6. Estuaries

Key Findings

- Two NRM regions provided information for estuary environmental accounts, based on data collected for specific management-focussed programs.
- Indicators of condition include measures of water quality, foreshore vegetation and biological health. These indicators were shown to be useful in the calculation of *Econds* for both particular parts of estuaries and for the whole estuarine system.
- It is not possible to compare between the two regions because of differences in the selection of indicator types, particularly where human health indicators are used along with ecological indicators.
- There is an opportunity to assess changes in estuarine condition across NRM regions at a general level by reinstating the audit process used to sample 979 estuaries as part of the *Australian Catchment, River and Estuary Assessment 2002*.

Introduction

Estuarine systems are semi-enclosed by land with a permanently or intermittently open connection with the ocean, and where ocean water can be diluted by freshwater runoff from the land (Aquatic Ecosystems Task Group, 2012). The upstream boundary of an estuary is generally described as the limit of tidal influence. Estuaries comprise deep-water habitats, tidal wetlands, lagoons, salt marshes and mangroves.

Estuary assets were listed by 57% of NRM regions in their regional strategic plans (GHD, 2012) (see also **Supplementary Material 7**). Two regions, NRM North in Tasmania and SEQ Catchments in QLD, contributed estuaries accounts. These two regions collected information that allowed the creation of *Econds*.

Comparison of Approaches

Classification of Assets

NRM North (**Figure 37**) and SEQ Catchments (**Figure 38**) have each split their estuaries by major catchments, and then further into zones. In addition, as a receiving basin for the Brisbane River estuary, Moreton Bay was included in the trial as a special asset. Moreton Bay was delineated into nine zones (**Figure 39**). A separate set of *Econds* was produced for Moreton Bay in additional to those of the SEQ estuarine catchments.

NRM North's zones (**Figure 37**) reflect critical habitats (eg seagrass, rocky reefs, wetlands), key processes (phytoplankton abundance; chlorophyll-a), human impacts, nutrient levels, metals and salinity within the estuary (Attard *et al.* 2012). Zones are defined as geographic entities with common structural and functional characteristics (Dennison 2009 in Attard *et al.* 2012) which provide a focus for management actions and future research (Pantus and Dennison 2005).

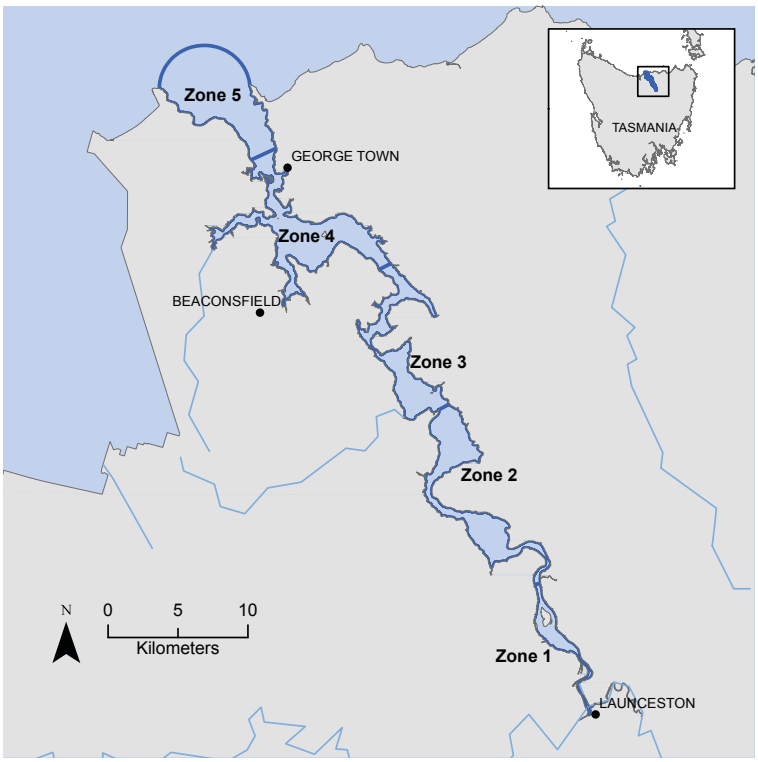

Figure 37: Tamar Estuary Zones, NRM North (Australian Maritime College 2009)

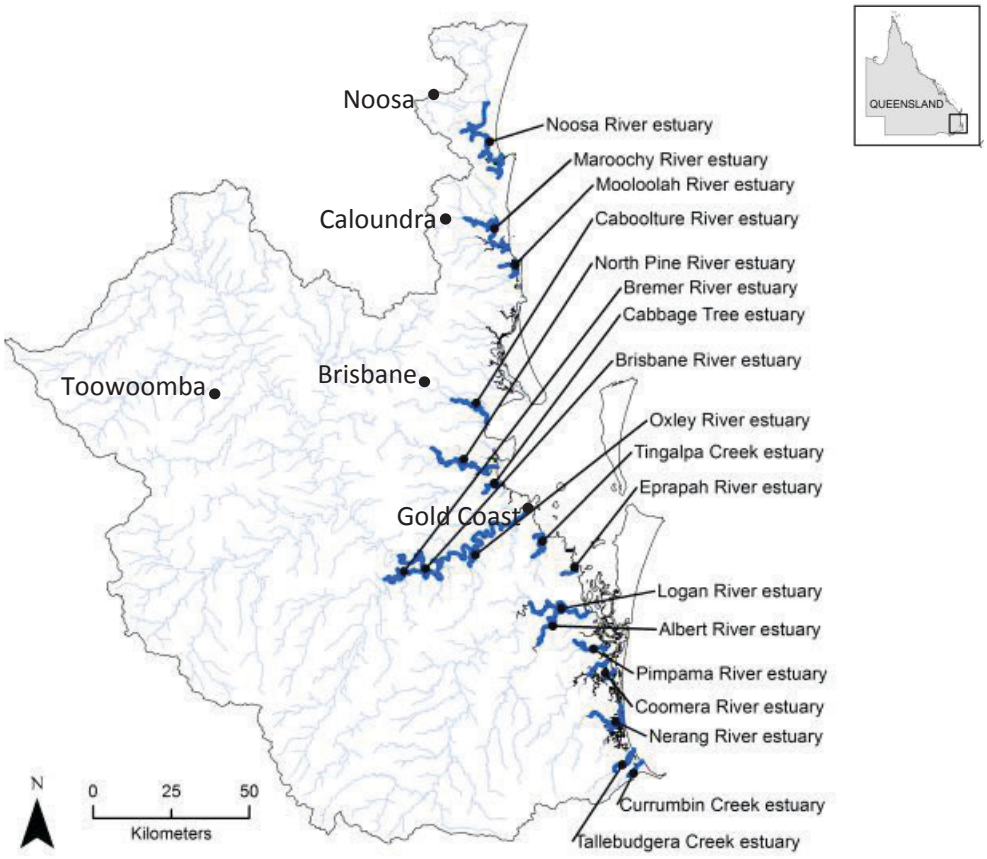

Figure 38: Estuaries of the South East Queensland region, Queensland

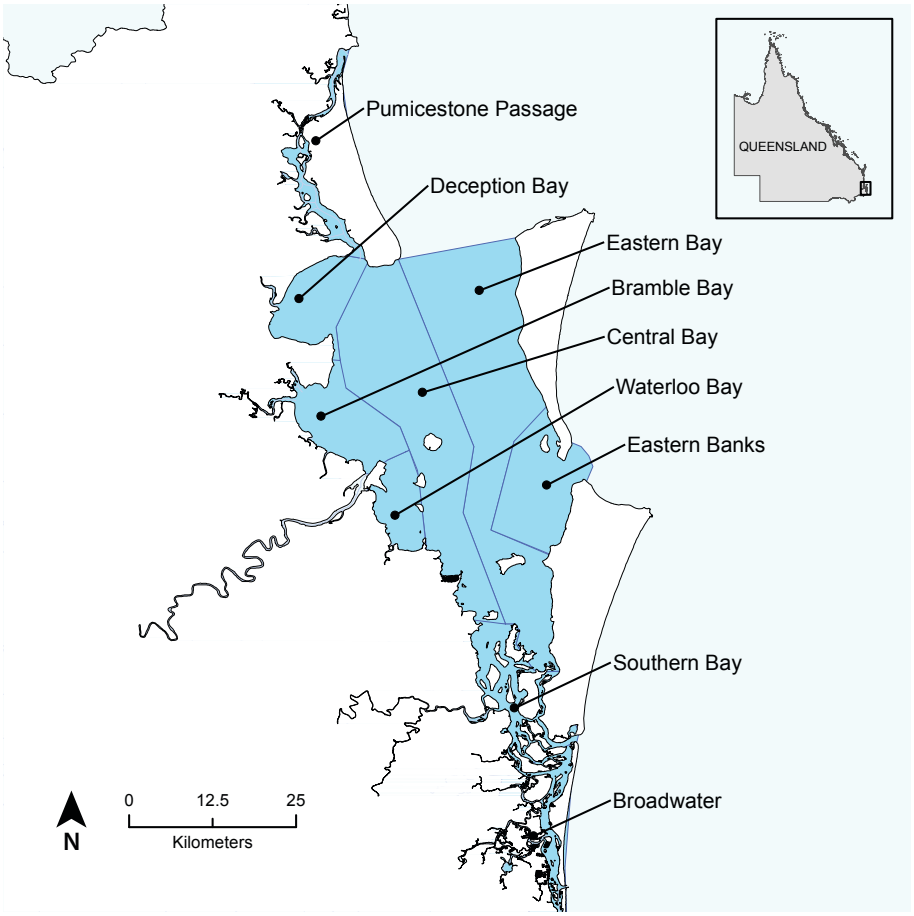

Figure 39: Zones of Moreton Bay, Queensland

Selection of Indicators

Estuaries are diverse and indicators for measuring them are varied (Ward *et al.* 1998; Deeley and Paling 1999). Water quality indicators feature prominently and consistently across estuarine assessment programs (Connolly *et al.* 2013).

Indicators used in SEQ's account are derived from the long-standing Ecosystem Health Monitoring Program, established under the Healthy Waterways collaboration between community, government and industry (EHMP 2008). Three sets of indicators were used for the catchment-based estuaries account: ecological health comprising physical or chemical water quality indicators; biological health comprising sewage plume mapping, seagrass distribution and variation, and uptake of nutrients; and foreshore vegetation (**Table 40**). Two sets of indicators were used for the Moreton Bay account, ecological health and biological health.

In the Tamar Estuary, the work of the Estuary Health Assessment Program (Australian Maritime College 2009) forms the basis of the account by NRM North. Two sets of indicators were used for the Tamar account: ambient water quality, comprising physical chemical parameters and metal toxicants; and recreational, comprising bacteriological parameters (**Table 40**).

Most estuary monitoring programs in Australia have been designed to address specific identified issues, rather than produce a holistic account of the condition of the entire system. This is the case with accounts produced as part of the trial (EHMP 2008; Attard *et al.* 2012) where, especially for the Tamar Estuary, human health assessments have also been made.

Table 40: Comparison of estuary indicators, environmental accounts trial.

	SEQ - Estuaries	SEQ – Moreton Bay	NRM North - Estuaries
Assessment Program	Ecosystem Health Monitoring Program (EHMP)	Ecosystem Health Monitoring Program (EHMP)	Estuary Health Assessment Program (EHAP)
Purpose of monitoring program	Provide an assessment of the responses of aquatic ecosystems to human activities, such as catchment alterations and point source discharges	Provide an assessment of declining health, report on the effects of different land uses on aquatic ecosystems and evaluate the effectiveness of management actions aimed at improving and protecting aquatic ecosystems	Enable managers to better evaluate the effectiveness of future activities undertaken to improve waterway health such as sewage treatment plant upgrades, stormwater controls, and wastewater treatment.
Physical/Chemical Indicators	Ecological health: turbidity, dissolved oxygen, total nitrogen, total phosphorus, chlorophyll-A, uptake of nutrients	Ecological health: total nitrogen, chlorophyll-A, salinity, temperature, sewage plume mapping, toxic alga Lyngbya, secchi depth	Water Quality: temperature, salinity, turbidity, dissolved oxygen, pH, total suspended solids, total nitrogen, total phosphorus, mono-nitrogen oxides, chlorophyll-a Toxicants: ammonium, dissolved reactive phosphorus, aluminium, arsenic, copper, lead, zinc, mercury, cadmium
Biological Indicators	Biological health: seagrass depth range, coral cover, nutrient processing (mixing plots), sewage plume mapping	Biological health: seagrass depth range, seagrass distribution and variation, coral cover	n/a (although information provided suggests bio-indicator measures of pest species, sponges and seagrasses are available)
Foreshore Vegetation Indicators	Extent of foreshore/riparian vegetation	n/a	n/a
Human Health Indicators	n/a	n/a	Recreational: Enterococci

Estimation of Reference Benchmarks

With respect to water quality, thresholds of condition have been developed by the Australian New Zealand Environment Conservation Council (ANZECC) for estuaries depending on geographic location (ANZECC, 1992). These are general guidelines providing a conservative idea of reference. ANZECC recommends the development of regional thresholds ("guideline values") to address risks to water quality of particular estuaries (ANZECC & ARMCANZ 2000).

SEQ uses the South East Queensland Regional Water Quality Management Strategy water quality objectives, described in EHMP (2008) for both the Regional Estuaries account and the separate account for the Moreton Bay Estuary. Water quality objectives, or targets, were established in response to the identification of pressures on the environmental systems in SEQ and measured from geographic or historical references (EHMP 2008). NRM North uses a similar system of exceedance-based references, and its thresholds are based on measurements from a proxy site which represents minimal impact (Attard *et al.* 2012).

Data Sources and Analysis

The Ecosystem Health Monitoring Program, conducted in SEQ Catchments, was initiated in the 1990s. It was based on a partnership of six local councils with a number of Queensland government departments to address a range of issues affecting the health of Moreton Bay and the rivers flowing into the bay. The focus has been on the estuarine sections of the rivers and central and northern regions of Moreton Bay. *The Moreton Bay Study: A scientific basis for the healthy waterways campaign* published in 1999 presented initial scientific findings for this work (Abal, Bunn, & Dennison, 2005). The partnership now includes all local government areas of SEQ[1] (Abal *et al.* 2005; Healthy Waterways 2014).

NRM North in Tasmania made two annual periods available (2010, 2011) for purposes of calculating *Econds,* sourced from the region's Ecosystem Health Assessment Program. The monitoring program was specifically designed to address issues in the Tamar Estuary (Australian Maritime College 2009). This is the only estuary that contributes to NRM North's regional estuary account at this point in time

1 19 local councils were involved in 2005; amalgamations occurred thereafter and as of 2014 there are nine councils participating in the EHMP

Indicator Condition Scores

Indicator condition scores for individual indicators within the SEQ Catchments account were determined by a process based on distance-to-threshold principles (EHMP 2008). Indicator condition scores for the sets of indicators were derived in two ways. For the ecological health and foreshore set, mean values of indicators within the set were used. For biological health, expert rules were used to weight the individual indicator scores.

Ecological health indicator condition scores for Moreton Bay were calculated by taking the medians of individual indicator scores at sites, spatially interpolating them, and then assessing them against benchmarks. These scores were then averaged and scaled by spatial area of zone. Biological health indicator condition scores were calculated by summing the individual indicators per zone, averaging and scaling by spatial area of zone (EHMP 2008).

For NRM North, exceedance scores were calculated for each indicator from the two sets of indicators, water quality and recreational, for each of the five zones. These used a 1 to 4 categorisation of distance from the guideline values (reference condition) set by ANZECC and ARMCANZ (2000) and by the Tasmanian State Government for recreational water quality (Attard *et al.* 2012). For example, indicator measures were first integrated spatially along the length of the estuary using a smoothing LOWESS model, as described by Attard *et al.* (2012) and given a categorical score to represent its condition. If the model estimates exceeded the guideline value by more than 50% it was given a categorical score of 1, indicating very poor health, whereas if it was below the guideline value by more than 50% it was given a categorical score of 4, indicating a healthy condition. An indicator condition score for each set of indicators is calculated for each zone by averaging the categorical values

Indicator condition scores were provided for estuaries in SEQ Catchments for an eight-year period between 2003 and 2011, Moreton Bay in SEQ Catchments for a seven-year period between 2003 and 2011, and NRM North in Tasmania for two years, 2010 and 2011. For the SEQ Catchments Regional Estuaries account and the Moreton Bay Estuary account, three indicators were measured: physical/chemical index, biological health rating and foreshore/riparian habitat extent. An excerpt from the account is shown in **Table 41**. The full set of indicator condition scores for SEQ Catchments, Moreton Bay (physical/chemical and biological) and NRM North (water quality, recreational water quality) are available online (nrmregionsaustralia.com.au).

Table 41: Indicator condition scores for 11 of the 18 estuaries included in the SEQ Catchments account.

ESTUARIES ASSET ACCOUNT SEQ CATCHMENTS, QUEENSLAND

Asset Table: Freshwater > Estuaries

Class	Indicator (unit)	Reference Benchmark	2003			2004			2006			2007			2008			2009			2010			2011		
			Measure	Indicator Condition Score	*Econd*	Measure	Indicator Condition Score	*Econd*	Measure	Indicator Condition Score	*Econd*	Measure	Indicator Condition Score	*Econd*	Measure	Indicator Condition Score	*Econd*	Measure	Indicator Condition Score	*Econd*	Measure	Indicator Condition Score	*Econd*	Measure	Indicator Condition Score	*Econd*
Total								57			55			42			44			39			41			41
Albert River estuary								32			24			17			19			22			18			20
	Physical/chemical index (%)	100	14.0	14		23.6	24		21.8	22		8.2	8		10.4	10		15.2	15		9.2	9		12.4	12	
	Biological Health Rating (%)	100				50.0	50		28.0	28		28.0	28		29.2	29		29.2	29		29.2	29		29.2	29	
	Foreshore/riparian habitat extent (km)	32.2											45		15.5	48		15.5	48		15.5	48		15.5	48	
Bremer River estuary								31			19			28			23			22			21			22
	Physical/chemical index (%)	100	16.2	16		20.0	20		11.4	11		20.0	20		11.2	11		15.2	15		13.0	13		14.2	14	
	Biological Health Rating (%)	100				56.0	56		36.0	36		44.0	44		54.2	54		33.3	33		33.3	33		33.3	33	
	Foreshore/riparian habitat extent (km)	34.8											46		15.3	44		15.3	44		15.3	44		15.3	44	
Brisbane River estuary								43			42			34			33			30			31			32
	Physical/chemical index (%)	100	36.8	37		36.8	37		41.8	42		33.2	33		28.0	28		26.2	26		24.8	25		29.4	29	
	Biological Health Rating (%)	100				56.0	56		42.0	42		40.0	40		55.6	56		47.2	47		55.6	56		47.2	47	
	Foreshore/riparian habitat extent (km)	160.6											33		51.4	32		51.4	32		51.4	32		51.4	32	
Cabbage Tree Creek estuary								43			42			23			29			22			27			36
	Physical/chemical index (%)	100				43.6	44		43.0	43		10.6	11		21.6	22		10.6	11		17.8	18		28.0	28	
	Biological Health Rating (%)	100				42.0	42		40.0	40		47.0	47		36.1	36		36.1	36		36.1	36		50.0	50	
	Foreshore/riparian habitat extent (km)	12.5											58		7.4	59		7.4	59		7.4	59		7.4	59	
Caboolture River estuary								65			57			29			23			26			30			38
	Physical/chemical index (%)	100	62.6	63		66.0	66		55.2	55		16.8	17		6.2	6		9.8	10		17.0	17		30.0	30	
	Biological Health Rating (%)	100				62.0	62		62.0	62		60.0	60		58.3	58		66.7	67		58.3	58		50.0	50	
	Foreshore/riparian habitat extent (km)	42.7											54		26.9	63		26.9	63		26.9	63		26.9	63	
Coomera River estuary								90			91			66			71			59			50			67
	Physical/chemical index (%)	100	100.0	100		100.0	100		100.0	100		77.2	77		79.2	79		61.2	61		47.8	48		73.4	73	
	Biological Health Rating (%)	100				65.0	65		69.0	69		51.0	51		63.9	64		66.7	67		75.0	75		63.9	64	
	Foreshore/riparian habitat extent (km)	26.8											28		10.2	38		10.2	38		10.2	38		10.2	38	
Currumbin Creek estuary								89			86			55			69			57			43			59
	Physical/chemical index (%)	100	91.6	92		93.2	93		92.6	93		61.2	61		74.0	74		58.0	58		45.0	45		64.0	64	
	Biological Health Rating (%)	100				78.0	78		72.0	72		50.0	50		79.2	79		70.8	71		40.3	40		59.7	60	
	Foreshore/riparian habitat extent (km)	13.6											29		5.0	37		5.0	37		5.0	37		5.0	37	
Eprapah Creek estuary								0			64			33			42			42			38			42
	Physical/chemical index (%)	100							66.0	66		10.4	10		28.6	29		28.6	29		21.6	22		29.0	29	
	Biological Health Rating (%)	100							60.0	60		75.0	75		55.6	56		55.6	56		58.3	58		55.6	56	
	Foreshore/riparian habitat extent (km)	7.9											95		7.2	91		7.2	91		7.2	91		7.2	91	
Logan River estuary								52			38			23			25			21			17			20
	Physical/chemical index (%)	100	43.2	43		49.8	50		34.6	35		13.0	13		16.4	16		10.2	10		4.0	4		9.2	9	
	Biological Health Rating (%)	100				56.0	56		46.0	46		45.0	45		38.9	39		38.9	39		38.9	39		38.9	39	
	Foreshore/riparian habitat extent (km)	65.7											46		34.8	53		34.8	53		34.8	53		34.8	53	
Maroochy River estuary								50			61			36			40			30			45			36
	Physical/chemical index (%)	100	56.6	57		51.2	51		64.0	64		31.6	32		36.8	37		17.6	18		41.2	41		28.6	29	
	Biological Health Rating (%)	100				48.0	48		54.0	54		48.0	48		36.1	36		55.6	56		47.2	47		44.4	44	
	Foreshore/riparian habitat extent (km)	49.6											47		29.3	59		29.3	59		29.3	59		29.3	59	
Mooloolah River estuary								83			82			71			77			70			76			56
	Physical/chemical index (%)	100	96.4	96		95.2	95		94.4	94		78.4	78		86.2	86		75.4	75		86.2	86		55.6	56	
	Biological Health Rating (%)	100				54.0	54		54.0	54		55.0	55		55.6	56		58.3	58		47.2	47		55.6	56	
	Foreshore/riparian habitat extent (km)	22.4											55		13.0	58		13.0	58		13.0	58		13.0	58	

Environmental Condition Index (*Econd*)

For SEQ, the catchment-based estuaries *Econds* have been calculated with weighted components (70% physical/chemical index, 15% biological health rating, 15% foreshore/riparian habitat extent) and weighted by estuary length. Moreton Bay's *Econd* has been calculated with weighted components (80% ecosystem health index and 20% biological health rating). These were determined as part of the Healthy Waterways Scientific Panel as best reflecting the overall condition of these assets (EHMP 2008).

For NRM North, an *Econd* is calculated by averaging scores of the two sets of indicators, ambient water quality and recreational. No length weighting has been applied as all zones were of equal length.

Combined Estuary Accounts

Table 42 shows regional estuary *Econds* for two NRM regions covering the period 2004-2011. The account for NRM North is not comparable with SEQ because of the different indicator grouping used and issues in the methods of calculating its *Econds*. Although Moreton Bay has some differences in indicators compared to the catchment-based estuaries accounts, it is possible to compare *Econds* for this region (Figure 40).

Table 42: Regional Estuary *Econds*

Region	Year							
	2004	2005	2006	2007	2008	2009	2010	2011
SEQ Catchments (QLD)	57		55	42	44	39	41	41
SEQ Moreton Bay (QLD)	87	83	82	81	81	68	75	75
NRM North (TAS)							81	77

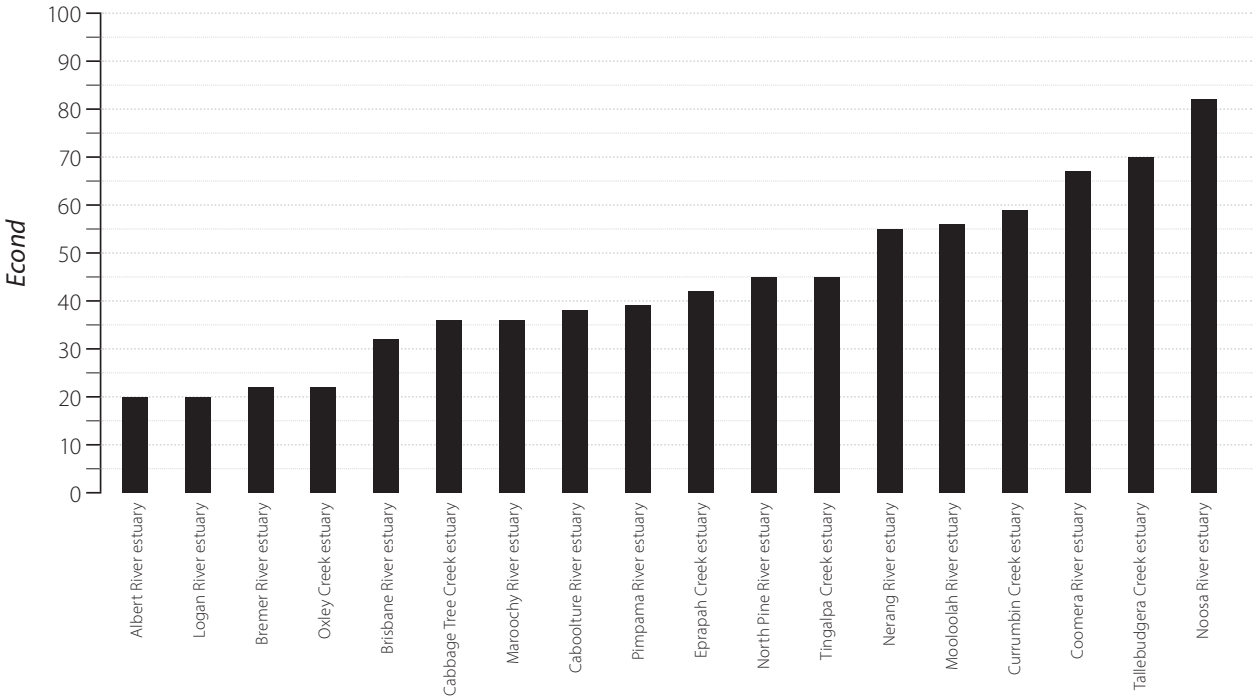

Figure 40: *Econds* for 18 estuaries in the SEQ Region for 2011 (see Figure 38 for location).

South East Queensland Coastal Estuaries

SEQ Catchments submitted their estuary account in 2012 for the period 2004 to 2011 (Figure 40). The longer time series for SEQ's estuarine catchments provides an opportunity to look at trends in the condition of these estuaries over a number of years (2004-2011). Figure 41 shows that coastal estuaries in the SEQ region achieved a regional *Econd* of between 60 and 40, declining from an *Econd* of 57 in 2004 to an *Econd* of 41 in 2011. Figure 42 depicts the *Econds* in detail for each of the estuaries in the region over this seven-year period. Figure 43 shows four examples of the degree of difference in the condition of some of these estuaries: high stable (Noosa), low stable (Bremer), declining (Pimpama), and recovering (Caboolture).

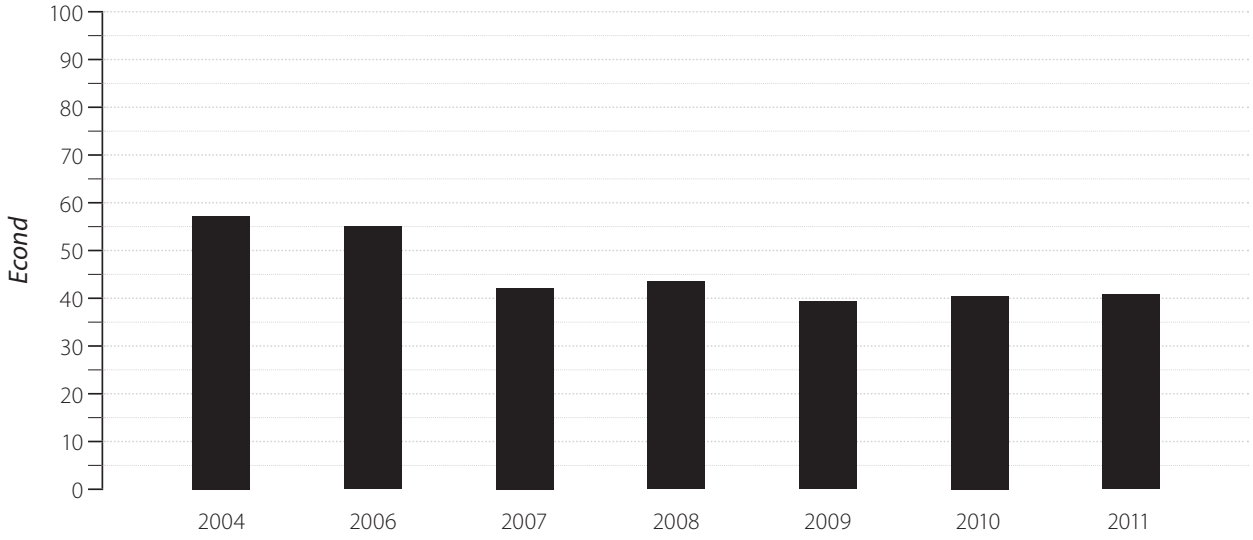

Figure 41: Trend in estuary condition for South East Queensland region, 2004-2011

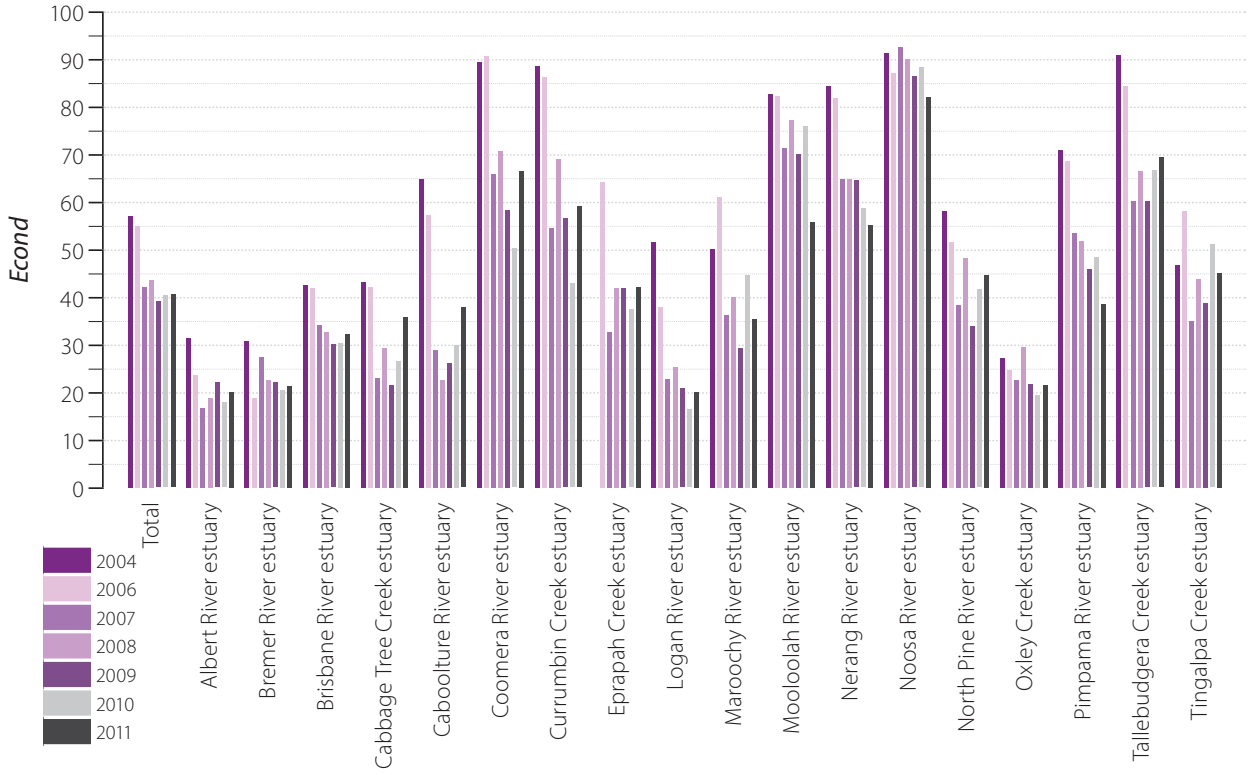

Figure 42: Changes in *Econds* for each of the estuaries in South East Queensland, 2004-2011

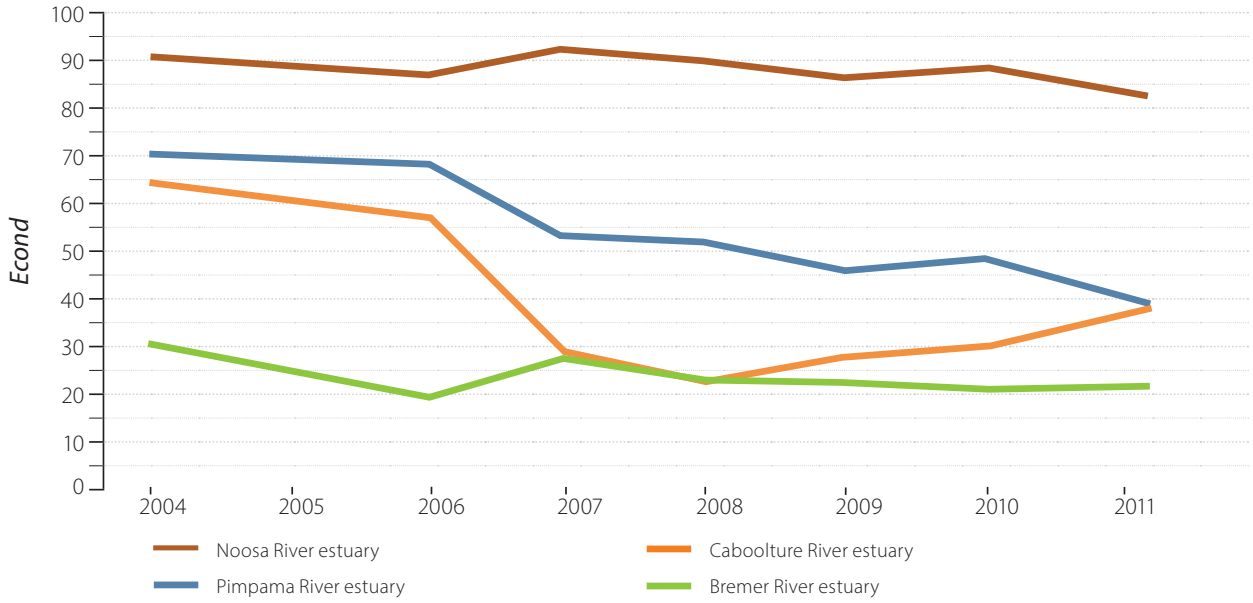

Figure 43: *Econds* for a selection of four estuaries in South East Queensland, 2004-2011

Moreton Bay

The declining trend in condition for Moreton Bay is shown in **Figure 44**. Moreton Bay consistently achieves results ranging between 60 and 80, and shows some recovery from its lowest score in 2009.

Further analysis and projections of trend following the 2009 and 2011 flood events are highlighted in **Figure 45**. Also shown in the figure is the need for management action in order to prevent further decline in condition.

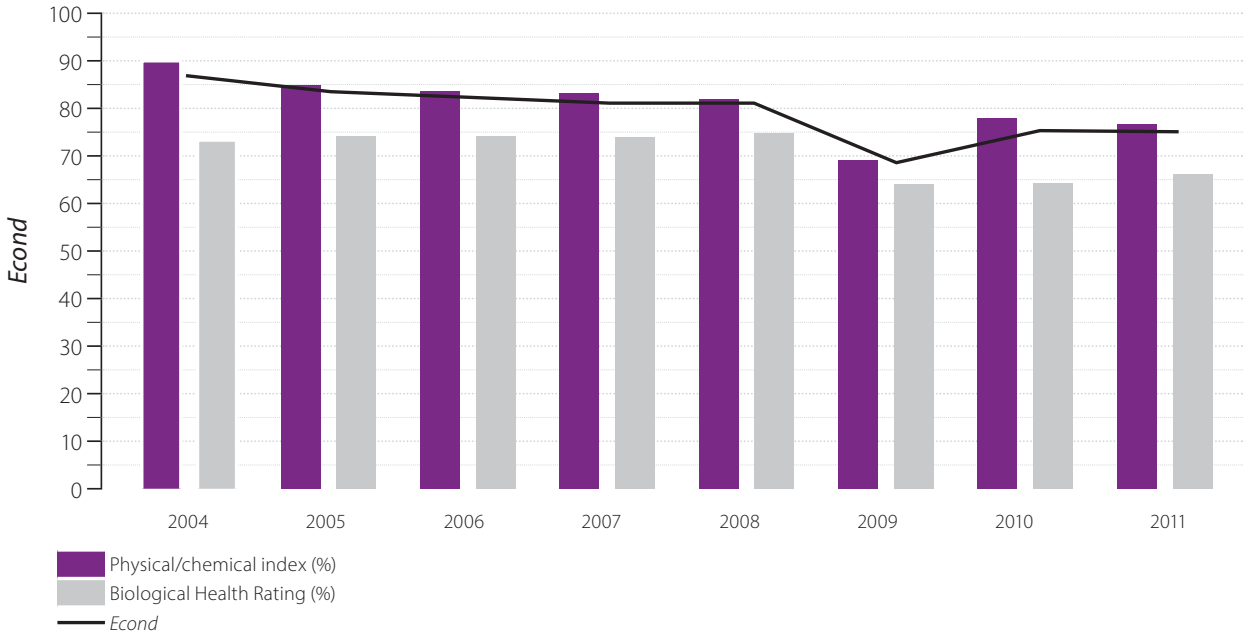

Figure 44: *Econds* and Indicator Condition Scores for the Moreton Bay Estuary, South East Queensland region, 2004-2011

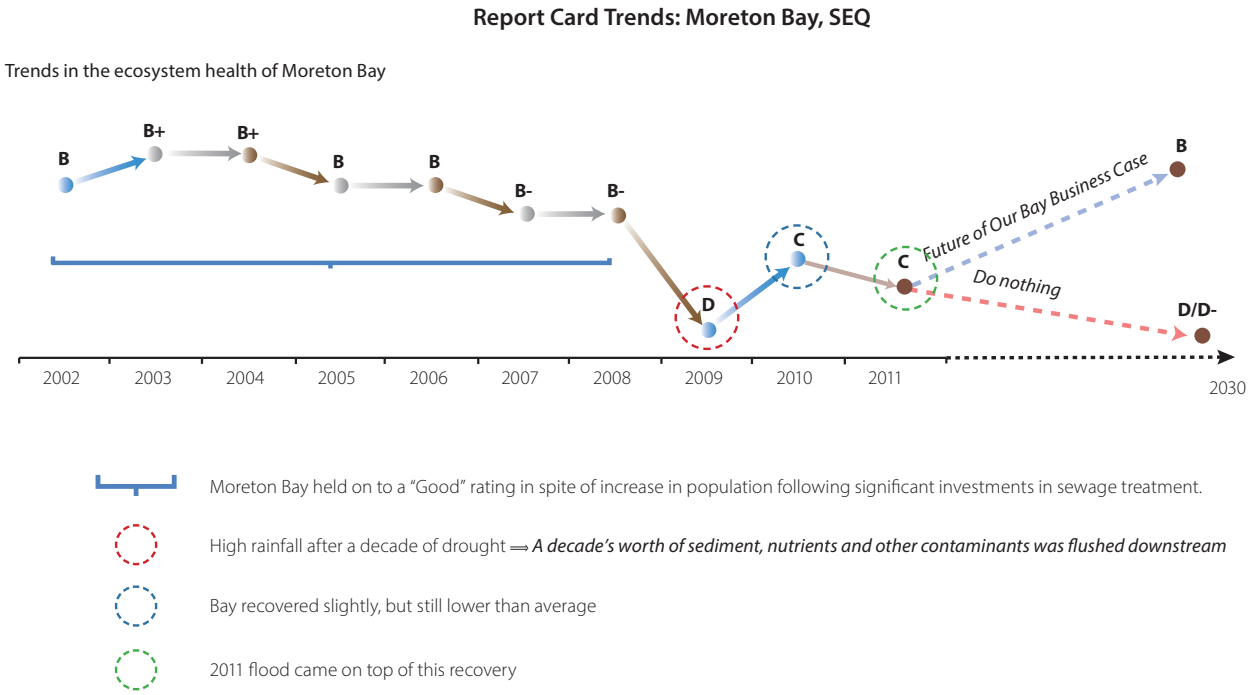

Figure 45: Long term trends, combined with qualitative interpretive information on events in the region, informs management options for Moreton Bay (Marsden Jacob Associates 2011).

Tamar River Estuary, Tasmania

Two surveys of the Tamar River Estuary in 2010 and 2011 showed a decline in the condition of the estuary over this period (**Figure 46**). This large change in regional *Econds* coincided with freshwater inputs due to higher rainfall and flooding during the second measurement period (Attard *et al.* 2012). These changes in condition affected downstream zones 2-5. The accounts also show that the mouth of the estuary (Zone 5) is in better condition than the zones further inland (Zone 1).

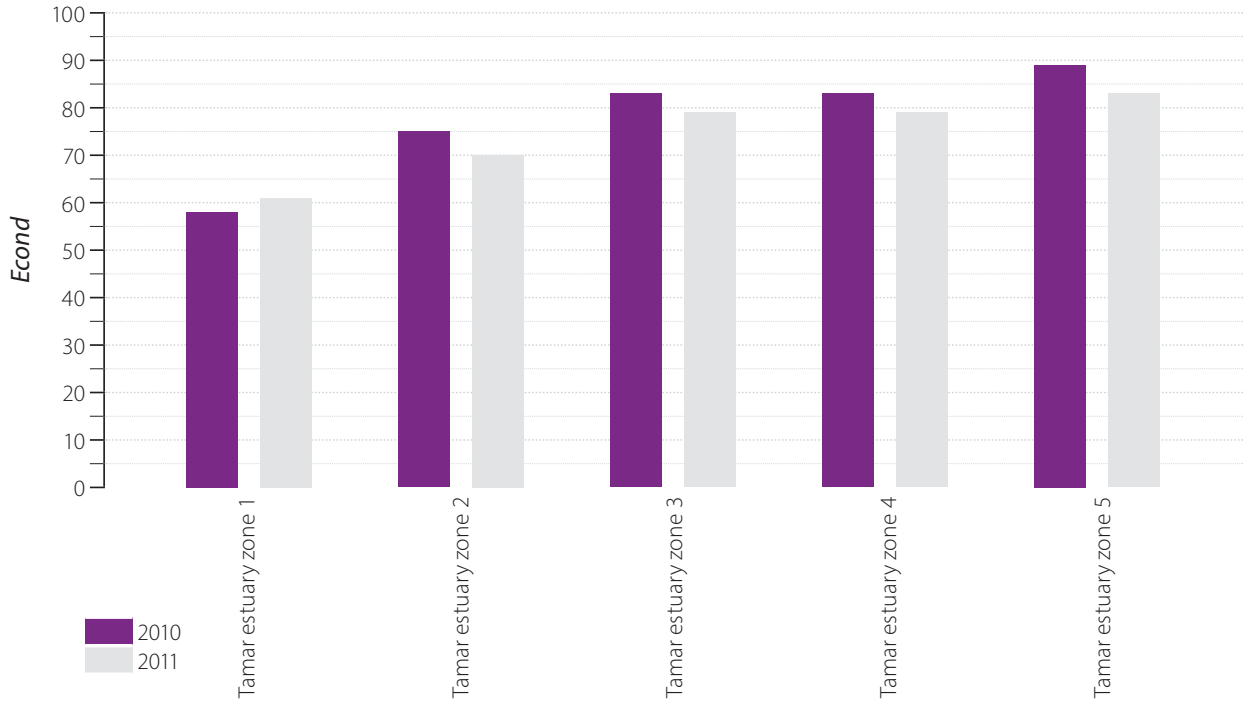

Figure 46: Change in condition of zones in the Tamar Estuary, NRM North, Tasmania, 2010-2011. Zone 1 is upstream and zone 5 is downstream at the estuary mouth.

Discussion

Two NRM regions provided estuary environmental accounts. SEQ Catchments used data from the long-established monitoring program set up by the Healthy Waterways Partnership. NRM North focussed on a single estuary within its region, the Tamar River. In both cases, a range of indicators were used to assess estuary condition and to calculate *Econds*. Estuary *Econds* for both regions have been derived from credible monitoring programs. It is necessary, however, to consider the original purpose of monitoring to determine how the information can be applied to the accounts.

As data for this asset are exclusively derived from state or other agency programs, incorporating expertise from within these agencies and institutional agreements is important for the development of comparable estuarine *Econds*.

Water quality was the one common element in the assessment of estuaries for these two regions. NRM North and Moreton Bay's *Econds* are based on how much of an area complies with defined water quality objectives, and for these two programs in particular, the defined objectives are not specific to an ecological reference condition (Attard *et al.* 2012; EHMP 2008). The use of human health indicators (bacteriological and toxicants) in NRM North's account reflects the purpose of the original monitoring program. By themselves these human health indicators, while a useful component, do not satisfy the standard required for an ecological condition account. An existing framework, such as that proposed by Moss *et al.* (2006), could be used to translate NRM North's assessment program into a condition account.

There are different estuary assessment programs in use across the continent (**Table 43**). Each of these has its own approaches, relating to many factors such as the geographic scale and the objectives (purpose) of the program (Harwell in Connolly *et al.* 2013). This supports the need for locally and regionally determined assessment programs, but it also demonstrates a need for a nationally consistent framework for reporting on the condition of these estuaries (Moss *et al.* 2006; Scheltinga *et al.* 2004). **Table 44** shows that there are many indicators for measuring the condition of estuaries (ANZECC 2000; Deeley and Paling 1999; NOW 2013; Scheltinga *et al.* 2004; Ward *et al.* 1998). As with many environmental assets, estuaries exhibit different forms in Australia based on a wide range of factors (eg tide, wave or river-dominated (see OzCoasts: www.ozcoasts.gov.au and WetlandInfo: http://wetlandinfo.ehp.qld.gov.au).

To enable the comparison of estuary condition across the country, a national estuary accounting standard should describe a conceptual picture of estuarine physical processes and ecological functions, so that a consistent set of appropriate indicators and reference values are used to construct an account (Moss *et al.* 2006; Queensland Department of Environment and Heritage Protection 2012; Scheltinga *et al.* 2004). Adaptation of the Interim Australian National Aquatic Ecosystem Classification Framework suggests estuaries could be classified according to aspects such as substrate, structural biota and water depth to provide a basis for national comparisons (Aquatic Ecosystems Task Group 2012). This would enable NRM regions to develop accounts that could compare the condition of estuaries between regions.

Table 43: Estuary assessment programs across Australia

Assessment Program	Location	Website, report
Great Barrier Reef Report Card	QLD	www.reefplan.qld.gov.au
Port Curtis Integrated Monitoring Program	QLD	www.pcimp.com.au
Fitzroy Report Card	QLD	www.riverhealth.org.au
South East Queensland Healthy Waterways	QLD	www.ehmp.org
Tamar Estuary Report Card	TAS	www.nrmnorth.org.au
Derwent Estuary	TAS	www.derwentestuary.org.au/report-card/
Gippsland Lakes	VIC	http://www.gippslandlakes.net.au/
State of the Catchments: Estuaries and Coastal Lakes	NSW	http://www.environment.nsw.gov.au
Ecohealth	NSW	http://www.clarence.nsw.gov.au http://www.bellingen.nsw.gov.au http://www.ourlivingcoast.com.au http://www.pmhc.nsw.gov.au/
Gladstone Healthy Harbour Partnership	QLD	rc.ghhp.org.au/report-cards
Yarra and Port Philip Bay	VIC	www.cleaneryarrabay.vic.gov.au/report-card
Swan River	WA	www.swanrivertrust.wa.gov.au
Darwin Harbour	NT	http://www.lrm.nt.gov.au/water/darwin-harbour/reportcards
Peel-Harvey	WA	http://www.peel-harvey.org.au
Land and Water Resources Audit	Australia (979 estuaries)	http://lwa.gov.au

Table 44: Examples of proposed indicators of condition for estuaries (Deeley & Paling, 1999)

Component	Item	Environmental indicator
Ecosystem	Communities	stability
		diversity
		productivity
Catchment	Attributes	drainage density
		erosion
		landuse
		land management practices
		flood frequency, peak flow velocities
		runoff quality (nutrients, sediment)
		nutrient pollution index
		stream width-depth ratio
		vegetation status, catchment, riparian zones
Waterbody	Attributes	dissolved concentration potential
		equilibrium discharge
		flushing (retention time)
		stratification
		particle retention efficiency
Biotic condition	General	mixed-function oxidase (fish biomarkers)
		presence of abnormal organisms, attributes
	Pelagic	phytoplankton composition, chlorophyll-a, biomass, cell size
	Biota	periphyton composition, biomass, autotrophic index
		macrophyte community composition, biomass
		translocated species
		fish community composition, biomass
	Benthic biota	benthic community composition, biomass
		benthic community indices
Habitat	Water quality	biochemical oxygen demand (BOD)
		clarity, turbidity (Secchi depth)
		chlorophyll-α
		pH
		P, N and toxicant concentrations,N:P ratios
		salinity, conductivity
		silica concentrations
		temperature
		water depth, levels
		combined water quality index
	Sediments	organic matter content
		percent silt-clay
		sediment nutrient concentrations
		dissolved oxygen concentrations

Conclusions

Regional accounts can contribute to the understanding of changing condition in estuaries in Australia by simplifying complex information for a range of measurements of different indicators. It allows information in different formats, from different sources, to be produced in a common form to draw out patterns. Even with examples from only two NRM regions, general conclusions can be drawn about the relative conditions in these estuaries. This is an important achievement and, with further examples, will demonstrate changes occurring in estuaries throughout the country and will assist in uncovering drivers of change.

SEQ Catchments is in a particularly strong position of having wide community support for a broad-scale, annual catchment monitoring and reporting program, the Ecosystem Health Monitoring Program. Multiple time periods were available, and the science has been tested over 15 years, providing excellent lessons for the other NRM regions on indicator selection, sampling methods, data analysis and reporting.

We recognise how resource-intensive such a program has proven to be, and this raises questions as to the level of detail required for different estuarine settings around the Australian coast. There are clearly examples where similar intensive sampling should be undertaken in areas under pressure. However, it is equally important that a 'watching brief' is maintained on all other estuaries. These may not require a similar level of sampling. NSW's State of the Catchments Estuaries assessments (NOW 2013; Roper *et al.* 2011) or the National Land and Water Resources Audit, *Australian Catchment, River and Estuary Assessment 2002* (NLWRA 2002), provide examples for such a less-intensive assessment.

Coastal regions would benefit from a program of assessment for each of their estuaries, taking into account their capacity to apply sampling methods required for identification and management of environmental issues. A good place to begin may be to reinstate sampling in the 979 estuaries assessed as part of the *Australian Catchment, River and Estuary Assessment 2002* (NLWRA 2002) which would measure changes in condition in estuaries over the last 15 years.

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