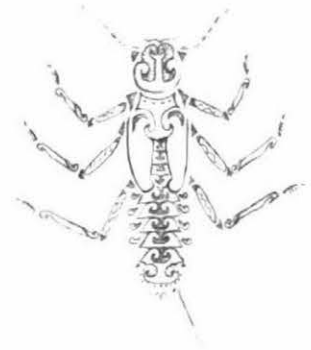
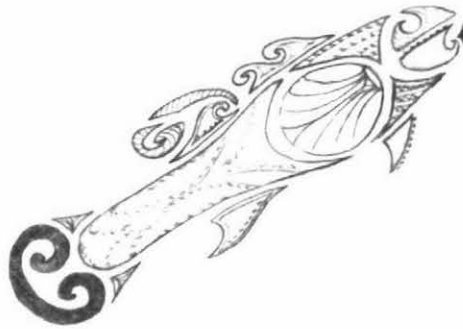
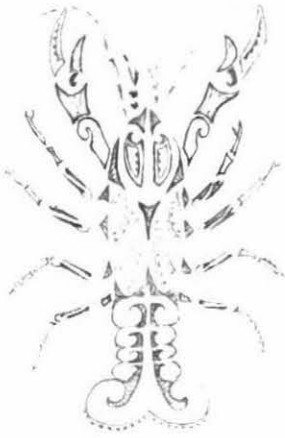


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'Rites of passage': biotic and abiotic influences on freshwater fish migration



Drawings by Nicola Atkinson

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Abstract

Assessing the impacts of barriers to native fish migration has in the past been largely subjective due to the difficulties involved in determining whether a species absence upstream of a potential migration barrier is due to a restriction in passage or a consequence of its natural distribution. Now with the increased availability of GIS data and new modelling techniques, accurate models of species occurrences have the potential to be used in the assessment of migration barriers. Consequently, this study uses a predictive model of species occurrence to accurately quantify the passage restrictions caused by 28 structures in the Wellington Region. Comparisons were made between the species observed to be present upstream of a structure and what would be expected to be there in the absence of a barrier. In addition, impacts were quantified in terms of amount of native fish habitat lost and combined with five other metrics to create an index that gauges the priority each structure has for remediation. The application of this method revealed its potential to be used in management decisions but highlighted its reliance on a large amount of data for it to draw statistically robust conclusions. An assessment of the effectiveness of three fish passes was also carried out but revealed that none were successful in facilitating passage.

The ability of bluegill bullies (*Gobiomorphus hubbsi*) to detect and respond to the odour of conspecific fish upstream under neutrally odoured (rainwater) and naturally odoured (stream water) conditions was tested. Bluegill bullies were presented with a choice of two flows of water to move into, one of which contained the odour of conspecific fish. Bluegill bullies displayed a concentration-dependent reaction under neutral water conditions, where they were attracted to low concentrations of conspecific odour but repelled by high concentrations of odour. This result was not consistent under naturally odoured water conditions, where no attraction towards conspecific odour occurred at low odour concentrations and only a weak avoidance of odour occurred at high concentrations. The differences revealed between natural and neutral water trials suggests the use of habitat odours over conspecific odours and casts doubt on previous studies only conducted under neutral conditions.

The longitudinal size distribution of two populations of bluegill bully from Hutt and Rakaia Rivers and one population of torrentfish from Rakaia River was examined. All populations had longitudinal trajectories that showed some increase in size with distance upstream. This increase in size primarily reflects the influence of amphidromous life styles, where

juveniles diffuse upstream from the sea. However, a quantile regression analysis revealed differences in growth and migration rate between the two bluegill bully populations; bluegill bullies from Rakaia River grew at a slower rate and showed variation in migration rate within their population that was not evident in the Hutt River population. Null models were also generated for each population to test for the presence of all size classes of fish in the lower reaches of each river. Both bluegill bully populations showed a significant absence of the largest size classes in the lower reaches and differed significantly from the null models. This difference suggests that all individual bluegill bullies continuously move upstream throughout their lives. In comparison, the size distribution of torrentfish closely resembled the null model, indicating that some individuals did not migrate upstream to the same extent as others. The differences revealed between the two bluegill bully populations may be explained through a combination of differences in competition and stability between the Hutt and Rakaia River, while the difference between bluegill bully and torrentfish distributions may be a consequence of different reproductive strategies.

Explanation of text

This thesis is a combination of three individual papers. This format has resulted in some repetition in introductions between chapters. Chapter 3 was published in the New Zealand Journal of Marine and Freshwater Research in June 2008 (42(2): 173-180). Chapter 4 was submitted to the New Zealand Journal of Marine and Freshwater Research in June 2008 and is currently under review.

The experimental manipulations and fish sampling methods have been sanctioned by the Massey University Animal Ethics Committee (protocol No. 07/08).

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