The trophic ecology of the freshwater fishes of an Australian rainforest river

Thesis submitted by

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Abstract

In tropical rivers, seasonal cycles of flooding and drying have a major influence on the dynamics of biotic communities. Several global paradigms have been developed which attempt to account for the relationships between river flow, primary productivity, instream habitats, invertebrate and fish communities, fish feeding and food web structure. However, information from Australia is limited, particularly for rivers in the Wet Tropics region of north Queensland, which feature unique hydrogeomorphological characteristics and diverse freshwater fish assemblages. This thesis tests the applicability of global paradigms of riverine ecology to the Mulgrave River, a typical Wet Tropics system.

Four lowland, main-channel sites were sampled on five occasions under a range of flow conditions, from dry season base flows to a one-in-ten year wet season flood. At each site, water quality and habitat data was collected, invertebrate communities in littoral and benthic habitats were sampled and fish were surveyed using a combination of boat electrofishing, gill netting and bait traps. This data was analysed using both univariate and multivariate statistical methods, before being collated into seasonal food web diagrams of the feeding links between fish and their food sources. Stable isotopes analysis was used to identify the most important pathways of energy transfer through these webs and a conceptual model of the factors affecting fish resource use and community structure was constructed.

A total of 1530 fish were caught, representing 36 species. Longitudinal variation in fish community structure was identified, with species such as *Melanotaenia splendida splendida* and *Tandanus tandanus* abundant in upstream areas and *Ambassis agrammus*, *Redigobius bikolanus* and *Lates calcarifer* more common downstream. Some species, such as *Nematalosa erebi*, preferred open waters, while others were associated with particular microhabitat features (e.g., *Notesthes robusta* was generally found near root masses of riparian trees). During the dry season, the community was dominated by *Gerres filamentosus*, *Neosilurus ater* and the introduced *Tilapia mariae*, while during the wet season the community was dominated by *Glossamia aprion* and *Nematalosa erebi*.

The fish fauna was classified into eight habitat guilds and seven feeding guilds. Most species preferred specific habitat features, such as root masses and instream vegetation, during the dry season, and then shifted to larger, deeper habitats with mud substrates and woody debris during the wet season. At this time, instream vegetation was removed from the main channel by high flow velocities

and the scour of bed sediments, which reduced habitat heterogeneity. A range of foods were consumed by fish species, from detritus, algae and fruit, to aquatic invertebrates, molluscs and fish. While the availability of these foods tracked temporal changes in habitat, seasonal shifts in dietary composition were limited to two species and ontogenetic shifts were observed in just three species. Nonetheless, food consumption by the fish community as a whole reflected seasonal fluctuations in productivity and food supply: during the wet season, aerial and surface invertebrates, algae and some detritus appeared to be consumed more frequently, while macrophytes, microcrustaceans and molluscs appeared more important in the mean diet during the dry season.

I hypothesise that fish were limited in their prey selection by their phylogeny and that they tracked changes in food availability by moving between habitat types, which resulted in the observed changes in fish assemblage structure. However, while the identity of fish species comprising the assemblage present in lowland reaches changed seasonally, food web structure did not change substantially, with many weak links and a few strong links at all times. Stable isotope analysis indicated that energy was transferred through these webs via algal and detrital pathways, with a greater diversity of productivity sources contributing to animal production during the wet season than during the dry season.

In general, the dynamics of fish communities in the Mulgrave River are regulated by the unique hydrogeomorphological features of the catchment, which are typical of the Wet Tropics region. Specifically, upland streams in these systems are steep and main channels in lowland reaches are deeply incised relative to the surrounding floodplain. As a result, floodplain habitats in Wet Tropics catchments are poorly connected to the main channel, limiting their influence on primary productivity and their utility to freshwater fish species. While wet season flows are predictable, they act as disturbances in main-channel habitats, rather than the gentle flood ‘pulses’ documented in other tropical areas.

The results of this study emphasise the importance of flow seasonality in governing the spatial and temporal dynamics of productivity, instream habitat, invertebrate and fish populations, fish feeding and, therefore, the structure and function of aquatic food webs. Elements of several global models appear to apply under differing flow conditions, but no single model accounts for all of the dynamics observed in the lowland fish communities of the Mulgrave River. Given the inherent similarities of Wet Tropics catchments, the results of this study are widely applicable to other rivers across the region and provide support for the long-standing doctrine of the importance of maintaining natural flow regimes if freshwater fish diversity is to be conserved.

Table of contents

List of tables

List of figures