

NATIVE FRESHWATER FISH

Studies on glass eels in New Zealand

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Understanding how New Zealand's freshwater eel populations are replenished each year may allow more effective sustainable management of the wild fishery.

BETWEEN AUGUST AND DECEMBER each year, millions of young eels enter rivers and streams around New Zealand from the sea. These small fish – 55–65 mm long – are called “glass eels” because they have no pigments and are therefore transparent. Their arrival marks the end of a journey of several thousand kilometres from their tropical spawning grounds.

The past few decades have seen a decline in glass eel numbers of Northern Hemisphere species of freshwater eel. Is the same thing happening to the New Zealand species?

Without the benefit of long-term databases, we can't be certain. However, a five-year research programme recently investigated trends in size, pigmentation and condition of glass eels of the two New Zealand eel species – the shortfinned eel, *Anguilla australis*, and longfinned eel, *Anguilla dieffenbachii*. As part of this programme we examined the glass eels arriving in 13 New Zealand rivers over four seasons (1995 to 1998). This was done by electric fishing in these rivers every two weeks from August to December. Electric fishing provides good estimates of fish populations: fish are netted after being temporarily stunned by an electric current. They can be examined and counted in captivity and then returned, unharmed, to the river.

The information gathered was used to examine trends in stage of development, condition and size of the glass eels.

Clues from pigments

Glass eels begin to develop pigmentation soon after they enter estuaries and the lower reaches of rivers. The amount of pigment in their skins indicates how long it has been since they arrived in fresh water. From data on the pigmentation of almost 11,500 glass eels caught over the four years, several facts emerged.

- Of all the glass eels caught and examined, 67% were newly arrived, i.e., had arrived since the previous sampling.
- Newly arrived glass eels caught later in the season tended to have more pigment than those caught earlier. This may be because the later arrivals develop more rapidly in the higher summer temperatures.
- North Island glass eels were always more advanced in pigmentation than those in South Island. This is probably because sampling sites in the North Island were above estuaries and harbours, whereas South Island rivers emptied directly into the sea. Thus in the North we were sampling later stages of development.

Condition: clues to arrival patterns

Condition is the ratio of weight to length. The higher this ratio, the fatter and healthier are the fish. The condition of glass eels tends to decline as they migrate, so those that enter estuaries and rivers first tend to be in better condition than those that travel farther. This means that we can deduce from the condition of newly arrived glass eels at different sites the order of their arrival in the rivers.

For example, in 1996 we found that glass eels were in better condition in the north-east of the



top:
 Typical sampling site, with
 Ralph Morse carrying
 electric-fishing gear.
 below:
 Typical eel habitat.



Glass eel of the shortfinned eel.

North Island than in the north-west. This suggested that the eels were arriving from a more north-easterly direction and their condition probably reflected a more direct route from the tropics – a shorter journey.

If this assumption is correct, then glass eels probably arrive first in the north of New Zealand. New arrivals then gradually turn up farther south, dispersing anti-clockwise around the country. However, this arrival pattern seems to vary with the El Niño–Southern Oscillation (ENSO) weather pattern. Results for the four years of the survey are shown on the right: an anti-clockwise pattern of arrival of glass eels in New Zealand in El Niño conditions (1995, 1997 and 1998) and a clockwise pattern associated with La Niña (1996).

During El Niño conditions, the winds tend to be persistent westerlies. In La Niña conditions there are persistent north-easterlies. These changing wind patterns influence the migration of the very tiny larval stages of the eels. (For more details on ENSO see *Water & Atmosphere* 8(2): 15–18.)

Shifting eel spawning grounds?

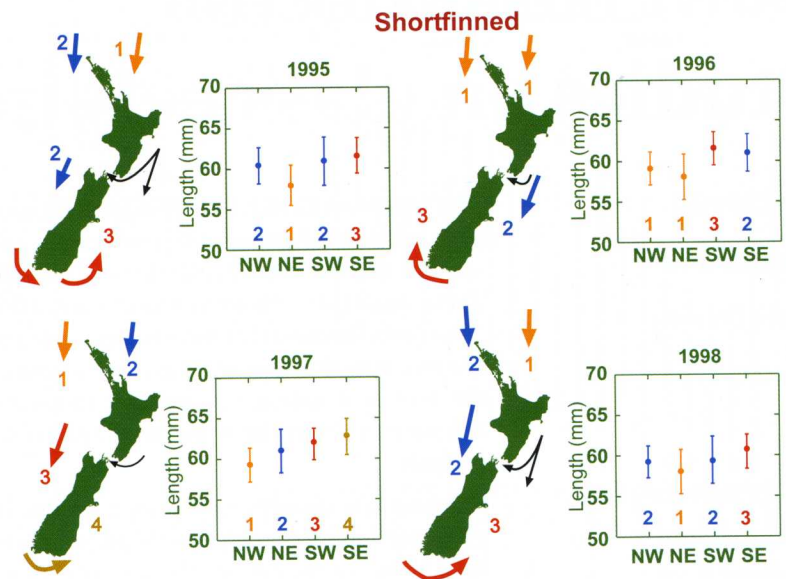
Over the four years of the study (1995–98), the average size (i.e., length) of glass eels arriving in the north-west (North Island) increased, but decreased in the south-west (South Island) arrivals. We don't yet know why. One suggestion is that the location of the spawning grounds could vary. For example, spawning areas could be associated with thermal fronts – places where water masses of different temperatures meet. This has been suggested for both Atlantic eel species.

If these thermal fronts have shifted south, closer to New Zealand, then this would explain why the size of glass eels arriving in the South Island has declined – the eels have not travelled as far and are therefore younger. Shifting spawning grounds could also account for the recent identification of a third eel species, *A. reinhardtii*, in the North Island.

Good data needed

It probably takes the best part of a year for larval eels to arrive in New Zealand from their tropical spawning grounds. Therefore, we would expect big variations in the numbers of glass eels arriving each year. In the Northern Hemisphere information on glass eel arrivals has been collected over the past 30 or 40 years. This has allowed scientists to sort out long-term trends from short-term fluctuations.

Our study is the first in New Zealand to try to get information on how glass eel arrivals vary over both space and time. More years of data are



needed before we can get a really good picture of the factors that affect eel populations,

Recent research on the age-class composition of young eels in New Zealand streams suggests that young longfinned eels are not being replaced as quickly as they were 10 or 20 years ago. This has highlighted the importance of the current glass eel surveys in getting baseline information on actual numbers of eels arriving, which can then be used as a reference point for future comparisons.

Monitoring the size and condition of glass eels during this study has shown that there can be large differences between regions. Further study is needed before we can explain all of the differences. For example, why are glass eels arriving in the north-west bigger than they were five years ago?

Our data showed that glass eels arrive in New Zealand mainly from the north. However, before we can put together a full picture of their migratory pathways, we need further information on the ages of glass eels. This work is currently being carried out in collaboration with Japanese and Taiwanese researchers. We also need to collect additional larvae from the South Pacific Ocean.

Trends in size of early pigmented shortfinned glass eels between regions over the four years of sampling. One to four gives order of small to large size, corresponding to the order of arrival in regions. Bars are mean lengths with standard deviations.

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Further reading

Jellyman, D.J., Chisnall, B.L., Bonnett, M.L. and Sykes, J.R.E. 1999. Seasonal arrival patterns of juvenile freshwater eels (*Anguilla* spp.) in New Zealand. *New Zealand Journal of Marine and Freshwater Research* 33: 233–248.