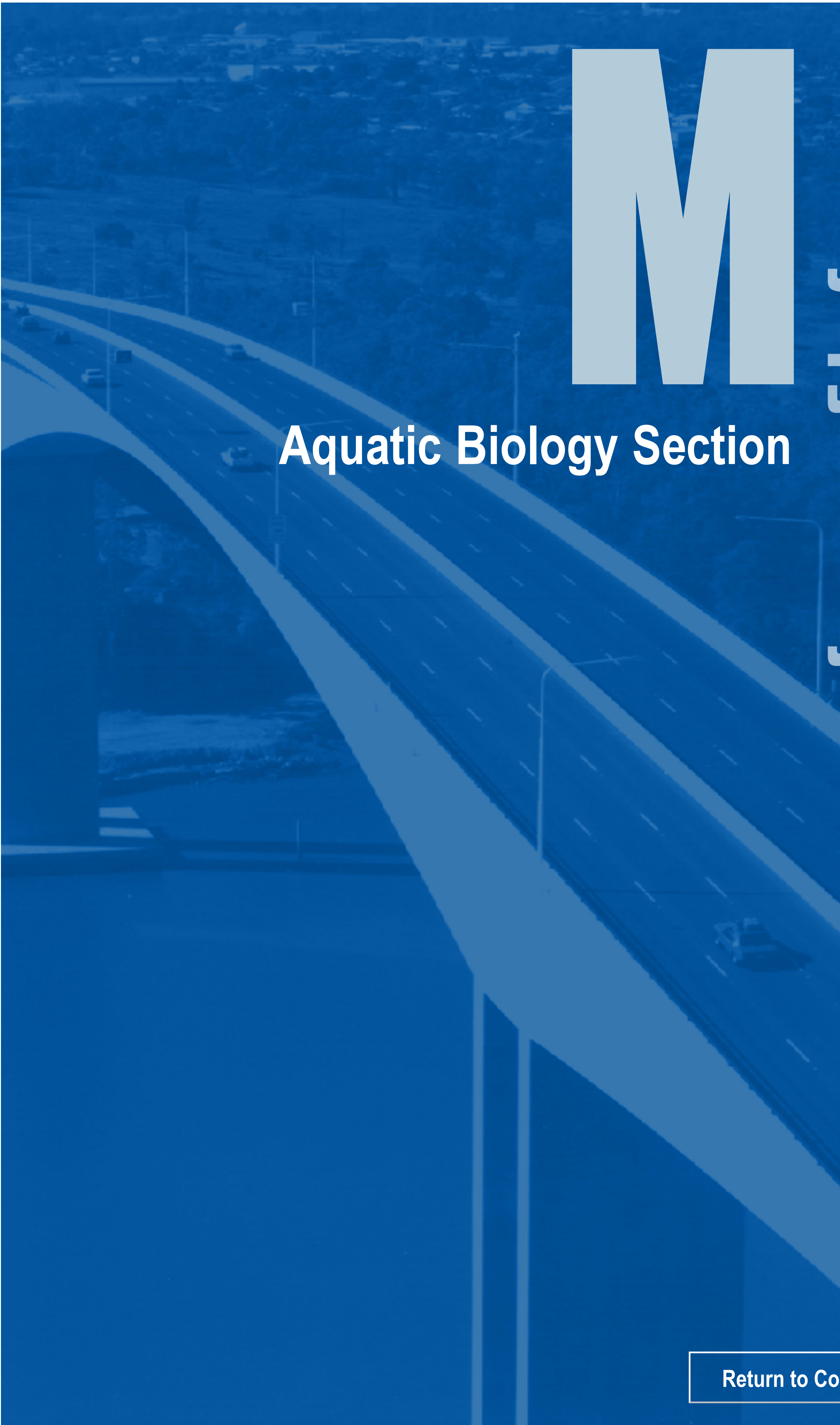

M

Aquatic Biology Section

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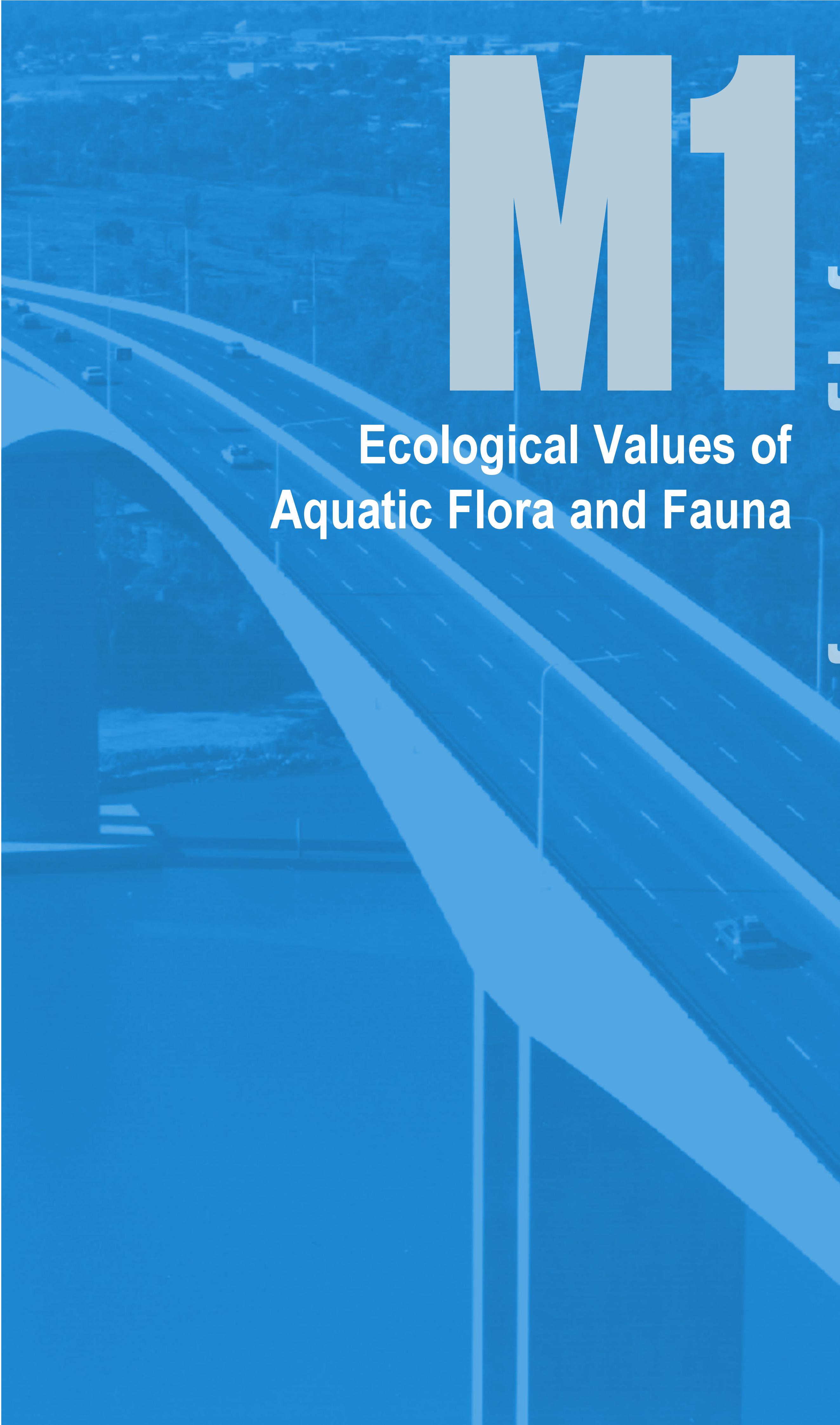


M1

Ecological Values of Aquatic Flora and Fauna

Gateway Upgrade Project

Appendix M1 Ecological Values of Aquatic Flora and Flora

Ecological Value of Riparian Vegetation

The riparian zone is an essential component of the landscape for the maintenance of wildlife distribution, abundance and diversity and for the maintenance of instream flora and fauna (Sattler 1993). In particular riparian vegetation:

- forms corridors which link bushland remnants into sustainable regional networks
- provides critical habitat refugia within which species are maintained in times of drought and fire
- provides critical habitat and food for aquatic fauna
- forms part of local habitat complexes which sustain terrestrial wildlife
- stabilises river and channel banks
- reduces sedimentation downstream
- has a major impact on the carbon and nutrient fluxes in stream and river ecosystems (Arthington et al. 1992, cited in Sattler 1993).

Ecological Values of Aquatic Macrophytes

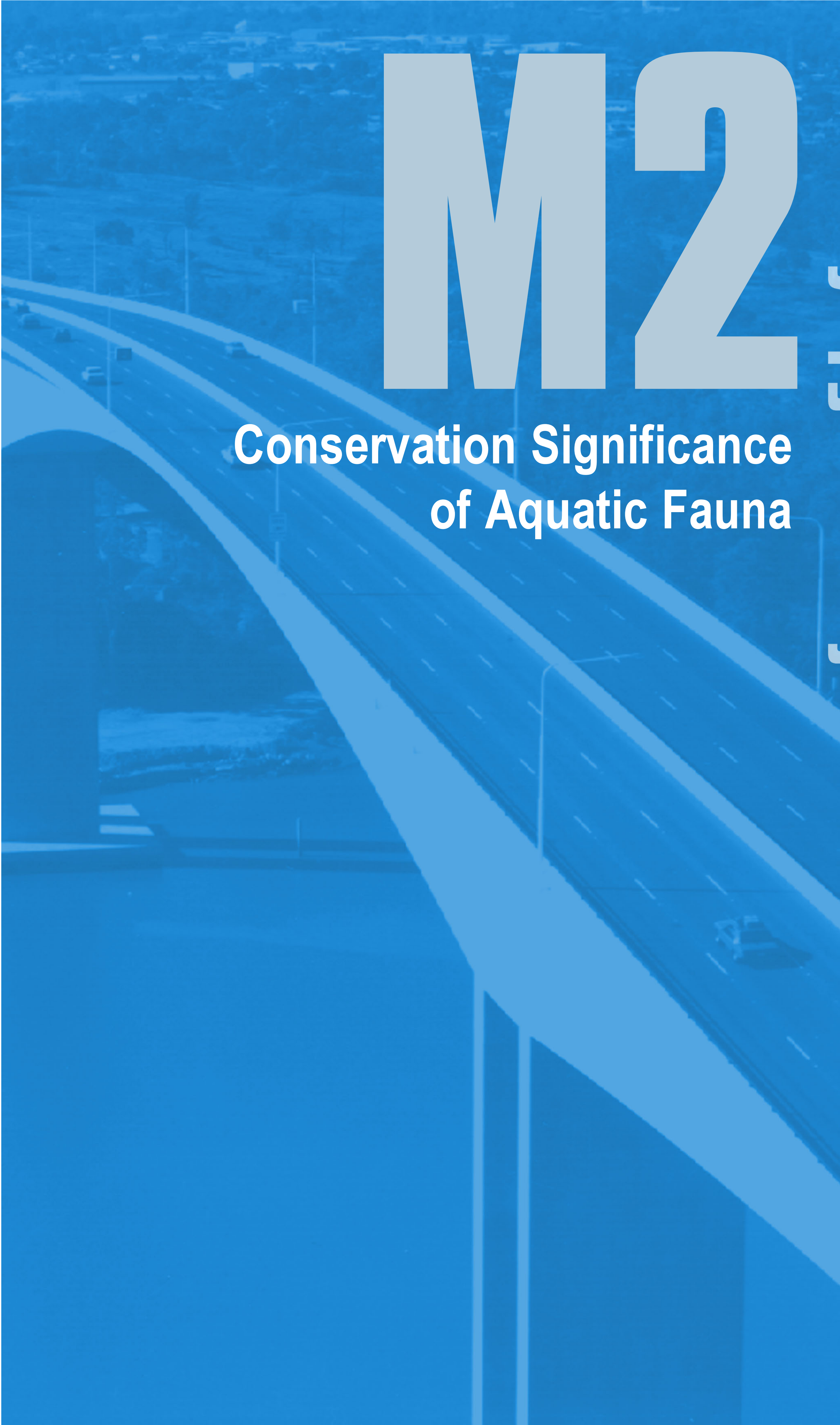
Aquatic macrophyte communities are comprised of emergent, floating and submerged plants. These plants have important roles in maintaining the functioning and biodiversity of riverine ecosystems. These plants play an important role, including:

- in stream bank stabilisation
- reducing flow rates
- trapping suspended sediments and reducing turbidity
- providing food and harbour for aquatic animals, including critical breeding habitat for some species
- providing the habitat for organisms that improve water quality
- stripping nutrients from water and sediments, and competing with bloom forming algae for nutrients
- providing food and habitat for terrestrial species such as wading birds and frogs
- helping maintain habitat diversity and therefore total species richness (Burchmore 1991; Sainty & Jacobs 1994; Environmental Protection Authority 1995; West 1996)

Ecological Values of Mangroves

Mangroves are an important component of the estuarine habitat because they:

- input significant amounts of vegetable matter into the food chain. Decomposing leaves, fruits and bark fragments provide both soluble nutrients and detrital fragments that are eaten by crustacea and some fish. Bacteria and fungi also feed on the decomposing matter and in turn are eaten by larger organisms (West 1985)
- trap, accumulate and release nutrients (and in some cases pollutants) and particulate matter (silt) from surrounding land, thus acting as a buffer to the direct effects of runoff (West 1985)
- provide a habitat or shelter to a range of fauna and flora (egMorton et al. 1987). Mangroves are recognised as important roosting sites for birds and macrobats (egDriscoll 1992), and the sediment in which they grow typically supports both a high diversity and abundance of fauna. The creeks which wind through large mangrove forests are also important as fish and crustacean habitats (Blaber et al. 2000; Robertson & Blaber 1982; Vance et al.1990; Robertson & Duke 1990)
- protect the shoreline from erosion emanating either from the water (waves, boat wash) or the land (runoff) (Blamey 1992) and contribute to the establishment of islands and the extension of shorelines (Blamey 1992)



M2

Conservation Significance of Aquatic Fauna

Gateway Upgrade Project

Appendix M2 Conservation Significance of Aquatic Fauna

All marine plants, including mangroves, seagrass and saltmarsh plants that grow on intertidal and subtidal lands are fully protected under the *Fisheries Act 1994*. It is an offence to unlawfully remove, damage or destroy a marine plant, being a plant that usually grows on, or adjacent to tidal lands. In Queensland, tidal lands are commonly defined as land below Highest Astronomical Tide (HAT) (Beumer & Couchman 2002). A permit (issued under s55) to undertake these activities may be obtained on application to the Chief Executive of the Department of Primary Industries, Fisheries Division.

Marine Mammals and Reptiles

The Indopacific humpback dolphin (*Sousa chinensis*) and the bottlenose dolphin *(Tursiops truncatus)* are common in the Kedron Brook floodway, and are likely to occasionally enter the Brisbane River. They may also enter Schultz Canal upstream of the Brisbane Airport, as these waters are well flushed, are of sufficient size for easy passage and support prey items including mullet, clupeids and prawns.

Turtles however are less likely to use these waterways, as appropriate food sources in these waterways are limited. Green turtles (*Chelonia mydas*) may occasionally enter the waterways seeking propagules from the grey mangrove (*Avicennia marina)*. Similarly dugong are unlikely to come into these channels, as they do not support seagrass, their primary food source.

The conservation status of dugong and those species of turtle and dolphin likely to be found in the study area is presented in Table ??.

All waters of the state are now protected against degradation by direct or indirect impact under section 125 of the *Fisheries Act 1994*. If litter, soil, a noxious substance, refuse or other polluting matter is on land (including the foreshore, tidal and non-tidal land), in waters, on marine plants, or in a fish habitat, and it appears to the chief executive that the polluting matter is likely to adversely affect fisheries resources or a fish habitat, the chief executive may issue a notice requiring the person suspected of causing the pollution to take action to redress the situation.

All whales, porpoises and dolphins (cetaceans) are protected under the *Environment Protection & Biodiversity Conservation Act 1999.* There are guidelines for the observation of, and other activities involving cetaceans. Additionally, listed 'marine species' and 'migratory species' (listed under Section 248 and Section 209, respectively) have particular protection under the Act.

Migratory wader birds, which are protected under the Japan-Australia Migratory Bird Agreement (JAMBA), China-Australia Migratory Bird Agreement (CAMBA) and under the 'migratory species' and in some cases 'marine species' listings of the EPBC Act also inhabit western Moreton Bay. Those species recorded from the EPBC Protected Matters Search Tool (DEH 2004) are listed in Appendix P.

All of Australia's six species of marine turtles occur in Moreton Bay. This includes resident populations of hawksbill (*Eretmochelys imbricata),* green (*Chelonia mydas*), and loggerhead (*Caretta caretta*) turtles, and seasonal and occasional sightings of the other species (Couper 1998). Sub-adult and adult green turtle are common in the region, particularly in the shallows. Green turtles feed extensively on seagrass beds, particularly those dominated by *Halophila ovalis*, *Halophila spinulosa* and *Halodule uninervis* and may also feed upon the fallen fruit of the grey mangrove, *Avicennia marina* and algae (Col Limpus, Environmental Protection Agency, pers. comm.).

Moreton Bay is an important feeding ground for marine turtles – the long life-span of these reptiles (35 – 50 years to sexual maturity) and fidelity to feeding grounds (Couper 1998) means that turtles may rely heavily on the seagrass meadows in the bay. Historical evidence indicates that large turtle populations once inhabited western parts of the bay, however today their distribution in mostly confined to the eastern sections (Neil 1998).

Moreton Bay is the southern limit of dugong distribution on Australia's east coast (Preen 1995). Approximately 800 - 900 dugong live within the Bay, feeding almost exclusively on the seagrass species *Halophila ovalis*, *Halophila spinulosa* and *Halodule uninervis* (Lanyon & Morris 1997; Preen et al. 1995; Preen 1992). However they also feed on the seagrass *Zostera capricorni*, particularly when it is in flower (Conacher, pers. comm. 1996). In Moreton Bay, there is over 260km^2 of dugong habitat, which supports one of the largest populations in Queensland (WBM-SKM 1995; Marsh et al. 1990 cited in Lanyon & Morrice 1997).

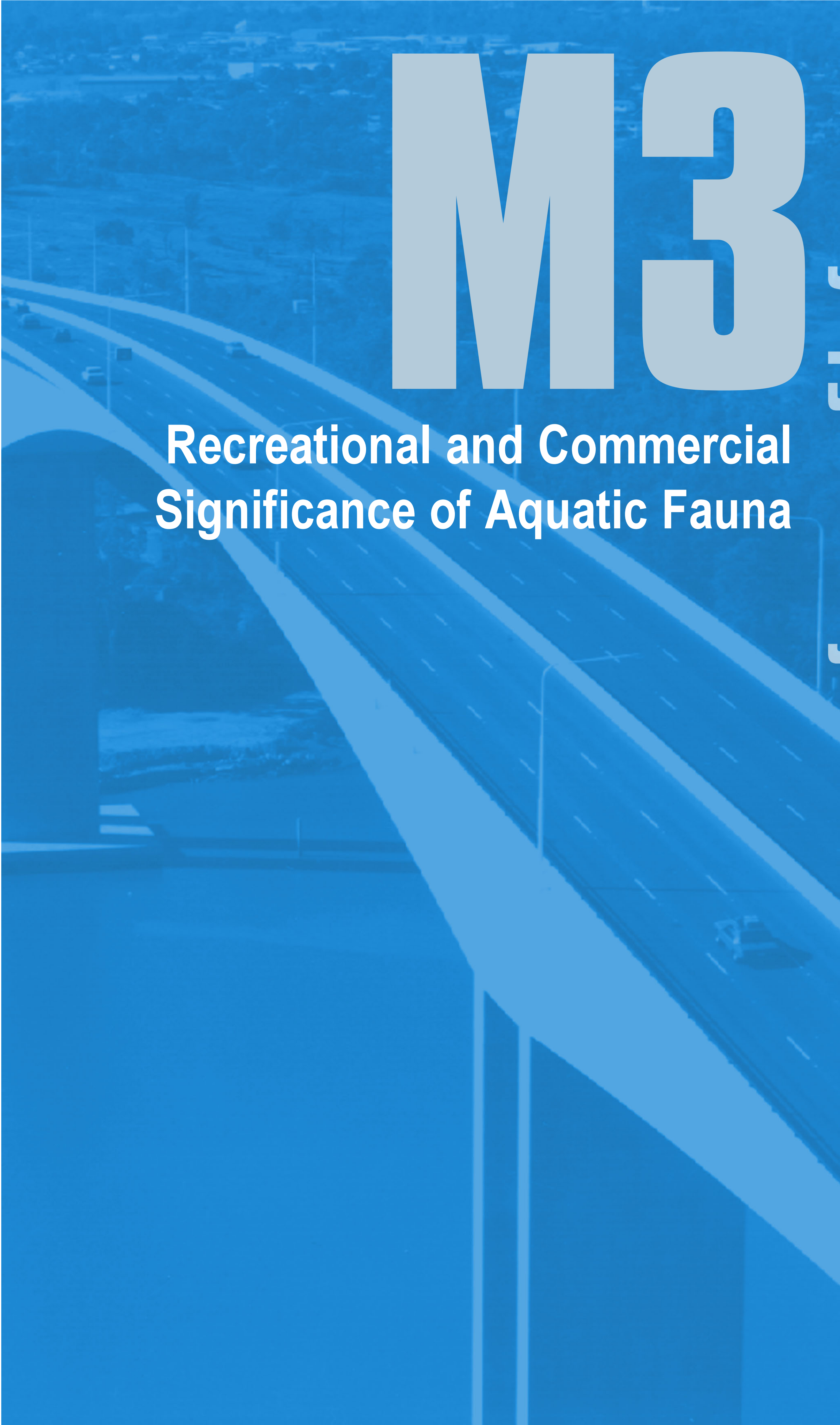
Bottlenose dolphins (*Tursiops truncatus*) and the Indopacific humpback dolphin (*Sousa chinensis*) are common within southern Moreton Bay. Humpback dolphins eat fish associated with mangrove habitats and are consequently affected by disturbances to these habitats. Humpback dolphins seem to stay within a 'home range' and females in particular are site-specific.

Freshwater Mammals and Reptiles

The false water rat *(Xeromys myoides)* is found in coastal habitats such as swamps and sedgelands; it forages in mangrove forests at night (DEH 2003). This species is listed as 'vulnerable' under the EPBC Act and the *Queensland Nature Conservation Act 1992*. No false water rats were captured in extensive trapping undertaken by Lambert & Reihbein at the Brisbane Airport as part of the Brisbane Airport Fauna Study (Wendy Drury [Lambert & Rehbein] 2004, pers. comm., 13 April). It is therefore unlikely to be present in similar habitats along the Gateway Upgrade alignment.

Migratory Birds

Migratory birds that are protected under the 'migratory' listing of the EPBC Act, and protected under the JAMBA and CAMBA treaties may use the aquatic habitats along the Gateway Upgrade alignment (in particular, the wetlands of the Brisbane Airport and to the north of the Kedron Brook Floodway). Birds that are listed under the 'marine' listing of the EPBC Act may also use the area.



M3

Recreational and Commercial Significance of Aquatic Fauna

Gateway Upgrade Project

Appendix M3 Recreational and Commercial Significance of Aquatic Fauna

Fisheries

Previous surveys undertaken in the vicinity of Kedron Brook Floodway (FRC Environmental 2003) have noted that the area was popular with two categories of recreational fishers. 'Family' fishers, who frequented the lower reaches of creeks and inlets; and more serious recreational fishers who fish further upstream. All the recreational fishers interviewed spoke of better times 10 – 30 years ago when it was possible to catch a good feed of bream or flathead in the creek. Today it seems that only mud crabs were considered reliably abundant. Similar comments might be made about any of the creeks running into central western Moreton Bay (Martin Cowling pers. comm.).

Fishers operating from non-commercially registered vessels were observed cast netting for hours on end for prawns (presumably early-run banana prawns) in the upper reaches of the Kedron Brook Floodway. The Kedron Brook Floodway is known for good bream fishing on making tides. Recreational anglers commonly also catch small sharks and stingrays (Harrison 2002).

The Brisbane River frontage of Bulwer Island (adjoining Boggy Creek) is renown for producing a regular December run of bream. Bream, flathead and mulloway are also commonly taken year-round in the deepwater of the Brisbane River opposite and to seaward of the Boat Passage. Flathead are frequently caught on the mangrove-lined flats adjacent to the mouth of the river, with the fish following the tide. Winter whiting are taken from the outer edges of the extensive intertidal sand banks around Juno Point and north to Sandgate.

In contrast to the intertidal flats to the south of the mouth of the Brisbane River, the flats to the north are not known to support abundant blood worms (a commercially harvested recreational bait).

There are no declared fish habitat area in western Moreton Bay immediately downstream of the Brisbane River and Kedron Brook Floodway. However, the relatively large size and pristine nature of the wetlands in the area, in particular the Boondall wetlands, make the area an important fish habitat area. Nundah Creek has been proposed as a fish sanctuary, by the Subtropical Finfish Advisory Committee (David Bateman, SUNFISH, pers comm.; Melissa Dixon, DPI Queensland Fisheries Service, pers comm.). Fishes that develop as juveniles within the creek system migrate to Moreton Bay and further a field.

No aquaculture ventures nor oyster leases are located in the adjoining region of Moreton Bay (Kerrid Beattie, QFS, pers. comm.).

Significant Fishery Species Habitat Associations

Sea Mullet (Mugil cephalus)

Sea mullet live in fresh, coastal and estuarine waters in tropical and temperate zones world-wide (Kailola et al. 1993). Adult sea mullet are typically found in freshwater reaches of coastal rivers, except during spawning season, when mature fish migrate through estuaries to coastal waters (Thomson 1951) (refer Figure 17.5). Sea mullet have a tendency to school as juveniles, with schools dispersing over estuarine flats to feed on an incoming tide and reforming as the tide ebbs (Thomson 1955).

Post-larval sea mullet enter estuaries when they are approximately 10 to 20mm TL (total length) (Chubb et al. 1981), moving to shallow nursery areas within the estuarine and freshwater reaches of tidal waterways (Thomson 1955). Juveniles grow to approximately 150mm TL at the end of their first year, reaching sexual maturity at around 300 to 350mm TL at the end of their third year (Thomson 1951).
In estuarine waters mullet feed on detritus, diatoms, algae and benthic micro-invertebrates, which they filter from the substrate (Thomson 1963).

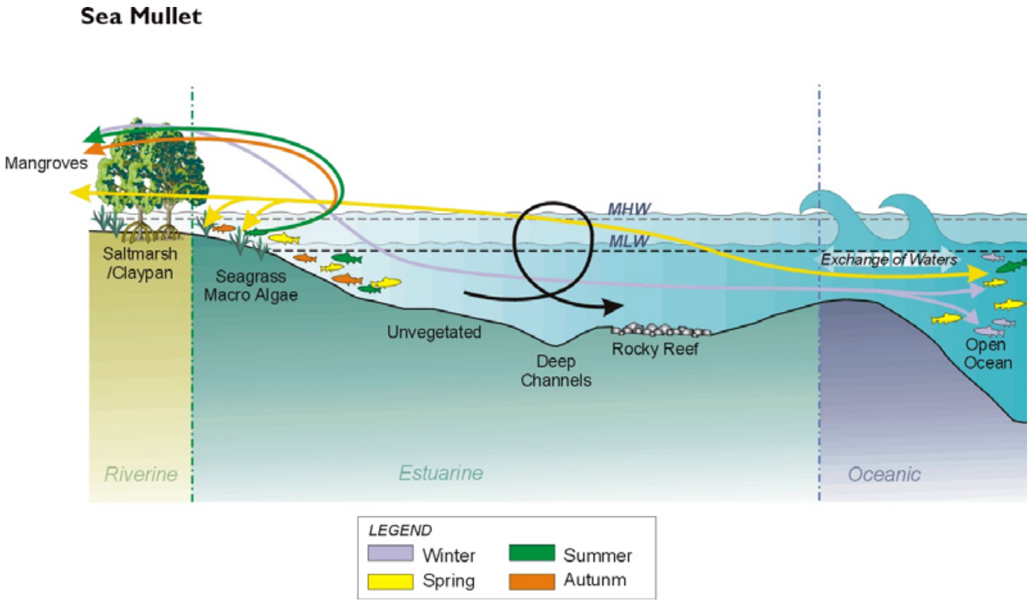


Figure M1 Habitat associations for the mullet (SKM/FRC 2001)

Yellowfin Bream (Acanthopagrus australis)

Yellowfin bream are common in coastal and estuarine waters from Townsville south to the Gippsland Lakes in Victoria (Roland 1984). They consume a wide variety of prey including small crabs, prawns, molluscs and small fish. Bream migrate to surf bars to spawn in winter (Dredge 1976; Pollock 1982; SPCC 1981), the larvae are carried back to estuarine habitats by tidal currents, and they settle out at approximately 13mm TL (refer Figure 17.6). Juveniles grow to over 130mm TL by the end of their first year and become sexually mature at about 240mm TL (SPCC 1981). Maximum size is approximately 390mm TL (Henry 1983).

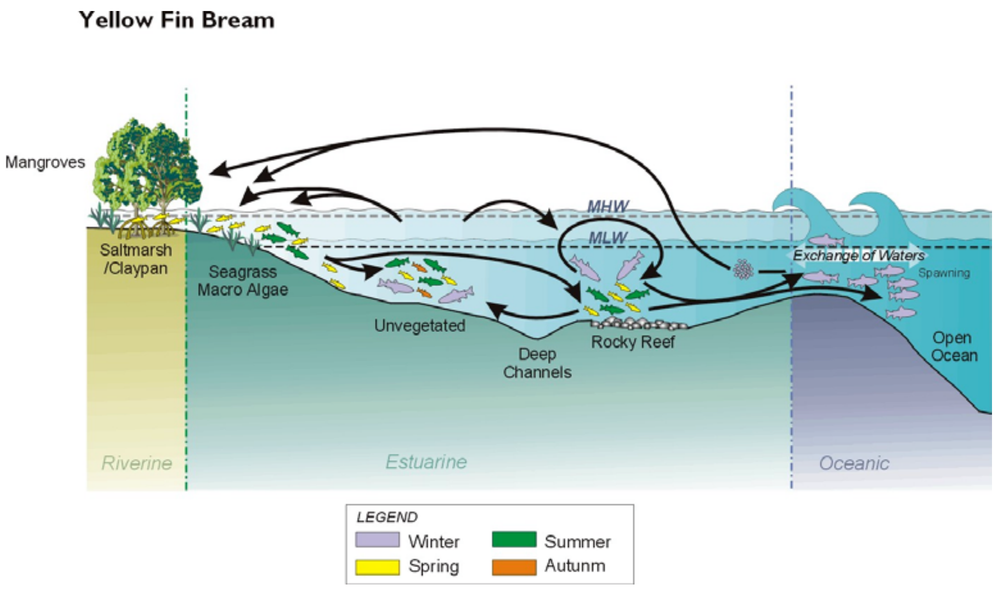


Figure M2 Habitat Associations for Yellowfin Bream (SKM/FRC 2001)

Mud Crab (Scylla serrata)

Mud crabs are widely distributed throughout the Indo-West Pacific, commonly associated with sheltered estuaries and tidal rivers (Kailola et al 1993). Mud crabs spawn off shore, with post-larvae moving inshore to settle (Hill et al. 1982). There is little growth during the winter months. Crabs become sexually mature around 2 years old, and reach a maximum carapace width of around 240m (Kailola et al. 1993). Smaller crabs are typically found in association with seagrass meadows and adjacent sand bars whilst mature adults are usually recorded from deeper channels (refer Figure 17.7).

Juvenile mud crabs feed on planktonic animals, benthic molluscs and crustaceans. Adults generally feed at night on a variety of gastropod and bivalve molluscs, small crabs and polychaete worms (Fielder & Heasman 1987; Hill 1979; Hill 1976). Adult mud crabs do not move much between locations (Hyland et al. 1984).

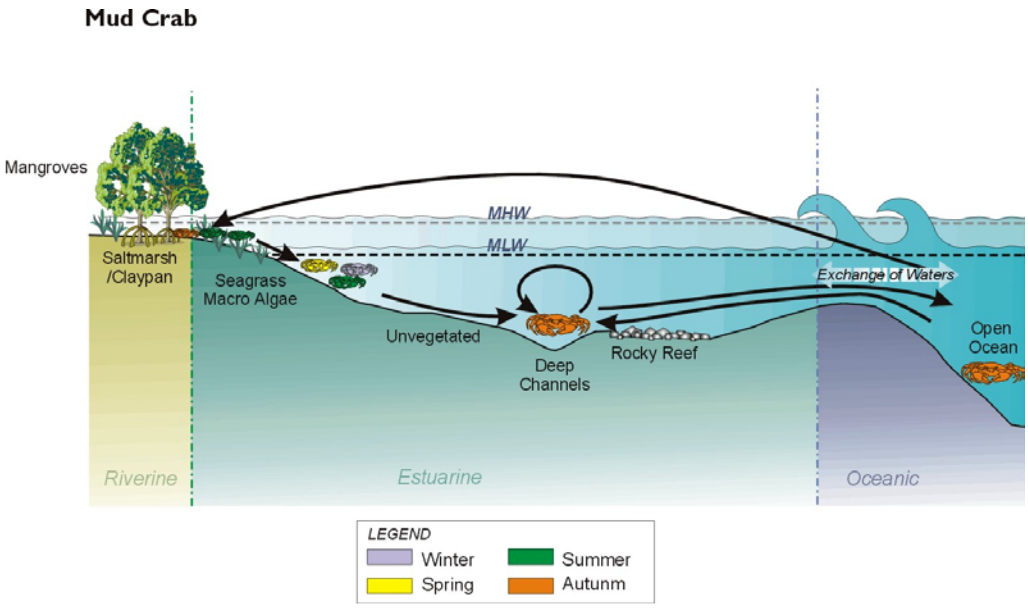


Figure M3 Habitat Associations for the Mud Crab (SKM/FRC 2001)

Penaeid Prawns

A number of penaeid prawn species were caught during the study. This family includes many prawn species of commercial significance. Species of commercial or recreational significance caught during the present study include the greasy-back prawn (*Metapenaeus bennettae),* endeavour prawn (*Metapenaeus ensis)*, banana prawn (*Penaeus merguiensis)* and the brown-tiger prawn (*Penaeus esculentus)*. By far the most abundant of these was the greasy-back prawn. Banana prawns were caught both in the medium sized creeks and channels of the airport. Endeavour prawns were collected in a small tributary of Serpentine Creek. Brown-tiger prawns were caught Kedron Brook Floodway.

Except for the greasy-back prawn, the life cycle of prawns caught in Moreton Bay involves adult life and spawning in the open sea. Developing larvae are carried back into near shore and estuarine waters where mangroves and seagrasses shelter the developing juveniles. After a few months of rapid growth, juveniles migrate into deeper water to complete the cycle. Greasy-back prawns are strongly dependent on estuaries with most (if not all) of their development completed within the estuary. Development and mating takes place within rivers, whilst spawning takes place within the bay (Quinn 1992). Whiting and sand crabs are also important target species for commercial fisheries.

M4

Potential Impacts Associated with Runoff

Gateway Upgrade Project

Appendix M4 Potential Impacts Associated with Runoff

Impacts of Elevated Turbidity and Sediment Deposition

Elevated turbidity reduces the penetration of light through the water column, and may consequently adversely affect submerged aquatic macrophytes which are reliant on light for photosynthesis. Increased turbidity may also alter temperature throughout the water column (Department of Natural Resources 1998).

Saltmarsh and mangroves are particularly sensitive to increased sedimentation rates, which for example, may bury the air breathing pneumatophores of *Avicennia*, or change sediment levels such that they are no longer suitable for colonisation. Increases in turbidity and sedimentation are likely to detrimentally impact filter feeding benthic invertebrates. Smothering of benthic invertebrates may also impact animals higher in the food chain (Department of Public Works 1991). However, increased turbidity may also be attractive to a range of fishes, and in particular juveniles, as it protects them from predators (Blaber & Blaber 1980).

Impacts of Elevated Nutrients

Both erosion and disturbance of sediments may also lead to the release of nutrients, which may alter the composition of floral and consequently faunal communities. Increased nutrient concentrations may to lead to an increase in phytoplankton densities and altered community structure: in extreme cases fish kills may result. In the short to medium term the production of mangroves and to a lesser extent the more shallow rooted saltmarsh flora may increase.

Impacts of Petroleum Hydrocarbons (fuels and oils)

Different organisms and different life-stages of particular organisms react to petroleum hydrocarbon pollution in different ways. The damage to aquatic biota by petroleum hydrocarbons is determined more by the degree of persistence of the oil than its absolute toxicity when fresh (van Gelder-Ottway 1976).

Both petroleum and petroleum by-products are harmful to mangroves (Odum & Johaness 1975). Between 0.01ppm and 0.1ppm some adult animals show sub-lethal behaviour and physiological disturbance, while developmental stages may show retarded growth or increased abnormalities. Changes in behaviour in response to sub-lethal doses of pollutant may have far reaching ecological effects (Dicks 1976).

Impacts of Heavy Metals

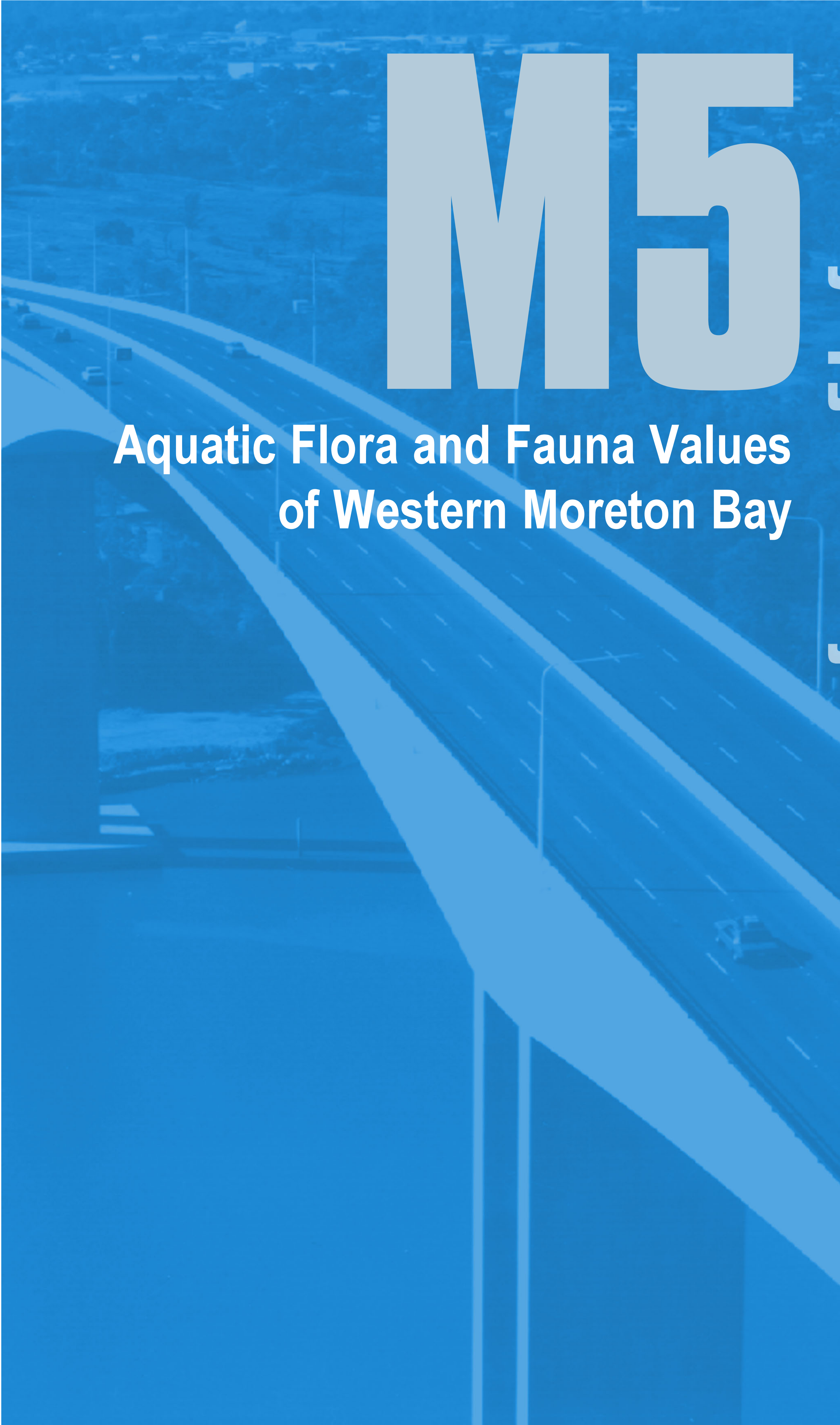
A variety of heavy metals are commonly present within the soil. Physical disturbance of the soil and acidification of ground or surface waters can result in highly increased mobilisation and hence availability of these metals to both flora and fauna.

Metals also occur naturally in the aquatic environment and many, such as copper, cobalt, iron, manganese, nickel, selenium, vanadium and zinc are essential for the survival of aquatic organisms. However if the assimilative capacity of the system is overloaded, either by an excess of an essential metal or by unusually high levels of the rarer, non-essential metals (eg silver, cadmium, mercury and lead) there may be deleterious effects (Langston 1988).

Impacts of Acid Leachate

Acidified waters may be produced where acid sulfate sediments or potential acid sulfate sediments are allowed to oxidise and produce acidic leachate.

Short-term effects of acid water may include: fish kills; fish disease; mass mortalities of benthic invertebrates (including crustacea, molluscs and worms) and microscopic organisms; and increased light penetration due to water clarity (Sammut et al. 1993; 1996; Wendelaar-Bonga & Dederen 1986). Short-term acidification has the potential to alter the natural community structure for many years. Long term effects may include the alteration (loss) of habitat; reduced spawning success due to stress; reduced food resources; dominance of acid-tolerant plankton species; increased predation; changes in food chain and web; damaged and undeveloped eggs; reduced recruitment; increased availability of toxic elements, and; reduced availability of nutrients. Low pH alone has a deleterious effect on biota, but it is the indirect effects including lowering of dissolved oxygen concentrations (eg Razzell 1990) and the biotoxification of elements that are most crucial.



M5

Aquatic Flora and Fauna Values of Western Moreton Bay

Gateway Upgrade Project

Appendix M5 Aquatic Flora and Fauna Values of Western Moreton Bay

Aquatic Flora of Western Moreton Bay

Moreton Bay is listed as a wetland of National Importance (Australia Nature Conservation Agency 1996). A wetland may be considered nationally important if it meets at least one of the following criteria:

- it is a good example of a wetland type occurring within a biogeographic region in Australia;
- it is a wetland that plays an important ecological or hydrological role in the natural functioning of a major wetland system/ complex;
- the wetland supports 1% or more of the national populations of any native plant or animal taxa;
- the wetland supports native plants or animal taxa or communities which are considered endangered or vulnerable at the national level;
- it is a wetland that is important as the habitat for animal taxa at a vulnerable stage in their lifecycles, or provides a refuge when adverse conditions such as drought prevail; and
- the wetland is of outstanding historical or cultural significance (ANCA 1996).

Wetland communities in western Moreton Bay typically comprise grey mangrove (*Avicennia marina)* dominated mangrove communities, salt couch (*Sporobolus virginicus)* dominated saltmarsh, claypan and associated samphires, swamp oak (*Casuarina glauca)* and paperbark (*Melaleuca quinquenervia)* open forests and woodlands (Dowling & Stephens 2001).

Moreton Bay supports approximately 25,000ha of seagrass, with the greatest expanses occurring in association with the sand - banks of the eastern bay (Hyland et al. 1989). The seagrass communities of Moreton Bay are floristically simple, comprised of the seven species recorded from southern Queensland: *Halophila decipiens, Halophila ovalis, Halophila spinulosa, Halodule uninervis* and *Zostera capricorni* (QDEH 1992; Hyland et al. 1989). This relatively simple community structure reflects the dynamic nature of the estuarine habitat. In Western Moreton Bay, seagrass meadows grow at the mouth of the Brisbane River, and south offshore of Wynnum, Manly and Tingalpa Creek (CHRIS 2004). With increasing urbanisation and industrial development, seagrass beds within western Moreton Bay have been lost over the past decades. Whilst some beds have been lost as a direct result of infilling, a far greater area of seagrass has been lost as a result of changes in water quality.

Figure M4 Seagrass Distribution in Western Moreton Bay (CHRIS 2004)

Ecological Importance of Western Moreton Bay

Estuarine habitats such as the Brisbane River and western Moreton Bay provide valuable habitat and food sources for a variety of vertebrate and invertebrate species. Some of these are conservationally significant (egwader birds) whilst others are of recreational and commercial importance, with the majority of commercially and recreationally important species of fish from eastern Australia dependent upon estuarine environments (Quinn 1992; Pollard 1976; Zeller 1998). Shallow water and intertidal habitats are amongst the most productive environments for fisheries (Quinn 1992). Mangroves in particular are important nursery and feeding grounds for most economically important fish in subtropical Australian estuaries (Morton et al. 1987, Morton 1990).

Mangroves input significant amounts of vegetative matter into the food chain and provide a habitat or shelter to a range of fauna and flora. The sediment in which mangroves grow typically supports both a high diversity and abundance of fauna. Many species of algae and terrestrial epiphytes are commonly found in association with mangrove communities. Mangroves trap, accumulate and release nutrients (and in some cases pollutants) and silt from surrounding land, buffering the direct effects of runoff (West 1985). Mangroves are recognised as important rookeries for birds (egDriscoll 1992) and bats.

Conservation Significance of Western Moreton Bay

Western Moreton Bay is part of the Moreton Bay Marine Park, part of the Moreton Bay Ramsar site. It is also protected under legislative instruments of the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*. Marine flora of the region is protected under the Queensland *Fisheries Act 1994*.

A number of conservationally significant aquatic mammals and reptiles inhabit Moreton Bay. A comprehensive list of all aquatic fauna likely to be present and that is listed under the EPBC Act is presented in Appendix M8.

Table M1 International, Commonwealth and Queensland conservation status of marine mammals and reptiles found in Moreton Bay and nearby coastal waters

Species	Common Name	Nature Conservation (Wildlife) Regulation*	EPBC Act**
Dugongidae			
Dugong dugon	dugong	V	O, M
Delphinidae			
Delphinus delphis	common dolphin		C
Orcinus orca	killer whale		C
Orcaella brevirostris	Irrawaddy River dolphin	R	M,C,
Sousa chinensis	Indo-Pacific humpback dolphin	R	M, C
Tursiops truncatus	bottlenose dolphin		C
Dermochelyidae			
Dermochelys coriacea	leatherback turtle	E	V, M, O
Cheloniidae			
Chelonia mydas	green turtle	V	V, M, O
Eretmochelys imbricata	hawksbill turtle	V	V, M, O
Caretta caretta	loggerhead turtle	E	E, M, O
Lepidochelys olivaceae	olive ridley turtle	E	E, M, O
Natator depressa	flatback turtle	V	V,M, O

Table Notes:

* The status of species under the *Queensland Nature Conservation (Wildlife) Regulation 1994:* V – vulnerable, E – endangered.

** The status of species under the *Environment Protection & Biodiversity Conservation Act 1999.* E: Endangered, V: Vulnerable, M: Migratory, O: Marine, C: Cetacean.

Migratory Birds

Moreton Bay is a refuge for migratory wader birds of national importance, and is estimated to support between 50,000 and 100,000 waders during peak times (Environmental Protection Agency 1996). The vegetation communities of the Boondall Wetlands, in Western Moreton Bay, have been identified as important habitat and feeding grounds for a number of migratory bird species, many of which are protected under the JAMBA and CAMBA Agreements.

More than 273 species of bird have been recorded in Moreton Bay; these include 33 species of migratory and 11 species of resident shorebird. Moreton Bay is particularly important for seven species of migratory shorebirds: Pacific golden plover (*Pluvalis fulva*), grey-tailed tattler (*Heterosceles brevipes),* lesser sand plover (*Charadrius mongolus*), eastern curlew (*Numenius madagascariensis*), bartailed godwit (*Limosa lapponica*), curlew sandpiper (*Calidris ferruginea*) and the pied oystercatcher (*Haematopus longirostris*) (O'Brien et al. 2001).

The migratory birds and the Ramsar wetlands are discussed further in section 16.

Fisheries Significance of Moreton Bay

Moreton Bay is Queensland's single most important fishing ground. Although representing only 3% of the states coastline, it produces 10% of the total volume of commercial seafood landings and accounts for one-third of the recreational fishing effort in the state (Densley, cited in Quinn 1992). Quinn (1992) has reviewed the fisheries of Moreton Bay, together with the biology of the major commercial species in the report "Fisheries Resources of the Moreton Bay Region". Despite the considerable coastal development of Moreton Bay, the level of fisheries production from the Bay has been described as "extremely high and relatively stable" (Williams 1989).

Commercial fisheries production from the Moreton Bay region is valued at approximately $33,000,000 (wholesale) annually (Quinn 1992). Commercial fisheries statistics are compiled based upon a 30nm by 30nm grid: consequently the Moreton Bay region covers part of Pumicestone Passage, the ocean beaches of Moreton and Stradbroke Islands, and trawling areas outside the Bay.

Fishing is significant both as a commercial and recreational activity, with about one quarter of the State's population aged 15 years and over fishing at least annually, and the State's commercial catch exceeding $300,000,000 in landed value (Roy Morgan Research 1999; Bishop 1993). Whilst the value of the recreational catch is difficult to define, recreational fishers within the Moreton Bay region spend over $120,000,000 annually to pursue their quarry (Quinn 1992).

There are approximately 800 commercial fishers working within the Moreton Bay region (Moreton Bay Task Force 1997). Estuarine fish comprise 97% of the fish landed by commercial fishers in the Moreton Region, as opposed to reef or pelagic fish (Quinn 1992). Commercially important estuarine fish include whiting (*Sillago* spp.*)*, yellowfin bream (*Acanthopagrus australis)*, tailor (*Pomatomus saltatrix)* and flathead (*Platycephalus* spp.*)* (Quinn 1992).

Within the rivers and creeks draining to Moreton Bay generally, and on the extensive intertidal flats of the bay's western shore, those species of greatest importance to recreational fishers are yellowfin bream, whiting (*Sillago maculata, S. ciliata* and *S. analis)* and flathead (refer Table P2).

Habitat associations of commercially and recreationally significant aquatic fauna species are discussed further in appendix ?

Table M2 Principal species of fish targeted by recreational fishers in the tributaries and over the intertidal flats of western Moreton Bay (adapted from Quinn 1992)

Species	% of Fishing Households
bream	67.3
whiting	61.3
flathead	42.1
sand/mud crabs	12.3
mullet	6.0
cod	4.3
trevally	3.6
jewfish	3.3
catfish	3.1
prawn	2.7
luderick	2.5
flounder	1.4

M6

Stakeholders Comments

Gateway Upgrade Project

Appendix M6 Stakeholders Comments

Commercial fishers who use Bulimba Creek, Kedron Brook and the Brisbane River are unlikely to have concerns regarding the construction and operation of the proposed alignment, provided the ability of beam trawlers to operate in existing trawl grounds is not altered or reduced (J. Toon, [Queensland Seafood Industry Association] 2004, pers. comm., 26 March). Recreational fishers are also unlikely to have significant concerns (D. Bateman [Sunfish] 2004, pers comm., 26 March).

M7

Recognition of the Ecological Significance of the Region in Legislation and Other Instruments

Gateway Upgrade Project

Appendix M7 Recognition of the Ecological Significance of the Region in Legislation and Other Instruments

Moreton Bay Marine Park

Moreton Bay Marine Park extends from Caloundra in the north to the southern tip of south Stradbroke Island. Along the mainland and around the islands, the boundary is the line of the highest astronomical tide. Freehold land is not included unless the owner has agreed.

The Brisbane River's mouth is not part of the Moreton Bay Marine Park. Offshore of the mouth is designated a General Use Zone. North and south of the Brisbane River mouth is designated a Habitat Zone. The mouth of Kedron Brook is also a Habitat Zone; Nudgee Beach and Boondall Wetlands to the north is a Conservation Zone. Habitat Zones are designated for the conservation of significant habitats, cultural heritage and amenity values (QPWS 1999). Conservation zones conserve the natural condition of the area to the greatest possible extent, and provide for recreational activities free from trawling.

Marine Park permits are required for many activities in the Marine Park, including any works and collection of marine plants.

The *Fisheries Act 1994* and *Fisheries Regulations 1995*

The *Fisheries Act 1994* and subordinate Fisheries Regulations 1995 provide for the regulation of both commercial and recreational fisheries, and for the protection of endangered species and habitat critical to sustaining fish stocks.

Fish Habitat Areas

Fish Habitat Areas are declared under the Fisheries Act to enhance existing and future fishing activities and to protect the habitat upon which fish and other fauna depend. Developments involving the disturbance of a declared Fish Habitat Area are severely restricted, limited to those with minimal impact to ecological processes and considered appropriate with the original intention of the Fish Habitat Protection Area declaration. Development within Fish Habitat Areas is strictly limited to facilities provided by the local authority in the interests of public use and enjoyment, and those that contribute to the proper management of the reserve. Where works or related works are appropriate a specific Permit may be issued under S.51(d) of the Fisheries Act (Beumer et al. 1997).

Approximately 15% of Moreton Bay is protected by Fish Habitat Areas (Australian Nature Conservation Agency 1996).

There are no FHAs in the vicinity of the Brisbane River mouth and Kedron Brook Floodway. The nearest FHA is at Hayes Inlet and the North and South Pine Rivers.

Protection of Marine Vegetation and Fish Habitats

All marine plants, including mangroves, seagrass and saltmarsh plants that grow on intertidal and subtidal lands are fully protected under the Fisheries Act.

Mangroves and other marine plants are protected under the *Fisheries Act 1994* due to their importance to the estuarine environment and fisheries production. Marine plants include:

- a plant that usually grows on or adjacent to tidal land, whether living, dead, standing or fallen;
- material of a tidal plant, or other plant material on tidal land;
- a plant, or material of a plant, prescribed under a regulation or management plan to be a marine plant (Couchman & Beumer 2002).

Plants of highest significance to fisheries include all mangroves, seagrasses, marine algae, saltcouch and samphires (Couchman & Beumer 2002). Plants of medium significance to fisheries are plants that usually grow adjacent to tidal lands and include *Melaleuca* and *Allocasuarina* species. In particular, where *Melaleuca* swamps adjacent to tidal areas are either permanently or periodically tidally connected and where *Allocasuarina* stands on the landward edge of tidal flats have saltcouch or samphire communities growing underneath them. A Section 51 permit is required for any disturbance of these communities (Couchman & Beumer 2002).

All waters of the state are now protected against degradation by direct or indirect impact under section 125 of the Fisheries Act. If litter, soil, a noxious substance, refuse or other polluting matter is on land (including the foreshore, tidal and non-tidal land), in waters, on marine plants, or in a fish habitat, and it appears to the chief executive that the polluting matter is likely to adversely affect fisheries resources or a fish habitat, the chief executive may issue a notice requiring the person suspected of causing the pollution to take action to redress the situation.

Commonwealth Environment Protection and Biodiversity Conservation Act 1999

This Act commenced on 16 July 2000. This Act provides that certain actions, in particular actions which are likely to have a significant impact on a matter of national environmental significance, are subject to a rigorous assessment and approval process. The Commonwealth may delegate to the States the responsibility for conducting assessments and, in limited circumstances, the responsibility for deciding whether to grant approval. Matters of national significance identified in the Act as triggers for the Commonwealth assessment and approval regime are:

- World Heritage properties
- Ramsar wetlands (including Moreton Bay)
- Nationally threatened species and ecological communities
- Migratory species
- Commonwealth marine areas
- Nuclear Actions (including uranium mining).

An impact on the ecological character of a declared Ramsar wetland is significant if:

- areas of the wetland are destroyed or seriously modified, or
- there is a major and measurable change in the natural hydrological regime of the wetland (eg changes to the timing, duration and frequency of ground and surface water flows to and within the wetland), or
- the habitat or lifecycle of native species dependent on the wetland is seriously affected, or
- there is a major and measurable change in the physico-chemical status of the wetland (eg salinity, pollutants, nutrients, temperature, turbidity), or
- invasive species are introduced into the wetland.

Species listed under the EPBC Act that have potential habitat in and adjacent to the Brisbane River, Kedron Brook Floodway and adjoining Moreton Bay and other aquatic habitats in the vicinity of the Gateway Upgrade alignment are listed in Appendix M8.

Ramsar Sites

In 1971 representatives of 18 nations including Australia met in the small Iranian town of Ramsar to sign the Convention on Wetlands of International Importance, commonly referred to as the Ramsar convention. This convention aims to conserve one of the most threatened habitats – wetlands. Currently over 80 nations are signatory to the convention. Countries which are party to the Ramsar convention promote wetland conservation by nominating specific sites to the List of Wetlands of International Importance, and by various other activities. In 1996 Moreton Bay was added to this list, primarily for its importance for many species of birds, but also for its importance to fisheries, dugong and turtle.

Nationally Important Wetland

Moreton Bay is listed as a wetland of National Importance (Australia Nature Conservation Agency, 1996). A wetland may be considered nationally important if it meets at least one of the following criteria:

- it is a good example of a wetland type occurring within a biogeographic region in Australia;
- it is a wetland which plays an important ecological or hydrological role in the natural functioning of a major wetland system/ complex;
- the wetland supports 1% or more of the national populations of any native plant or animal taxa;
- the wetland supports native plants or animal taxa or communities which are considered endangered or vulnerable at the national level;
- it is a wetland which is important as the habitat for animal taxa at a vulnerable stage in their lifecycles, or provides a refuge when adverse conditions such as drought prevail; or
- the wetland is of outstanding historical or cultural significance (ANCA 1996).

***Integrated Planning Act 1997* and Local Government Planning Schemes**

The Integrated Planning Act (IPA) establishes the land use planning system in Queensland to plan and regulate development. The IPA does not allow local governments to prohibit development, but each development application is assessed against desired environmental outcomes (DEO). Hence the zoning of land for conservation or open space, in which development is prohibited, will probably be phased out in favour of defined areas with DEOs which may include preservation of existing vegetation and habitat.

Under Brisbane City Council's *Natural Assets Local Law 2003* there are seven categories of protected vegetation:

- Council-controlled Vegetation (CCV)
- Vegetation Protection Orders (VPO)
- Significant Native Vegetation (SNV)
- Valued Urban Vegetation (VUV)
- Waterway Vegetation (WAV)
- Wetland Vegetation (WEV)
- Significant Landscape Trees (SLT).

The Waterway Vegetation (WV) category protects vegetation in waterway corridors, as defined in the City Plan. In built up areas, the Brisbane River corridor includes all land 20 m horizontal from the high water mark on each side of the bank. Corridors on other waterways, such as Bulimba Creek, are measured by flood regulation lines or a 30 m setback from each side of the centreline of the waterway (BCC 2003). To disturb protected vegetation, an application to *Carry Out Works on Protected Vegetation* should be submitted to Brisbane City Council.

Queensland Nature Conservation Act 1992* and *Nature Conservation (Wildlife) Regulation 1994

This Act provides generally for the protection and management of protected area, native wildlife and wildlife habitats throughout Queensland. Native wildlife may be declared protected and classified according to the status of its population – ranging from presumed extinct to common. Protected wildlife is to be managed according to the management principles detailed in the Act and any conservation plan that has been prepared for the wildlife.

Under this Act areas can also be acquired for inclusion in one of a range of protected area categories (including national parks and conservation parks) or can be made subject to voluntary conservation agreements.

Queensland Wetlands Strategy

The *Strategy for the Conservation and Management of Queensland Wetlands 1999* aims to provide an integrating framework to guide State agencies responsible for wetlands management. The Queensland Government's main objectives for wetlands are to:

- avoid further loss or degradation of natural wetlands, unless overriding public interest can be shown
- ensure a comprehensive and adequate representation of wetlands in the conservation reserve system
- base the management and use of natural wetlands on ecologically sustainable management and integrated catchment management principles
- develop community awareness of and respect for the values and benefits of wetlands and involvement in their management

Under this strategy all coastal wetlands in south east Queensland were mapped and classified according to their significance. State and regionally significant wetlands are in general to be managed for nature conservation and are to be maintained and enhanced.

Wetlands of state significance should be, in general, managed for nature conservation and to maintain and enhance the natural values, which contribute to conservation significance. They should be protected from development and disturbance of the physical and biological components of the ecosystem (Mclean et al 2001). Further, regionally significant wetlands should be recognised in catchment management plans and strategies, and no stormwater should be discharged into these areas (or there should be controls and monitoring to ensure any discharge is only of high quality) and that ground and surface flows are maintained at an appropriate standard (Mclean et al 2001).

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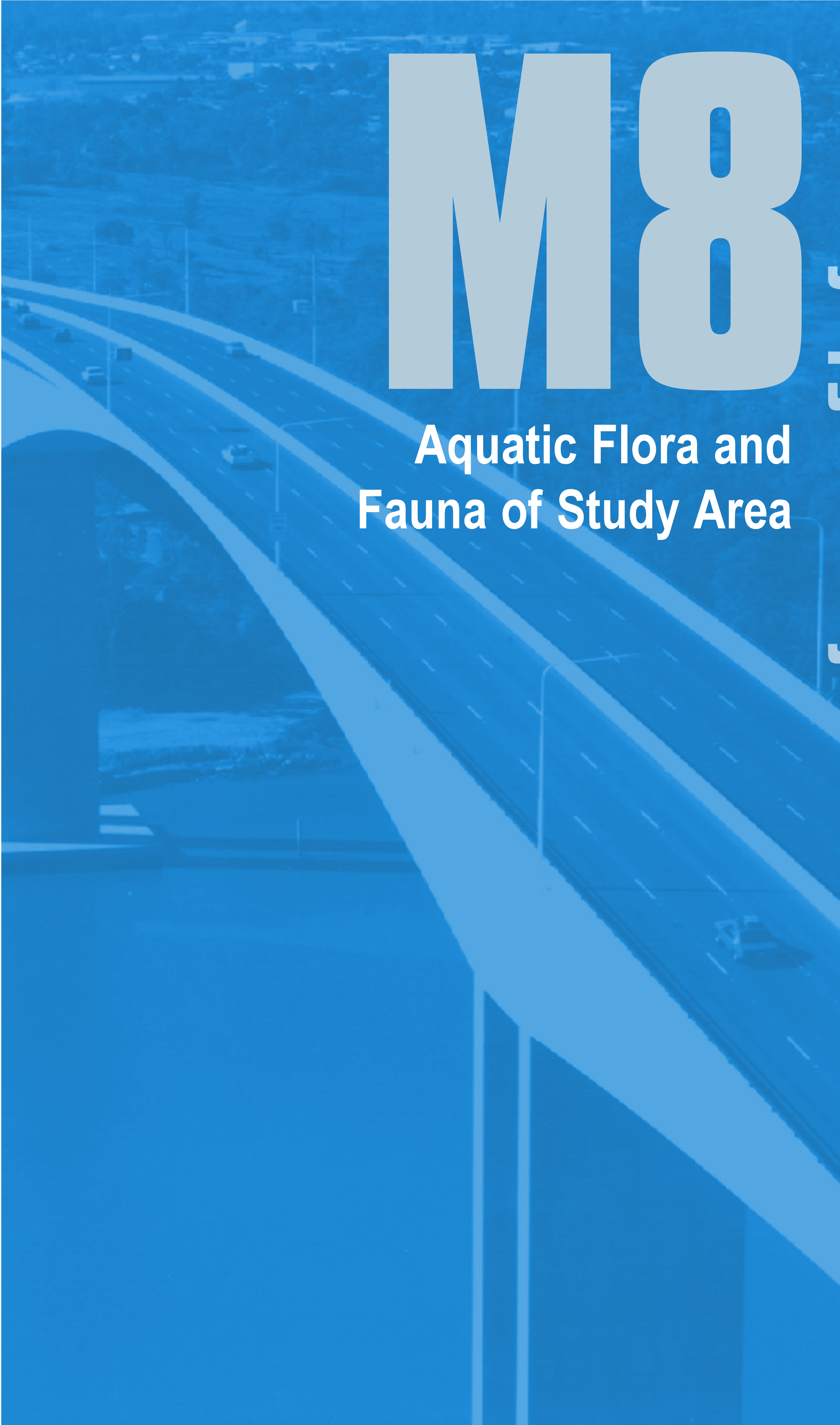


M8

Aquatic Flora and Fauna of Study Area

Gateway Upgrade Project

Appendix M8 Aquatic Flora and Fauna of Study Area

Table M3 Aquatic and intertidal plants recorded in the vicinity of the alignment

Species	Common Name	Bulimba Creek 1	Bulimba Creek 2	Bulimba Creek 3	Brisbane River	Lomandra Drive	Brisbane Airport	Schultz Canal	Kedron Brook	Kedron Brook Tributary	Wetlands Adjacent to Kedron Brook
MANGROVES											
Amaryllidaceae											
Crinum pedunculatum	mangrove lily		X	X							
Avicenniaceae											
Avicennia marina	grey mangrove			X	X	X	X	X	X	X	X
Euphorbiaceae											
Excoecaria agallocha	milky mangrove		X				X	X			
Myrsinaceae											
Aegiceras corniculatum,	river mangrove			X	X		X	X	X		X
Pteridaceae											
Acrostichum speciosum	mangrove fern		X	X							
Rhizophoraceae											
Rhizophora stylosa	red mangrove								X		
SALTMARSH											
Poaceae											
Sporobolus virginicus	marine couch					X	X	X	X	X	X
Chenopodiaceae											
Suaeda australis									X	X	
Casuarinaceae											
Casuarina glauca	swamp oak						X	X	X		X
FRESHWATER											
Araceae											
Xanthosoma violaceum	blue taro		X								
Potamogetonaceae											
Potamogeton pectinatus		X				X					
Polygonaceae											
Persicaria attenuata	smart weed	X									
Poaceae											
Phragmites australis	common reed						X			X	X
Cyperaceae											
Schoenoplectus sp.						X					X

Species	Common Name	Bulimba Creek 1	Bulimba Creek 2	Bulimba Creek 3	Brisbane River	Lomandra Drive	Brisbane Airport	Schultz Canal	Kedron Brook	Kedron Brook Tributary	Wetlands Adjacent to Kedron Brook
Schoenoplectus validus	river clubrush						X				X
Elatinaceae											
Elatine gratioloides	waterwort		X								
INTRODUCED/INVASIVE SPECIES											
Poaceae											
*Urochloa mutica**	para grass	X					X		X		X
Chloris gayana	rhodes grass						X	X	X		X
Caesalpiniaceae											
Senna pendula var. *glabrata*	easter cassia	X		X			X				X
Anacardiaceae											
Schinus terebinthifolia	Broad-leaf pepper tree			X	X		X				X
Convolvulaceae											
Ipomoea cairica	mile-a-minute			X			X				X
Verbenaceae											
Lantana camara	lantana						X		X		X

Table M4 Fish recorded in waterways in the vicinity of the alignment

Species	Common Name	Bulimba Creek 1	Bulimba Creek 2	Bulimba Creek 3	Brisbane River	Lomandra Drive	Brisbane Airport	Kedron Brook
Ambassidae								
Ambassis marianus	estuary perchlet		+	+	+++		++	
Anguillidae								
Anguilla reinhardtii	long-finned eel	+						
Apogonidae								
Apogon fasciata	common cardinalfish				++			
Siphamia rosiegaster	rose-belled siphonfish				++			
Ariidae								
Arius graeffei	blue catfish		+	+	+++		++	
Atherinidae								
Atherinomorus ogilbyi	Ogilby's hardyhead				++			
Craterocephalus marjoriae	marjorie's hardyhead		+					
Belonidae								
Tylosurus gavialoides	longtoms				++			
Blennidae								
Omobranchus punctatus	spotted oyster blenny				++			
Sp 1.							+	

Species	Common Name	Bulimba Creek 1	Bulimba Creek 2	Bulimba Creek 3	Brisbane River	Lomandra Drive	Brisbane Airport	Kedron Brook
Bothidae								
Pseudorhombus arsius	large-toothed flounder				++			
Callionymidae								
Repomucenus calcaratus	chalk-spot stinkfish				++			
Carangidae								
Alepes sp	trevally				++			
Carcharhinidae								
Charcharhinus leucas	river whaler				++			
Cheilodactylidae								
Cheilodactylus vestitus	eastern magpie morwong				++			
Clupeidae								
Herklotsichthys castelnaui	southern herring				++		+++	
Hyperlophus translucidus	glassy sprat				++			
Nematolosa comei	bony bream		++	++	++		+	
Cynoglossidae								
Paraplagusia guttata	spotted tongue sole				++			
Dasyatidae								
Dasyatis fluviorum	estuary stingray				++			
Himantura uarnak	coachwhip ray				++			

Species	Common Name	Bulimba Creek 1	Bulimba Creek 2	Bulimba Creek 3	Brisbane River	Lomandra Drive	Brisbane Airport	Kedron Brook
Diodontidae								
Dicotylichthys punctulatus	three-barred porcupinefish				++			
Tragulichthys jaculiferus	common porcupinefish				++			
Eleotridae								
Butis butis	crimson tipped gudgeon		+	+	++		+	
Hypseleotris compressa	empire gudgeon	+	+	+		+		
Prionobutis microps	small-eyed gudgeon				++			
Elopidae								
Elops hawaiiensis	giant herring				++		+	
Engraulidae								
Thryssa aestuaria	estuary anchovy				+++		+	
Gerridae								
Gerres subfasciatus	silverbiddy				+++		+	
Gobiidae								
Arenigobius frenatus	half-bridled goby		+	+	+++		+	
Cryptocentrus cristatus	crested mud goby				+++			
Gobiopterus semivestita	transparent goby				++		+++	
Istigobius nigroocellatus	black-spotted goby						++	
Mugilgobius stigmaticus	eye-tailed mangrove goby				++		++	++
Favonigobius exquisites	exquisite sand goby				++			
Pseudogobius sp.	blue-spotted goby				++		++	+

Species	Common Name	Bulimba Creek 1	Bulimba Creek 2	Bulimba Creek 3	Brisbane River	Lomandra Drive	Brisbane Airport	Kedron Brook
Redigobius bikolanus	bug-eyed goby				++			
Taeniodes purpurascens	blind goby				++			
Gobiodidae								
Brachyamblyopus sp	burrowing goby				++			
Hemiramphidae								
Arramphus sclerolepis	snubnosed garfish				+++		+	
Hyporhamphus regularis ardelio	river garfish				++			
Kyphosidae								
Girella tricuspidata	luderick				++			
Leiognathidae								
Leiognathus decorus	black-naped ponyfish				++			
Leiognathus moretoniensis	Moreton Bay ponyfish				++			
Lutjanidae								
Lutjanus russelli	mose's perch				++			
Megalopidae								
Megalops cyprinoides	oxeye herring				++			
Melanotaeniidae								
Melanotaenia duboulayi	crimson-spotted rainbowfish	+			++			

Species	Common Name	Bulimba Creek 1	Bulimba Creek 2	Bulimba Creek 3	Brisbane River	Lomandra Drive	Brisbane Airport	Kedron Brook
Monacanthidae								
Monacanthus chinensis	fan-bellied leatherjacket				++			
Paramonacanthus oblongus	dusky leatherjacket				++			
Monodactylidae								
Monodactylus argenteus	diamond fish				++			
Mugilidae								
Liza argentea	tiger mullet				++			
Liza subviridis	golden-eyed mullet				++			
Mugil cephalus	sea mullet				+++		++	
Myxus pertardi	freshwater mullet	++			++			
Valamugil georgii	fantail mullet				+++		++	
Mugiloididae								
Sp 1.							++	
Parapercis nebulosus	bar-faced weever				++			
Mullidae								
Upeneus tragula	flat-tailed goatfish				++			
Muraenesocidae								
Muraenesox bagio	pike eel				++			
Pegasidae								
Pegasus volitans	slender seamoth						+	

Species	Common Name	Bulimba Creek 1	Bulimba Creek 2	Bulimba Creek 3	Brisbane River	Lomandra Drive	Brisbane Airport	Kedron Brook
Platycephalidae								
Platycephalus fuscus	northern dusky flathead				++		+	
Playcephalus indicus	bar-tailed flathead				++			
Plotosidae								
Euristhmus lepturus	long-tailed catfish				++			
Plotosus lineatus	striped catfish eel				++		+	
Poeciliidae								
Gambusia hollbrooki	mosquitofish	+++			++	++++		
Xiphophorus helleri	swordtail	+						
Xiphophorus maculatus	platy	+				++		
Polynemidae								
Polynemus heptadactylus	seven-fingers threadfin				++		+	
Pomatomidae								
Pomatomus saltator	tailor				++		+	
Priacanthidae								
Priacanthus macracanthus	red bullseye				++	++		
Pseudomugilidae								
Pseudomugil signifer	pacific blue eye		++	++	++	+	+++	
Rhinobatidae								
Aptychrotrema banksii	Bank's shovelnose ray				++			

Species	Common Name	Bulimba Creek 1	Bulimba Creek 2	Bulimba Creek 3	Brisbane River	Lomandra Drive	Brisbane Airport	Kedron Brook
Scatophagidae								
Scatophagus argus	spotted butterfish				++		+	
Selenotoca multifasciata	striped butterfish				+++			
Sciaenidae								
Argyrosoma hololepidotus	jewfish				++			
Johnius vogleri	little jewfish				++			
Scorpaenidae								
Centropogon australis	barred fortesque				++			
Centropogon marmoratus	northern fortesque				++		+	
Notesthes robusta	bullrout				+++			
Synanceia horrida	estuary stonefish				++			
Sp 1.							+	
Siganidae								
Siganus spinus	black spinefoot				++			
Sillaginidae								
Sillago analis	golden-lined whiting				++			
Sillago ciliata	sand whiting				++			
Sillago maculata	diver whiting				+++		+	
Soleidae								
Aseraggodes macleayanus	narrow-banded sole				++			
Synaptura nigra	black sole				++		+	

Species	Common Name	Bulimba Creek 1	Bulimba Creek 2	Bulimba Creek 3	Brisbane River	Lomandra Drive	Brisbane Airport	Kedron Brook
Sparidae								
Acanthopagrus australis	yellowfin bream			+	+++		++	+
Rhabdosargus sarba	tarwhine				++			
Sphyraeniidae								
Sphyraena obtusata	stripped sea pike				++		+	
Sygnathidae								
Hippichthys penicillus	black-chinned pipefish				++			
Sp 1.							+	
Teraponidae								
Pelates quadrilineatus	trumpeter				++		++	
Terapon jarbua	crescent perch				++			
Tetraodontidae								
Marilyna pleurosticta	banded toado				++		+++	+
Tetractenos hamiltoni	common toadfish				+++		+++	+++
Urolophidae								
Urolophus testaceus	common stingaree				++			

Table Notes:

+ approx. 1 – 5 individuals recorded per event per sampling mechanism
++ approx . 6 – 20 individuals recorded per event per sampling mechanism
+++ approx . 21 – 100 individuals recorded per event per sampling mechanism
++++ approx . > 100 individuals recorded per event per sampling mechanism

Table M5 Invertebrates recorded in waterways in the vicinity of the alignment

Species	Common Name	Bulimba Creek 1	Bulimba Creek 2	Bulimba Creek 3	Brisbane River	Lomandra Drive	Brisbane Airport	Kedron Brook
BIVALVIA								
Corbulidae								
sp.	basket shell						+	
Laternulidae								
Laternula sp.	lantern shell						+	
Lucinidae								
Anodontia sp.	clam						+	
Mactridae								
Mactra sp.	clam						+	
Mesodesmatidae								
sp.							+	
Mytilidae								
Modiolus sp.	mussel						++	
Tellinidae								
Tellina sp.	clam						++	
sp.	clam						+	
CEPHALOPODA								
sp.	squid						+	
GASTROPODA								
Amphibolidae								
Salinator fragilis							+++	

Species	Common Name	Bulimba Creek 1	Bulimba Creek 2	Bulimba Creek 3	Brisbane River	Lomandra Drive	Brisbane Airport	Kedron Brook
Ellobiidae								
Ophicardelus sp.	mangrove air breather						+++	
Littorinidae								
Bembicium auratum	gold-mouthed periwinkle				+++			
Littoria sp.						+		+
Mitridae								
sp.	mitre						+	
Muricidae								
sp.							+	
Nassariidae								
Nassarius sp.	dog whelk						+	
sp.	dog whelk							
Nassarius pullus	dog whelk						+	
Naticidae								
Polinices sordidus	moon snail						+	
Onchidiidae								
Onchidina australis	mangrove slug				+++		+	
Potamididae								
sp.	horn shells						+	
Thiaridae								
sp.	freshwater snail	++						
Viviparidae								

Species	Common Name	Bulimba Creek 1	Bulimba Creek 2	Bulimba Creek 3	Brisbane River	Lomandra Drive	Brisbane Airport	Kedron Brook
sp.	freshwater snail	+++				+		+
INSECTA								
Belastomatidae								
sp.	giant water bug	+						
Coenagrionidae								
sp.	damselfly larvae	++						
Calmoceratidae								
sp.	caddisfly larvae	+						
Corduliidae								
sp.	dragonfly larvae	+						
Chironomidae								
chironominae	midge larvae	+						
Diochopodidae								
sp.	dollie fly larvae						+	
Dytiscidae								
sp.	diving beetle larvae						+	
Gomphidae								
sp.	dragonfly larvae	+						
Stratiomyidae								
sp.	soldier fly larvae						+	
CIRRIPEDIA								
spp.	barnacle				+++		+	

Species	Common Name	Bulimba Creek 1	Bulimba Creek 2	Bulimba Creek 3	Brisbane River	Lomandra Drive	Brisbane Airport	Kedron Brook
MALACOSTRACA								
Alpheidae								
Alephus sp.	snapping shrimp						+	
Caprellidea								
sp.	skeleton shrimp						+	
Diogenidae								
sp.	hermit crab						+	
Gammaridea								
spp.	amphipod						+	
Grapsidae								
Helograpsus haswellianus	Haswell's shore crab				++		++	
Macrophthalmus punctulatus	smooth sentinel crab						+	
Macrophthalmus sp.	sentinel crab						+	
Metapograpsus frontalis	broad fronted mangrove crab				+		+	
Perisesarma spp.							+	
Isopoda								
Flabellifera sp.	isopod						+	
Luciferidae								
Lucifer hanseni	luciferid shrimp						++	
Mictyridae								
Mictyris longicarpus	soldier crab						+	
Ocypodidae								
Australoplax tridentata	furry-clawed crab				+		++	

Species	Common Name	Bulimba Creek 1	Bulimba Creek 2	Bulimba Creek 3	Brisbane River	Lomandra Drive	Brisbane Airport	Kedron Brook
Paracleistostoma sp.	hairy-legged crab						+	
Paracleistostoma wardii	hairy-legged crab						++	
Scopimera sp.							+	
Heloecius cordiformus	semaphore crab						+	
Uca longidigita	grey-clawed fiddler crab				+			
Uca sp.	fiddler crab						+++	
Palaemonidae								
Macrobrachium australiense	long-armed prawn	+++	+	++			++	++
Palaemon sp.	estuarine shrimp					++++	+	++
Penaeidae								
Metapenaeus sp.							+	
Metapenaeus ensis			+				+	
Metapenaeus bennettae	greasy-back prawn		++	++	+		++	
Penaeus esculentus	brown-tiger prawn							+
Penaeus merguiensis	banana prawn						+	
Penaeus sp.							++	
Porcellanidae								
sp. 1					++			
Portunidae								
Portunus pelagicus	sand crab						+	
Scylla serrata	mud crab						+	
Thalmita sp.	swimmer crab						+	

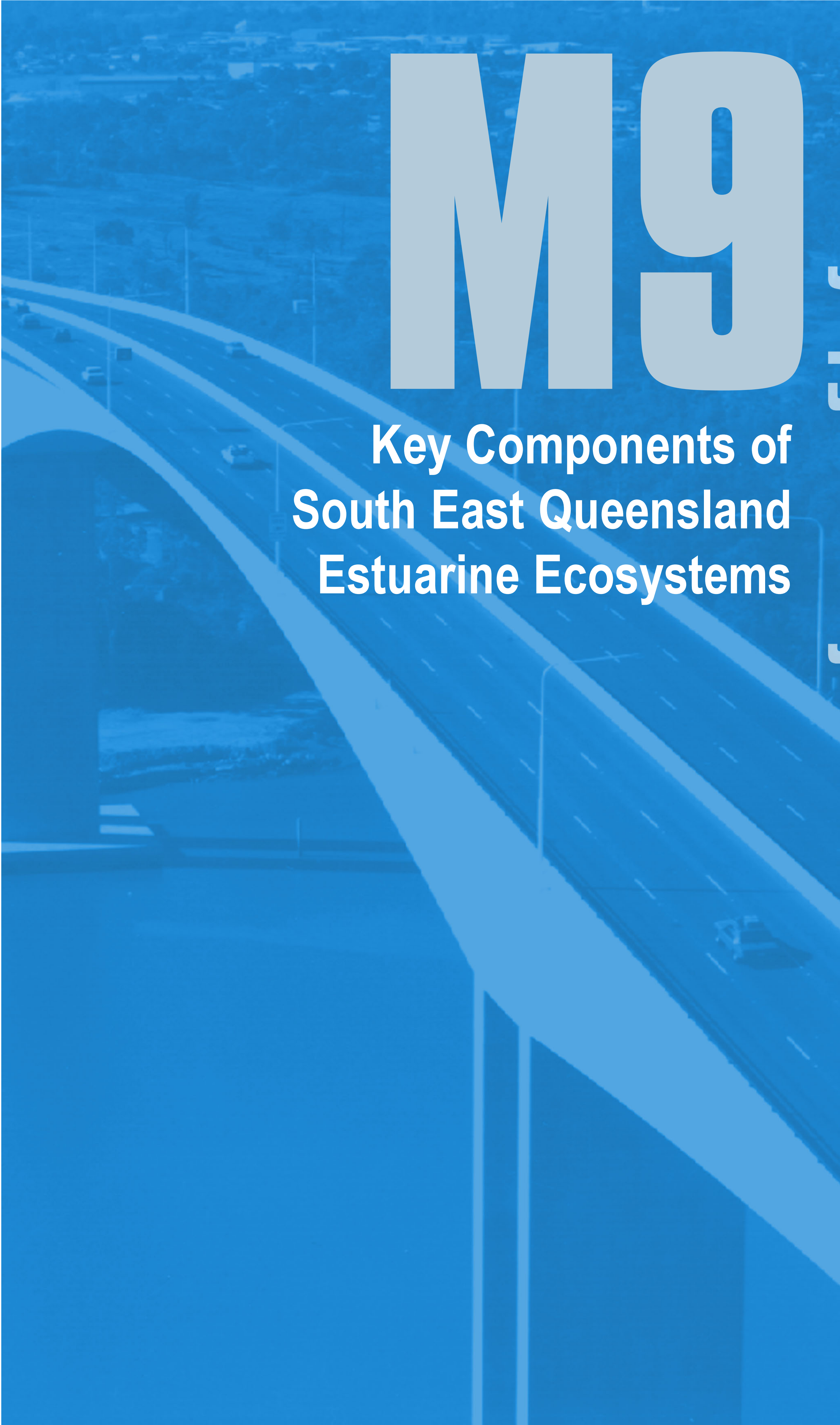
Species	Common Name	Bulimba Creek 1	Bulimba Creek 2	Bulimba Creek 3	Brisbane River	Lomandra Drive	Brisbane Airport	Kedron Brook
Sergestidae								
Acetes australis	Australian paste shrimp				+++		+++	+++
Tanaidacea								
Apseudidae								
Apseudes estuarinus	tanaid						+++	
PENNATULACEA								
Virgulariidae								
Virgularia rumphii	long-quill sea pen						+	
POLYCHAETA								
Amphinomidae								
spp.	fireworm						+	
Arenicolidae								
spp.	lugworm						+	
Capitellidae								
spp.	lugworm						++	
Cirratulidae								
spp.							+	
Eunicidae								
spp.	fireworm						+	
Glyceridae								
spp.	bloodworm						+	
Goniadidae								

Species	Common Name	Bulimba Creek 1	Bulimba Creek 2	Bulimba Creek 3	Brisbane River	Lomandra Drive	Brisbane Airport	Kedron Brook
spp.							++	
Lumbrineridae								
spp.							++	
Magelonidae								
spp.							+	
Maldanidae								
spp.	bamboo worm						+	
Nereididae								
spp.	rag worm						++	
Onuphidae								
spp.							++	
Orpheliidae								
spp.							+	
Oweniidae								
spp.							+	
Phyllodocidae								
spp.	sandworm						+	
Polynoidae								
spp.	scale worm						++	
Serpulidae								
spp.							++	
Spionidae								
spp.							+	

Species	Common Name	Bulimba Creek 1	Bulimba Creek 2	Bulimba Creek 3	Brisbane River	Lomandra Drive	Brisbane Airport	Kedron Brook
unknown polycheates							++	
unknown worms							++	
SCYPHOZOA								
sp.	jellyfish						+	
SIPUNCULA								
sp.							+	
Phascolosomatidae								
Phascolosoma arcuatum arcuatum	peanut worm						+	

Table Notes:

+ approx. 1 – 5 individuals recorded per event per sampling mechanism
++ approx . 6 – 20 individuals recorded per event per sampling mechanism
+++ approx . 21 – 100 individuals recorded per event per sampling mechanism
++++ approx . > 100 individuals recorded per event per sampling mechanism



M9

Key Components of South East Queensland Estuarine Ecosystems

Gateway Upgrade Project

Appendix M9 Key Components of South East Queensland Estuarine Ecosystems

Mangroves

The term 'mangroves' refers to a vegetation type, essentially comprised of trees able to withstand regular inundation by both fresh and salt water. Typically, mangroves are restricted to sheltered shorelines occupying the intertidal shallows between the sea and land. The 'soil' or sediment upon which mangroves grow may be clean coarse sand, but is more commonly fine silt and mud, high in nutrients but essentially anaerobic (lacking in oxygen).

Mangroves are an important component of the estuarine habitat because they:

- input significant amounts of vegetable matter into the food chain. Leaves, fruits and bark fragments fall either directly into the water or to the ground where they are carried into the water on the next tide. As these components decompose, they provide both soluble nutrients and detrital fragments that are eaten by crustacea such as prawns and crabs and some fish. Bacteria and fungi also feed on the decomposing matter and in turn are eaten by larger organisms (West 1985)
- trap, accumulate and release nutrients (and in some cases pollutants) and particulate matter (silt) from surrounding land, thus acting as a buffer to the direct effects of runoff (West 1985)
- provide a habitat or shelter to a range of fauna and flora (eg Morton et al. 1987). Mangroves are recognised as important roosting sites for birds and macro-bats (eg Driscoll 1992), and the sediment in which they grow typically supports both a high diversity and abundance of fauna. Many species of algae and 'terrestrial' epiphytes are commonly found in association with mangrove communities. The creeks which wind through large mangrove forests are also important as fish and crustacean habitats (Blaber 2000; Robertson and Blaber 1992; Vance et al. 1990; Robertson and Duke 1990)
- protect the shoreline from erosion emanating either from the water (waves, boat wash) or the land (runoff) (Blamey 1992) and contribute to the establishment of islands and the extension of shorelines (Blamey 1992)

Estuarine mangrove forests are important nursery grounds for many species of juvenile fishes (Blaber 1997; Halliday and Young 1996; Laegdsgaard and Johnson 1995; Robertson and Blaber 1992; Robertson and Duke 1990) and by comparison characteristically support greater abundances of fish than either seagrass areas or unvegetated tidal flats (Laegdsgaard and Johnson 1995; Blaber et al. 1992; Robertson and Duke 1987). Sub-tidal habitats characterised by mangrove-lined channels support a variety of fish species, which appear to have habitat-specific distributions according to individual species requirements for food and shelter from predation (Zeller 1998). For example, mangrove prop roots and fallen timber snags are influential in the distribution of estuarine snappers (such as *Lutjanus argentimaculatus*), rabbit fishes and bream, supporting a higher abundance of these species than unvegetated banks and mid-channel habitat. These latter habitats also support a smaller diversity of species, but are none the less positively correlated with the distribution of groupers and ariid catfishes (Sheaves 1996).

Juveniles of 7 of the 10 commercially harvested fish species in Moreton Bay are most abundant in mangroves (Laegdsgaard and Johnson 1995). Further, Morton (1990) reported that 46% by species and 94% by weight, of fishes associated with an *Avicennia marina* forest in Moreton Bay were of direct commercial significance (Morton 1990). Adjacent waters supported significantly less fish, both in terms of abundance and biomass.

The branches, twigs and leaves of mangroves and other coastal plants, fallen into the sea and moved about by tidal action, also form temporary habitats for juvenile fishes (Conacher et al. 1996), often remote from the mangrove forests themselves (Daniel and Robertson 1990). Decaying organic matter of both plant and animal origins is consumed by both juvenile and adult greasy back prawn, and juvenile banana prawns – obligate residents of mud banks adjacent to mangroves (Staples et al. 1985). Adult banana prawns eat both small benthic invertebrates feeding on detritus in channels draining mangroves, and benthic algae on adjacent mud flats (Newell et al. 1995).

Saltmarsh/Claypan
Coastal saltmarshes are found in saline areas and are dominated by herbs, grasses or low shrubs (Adam 1990). In south-east Queensland, saltmarshes are frequently found in the upper intertidal, landward of the mangrove forests on areas which are infrequently inundated by tidal or fresh water, and that consequently have very high soil water salinities. Where soil salinity exceeds the ability of even saltmarsh plants to grow, bare claypans may form. The mosaic of saltmarsh and claypan elements may result in a high quantity of eco-tonal habitat.

Unlike mangrove forests, which are found next to saline water bodies, and are dominated by trees, coastal saltmarshes are dominated by herbs, grasses or low shrubs (Adam 1990). In south-east Queensland, saltmarshes are frequently found in the upper intertidal, behind the mangrove forests on areas which are infrequently inundated by tidal or fresh water, and that consequently have very high soil water salinities.

Saltmarsh communities and the role they play in the broad ecology of estuaries, are perhaps the least well understood of the intertidal communities (saltmarsh, mangroves and seagrasses), particularly in Australia. However they are thought to have the following important roles:

- stabilisation of bare mud flats. Algae frequently colonise first forming mats over the bare mud. The mucilaginous nature of the algae stabilises the sediment surface, enabling colonisation by other (saltmarsh) plants. Sediment is then trapped by the leaves of these plants, causing a gradual build up of sediment. The binding of sediment by plant roots also probably confers some resistance to erosion (van Erdt 1985; cited in Adam 1990)
- habitat for fish and invertebrates
- remineralisation of terrestrial and marine debris: saltmarshes contribute to the nutrient cycling of estuaries, and may buffer the water bodies from excess nutrients from the land (Adam 1990)
- direct food source for terrestrial, avian and marine fauna

Our understanding of the direct use of saltmarshes by finfish and nektonic crustaceans is comparatively poor. Early seasonal studies indicated that fish of importance to commercial (and recreational fisheries) rarely utilise upper littoral saltmarsh habitat (Morton et al. 1988; Connolly et al. 1997); whilst more recent studies indicate that some Queensland saltmarsh / claypan areas are commonly frequented by fish species of significance to commercial and recreational fishers (Connolly 1999).

Saltmarshes may support dense mats of algae, which are important contributors to local fisheries productivity through providing an alternative source of food to detritus (Adam 1995). Further, the shallow pools topped up intermittently by rainfall support a variety of invertebrates (including crabs, other small crustaceans and insects) that are consumed by fishes following the rising tide. In particular, juvenile bream are known to enter tidal drains into saltmarsh habitat on the rising tide to feed, moving back into deeper water as the tide recedes (Morton et al. 1987).

Seagrass
As significant primary producers (Hillman et al, 1989), seagrasses have been recognised as playing a critical role in coastal marine ecosystems (Hyland et al. 1989; (Poiner and Roberts 1986; Pollard 1984). They also provide shelter and refuge for resident and transient adult and juvenile finfish, crustacea and cephalopods, many of which are of commercial and recreational importance, others of which are the preferred foods of these species (Connolly 1997; Gray, McElligott and Chick 1996; Edgar and Shaw 1995; Coles et al. 1993; McNeill, Worthington, Ferrell and Bell 1992; Howard et al. 1989; Hutchings 1982; Dredge et al. 1977)

Seagrass meadows, like mangroves, provide important nursery habitat, particularly for a range of crustacean species (West and King 1996; Laegdsgaard and Johnson 1995; Connolly 1994; McNeill et al. 1992; Coles and Lee Long 1985; Young 1978). In Eastern Australia, seagrasses support both a greater diversity and abundance of fishes than bare substrate (Gray et al. 1996; Middleton et al. 1984; Ramm 1986). Seagrasses also provide a direct source of food for dugong, some turtle species (Lanyon et al. 1989), and some species of fish and crustacea.

The distribution of juvenile tiger prawns (*Penaeus semisulcatus* and *P. esculentus*), eastern king prawns and endeavour prawns is strongly correlated with inshore seagrass meadows (Staples et al. 1985). Each of the species in Queensland's east coast commercial prawn catch are dependent upon seagrass meadows as nurseries where juveniles may shelter and feed before recruiting to deepwater fishing grounds (Zeller 1998). Seagrass leaves provide physical cover for young prawns and provides a substrate for both epiphytic algae and minute grazing animals which form a major component of the prawns' diet. Some seagrasses including the common eelgrass (*Zostera capricorni*) are themselves eaten by juvenile tiger prawns in Moreton Bay (O'Brien 1994).

The distribution of juveniles of commercially important species such as bream, tarwhine, sea mullet, flat-tail mullet, luderick and sand whiting are also positively correlated with the occurrence of seagrass (West and King 1996).

Seagrasses also trap, stabilise and hold bottom sediments (Poiner and Peterken 1995; Fonseca and Kenworthy 1987); slow and retard water movement promoting sedimentation of particulate matter and inhibiting resuspension of organic and inorganic matter (Philips and Menez 1988); supply and fix biogenic calcium carbonate (den Hartog 1970); produce and trap detritus and secrete dissolved organic matter that tends to internalise nutrient cycles within the system (Moriarty et al. 1984); and provide large amounts of substrate for encrusting animals and plants (Klumpp et al. 1989; Harlin 1975).

Macroalgae

Macroalgae are a commonly overlooked component of the marine environment, which may significantly contribute to a localities ability to support marine life, in particular fish and crustacea. The macroalgal component of estuarine floral communities may consist of several elements: loose lying or drift algae, rhizophytic or benthic macroalgae, and epiphytic algae on seagrass or other algae (den Hartog 1979).

Approximately 275 species of macroalgae have been identified from Moreton Bay (Phillips 1998). Moreton Bay is a zone of overlap between tropical/subtropical species and temperate species of macroalgae, and consequently has a diverse range of species. Many tropical and subtropical species have their southern limit of distribution in Moreton Bay. Over fifty species of macroalgae have been recorded in association with mangroves (Cribb 1979); whilst a number of species of macroalgae (eg *Caulerpa taxifolia*, *Udotea argentea*) are commonly associated with seagrass meadows in Moreton Bay (eg Young and Kirkman 1975); and often extend into depths too great for seagrasses. Because of their close association with seagrasses, it is likely that these species contribute to the habitat of juvenile prawns that use seagrass meadows as nursery habitat (Zeller 1998).

The ecological significance of macroalgae and its role in nurturing and feeding fish and crustacea of importance to commercial and recreational fisheries has only recently been investigated. Macroalgal communities can play a role similar to other macrobenthic plants, providing oxygen, food and habitat for small fauna.

Macroalgae are likely to perform the following functions:

- provide shelter and refuge for resident and transient adult and juvenile animals, many of which are of commercial and recreational importance (Zeller 1998; Jenkins and Wheatley 1998)
- trap, stabilise and hold bottom sediments
- slow and retard water movement promoting sedimentation of particulate matter and inhibiting resuspension of organic and inorganic matter
- supply and fix biogenic calcium carbonate
- produce and trap detritus and secrete dissolved organic matter that tends to internalise nutrient cycles within the system
- provide food for many species including the green turtle (*Chelonia mydas*), an endangered species

Algae and invertebrates attached to rocky shores and reefs are grazed by fishes such as luderick, drummer, rabbit fish and bream.

Drifting macroalgae increase habitat complexity of coastal waters and substrates, and may also serve to 'redistribute' small fish and invertebrates.

Unvegetated Soft Substrate
Unvegetated sandy and muddy sediment, whilst commonly considered to be not as productive as areas supporting seagrass are also important to the ecosystem. Bare substrate is rarely bare. Where sediments are stable, microalgae communities (BMA or benthic micro-algae) become established within both the intertidal and shallow subtidal, predominantly in the top 3 cm of sediment. Benthic micro-algae are ubiquitous throughout Moreton Bay and are a major food source for benthic feeders such as prawns and other crustacea, bivalves and polychaete and nematode worms, which in turn are an important source of food for fishes including juvenile mullet (Hollaway and Tibbetts 1995), bream and whiting (Weng 1983).

Productivity rates of benthic micro-algae are highest in shallow coastal regions, with biomass greatest at water depths of less than 5m. In these shallow regions benthic micro-algae may form the basis of the coastal food web (Dennison & Abal 1999).

Mudflat habitats may be transitional zones between juvenile and adult habitats (Laegdsgaard & Johnson 1995). Bare substrates in shallow waters may also provide shelter from larger predators and the opportunity to employ camouflage: whiting, flathead and flounder are each examples of species positively associated with bare substrate habitat.

Intertidal and shallow subtidal sand flats support a variety of fish species. Fish such as whiting and flathead feed in sandy areas, whereas other such as bream and mullet prefer the fauna associated with muddy areas. In southern Moreton Bay, the yellowfin bream is perhaps the best known example of a species that migrates to surfbars (including Jumpin-pin) to spawn (Pollock et al. 1983). Shallow surf bars are also the spawning grounds for whiting, flathead, luderick, tailor and mullet.

Bream and other important species including juvenile sand whiting, feed over and along the edges of sand banks (Morton et al. 1987). Female sand crabs are associated with sand banks, whilst males are likely to be found in adjacent gutters (Smith & Sumpton 1987). Bait species important to both commercial and recreational fishers inhabit intertidal and shallow subtidal banks of sheltered bays (eg worms) and estuaries (eg yabbies) (Zeller 1998).

The fauna associated with soft sediment habitats is typically determined by the character of the sediment: its grain size and stability; and with the presence or absence (Humphries et al. 1992b; Poiner 1980), *or* proximity of seagrass (Ferrell & Bell 1991). Grain size influences the ability of organisms to burrow, and the stability of 'permanent' burrows. Unstable sediments support less diverse benthic communities than those that are relatively stable. Bare sediments within 10m of seagrass meadows were shown to support a similar total abundance of fishes, but a reduced diversity of species when compared with the nearby *Zostera* meadows themselves; whereas bare substrate 100m distant from the seagrass meadows supported significantly fewer individuals and species (Ferrell & Bell 1991). In partial contrast, studies of bare substrate and nearby *Ruppia* meadows showed finfish diversity to be higher over bare substrate, but abundance and biomass highest in the seagrass meadows (Humphries et al. 1992b).

Shallow water, bare sediment communities are characterised by widely fluctuating abundances, species richness and diversity. These fluctuations are correlated with severe abiotic disturbances (such as wind and wave activity). During calmer months, shallow bare sand developed similar communities to deep water bare sand habitats (Poiner 1980).

Rocky Reefs
Western Moreton Bay has only small areas of rocky reef and foreshore. These rocky reefs and shores support a mix of tropical, sub-tropical and temperate species (Wilson & Allen 1987). The occurrence of both tropical and temperate species may be subject to seasonal conditions, with species often becoming locally extinct following changes in water temperature (Richardson 1996). The floral and faunal communities colonising rocky reefs and intertidal rocky shores have been described by a number of studies (eg WBM Oceanics 1997; Banks and Harriott 1995; Harrison et al. 1995; FRC Coastal Resource and Environmental 1993; Endean et al. 1955).

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