



Land and Water

A review of available information on aquatic biodiversity in the Douglas Shire catchments

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Cover Photograph:

Description: Undescribed species of the speckled goby (*Redigobius bikolanus*) "species-complex". Currently, there are at least three "*bikolanus*" species in northern Australia. This specimen was collected in the Mossman River, Douglas Shire, 9 March 2004.

Photographer: David Westcott

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Executive Summary

This report provides a review of available information on data on aquatic biodiversity in the Douglas Shire catchments. It establishes a baseline synthesis of data to enable evaluation of potential effects of land-use and landscape change on Douglas Shire's aquatic biodiversity.

Douglas Shire contains four major catchments, the Daintree, Mossman and Mowbray rivers, and Saltwater Creek, with a total catchment area of ~1850 km². All four catchments originate in the Wet Tropics World Heritage Area, and drain small, intensively farmed coastal floodplains before discharging into the Great Barrier Reef lagoon. Aquatic biodiversity of all creeks draining into the Coral Sea between the Daintree River and Cape Tribulation was also considered. These creeks were combined into Cape Tribulation streams.

Species distribution information in catchments of Douglas Shire was obtained for aquatic macrophytes, aquatic invertebrates, fish, aquatic amphibians and reptiles, and aquatic mammals. Only coastal lowlands habitats at elevations from 0 – 400 m above sea level are considered here, encompassing both freshwater and estuarine environments of the study catchments. Neither birds nor terrestrial vegetation of freshwater and estuarine wetlands were considered here, as they are included in the Terrestrial Biodiversity review as part of Project Area C4.P1 of the Terrestrial Biodiversity Water Use Benefits crosscutting theme.

Currently, a total of 348 aquatic taxa have been documented in the catchments of Douglas Shire. Fish are the most commonly recorded taxa, followed by aquatic invertebrates, amphibians and reptiles, macrophytes and mammals. At least twelve of these species have been introduced from overseas, with four additional aquatic exotic weeds recorded within the Shire but outside the catchments reviewed, while translocated species (native species from other catchments) were not differentiated as such here. It is likely that with additional studies and research, new species, or an expansion of distribution ranges of aquatic plants, invertebrates and vertebrates will be documented.

The review demonstrates that knowledge on the distribution of aquatic biodiversity in Douglas Shire catchments is patchy and highly variable within and between taxonomic groups and catchments. The distributions of freshwater fish and amphibians are probably best documented, followed by aquatic reptiles, mammals, invertebrates, and macrophytes. In contrast, little information is available on the biology of estuarine and inshore fish species, including many species important for fisheries. This knowledge gap needs to be addressed in order to be able to quantify the contribution tropical rivers make to estuarine and coastal fisheries. To enable rigorous evaluation of the potential effects of future changes in land-use practice and landscape composition on aquatic biodiversity across the Wet Tropics, a larger review encompassing all Wet Tropics catchments should be conducted.

To assess future impacts of land-use and landscape changes on aquatic biodiversity, different assessments of biodiversity can be used. This can include changes in species richness, distribution, diversity, and assemblage composition, as well as changes in presence / absence data. Changes in occurrences of endemic and threatened species, as well as exotic species may be of particular interest. Fish provide a particularly valuable tool to evaluate changes in aquatic ecosystem health, because they are affected by most forms of human impacts and integrate ecological processes of streams. The specific change of interest will depend on the specific question being asked in relation to the land-use change being implemented, as the type, direction and magnitude of changes will depend on the specific type of land-use improvement. Regardless, it is critical that these changes are assessed against well-established baseline data, and the data provided in this report can serve as a starting point. Current and future threats to aquatic biodiversity associated with land-use and landscape composition are discussed, as well as potential ways of alleviating them, and recommendations for further research are given.

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1 Introduction

The landscape in the Wet Tropics has been transformed by agriculture. Extensive clearing and drainage of the coastal lowlands has caused changes in floodplain hydrology, destruction of wetlands, and loss of biodiversity (Armour *et al.* 2004, Weston & Goosem 2004). Off-farm export of major riverine contaminants – including nutrients, sediments and agricultural chemicals – has resulted in deterioration of water quality in the Wet Tropics catchments, causing degradation of riverine ecosystems and damage to the GBR (Baker 2003, Armour *et al.* 2004, Weston & Goosem 2004).

Profound changes in land management practices are on the horizon in the GBR region, because of severe economic pressure on the sugar industry, as well as implementation of strategies under the Reef Water Quality Protection Plan (RWQPP). Consequently, a window of opportunity is currently emerging to drive change in land management that will improve ecosystem health of Wet Tropics' rivers and the GBR.

A key benefit of sustainable management of Wet Tropics floodplains and improved water quality will be healthier aquatic ecosystems. Water-use benefits will be created where steps taken to improve water quality result in rehabilitation and greater resilience of ecosystem processes in floodplain rivers and wetlands, and therefore in conservation of aquatic biodiversity. In addition, freshwater and marine ecosystems are closely linked within the Wet Tropics catchments, with, for example, coastal floodplains and wetlands providing essential nursery habitat for a large number of fish and prawn species. Thus, a predictive understanding of aquatic ecosystem response to land-use and landscape change is a critical element of the linkage between catchment management and reef protection.

Managing aquatic environments for ecological sustainability requires an understanding of ecosystem structure and function, as well as their natural variability. For Wet Tropics river systems this knowledge is patchy and highly variable within and between catchment areas. Quantification of changes in Wet Tropics river ecology, including the distribution and functioning of aquatic ecosystem processes and biodiversity, is critical for rigorous evaluation of improvements to land-use practice and landscape composition. Such knowledge is fundamental to identify land management practices that contribute most to improving ecosystem health of Wet Tropics' rivers and the Great Barrier Reef, as well as to the viability of regional industries, including fisheries, which depend on these systems.

This review synthesises the available information on the distribution of aquatic biodiversity in the Douglas Shire catchments. This baseline synthesis of data will contribute to evaluation of future impacts of land-use and landscape change on Douglas Shire aquatic biodiversity. The review identifies knowledge gaps, and discusses impacts and threats to aquatic biodiversity, and potential ways of alleviating them, associated with land-use and landscape composition.

2 Methods

2.1 Study area

Douglas Shire contains four major catchments, the Daintree, Mossman and Mowbray rivers, and Saltwater Creek, with a total catchment area of ~1850 km² (Bartley *et al.* 2004a). The four catchments originate in the Wet Tropics World Heritage Area, and drain small, intensively farmed coastal floodplains before discharging into the Great Barrier Reef lagoon. Here, aquatic biodiversity of creeks draining into the Coral Sea between the Daintree River and Cape Tribulation is also considered, including Bailey, Buchanan, MacLean, Fairy, Hutchison, Mackenzie, Cooper, Noah, Myall and Mason Creeks. For ease of reference, these creeks are combined into Cape Tribulation streams.

Total catchment area of the Daintree River is approximately 1332 km² (Table 1). The coastal floodplain is dominated by grazing (3% of total catchment area) and sugar cane (1%) (Bartley *et al.* 2004a). The townships of Daintree (estimated population of 100) (Russell *et al.* 1998) and Wonga are the only population centres in the catchment. Saltwater Creek catchment comprises a total area of 136 km² (Table 1), with most of the coastal floodplain under intensive farming. The predominant land-uses are sugar cane (25% of the total catchment area) and small-scale horticulture (5%) (Bartley *et al.* 2004a, b). The township of Palm Beach is the only population centre in the catchment. The Mossman River catchment is approximately 208 km², with the coastal floodplain dominated by sugar cane (20% of the total catchment area, 4000 ha), and additional, minor areas taken up by horticulture (mainly papaw) (Bartley *et al.* 2004a). The town of Mossman (estimated population of 1600) (Russell *et al.* 1998), the coastal townships of Newell and Cooya Beach, and the Mossman Mill are located on the coastal floodplain. The total area of the Mowbray River catchment is 174 km² (Table 1). The coastal floodplain of the Mowbray River is dominated by sugar cane and grazing (Bartley *et al.* 2004a, b), and Port Douglas is located within this catchment. The remaining area of each catchment is mostly undeveloped forest or wetland, with 78% of Douglas Shire located within the Wet Tropics World Heritage Area (Bartley *et al.* 2004a).

Table 1. Total catchment area and mean annual discharge for each of the four main catchments in Douglas Shire.

| Catchment | Total catchment area (km ²) | Mean annual discharge (ML) |
|------------------------|---|----------------------------|
| Daintree River | 1,332 | 907,000 |
| Saltwater Creek | 136 | 46,000 |
| Mossman River | 208 | 224,000 |
| Mowbray River | 174 | 14,000 |
| Total | 1,850 | 1,191,000 |

Catchment areas from Bartley *et al.*, 2004a; discharge from: N. Searle, Department of Natural Resources, pers. comm. in Russell *et al.* 1998

2.2 Data sources on aquatic biodiversity

Information on species distribution in Douglas Shire catchments was obtained for aquatic macrophytes, aquatic invertebrates, fish, aquatic amphibians and reptiles, and aquatic mammals. Only coastal lowlands habitats at elevations from 0 – 400 m above sea level are considered here, encompassing both freshwater and estuarine environments of the study catchments. Neither birds nor terrestrial vegetation of freshwater and estuarine wetlands were considered here, as they are included in the Terrestrial Biodiversity review as part of Project Area C4.P1 of the Terrestrial Biodiversity Water Use Benefits crosscutting theme (D. Westcott, CSIRO Sustainable Ecosystems, pers. comm.).

Data were collated on species present within each catchment, including published scientific papers and reports, field guides, published reports from Rainforest Cooperative Research Centre, Qld Department of Primary Industries, records of the Queensland Museum and Queensland Herbarium, and unpublished CSIRO records. Database searches at the Queensland Museum and Queensland Herbarium were conducted within latitude 16°40' S to 16°05' S, and longitude 145°15' E to 145°40' E.

Distribution descriptions in general keys (e.g. Sainty & Jacobs 2003 – aquatic macrophytes, Allen *et al.* 2002 - fish, Cogger 1994, 2000 – amphibians and reptiles, etc.) sometimes suggested the presence of particular species in the study area. However, detailed studies conducted within the catchments of interest have not recorded some of these species (e.g. Russell *et al.* 1998, Jebreen *et al.* 2002, and Pusey *et al.* 2004 – fish, Williams *et al.*, 1996 –

amphibians, reptiles and mammals). In these cases, only records from detailed studies and museum and herbarium databases were included. Future studies may nevertheless reveal the presence of these species in the Douglas Shire catchments.

2.2.1 Aquatic macrophytes

Information on aquatic macrophytes was obtained from the Queensland Herbarium (HERBRECS). The record search in HERBRECS was based on all 48 family names listed in Sainty & Jacobs (2003), and subsequently limited within the relevant latitudes and longitudes. A total of 1667 records were obtained, which were subsequently cross-referenced against the species described in Sainty & Jacobs (2003), and Stephens & Dowling (2002). If present in either or both books, species were placed within the appropriate catchment based on the geographic information provided by HERBRECS. A few additional records were obtained from Russell *et al.* (1998) and personal observations. Because of their detrimental impact on aquatic ecosystems, exotic (ponded pasture) species were included in the list, if the presence of a particular species in a catchment could be confirmed.

2.2.2 Aquatic invertebrates

Information on aquatic invertebrates was primarily obtained from Pearson & Penridge (1979). Taxonomy and identifications were checked against Gooderham & Tsyrlin (2003).

2.2.3 Fish

Information on fish species distribution in Douglas Shire catchments were obtained primarily from Russell *et al.* (1998), Jebreen *et al.* (2002), and Pusey *et al.* (2004), and records from the Queensland Museum. The identity of some native taxa in certain locations is reported as “uncertain” by Pusey *et al.* (2004); these taxa have not been included here. Fish species that spend only a part of their life cycle in freshwater or estuarine environments were included, as much as this could be inferred from information currently available.

2.2.4 Aquatic amphibians and reptiles

Information on amphibian and reptile species distribution in Douglas Shire catchments was obtained primarily from Williams *et al.* (1996). Here, only amphibians and reptiles with a strong association with aquatic habitats are considered. Williams *et al.* (1996) use faunal zones modified from and defined by Winter *et al.* (1984), rather than single catchments. The two faunal zones of interest here are the Thornton lowlands, which overlap with the Cape Tribulation streams, and the Mossman lowlands, which include the Daintree, Mossman, and Mowbray River, and Saltwater Creek. The distribution of species recorded as present in either lowland (Williams *et al.* 1996) was subsequently checked against records from the Queensland Museum, and information from Hero & Fickling (1994), Cogger (1994, 2000), Barker *et al.* (1995), and websites from the Queensland Environmental Protection Agency (<http://www.epa.qld.gov.au>), Wet Tropics Management Authority (<http://www.wettropics.gov.au>), and Department of the Environment and Heritage (<http://www.deh.gov.au>), to include only those species occurring in lowlands and foothills (i.e. at altitudes ≤ 400 m).

2.2.5 Aquatic mammals

Information on the distribution of mammalian species in Douglas Shire catchments was obtained from Williams *et al.* (1996), as described for aquatic amphibians and reptiles. Additional information was obtained from Weston & Goosem (2004), and records from the Queensland Museum. Here, only mammals with a strong association with aquatic habitats are considered.

3 Results

3.1 Aquatic biodiversity

A total of 348 aquatic taxa have currently been documented in the catchments of Douglas Shire (Table 2). These taxa include some species that are endemic to the Wet Tropics region, but none of the taxa are endemic to the catchments reviewed here. Fish are the most commonly recorded taxa, followed by aquatic invertebrates, amphibians and reptiles, macrophytes and mammals. At least twelve of these species are exotic (species introduced from overseas). Translocated species (native species from other catchments) were not differentiated as such here.

Table 2. Summary of overall aquatic biodiversity and number of species currently documented in the coastal lowlands of Douglas Shire catchments.

| Group | Number of species | Number of introduced species |
|-----------------------|-------------------|------------------------------|
| Macrophytes | 27 (+4)* | 8 (+4)* |
| Invertebrates | 105 (taxa) | unknown |
| Fish | 180 | 3 |
| Amphibians & reptiles | 33 | 1 |
| Mammals | 3 | 0 |
| Total | 348 (+4)* | 12 (+4)* |

* four additional species of exotic aquatic macrophytes are present in aquatic systems in Douglas Shire outside the catchments reviewed in this desktop study. See text for details.

3.1.1 Aquatic macrophytes

Twenty-seven aquatic macrophyte species in 13 families have been documented in the catchments of Douglas Shire (Table 3); 4 in Cape Tribulation streams, 17 in the Daintree River, 8 in Saltwater Creek (+ 1 probable occurrence), 5 in the Mossman River (+ 1 probable occurrence), and 5 in the Mowbray River. Eight of these 27 species are introduced in Queensland, including Singapore daisy (*Sphagneticola trilobata*), Taro (*Colocasia esculenta*), a sedge (*Cyperus involucratus*), Awnless barnyard grass (*Echinochloa colona*), Hymenachne (*Hymenachne acutigluma*), Paragrass (*Urochloa (= Brachiaria) mutica*), Northern cow cane (*Mnesithea rottboellioides*), and Guinea grass (*Panicum* spp.).

In addition to these species, Werren (2001) lists seven exotic aquatic macrophytes (excluding ponded pasture species) known to have naturalised in the Wet Tropics region. Four of these occur in Douglas Shire but not in the main catchments: a small infestation of Alligator weed (*Alternanthera philoxeroides*) occurs in resort ponds in Port Douglas, Salvinia (*Salvinia molesta*) occurs in waterways draining into Dickinson Inlet, and Water hyacinth (*Eichhornia crassipes*), Water lettuce (*Pistia stratiotes*), and Salvinia (as well as Hymenachne) occur in the swale creeks at Wonga Beach (P. Logan, Douglas Shire Council, pers. comm.). The remaining three species listed by Werren (2001), Cambomba (*Cambomba caroliniana*), Pondweed (*Elodea canadensis*), and Arrowhead (*Sagittaria graminea* spp. *platyphylla*) have not been documented in Douglas Shire at all (P. Logan, Douglas Shire Council, pers. comm.).

3.1.2 Aquatic invertebrates

One hundred and five taxa of aquatic invertebrates have been documented in the catchments of Douglas Shire (Table 4); 54 in Daintree River, and 87 in Mossman River. The taxa included annelids, molluscs, crustaceans, and insects. No data could be retrieved on aquatic invertebrates from the other catchments.

3.1.3 Fish

A total of 180 fish species in 52 families have been documented in the catchments of Douglas Shire (Table 5); 15 in Cape Tribulation streams, 164 in the Daintree River, 52 in Saltwater Creek, 48 in Mossman River, and 37 in Mowbray River. Fifty-seven of these 180 species are currently un-identified, and may comprise either new or already known species. For 125 out of the 180 species, the affinity with a particular environment (freshwater, brackish, marine) is known. Twenty-one (17%) are obligate freshwater species and 17 (14%) are obligate marine species. The remaining 87 species (70%) occur in a combination of floodplain environments, with 12 (10%) occurring in fresh and brackish water, 29 (23%) in brackish and marine water, and 46 (37%) in fresh, brackish and marine water. Three out of the 180 species have been introduced to the Douglas Shire catchments (not including translocations, see Burrows 2004), comprising the guppy, green swordtail, and tilapia.

3.1.4 Aquatic amphibians and reptiles

Thirty-three species of aquatic amphibians and reptiles have been documented in the catchments of Douglas Shire (Table 6); 27 in Cape Tribulation streams (+ 2 probable occurrences), 32 in Daintree River (+ 1 probable occurrence), and 33 in Saltwater Creek, and Mossman and Mowbray rivers (+ 1 probable occurrence). The species consist of 23 frogs, 1 crocodile, 1 turtle, 1 water dragon, 1 skink, 2 pythons, 3 other snakes, and the exotic cane toad.

3.1.5 Aquatic mammals

Three species of aquatic mammals have been documented in the catchments of Douglas Shire (Table 7), with four additional species possibly occurring in at least the Daintree estuary. The platypus, pond bat and water rat have all been documented in Cape Tribulation streams, but only the water rat has also been documented in the other catchments. Three species of dolphin (Irrawaddy river dolphin, Indo-Pacific humpback dolphin, Bottlenose dolphin) as well as dugong use estuarine and inshore habitats, however, no data could be retrieved on definite records of these species in the catchments of interest.

Table 3. Aquatic macrophyte distributions within Douglas Shire catchments. Environment indicates the aquatic habitat a species may be found (F = freshwater, B = brackish). Empty cells indicate that information is not available, P indicates probable occurrence, and # indicates exotic species. List compiled from sources outlined in text.

| Family | Scientific Name | Common Name | Environment | Douglas Shire catchments | | | | |
|-------------------------|--|------------------------|-------------|--------------------------|----------------|-----------------|---------------|---------------|
| | | | | Cape Tribulation | Daintree river | Saltwater Creek | Mossman river | Mowbray river |
| Aponogetonaceae | <i>Aponogeton vanbruggenii</i> | | F | | | P | P | |
| Araceae | <i>Colocasia esculenta</i> # | Taro | F | | | * | | |
| Asteraceae | <i>Eclipta prostrata</i> | White eclipta | F | * | * | | | |
| | <i>Sphagneticola trilobata</i> # | Singapore daisy | F | | * | * | * | |
| Characeae | <i>Chara</i> spp. | Chara, stonewort | F | | | | | * |
| Cyperaceae | <i>Cyperus digitatus</i> | | F | | * | | | |
| | <i>Cyperus involucratus</i> # | | F | | | | * | |
| | <i>Cyperus polystachyos</i> | Bunchy sedge | F | | * | | | |
| | <i>Cyperus trinervis</i> | | F | | * | | * | |
| | <i>Schoenoplectus mucronatus</i> | Schoenoplectus | F | | * | | | |
| Hydrocharitaceae | <i>Blyxa aubertii</i> var. <i>aubertii</i> | Blyxa | F | * | * | * | * | * |
| | <i>Hydrilla verticillata</i> | Hydrilla | F | | * | * | | |
| | <i>Vallisneria nana</i> | Ribbonweed | F | | * | | | * |
| Myrtaceae | <i>Melaleuca quinquenervia</i> | Paperbark | F - B | | | * | | |
| Najadaceae | <i>Naja tenuifolia</i> | Water nymph | F | | * | | | |
| Nymphaeaceae | <i>Nymphaea nouchali</i> | Tiny waterlily | F | | * | | | |
| Onagraceae | <i>Ludwigia octovalvis</i> | Willow primrose | F | * | | | | |
| Philydraceae | <i>Philydrum lanuginosum</i> | Frogsmouth | F | | | * | | |
| Poaceae | <i>Echinochloa colona</i> # | Awnless barnyard grass | F | * | | | | |
| | <i>Hymenachne acutigluma</i> | Hymenachne | F | | * | | | |
| | <i>Hymenachne amplexicaulis</i> # | Hymenachne | F | | * | | | |
| | <i>Leersia hexandra</i> | Swamp ricegrass | F | | | | | * |
| | <i>Mnesithea rottboellioides</i> # | Northern cow cane | F | | * | | | |
| | <i>Panicum</i> spp. # | Guinea grass | F | | * | * | | |
| | <i>Urochloa (= Brachiaria) mutica</i> # | Paragrass | F | | * | * | * | * |
| Pontederiaceae | <i>Monochoria cyanea</i> | Monochoria | F | | * | | | |
| | <i>Monochoria vaginalis</i> | | F | | * | | | |

Table 4. Aquatic invertebrate distributions within Douglas Shire catchments. Empty cells indicate that information is not available. For ease of reference, Family and Species are given in alphabetical order, rather than according to taxonomical relationships. List compiled from sources outlined in text.

| (Sub-) Phylum | Class | Common name | Taxa | Family | Scientific Name | Common Name | Douglas Shire catchments | | | |
|------------------|---------------------|---|---------------|-----------------|---|---|--------------------------|----------------|-----------------|---------------|
| | | | | | | | Cape Tribulation | Daintree river | Saltwater Creek | Mossman river |
| Porifera | - | Sponges | | | | | | | | * |
| Annelida | Polychaeta | Bristleworms | | | | | | * | | * |
| | Oligochaeta | Earthworms | | Naididae | <i>Branchiodrilus hortensis</i> | | | | | * |
| | | | | | <i>Nais</i> sp. | | | | | * |
| | | | | | <i>Nais</i> 1 | | | | | * |
| | | | | | <i>Pristina</i> 1 | | | | | * |
| | | | | | <i>Pristina</i> 2 | | | | | * |
| | | | | Tubificidae | <i>Limnodrilus hoffmeisteri</i> | | | * | | * |
| | Hirudinea | Leeches | | | | | | | | |
| Mollusca | Bivalvia | Mussels | | | | | | * | | * |
| | Gastropoda | Snails | | - | - | Undescribed Gastropoda | | | | * |
| | | | | Hydrobiidae | <i>Potamopyrgus</i> sp. | | | | | * |
| | | | | Thiaridae | <i>Stenomelania</i> sp. | | | * | | * |
| | | | | | <i>Pupiphyrx</i> * | | | * | | |
| | | | | | <i>Thiara</i> sp. | | | * | | |
| | | | | Vivparidae | <i>Bithynia</i> sp. (formerly <i>Gabbia</i>) | | | | | * |
| Crustacea | | | | | | | | | | |
| | Malacostraca | | Isopoda | | | Water slaters | | | | |
| | | Crabs, shrimp, krill, pill bugs, and relatives | | | | Undescribed Isopoda | | | | * |
| | | | Anthuridea | Anthuridae | | | | * | | |
| | | | Flabellifera | | | | | | | |
| | | | | Cirolanidae | <i>Cirolana</i> sp. | | | * | | * |
| | | | | Sphaeromatidae | <i>Sphaeroma</i> sp. | Marine pill bugs | | * | | * |
| | | | | - | - | Other Flabellifera | | * | | * |
| | | | Amphipoda | | | Side swimmers | | | | |
| | | | Gammaridea | | | Undescribed Gammaridea | | | | * |
| | | | Gammaridea 1 | | | | | * | | |
| | | | Gammaridea 2 | | | | | * | | |
| | | | Gammaridea 3 | | | | | | | |
| | | | Gammaridea 4 | | | | | * | | * |
| | | | Gammaridea 5 | | | | | * | | |
| | | | Gammaridea 6 | | | | | | | |
| | | | Gammaridea 7 | | | | | | | |
| | | | Gammaridea 8 | | | | | | | |
| | | | Gammaridea 9 | | | | | * | | * |
| | | | Gammaridea 10 | | | | | * | | |
| | | | Gammaridea 11 | | | | | | | |
| | | | Gammaridea 12 | | | | | | | |
| | | | Gammaridea 13 | | | | | * | | |
| | | | Decapoda | | | Freshwater shrimp, prawns, crabs and crayfish | | | | |
| | | | | Atyidae | <i>Caradina</i> | Undescribed Caradina | | | | * |
| | | | | | <i>Caridina nilotica</i> | | | * | | * |
| | | | | | <i>Caridina gracilirostris</i> | | | * | | * |
| | | | | | <i>Caradina</i> 1 | | | * | | * |
| | | | | Hymenosomatidae | | Spider crabs | | * | | * |

Table 4. Aquatic invertebrate distributions within Douglas Shire catchments (con't)

| (Sub-) Phylum | Class | Common name | Taxa | Family | Scientific Name | Common Name | Douglas Shire catchments | | | | | | |
|--------------------------|-----------------------------|---|------------------|-----------------------------|--|----------------------------------|--------------------------|------------------------|-------------------------|---------------|---|---|---|
| | | | | | | | Cape Tribulation | Daintree river | Saltwater Creek | Mossman river | | | |
| Crustacea (con't) | Malacostraca (con't) | Crabs, shrimp, krill, pill bugs, and relatives (con't) | Decapoda (con't) | Palaemonidae | <i>Macrobrachium</i> | Undescribed <i>Macrobrachium</i> | | | | * | | | |
| | | | | | <i>Macrobrachium latidactylus</i> | | | * | | * | | | |
| | | | | | <i>Macrobrachium tolmerum</i> | | | * | | * | | | |
| | | | | | <i>Macrobrachium atactum ischnomorphum</i> | | | * | | * | | | |
| | | | | | Penaeidae | Prawns | | * | | * | | | |
| | | | | | <i>Metapenaeus ensis</i> | Red endeavour prawn | | * | | | | | |
| | | | | | <i>Metapenaeus endeavouri</i> | Blue endeavour prawn | | * | | | | | |
| | | | | | <i>Metapenaeus</i> sp. | Unknown endeavour prawn | | * | | | | | |
| | | | | | <i>Penaeus esculentus</i> | Tiger prawn | | * | | | | | |
| | | | | | <i>Penaeus latisulcatus</i> | Western king prawn | | * | | | | | |
| | | | | <i>Penaeus merguensis</i> | Banana prawn | | * | | | | | | |
| | | | | <i>Penaeus monodon</i> | Giant tiger prawn | | * | | | | | | |
| | | | | <i>Penaeus semisulcatus</i> | Grooved tiger prawn | | * | | | | | | |
| | | | | <i>Penaeus</i> sp. | Unknow prawn | | * | | | | | | |
| | | | | - | - | - | - | Other Decapoda | | | * | | |
| | | | | - | - | - | - | Other Decapoda | | | * | | |
| | | | | | Tanaidacea | | | Undescribed Tanaidacea | | | * | | |
| | | | | | | Apseudidae | | | | | * | | |
| | | | | | | Tanaidae | | | | * | * | | |
| | | | | Maxillopoda | | Branchiura | | | Fish lice | | * | | |
| Hexapoda | Insecta | Insects | Collembola | Springtails | | | | | | * | | | |
| | | | Lepidoptera | | | | Butterflies, moths | | | | | | |
| | | | | Pyralidae | | | | Pyralid moths | | * | | * | |
| | | | | Neuroptera | - | - | - | Undescribed Neuroptera | | | | * | |
| | | | | Coleoptera | | | | Beetles | | | | | |
| | | | | | | Helminthidae | | | Riffle beetles | | * | | * |
| | | | | | | Psephenidae | | | | | | * | |
| | | | | | | - | - | - | Other larval Coleoptera | | | * | |
| | | | | | | - | - | - | Other adult Coleoptera | | | * | |
| | | | | | | Diptera | | | Flies, true flies | | | | |
| | | | | | | Nematocera | | | | | | | |
| | | | | | | | Ceratopogonidae | | | | * | | * |
| | | | | | | | Chironomidae 1 | | | | * | | * |
| | | | | | | | Chironomidae 2 | | | | * | | * |
| | | | | | | | Chironomidae 3 | | | | * | | * |
| | | | | | | | Chironomidae 4 | | | | * | | * |
| | | | | | | | Chironomidae 5 | | | | * | | * |
| | | | | | | | Chironomidae 6 | | | | * | | * |
| | | | | | | | Chironomidae 7 | | | | * | | * |
| | | | | | | | Chironomidae 8 | | | | * | | * |
| | | | | Chironomidae 9 | | | | * | | * | | | |
| | | | | Chironomidae 10 | | | | * | | * | | | |
| | | | | Chironomidae pupae | | | | * | | * | | | |
| | | | - | - | - | Other Nematocera | | * | | * | | | |

Table 4. Aquatic invertebrate distributions within Douglas Shire catchments (con't).

| (Sub-) Phylum | Class | Common name | Taxa | Family | Scientific Name | Common Name | Douglas Shire catchments | | | | | |
|------------------|-----------------|-----------------|------------|------------------|---------------------------------|-------------|--------------------------|---------------------------------|-----------------|---------------|---|---|
| | | | | | | | Cape Tribulation | Daintree river | Saltwater Creek | Mossman river | | |
| Hexapoda (con't) | Insecta (con't) | Insects (con't) | Brachycera | | | | | * | | * | | |
| | | | | | - | - | Undescribed Diptera | | | | * | |
| | | | Hemiptera | | | | True bugs | | | | | |
| | | | | Cryptocerata | Corixidae | | | | | * | | * |
| | | | | | Nepidae | | <i>Ranatra sp.</i> | Water scorpions and needle bugs | | | | * |
| | | | | | Notonectidae | | <i>Enithares sp.</i> | Backswimmers | | | | * |
| | | | | | | - | - | Undescribed species | | | | * |
| | | | | Gymnocerata | | - | - | | | * | | * |
| | | | | Odonata | | | | Damselflies, dragonflies | | | | |
| | | | | | | | Amphipterygidae | | | | | * |
| | | | | | | | Coenagrionidae | | | * | | * |
| | | | | | | | Corduliidae | | | | | * |
| | | | | | | | Gomphidae | | | * | | * |
| | | | | | | - | - | Undescribed Odonata | | | | * |
| | | | | | Ephemeroptera | | | Mayflies | | | | |
| | | | | | | | Baetidae | <i>Bungona sp.</i> | | | | * |
| | | | | | | | | <i>Cloeon sp.</i> | | | | * |
| | | | | | | | | <i>Pseudocloeon sp.</i> | | | | * |
| | | | | | | | Caenidae | <i>Tasmanocoenis 1</i> | | * | | * |
| | | | | | | | | <i>Tasmanocoenis 2</i> | | | | * |
| | | | | | | | Leptophlebiidae | <i>Atalophlebioides 1</i> | | | | * |
| | | | | | | | | <i>Atalophlebioides 2</i> | | | | * |
| | | | | | | | | <i>Atalophlebioides 3</i> | | | | * |
| | | | | | | | | <i>Atalophlebia 1</i> | | | | * |
| | | | | | | | | <i>Atalophlebia 2</i> | | | | * |
| | | | | | | | | <i>Jappa sp.</i> | | | | * |
| | | | | | | - | - | Undescribed Ephemeroptera | | | | * |
| | | | | | Plecoptera | | | Stoneflies | | | | |
| | | | | | | | Eustheniidae | | | | | * |
| | | | | | Trichoptera | | | Caddisflies | | | | |
| | | | | Helicopsychidae | | | | | * | | | |
| | | | | Leptoceridae | | | * | | * | | | |
| | | | | Psychomiidae | | | | | * | | | |
| | | | | Rhyacophilidae | | | | | * | | | |
| | | | | Sericostomatidae | | | | | * | | | |
| | | | | Tasimiidae | | | | | * | | | |
| | | | - | - | Undescribed Trichoptera species | | | | * | | | |

Table 5. Fish distributions within Douglas Shire catchments. Environment indicates the aquatic habitat a species may be found (F = freshwater, B = brackish, M = Marine); a question mark means that environment is uncertain. Empty cells indicate that species are most likely absent from that catchment; # indicates exotic species. For ease of reference, Family and Species are given in alphabetical order, rather than according to taxonomical relationships. List compiled from sources outlined in text.

| Family | Common name | Scientific Name | Common Name | Environment | Douglas Shire catchments | | | |
|-----------------------|-------------------------------|-----------------------------------|------------------------------|-------------|--------------------------|----------------|-----------------|---------------|
| | | | | | Cape Tribulation | Daintree river | Saltwater Creek | Mossman river |
| Anguillidae | Eels | <i>Anguilla obscura</i> | Pacific short-finned eel | F - B - M | * | * | * | * |
| | | <i>Anguilla reinhardtii</i> | Long-finned eel | F - B - M | * | * | * | * |
| Apogonidae | Cardinal fishes | <i>Apogon ceramensis</i> | Ceram cardinalfish | M | | * | | |
| | | <i>Apogon hyalosoma</i> | Mangrove cardinalfish | F - B - M | | * | | |
| | | Apogonidae sp. | un-identified cardinalfish | ? | | * | | |
| | | <i>Glossamia aprion</i> | Mouth almighty | F | | * | * | * |
| Atherinidae | Hardyheads | <i>Atherinomorus lacunosus</i> | Slender hardyhead | M | | * | | |
| Belonidae | Needlefishes | <i>Tylosurus crocodilus</i> | Hound needlefish | M | | * | | |
| | | <i>Tylosurus strongylura</i> | Spottail needlefish | B - M | | | * | |
| Bothidae | Lefteye flounders | <i>Bothidae</i> sp. | un-identified flounder | ? | | * | | |
| Carangidae | Jacks, pompanos | <i>Alectis indicus</i> | Diamond trevally | B - M | | | | |
| | | <i>Caranx ignobilis</i> | Giant trevally | B - M | | * | | |
| | | <i>Caranx sexfasciatus</i> | Bigeye trevally | F - B - M | | * | * | |
| | | <i>Carangidae</i> sp. | un-identified trevally | ? | | * | | |
| Centropomidae | Barramundi | <i>Lates calcarifer</i> | Barramundi | F - B - M | | * | * | |
| Chandidae | Glass perchlets | <i>Ambassis agassizi</i> | Agassiz's glass perchlet | F | | | | |
| | | <i>Ambassis agrammus</i> | Salifin glass perchlet | F | | * | | |
| | | <i>Ambassis gymnocephalus</i> | Glass perchlet | F - B - M | | * | * | |
| | | <i>Ambassis interruptus</i> | Long-spined glass perchlet | F - B - M | | * | | |
| | | <i>Ambassis miops</i> | Flag-tailed glass perchlet | F - B - M | | * | * | * |
| | | <i>Ambassis</i> sp. | un-identified glass perchlet | ? | | * | | |
| Chanidae | Milkfish | <i>Ambassis vachellii</i> | Vachelli's glass perchlet | F - B - M | | * | * | |
| | | <i>Chanos chanos</i> | Milkfish | F - B - M | | | | |
| Chirocentridae | Wolf herring | <i>Chirocentrus dorab</i> | Wolf herring | B - M | | | | |
| Cichlidae | Cichlids | <i>Oreochromis mossambica</i> # | Tilapia | F - B | | * | * | |
| Clupeidae | Herring | <i>Clupeidae</i> sp. | Herring | ? | | * | | |
| | | <i>Herklotsichthys castelnaui</i> | Southern herring | F - B - M | | * | * | |
| | | <i>Herklotsichthys</i> sp. | Herring | ? | | * | | |
| | | <i>Nematalosa come</i> | Saltwater bony bream | M | | * | * | |
| | | <i>Nematalosa erebi</i> | Bony bream | F - B | | * | | |
| | | <i>Nematalosa</i> sp. | Bream | ? | | * | | |
| Cynoglossidae | Tonguefishes | <i>Sardinella</i> sp. | Herring | ? | | * | | |
| | | <i>Cynoglossus</i> sp. | un-identified sole | ? | | * | | |
| | | <i>Paraplagusia guttata</i> | | M | | * | | |
| | | <i>Paraplagusia</i> sp. | un-identified sole | ? | | * | | |
| Drepaneidae | Sicklefishes | <i>Drepane punctata</i> | Spotted sicklefish | B - M | | * | * | |
| Ephippidae | Spadefishes, batfishes | <i>Zabidius novemaculeatus</i> | Ninespine batfish | M | | * | | |

Table 5. Fish distributions within Douglas Shire catchments (con't).

| Family | Common name | Scientific Name | Common Name | Environment | Douglas Shire catchments | | | |
|---------------------------------|-------------------------------|---|---------------------------|-------------|--------------------------|----------------|-----------------|---------------|
| | | | | | Cape Tribulation | Daintree river | Saltwater Creek | Mossman river |
| Engraulidae | Anchovies | <i>Stolephorus</i> sp. | un-identified anchovy | ? | | * | | |
| | | <i>Thrissa hamiltoni</i> | Hamilton's anchovy | B - M | | * | | * |
| Gerreidae | Silver biddies | <i>Gerres abbreviatus</i> | Short silver bidy | B - M | | * | | |
| | | <i>Gerres erythrourus</i> | Deep-bodied silver bidy | B - M | | * | | |
| | | <i>Gerres filamentosus</i> | Threadfin silver bidy | F - B - M | | * | * | * |
| | | <i>Gerres oyena</i> (= <i>splendens</i>) | Common silver bidy | B - M | | * | | |
| | | <i>Gerres</i> sp. | un-identified silver bidy | ? | | * | | |
| Gobiidae | Gobies | <i>Acentrogobius multifasciatus</i> | | M | | * | | |
| | | <i>Acentrogobius</i> sp. | un-identified goby | ? | | * | | |
| | | <i>Apocryptodon madurensis</i> | | F - B - M | | * | | |
| | | <i>Awaous acritosus</i> | Roman-nosed goby | F | | * | * | * |
| | | <i>Callogobius</i> sp. | un-identified goby | ? | | * | | |
| | | <i>Cryptocentrus</i> sp. | un-identified goby | ? | | * | | |
| | | <i>Drombus globiceps</i> | | F - B - M | | * | | |
| | | <i>Drombus</i> sp. | un-identified goby | ? | | * | | |
| | | <i>Favonigobius exquisitus</i> | Exquisite sand-goby | B - M | | * | | |
| | | <i>Favonigobius</i> sp. | un-identified goby | ? | | * | | |
| | | <i>Glossogobius biocellatus</i> | Sleepy goby | B - M | | * | | |
| | | <i>Glossogobius bicirrhosus</i> | Bearded goby | F - B | | * | | |
| | | <i>Glossogobius circumspectus</i> | Circumspect goby | F | | * | | |
| | | <i>Glossogobius giurus</i> | Flathead goby | F - B - M | | * | * | |
| | | <i>Glossogobius</i> sp 1 | False Celebes goby | F | * | * | | * |
| | | <i>Glossogobius</i> sp 3 | | ? | | | * | |
| | | <i>Glossogobius</i> sp 4 | Mulgrave goby | F | | | * | |
| | | <i>Glossogobius</i> sp C | Square blotched goby | ? | | * | | |
| | | <i>Glossogobius</i> sp. | un-identified goby | ? | | * | * | * |
| | | <i>Gobiidae</i> sp. | un-identified goby | ? | | * | * | |
| | | <i>Mahidolia mystacina</i> | Flagfin prawn goby | B - M | | * | | |
| <i>Mugilogobius notospilus</i> | Pacific mangrove goby | F - B - M | | * | | | | |
| <i>Mugilogobius</i> sp. | un-identified goby | ? | | * | | | | |
| <i>Periophthalmus</i> sp. | un-identified mudskipper | ? | | | * | | | |
| <i>Psammogobius biocellatus</i> | Mangrove goby | F - B | | * | | * | | |
| <i>Redigobius bikolanus</i> | Speckled goby | F - B - M | * | * | * | * | | |
| <i>Redigobius chrysosoma</i> | Spotfin goby | F - B | | * | | | | |
| <i>Schismatogobius</i> sp. | un-identified scaleless goby | ? | | * | * | * | | |
| <i>Sicyopterus lagocephalus</i> | Rabbithead cling-goby | F - B - M | | * | | | | |
| <i>Sicyopterus</i> sp. | un-identified cling-goby | ? | | * | | | | |
| | <i>Yongeichthys nebulosus</i> | Shadow goby | F - B - M | | * | | | |

Table 5. Fish distributions within Douglas Shire catchments (con't).

| Family | Common name | Scientific Name | Common Name | Environment | Douglas Shire catchments | | | |
|----------------------------|--------------------|---|---------------------------|--------------------------------|--------------------------|----------------|-----------------|---------------|
| | | | | | Cape Tribulation | Daintree river | Saltwater Creek | Mossman river |
| Gobiidae | Gudgeons | <i>Bunaka gyrinoides</i> | Greenback gaudina | F | * | * | * | * |
| | | <i>Butis butis</i> | Crimson-tipped gudgeon | F - B - M | | * | | |
| | | <i>Eleotris acanthopoma</i> | Spinecheek gudgeon | F - B - M | | * | | |
| | | <i>Eleotris fusca</i> | Brown gudgeon | F - B - M | * | * | * | * |
| | | <i>Eleotris melanosoma</i> | Ebony gudgeon | F - B - M | | * | * | * |
| | | <i>Eleotris</i> sp. | un-identified gudgeon | ? | | * | | |
| | | <i>Giurus margaritacea</i> | Snakehead gudgeon | F - B - M | * | * | * | * |
| | | <i>Hypseleotris compressa</i> | Empirefish | F | * | * | * | * |
| | | <i>Hypseleotris</i> sp. | un-identified gudgeon | ? | | * | | |
| | | <i>Mogurnda adspersa</i> | Purple-spotted gudgeon | F | | * | * | * |
| | | <i>Mogurnda</i> sp. | un-identified gudgeon | F | | * | | |
| | | <i>Ophiocara porocephala</i> | Spangled gudgeon | F - B - M | * | * | | |
| | | <i>Oxyeleotris lineolatus</i> | Sleepy cod | F | | * | | |
| | | Haemulidae | Grunters | <i>Plectorhinchus gibbosus</i> | Sweetlip | F - B - M | | * |
| <i>Pomadasyg argenteus</i> | Silver grunter | | | F - B - M | | * | | |
| <i>Pomadasyg kaakan</i> | Javelin grunter | | | B - M | | * | | |
| Hemiramphidae | Halfbeaks | <i>Arrhamphus sclerolepis sclerolepis</i> | Snub-nosed garfish | F - B - M | | * | * | |
| | | <i>Hyporamphus regularis ardelio</i> | Eastern river garfish | F - B - M | | * | | |
| | | <i>Hyporamphus</i> sp. | un-identified garfish | ? | | * | | |
| Kuhliidae | Flag tails | <i>Kuhlia marginata</i> | Red-margined jungle perch | F | * | * | * | |
| | | <i>Kuhlia rupestris</i> | Jungle perch | F - B - M | * | * | * | |
| Leiognathidae | Ponyfishes | <i>Gazza minuta</i> | Toothpony | B - M | | * | | |
| | | <i>Leiognathus decorus</i> | Decorated ponyfish | B - M | | * | * | |
| | | <i>Leiognathus equulus</i> | Common ponyfish | F - B - M | | * | * | |
| | | <i>Leiognathus fasciatus</i> | Striped ponyfish | B - M | | * | | |
| | | <i>Leiognathus smithursti</i> | Smithurst's ponyfish | M | | * | * | |
| | | <i>Leiognathus splendens</i> | Splendid ponyfish | B - M | | * | | |
| | | <i>Leiognathus</i> sp. | un-identified ponyfish | ? | | * | | |
| | | <i>Secutor ruconius</i> | Pig-nosed ponyfish | F - B - M | | * | | |
| Lethrinidae | Emperors | <i>Lethrinus</i> sp. | un-identified sweetlip | ? | | * | | |
| Lutjanidae | Snappers | <i>Lutjanus argentimaculatus</i> | Mangrove jack | F - B - M | | * | * | |
| | | <i>Lutjanus fluviflamma</i> | Dory snapper | B - M | | * | | |
| | | <i>Lutjanus russelli</i> | Russell's snapper | B - M | | * | * | |
| | | <i>Lutjanus</i> sp. | Snapper species | ? | | * | | |
| Megalopidae | Tarpon | <i>Megalops cyprinoides</i> | Tarpon, Oxeye herring | F - B - M | * | * | * | |
| Melanotaeniidae | Rainbowfish | <i>Melanotaenia maccullochi</i> | McCulloch's rainbowfish | F | | * | | |
| | | <i>Melanotaenia splendida splendida</i> | Eastern rainbowfish | F | * | * | * | |

Table 5. Fish distributions within Douglas Shire catchments (con't).

| Family | Common name | Scientific Name | Common Name | Environment | Douglas Shire catchments | | | |
|------------------------|------------------------------|---|---------------------------|-------------|--------------------------|----------------|-----------------|---------------|
| | | | | | Cape Tribulation | Daintree river | Saltwater Creek | Mossman river |
| Monodactylidae | Diamondfishes | <i>Monodactylus argenteus</i> | Diamond fish | F - B - M | | | | |
| Mugilidae | Mullet | <i>Liza subviridis</i> (= <i>dussumieri</i>) | Greenback mullet | F - B - M | | * | | |
| | | <i>Liza vaigiensis</i> | Squartail mullet | B - M | | | * | * |
| | | <i>Mugil cephalus</i> | Sea mullet | F - B - M | | * | | |
| | | Mugilidae sp. | un-identified mullet | ? | | * | | |
| | | <i>Valamugil buchanani</i> | Bluetail mullet | F - B - M | | * | * | * |
| | | <i>Valamugil seheli</i> | Bluespot mullet | B - M | | * | | |
| Ophichthidae | Snake eels | <i>Ophichthidae</i> sp. | un-identified swamp eel | ? | | * | | |
| Paralichthyidae | Large-tooth flounders | <i>Pseudorhombus arsius</i> | Large-tooth flounder | B - M | | * | * | * |
| | | <i>Pseudorhombus elevatus</i> | Deep flounder | M | | * | | |
| | | <i>Pseudorhombus</i> sp. | un-identified flounder | ? | | * | | |
| Platycephalidae | Flatheads | <i>Platycephalus fuscus</i> | Dusky flathead | B - M | | * | | |
| | | <i>Platycephalidae</i> sp. (juv) | un-identified flathead | ? | | | * | |
| Plotosidae | Eel tailed catfishes | <i>Neosilurus ater</i> | Black catfish, butter jew | F | | * | | |
| | | <i>Neosilurus</i> sp | un-identified catfish | ? | | | * | |
| | | <i>Porochilus rendahli</i> | Rendah's catfish | F | | * | | |
| | | <i>Tandanus tandanus</i> | Freshwater catfish | F | * | * | * | * |
| Poeciliidae | Life bearers | <i>Poecilia reticulata</i> [#] | Guppy | F - B | | * | * | |
| | | <i>Xiphophorus helleri</i> [#] | Green swordtail | F - B | | | * | |
| Pseudomugilidae | Blue-eyes | <i>Pseudomugil signifer</i> | Pacific blue-eye | F - B - M | * | * | * | |
| Scatophagidae | Scats | <i>Scatophagus argus</i> | Spotted scat | F - B - M | | * | | |
| | | <i>Scatophagus</i> sp. | un-identified scat | ? | | * | | |
| | | <i>Selenotoca multifasciata</i> | Banded scat | B - M | | * | | |
| Sciaenidae | Drums, croakers | <i>Nibea soldado</i> | Soldier croaker | F - B - M | | | * | |
| Scombridae | Queensfishes | <i>Scomberoides commersonianus</i> | Talang queenfish | B - M | | * | * | |
| | | <i>Scomberoides tala</i> | Barred queenfish | M | | * | * | |
| Synanceiidae | Stonefishes | <i>Minous versicolor</i> | Plum-striped waspfish | M | | * | | |
| Serranidae | Sea basses | <i>Serranidae</i> sp. | un-identified grouper | ? | | * | | |
| Siganidae | Spinefoot | <i>Siganus lineatus</i> | Golden-lined spinefoot | M | | * | | |
| | | <i>Siganus cf. spinus</i> | Little spinefoot | M | | * | | |
| | | <i>Siganus</i> sp. (juv.) | un-identified spinefoot | ? | | * | | |
| | | | | | | | | |
| Sillaginidae | Whiting | <i>Sillago sihama</i> | Silver sillago | B - M | | * | * | |
| | | <i>Sillago</i> sp. | un-identified whiting | ? | | * | | |
| Soleidae | Soles | <i>Brachius</i> (= <i>Dexillichthys</i>) <i>muelleri</i> | Tufted sole | M | | * | | |
| | | <i>Brachirus</i> sp. | un-identified sole | ? | | * | | |
| | | <i>Synaptura</i> sp. | un-identified sole | ? | | * | | |

Table 5. Fish distributions within Douglas Shire catchments (con't).

| Family | Common name | Scientific Name | Common Name | Environment | Douglas Shire catchments | | | |
|-----------------------|------------------------------|----------------------------------|---------------------------|-------------|--------------------------|----------------|-----------------|---------------|
| | | | | | Cape Tribulation | Daintree river | Saltwater Creek | Mossman river |
| Sparidae | Bream | <i>Acanthopagrus berda</i> | Pikey black bream | F - B - M | | * | * | |
| Sphyraenidae | Barracuda | <i>Sphyraena barracuda</i> | Giant barracuda | B - M | | * | | |
| | | <i>Sphyraena jello</i> | Slender barracuda | B - M | | | | |
| Symbranchidae | Swamp eels | <i>Ophisternon gutturale</i> | Australian swamp eel | F - B | | * | | * |
| | | <i>Ophisternon cf bengalense</i> | One-gilled eel | F - B | | | | * |
| | | <i>Ophisternon sp.</i> | un-identified swamp eel | ? | | * | * | |
| | | <i>Synbranchidae sp.</i> | un-identified swamp eel | ? | | * | * | * |
| Syngnathidae | Pipefishes, seahorses | <i>Hippichthys heptagonus</i> | Belly pipefish | F - B | | * | | |
| | | <i>Hippocampus sp.</i> | un-identified seahorse | ? | | * | | |
| | | <i>Syngnathidae sp</i> | un-identified pipefish | ? | | * | | |
| Synodontidae | Lizardfishes | <i>Synodus sp.</i> | un-identified lizardfish | ? | | * | | |
| | | <i>Synodus cf. variegatus</i> | Variegated lizardfish | M | | * | | |
| Terapontidae | Grunters | <i>Amniataba percoides</i> | Barred grunter | F | | * | | |
| | | <i>Hephaestus fuliginosus</i> | Sooty grunter | F | | * | | |
| | | <i>Hephaestus tulliensis</i> | Khaki grunter | F | | * | | |
| | | <i>Hephaestue sp.</i> | un-identified grunter | ? | | * | | |
| | | <i>Mesopristes argenteus</i> | Silver grunter | F - B - M | | * | * | |
| | | <i>Pelates quadrilineatus</i> | Fourlined terapon | B - M | | * | | |
| | | <i>Terapon puta</i> | Three-lined grunter | F - B - M | | * | | |
| | <i>Terapon sp.</i> | un-identified grunter | ? | | * | | | |
| Tetraodontidae | Toadfishes, puffers | <i>Chelonodon patoca</i> | Milk-spotted toadfish | F - B - M | | * | * | |
| | | <i>Lagocephalus sp.</i> | un-identified toadfish | ? | | * | | |
| | | <i>Marilyna sp.</i> | un-identified toadfish | ? | | * | | |
| | | <i>Torquigener pleurostictus</i> | Banded toadfish | ? | | * | | * |
| | | <i>Torquigener sp.</i> | un-identified toadfish | ? | | * | | |
| Tetrarogidae | Waspfishes | <i>Notesthes robusta</i> | Bullrout | F - B - M | | * | * | * |
| | | <i>Paracentropogon vespa</i> | Flecked waspfish | M | | * | | |
| | | <i>Paracentropogon sp.</i> | Waspfish | ? | | * | | |
| Toxotidae | Archerfishes | <i>Toxotes chatareus</i> | Seven-spot archerfish | F - B | | * | * | * |
| | | <i>Toxotes jaculatrix</i> | Banded archerfish | F - B | | * | | * |
| Triacanthidae | Triplespines | <i>Triacanthus biaculeatus</i> | Short-nosed tripodfish | M | | * | | |
| | | <i>Triacanthus sp.</i> | un-identified triplespine | ? | | * | | |

Table 6. Aquatic amphibian and reptile distributions within Douglas Shire catchments. Environment indicates the aquatic habitat a species may be found (F = freshwater, B = brackish, M = Marine). P indicates probably occurrence; - indicates no occurrence, # indicates exotic species. List compiled from sources outlined in text.

| Family | Common name | Scientific Name | Common Name* | Environment | Douglas Shire catchments | | | | |
|----------------------------------|---------------------------------|-------------------------------------|--------------------------|-----------------------------|--------------------------|----------------|-----------------|---------------|---------------|
| | | | | | Cape Tribulation | Daintree river | Saltwater Creek | Mossman river | Mowbray river |
| AMPHIBIANS | | | | | | | | | |
| Myobatrachidae | Australian froglets | <i>Limnodynastes convexiusculus</i> | Marbled frog | F | * | * | * | * | * |
| | | <i>Limnodynastes ornatus</i> | Ornate burrowing frog | F | P | * | * | * | * |
| | | <i>Limnodynastes peronii</i> | Brown-striped frog | F | * | * | * | * | * |
| | | <i>Mixophyes schevilli</i> | Northern barred-frog | F | * | * | * | * | * |
| Hylidae | Tree frogs | <i>Litoria bicolor</i> | Northern dwarf tree frog | F | - | * | * | * | * |
| | | <i>Litoria caerulea</i> | Green tree frog | F | * | * | * | * | * |
| | | <i>Litoria dorsalis</i> | Dwarf rocket frog | F | - | * | * | * | * |
| | | <i>Litoria fallax</i> | Eastern dwarf tree frog | F | * | * | * | * | * |
| | | <i>Litoria genimaculata</i> | Green-eyed treefrog | F | * | * | * | * | * |
| | | <i>Litoria gracilentia</i> | Dainty green tree frog | F | * | * | * | * | * |
| | | <i>Litoria infrafrenata</i> | Giant tree frog | F | * | * | * | * | * |
| | | <i>Litoria leseuri</i> | Leseur's frog | F | * | * | * | * | * |
| | | <i>Litoria nannotis</i> | Torrent tree frog | F | * | * | * | * | * |
| | | <i>Litoria nasuta</i> | Rocket frog | F | * | * | * | * | * |
| | | <i>Litoria nigrofrenata</i> | | F | - | * | * | * | * |
| | | <i>Litoria rheocola</i> | | F | * | * | * | * | * |
| | | <i>Litoria rothii</i> | | F | * | * | * | * | * |
| | | <i>Litoria rubella</i> | Desert tree frog | F | * | * | * | * | * |
| | | <i>Litoria xanthomera</i> | | F | * | * | * | * | * |
| | | <i>Nyctimistes dayi</i> | | F | * | * | * | * | * |
| | | Microhylidae | Small tree frogs | <i>Austrochaperina fryi</i> | | F | * | * | * |
| <i>Austrochaperina pluvialis</i> | | | | F | * | * | * | * | * |
| Ranidae | True frogs | <i>Rana daemeli</i> | Wood frog | F | * | * | * | * | * |
| Bufo | Toads | <i>Bufo marinus</i> # | Cane toad | F | * | * | * | * | * |
| REPTILES | | | | | | | | | |
| Crocodylidae | Crocodiles | <i>Crocodylus porosus</i> | Estuarine crocodile | F - B - M | * | * | * | * | * |
| Chelidae | Side-necked tortoises | <i>Elseya latisternum</i> | Saw-shelled turtle | F | * | * | * | * | * |
| Agamidae | Dragons | <i>Physignathus lesueurii</i> | Eastern water dragon | F | * | * | * | * | * |
| Scincidae | Skinks | <i>Eulamprus quoyii</i> | Eastern water skink | F | - | * | * | * | * |
| Boidae | Pythons | <i>Liasis fuscus</i> | Water python | F | P | P | P | P | P |
| | | <i>Morelia amethystina</i> | Amethystine python | F | * | * | * | * | * |
| Acrochordidae | Blind snakes | <i>Acrochordus granulatus</i> | Little file snake | F - B - M | * | * | * | * | * |
| Colubridae | Colubrid snakes | <i>Tropidonophis mairii</i> | Keelback | F | * | * | * | * | * |
| Elapidae | Front-fanged land snakes | <i>Pseudechis porphyriacus</i> | Red-bellied black snake | F | * | * | * | * | * |

Table 7. Aquatic mammal distributions within Douglas Shire catchments. Environment indicates the aquatic habitat a species may be found (F = freshwater, B = brackish, M = Marine). P indicates probable occurrence, empty cells means information is not available. List compiled from sources outlined in text.

| Family | Common name | Scientific Name | Common Name | Environment | Douglas Shire catchments | | | | |
|--------------------------|--------------------------|---------------------------------|-------------------------------|-------------|--------------------------|----------------|-----------------|---------------|---------------|
| | | | | | Cape Tribulation | Daintree river | Saltwater Creek | Mossman river | Mowbray river |
| Ornithorhynchidae | | <i>Ornithorhynchus anatinus</i> | Platypus | F | * | P | P | P | P |
| Vespertilionidae | | <i>Myotis adversus</i> | Pond bat | F | * | P | P | P | P |
| Muridae | Mice, rats, voles | <i>Hydromus chrysogaster</i> | Water rat | F | * | * | * | * | * |
| Delphinidae | Dolphins | <i>Orcaella brevirostris</i> | Irrawaddy river dolphin | F - B - M | | P | | | |
| | | <i>Sousa chinensis</i> | Indo-Pacific humpback dolphin | B - M | | P | | | |
| | | <i>Tursiops truncatus</i> | Bottlenose dolphin | B - M | | P | | | |
| Dugongidae | Dugong | <i>Dugong dugon</i> | Dugong | B - M | | P | | | |

4 Discussion

As is the case with terrestrial vertebrates across the Wet Tropics (Williams *et al.* 1996), knowledge on the distribution of aquatic biodiversity in Douglas Shire catchments is patchy and highly variable within and between taxonomic groups and catchments. In Douglas Shire catchments, the distributions of freshwater fish and amphibians are probably best documented, followed by aquatic reptiles, mammals, invertebrates, and macrophytes. In contrast, little information is available on the biology of estuarine and inshore fish species (Weston & Goosem 2004). Given the importance of many of these species to commercial, recreational and indigenous fisheries, this knowledge gap should be addressed to be able to implement those remediation actions that are most conducive to improving ecosystem health of Wet Tropics catchments and the GBR. Moreover, while this review focussed on Douglas Shire catchments, a larger review encompassing all Wet Tropics catchments should be conducted to enable rigorous evaluation of future impacts from of land-use and landscape change on aquatic biodiversity across the Wet Tropics.

The information presented here is based on presence / absence data. It is likely that with additional studies and research, new species, or an expansion of distribution ranges of aquatic plants, invertebrates and vertebrates will be identified. For example, the relatively low number of aquatic macrophyte species in the Douglas Shire catchments (Table 3) most likely reflects the low representation of aquatic plants in the Queensland Herbarium records, rather than the absence of particular species from the catchments. In addition, within the last 10 years, at least three new species of freshwater fish have been described in the Wet Tropics region: the Utchee Creek rainbowfish (*Melanotaenia utcheensis*, McGuigan 2001), Bloomfield River cod (*Guyu wujalwujalensis*, Pusey & Kennard 2001), and Khaki bream (*Hephaestus tulliensis*, Pusey 2001). Many other fish species are yet to be formally described, including a goby species captured in the Mossman River in March 2004 (F. Kroon, CSIRO Land and Water, unpublished data) which is part of the *Redigobius bikolanus* "species-complex" (H. Larson, Museum and Art Gallery of the Northern Territory, pers. comm.), as well as other rainbowfish, hardyheads and catfish (Pusey 2001). Only a few studies have been conducted on freshwater fish in Douglas Shire (Pusey & Kennard 1994, 1996, Russell *et al.* 1998), with two more currently being conducted (Fisheries long-term monitoring program, S. Helmke *et al.*, Qld Department of Primary Industries & Fisheries; Effectiveness of riparian restoration, F. Kroon, CSIRO Land and Water). Furthermore, the biodiversity of aquatic macrophytes in the Wet Tropics is currently being documented within the Rainforest CRC (Kapitzke & Arthington 2001). These current projects, as well as any upcoming ones, will most likely document additional species present in the coastal floodplains of Douglas Shire.

The information contained in this report can be utilised to assess which taxa may be most useful in evaluating future impacts of land-use and landscape changes. Both native and exotic species of aquatic macrophytes and fish occur in Douglas Shire (Table 3, 5). Moreover, most fish species occurring in Douglas Shire are known to species level (Pusey *et al.* 2004) and are abundant (Russell *et al.* 1998), while aquatic weeds in the region are well documented (Werren 2001) and abundant in land-use systems such as cane-land streams (e.g. Bunn *et al.* 1998). Thus, a comparison of distribution and abundance of pest and native species can be used to assess whether land-use practices have been effective in improving stream ecosystem health. With the possible exception of frogs, aquatic amphibians, reptiles and mammals may not be abundant enough in individual streams to be able to conduct statistically powerful comparisons. However, their distribution and abundance at a larger (sub-) catchment scale, in particular of top-predators such as estuarine crocodiles, could be used to assess as indicators of overall catchment health. While aquatic macro-invertebrates can be used as indicators of the ecological health of freshwater habitats (e.g. Gooderham & Tsyrlin 2003), the combination in Wet Tropics streams of extreme species richness (e.g. 267 taxa in one 50 m stretch of riffle of Yuccabine Creek, Herbert River), high temporal and

spatial variability at small scales, and numerous undescribed taxa (Pearson *et al.* 1986, Table 4) makes this a difficult group to use in evaluations, unless some key indicator species are established for Douglas Shire catchments.

To assess future impacts of land-use and landscape changes on aquatic biodiversity, different assessments of biodiversity can be used. This can include changes in species richness, distribution, diversity, and assemblage composition, as well as changes in presence / absence data. Of specific interest may be species that are endemic to the Wet Tropics, including fish species such as the Mulgrave goby (*Glossogobius* sp.4), Khaki grunter (*Hephaestus tulliensis*), and an undescribed scaleless goby (*Schismatogobius* sp.), or species listed as endangered in Queensland, such as the treefrogs *Litoria nannotis*, *L. rheocola*, and *Nyctimistes dayi*. The specific change of interest will depend on the specific question being asked in relation to the land-use change being implemented. For example, restoring riparian vegetation may result in reduced abundance and distribution of aquatic weeds (e.g. paragrass, Bunn *et al.* 1998) or exotic fish species (e.g. tilapia, Hogan & Vallance undated), while floodgate opening may result in increased fish species richness and diversity in waterways upstream (e.g. Kroon *et al.* 2004). Regardless, changes in relative abundances and assemblage composition is thought to provide a better reflection of overall aquatic ecosystem response than other measures (e.g. Fausch *et al.* 1990, Whitfield & Elliott 2002), because assemblage composition integrates the proportional contribution of each species to the total number of species present. Of all the taxa compiled here, fish would be most amenable to be used in assemblages assessments, as most species are known (Pusey *et al.* 2004) and fish sampling methods in this region are well established (e.g. Pusey & Kennard 1994, 1996, Russell *et al.* 1998, Jebreen *et al.* 2004). Moreover, fish provide a valuable tool to evaluate changes in aquatic ecosystem health, because they are affected by most forms of human impacts and integrate ecological processes of streams (Harris 1995). It is imperative that any assessment using fish considers the high β diversity of fish in Wet Tropics rivers, that is the high number of species that occur in one stream of a particular river system, but not in another (M. Kennard, Griffith University, pers. comm.; F. Kroon, CSIRO Land and Water, unpublished data).

Improved land-use management may result in changes in aquatic biodiversity in Douglas Shire, with the type, direction and magnitude of changes dependent on the specific type of land-use improvement. For changes in land management to be effective in improving aquatic ecosystem health, potential improvements for land-use (including “Best Management Practices”) should be examined in the context of reducing current and future impacts faced by aquatic biodiversity in Douglas Shire. It is critical that these changes are assessed against well-established baseline data, and the data provided in this report can serve as a starting point. Here, current threats of land-use to aquatic biodiversity in the Douglas Shire catchments, and potential ways of alleviating them, will be discussed, in particular water quality and quantity, and habitat condition (Table 8). Other threats to aquatic biodiversity in Douglas Shire, including relocation of native and exotic fish and invertebrate species by people (Arthington 1991, Armour *et al.* 2004, Burrows 2004), and recreational and commercial fishing (Armour *et al.* 2004) are discussed elsewhere.

4.1 Water quality and quantity

Land-use and landscape composition can impact on water quality and water quantity in various manners. Similarly to other coastal floodplains in the Wet Tropics, the coastal floodplains in Douglas Shire have been transformed by vegetation clearing and land management for sugar cane, horticulture and grazing, as well as urban development and associated non-agricultural industries (Armour *et al.* 2004, Weston & Goosem 2004). This has resulted in alteration of drainage patterns in the coastal floodplains, as well as a deterioration of water quality associated with land-use (Armour *et al.* 2004, Bartley *et al.* 2004a).

Table 8. Threats to aquatic biodiversity in Douglas Shire catchments, related to water quality, water quantity and habitat condition. * indicates that a particular threat can have a direct, detrimental impact on that particular group. Indirect effects, for example via food webs, are not considered here but can nevertheless be significant.

| Threat | Macrophytes | Invertebrates | Fish | Amphibians & reptiles | Mammals |
|--------------------------------|-------------|---------------|------|-----------------------|---------|
| Water quality | | | | | |
| Suspended sediment / turbidity | * | * | * | * | |
| Nutrients | * | | | | |
| Heavy metals and pesticides | * | * | * | * | * |
| Water treatment waste | * | * | * | * | * |
| Water quantity | | | | | |
| Altered flow paths | * | * | * | * | * |
| Habitat condition | | | | | |
| Drainage of floodplain habitat | * | * | * | * | * |
| Removal of riparian vegetation | * | * | * | * | * |
| Erosion & siltation | * | * | * | | |
| Straightening of streams | * | * | * | * | * |
| Barriers to migration | * | | * | | |
| Trampling by cattle | * | * | * | * | * |
| Off-stream mining | * | * | * | * | * |
| Exotic grasses and weeds | * | * | * | * | * |

4.1.1 Water quality

Aquatic ecosystems in the Wet Tropics, including aquatic biodiversity, can be affected by changes in water quality (e.g. Armour *et al.* 2004). Water quality guidelines for aquatic ecosystems in Australia are presented in the Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZECC 2000). However, the relevance of these for tropical catchments with highly seasonal rainfall has been called into question (e.g. B. Roberts, DSJVP, pers. comm.), and the relationships between water quality and condition of aquatic ecosystems are currently being reviewed for some GBR catchments (e.g. Kroon & Butler, CSIRO Land and Water & ACTFR, in prep.).

The most important water quality issue facing the Wet Tropics region is to achieve a reduction in nutrient inputs and sediment loads entering the Great Barrier Reef Marine Park from coastal catchments (Baker 2003). Consequently, a lot of effort has been going into modelling of nutrient and sediment sources and delivery within this region (e.g. Brodie *et al.* 2003). Estimates of relative contributions of N and P from different land-use categories to water quality in the GBR lagoon reveal that grazing contributes most to nutrients, followed by sugar cane, other crops and sewage (Armour *et al.* 2004). For the Douglas Shire catchments, Bartley *et al.* (2004a) estimated that, on a per area basis, fruit trees (which included bananas in this analysis), sclerophyll forest, grazing and rural / residential contribute the highest amount of sediment. While fruit trees currently only occupy less than 1% of these catchments, the results suggest that expansion of the horticulture industry may be of concern to water quality, unless stringent land management practices are put in place to reduce sediment export (see also Armour *et al.* 2004). The potential expansion of banana cultivation is of particular concern is, because particular cultivation techniques associated with banana most likely contribute more to sediment and nutrient loads than cultivation of orchard trees (M. Smith, CSIRO Sustainable Ecosystems, pers. comm.). These techniques include the fact that banana is not a perennial, has approximate annual cultivation, and generally has no grassed inter-rows (M. Smith, CSIRO Sustainable Ecosystems, pers. comm.). An associated concern with banana cultivation for aquatic biodiversity is that it

requires considerable use of pesticides, which can act as ichthyocides (Pusey & Kennard 1994) and may also be detrimental to other aquatic flora and fauna.

To predict future impacts of land-use and landscape change on aquatic biodiversity, the flow of nutrients among different and higher trophic levels that underpin aquatic biodiversity will need to be quantified. Impacts of changes in land management practices on water quality and primary production in tropical rivers can be assessed using existing models (although some improvements to these models may be required, Bartley *et al.* 2004a). However, a model that is capable of assessing the implications of changes in land management practices on higher trophic function in tropical rivers beyond primary production is currently missing. Importantly, an integrated and overarching model that draws all these models together in a quantitative manner, and can predict and evaluate aquatic ecosystem health outcomes of different land management scenarios does not exist. Such predictive understanding is critical for assessment of the Reef Water Quality Protection Plan, and the development and application of the Wet Tropics Toolkit (for description of Toolkit, see Smith 2003).

Actions to minimise the movement and delivery of nutrient and sediment within the Wet Tropics region have been outlined in Armour *et al.* (2004), and include:

- setting water quality targets for catchment and sub-catchments;
- appropriate nutrient management for primary production (agricultural and aquaculture);
- control of erosion in catchments, including grazing and cropped lands, roads and urban development;
- rehabilitation and extension of riparian buffers in appropriate areas; and
- avoidance of coarse textured soils with associated risk of N leaching for heavily fertilised systems.

Most of these actions are currently being addressed in Douglas Shire Water Quality Improvement Plan. To assess the effectiveness of these actions in improving water quality in the Shire, however, standardised, long-term monitoring programs will need to be established.

A current focus of natural resource management is very much on water quality in general, and in the GBR lagoon on reducing sediment and nutrient transport in particular. While important (see Baker 2003), this creates the risk of neglecting other water quality components that may impact detrimentally on aquatic biodiversity in the region. For example, the detection of pesticides in aquatic organisms in the Wet Tropics (Armour *et al.* 2004, and references therein) warrants a comprehensive risk-assessment of pesticides (Russell *et al.* 1998), particularly given their potential to act as endocrine disruptors (Kime 1998). Further, comprehensive acid sulfate soils mapping in the Wet Tropics region from Ingham north is required to avoid the disturbance of acid sulfate soils, and its associated detrimental impacts on water quality and aquatic ecosystems (Cook *et al.* 2000, Preda & Cox 2001, Russell & Helmke 2002, Kroon 2004), wherever possible (Dear *et al.* 2002). In addition to expanding the current focus on reducing sediment and nutrient transport, other critical components underpinning a healthy and sustainable aquatic biodiversity, such as water quantity and habitat condition, should not be ignored.

4.1.2 Water quantity

Unlike many other coastal catchments in Queensland, the catchments in Douglas Shire have no major impoundments, and groundwater harvesting appears to be minor. Hence, flow volumes, seasonality of flow and flood frequencies have not been significantly altered by human impact. Nevertheless, drainage of coastal floodplains has resulted in changes in hydrology, including the rate of delivery of floodwaters to the estuary (Pressey & Middleton 1982, White *et al.* 1997). Prior to drainage, part of the floodwaters would have been retained on the floodplain for extended periods of time (White *et al.* 1997), providing significant habitat areas for aquatic flora and fauna, including estuarine and inshore fish and invertebrates

(Pollard 1976). Research in Douglas Shire has demonstrated that this landscape “sink” zone has been transformed into a “source” zone, with land-uses such as constructed drains and cleared areas now serving as sediment sources (Bartley *et al.* 2004a). In the Wet Tropics, these transformations of coastal floodplain hydrology have resulted in a significant loss of, and connectivity between aquatic habitats, including tidal and freshwater wetlands, with associated adverse impacts on fish and fish habitats (Armour *et al.* 2004).

A first step to maintain and improve aquatic ecosystem health in Douglas Shire catchments would be to describe the coastal floodplain hydrology, including preferential flowpaths, flood and flow duration, and “source” and “sink” zones. The results can aid in identifying catchment areas most suitable for certain land-uses, such as sugar cane, horticulture, and freshwater or tidal wetland.

4.2 Habitat condition

In the coastal floodplains of Douglas Shire, aquatic habitats range from first order streams through to main river channels, and from freshwater and tidal wetlands through to mangroves. The majority of all fish species (70%) documented in Douglas Shire catchments (Table 5), including many of the important fisheries species, such as barramundi, grunTERS, snappers, mullets, trevallies and eels (Kailola *et al.* 1993, and references therein), use a number of these floodplain habitats. Hence, to protect and conserve aquatic biodiversity, it is vital to protect and rehabilitate a variety of coastal floodplain habitats, rather than a single key or critical habitat. Moreover, with increasing development pressure in Douglas Shire, tools are required to compare the economic, environmental and social values of coastal habitats, to aid in decision making for land-use planning.

Artificial draining of coastal floodplains and wetlands is commonly achieved with the construction of flood mitigation structures, such as tidal floodgates and associated drainage systems. These structures prevent tidal access, thereby alienating significant habitat areas, blocking larval transport and restricting fish movement (e.g. Pollard & Hannan 1994, Gibbs *et al.* 1999, Russell & Helmke 2002, Kroon *et al.* 2004). Consequently, tidal barriers play a role in the depletion of estuarine fish stocks, by decreasing estuarine water quality as well as limiting juvenile and adult fish access to habitat and food upstream of these structures (Sultana & Thompson, 1997). Floodgated drainage systems can be managed to improve aquatic ecosystem health in coastal floodplain rivers, while retaining their benefits for agriculture (Johnston *et al.* 2003). Hence, it is recommended that an assessment of floodgated watercourses and drainage systems be conducted for Douglas Shire catchments for management improvements. Given that sugar cane drains are major contributors of fine sediments to local waterways in Douglas Shire (Bartley *et al.* 2004a), improved management of these structures is highly desirable. Additional structures that impede water flow and fish passage, such as stream barriers, sand dams, and road, rail and farm crossings, may also need to be audited and re-engineered to facilitate fish passage (Armour *et al.* 2004).

Most native vegetation on the coastal floodplains of the Wet Tropics region, including riparian vegetation, has been cleared, primarily for cane production (Herbert & Peeters 1995, Lovett & Price 2001). Clearing of riparian vegetation has profound impacts on aquatic ecology (for detailed review, see Pusey & Arthington 2003), including an increase in exotic grasses and weeds (Bunn *et al.* 1998), and in bank erosion and sediment loads into coastal floodplains and inshore reefs (Prosser *et al.* 2001, Hossain *et al.* 2002, Baker 2003,). These impacts can eventually result in overall changes in water quality, habitat quality and diversity, trophic dynamics, and aquatic communities. In the Wet Tropics region, riparian restoration projects have been conducted for a number of years (Lovett & Price 2001), while in Douglas Shire protection and restoration of riparian and wetland areas is currently addressed as part of the Water Quality Improvement Project (Project 4). These projects aim to at least halt, and preferably reverse the impacts of clearing on stream ecology, and are generally promoted to reduce erosion and sedimentation, shade out invasive weeds (e.g. Bunn *et al.* 1998), and connect remnant fragments. Economic benefits resulting from these projects can include

good water quality and nursery habitat for important fisheries species. Current and future projects may want to include three native aquatic macrophyte species present in Douglas Shire (Table 3) that appear to be suitable for stream bank stabilisation (Stephens & Dowling 2002), including White eclipta (*Eclipta prostrata*), Schoenoplectus (*Schoenoplectus mucronatus*), and Swamp ricegrass (*Leersia hexandra*). Whether riparian rehabilitation projects are effective in improving in-stream health is currently being investigated in a three-year research project conducted in Douglas Shire catchments (F. Kroon, CSIRO Land and Water).

Cattle activity may have profound impacts on aquatic ecosystem, since it is usually concentrated near water (Arnold & Dudzinski, 1978). This is most likely exacerbated during summer and early autumns, particularly during drought years, when aquatic systems dry up. In Douglas Shire, several creeks outlined on topographical maps from 1983 had completely disappeared under grazing (or sugar cane) in 2003 (FK, pers. obs.), including sections of Chinaman Creek in the Saltwater Creek catchment, and Cassowary Creek in the Mossman River catchment. To halt and potentially reverse the impacts of cattle trampling, stock access to riparian zones should be excluded by fencing, and off-stream watering points provided.

Finally, unlike some other coastal catchments in Queensland, the catchments in Douglas Shire have no major in-stream mining operations. One quarry, regulated by Qld Environmental Protection Agency, conducts off-stream mining in the upper South Mossman River. Substrate material immediately downstream from the quarry appears to include quarry material (FK, pers. obs.), however, whether the operation affects water quality or quantity is uncertain.

5 Conclusion

Currently, a total of 348 aquatic taxa have been documented in the catchments of Douglas Shire. Fish are the most commonly recorded taxa, followed by aquatic invertebrates, amphibians and reptiles, macrophytes and mammals. At least twelve of these species have been introduced from overseas, with four additional aquatic exotic weeds recorded within the Shire but outside the catchments reviewed, while translocated species (native species from other catchments) were not differentiated as such here. It is likely that with additional studies and research, new species, or an expansion of distribution ranges of aquatic plants, invertebrates and vertebrates will be documented.

The review demonstrates that knowledge on the distribution of aquatic biodiversity in Douglas Shire catchments is patchy and highly variable within and between taxonomic groups and catchments. The distributions of freshwater fish and amphibians are probably best documented, followed by aquatic reptiles, mammals, invertebrates, and macrophytes. In contrast, little information is available on the biology of estuarine and inshore fish species, including many species important for fisheries. This knowledge gap needs to be addressed in order to improve understanding of the contribution tropical rivers make to estuarine and coastal fisheries. To enable rigorous evaluation of the potential effects of future changes in land-use practice and landscape composition on aquatic biodiversity across the Wet Tropics, a larger review encompassing all Wet Tropics catchments should be conducted.

To assess future impacts of land-use and landscape changes on aquatic biodiversity, different assessments of biodiversity can be used. This can include changes in species richness, distribution, diversity, and assemblage composition, as well as changes in presence / absence data. Changes in occurrences of endemic and threatened species, as well as exotic species may be of particular interest. Fish provide a particularly valuable tool to evaluate changes in aquatic ecosystem health, because they are affected by most forms of human impacts and integrate ecological processes of streams. The specific change of interest will depend on the specific question being asked in relation to the land-use change being implemented, as the type, direction and magnitude of changes will depend on the

specific type of land-use improvement. Regardless, it is critical that these changes are assessed against well-established baseline data, and the data provided in this report can serve as a starting point.

Recommendations

- To capitalise on this review, and establish baseline data for aquatic ecosystem health within the major land-uses in Douglas Shire. This baseline can subsequently be used to evaluate future impacts of specific land-use changes on aquatic ecosystems, and outcomes can be included in an integrated assessment of sustainable coastal floodplain management (i.e. WfHC Wet Tropics toolkit).
- To develop the capability to predict aquatic biodiversity outcomes of alternative land-use and landscape composition scenarios in Douglas Shire. This includes:
 - i. the development of a quantitative understanding of ecological processes underpinning aquatic biodiversity, including primary production and food web function, and their response to proposed reductions in sediment and nutrient loads under the RWQPP;
 - ii. the development of a quantitative understanding of the relationship between available floodplain habitat area, aquatic biodiversity, and fisheries stocks.
- To collate biological knowledge available on estuarine and inshore fish species, in particular important fisheries species that use coastal river ecosystems. Such a synthesis is pivotal to identify land-use and landscape practices that contribute most to improving ecosystem health of Wet Tropics' rivers and the Great Barrier Reef, as well as to the viability of regional industries (including fisheries) that depend on these systems.
- To aid in identifying catchment areas most suitable for specific land-uses, such as sugar cane, horticulture, and freshwater or tidal wetlands, an improved understanding of coastal floodplain hydrology, including preferential flowpaths, flood and flow duration, and "source" and "sink" zones, is required for Douglas Shire.
- Standardised, long-term monitoring programs will need to be established, to evaluate the effectiveness of actions to minimise the movement and delivery of nutrient and sediment within the Douglas Shire.
- To conduct a comprehensive risk-assessment of pesticides used in coastal catchments, and their potential impacts on aquatic ecosystem health (including fisheries species), for management improvements.
- To avoid the disturbance of ASS, and its associated detrimental impacts on aquatic ecosystem health, comprehensive ASS mapping in the Wet Tropics region from Ingham north is required.
- To conduct an assessment of floodgated watercourses and drainage systems, as well as additional structures that impede water flow and fish passage, in Douglas Shire for management improvements.
- To protect and rehabilitate critical riparian and wetland areas. This includes the exclusion of stock access to riparian and wetland areas by fencing, and the provision of off-stream watering points, to halt and potentially reverse the impacts of cattle trampling.
- To expand this review to encompass all Wet Tropics catchments, to enable rigorous evaluation of future impacts of land-use and landscape change on Wet Tropics aquatic biodiversity and ecosystem health.

Note The focus of this review was Douglas Shire, hence, most recommendations have been made with Douglas Shire catchments in mind. However, most recommendations, if not all, would be applicable to most other Wet Tropics catchments.

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