



Technical Paper
Burnett Mary Regional Assessment

**Marine and Estuarine Water Quality and Wetland
Habitats of the Burnett Mary Region**

Final Report:

Submitted to:

**Burnett Mary Regional Group
for Natural Resource Management**

By

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The Burnett Mary region comprises of 5 major river catchments including the Baffle, Kolan, Burnett, Burrum and the Mary, the major land-use within these catchments is summarised in Table 1. For the purpose of this report estuarine and marine water quality and habitats are address within these regions, in addition the marine environment has been divided into Hervey Bay and the Great Sandy Strait (Figure 1).

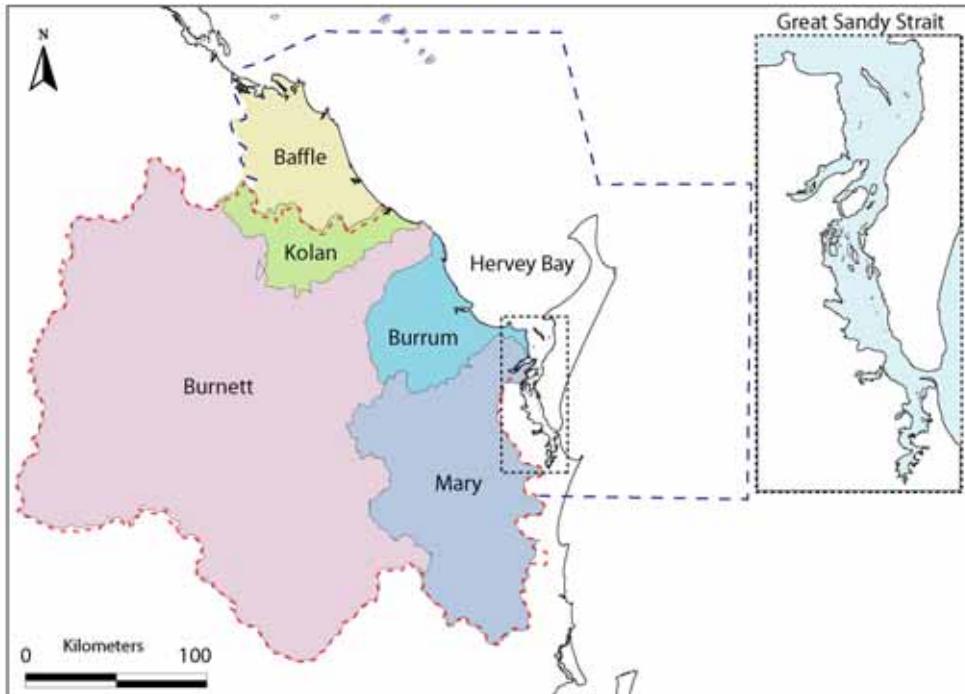


Figure 1- Map of major catchments and marine areas within the study region

Table 1 A summary of the major land-use within the Burnett-

Mary catchments (modified from Tomlinson, 2004).

| | % land use within river Catchments | | | | |
|-----------------------------------|------------------------------------|-------|---------|--------|--------|
| | Baffle | Kolan | Burnett | Burrum | Mary |
| Conservation | 19 | 7.8 | 5.0 | 14 | 23 |
| Forestry | 2.04 | 8.7 | 11 | 20 | 20 |
| Grazing | 71 | 70 | 77 | 51 | 44 |
| Intensive livestock and dairy | 0.18 | 0.15 | 0.80 | 0.11 | 2.9 |
| Dry crop | 0.36 | 0.16 | 2.2 | 0.29 | 0.12 |
| Horticulture | 0.31 | 0.40 | 0.24 | 0.69 | 0.82 |
| Sugarcane and other irrigation | 0.39 | 8.0 | 1.7 | 10 | 2.4 |
| Industry and Mining | 0.07 | 0.10 | 0.17 | 0.67 | 0.72 |
| Urban and Rural Residential | 5.86 | 4.83 | 1.3 | 2.39 | 5.36 |
| Catchment area (km ²) | 4 010 | 2 170 | 37 310 | 3 330 | 10 540 |

Current Resource Status

Principle water quality issues

Environmental degradation of estuarine and marine ecosystems is often a consequence of increased sediment and nutrients. Such forms of degradation significantly influence estuarine and marine water quality, which can result in changes in both the composition and physiological responses of marine biota. Traditional water quality parameters (including physical chemical attributes; turbidity, salinity, temperature, and dissolved oxygen, as well as nutrient and chlorophyll *a* concentrations) provides information on the water quality status. In the Burnett Mary regions water quality monitoring (of rivers and estuarine ecosystems), has primarily been conducted by DPI and QEPA. In contrast to freshwater riverine systems, of which substantial water quality analysis has been performed, estuarine and marine sampling however has been limited to few rivers; primarily that of the Mary, Burnett and Burrum Rivers and a few sites within Harvey Bay and the Great Sandy Strait (Figure 2 A and B).

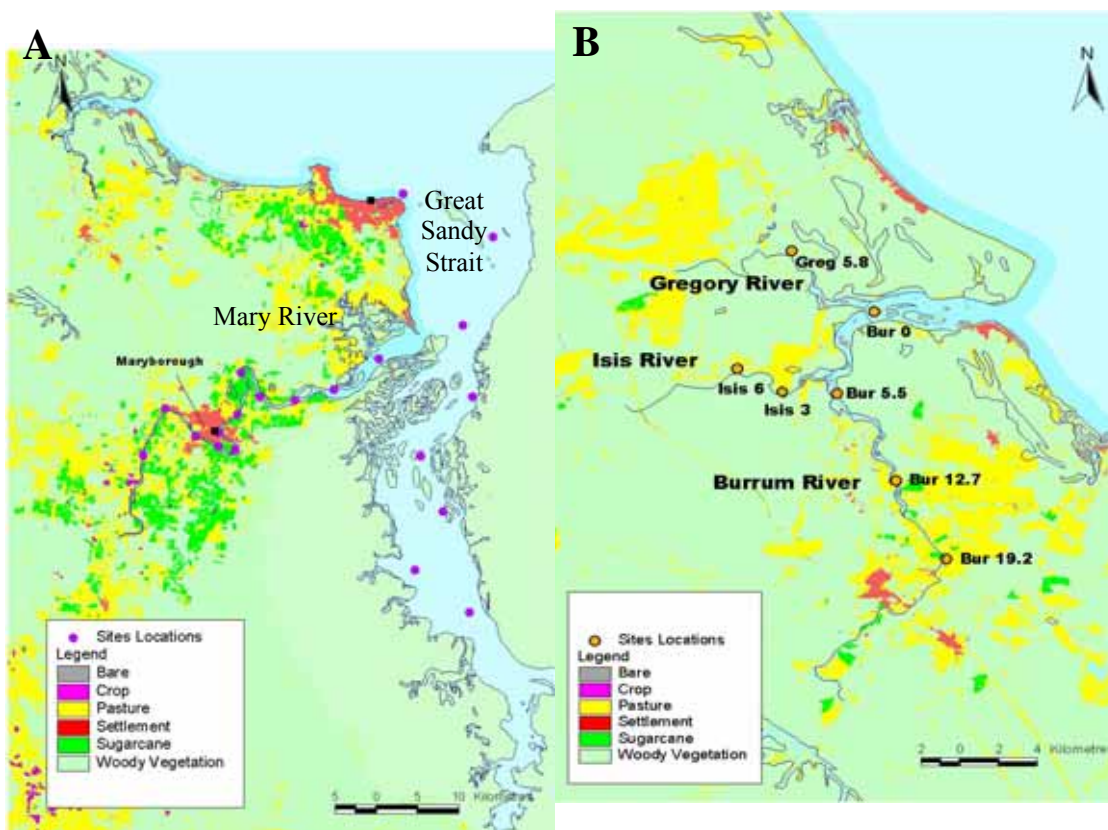


Figure 2 – A) Mary River estuarine and Great Sandy Straits marine QEPA water quality monitoring sites and B) Gregory, Isis and Burrum River QEPA estuarine water quality sites (QEPA Condition Assessment Report)

Nutrients

Nutrients (in particular nitrogen and phosphorus) are essential in any aquatic ecosystem. However, excess nutrients can stimulate the growth of macrophytes and algae in waterways (i.e. eutrophication). Eutrophication diminishes light availability to benthic communities such as seagrass and corals and causes fluctuations in dissolved oxygen and pH which may result in the loss of sensitive species. Chlorophyll *a* concentrations (a measure of algae biomass) are often measured as an indicator of nutrient and light conditions. In coastal regions, key sources of anthropogenic nutrient inputs include fertilizer run-off, sewage outlets, leaching from cleared lands and industrial, agricultural and aquaculture effluents (EHMP, 2004).

Exports of nitrogen and phosphorus (tonnes/year) into the marine environment have been estimated for various catchments along the Queensland coastline by a number of studies and using various models (e.g Moss et al, 1992, Furnas, 2002). The most recent studies have estimated that approximately 5 000 tonnes of nitrogen and 1 000 tonnes of phosphorus are exported annually from the entire Burnett Mary region (Table 2). In comparison to the total exports into the GBR lagoon, this region contributes to approximately 11% and 13% of nitrogen and phosphorus loads (respectively). The highest contribution to these nutrient inputs are from the Mary and Burnett catchments, although relatively high rates of nitrogen and phosphorus are exported from the Baffle catchment.

Table 2 – Total Sediment, Nitrogen and Phosphorus exports (tonnes/year) from the Burnett Mary catchments (Furnas, 2002)

| | Sediment | Nitrogen | Phosphorus |
|------------------------|------------|----------|------------|
| Baffle | 290 000 | 654 | 128 |
| Kolan | 150 000 | 344 | 68 |
| Burnett | 420 000 | 965 | 189 |
| Burrum | 200 000 | 461 | 91 |
| Mary | 1 000 000 | 2 292 | 448 |
| Total Burnett-Mary | 2 060 000 | 4 716 | 924 |
| Total GBR catchment | 14 400 000 | 42 907 | 7 090 |
| % of total GBR exports | 14 | 11 | 13 |

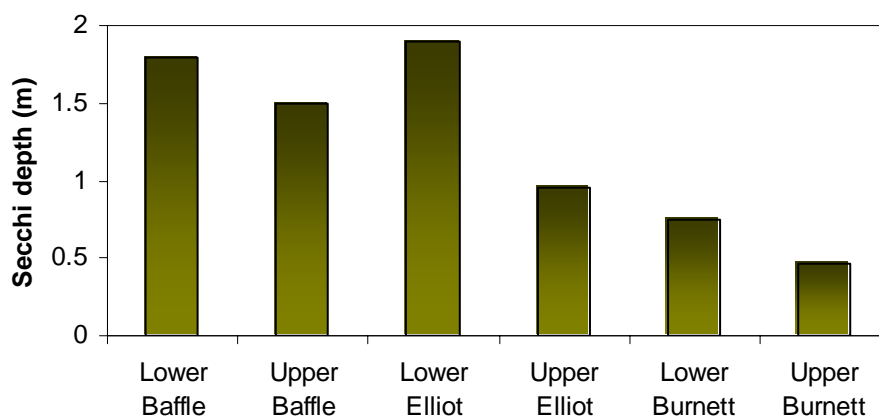
QEPA has established a number of long-term monitoring sites in various locations within rivers and creeks in the Baffle (1982 – 2004), Kolan (1982 – 2004), Burnett (1980 – 2004), Burrum (1979 – 2004) and Mary (1984 – 2004) catchments as well as the Great Sandy Strait (1992 – 2004) and Hervey Bay (1984 – 2004). Although there is substantial data for each of these catchments, few attempts have been made to assess and analyse these long term data sets. Some exceptions are that of the Mary River estuary and the Great Sandy Strait, which in 2001 QEPA assessed the monitoring data from 1997 – 2000. This data indicated that the Mary River estuary (particularly in the lower reaches) is nutrient enriched with nitrogen and phosphorus concentrations often exceeding ANZECC (1992) water quality (QEPA, 2001a). Chlorophyll *a* concentrations were above guideline within the Mary River estuary, most likely due to the lack of light availability. In the Great Sandy Strait, nitrogen and phosphorus complied with guidelines at all sites, although chlorophyll *a* concentrations were slightly higher than guidelines at some sites. Chlorophyll *a* concentrations have been recorded in the eastern region of Hervey Bay as part of the Oceania Project (during whale watching season i.e. August - October), which aimed to establish a long term record of chlorophyll *a* concentrations in the region (Moss and Kocoviski, 1998). The findings from this study indicated that chl *a* concentrations have remained fairly consistent over time (1993-1997) and were generally below ANZECC 1992 water quality guidelines.

Sedimentation and turbidity

Estuarine and marine environments are usually adapted to fluctuating turbidity and sedimentation due to the natural processes such as wave and wind action. However, alterations in catchment land use, resulting in erosion can increase sediment runoff. The increase in suspended particles can result in reduced light penetration as well as smother benthic organisms, affect fish respiration and transport other chemicals and contaminants. Flood events are a particular issue in the Burnett Mary region. In 1992 and 1999, the Mary River flooded, resulting in significant plumes of suspended sediments into the Hervey Bay and Sandy Strait regions (Preen et al., 1995 and McKenzie et al., 2000). These events resulted in substantial loss of seagrass meadows, with flow on effects leading to the reduction of fisheries and declining dugong and turtle numbers (See Biodiversity Technical paper for maps of seagrass with in Hervey Bay and the Great Sandy Strait).

The Department of Primary Industries has conducted fisheries resource assessments in various estuaries in the Burnett Mary region (including the Burnett, Baffle and Elliot Rivers). As part of these studies, secchi depths were determined which provide an indication on light penetration, i.e. a larger secchi depth indicates clearer waters. The results from these studies indicate that lower water clarity was observed in the upper reaches of the estuaries studied and lower water clarity was observed in the Burnett River compared to Elliot River and Baffle Creek (Lupton and Heidenreich, 1993;1996).

Figure 2 – Average Secchi depth (m) in the upper and lower estuarine reaches



of the Baffle, Elliot and Burnett estuaries (Adapted from Lupton and Heidenreich, 1993; 1996).

QEPA has determine

d that water clarity in the Mary River estuary is generally poor. Within the Great Sandy Strait, water clarity is generally above guidelines, although slightly elevated turbidity was measured at some sites, particularly near the Mary River mouth (QEPA, 2001a).

Similarly to nutrients, sediment export rates (tonnes/year) have been estimated for various catchments along the Queensland coast. These estimates suggest that a total of approximately 2 million tonnes of sediment are exported from the Burnett Mary region per year, the majority of which are from the Mary and Burnett catchments. In comparison to the total exports into the GBR lagoon, the Burnett Mary region contributes to approximately 14% of the total sediment exports to the GBR lagoon (Furnas et al., 2004).

Overall, dry catchments along the Queensland coastal are the source of 85 % of sediment, 66 % of nitrogen and 78 % of phosphorus inputs into the GBR lagoon, (Furnas et al., 2004). These catchments are predominately used for grazing purposes and it is becoming increasingly apparent that nutrient and sediment loss from grazing lands is becoming a serious

issue for coastal marine environments (Furnas et al., 2004). Within the Burnett Mary region approximately 70 % of the land is used for grazing (Thompson, 2004) thus efforts to effectively manage grazing lands, and reduce erosion will reduce the loads of nutrients and sediments entering the marine environment.

Pesticides

Pesticides are substances, or a group of substances (including herbicides, fungicides, and insecticides) used to prevent, destroy, repel or mitigate any pest. Pesticide application is associated with agricultural, industrial and urban usage. In the Burnett Mary region, little information exists on the use of pesticides and the only documented estimates are available for the sugar industry (Hamilton and Haydon, 1996). Diuron, chlorpyrifos, atrazine, asulam, paraquat are overall the pesticides with the highest application in the Burnett Mary region (Table 3). The total estimated use of pesticides (in 1996) in the region is 100 661 kg ai/year, which represents approximately 10% of the total use of these pesticides in Queensland sugarcane areas, in comparison the area of sugarcane within the region represents approximately 16 % of the total area of sugarcane (derived from Hamilton and Haydon, 1996). The highest application of herbicides occurs in the Burrum and Burnett catchments, whereas the least applications occur in the Baffle catchment (which also has the lowest area of sugarcane farming). Within the Burnett Mary region, recent pesticide measurements have been conducted in a study by McMahon et al., 2003. In this study, five herbicides (including diuron, atrazine, simazine, hexazinone, ametryn) were detected in water samples from Hervey Bay, the Great Sandy Strait and the Mary and Burrum Rivers with the most common and most toxic of the herbicides surveyed being diuron (McMahon et al., 2003). The results from this study indicated that these chemicals may not directly impact the health of seagrasses, however the consequence of long-term and lethal exposure during flood events remains unknown (McMahon et al., 2003). Preliminary investigations have also implicated diuron as the potential cause of mangrove dieback within the Mackay region (Duke et al., 2001; 2003).

Table 3 Estimated use of pesticides in sugarcane areas of the Burnett Mary major catchments (kg active ingredient (ai)/year) (based on: Hamilton and Haydon, 1996)

| % Sugarcane | Catchment | | | | | TOTAL |
|----------------------|---|-------|---------|--------|-------|---------------|
| | Baffle | Kolan | Burnett | Burrum | Mary | |
| | 0.39 | 8 | 1.7 | 10 | 2.4 | |
| | Pesticide application (kg ai/yr) | | | | | |
| Atrazine | 523 | 4 070 | 8 169 | 9 034 | 410 | 22 206 |
| Diuron | 234 | 1 761 | 3 445 | 3 303 | 9 614 | 18 357 |
| 2,4-D | 66 | 499 | 1 028 | 1 620 | 1 197 | 4 410 |
| Glyphosat | 121 | 907 | 1 765 | 1 654 | 211 | 4 658 |
| Ametryn | 15 | 110 | 257 | 792 | 6 | 1 180 |
| Paraquat | 108 | 844 | 1 695 | 2 104 | 1 270 | 6 021 |
| Trifluralin | 72 | 560 | 1 117 | 1 133 | 78 | 2 960 |
| Asulam | 306 | 2 377 | 4 655 | 3 397 | 290 | 11 025 |
| MSMA | 7 | 50 | 97 | 137 | 1 027 | 1 318 |
| Pendimethalin | 3 | 22 | 40 | 26 | 5 | 96 |
| Chlorpyrifos | 356 | 2 696 | 5 220 | 10 500 | 2 853 | 21 625 |

| | | | | | | |
|--------------------|--------------|---------------|---------------|---------------|---------------|----------------|
| Ethoprophos | 97 | 731 | 1 427 | 2 468 | 23 | 4 746 |
| Aldicarb | 47 | 357 | 695 | 459 | 24 | 1 582 |
| MEMC | 24 | 39 | 109 | 117 | 18 | 307 |
| Prochloraz | 4 | 32 | 62 | 54 | 18 | 170 |
| TOTAL | 1 983 | 15 055 | 29 781 | 36 798 | 17 044 | 100 661 |

Other Water Quality Issues

Contaminants

Dioxins (polychlorinated dibenzo-*p*-dioxins and dibenzofurans) are persistent organic pollutants of global concern as they are toxic, persistent and can biomagnify through the food chain. Dioxins are generally regarded as trace contaminants in a number of chemical products and are released as by-products from various chemical, industrial and combustion processes. There are few industrial or chemical activities in the Queensland coastal region, yet elevated concentrations of dioxins (specifically octachlorinated dibenzodioxins (OCDD)) have been detected in Queensland coastal soils, river and marine sediments (Prange et al., 2002; Gaus et al., 2001). The source of dioxins in Queensland remains unknown, however a biogenic origin has been suggested (Prange, 2003). Particularly elevated concentrations of dioxins have been detected in marine sediments and dugongs and turtles from Hervey Bay, consequently health effects associated with the exposure of these compounds to dugongs, turtles and indigenous people is currently being investigated (Gaus et al., 2004).

Cyanobacteria blooms

Lyngbya Majuscula is a toxic marine cyanobacteria (blue-green algae) that has been reported to occur in large blooms, particular in Moreton Bay, Southeast Queensland. In these regions *Lyngbya* is generally found attached to seagrass in shallow clear waters, and smaller blooms have been reported to grow on rocks and corals. Blooms of *Lyngbya* are a concern, due to associated health effects including skin, eye and throat irritations, asthma like symptoms and nausea as well as environmental health effects including the smothering of seagrass and other benthic fauna and flora. There have been reports of *Lyngbya* in Hervey Bay and near Fraser Island dating from the 1960's. In contrast to other regions where *Lyngbya* has been found, in Hervey Bay and Fraser Island scallop and deep-crab fisherman have indicated that *Lyngbya* is associated mainly with deep waters and gutters. It is currently unknown why *Lyngbya* is present in Hervey Bay, whether it has always been there, and only reported since scallop fishing began, or whether it has been spread by trawling activities (Buchanan Heritage Services, 2003).

Estuarine and Marine wetland habitats

For the purpose of this report, the focus will be on coastal marine wetlands including tidal mangrove and salt marsh and inter-tidal seagrass. These habitats are recognised for their value to fisheries, through the provision of food, shelter, breeding and nursery habitats, but are also important as buffer zones to reduce downstream effects of excessive nutrient and sediments inputs.

Mangroves and Salt marshes

Mangroves are a diverse group of tropical shrubs and trees growing in the inter-tidal zone (Duke 1992), whereas salt marshes are low shrubs and herbs inhabiting the inter-tidal zone. Within the Burnett Mary region, 14 species of mangroves and 4 dominant species of salt marshes have been identified; see Table 4 (Duke, 1997; Bruinsma, C and Danaher, K, 2000; Lupton and Heidenreich, 1993, 1996). Mangrove species distribution is limited by the physiological tolerances of individual species to temperature (Duke et al., 1998) and noting that 3 species in the region are at their southern most distribution (in the Baffle area). The distribution and extent of mangroves in the Burnett Mary regions was estimated in a study by Bruinsma, C and Danaher, K, 2000, which used aerial photography and remote sensing images to estimate the coverage by major species groups.

The total area of mangroves within the defined areas of the Burnett Mary region was estimated to be 175 km², with the regions of the Great Sandy Strait and the Mary River comprising of the largest areas (Table 5). Salt marshes comprise of an area of 64 km² with the largest areas within the Great Sandy Strait, the Burrum and Mary River regions. Although the Bruinsma, C and Danaher, K, 2000 study provided a comprehensive documentation on the distribution of mangroves within the region, due to the scale limitations of using aerial photography and remote sensing images, mangrove and salt marsh fringes and smaller regions were unable to be distinguished.

Table 4 Mangrove and salt marsh species within the Mary-Burnett study region

| Mangroves | Salt marshes |
|-----------------------------------|---------------------------------|
| <i>Aegialitis annulata</i> | <i>Arthrocnemum spp.</i> |
| <i>Aegiceras corniculatum</i> | <i>Sarcocornia quinqueflora</i> |
| <i>Osbornia octodonta</i> | <i>Suavela sp</i> |
| <i>Excoecaria agallocha</i> | <i>Sporobolus virginicus</i> |
| <i>Rhizophora stylosa</i> | |
| <i>Avicennia marina</i> | |
| <i>Bruguiera gymnorrhiza</i> | |
| <i>Ceriops tagal</i> | |
| <i>Acrostichum speciosum</i> | |
| <i>Lumnitera racemosa</i> | |
| <i>Xylocarpus granatum</i> | |
| <i>Xylocarpus mekongensis</i> | |
| <i>Scyphiphora hydrophyllacea</i> | |
| <i>Pemphis acidula</i> | |

Table 5 – Mangrove and Salt Marsh areas (km²) within the Burnett Mary region

| | Mangrove | Salt marsh |
|--------------------|------------|-------------|
| Baffle | 6.8 | 3.6 |
| Kolan | 5.7 | 0.25 |
| Burnett | 10 | 2.1 |
| Burrum | 11 | 8.6 |
| Mary | 27 | 8.2 |
| Fraser | 1.7 | 0.8 |
| Great Sandy Strait | 113 | 40.2 |
| TOTAL | 175 | 63.7 |

Mangroves and salt marshes are important habitats within the tidal and inter-tidal regions as providing a habitat for many for wildlife, bird and fish. These habitats are also important with respect to water quality as they can reduce the downstream effects of excessive nutrients and sediments on marine habitats by trapping and stabilising sediments in their roots (reducing turbidity), absorb nutrients and other pollutants and physically protecting of the coastal fringe from erosion and flooding. Clearing and alteration of mangroves and salt marshes can thus contribute to water quality deterioration.

Seagrasses

Seagrasses are highly specialised marine flowering plants that have evolved from the land into the ocean, adapt to soft sediments in near-shore environments. Seagrass meadows are a critical component of coastal ecosystems as they increase primary productivity, stabilise sediments, support complex food webs, provide habitats for numerous species, including fish, crustaceans and other invertebrates as well as being an important food source for regionally important dugong and turtle populations. In order to survive, seagrass require adequate light availability to photosynthesis (Abal and Dennison, 1996, Dennison, 1987). Consequently the state of the water quality entering the marine environment i.e. the amount of suspended sediments, freshwater runoff and nutrient concentrations influence the distribution and abundance of seagrass.

The seagrass meadows of the Burnett Mary region are one of the largest single areas of seagrass resources in eastern Australia (McKenzie et al., 2000). Seagrass meadows of Hervey Bay and the Great Sandy Strait have been mapped at various times since 1977. In 1998 it was estimated that there was approximately 55km² of seagrass in the Great Sandy Strait region and 2 300km² in the Hervey Bay region (McKenzie et al., 2000). These mapping events have shown massive loss of seagrass meadows after flood events (e.g. 1 000 km² loss of seagrass in Hervey Bay after 1992 floods and 50% loss of seagrass in the Great Sandy Strait region during floods in 1998).

In total 7 seagrass species have been identified in the Burnett Mary region, although changes in species abundance and diversity are influenced by the status of the water quality (Table 6).

Table 6 Seagrass species within the Burnett Mary region

| Species |
|---------------------------------|
| <i>Cymodocea serrulata</i> |
| <i>Halodule uninervis</i> |
| <i>Halophila decipiens</i> |
| <i>Halophila ovalis</i> |
| <i>Halophila spinulosa</i> |
| <i>Syringodium isoetifolium</i> |
| <i>Zostera capricorni</i> |

Due to the high light requirements of seagrass (average of 10% of surface light), seagrass depth range, i.e. the vertical distribution of seagrass can be used as an indicator of water quality, with the maximum depth that seagrass grows representing the photosynthetically useful light available to benthic habitats. A number of long-term monitoring sites have been established within the Great Sandy Strait and Hervey Bay region. These monitoring sites are part of a 'Seagrass-Watch' program involving local community groups in conjunction with DPI/QPWS, such programs are vital to monitor the changes in seagrass distribution and to assess seagrass recovery after major flood events.

Pressures and Risks

Pressures and threats to Water Quality

Key influences on water quality include; loss of riparian zones, sediment, nutrient and pollutant runoff from agricultural and grazing lands and urban regions as well as tourism, industrial and mining activities.

| Threat | Cause | Effect |
|-------------------------|----------------------------------|------------------------------|
| Coastal Development | | |
| - ports, marinas | - sediment re-suspension | - reduced light penetration |
| - dredging | - storm water runoff | - eutrophication |
| - urban growth | - effluent runoff | |
| - industrial | - sediment runoff | |
| | - alteration of habitats | |
| Agriculture and grazing | - nutrient runoff | - eutrophication |
| | - sediment runoff | - reduced light penetration |
| | - pesticide and herbicide runoff | - effect health of organisms |
| | - loss of riparian zones | |
| Boating and shipping | - antifouling | - effect health of organisms |
| Aquaculture | - nutrient enrichment | - eutrophication |
| Impoundments | - restriction of water flow | - reduce regular flushing |
| Global warming | - increase sea temperatures | - eutrophication |

Pressures and threats to mangrove and salt marsh habitats

Mangrove and salt marshes are particularly vulnerable to changes in the coastal region as a consequence of urbanization and expansion, port development as well as climatic changes such as storm events, and rising sea-levels.

| Threat | Cause | Effect |
|----------------------------|-------------------------------|--------------------------------|
| Coastal Development | | |
| - ports, marinas | - alteration and habitat loss | - reduced erosion control |
| - dredging | | - reduced sediment trapping |
| - urban growth | | - reduced nutrient uptake |
| - industrial | | - mangrove dieback |
| Agriculture and grazing | - loss of riparian zones | - loss of habitat |
| | | - reduced erosion control |
| | | - reduced sediment trapping |
| Impoundments | - reduced waterflow | - reduced regular flushing |
| | | - hinder distribution upstream |
| Aquaculture | - alteration and habitat loss | - see coastal development |
| Mosquito and midge control | - draining saltmarsh areas | - loss of habitat |
| | - use of pesticides | - effect health of organisms |
| | | - mangrove dieback |
| Global warming | - sea level rise | - mangrove dieback |

Pressures and threats to seagrass habitats

Due to the locality of seagrasses in near-shore marine environments, seagrasses are particularly vulnerable to adverse light conditions as a consequence of algae growth (due to increased nutrients) and suspended sediments. Seagrasses are known to be sensitive to high acute herbicide exposure (Haynes et al., 2000), however the longterm exposure at low concentrations it is still unknown.

| Threat | Cause | Effect |
|-------------------------------|-------------------------------------|-----------------------------|
| Coastal Development | | |
| - ports, marinas | - sediment runoff and re-suspension | - smothering seagrass |
| - dredging | | - effect seagrass health |
| - urban growth | - toxicant runoff | - reduced light penetration |
| - industrial | | |
| Agriculture and grazing | - sediment runoff | As above |
| | - nutrient runoff | |
| | - pesticide and herbicide runoff | |
| Boating, shipping and fishing | - trawling | - habitat damage |
| | - prop plowing/anchoring | - effect seagrass health |
| | - antifoulants | |
| Aquaculture | - nutrient input | - As above |
| | - habitat destruction | |

Regional Assessments

As part of the Great Barrier Reef Water Quality Protection Plan (RWQPP), catchment associated with the GBR lagoon were ranked against 4 risks; Biophysical risk – pertaining to scale of potential land-based pollutants from the catchment and the impact on coastal/marine ecosystems, Social Risk - the capacity for communities to change practices that cause land-based pollution, Development Risk – future development pressures that may result in increase pollution and Risk to Marine Industries – economic impact of land-based pollution on industries operating in the catchment impact area. According to this assessment, the risk ratings for catchments within the Burnett Mary region are summarised in Table 7.

Table 7 – RWQPP Burnett Mary Regional Catchment Risk Rating (RWQPP, 2003)

| Basin | Biophysical Risk | Social Risk | Development Risk | Risk to Marine Industries |
|--------------|-------------------------|--------------------|-------------------------|----------------------------------|
| Baffle | M | H | M | L |
| Kolan | L | H | M | L |
| Burnett | M/H | H | M | M/H |
| Burrum | M | M/H | H | L |
| Mary | M/H | L | H | M/H |

Note: L (low risk), M (moderate risk), H (high risk)

OzEstuaries is an interactive web-based database that has been developed by Geoscience Australia, the National Land and Water Resources Audit (NLWRA) and as part of the coastal CRC's national estuaries project. Within this data base information on estuaries within the Burnett Mary Region (including estuary length, catchment area, condition, tidal range, classification, mangrove, salt marsh and seagrass area) have been collated (See Table 8). This information together with the RWQPP assessments have been used the regional assessments of the region.

Baffle

The Baffle Creek catchment encompasses an area of approximately 4 000 km². The major land use within the catchment is grazing (70 %), however a high percentage of the catchment (20 %) is maintained as conservation areas and the area is considered relatively pristine (Geoscience Australia, 2004). In some areas, riparian zones have been cleared for agricultural purposes, (in particularly sugarcane) and grazing lands have been cleared on slopes which poses a risk for erosion (GBRMPA, 2001). The majority of mangrove habitats within the Baffle region are protected under the Fisheries Habitat Area (FHA), including Rodd's Bay (management A and B), Eurimbula (A) Seventeen Seventy- Round Hill (A and B), Colosseum Inlet (A and B) and Baffle Creek (A) (DPI&F, 2004). Few studies have investigated the water quality status of the region, however there is an estimated high degree of sediment input and a moderate level of nitrogen and phosphorus input into the coastal marine environment (Furnas et al., 2002). According to the RWQPP, within the Baffle catchment there is a moderate biophysical and development risk, and a low economic impact on marine industries, however there is an estimate high capacity for communities to change practices that cause land-based pollution. Future management objectives need to include a baseline assessment of the Baffle in order to maintain the current status of the region and to monitor future effects.

Table 8 Estuary Classifications according to the Ozestuaries website (Geoscience Australia, 2004).

| Catchment | River/creek | Classification (dominant) | | Catchment area (km ²) | Tidal Range (semi-diurnal) | Estuary length (km) | Condition | Mangrove area (km ²) | Salt marsh area (km ²) | Seagrass area (km ²) |
|----------------------------------|---------------------|---------------------------|--------------|-----------------------------------|----------------------------|---------------------|----------------------|----------------------------------|------------------------------------|----------------------------------|
| | | Estuary | Delta | | | | | | | |
| Baffle | Colosseum Inlet | Tide | Tide | 475 | 2.8 | 13.75 | Near pristine | (44.1) | (20.7) | 0.001 |
| | Rodds Bay | Tide | Tide | 231 | 2.6 | 16.1 | Near pristine | (17.3) | (6.3) | 0.001 |
| Kolan | Baffle | River | Tide | 2652 | 2.3 | 19.81 | Near pristine | (4.99) | (1.25) | 0 |
| | Pancake/Jenny Lind | Tide | Tide | 115 | 2.5 | 10.25 | Near pristine | 2.5 | 3.38 | 0 |
| | Eurimbula | Tide | Tide | 83 | 2.5 | 4.34 | Near pristine | (16.4) | (10.9) | 0 |
| | Round Hill | Tide | Tide | 99 | 2.5 | 7.54 | Near pristine | (3.0) | (1.1) | 0 |
| | Blackwater/Mitchell | River | Wave | 268 | 2.4 | 5.75 | Near pristine | (4.8) | (3.2) | .001 |
| | Kolan | River | Wave | 2823 | 2.3 | 18.22 | modified | (0.99) | (0) | 0 |
| Burrum | Littabella | River | Wave | 184 | 2.3 | 11.75 | Largely unmodified | (5.88) | (0) | 0 |
| | Elliot | Tide | Tide | 293 | 2.3 | 4.12 | Largely unmodified | 7.10 | 0.16 | 0 |
| | Coonar | Wave | Strand plain | 62 | 2.3 | 2.36 | Largely unmodified | (2.4) | (0.05) | 0 |
| | Theodolite/Lagoon | Tide | Tide | 240 | 2.3 | 3.71 | Largely unmodified | 1.78 | 0.01 | 0 |
| | Burrum | River | Tide | 2368 | 2.4 | 21.61 | Largely unmodified | (3.6) | (0.21) | 0 |
| | Beelbi | Tide | Tide | 155 | 2.4 | 6.29 | Largely unmodified | 2.08 | 1.86 | 0 |
| Burnett | Burnett | River | Tide | 33 323 | 2.3 | 24.51 | Extensively modified | (0.45) | (0) | 0 |
| Mary | Mary | Tide | Tide | No data | 2.3 | 48.62 | Ext. modified | 0.31 | 0.25 | 0 |
| Hervey Bay Great Sandy Strait | | | Tide | No data | No data | 65.59 | Largely unmodified | (1.84) | (2.28) | 0 |
| | | | Tide | 11 636 | 2.7 | 50.63 | Largely unmodified | 1.30 | 2.42 | 0.001 |

Kolan

The Kolan River catchment covers an area of approximately 2 000 km², grazing is the dominant land use occupying 70 %. Other land uses include forestry (9 %) and sugarcane (8 %). In the Kolan, large areas of vegetation have been cleared for grazing and sugarcane cultivation, often extending to wetland boundaries (Bruinsma, C and Danaher, K. 2000). Several impoundments have been constructed in the Kolan, which have modified freshwater flows. Salinity is a problem in the region, associated with high water tables on cultivated lands, salt water intrusion to aquifers has occurred due to overuse of ground water (GBRMPA, 2001). There is little data available on the water quality of the region, and although the estimated sediment and nutrient exports are amongst the lowest for the region, urbanization and the use of agricultural chemical has resulted in the contamination of some local groundwaters (GBRMPA, 2001). Wetland areas are protected in this region under the Kolan River FHA (management B) (DPI&F, 2004). Within the RWQPP, the Kolan is classified as the least 'at risk' catchment within the Burnett Mary region, with a low risk for land based pollution impacting biophysical and economic impacts on marine industries, and a moderate risk from development, however similarly to the Baffle catchment there is a high capacity for communities to change practices to reduce land-based pollution.

Burnett

The Burnett is the largest catchment in the Burnett Mary region, encompassing an area of approximately 37 000 km². The major land use within the region is grazing (77%), other major land uses include state forestry, sugarcane and other dry crop cultivation. The Burnett catchment has undergone extensive alterations over past 40 yrs, including industrial and port development at the river mouth (Geoscience Australia, 2004; Bruinsma, C and Danaher, K. 2000). According to the RWQPP the Burnett catchment has a moderate to high risk for biophysical, development and economic impact associated with land-based pollutants, although there is a high capacity for communities to change practices to reduce these effects. Contaminants associated with urban runoff from Bundaberg have been suggested as a potential problem within the region, however little data is available to assess the level of this contamination. Due to the large area of the catchment and the close proximity to seagrass beds sediment and nutrient runoff is a major issue for this region (McKenzie et al., 2000). This is compounded by the reduction of freshwater flow associated with impoundments in the Burnett River, including the barrage and the future proposed dam. These impoundments restrict fish migration and reduce water flow, resulting in the sedimentation of the river mouth which will have long-term adverse effects on adjacent marine habitats, such as sediment accumulation and re-suspension (GBRMPA, 2001).

Burrum

The Burrum catchment is the second smallest catchment in the region, occupying approximately 3 300km². Grazing is the dominate land use in the region (50%), and 20 % of the land is used for forestry. Sugarcane agriculture and conservation areas account for 10 % and 14 %, respectively. Vegetation clearing for industrial, port and urban development is encroaching on coastal wetland habitats (Bruinsma, C and Danaher, K. 2000). There is a moderate degree of sediment and nutrient input into the coastal region, although due to the close proximity to seagrass beds, sediment and nutrient inputs are a concern for this region. Within the Burrum catchment there are large areas of mangroves and salt marshes, of which many are protected under FHA's including the Burrum (management a and B), Beelbi (management A and B) and Elliot (management A) (DPI&F, 2004). Although the region is considered largely unmodified (Geoscience Australia, 2004), the pesticide usage is the highest within the Burnett Mary region (Hamilton and Haydon, 1996). Under the RWQPP, the Burrum catchment is facing a high risk of future development increasing pollution and a

moderate risk for biophysical parameters. It is suggested that this will have low economic impacts on marine industries and there is a moderate to high capacity for communities to change land use practices.

Mary

The Mary River is the second largest catchment in the region (10 000 km²). It has been extensively cleared for agriculture and the lower reaches of the catchment are under significant pressure from grazing and agriculture (Lupton and Heidenreich, 1993). The main land use is cattle grazing with some area of sugarcane cultivation in the lower catchment areas. Within the Mary River estuarine water quality monitoring has been conducted resulting in an overall poor water quality status, particularly in the lower reaches of the estuary (QEPA, 2001a). Much of the area has a poor status of riparian vegetation (Johnson, 1996), thus land clearing, erosion and sediment transport, particularly during flood events is a concern for this region. In the past (e.g. 1992 and 1998) major flood events have resulted in the significant loss of seagrass meadows in Hervey Bay and the Great Sandy Strait (Preen, et al., 1995, McKenzie et al., 2000). The estimated sediment, nitrogen and phosphorus inputs to the coastal region are high, being the highest within the Burnett Mary region (Furnas et al., 2002). The Mary catchment is the most 'at risk' within the Burnett Mary region according to the RWQPP, with a moderate to high risk for biophysical and economic impacts on marine industries and a high risk for future development increasing pollution. Coupled with these moderate to high risks, there is an estimate low capacity for communities to change practices that cause land-based pollution.

Great Sandy Strait

The Great Sandy Strait is a region of significance, particularly for fisheries and as feeding grounds for dugongs and turtles. The Great Sandy Strait supports the largest mangrove area within the Burnett Mary region, and has been designated as a wetland of importance by RAMSAR of which approximately 932 km² have been declared a RAMSAR site. Most of the region is included within the Maroom fishery habitat area (Management A) (DPI&F, 2004). Although this region is relatively unmodified (Geoscience Australia, 2004), this region is vulnerable to declining water quality entering the region from the adjacent catchments. Massive seagrass loss, post flood events have been documented in the area (McKenzie, et al., 2000). Land clearing for urban and agricultural development pose a threat to wetland and mangrove habitats and sedimentation from major floods is resulting in the development of new wetland environments (Bruinsma, C and Danaher, K. 2000).

Hervey Bay

Hervey Bay is region of importance for fisheries, as a feeding ground for dugongs and turtles but also as a resting area for whales, during their migration along the Queensland coastline. Hervey Bay receives inputs from surrounding catchments particularly the Burnett, Burrum and Mary. Thus, this region is vulnerable to sediment and nutrient inputs from these catchments. Massive seagrass losses have been reported in Hervey Bay after flood events (McKenzie et al., 2000, Preen et al., 1995). Reports from the Oceanic Project, indicate that chlorophyll *a* concentrations in the eastern part of the bay have remained fairly consistent overtime (1993 – 1997) and were generally below ANZECC 1992 water quality guidelines. These measurements however were determined during whale watching season (i.e. August to October), which is concurrent with generally low rainfall and low temperature regimes (BOM, 2004). There is little information available during the summer months, when it may be expected to record higher chlorophyll *a* concentrations (due to the availability of light, temperature and nutrients).

The current responses to address issues

There are key legislation responses to growing concerns regarding the condition of marine and estuarine environment. These are reflected in Table 9.

Table 9 Regional, State/National and International responses identified

| Regional | State/National | International |
|---|--|---|
| <ul style="list-style-type: none"> • Wide Bay 2020 | <ul style="list-style-type: none"> • GBR Water Quality Protection Plan | <ul style="list-style-type: none"> • World Heritage Areas <ul style="list-style-type: none"> - Fraser Island - Great Barrier Reef |
| <ul style="list-style-type: none"> • Wide Bay Regional Planning Advisory Committee | <ul style="list-style-type: none"> • State Coastal Management Plan | <ul style="list-style-type: none"> • RAMSAR Convention <ul style="list-style-type: none"> - Great Sandy Strait |
| <ul style="list-style-type: none"> • Wide Bay Regional Growth Management Framework | <ul style="list-style-type: none"> • Healthy Waterways - Environmental Health Monitoring Program | <ul style="list-style-type: none"> • ANZECC WQ Guidelines |
| <ul style="list-style-type: none"> • Burnett Mary Regional Group | <ul style="list-style-type: none"> • Dugong Protected Areas <ul style="list-style-type: none"> • Fish Habitat Areas • Urban Stormwater management plan • National Action plan for salinity and WQ | |

Legislative Controls

- Great Barrier Reef Marine Park Act 1975
- Native Title Act 1993
- Native Title (Queensland) Act 1993
- Integrated Planning Act 1997
- Land Act 1994
- Transport Operations (Marine Pollution) Act 1994
- Transport Infrastructure Act 1994
- Local Government Act 1993
- Canals Act 1958
- Harbours Act 1955
- Cultural Records Act 1987
- Queensland Heritage Act 1992
- Acquisition of Land Act 1967
- River Improvement Trust 1940
- Water Resources Act 1989
- Petroleum (Submerged Lands) Act 1982
- Beach Protection Act 1968
- Environmental Protection Act 1994
- Nature Conservation Act 1992
- Marine Parks Act 1982
- Coastal Protection & Management Act 1995
- Fisheries Act 1995

Information and Management Gaps

To date there are numerous responses from local, state, national and international agencies as well as legislative controls that aim to protect the environment from adverse effects (summarised above). Yet sediment, nutrients and other contaminants pose threats to ecosystem health. It is currently unknown whether these plans and actions are effective in reducing environmental degradation in coastal marine ecosystems. Our concern is that many of these responses are initiated in a haphazard and uncoordinated manner to address high profile and broadly-based environmental issues and not catering directly to local specific issues. This needs to be addressed within local management agency using sound scientific evidence and advice. What is needed further is a monitoring program also to establish the effect of responses and mitigations programs already initiated. Without this information management and responses would not be improved or enhanced since lessons must be re-learned.

There is a need for institutions to have the capacity to respond and monitor the environment or processes within the environment when there is a rapid deterioration of ecosystem health. Such rapid deterioration may include for example fish kills, mangrove dieback and massive seagrass loss.

Since the early 1980's, the QEPA has been monitoring water quality within the Burnett Mary region, yet there have been few reports on the long term trends and changes in the state of the environment, with the exception of the Burnett and Mary Rivers and the Great Sandy Strait region (QEPA, 2001a). There is a need for a full review of current, past and ongoing changes in estuarine and marine water quality within the region. Furthermore, there is a large knowledge gap on ecosystem health and historic rates of change within key habitats including mangrove wetlands, seagrass, corals, macroalgae, freshwater wetlands and saltmarshes.

Environmental degradation of estuarine and marine ecosystems has occurred in the Queensland coastal region (e.g. seagrass loss, mangrove loss, coral bleaching). These forms of degradation are considered inevitable with the changes in catchment land use that has occurred over the past 40 years. However, communities often do not appear to understand that such changes in land-use patterns and the construction of dams for water supply, for example, result in a cost to the environment. For example, there have been appreciable changes in turbidity levels and accumulation of sediments in estuaries which have increased opportunities for mangrove colonisation. It would be inappropriate to blame the mangroves and to not look to the root cause of the problem, i.e. changed land use and altered water flows (See Wolanski, 2000). Communities need to accept the downstream effects of such change through formal awareness (e.g. schools and public documentaries) and to accept and maintain best management practices to reduce the extent of environmental degradation or to live with the inevitable changes.

Options for Burnett Mary NRM planning responses

Priority Actions

1. Develop a thorough inventory of marine and estuarine habitats of today
2. Assessment of historical changes to wetland habitats status over the last 200 y
3. Development of a water quality objectives for the region
4. Develop a regional water quality and ecosystem health monitoring program with review and status reporting every 2 years
5. Develop locally relevant threshold or trigger values for the full range of key bio-indicators and key water quality factors, including pesticides, nutrients and sediments
6. Restoration of riparian zones
7. Support rapid response to assess environmental deterioration.

Management Actions

1. Implementation of Best Management Practises

Best management practises can help preserve the aquatic environment and reduce detrimental effects on coastal ecosystems. Many industries such as the sugarcane and cotton growing industries have developed best management practises. Such practices include the maintenance of riparian areas, reduction of fertiliser and pesticide use and the recycling of water. Best management practices can be extended to the general public (through ecofriendly targeted education) to for example: reduce water usage, the use of fertilisers and to recycle waste.

2. Reduction of nutrients and sediments entering the waterways

One of the main management objectives for the Burnett- Mary regions is to reduce excessive nutrients and sediments entering the waterways. The major land use within this region is grazing. Pressures from over-grazing and loss of vegetation result in erosion, and consequently the runoff of sediments and nutrients. The region currently has a relatively low urban population, however with increase residential development there will be a need to assess the current status of sewage treatment plants, and upgrade the treatment process if necessary to account for increasing populations.

Restoration of riparian areas

Riparian areas are important for a number of functions, including the filtering of run-off, shading waterways, stabilising banks as well as providing food and shelter for aquatic and terrestrial fauna. The rehabilitation of riparian areas, such as tree planting and fencing stream areas adjacent to cattle grazing, can minimise sediment and nutrient inputs into the aquatic system, particular during flood events. Riparian restoration can be achieved through community groups, such as land-care and local volunteers groups.

Reduce impacts of stormwater runoff

Stormwater runoff carries pollutants including sediments, nutrients, organic matter, pesticides and rubbish that can harm our waterways. Urban stormwater plans can help reduce the impacts of stormwater runoff on the environment, by minimising pollution, the treatment and recycling of stormwater and promoting public awareness. In rural regions, few conventional stormwater systems and runoff occurs over the land into waterways. These stormwater plans need to focus on both urban and rural localities.

3. Baseline Ecosystem Health Assessment

There is a need to establish baseline data on ecosystem health of the Burnett Mary region. Such baseline data includes water quality monitoring, indicators of ecosystem health and indicators of historic environmental change.

Water quality monitoring

There is significant monitoring data available (from QEPA) on traditional water quality parameters (including temperature, salinity, turbidity, chlorophyll *a* concentrations, nutrients, light penetration, dissolved oxygen, conductivity and pH) within the catchments of the Burnett Mary region, since the early 1980's. However to date, the majority of this information remains un-synthesised and assessments of the historic, current and future projections of water quality for many of these regions has not been conducted. It is critical to conduct these assessments to a) establish the current state of the ecosystem, b) to assess whether plans and response are having an effect on the state on the environment and c) to assist in the development of water quality guidelines. Development of a biennial assessment of the water quality parameters measured monthly by QEPA will provide an integrative assessment of water quality issues in the Burnett Mary regional area.

Ecosystem Health Indicators

Ecosystem health indicators can provide an integrative assessment of the status or health of the estuarine and marine environment. A suite of ecological indicators have been developed, and are currently used by the SEQ Healthy Waterways program – Ecosystem Health Monitoring Program (EHMP). The following estuarine and marine indicators are used as part of this program and may be adapted for the Burnett Mary region.

Water Column Physical Chemical Parameters: turbidity, dissolved oxygen, salinity, pH, water temperature, light penetration (secchi depth), chlorophyll *a* concentrations, nutrients analysis (total nitrogen, total phosphorus, oxides of nitrogen, ammonium, filterable reactive phosphorus). These parameters are currently conducted through the QEPA water quality monitoring.

Seagrass Distribution: The distribution of seagrass can provide information on the water quality status in coastal marine ecosystems. In Hervey Bay and the Great Sandy Strait there are already a number of established seagrass-watch sites. The seagrass-watch program is a community based program that monitors the change in seagrass over time. It is essential that this program is expanded and continues.

Nitrogen Source Mapping: The source of nitrogen in aquatic systems can be determined by using a measure of the ratio of ^{14}N to ^{15}N ($\delta^{15}\text{N}$).

Sewage plume mapping can be achieved through the deployment of macroalgae at various sites in the estuarine and marine environment. Natural nitrogen abundance can also be measured by the determination of $\delta^{15}\text{N}$ value of mangrove, seagrass or macroalgae present in the environment.

Coral Health: Coral bleaching, sclerochronology, reef-check can provide information on coral health

Mangrove Health: The extent of tidal wetland vegetation cover and areas of dieback are key indicators of the health of estuarine ecosystems. Such measures monitored over time, both historically and into the future, provide quantification of condition or rates of change.

Benthic Microalgae (BMA): spatial and biodiversity assessments of BMA can provide a measure of health and species shift.

As part of the monitoring of these ecosystem health indicators it is essential to develop threshold limits for these indicators. This will assist the agencies in the rapid response to environmental deterioration.

Historical Change in marine and estuarine habitats

Monitoring of anthropogenic and natural change in wetlands, rivers and the coastal system can provide invaluable information of trends and rates of change. The systematic assessment of change, also provide essential information on the drivers of change. Knowing the drivers (sediments, toxicants, nutrients or climate change) is needed in management programs seeking to control and limit the detrimental influences in order to preserve and protect our coastal ecosystem. The decadal assessment of aerial photography (available since the 1940's) in combination with field surveys and remote sensing imagery can provide this detailed historical assessment. Such techniques have used for the historical coastlines assessment of the Moreton Bay, Port Curtis and Fitzroy regions, which showed the trends of change in these regions (Duke et al., 2003).

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