

# Fish Studies

## 3, 6, 9 ... what don't fish mind?

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*Experiments have shown that some New Zealand native fish species are surprisingly tolerant of high pH levels. This is just one part of a NIWA study on the effects of agriculture on stream ecosystems.*

HOW ARE lowland stream ecosystems influenced by agricultural activities? NIWA staff in Hamilton are investigating this question in order to develop appropriate guidelines for minimising detrimental impacts. One aspect of the study is to determine the effects of common pollutants on native fish species likely to be found in lowland streams. In this article, we present the results of our toxicity and preference experiments with pH.

Typical enriched lowland stream summer conditions are a combination of high plant density (including algae), high temperature and strong sunlight. Under these conditions, vigorous photosynthetic activity in both lakes and rivers can raise the pH value of water to high levels for short periods; pH values of 9.0 to 9.5 are typically recorded for up to 6 hours. There has been little research on the effects of high pH on New Zealand's native fish, but data for species from North America and Europe suggest that pH values of over 9.0 could be harmful.

### Toxicity tests

Our first experiment was simply to see if high pH levels were lethal to native species. All our tests were conducted using Hamilton tap water (pH 8 to 8.5), which was aged and aerated to remove free chlorine. Calcium hydroxide, filtered to remove the calcium, was used as our alkaline solution, while sulphuric acid was used to decrease pH. We duplicated extreme summer conditions by conducting the lethal tests at 20 and 25°C.

Fish resident in, or likely to be migrating through, lowland stream reaches were tested. Individuals collected from the wild were acclimatised at the chosen temperature in water of pH 6.5 to 7.5 (i.e., around neutral) for at least 24 hours before experiments began.

The fish were then placed in water of pH 7.5

for 30 minutes, then pH 8.5 for 30 minutes, before being moved to pH 9.5 where they were held for 6 hours. After 6 hours, any dead fish were counted and the experiment finished.

Results from the toxicity experiments are shown in the table below. Most species tolerated pH 9.5 for 6 hours without problems. One exception was common smelt held at 25°C; in this case, over 50% of the fish died.

*Results from the pH toxicity tests.*

Species	Mean length (mm)	Percentage deaths	
		20°C	25°C
Shortfinned elver	93.6	0	-
Longfinned elver	106.3	0	-
Glass eel	59.5	0	0
Inanga	whitebait	0	0
	adult	0	0
Redfinned bully	65.5	8.3	8.3
Common smelt	64.2	0	52.3

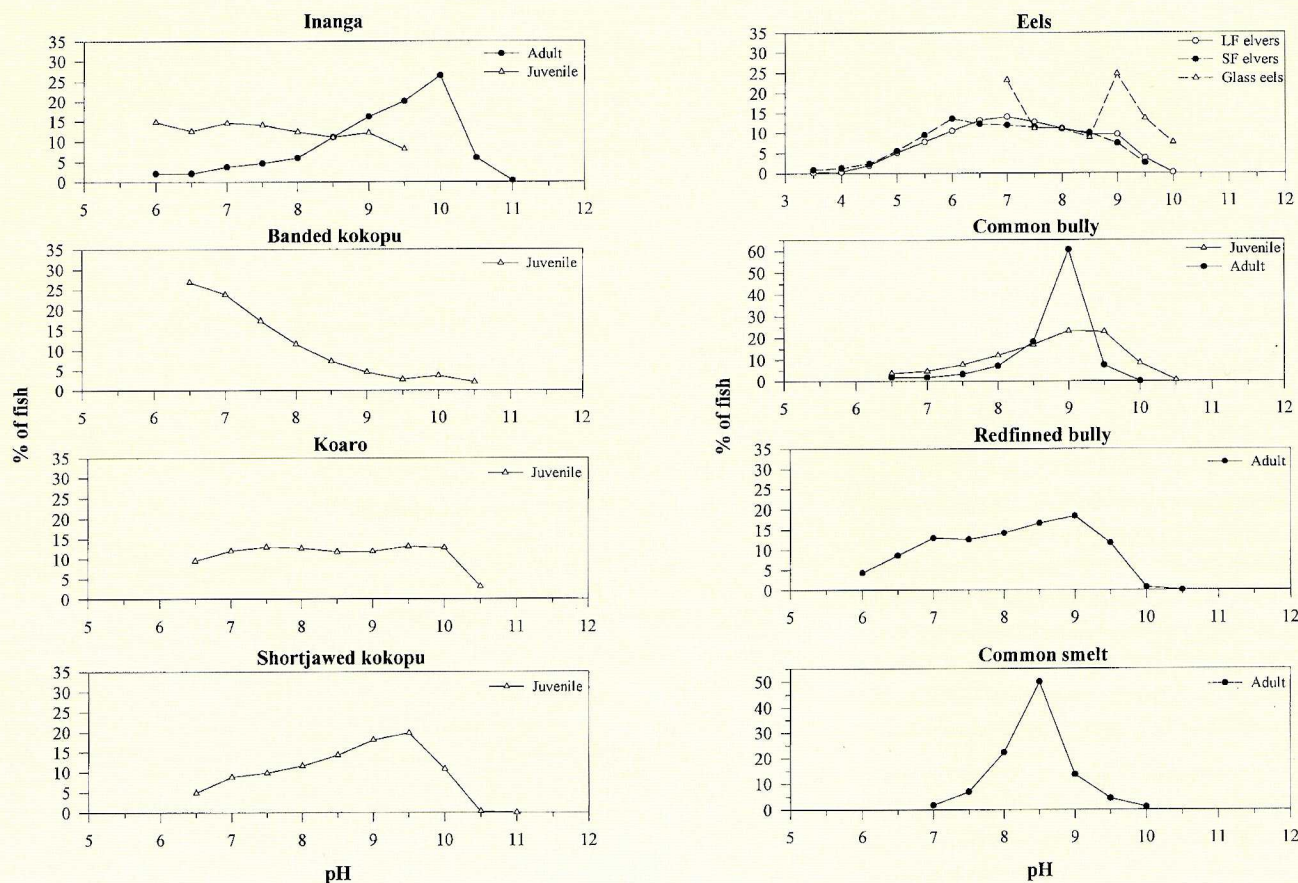
- = not tested.

### Preference tests

Having established that high pH is generally not lethal to native species, we decided to investigate whether native fish species showed pH preferences.

A gradient tank 2.4 metres long was set up for these experiments, all of which were conducted at 20°C. A gradient from about pH 3.5 to 12.0 was established along the length of the tank; pH was measured at eight locations along the tank prior to and at 2-hourly intervals during the experiment. The gradient tank was marked off into 12 sections, each 200 mm long. Four video cameras were set up so that the entire tank length could be seen.

Fish were collected from the wild as before, and acclimatised for at least 24 hours at 20°C at pH 7.5 to 8.0. They were then placed in the gradient



Results from pH preference tests on eight species of freshwater fish. See text for explanation of the experimental procedure.

tank at the approximate position of their acclimatisation pH and allowed to settle down for 2 hours. Fish were then left undisturbed for a further 6 hours while the test was video-taped. Up to three trials were conducted for each species using fresh fish each time.

The video tapes were later viewed to count the number of fish in each 200 mm section of the tank at 10-minute intervals. For the whole experimental period, the number of fish in each of the 12 sections was summed and converted to percentages. Results from individual trials were combined, and the percentages graphed against the measured pH gradient to show the pH preference, as shown in the figure above.

The preference tests gave some interesting results. Almost without exception, juvenile fish spent the test period swimming up and down the tank. Either no pH preference could be established or the preferred range was very wide. We concluded their migratory urge overrode any pH preference.

In contrast, adult-sized fish, except redfinned bullies, showed quite definite preferences. Preferred pH values were quite high – over 8.5 in every case.

## Management implications

High pH values were generally not lethal to native fish species and the migratory urge of juvenile fish species likely to pass through enriched lowland reaches overrode any pH preference or avoidance. Most adult fish likely to be resident in lowland areas showed relatively high pH preferences, and with the exception of common smelt, pH values of 9.0 to 9.5 did not appear to be harmful. This suggests that high pH *per se* is unlikely to influence the distribution of New Zealand fish species.

However, it should be noted that pH values can affect the toxicity of other pollutants. Of particular concern is ammonia, the toxicity of which increases as pH increases. Ammonia is a common pollutant in streams flowing through areas with intense agricultural activity. Our next series of experiments will focus on the toxicity of ammonia to native fish. ■

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