Upstream migration of glass eels in the Waipaoa River 2007

Te Aitanga a Mahaki
&
Te Wai Maori Trust

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1 Executive Summary

Combined arrival patterns of shortfin (*Anguilla australis*) and longfin (*A. dieffenbachii*) glass eels were examined and compared to environmental conditions by trapping glass eels nightly in the Waipaoa River, Turanganui a Kiwa, Gisborne in 2007. A total number of 4354 glass eels were trapped between September and December 2007. Monthly catches of glass eels peaked in September (3017 from 23 nights fishing) and October (1337 from 26 nights fishing). No glass eels were trapped during November (26 nights fishing) or December (28 nights fishing). The highest single nightly catch of 530 glass eels occurred on 24 September. The last glass eel captured was on 31 October. Future studies of Waipaoa glass eel recruitment will benefit from monitoring migration signals from July instead of September of any particular year. While improvements in species differentiation are required for future studies, results from this survey can be used to compare inter-annual patterns of glass eel migrations in the Waipaoa River. The new knowledge generated from this research will further enable Te Aitanga a Mahaki to implement eel management initiatives that include prudent harvest measures, restocking, and habitat restoration thus enabling the fishery to rebuild numbers and sizes of eels available for customary use.

2 Research Objectives

Overall Objectives:

1. To investigate the number, size, and species of glass eels migrating into the Waipaoa River and the timing and various environmental factors that are associated with this upstream migration.
2. To determine recruitment levels and recruitment barriers of migratory elvers in the Waipaoa catchment.

3 Introduction

3.1 Kaitiakitanga

Kaitiakitanga, as defined by the RMA Act, means 'the exercise of guardianship by the tangata whenua of an area in accordance with tikanga Maori in relation to natural and physical resources; and includes an ethic of stewardship.' Since 1910, human activity has resulted in severe environmental and ecological changes to the Waipaoa Catchment. Resource depletion, water quality degradation and changes in environmental conditions have impacted negatively on the ability for Te Aitanga a Mahaki to exercise its role as Kaitiaki.

3.2 Te Aitanga a Mahaki and Waipaoa

The Waipaoa River is the ancestral river of Te Aitanga a Mahaki. This ancient connection, highlighting mana, tangata whenua and kaitiakitanga, is symbolised in the whakatauki (proverb):

Ko Maungahaumi te Maunga	*Maungahaumi is the Mountain*
Ko Waipaoa te Awa	*Waipaoa is the River*
Ko Te Aitanga a Mahaki te Iwi	*Te Aitanga a Mahaki is the Tribe*

Te Aitanga a Mahaki also trace their beginnings from the moteatea (ancient chant) "Haramai a Paoa" which conveys the arrival of some of the earliest inhabitants to the Tairawhiti East Coast Region. Inextricably linking the people to the environment, the moteatea implies the responsibility of Te Aitanga a Mahaki as kaitiaki to its whenua, awa and moana - a role bestowed to tangata whenua.

At the time of James Cook's arrival in 1769 the abundance and diversity of the flora and fauna in Turanganui a Kiwa was well documented (Salmond 1991). The Waipaoa River provided food or materials for practical, spiritual and ceremonial occasions. Freshwater species of significance include koura (fresh water crayfish), inanga (whitebait), morihana (cockabully), moruru (banded kokopu), koaro and korokoro (lamprey). But tuna (eels) were by far the most important freshwater species to Te Aitanga a Mahaki (Ruru 2006).

3.3 Customary eel fishery

Eels are the principal freshwater customary fishery of the iwi and hapu of Te Aitanga a Mahaki. Pa tuna (eel weirs) were highly prized and often the cause of many battles. Wi Haronga lists the following 15 eel weirs situated in the lower Waipaoa River alone (Maori Land Court, 1875).

Roroapako	Te Arowhata	Turi a Parua
Pou ate Ra	Totara	Hauai Tunui
Whakawhiti	Mahuwaka	Rua Mapewa
Te Mingi	Whainu Kota	Te Moutere
Tauhinu	Te Kotipua	Whatuahi

Several more pa tuna were found along waterways throughout Patutahi and Waituhi and belonged to Te Whanau a Kaikoreaunei. In particular, Lake Repongaere provided an important eel fishery that still exists today.

Lake Repongaere was famous for providing plentiful amounts of eels and always having kai for the people. Locals remember times as recently as the 1950s when around April and May there would be big rains and the water would spill out into the paddocks up to 1.5 metres in depth (impossible today with the extensive stock banks in place). Within the spill zone would be thousands of eels and the whole community would go there for the harvest. Eels of at least 700 mm in length would be pawhara (prepared) and preserved by being hung out to dry. Each family had its own rua or shed for storing the eel meat once it had shrivelled and dried hard. The pawhara eels could be stored for over a year and were a delicacy when reconstituted with boiled vegetables (puha).

To local Maori, Lake Repongaere was more than a significant source of sustenance for the generations that lived around it. The Maori owners of the lake tell of its significance as a provider of natural resources, 'te waiora o oku tupuna', but there are also traditional accounts of the origin of the lake itself. One account tells of a pa that existed at the southern end of the lake. People from that pa travelled further up the East Coast and returned with a legendary eel. The eel was placed in a drinking well to keep the water clean. This special eel, mokemoke, was restless and became very agitated. In a frenzied state it thrashed around and around thus creating the lake. The trapped eel eventually grew to such a size that it became a man eater, 'ko ena nga pakiwaitara".

3.4 Relevant research

3.4.1 Lake Repongaere

Lake Repongaere, inland from Gisborne, is important as a customary eel fishery to three marae of Te Whanau a Kai and Te Aitanga a Mahaki and has been intensively commercially fished.

To determine the well-being of the existing eel population, eel species composition, size and age structure in Lake Repongaere was sampled over the summer of 2003 with;

- Unbaited fleets of standard commercial fyke nets (12 mm stretched mesh, and fitted with two escapement tubes in the cod ends – 28 mm internal diameter) and
- G-minnow traps (3 mm square meshed hinaki approximately 500 mm long) to capture small eels and other fish.

A total of 939 shortfinned and 4 longfinned eels were captured. Rates of capture were around 12 eels per net in shoreline positions, 10 eels per net in open water positions, and 4 eels per net in the wetlands. Overall, shortfinned eels ranged from 295 – 775 mm in length and from 55 – 1035 g in weight. Longfinned eels ranged from 384 – 505 mm and from 200 – 301 g in weight. Larger eels were captured in the wetlands than in the lake. Wetland catches showed marked multi-peaks in size.

Shortfinned eels trapped in fyke nets with open escapement tubes all exceeded commercial size. Historical accounts indicated an abundance of fish species; however, the absence of by-catch species from standard fyke nets, zero catches in the g-minnow traps, and absence of fish in eel gut contents, indicated a lack of fish prey available for larger eels.

The size distribution reflected a healthy representation of shortfinned eel size classes. In total, 124 shortfinned eels were killed for aging. Most eels aged had otolith growth patterns showing consistent growth. Eels averaged 5.7 yr at 450 mm (220 g), equivalent to the commercial size threshold, compared with about 13 yr for shortfinned eels in several lowland lakes throughout the North Island, and 9 yr in the similar Maori customary fishery of Lake Horowhenua.

However, growth appeared limited for eels of commercial size and above (which are mainly females). Eels usually become piscivorous at this size, and eel growth is likely to slow if fish are not available.

Lower CPUE in our survey at 4.6 kg per net per night than in 1997 at 7.7 kg per net per night suggests that stock density may be lower now than 6 years ago. Catch rates of around 12 eels per net in 2003 were comparable to another Maori owned lowland coastal lake, Lake Horowhenua but substantially lower than compared to many other intensively fished lowland areas. Our age data suggested that whereas growth of threshold commercial sized eels (≤ 250 g) appeared to be similar to that reported in 1997, mid-sized stock (251 – 499 g) appear to now be slower growing.

Given the rapid growth of sub-commercial sized eels and the apparent lack of high energy forage prey for larger eels, a more intensive or regular harvest of commercial sized eels would seem appropriate for the lake fishery. However, densities of small eel have increased elsewhere following intensive harvest, which has been suggested to be a reflection of increased survival of small eels, which in turn leads to lower growth rates. If recruitment is limited here, improving the extent and regularity of lakes outlet to the main Waipaoa River to improve elver immigration may not be the sole answer in this lake habitat. Earlier research into elver recruitment at impediments has clearly shown that fish transfers are far more effective at stocking upstream waterways than through fish passes. Stocking rates should be carefully considered to avoid impacting the existing population, and increasing densities of small eels beyond the capacity of the environment. Peak upstream timing should also be assessed prior to putting effort into trapping elvers. Natural forage fish species could also be re-introduced to the lake (e.g., common bully, *Gobiomorphus cotidianus*) to increase production of larger eels.

3.4.2 The wider Waipaoa catchment survey

In 2006, high priority customary eel areas within the Waipaoa River catchment were identified and then assessed by sampling 18 sites throughout the mainstem and tributaries using a combination of electrofishing techniques, fleets of fyke nets and g–minnow traps.

An unusually large 37% of the 955 eels sampled were endemic longfinned eels (*Anguilla dieffenbachii*) dominating the mainstem and upper catchment catches.

The shortfinned eel (*Anguilla australis*) followed a typical distribution pattern residing predominantly in the mainstem estuarine, lowland pond, and lakelet sites.

Substantial proportions of both species of eels sampled from the lower sites were longer than 450 mm suggesting that the populations have not been intensively commercially harvested. However, the paucity of larger size classes in mid to upper catchment sites reflects decimation by harvest, severe habitat degradation and high temperatures from low water flow. An apparent strong correlation between peak water flows during the main months of upstream migration of elvers and peaks in eel age frequency data warrants rigorous statistical modelling.

4 Materials and methods

The Waipaoa River drains a catchment of 2,200 km^2 and is the largest in the East Coast region. Geologically, the catchment comprises of relatively young, soft sandstone and mudstone (bentonic) and large areas of alluvium in the lower reaches of tributaries that contribute to a relatively high hardness level. Erosion problems began in the Waipaoa catchment from about 1910 onwards, when European settlers began deforesting the unstable hill country for farming (Ministry for the Environment, 1997). Heavy rain storms resulted in land slips and large amounts of sediment washing into rivers increasing the incidence of further flooding. Stopbanks were constructed along the Waipaoa River after floods in the 1930's and 1940's and 90% of the wetlands were drained when the land was converted to pasture. The Waipaoa has become a high sediment–yielding river, (15 MTyr^{-1}) and is predominantly slow–flowing through wide, open valleys, becoming silt–laden after heavy rain. It experiences low summer flows resulting in elevated water temperatures (Gisborne District Council, 2004).

The study site (Easting 2938000 Northing 6266000) was 400 m from the coast in the lower tidal reaches of the Waipaoa River (Figure 1).

A trap net (1-mm mesh) with a mouth 1.5 m wide by 1 m deep was set on sand substrate in water 0.50 – 0.75 m deep flowing at about 0.1 – 0.3 m s^{-1} about 3 – 7 m from the water's edge. Two 1 – mm mesh screens (1.5 m x 1 m) were used on the shore to guide glass eels into the trap net. To maintain a constant water depth and velocity at the trap site the net and screens were moved to allow for fluctuations in river height of up to 4 m associated with the tide phase and river flows (Figure 8 and Figure 9).

The majority of fishing time took place between 3 pm and 9 pm, but was determined by the catch rate of glass eels, concluding when glass eel numbers diminished over three consecutive 45 minute trapping periods. The net was lifted every 45 minutes and glass eels and by-catch were removed. The net was re-set and left to fish while the catch was counted and recorded.

The attempt to estimate the proportion of each species in the entire catch involved a sub-sample of approximately 25 glass eels were removed from the catch after each 45 – min interval if catches exceeded 6 eels. Each night, approximately 25 glass eels were anaesthetised with a drop of clove oil (about 0.2 ml) dissolved in 500 ml of water. Individual total lengths were measured to the nearest 0.5 mm and individual weights were recorded to three decimal places after surface water was removed with absorbent paper. Pigmentation was recorded based on a variation of Strubberg (1913; in Jellyman et al.1999). Glass eels with a pigmentation stage equal to or less than 6_{A23} were considered ''newly arrived'' and those with a pigmentation stage equal to or greater than 6A24 were considered ''previously arrived'' (Chisnall et al. 2002; Jellyman et al. 2002).

Most glass eels survived anaesthesia and examination and were released back into the Waipaoa River 0.5 km above the sampling site on the following night. Daily means of total lengths for each species were determined.

River water temperature was measured at the sampling site and sea water temperature was measured at the mouth of the Waipaoa River once at commencement of fishing each night.

River level was measured at the Gisborne District Council's Matawhero monitoring station (Figure 8) and river flow was measured at 30-min intervals at the Gisborne District Council's Kanakanaia monitoring station (Figure 9). Wind, barometric pressure and rainfall were measured at the Gisborne Airport about 8 km from the sampling site. All times are given as New Zealand Standard Time (NZST).

5 Results and conclusion

5.1 Arrival pattern

Glass eels were trapped nightly for the period 7 September – 31 December in 2007. Fishing occurred on 103 nights out of the available 116 nights, representing a very high trapping - night percentage (89 %). A total combined number of 4354 of shortfin and longfin glass eels were trapped between September and December 2007. Monthly catches of glass eels peaked in September (3017 from 23 nights fishing) and October (1337 from 26 nights fishing). No glass eels were trapped during November (26 nights fishing) or December (28 nights fishing). The highest single nightly catch of 530 glass eels occurred on 24 September (Figure 2). The last glass eel captured was on 31 October.

Waipaoa River catches were significantly lower than for Tukituki River during 2001 and 2002 (Table 1) even though there was a higher percentage of fishing nights (Table 2).

Table 1: Comparison of glass eels trapped migrating into the Tukituki River, in 2001 and 2002[1] and the Waipaoa River 2007.

	Tukituki River	Tukituki River	Waipaoa River
Month / Year	2001	2002	2007
September	44,020	1,904	3,017
October	3,953	10,819	1,337
November	2,314	5,898	0
December	No trapping	1,333	0
Total number trapped	**50,287**	**19,954**	**4,354**

Table 2: Comparison of actual trapping nights between the Tukituki River, in 2001 and 2002[2] and the Waipaoa River 2007.

	Tukituki River	Tukituki River	Waipaoa River
Month / Year	2001	2002	2007
Actual trapping nights from total nights available.	59 from 76	67 from 87	103 from 116
Percentage	78%	77%	89%

Glass eels were trapped immediately from the first moments that the trap was set in the river on 7 September indicating the glass eel migration for 2007 had already begun. Therefore it is impossible to determine if September was the month with the highest glass eel runs.

Comparisons of eel catch versus;

- river flow (Figure 3),
- daily rainfall (Figure 4),
- seawater temperature (Figure 5),
- river temperature (Figure 6), and
- average daily air temperature (Figure 7),

failed to show any significant statistical relationship. This could be attributed to the timing or season of the glass eel migration in 2007. Future Waipaoa surveys may benefit from adjusting fishing times to July to October instead of September to December.

Future studies of glass eels entering the Waipaoa would benefit from:
1. Beginning the survey in July to ensure the capture of glass eel run data.
2. Improved methods of determining species.

While improvements in determining species migration are required for future studies, valuable information on the scale and seasonal timing of glass eel migrations specific to the Waipaoa have been gained.

Eel management initiatives would include prudent harvest measures, restocking, and habitat restoration to rebuild numbers and sizes of eels available for customary use.

[1] Tukituki River data reproduced from (August, 2003).
[2] Tukituki River data reproduced from (August, 2003).

The new knowledge generated from this research will further enable Te Aitanga a Mahaki to implement eel management initiatives that include prudent harvest measures, restocking, and habitat restoration are required to rebuild numbers and sizes of eels available for customary use.

Wider benefits of this research to iwi Maori include:

- Increased knowledge of glass eels – their recruitment patterns and barriers to their movement.
- Knowledge shared for the sustainable management of the eel fishery.

6 Knowledge transfer

This report will be made available publicly via the iwi and Te Wai Maori websites.

7 Acknowledgements

This Project was made possible with the support of Te Wai Maori Trust and Te Aitanga a Mahaki Trust. Thanks to Ngahiwi Tomoana for the glass eel trap, and to Stella August and Brendan Hicks for advice. We are grateful to the Gisborne District Council for access to the survey site and for providing data. Special thanks to the survey technicians, Bill Ruru and Martin Baker, for braving the adverse weather conditions and bleak nights to allow us to gain an insight into our taonga tuku iho.

The results from this project provide another step towards realising the vision of Te Aitanga a Mahaki: to restore the mauri (life essence) of the Waipaoa River. Tena koutou katoa.

8 References

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9 List of Figures

Figure 1: Waipaoa river mouth survey site.

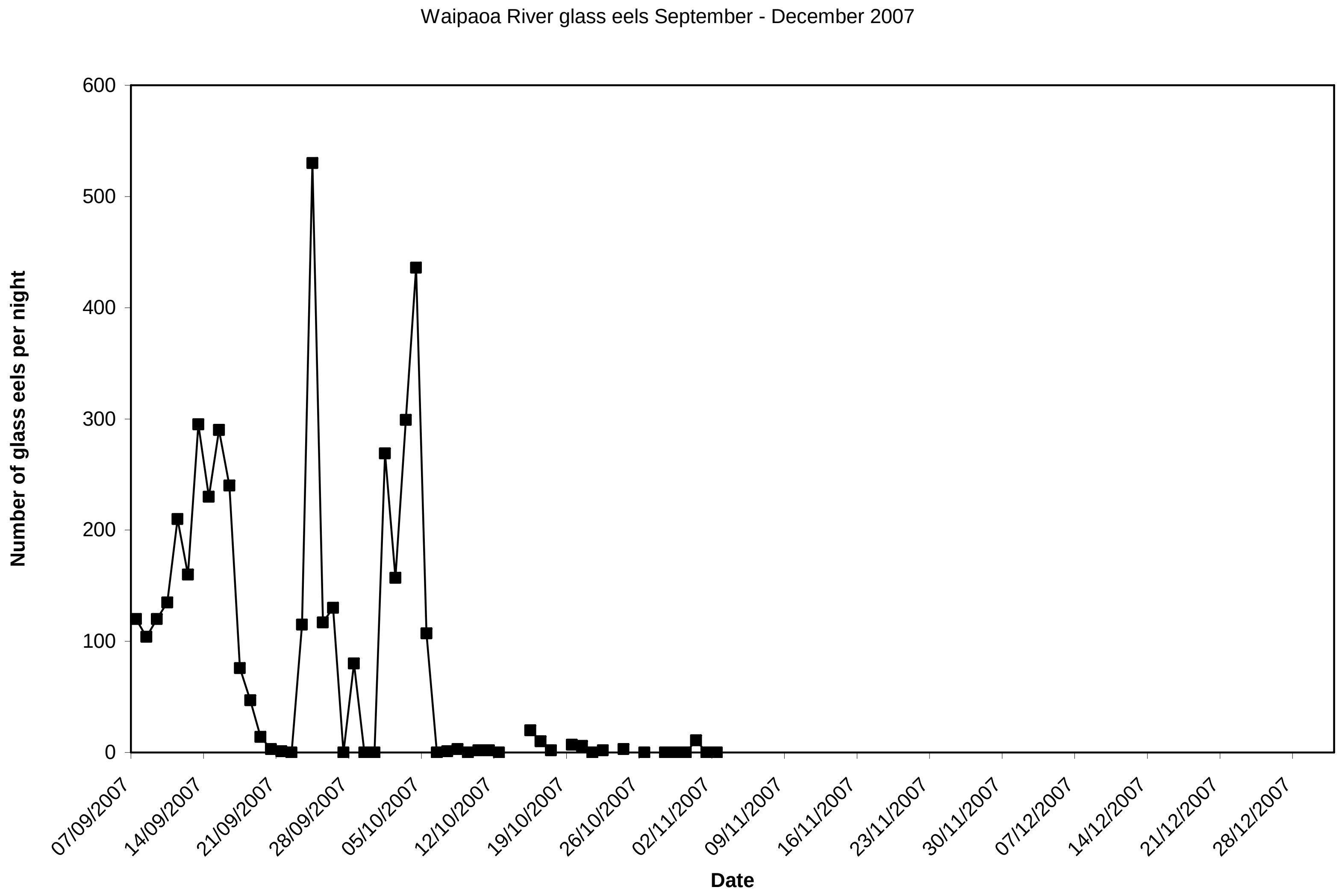


Figure 2: Number of glass eels trapped per night between September and December 2007.

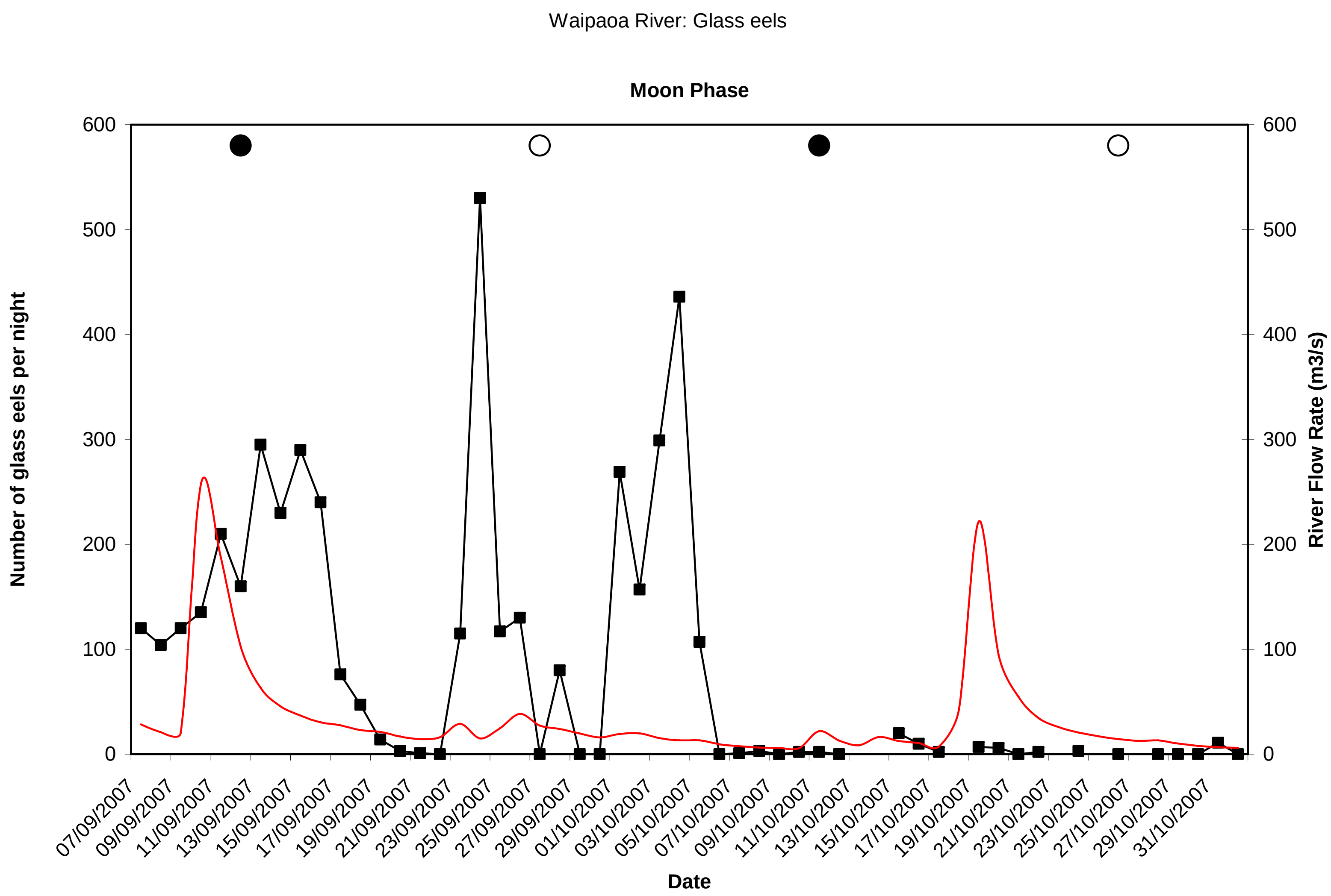


Figure 3: Glass eels vs. daily flow rate and moon phase.

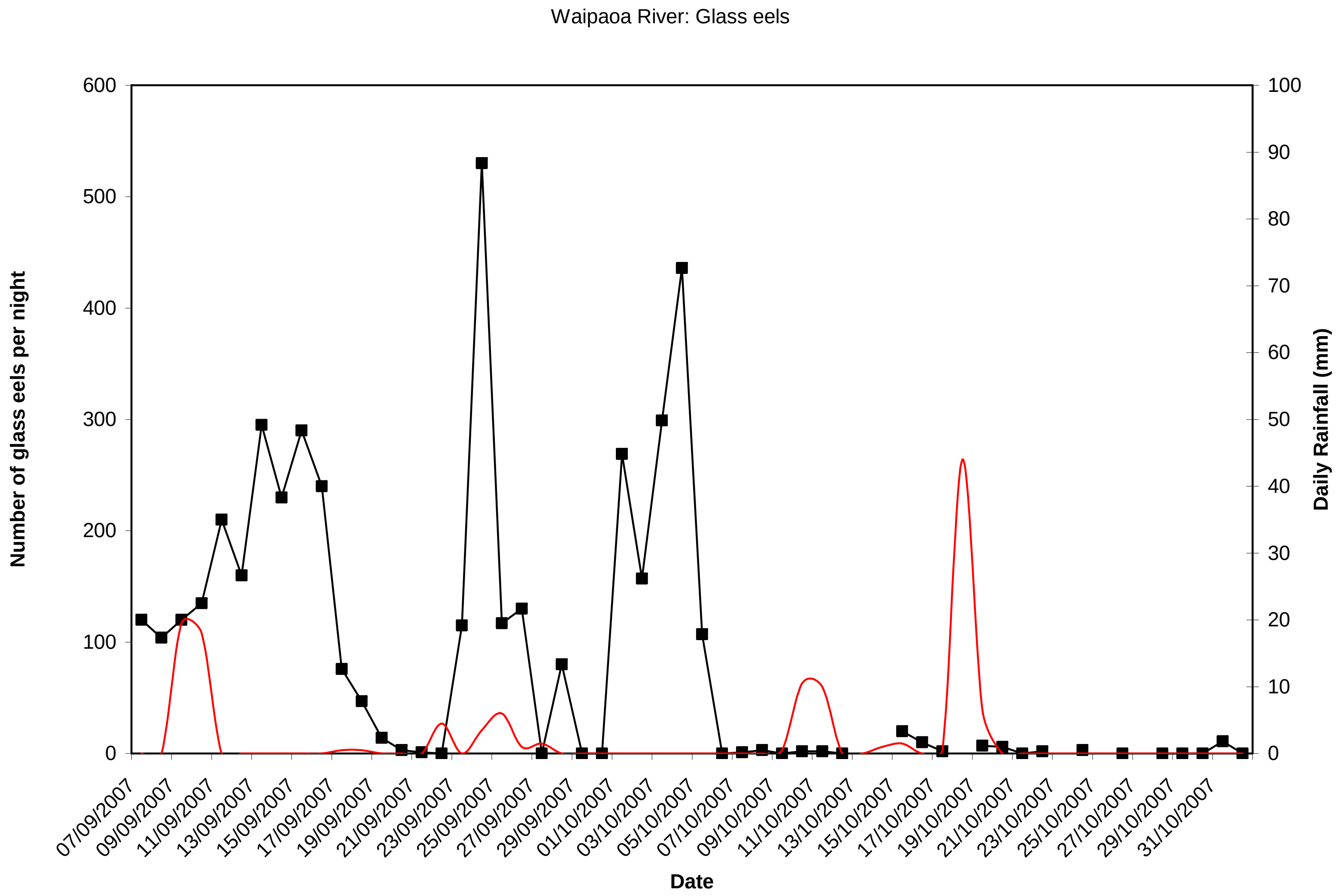


Figure 4: Glass eels vs. daily rainfall totals.

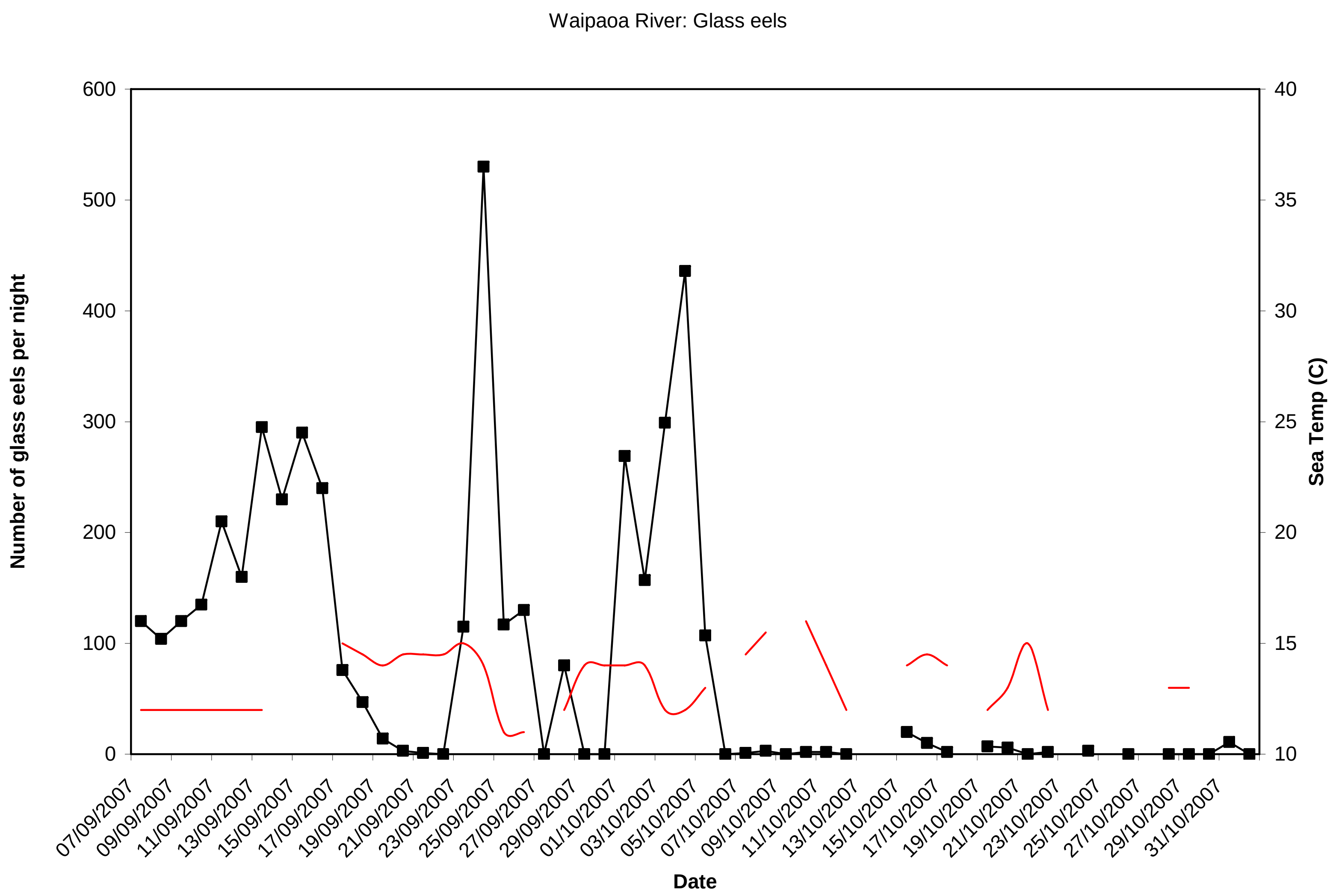


Figure 5: Glass eels vs. seawater temperatures at the start of each day.

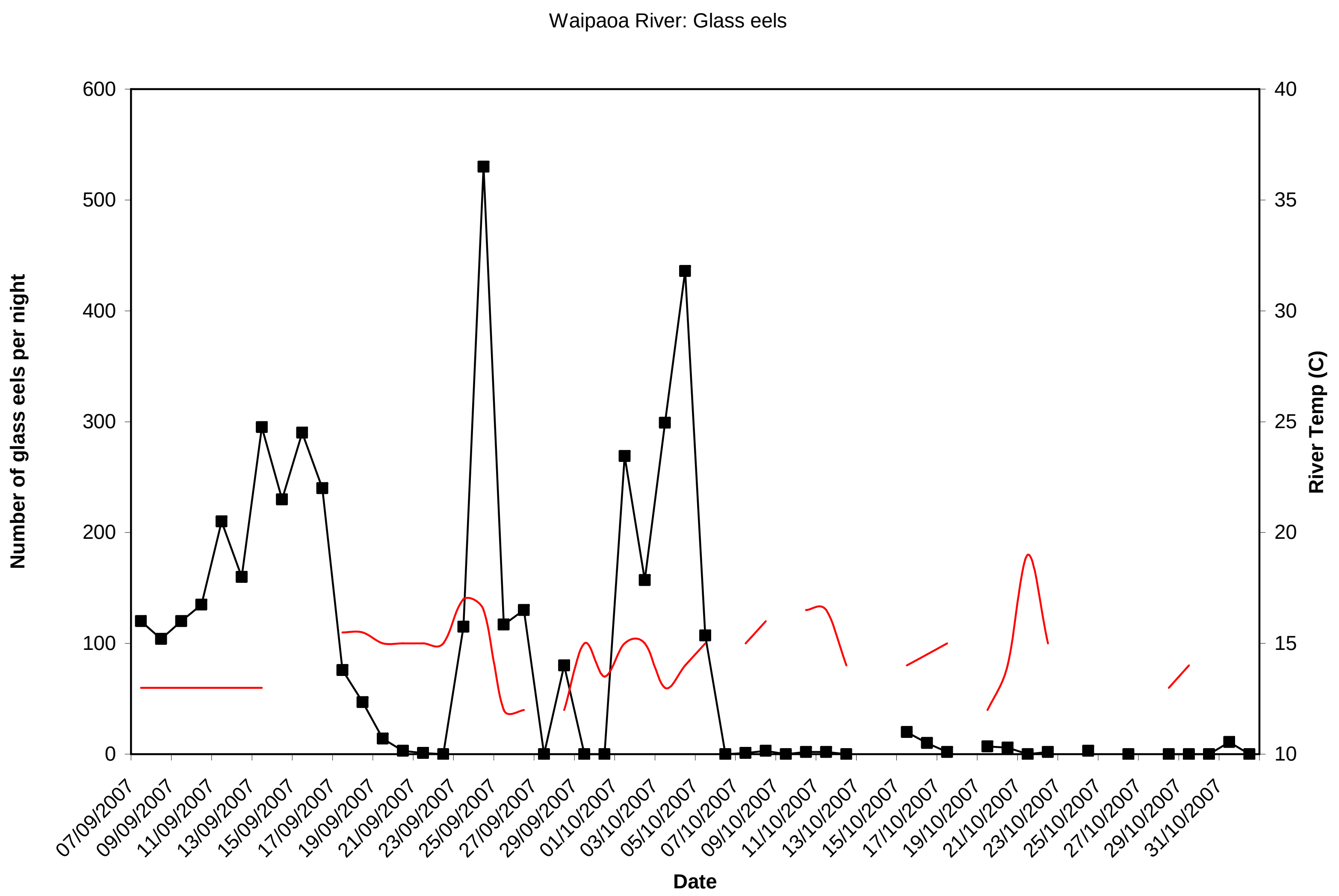


Figure 6: Glass eels vs. river temperatures at start of each day.

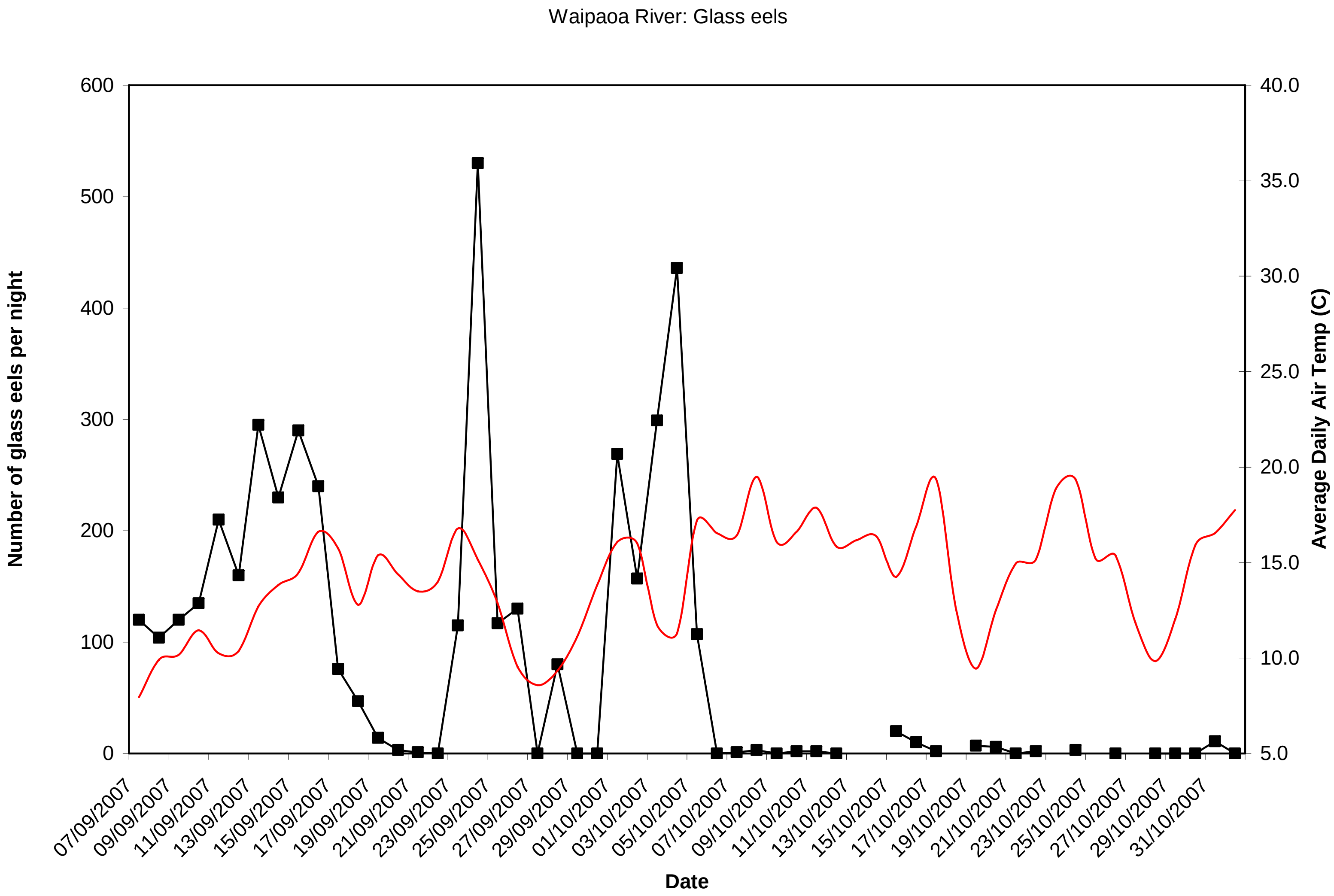


Figure 7: Glass eels vs. average daily air temperature.

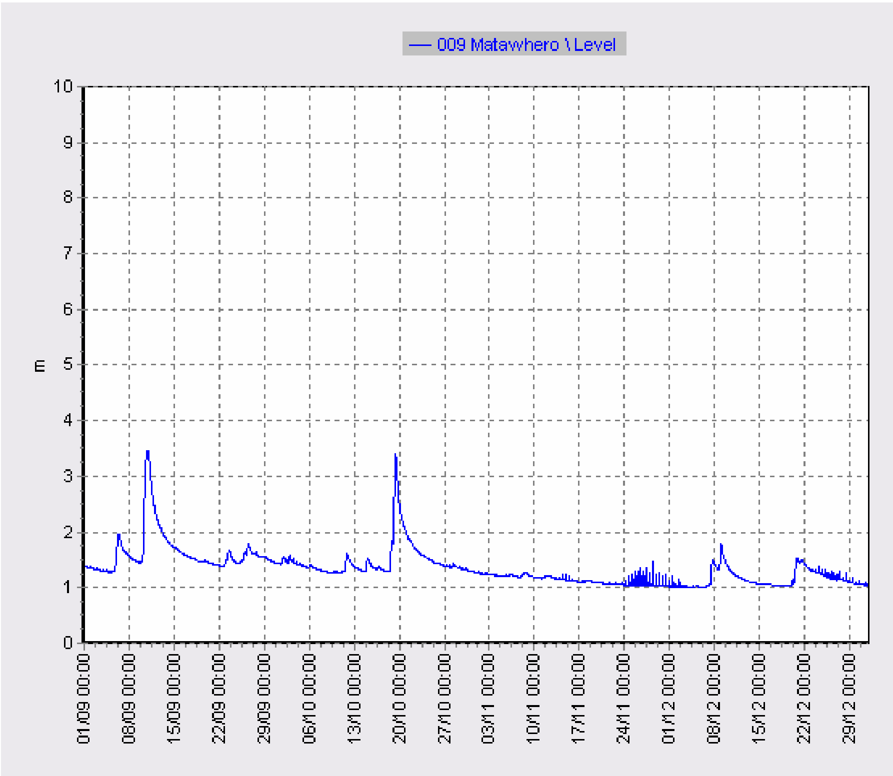


Figure 8: Waipaoa river level graph from Matawhero station September to December 2007.

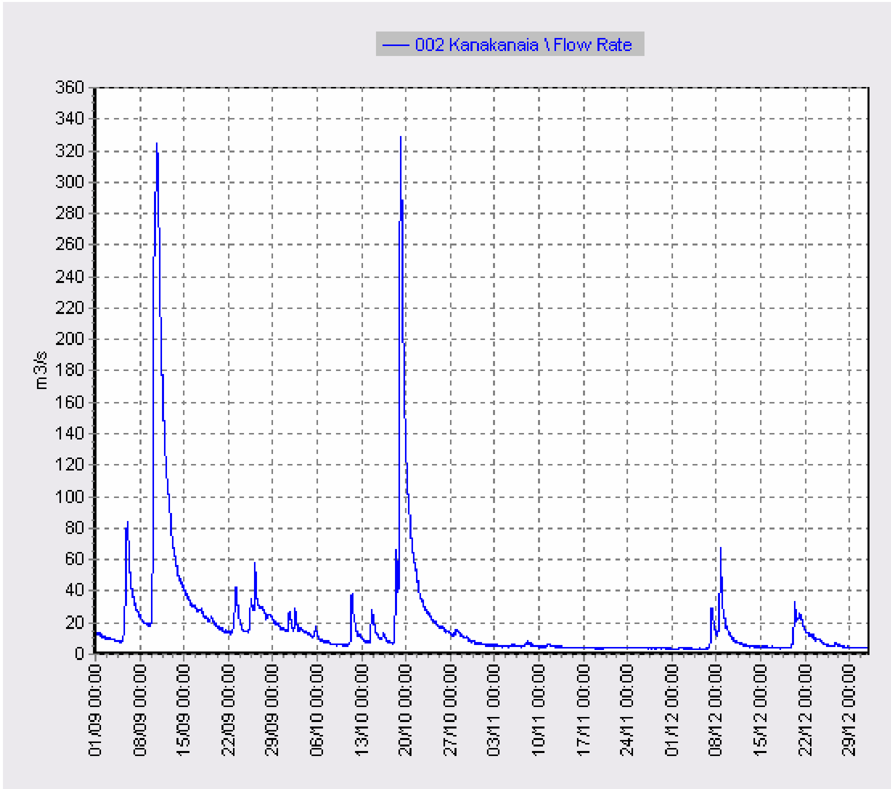
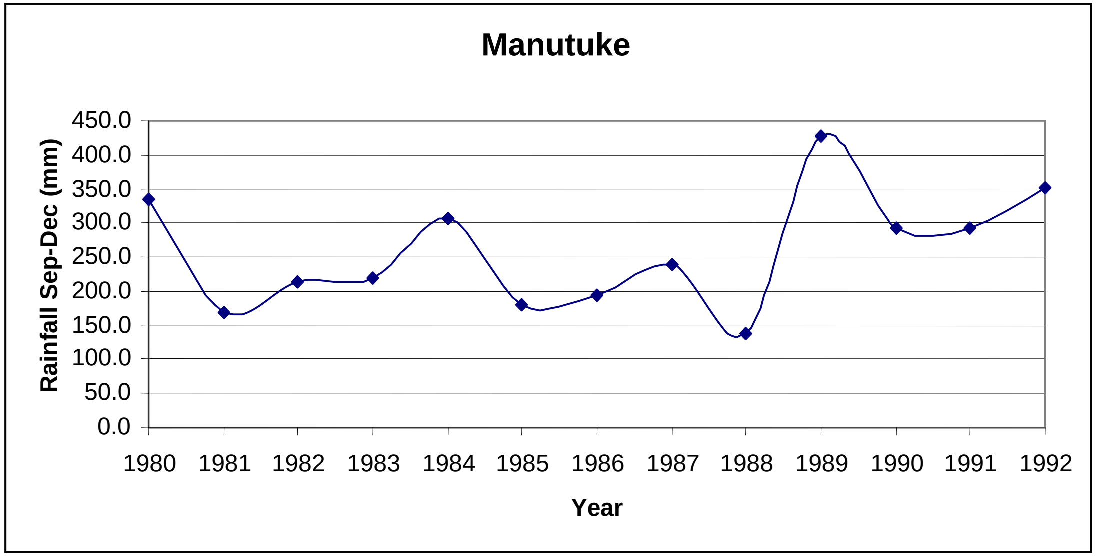
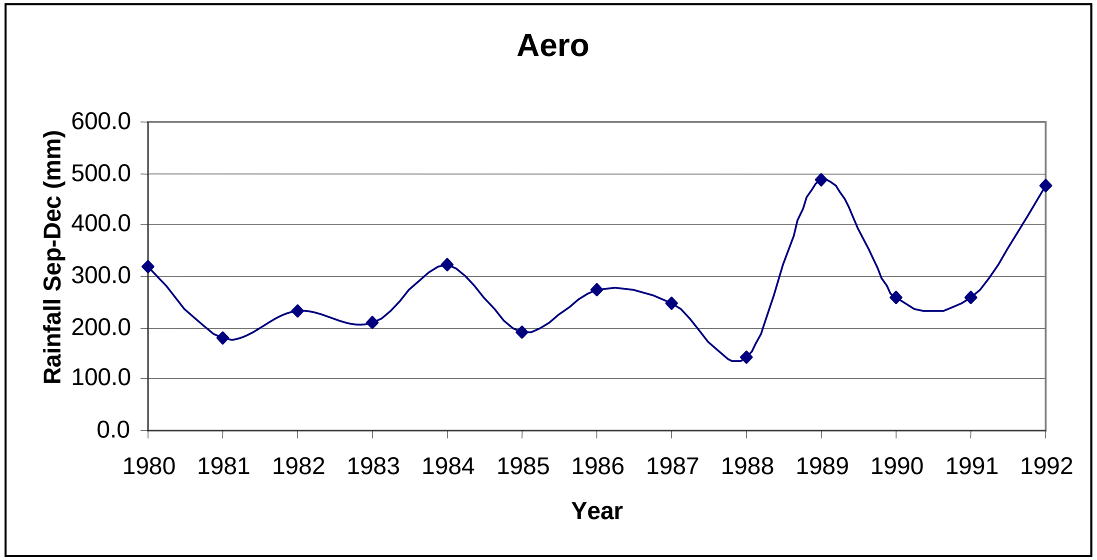


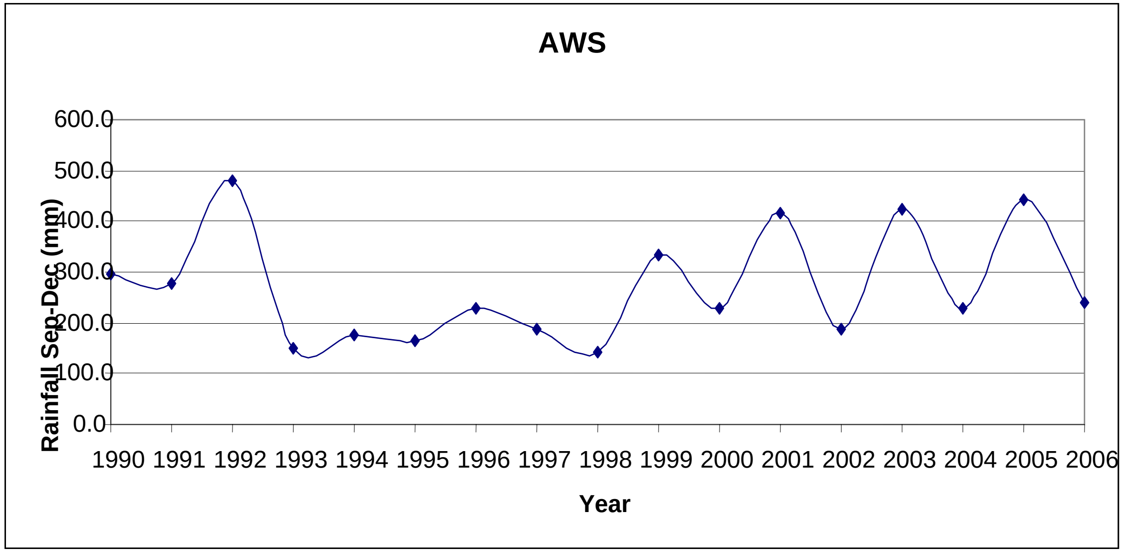
Figure 9: Waipaoa river flow rate Kanakanaia station September to December 2007.



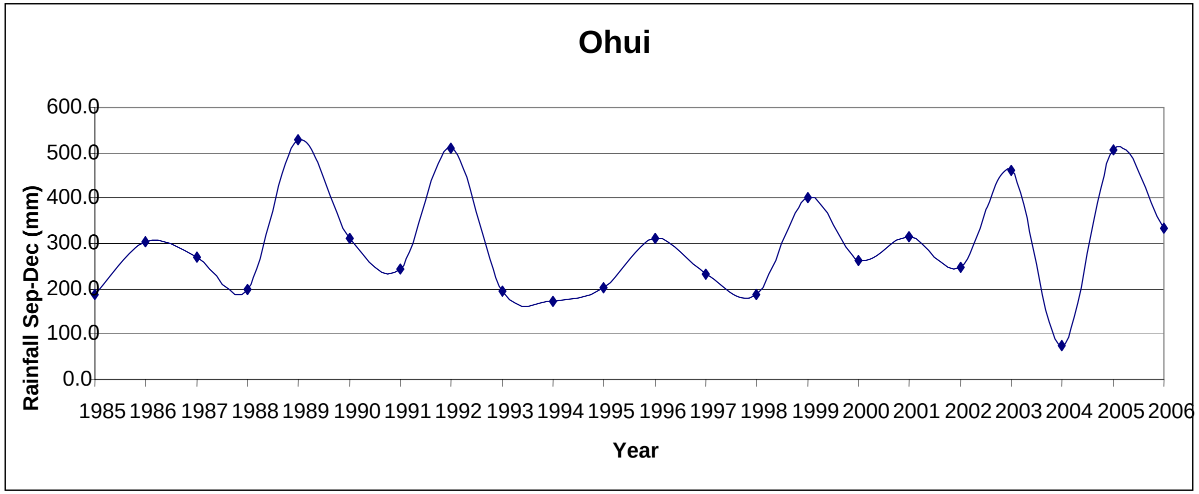
Appendix Figure 1: Total rainfall (mm) from the Manutuke, Gisborne area (Easting 2934861, Northing 6269187) during September-December between 1980–1992.



Appendix Figure 2: Total rainfall (mm) from the Gisborne 'Aero' station (Easting 2943648, Northing 6270456) during September-December between 1980–1992.



Appendix Figure 3: Total rainfall (mm) from the Gisborne 'AWS' station (Easting 2943818, Northing 6270969) during September-December between 1990–2006.



Appendix Figure 4: Total rainfall (mm) from the Gisborne 'Ohui' station (Easting 2958583, Northing 6272375) during September-December between 1985–2006.