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

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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

Chapter 1: Freshwater fish communities in tropical rivers ................................................. 1
  1.1 Introduction .................................................................................................................. 1
  1.2 Resource use by freshwater fish communities .......................................................... 2
  1.3 The influence of flow seasonality on fish feeding ...................................................... 3
  1.4 Models of riverine productivity .................................................................................. 5
  1.5 Aquatic food webs in tropical rivers .......................................................................... 6
  1.6 Australia’s Wet Tropics rivers ................................................................................... 7
  1.7 Freshwater fish feeding in tropical Australia ............................................................ 9
  1.8 Aims and structure of thesis ..................................................................................... 10
Chapter 2: Study area ........................................................................................................ 12
  2.1 Location .................................................................................................................... 12
  2.2 Geology and geomorphology .................................................................................... 12
  2.3 Climate and hydrology ............................................................................................. 15
  2.4 Land use and vegetation .......................................................................................... 16
Chapter 3: Spatial and temporal variation in fish habitats ................................................ 18
  3.1 Introduction ................................................................................................................ 18
  3.2 Methods ..................................................................................................................... 22
    3.2.1 Study sites .......................................................................................................... 22
    3.2.2 Hydrology .......................................................................................................... 23
    3.2.3 Habitat sampling ................................................................................................ 23
    3.2.4 Data analysis ...................................................................................................... 31
  3.3 Results ....................................................................................................................... 32
    3.3.1 Relative importance of habitat axes in determining spatial and temporal habitat variability .......................................................... 32
    3.3.2 Analysis of individual habitat axes ................................................................. 35
      3.3.2.1 Hydrogeomorphology ............................................................................... 35
      3.3.2.2 Vegetation ..................................................................................................... 38
      3.3.2.3 Water quality ................................................................................................. 40
  3.4 Discussion .................................................................................................................. 43
3.5 Conclusion ........................................................................................................ 46

Chapter 4: Spatial and temporal variability in invertebrate community structure ...... 47
4.1 Introduction ........................................................................................................ 47
4.2 Methods ............................................................................................................. 50
   4.2.1 Productivity ................................................................................................. 50
   4.2.2 Invertebrate sampling and sorting ............................................................... 50
   4.2.3 Statistical methods .................................................................................... 51
4.3 Results ............................................................................................................... 53
   4.3.1 Productivity ................................................................................................. 53
   4.3.2 Littoral invertebrate communities .............................................................. 54
   4.3.3 Benthic invertebrate communities .............................................................. 57
   4.3.4 Richness and evenness of invertebrate samples .......................................... 61
4.4 Discussion ......................................................................................................... 63
4.5 Conclusion ......................................................................................................... 65

Chapter 5: Spatial and temporal variation in fish community structure .................... 66
5.1 Introduction ....................................................................................................... 66
5.2 Methods ............................................................................................................. 68
   5.2.1 Fish surveys ............................................................................................... 68
   5.2.2 Statistical methods .................................................................................... 69
5.3 Results ............................................................................................................... 71
   5.3.1 Gear selectivity ......................................................................................... 71
   5.3.2 Analysis of electrofishing catch ................................................................. 73
   5.3.3 Analysis of gill net catch ......................................................................... 74
   5.3.4 Analysis of bait trap catch ...................................................................... 84
   5.3.5 Classification of habitat use by individual species .................................. 84
   5.3.6 Seasonal shifts in habitat use by fish species .......................................... 87
5.4 Discussion ......................................................................................................... 89
   5.4.1 Spatial variability in fish community structure ........................................ 89
   5.4.2 Temporal variation in fish community structure ...................................... 90
5.5 Conclusion ......................................................................................................... 92

Chapter 6: Spatial and temporal variation in fish feeding ........................................... 93
6.1 Introduction .......................................................................................................................... 93

6.2 Methods ............................................................................................................................... 96
  6.2.1 Specimen collection, morphological measurements and gut contents analysis . 96
  6.2.2 Data analysis .................................................................................................................. 97

6.3 Results .................................................................................................................................. 99
  6.3.1 Gut fullness .................................................................................................................... 99
  6.3.2 Temporal variation in species composition of feeding guilds ................................. 100
  6.3.3 Diet composition of species with low catch rates ....................................................... 103
  6.3.4 Ontogenetic diet shifts ............................................................................................... 103
  6.3.5 Spatial and temporal variability in mean diet composition ....................................... 105

6.4 Discussion ............................................................................................................................ 108
  6.4.1 Trophic guild structure ............................................................................................... 108
  6.4.2 Temporal variation in trophic guild structure ............................................................ 109
  6.4.3 Body size, predator-prey interactions and ontogenetic diet shifts ............................. 109
  6.4.4 The influence of taxonomic resolution of fish diets on guild classification ....... 110
  6.4.5 Community level changes in food consumption ....................................................... 111

6.5 Conclusion ............................................................................................................................ 111

Chapter 7: Food web structure.................................................................................................. 112

7.1 Introduction ........................................................................................................................... 112

7.2 Methods ............................................................................................................................... 115

7.3 Results .................................................................................................................................. 117
  7.3.1 Seasonal food webs based on field survey and gut contents data ......................... 117
  7.3.2 Stable isotope analysis ............................................................................................... 121
    7.3.2.1 Basal sources ....................................................................................................... 121
    7.3.2.2 Primary consumers ............................................................................................. 121
    7.3.2.3 Higher-order consumers .................................................................................... 122

7.4 Discussion ............................................................................................................................ 124
  7.4.1 Food web structure ...................................................................................................... 124
  7.4.2 Temporal change in food web structure .................................................................... 125
  7.4.3 Sources of production driving the food web ............................................................. 126
  7.4.4 Applicability of food web principles derived by Douglas et al. (2005) .............. 127
List of tables

**Table 2.1** Return periods for floods on the Mulgrave River near Gordonvale, based on a Log Pearson III distribution (source: Cameron McNamara, 1985). ................................................... ........................................16

**Table 3.1** The number of hydrogeomorphology and vegetation replicates collected at each site during each sampling date..........................................................................................................28

**Table 3.2** Geomorphology and vegetation variables recorded, with abbreviation codes used in figures..........................................................................................................................30

**Table 3.3** Within-treatment multivariate test results (MANOVA, Pillai’s Trace) for hydrogeomorphology variables (width, depth and velocity). * $p<0.05$, ** $p<0.01$, *** $p<0.001$......................................................................35

**Table 3.4** Results of between-subjects ANOVA testing on individual hydrogeomorphology variables. * $p<0.05$, ** $p<0.01$, *** $p<0.001$..........................................................................................................................36

**Table 3.5** Within-treatment multivariate test results (MANOVA, Pillai’s Trace) for water quality variables (conductivity, dissolved oxygen concentration, temperatures and pH). * $p<0.05$, ** $p<0.01$, *** $p<0.001$............................................. ................................................... ........................................40

**Table 3.6** Results of between-subjects ANOVA testing on individual water quality variables. * $p<0.05$, ** $p<0.01$, *** $p<0.001$..........................................................................................................................41

**Table 4.1** The number of littoral dip-net (D) and benthic grab (G) replicates collected at each site during each sampling date..........................................................................................................................51

**Table 4.2** Composition of broad invertebrate categories (after Pusey *et al.*, 1995b; 2004)........................................................................52

**Table 4.3** Results of one-way ANOVA tests performed on log-transformed mean chlorophyll $a$ and phaeophytin concentrations between sites and sampling dates. Significant differences ($p<0.05$) are highlighted in bold................................................................................................................53

**Table 4.4** Descriptive statistics for broad invertebrate categories in littoral dip-net samples, across all sites and sampling dates, along with Kruskal-Wallis test results between sites (pooled across sampling dates) and sampling dates (pooled across sites). Significant differences are highlighted in boldface. 54

**Table 4.5** Descriptive statistics for broad invertebrate categories in benthic grab samples, across all sites and sampling dates, along with Kruskal-Wallis test results between sites and sampling dates. Significant differences are highlighted in boldface......................................................................................58

**Table 4.6** Within-treatment test results (MANOVA, Pillai’s Trace) for richness and evenness of broad invertebrate categories in littoral dip-net and benthic grab samples. * $p<0.05$, ** $p<0.01$, *** $p<0.001$..............................................................61

**Table 4.7** Results of individual between-subjects ANOVA testing for mean richness and evenness of broad invertebrate categories in littoral dip-net and benthic grab samples. * $p<0.05$, ** $p<0.01$, *** $p<0.001$..................................................................................................................61
Table 5.1 Taxonomic details and habitat classes of the 36 species caught during the study. * indicates introduced species.

Table 5.2 Results of one-way ANOVA testing of mean electrofishing CPUE richness and evenness variables. The October 2003 sample from site 2 was removed from this analysis (see text). All p values were >0.1.

Table 5.3 Kruskal-Wallis test results for mean electrofishing CPUE and BPUE between sites and dates. Significant differences (p<0.05) are highlighted in bold. The October 2003 sample from site 2 was not included in this analysis (see text).

Table 5.4 Kruskal-Wallis test results for mean gill net CPUE (number of individuals per gill net hour) and mean BPUE (grams per gill net hour) between sites and sampling dates.

Table 5.5 Kruskal-Wallis test results for mean gill net CPUE (number of individuals per bait trap hour) and mean BPUE (grams per bait trap hour) between sites and sampling dates.

Table 6.1 Composition of broad diet categories used in gut contents analysis (after Pusey et al., 1995b; 2004).

Table 6.2 The number of individuals with gut fullness values of at least 0.2 in juvenile (J), sub-adult (SA) and adult (A) size classes for nine fish species caught during wet and dry season sampling dates.

Table 6.3 The proportional contributions of each dietary category to the total diet of species with low catch rates. Species are ordered according the guild, from Figure 6.2, to which they might be ascribed from this data. Values ≥0.2 are highlighted in boldface.

Table 6.4 Kruskal-Wallis test results for diet indices between sites (pooled across sampling dates) and sampling dates (pooled across sites).

Table 7.1 Estimated mean dry-masses of individual animals from each invertebrate category. Estimations were made using data from the present study, combined with length-weight relationships reported by Barmgartner and Rothaupt (2003) and Ganihar (1997).
List of figures

Figure 1.1 Hypothetical overlap on resource use axes as a function of resource availability in a local habitat (source: Matthews, 1998, p.459) .................................................................................................................................4

Figure 1.2 A map of the drainage basins of tropical Australia, indicating the relatively small size of the Wet Tropics bioregion, which is shaded in dark grey (after Erskine et al., 2005) .................................................................................................................................8

Figure 2.1 A map of the Mulgrave and Russell River catchments. Topography of the area is shown, along with major tributaries, urban areas and the locations of study sites 1-4 on the lowland reach of the Mulgrave River ........................................................................................................................................13

Figure 2.2 Mean monthly maximum and minimum air temperatures and mean monthly rainfall at Cairns Post Office (1882-1957; -16.9333 S; 145.7833 E; Elevation = 2.0 m; data source: Australian Bureau of Meteorology) ..................................................................................................................15

Figure 3.1 The relative importance of the three main habitat variables, in determining the range of fish habitats present at a site (represented as boxes), may change both spatially and temporally (here between dry and wet seasons) ..................................................................................................................21

Figure 3.2 Geomorphology and vegetation features of site 1 under base flow, dry season conditions (a), with photos facing upstream under dry (b) and wet season (c) conditions, and downstream during the dry season (d). See Table 3.2 for explanation of habitat codes ..................................................................................................................24

Figure 3.3 Geomorphology and vegetation features of site 2 under base flow, dry season conditions (a), with a photo of the large woody debris snag at the upstream end of the site (b), the view looking upstream (c). Several root masses are present on the left bank (d). See Table 3.2 for explanation of habitat codes ..................................................................................................................25

Figure 3.4 Geomorphology and vegetation features of site 3 under base flow, dry season conditions (a). As with site 2, the upstream end of this site is characterised by an exposed sand bar covered by emergent vegetation and grasses (b). Exposed root masses dominate the bank under two large Ficus trees (c), while emergent reeds colonise portions of the left bank without overhanging vegetation (d). See Table 3.2 for explanation of habitat codes ..................................................................................................................26

Figure 3.5 Geomorphology and vegetation features of site 4 under base flow, dry season conditions (a). The main feature of this site is a large, shallow submerged sand bar running along the left bank. The right bank is bordered by primary riparian forest with emergent palms (b, c). A pocket of small woody debris also exists on the left bank (d). See Table 3.2 for explanation of habitat codes ..................................................................................................................27

Figure 3.6 Mean daily discharge (m³/sec ± SE) for the Mulgrave River at Peet’s Bridge (gauging station 111007A – ca. 10km upstream from the study sites). Data is presented for each month between January 2001 and May 2005 (bars), along with the long-term average calculated for 1973-2005 (line). The timing of the pilot study (P) and sampling rounds (1-5) is also indicated. (data source: Queensland Department of Natural Resources Mines and Energy) ..................................................................................................................28

Figure 3.7 Schematic diagram of a river channel showing the total area sampled during a typical shot of fish sampling effort (e.g. a single electrofishing shot; ♦). Two different measures were used. ‘Percent bank length’ refers to the percentage of the total bank length sampled, which is
occupied/covered by the habitat variable. This method was used for structural habitat variables, such as overhanging vegetation (●). ‘Percent surface area’ refers to the percentage of total area sampled, covered by the habitat variable. This method was used for the remaining vegetation and substrate variables, such as instream macrophytes (●).

Figure 3.8 The distribution of study sites in three-dimensional ordination space, as defined by SSH MDS of habitat variables (Gower-Metric, stress = 0.1447), during wet (open) and dry (shaded) season sampling dates (a, b) (Site 1 = ○●, Site 2 = △▼, Site 3 = □■, Site 4 = ◇◆). PCC vector lines (including temperature (Temp), conductivity (Cond) and pH) are shown with MCAO r-squared values (c, d); *** = 0%, ** = 1%, * = 2-5%. Hydrogeomorphology and vegetation vector codes are provided in Table 3.2. Note: vector length is indicative of the orientation in three dimensions, not the relative importance in determining the distribution of sites in ordination space.

Figure 3.9 The temporal shifts in habitat characteristics of each study site relative to axes X and Z of the three dimensional SSH MDS ordination presented in Figure 3.8 (Gower-Metric, stress = 0.1447), during wet (open) and dry (shaded) season sampling dates conducted in October 2003 (○), April 2004 (●), June 2004 (▼), October 2004 (▼) and May 2005 (□). The PCC vectors relating to these ordination axes are presented in Figure 3.8d.

Figure 3.10 Mean depth (±SE) of sites 1 to 4 (pooled across sampling dates) and sampling dates (pooled across sites), with homogeneous subsets determined by Tukey’s HSD post hoc testing.

Figure 3.11 Mean wetted width (±SE) of sites 1 to 4 during each sampling date.

Figure 3.12 Mean flow velocity (±SE) of sites 1 to 4 during each sampling date.

Figure 3.13 Mean percent bank length (±SE) occupied by deep (DUC) and shallow (SUC) undercut banks at sites 1 to 4 (pooled across sampling dates) and for each sampling date (pooled across sites).

Figure 3.14 Mean percent surface area (±SE) covered by mud and sand substrate at sites 1 to 4 (pooled across sampling dates) and for each sampling date (pooled across sites).

Figure 3.15 Mean percent surface area or bank length (LWD, SWD, and OhV) (±SE) covered by vegetation variables at sites 1 to 4 (pooled across sampling dates, a and b) and for each sampling date (pooled across sites, c and d). See Table 3.2 for variable codes.

Figure 3.16 Mean conductivity (±SE) of sites 1 to 4 during each sampling date. The higher conductivity at site 4, and to a lesser extent during the dry season samples (October 2003 and October 2004), was due to the greater tidal penetration in the lower reaches of the Mulgrave River at this time.

Figure 3.17 Mean temperature (a, b), dissolved oxygen (DO, percent saturation, c, d), and pH (e, f) of sites 1 to 4 (pooled across sampling dates ±SE) and sampling dates (pooled across sites), with homogeneous subsets determined by Tukey’s HSD post hoc testing.

Figure 3.19 A conceptual model of seasonal fish habitat dynamics in the main channel of a typical Wet Tropics river.

Figure 4.1 Mean concentration (µg/L ± SE) of (a) chlorophyll a and (b) phaeophytin, pooled across sites for each sampling date, with homogenous subsets determined by Tukey’s HSD post hoc test.
Figure 4.2 Mean catch per unit effort (± SE) of the nine invertebrate categories in littoral dip-net samples for sites, pooled across sampling dates (a), and sampling dates, pooled across sites (b).......

Figure 4.3 The distribution of study sites in three-dimensional ordination space (a, b), as defined by SSH MDS of littoral invertebrate communities (range standardised, Bray Curtis, stress = 0.1112), during wet (open) and dry (shaded) season sampling dates (Site 1 = ○●, Site 2 = △▽, Site 3 = □■, Site 4 = ◆◇). PCC vector lines are shown with MCAO r-squared values (c, d): *** = 0%, ** = 1%, * = 2-5%. See Tables 3.2 and 4.2 for vector codes. Note: vector length is indicative of the orientation in three dimensions, not the relative importance in determining the distribution of sites in ordination space.................................................................

Figure 4.4 Mean densities (number of individuals per m² ± SE) of the nine broad invertebrate categories in benthic grab samples for sites, pooled across sampling dates (a), and sampling dates, pooled across sites (b)........................... ................................................... ............................................

Figure 4.5 The distribution of study sites in three-dimensional ordination space (a, b), as defined by SSH MDS of benthic invertebrate communities (range standardised, Bray Curtis, stress = 0.1068), during wet (open) and dry (shaded) season sampling dates (Site 1 = ○●, Site 2 = △▽, Site 3 = □■, Site 4 = ◆◇). PCC vector lines are shown with MCAO r-squared values (c, d): *** = 0%, ** = 1%, * = 2-5%. See Tables 3.2 and 4.2 for vector codes, some vectors have not been drawn in order to aid clarity. Note: vector length is indicative of the orientation in three dimensions, not the relative importance in determining the distribution of sites in ordination space............................... ................

Figure 4.7 Mean (± SE) richness (a, b) and evenness (c, d) of invertebrate categories in littoral dip-net (■) and benthic grab (■) samples for sites, pooled across sampling dates, and sampling dates, pooled across sites. Significant Tukey’s post hoc test results are presented where applicable..........

Figure 5.1 Mean catch per unit effort (number of individuals per second ±SE) of all species caught using electrofishing, averaged across sites and sampling dates, in order of descending abundance...

Figure 5.2 Mean biomass per unit effort (grams per second ±SE) of all species caught using electrofishing, averaged across sites and sampling dates, in order of descending biomass............

Figure 5.3 Mean catch per unit effort (number of individuals per second ±SE) of the eight most numerically abundant species caught using electrofishing, for sites averaged across sampling dates (a) and sampling dates averaged across sites (b). * denotes significant difference (Kruskal-Wallis p<0.05). See Table 5.3 for full test results. The October 2003 sample from site 2 was removed from this analysis (see text).................................................................

Figure 5.4 Mean biomass per unit effort (grams per second of electrofishing ±SE), of the ten species with greatest biomass, for sites averaged across sampling dates (a) and sampling dates averaged across sites (b). * denotes significant difference (Kruskal-Wallis p<0.05). See Table 5.3 for full test results. The October 2003 sample from site 2 was removed from this analysis (see text)..............

Figure 5.5 The distribution of study sites in three-dimensional ordination space (a, b), as defined by SSH MDS of electrofishing CPUE (log₁₀(x+1) transformed, Bray-Curtis metric, stress = 0.1882) during wet (open) and dry (shaded) season sampling dates (Site 1 = ○●, Site 2 = △▽, Site 3 = □■, Site 4 = ◆◇). PCC vector lines are shown with MCAO r-squared values (c, d): *** = 0%, ** = 1%, * = 2-5%. See Table 5.1 for species vector codes. Note: vector length is indicative of the orientation
in three dimensions, not the relative importance in determining the distribution of sites in ordination space.

**Figure 5.6** The distribution of study sites in three-dimensional ordination space (a, b), as defined by SSH MDS of electrofishing BPUE ($\log_{10}(x+1)$ transformed, Bray-Curtis metric, stress = 0.2044) during wet (open) and dry (shaded) season sampling dates (Site 1 = ○●, Site 2 = △▼, Site 3 = □■, Site 4 = ◇◆). *Glossogobius* sp. 1 was the only species strongly correlated with the distribution of study sites in ordination space.

**Figure 5.7** Mean catch per unit effort (number of individuals per gill net hour ±SE) of all species caught using gill netting, averaged across sites and sampling dates, in order of descending abundance.

**Figure 5.8** Mean catch per unit effort (grams per gill net hour ±SE) of all species caught using gill netting, averaged across sites and sampling dates, in order of descending biomass.

**Figure 5.9** Mean biomass per unit effort (grams per gill net hour ±SE), of all species caught gill netting, for sites averaged across sampling dates (a) and sampling dates averaged across sites (b). * denotes significant difference (Kruskal-Wallis $p<0.05$). See Table 5.4 for full test results.

**Figure 5.10** Mean biomass per unit effort (grams per gill net hour ±SE), of all species caught gill netting, for sites averaged across sampling dates (a) and sampling dates averaged across sites (b). * denotes significant difference (Kruskal-Wallis $p<0.05$). See Table 5.4 for full test results.

**Figure 5.11** The distribution of study sites in three-dimensional ordination space (a, b), as defined by SSH MDS of gill netting CPUE ($\log_{10}(x+1)$ transformed, Bray-Curtis metric, stress = 0.1357) during wet (open) and dry (shaded) season sampling dates (Site 1 = ○●, Site 2 = △▼, Site 3 = □■, Site 4 = ◇◆). PCC vector lines are shown with MCAO r-squared values (c, d): *** = 0%, ** = 1%, * = 2-5%. See Table 5.1 for species vector codes. Note: vector length is indicative of the orientation in three dimensions, not the relative importance in determining the distribution of sites in ordination space. The May 2004 sample from site 4 was excluded from this analysis due to zero catch.

**Figure 5.12** The distribution of study sites in three-dimensional ordination space (a, b), as defined by SSH MDS of gill netting BPUE ($\log_{10}(x+1)$ transformed, Bray-Curtis metric, cut-off=1, 50 iterations, 50 random starts, stress = 0.0985; Lee Belbin, pers. comm., stress = 0.0985) during wet (open) and dry (shaded) season sampling dates (Site 1 = ○●, Site 2 = △▼, Site 3 = □■, Site 4 = ◇◆). Other details as in Figure 5.11.

**Figure 5.13** Mean catch per unit effort (number of individuals per bait trap hour ±SE) of all species caught bait trapping, averaged across sites and sampling dates, in order of descending abundance.

**Figure 5.14** Mean biomass per unit effort (grams per bait trap hour ±SE) of all species caught bait trapping, averaged across sites and sampling dates, in order of descending biomass.

**Figure 5.15** Habitat guild structure of the freshwater fish community (caught using electrofishing) of the lowland Mulgrave River, during dry (closed circles) and wet (open circles) season samples, showing guilds 1 to 8 as defined by flexible UPGMA classification (grey dashed line). Grey arrows represent seasonal habitat shifts resulting in movement between guilds. Note that some species were only caught in one season.
Figure 6.1 Mean gut fullness (±SE) at each site across all species during each sampling date.............100

Figure 6.2 The trophic structure of the freshwater fish community of the lowland Mulgrave River. Seven feeding guilds were defined by flexible UPGMA classification on the basis of broad diet categories (grey dashed line) of species collected during dry (closed circles) and wet (open circles). Species names are followed by sample size (i.e., the no. individuals with gut fullness of at least 0.2). Grey arrows represent seasonal feeding shifts resulting in movement between guilds. Note that some species were only caught in one season (e.g., C. stercusmuscarum)..........................................................101

Figure 6.3 The distribution of fish species from wet and dry seasons (not delineated in plot), some divided into size classes, in ordination space as defined by SSH MDS axes X and Y of an ordination (3D, untransformed, Bray-Curtis metric, stress = 0.1538) of mean dietary composition (mean proportional contribution of each diet category), with guilds shown as defined by flexible UPGMA classification (a), and associated PCC diet category vectors with MCAO testing results (b). *** = 0%, ** = 1%, * = 2-5%. See Figure 6.2 for guild descriptions and Table 6.1 for prey category codes. Note: vector length is indicative of the orientation in three dimensions, not the relative importance in determining the distribution of sites in ordination space. Ontogenetic diet shifts in ordination space, resulting in movement between feeding guilds, are shown for three species; N. ater, M. s. splendida and G. filamentosus. Each species switched from a diet of aquatic insects to other prey items with increasing size/age..........................................................104

Figure 6.4 The ontogenetic dietary shift exhibited by M. s. splendida during the dry season. The mean proportional contribution of five resource categories is plotted for the three size classes used in the ordination analysis presented in Figure 6.3, with sample sizes in brackets. All other diet categories contributed less than 2% to the total diet of each size class..................................................................................105

Figure 6.5 Mean dietary richness (a, b) and evenness (c, d) of all fish with gut fullness values ≥0.2 at sites (pooled across sampling dates) and sampling dates (pooled across sites). Kruskal-Wallis test results are presented in Table 6.3 above..................................................106

Figure 6.6 The distribution of study sites in ordination space (a, b) as defined by SSH MDS axes X, Y and Z of an ordination (3D, untransformed, Bray-Curtis metric, stress=0.1389) of mean dietary composition of all fish present, during wet (open) and dry (shaded) season sampling dates (Site 1 = ○●, Site 2 = △▼, Site 3 = □■, Site 4 = ◊●). PCC diet, habitat and food availability vectors are shown with MCAO r-squared values (c, d): *** = 0%, ** = 1%, * = 2-5%. See Tables 6.1, 3.1 and 4.2, for respective vector codes. Note: vector length is indicative of the orientation in three dimensions, not the relative importance in determining the distribution of sites in ordination space..................................................................................107

Figure 7.1 Simplified food web for a lowland river (after: Winemiller, 2005; Power and Dietrich, 2002; Lowe-McConnell, 1987). Boxes represent aggregate material pools and vectors represent the main consumer-resource interactions. Food web elements that are quantified in this chapter using traditional methods and stable isotopes data are shaded dark grey, while elements that are assessed using stable isotopes data only are shaded light grey..........................................................113

Figure 7.2 Seasonal trophic links between fish feeding guilds, invertebrate prey categories and basal trophic levels in the main-channel food web of the Mulgrave River. The size of circles is indicative of relative biomass within each trophic level, while grey circles are estimates from habitat sampling and field observations. Very weak links (<0.0005% of strongest link) are shown as dashed lines...........119
Figure 7.3 Frequency histogram of relative feeding link strength (range standardised across both seasons) between fish guilds and their food sources.

Figure 7.4 Proportion of total feeding link biomass (energy transfer) associated with each measured food source during dry (shaded bars) and wet (open bars) seasons.

Figure 7.5 Stable-isotope signatures ($\delta^{13}C$ and $\delta^{15}N$) during dry and wet season samples. Primary sources are plotted as boxes ± SE about the mean, with samples from Bunn et al. (1997) suffixed with (B).

Figure 7.6 Changes in mean stable-isotope signatures of fish species caught during wet (shaded) and dry (open) seasons.

Figure 8.1 A conceptual model of the main influences on freshwater fish communities in the main channel of the lower Mulgrave River, with large arrows indicating the most important processes and the relevant thesis chapters.

Figure 8.2 Estimated altitudinal distribution of stream length characteristic of wet-dry and Wet Tropics river catchments in northern Australia.