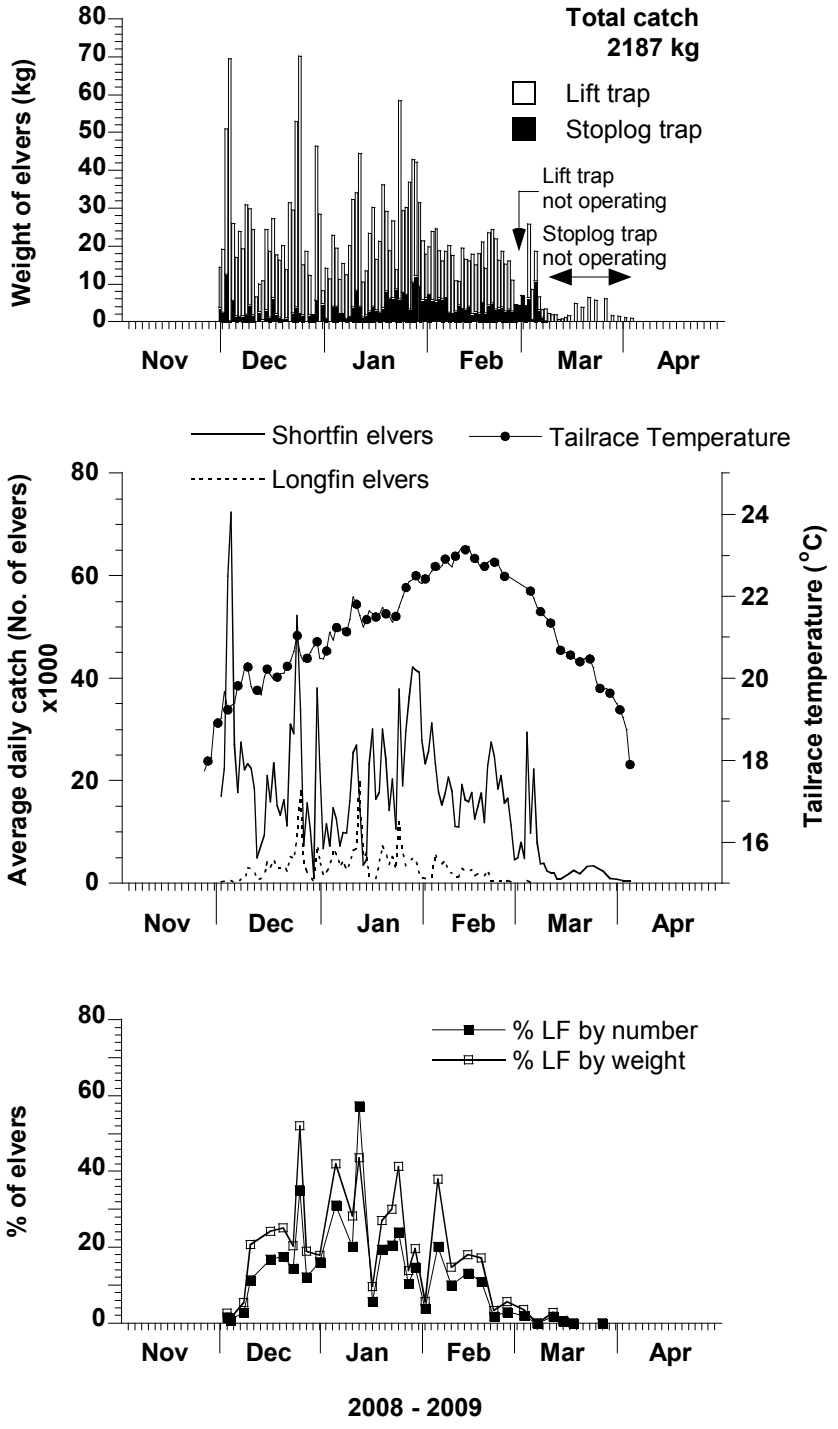

Figure 2: **Karapiro Dam elver catch for the 2008–09 season (upper, total daily catch for each trap; middle, average daily catch of shortfin and longfin elvers and tailrace temperature; lower, estimated proportion of longfin elvers in catch LF, longfin).**

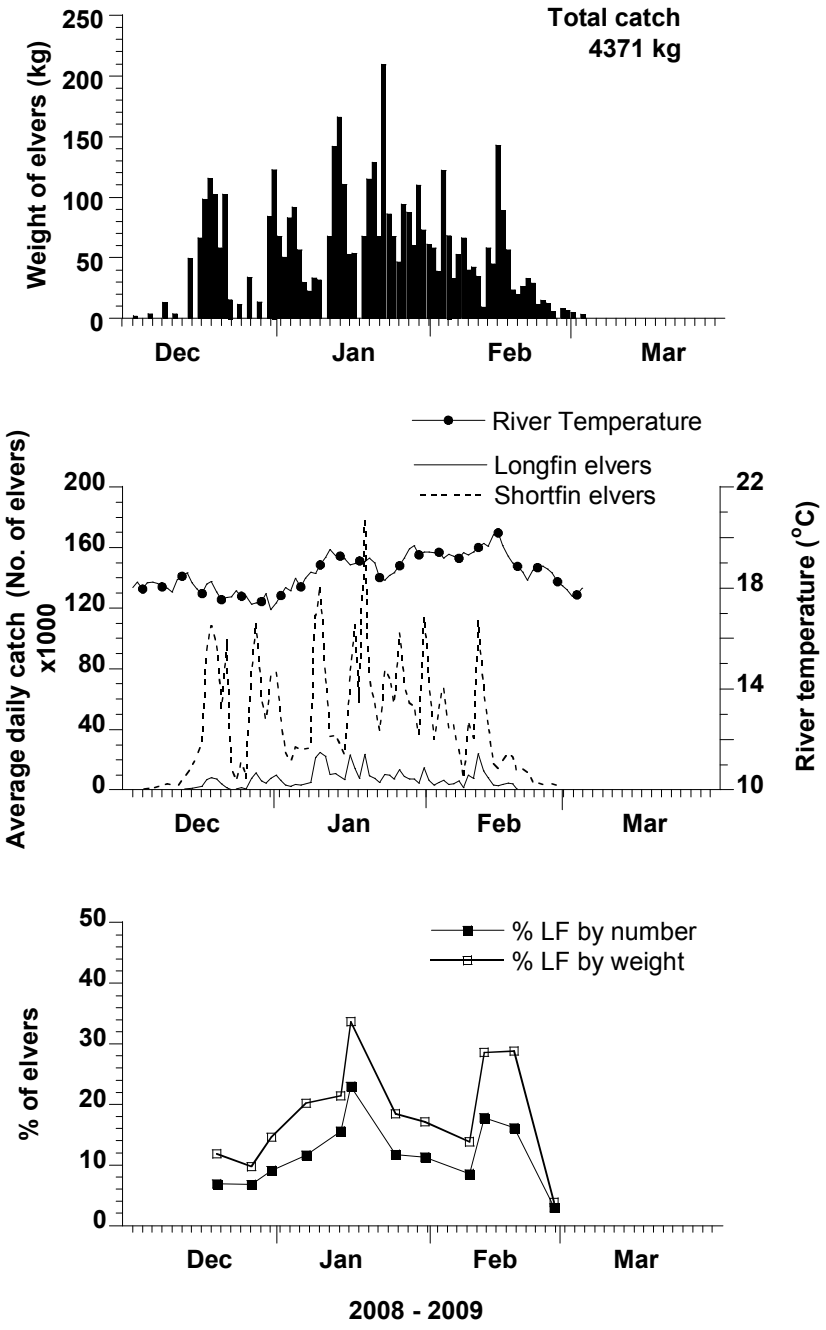

Figure 3: **Matahina Dam elver catch for 2008–09 season (upper, daily catch; middle, average daily catch and Rangitaiki River temperature; lower, proportion longfin elvers. LF, longfin).**

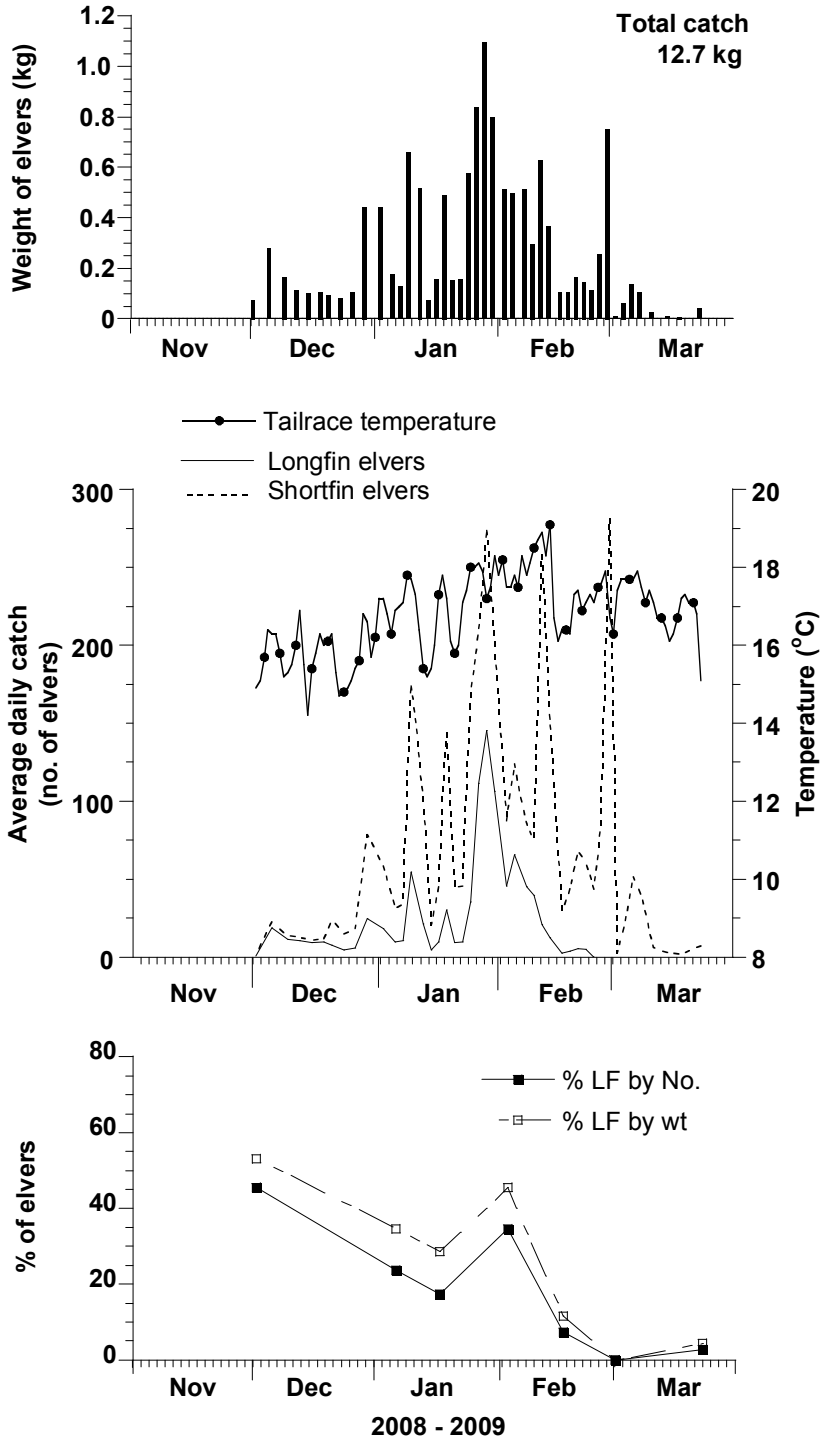

Figure 4: **Piripaua Power Station elver catch for the 2008–09 season (upper, daily catch; middle, average daily catch, rainfall and tailrace temperature; lower, proportion longfin elvers. LF, longfin).**

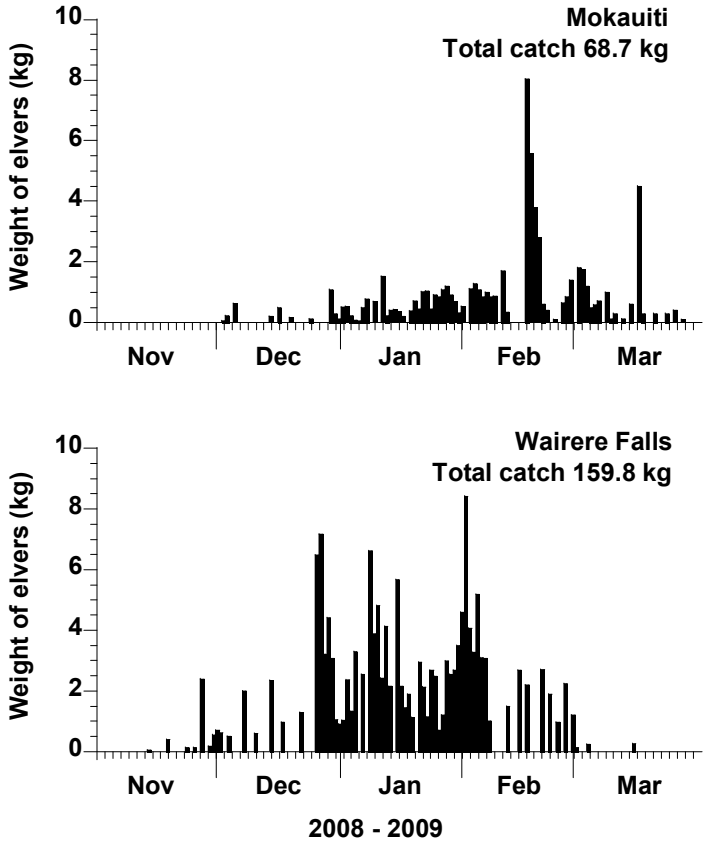

Figure 5: **Mokauiti (upper) and Wairere Falls (lower) Power Stations elver catches for the 2008–09 season.**

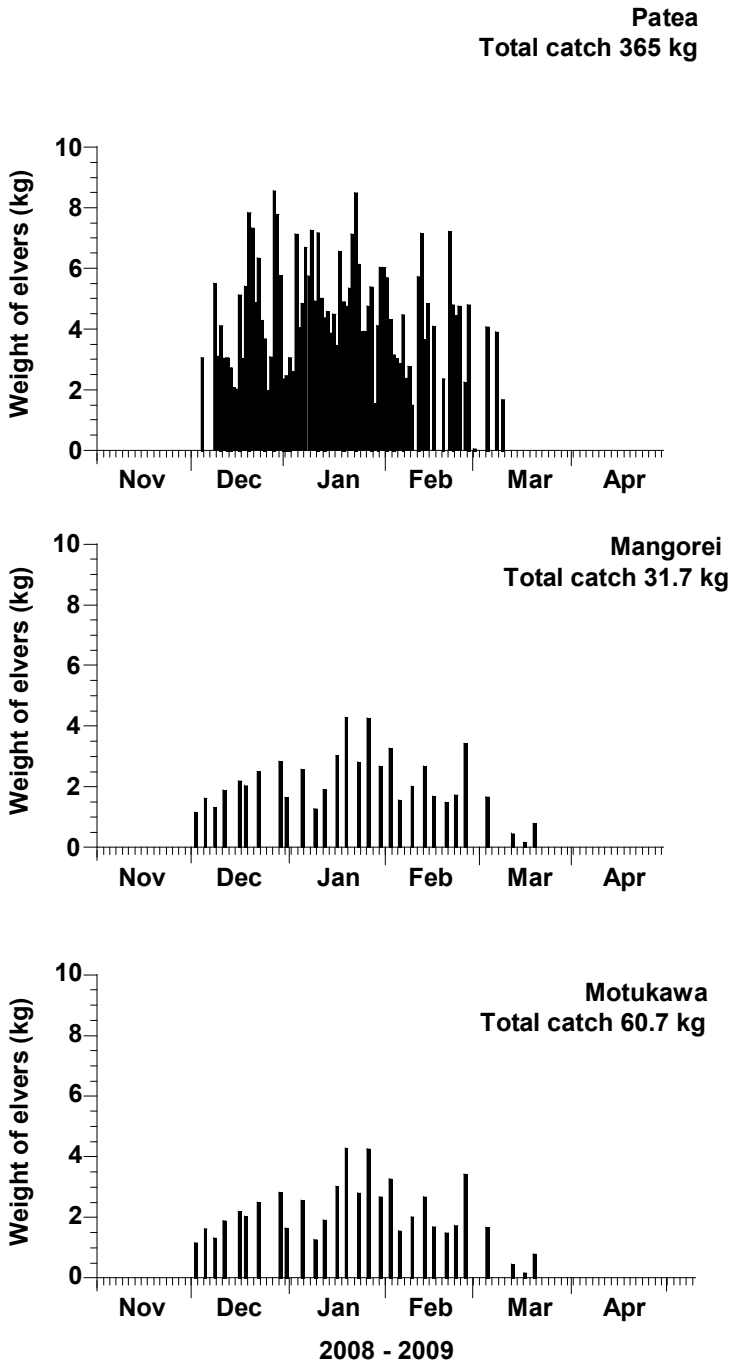

Figure 6: **Patea (upper), Mangorei (middle), and Motukawa (lower) elver catches for the 2008–09 season (data from Trustpower).**

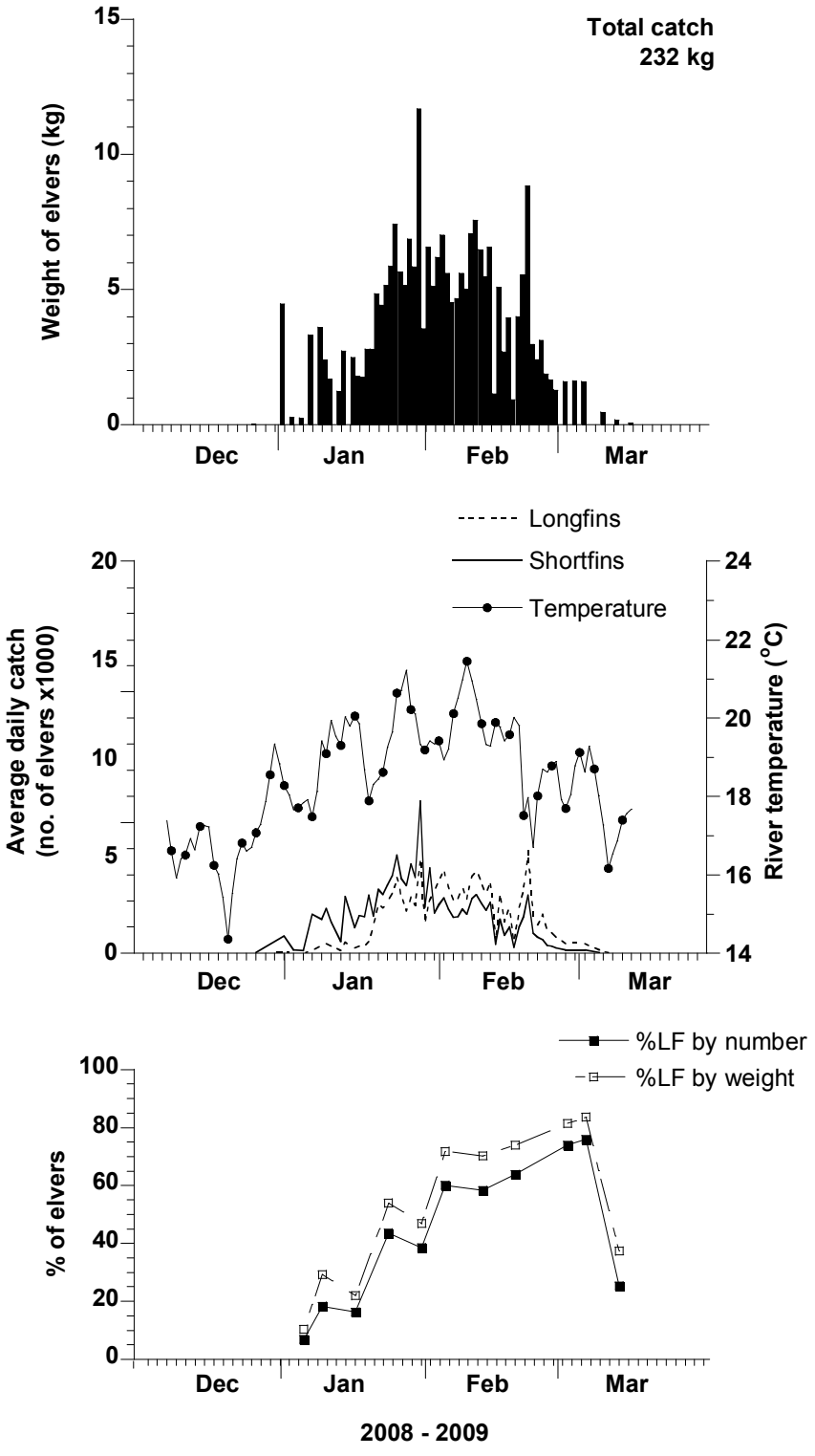

Figure 7: **Arnold Dam elver catch for the 2008–09 season (upper, daily catch; middle, average daily catch and temperature; lower, proportion of longfin elvers. LF, longfin).**

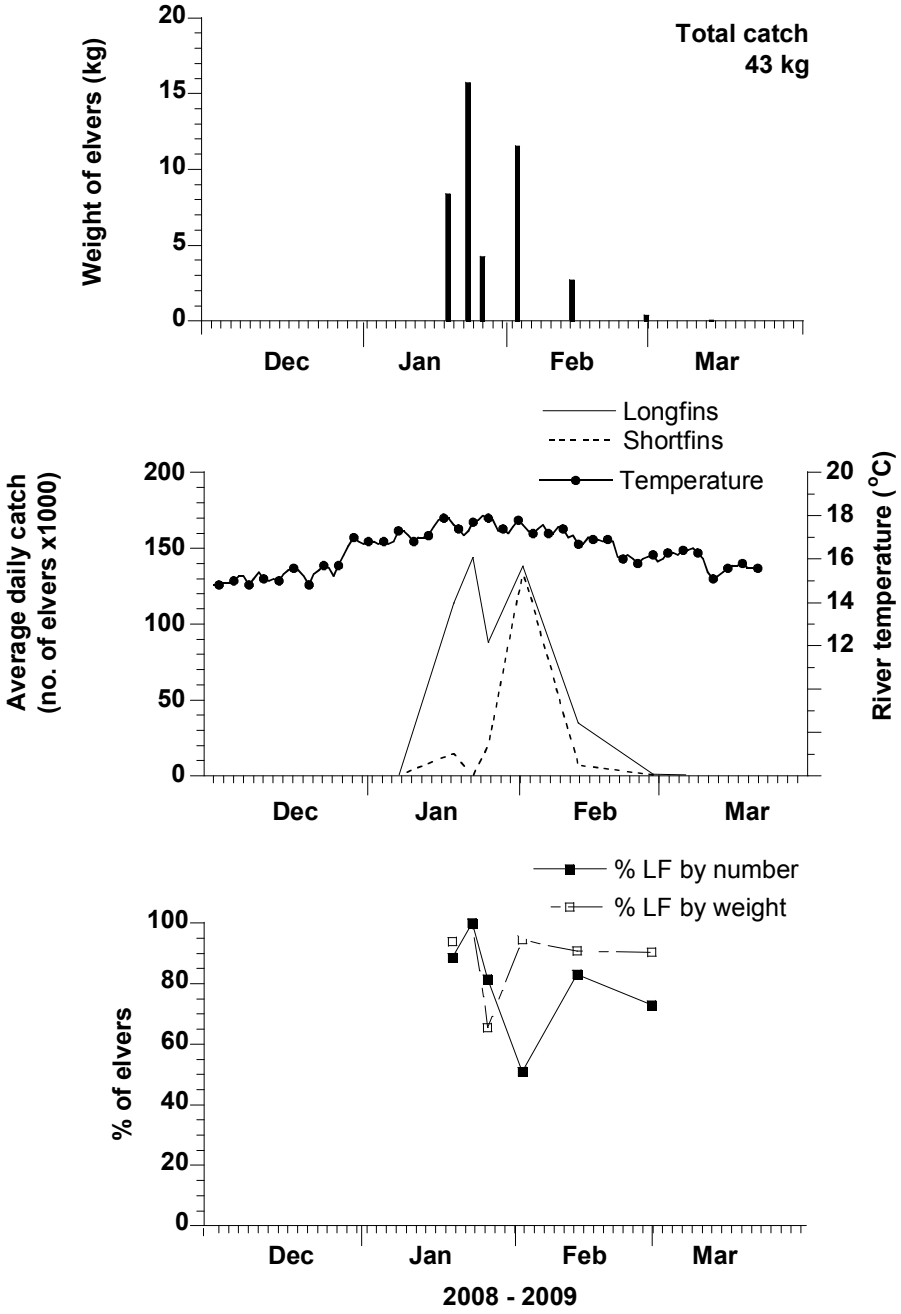

Figure 8: **Waitaki Dam elver catch (top), average daily catch (middle) and proportion of longfins (lower) for the 2008–09 season.**

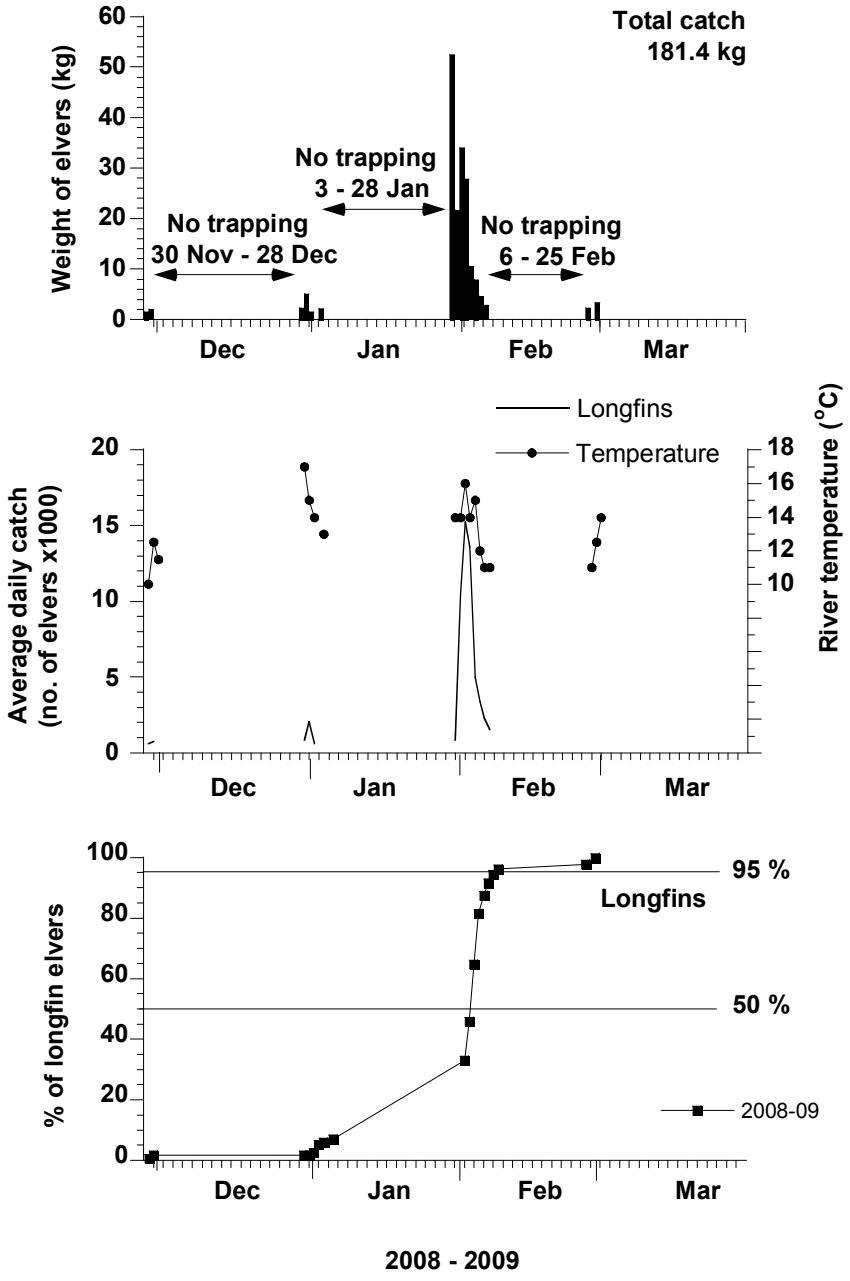

Figure 9: **Mararoa Weir elver catch (upper), average daily catch (middle) and cumulative catch (lower0 for the 2008–09 (lower) season (Data from Meridian Energy).**

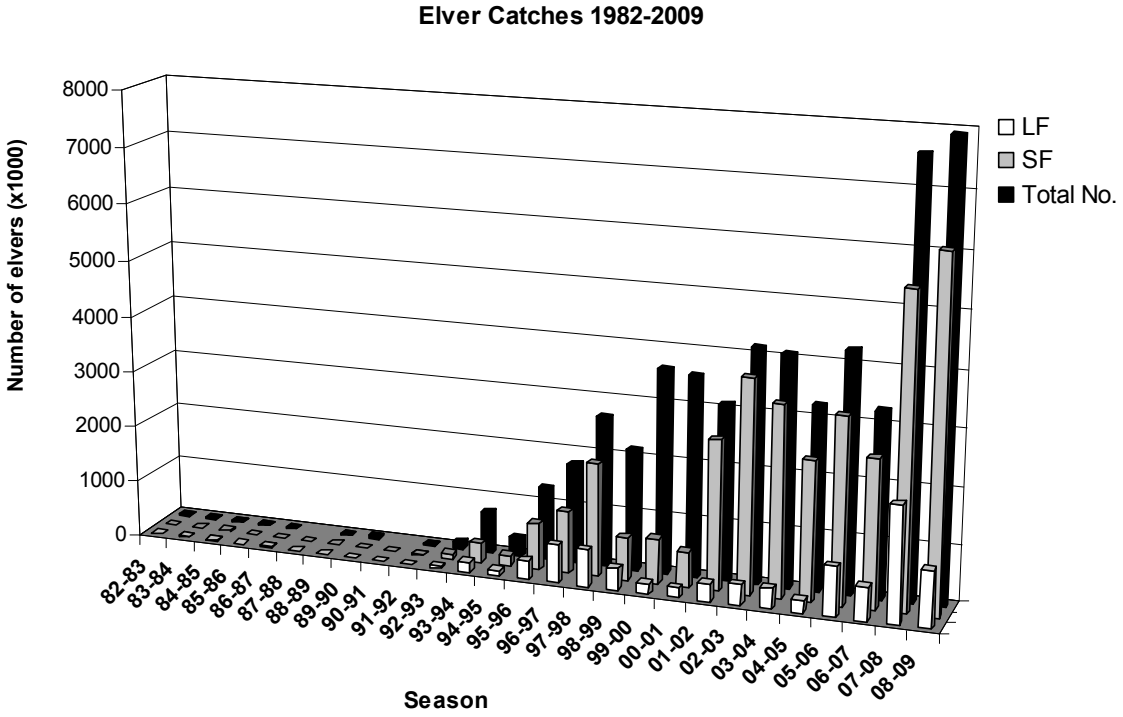

Figure 10: **Total elver catches for all monitored sites for 1982–83 to 2008–09. Longfin and shortfin data not available from some sites (LF, longfin; SF, shortfin).**

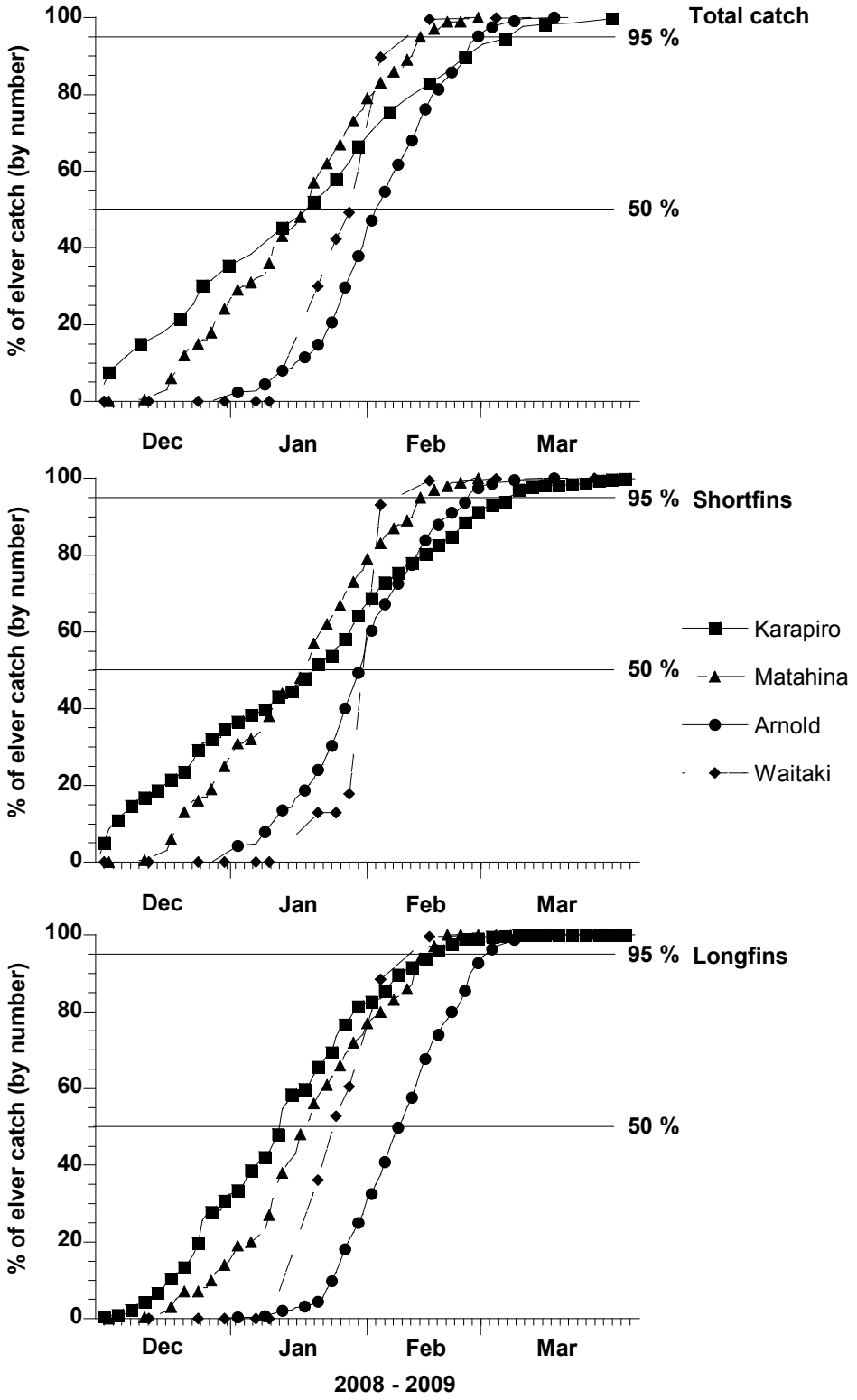

Figure 11: **Cumulative proportions of the total (upper), shortfin (middle) and longfin (lower) elver catches at Karapiro, Matahina, Arnold, and Waitaki dams for the 2008–09 season.**

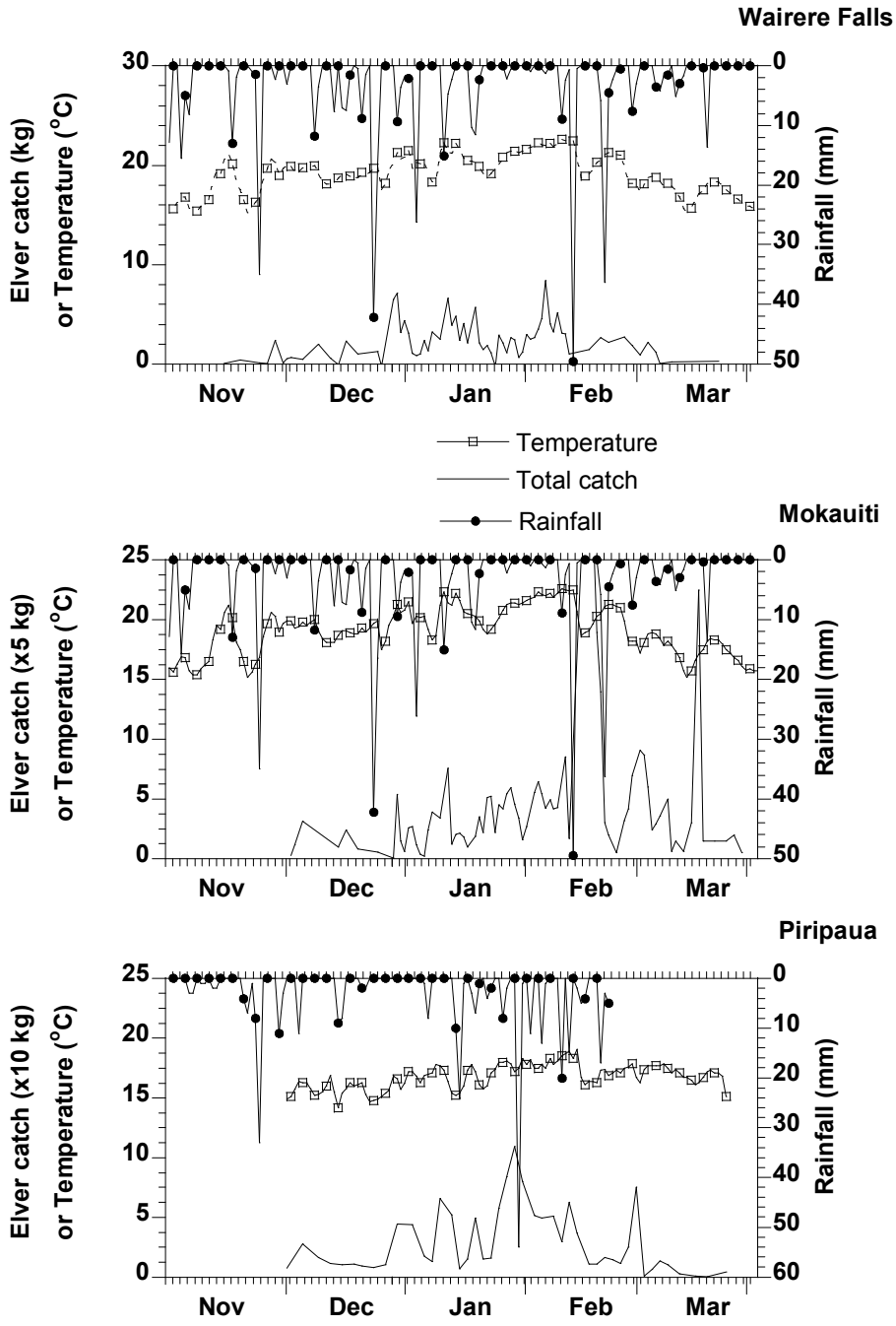

Figure 12: **Elver catch, rainfall and average daily tailrace temperature for Wairere Falls, Mokauiti and Piripaua hydroelectric power stations. Note that Y-axes are expanded for Mokauiti (x5) and Piripaua (x10) (data from King Country Energy).**

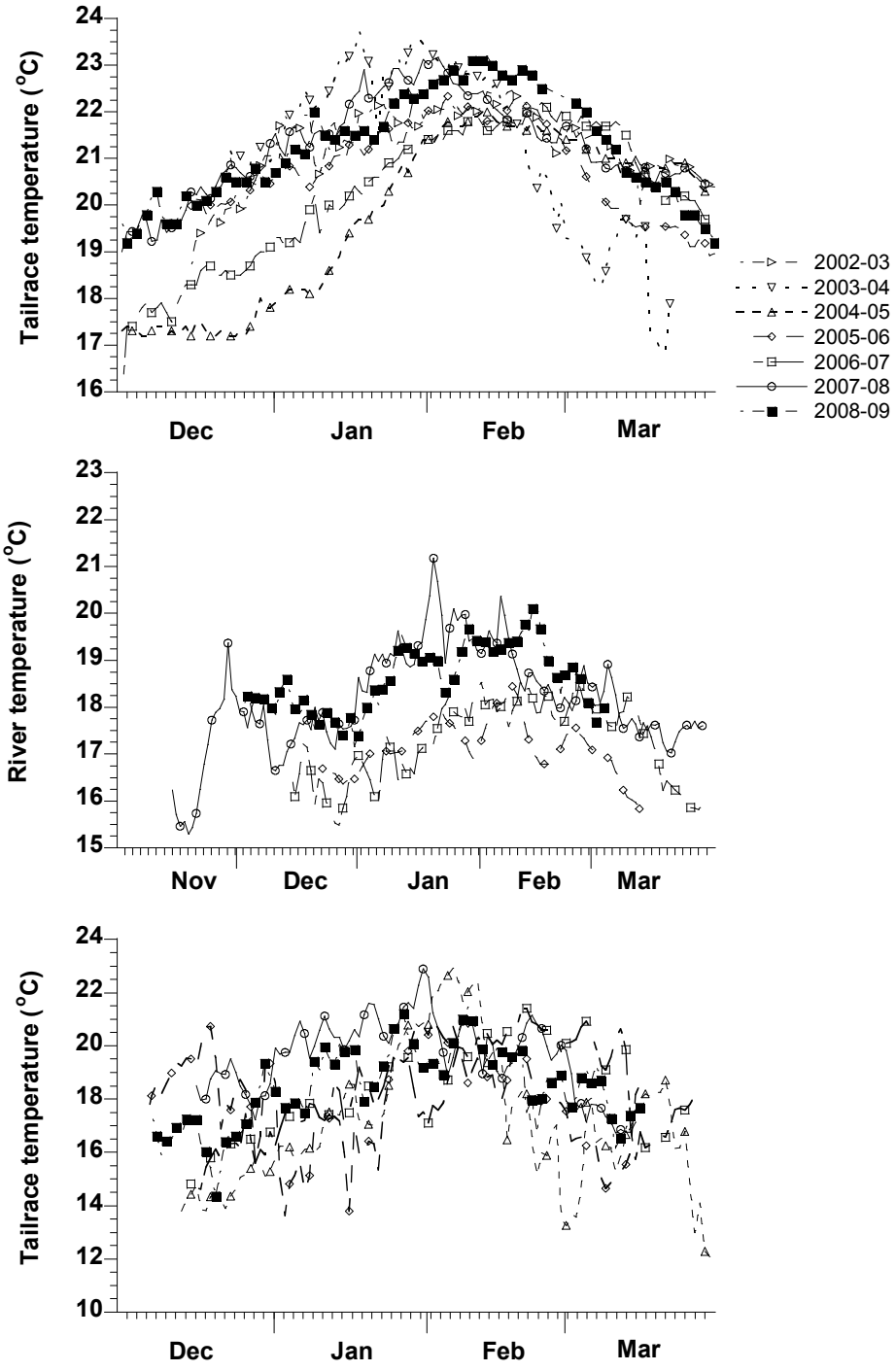

Figure 13: **Average daily tailrace temperature for Karapiro (upper), Matahina (middle) and Arnold (lower) for the 2002–03 to 2008–09 seasons (Note: 2004–05 Karapiro data estimated from Waikato River temperature at Hamilton from data supplied by Environment Waikato).**

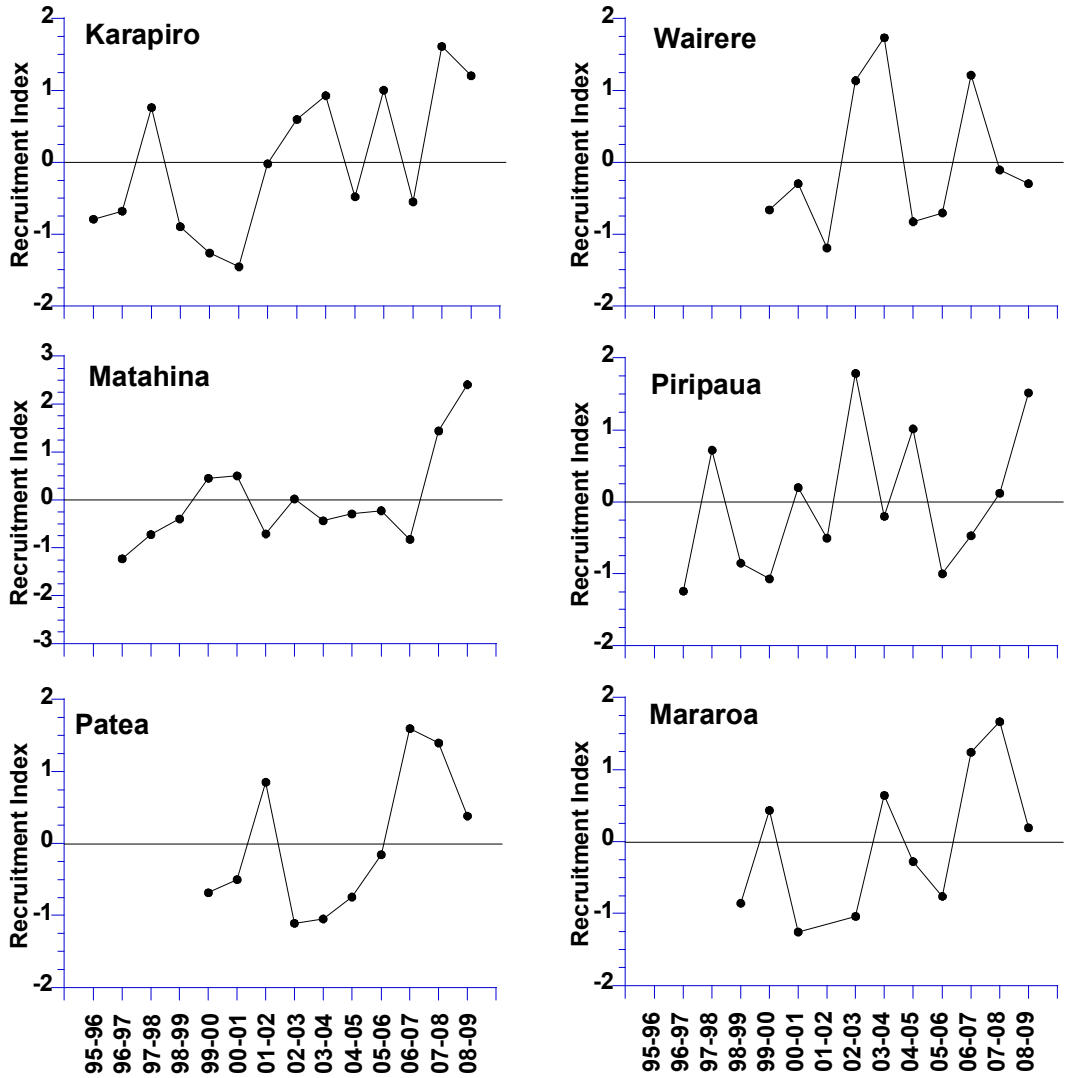

Figure 14: **Recruitment index for total elver catches at monitored sites from 1995–96 to 2008–09.**

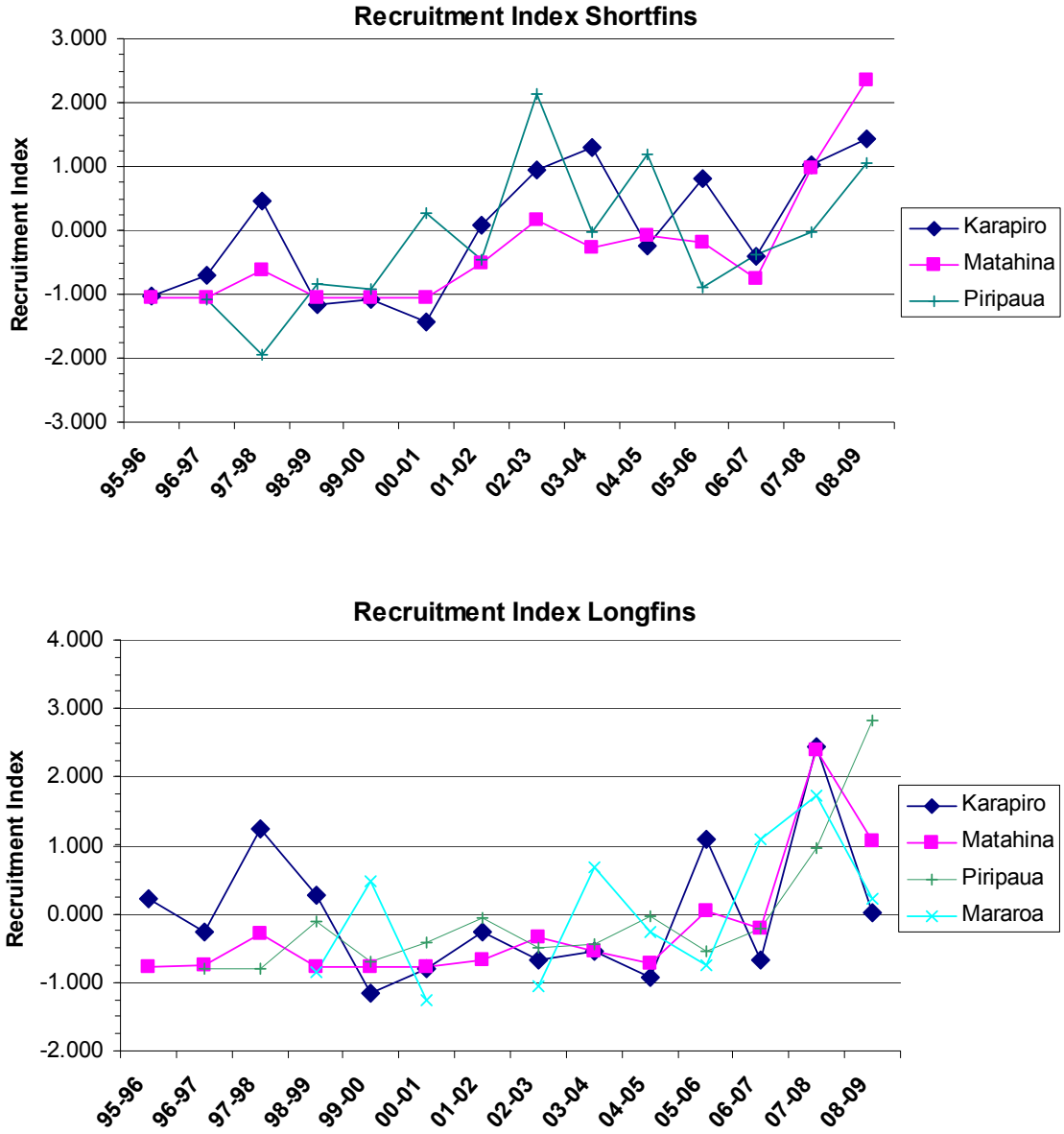

Figure 15: **Recruitment index for shortfin (upper) and longfin (lower) elvers at monitored sites from 1995–96 to 2008–09.**