

State of the catchments 2010

# Estuaries and coastal lakes

## Hawkesbury–Nepean and Sydney Metropolitan regions

### State Plan target

By 2015 there is an improvement in the condition of estuaries and coastal lake ecosystems.

### Background

An estuary is any semi-enclosed body of water having a permanently or intermittently open connection with the ocean. Water levels inside the estuary vary in a periodic way in response to the ocean tide at the entrance. The upstream boundary is defined as the limit of tidal influence and will typically be found in the lower reaches of the creeks and rivers draining to the estuary.

A detailed technical report describes the methods used to derive the information contained in this report. At the time of publication of the *State of the catchments (SOC) 2010* reports, the technical reports were being prepared for public release. When complete, they will be available on the DECCW website: [www.environment.nsw.gov.au/publications/reporting.htm](http://www.environment.nsw.gov.au/publications/reporting.htm).

**Note:** All data on natural resource condition, pressures and management activity included in this SOC report, as well as the technical report, was collected up to January 2009.

Estuaries in New South Wales can be classified into five main types with decreasing oceanic influence:

- semi-enclosed embayments (six in NSW) are characterised by marine waters with little freshwater inflow
- drowned river valleys (13) have large, wide entrances and tidal ranges similar to oceans
- barrier estuaries (51) are rivers and lakes that are generally open to the ocean but are constricted at their entrances by sand from adjacent beaches. They are often associated with larger catchments, the flow from which assists in keeping the entrances open
- intermittent estuaries (110) are creeks and lagoons that become closed to the ocean for extended periods of time. They often have small catchments, hence low river flows to keep entrances open. This is the largest group of estuaries in NSW with many located along the south coast
- brackish lakes (four) are generally connected to the ocean by a long creek and hence have extended flushing times, allowing freshwater inflows to dominate.

Variation in estuary type, entrance condition, catchment characteristics and climate along the NSW coast produces estuarine ecosystems that are complex, dynamic and variable. As estuaries slowly infill, and as development further increases sediment and nutrient inputs, excessive levels of nitrogen or phosphorus in the estuary can cause algal blooms ('eutrophic' conditions) and other harmful effects that adversely impact ecosystems as well as human usage.

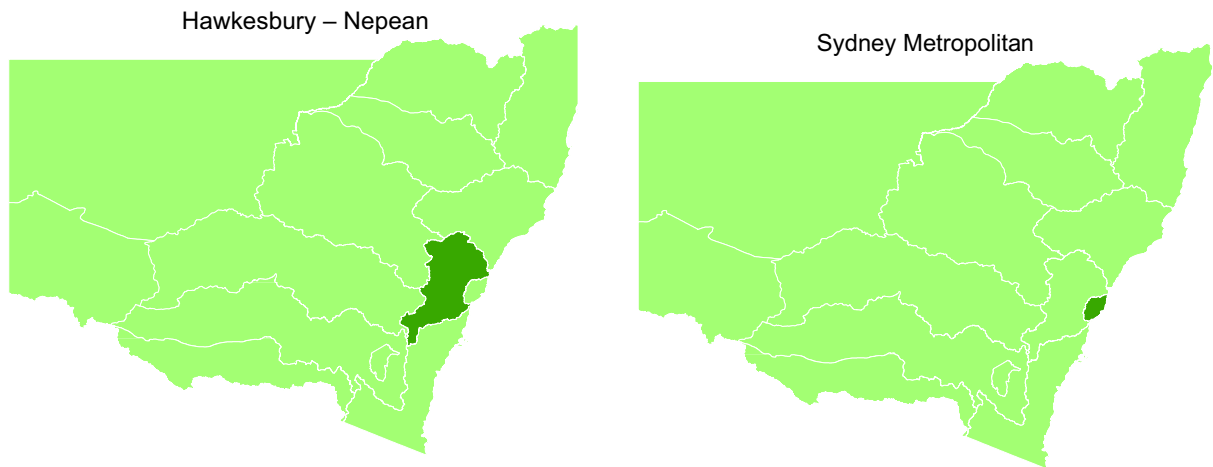
To adequately capture ecosystem complexity, a number of ecological indicators are being used to report estuary health covering eutrophication, habitat and fish.

Various pressures caused by human activity in the estuary and its catchment are also reported. The pressures were selected on the basis of the strength of their cause–effect link to condition and the feasibility of data collection or modelling along the entire coastline. Condition and pressure information combined provide valuable direction on priorities for policy, planning, investment and management.

The Hawkesbury–Nepean and Sydney Metropolitan regions have 16 estuaries, or nine per cent of the total number in NSW; 284 km<sup>2</sup> or 15 per cent of the total estuarine area in NSW; and 23,500 km<sup>2</sup> or 18 per cent of the total estuary catchment area. Of the 16 estuaries, there are 10 drowned river valleys, one embayment, and five creeks and lagoons with intermittently open entrances.

Waterway surface areas vary widely with four estuaries having very small areas of less than 0.5 km<sup>2</sup> and associated catchments of generally less than 15 km<sup>2</sup>. The eight largest estuaries have areas greater than 10 km<sup>2</sup> (and up to a maximum of 115 km<sup>2</sup> for the Hawkesbury–Nepean River) and catchments up to 21,600 km<sup>2</sup>.

## Maps of the catchments



## Assessment

### Indicators

The indicators of estuary condition used are:

- eutrophication: chlorophyll a, macroalgae and turbidity
- habitat distribution: change in seagrass, mangrove and saltmarsh (macrophytes) extent
- fish assemblages: species diversity and composition, species abundance, nursery function and trophic integrity (food web).

Each indicator has been scored relative to a reference or least impaired condition. A number of methods have been employed to develop scoring classes on a five-colour scale of 'very good', 'good', 'fair', 'poor' and 'very poor' representing the extent of deviation from the reference condition. In the case of macrophytes, the size of change in extent observed has been scored.

### *Estuary index*

A condition index has been calculated for each estuary by averaging the unweighted individual scores for each condition indicator and applying expert opinion to test whether the results look reasonable. A similar approach has been taken for a pressure index. Future statistical analysis is required to improve the aggregation rules currently being applied.

Owing to the limited availability of data for the condition index, additional rules have been applied to the aggregation process. At least one indicator from a minimum of two indicator groups must be populated; eg at least one eutrophication and one habitat or fish indicator. Also, if there were only one or two indicators that had data available, an overall score was not calculated.

### *Regional and state-wide index*

A regional and a state-wide score for condition and pressure indicators have been included for comparison purposes, also using a simple unweighted approach. In recognition of the patchiness of some of the condition indicator datasets, an aggregation rule was applied whereby the regional score would only be calculated if there were more than five estuaries in the region with individual estuary scores.

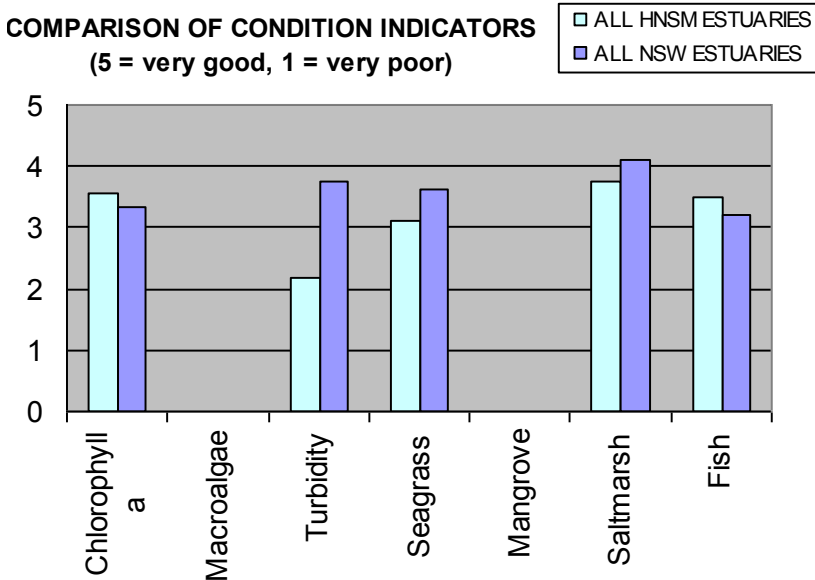
Consideration must be given to whether different approaches may be more appropriate. For example, weighting scores by the estuary area to give an average by total estuary area may be a more accurate reflection of the total value of the resource to the community.

All condition and pressure indices have been scored between 5 (best) and 1 (worst) on a five-colour green-red scale, representing index scoring classes of >4.2–5.0, >3.4–4.2, >2.6–3.4, >1.8–2.6 and 1.0–1.8.

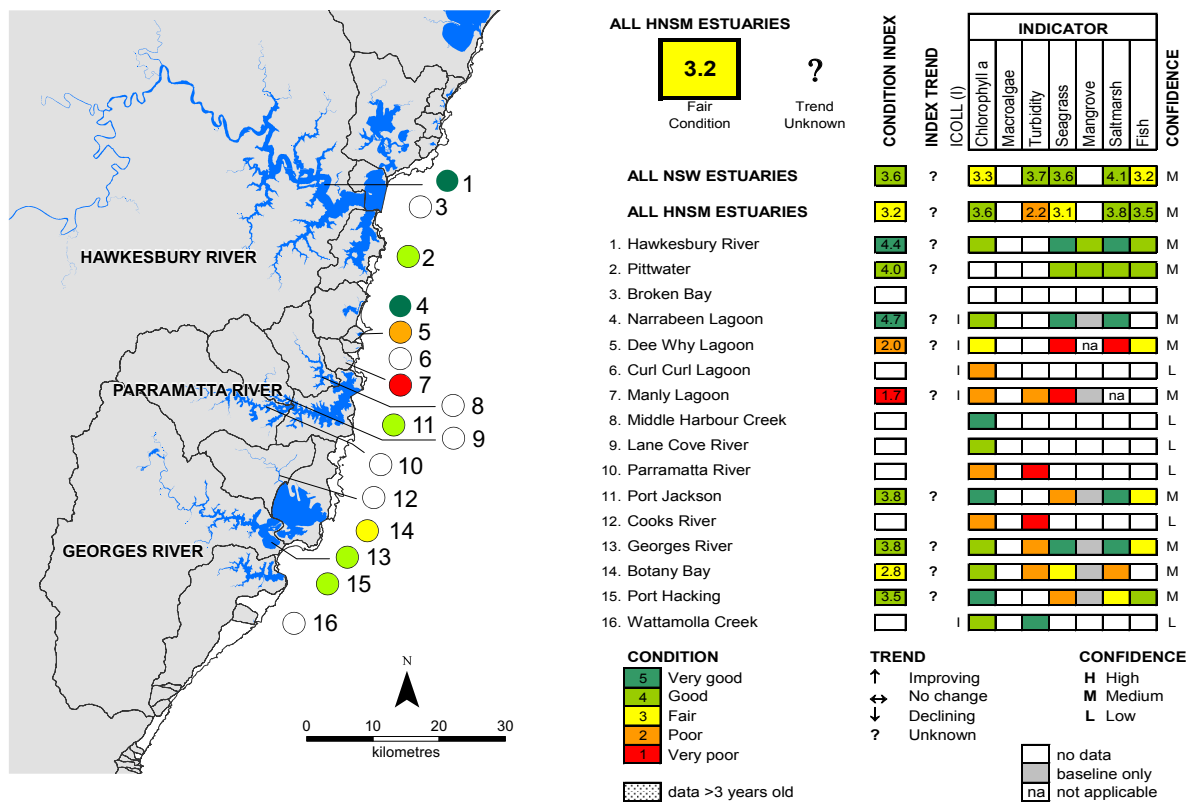
**Data confidence**

Systems were developed and applied for rating confidence in the data on eutrophication and fish. Seven criteria were defined for eutrophication and five for fish. However, in view of the number of data gaps in the condition report, it was decided to rate the confidence on the number of indicators for which data was available. When data was available for all seven indicators the confidence was rated high; for four to six indicators it was rated medium; and for three or fewer it was rated low. In the future, when more of the data gaps have been filled, it is proposed that an alternative system will be developed based on the confidence ratings for each individual indicator.

For the pressure indicators most of the data confidence is rated high except for the sediment and nutrient inputs which are rated medium because they have been modelled. As data is available for all indicators across all estuaries, a confidence level has been assigned on the basis of how many indicators have high, medium or low confidence. All indicators have the same datasets available, six of which are rated high and two of which are rated as medium confidence; therefore, an overall rating of high has been assigned to all estuaries. This is the type of rating system that will be applied to the condition indicators in future.



**Figure 1** Condition indicator scores for Hawkesbury–Nepean and Sydney Metropolitan regions (cont'd next page)



**Figure 1 Condition indicator scores for Hawkesbury–Nepean and Sydney Metropolitan regions (cont'd)**

Note: ICOLL (I) = Intermittently Closed and Open Lake or Lagoon

### Condition

The distribution of condition scores for each indicator at estuary, regional and state levels is shown in Figure 1.

*Chlorophyll a* indicates the amount of microscopic algae, called phytoplankton, growing in the water. Excessive input of nutrients from catchments can lead to algal blooms and detrimental effects on estuarine plants and animals. Estuaries were classified into three types according to their ability to dilute and flush catchment inputs, and trigger values were assigned for each type. Trigger values were defined as the 80th percentile of reference site data, in accordance with the recommendation of the National Water Quality Management Strategy (ANZECC & ARMCANZ 2000). Data was analysed for the period 2005–2008 and scored based on the percentage of samples complying with the triggers. If data was only available before 2005, the score in Figure 1 is shaded. The overall status for chlorophyll a in the 14 Hawkesbury–Nepean and Sydney Metropolitan estuaries with data is rated good.

*Macroalgae* are large algae, commonly called seaweeds, which grow on aquatic plants and may extend to the water surface or float in the water. Macroalgal blooms can reduce oxygen levels and shade out desirable aquatic plants. They may also smother other habitats and shellfish. Residential areas can be affected by unsightly floating blooms and odours, and tourism values may be affected. The method of gathering information on macroalgae is currently being modified; therefore,

Hawkesbury–Nepean and Sydney Metropolitan estuaries have not been rated.

*Turbidity* is a measure of light scattered by suspended particles such as sediment, algae and dissolved material in the water which affect its colour or murkiness. Turbidity can increase from sediment inflows, shoreline erosion and increased microscopic algae. As for chlorophyll a, trigger values were defined as the 80th percentile of reference site data. In assessing estuary condition and assigning triggers, only data collected for the two years of the monitoring, evaluation and reporting program was used, due to the potential uncertainty associated with data collected using different methods and/or for special purposes (eg flood runoff). The overall status for turbidity in the six Hawkesbury–Nepean and Sydney Metropolitan estuaries with data is rated poor.

*Seagrasses* are aquatic flowering plants that form meadows near shore. They are highly productive, provide nursery and foraging habitat (for fish, crustaceans and molluscs), bind sediments against erosion and help regulate nutrient cycling. They are very sensitive to changes in water clarity. Two broadly comparable surveys are available from 1985 and 2006 for estimating change in extent for seagrass, mangrove and saltmarsh. For seagrass and saltmarsh, scores were assigned as:

- >10% gain = very good
- ±10 % gain = good
- –10 to –40% loss = fair
- –40 to –70% loss = poor
- –70 to –100% loss = very poor.

The overall status for seagrass in the nine Hawkesbury–Nepean and Sydney Metropolitan estuaries with data is rated fair but with significant variability from very good to very poor.

*Mangroves* grow between mid and high tide levels. They are an important food source, provide habitat, protect shorelines and cycle nutrients and carbon. The comparison of survey data showed a general increase in mangroves.

However, increasing mangrove extent could be due to a number of factors including:

- recolonisation in areas previously removed, which would be viewed as a positive change
- colonisation upslope into areas currently occupied by saltmarsh, due to factors such as increased sedimentation and potentially sea level rise, which might be viewed as negative considering the limited areas of saltmarsh within NSW estuaries
- marination of estuaries (ie higher salinity levels) through entrance training, artificial entrance openings of lagoons, water extraction upstream, and lower rainfall associated with drought and climate change, providing mangroves with a competitive advantage, which could be considered negative.

With current knowledge, it is difficult to generalise about whether a change in mangrove extent is positive or negative for estuary health without conducting estuary-specific studies. The scoring system adopted therefore states that stable mangrove extent, defined as a change of between –10 to and +10%, is good. Any change outside that range has been shaded grey, indicating that change data is held but interpretation requires further investigation.

*Saltmarsh* is a community of plants and animals that grows above the mangroves at the highest tidal levels. Saltmarsh is important in estuarine food webs, providing a site for invertebrate breeding and a feeding area for economically important fish and shorebirds, the latter of which are subject to international agreements. Coastal saltmarsh is listed as an endangered ecological community under the *Threatened Species Conservation Act 1995*. The overall status for saltmarsh in

the nine Hawkesbury–Nepean and Sydney Metropolitan estuaries with data is rated good.

*Fish communities* are a good biological indicator of ecosystem health because they occur in most estuaries, integrate the effect of multiple catchment and aquatic habitat factors, are easy to identify and are highly valued by the community. Using data on juvenile fish sampled with small beach seine nets and gill nets, the overall status for fish in the six Hawkesbury–Nepean and Sydney Metropolitan estuaries with data is currently rated good. Future monitoring is likely to include additional ways of sampling fish and this will enable reporting of more comprehensive fish data for some estuaries in the Central bioregion for the next SOC report.

**Missing data**

The macroalgae indicator is still being trialled in a number of estuaries to determine the best method of gathering the data and will be available for future SOC reports. A significant number of estuaries did not have eutrophication or fish data available, but these may be captured during future monitoring.

**Regional summary**

Table 1 shows a summary of how estuaries rated for condition within the Hawkesbury–Nepean and Sydney Metropolitan regions, the number and proportion of estuaries with limited data that did not warrant a condition score and those with no data at all.

**Table 1 Regional summary of estuarine condition**

Category	Very good	Good	Fair	Poor	Very poor	Limited data	No data	Total
No. of Hawkesbury–Nepean and Sydney Metropolitan estuaries	2	4	1	1	1	6	1	16
% of Hawkesbury–Nepean and Sydney Metropolitan regions	13%	25%	6%	6%	6%	38%	6%	100%

**Pressures**

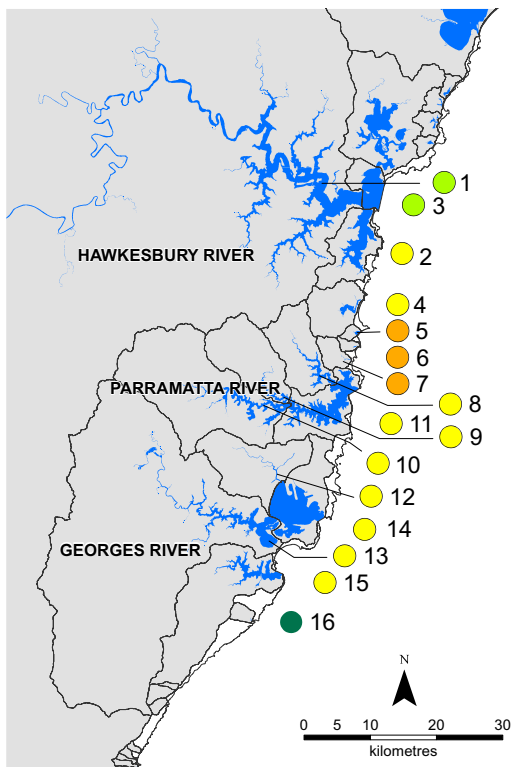
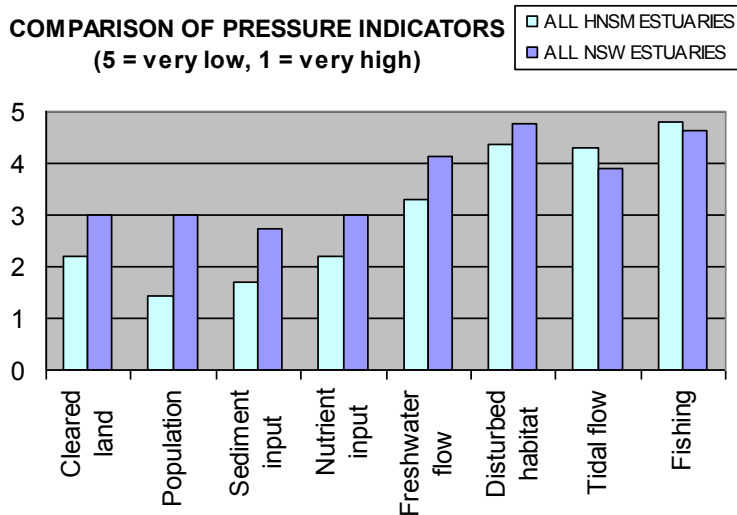
A total of eight indicators of estuary pressure are reported. To enable meaningful comparison of pressures between different types of estuaries, the data often has to be ‘normalised’ by such factors as the area of the estuary or its catchment, or some other physical characteristic. The indicators used, the normalised metric (ie measure) and the boundaries between scoring classes from very low to very high are described below, together with the regional assessment for each indicator. The distribution of pressure scores for each indicator at estuary, regional and state levels is shown in Figure 2.



### Indicators

Cleared land for agricultural, residential and industrial development is a major pressure in many NSW coastal catchments and is known to result in increased inputs of eroded sediments, nutrients and organic material into the estuary. Using data available from land-use mapping undertaken over the last five years, the percentage of cleared land in each estuary catchment was scored into five classes with approximate boundaries of 0, 8, 22, 39, 69 and >69 per cent (see supporting technical report). Hawkesbury–Nepean and Sydney Metropolitan estuaries are rated as being under high pressure from cleared land.

### COMPARISON OF PRESSURE INDICATORS (5 = very low, 1 = very high)



#### ALL HNSM ESTUARIES

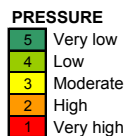


?  
Trend  
Unknown

#### ALL NSW ESTUARIES

#### ALL HNSM ESTUARIES

- Hawkesbury River
- Pittwater
- Broken Bay
- Narrabeen Lagoon
- Dee Why Lagoon
- Curly Curly Lagoon
- Manly Lagoon
- Middle Harbour Creek
- Lane Cove River
- Parramatta River
- Port Jackson
- Cooks River
- Georges River
- Botany Bay
- Port Hacking
- Wattamolla Creek



PRESSURE INDEX	INDEX TREND	ICOLL (I)	INDICATOR								CONFIDENCE
			Cleared land	Population	Sediment input	Nutrient input	Freshwater flow	Disturbed habitat	Tidal flow	Fishing	
3.0	?		3.0	3.0	2.7	3.0	4.1	4.8	3.9	4.6	H
3.0	?		2.2	1.4	1.7	2.2	3.3	4.4	4.3	4.6	H
3.5	?										H
3.0	?										H
3.6	?										H
3.0	?	I									H
2.4	?	I									H
2.5	?	I									H
2.4	?	I									H
3.1	?										H
3.0	?										H
2.9	?										H
2.9	?										H
2.8	?										H
2.8	?										H
2.6	?										H
2.8	?										H
3.3	?										H
5.0	?	I									H

TREND  
 ↓ Declining  
 ↔ No change  
 ↑ Increasing  
 ? Unknown

CONFIDENCE  
 H High  
 M Medium  
 L Low

Figure 2 Pressure indicator scores for Hawkesbury–Nepean and Sydney Metropolitan regions

Note: ICOLL (I) = Intermittently Closed and Open Lake or Lagoon



*Population density* of people residing in a catchment is a general measure of pressure placed on an estuary. Effects can include increased pollution loads in stormwater and sewage overflows, disturbance of riparian and foreshore vegetation, litter and general degradation of the environment. Population data was obtained from the 2006 census conducted by the Australian Bureau of Statistics and the density in the estuary catchment was scored into five classes with boundaries of 0, 2, 9, 41, 264 and >264 people/km<sup>2</sup>. Hawkesbury–Nepean and Sydney Metropolitan estuaries are rated as being under very high pressure from population density.

*Sediment inputs* are generated by soil erosion in catchments disturbed by human activity as well as riverbank and shoreline erosion. Coarse sediment settles out along river beds, floodplains and at tributary mouths while finer suspended sediment fills bays and central basins and reduces water clarity. Hydrology models of rainfall runoff developed for each estuary catchment were used to estimate the quantity of sediment exported on an annual basis. The models were run for current land-use conditions and for a fully forested, undisturbed catchment. Percentage increase in total suspended solids (TSS) export for current land-use was scored into five classes with boundaries of 0, 10, 40, 80, 600 and >600 per cent. Hawkesbury–Nepean and Sydney Metropolitan estuaries are rated as being under very high pressure from sediment inputs.

*Nutrient inputs* are also associated with catchment disturbance as well as fertiliser application, effluent discharges and urban stormwater. Excess nutrients can lead to blooms of microscopic algae (phytoplankton) or macroalgae and changes to ecosystems. As for sediment inputs, the same models were used to estimate the increase in nutrient inputs. Algal growth in estuaries is generally limited by the supply of nitrogen, so total nitrogen has been used and is in accordance with the internationally accepted measure of nutrient load increase. The percentage increase in total nitrogen inputs for current land-use conditions compared with a fully forested, undisturbed catchment has been scored into five classes with boundaries of 0, 10, 50, 150, 400 and >400 per cent. Hawkesbury–Nepean and Sydney Metropolitan estuaries are rated as being under high pressure from nutrient inputs.

*Freshwater flow* into estuaries affects salinity levels, aquatic plant distributions, migration and spawning of aquatic animals, frequency of estuary mouth openings and fish communities. These ecosystem characteristics are all modified by catchment clearing, which increases the frequency and intensity of rainfall runoff. This, in turn, causes a change to the quantity and timing of ecologically significant freshwater inflows to the estuary, catchment and river bed/bank erosion and polluted runoff. The percentage increase in catchment runoff between current land-use and a fully forested undisturbed catchment has been used as a net measure of these changes and scored into five classes with boundaries of 0, 4, 12, 22, 44 and >44 per cent increase.

Licensed water extraction entitlements have been used as a second metric and normalised by the annual freshwater inflow. The total volume of entitlements compared to the annual flow has been scored into five classes with boundaries of 0, 6, 13, 19, 25 and >25 per cent of annual flow and the two metrics then combined into a single score. Hawkesbury–Nepean and Sydney Metropolitan estuaries are rated as being under moderate pressure from freshwater flows.

*Disturbed habitat* can arise from removal of foreshore vegetation, placement of foreshore structures such as reclamation walls, jetties and moorings, aquaculture leases, presence of the invasive seaweed *Caulerpa taxifolia* and trawling for fish. Current data on the presence of foreshore structures and aquaculture leases has been used. The length of estuary perimeter occupied by foreshore structures has been scored into five classes with boundaries of 0, 4, 8, 12, 16 and >16 per cent. The area of estuary occupied by aquaculture has been scored into five classes with boundaries of 0, 5, 10, 15, 20 and >20 per cent, and both metrics combined into a single indicator score.

The validity of this indicator will improve significantly when mapping of the extent of foreshore vegetation is completed and this can also be included as a metric. Hawkesbury–Nepean and Sydney Metropolitan estuaries are rated as being under very low pressure from disturbed habitat using this simple indicator.

*Tidal flow* can be affected by training walls built to keep estuary entrances open and the artificial opening of lagoon entrances for flood mitigation and other purposes. Both result in an increase in salinity levels, tidal ranges and flushing, and associated ecological effects. A score of five has been assigned to estuaries without training walls, three for one wall and one for two walls. Entrance opening levels were obtained from local government records and have been assigned increasing pressure as the artificial opening level reduces. Scores have been assigned as five for opening levels above 2.9 m Australian Height Datum (AHD); four for 2.4–2.9 m; three for 1.9–2.4 m; two for 1.4–1.9 m; and one for <1.4 m AHD. Hawkesbury–Nepean and Sydney Metropolitan estuaries are rated as being under very low pressure from changes to tidal flows.

*Fishing* by recreational and commercial fishers removes finfish and shellfish from the estuarine ecosystem. Disturbance of habitats by boats, gear and people can also be associated with these activities. Annual commercial fish catch data was normalised by estuary area and scored into five classes with boundaries of 0, 2, 3.9, 5.9, 7.8 and >7.8 tonnes/km<sup>2</sup>/year. Hawkesbury–Nepean and Sydney Metropolitan estuaries are rated as being under very low pressure from commercial fishing.

### **Regional summary**

The main pressures occur along the more highly developed Sydney Metropolitan area coastline. The trend in pressures for Hawkesbury–Nepean and Sydney Metropolitan estuaries is not yet known.

Table 2 is a summary of how estuaries rated for pressure within the Hawkesbury–Nepean and Sydney Metropolitan regions and a comparison with how Hawkesbury–Nepean and Sydney Metropolitan estuaries rated against NSW estuaries generally. Compared to the state average, the Hawkesbury–Nepean and Sydney Metropolitan regions have a much smaller proportion of estuaries rated under very low or low pressure, and a much larger proportion under moderate or high pressure. This is due to the higher proportion of relatively developed estuaries and their catchments found in the Hawkesbury–Nepean and Sydney Metropolitan regions compared to elsewhere along the NSW coastline, particularly the south coast which contains more than half the estuaries in NSW.

**Table 2 Regional summary of estuarine pressures**

Category	Very low	Low	Moderate	High	Very high	Total
No. of Hawkesbury–Nepean and Sydney Metropolitan estuaries	1	2	10	3	0	16
% of Hawkesbury–Nepean and Sydney Metropolitan region	6%	13%	62%	19%	0%	100%
% across all NSW	26%	26%	42%	6%	0%	100%

## Management activity

### Condition and pressure assessment

The condition indicator of chlorophyll a has been given a good rating, turbidity a poor rating and seagrass a fair rating for the Hawkesbury–Nepean and Sydney Metropolitan regions. There may be multiple factors influencing these indicators, including the effect of lower water clarity (higher turbidity) in limiting the phytoplankton (chlorophyll a) response and reducing seagrass condition, and the relatively high flushing rate of the drowned river valleys along this part of the coastline. The indicators are also known to be affected by stresses from catchment development. Urban stormwater, agricultural diffuse source runoff, sewage and industrial effluent discharges contain nutrients, sediments, organic material and toxins that can increase algal blooms, contaminate sediments and alter the composition of fish assemblages. Waterway stresses such as habitat disturbance and fishing can also alter fish species composition.

The pressure indicators of cleared land, population density, sediment and nutrient inputs represent different aspects of catchment development. Population density and sediment input rated very poor overall with cleared land and nutrient input rated poor providing some confirmation of the condition indicator assessment, albeit with a limited dataset.

State and local government, catchment management authorities (CMAs), industry and the community respond to the pressures and threats posed to estuary health at a range of levels. Responses vary from state-wide policy, programs, land-use planning and economic instruments through regional planning and investment, down to local planning, capacity building, best management practice (BMP) and on-ground rehabilitation works.

### State level

The State Plan embodies the natural resource management (NRM) targets set by the NSW Government. The targets are being addressed through state, regional and local partnerships. Some of the main activities at state level are listed below.

### Policy/strategy

- Coastal and planning policies direct, and set the context for providing for, population growth and economic development, while at the same time protecting the natural, cultural, spiritual and heritage values of the coastal environment. Relevant policies include the NSW Coastal Policy 1997, NSW State Rivers and Estuaries Policy 1993 and NSW Estuary Management Policy 1992 and NSW Diffuse Source Water Pollution Strategy 2009.

### Planning

- The NSW Estuary Management Policy encourages state government, local government and communities to prepare and implement estuary management plans (EMPs) that aim to achieve integrated, balanced, responsible and ecologically sustainable use of estuaries. There are 23 plans prepared or in preparation, as shown in Table 3.

**Table 3 EMPs prepared for Hawkesbury–Nepean and Sydney Metropolitan region sites**

EMPs	CMA region
Lower Hawkesbury River*	Hawkesbury–Nepean
Berowra Creek	Hawkesbury–Nepean
Brooklyn, Mooney Mooney and Mullet creeks	Hawkesbury–Nepean
Pittwater, Scotland Island	Hawkesbury–Nepean
Narrabeen Lagoon	Sydney Metropolitan
Curl Curl Lagoon	Sydney Metropolitan
Dee Why Lagoon	Sydney Metropolitan
Manly Lagoon	Sydney Metropolitan
Clontarf, Seaforth and Bantry Bay	Sydney Metropolitan
Long Bay	Sydney Metropolitan
Lane Cove River	Sydney Metropolitan
Parramatta River*	Sydney Metropolitan
Georges River*	Sydney Metropolitan
Little Salt Pan Creek	Sydney Metropolitan
Kelso Creek	Sydney Metropolitan
Kogarah Bay	Sydney Metropolitan
Oatley Bay*	Sydney Metropolitan
Port Hacking~	Sydney Metropolitan

EMPs	CMA region
Woronora River	Sydney Metropolitan
Yowie Bay	Sydney Metropolitan
Gunnamatta Bay	Sydney Metropolitan
GyMEA Bay	Sydney Metropolitan
Bundeena Creek*	Sydney Metropolitan

\*EMPs in preparation

~ EMP being revised

### Legislation

State legislation designed to reduce the pressures and threats associated with catchment development includes, for example:

- the *Native Vegetation Act 2003* to limit land clearing
- the *Threatened Species Conservation Act 1995*, under which coastal saltmarsh is listed as an Endangered Ecological Community
- the *Water Management Act 2000* to protect environmental flows for rivers and estuaries
- the *Protection of the Environment Operations Act 1997* to licence sewage effluent discharges
- the *Fisheries Management Act 1994* to manage commercial fisheries, aquaculture, aquatic habitat disturbance and invasive species
- the *Environmental Planning and Assessment Act 1979* under which, for example, standard NRM clauses are being developed for local environmental plans (LEPs). Section 117 directions require LEP provisions to protect the environment; state environmental planning policies (SEPPs) cover coastal wetlands, littoral rainforests, canal developments, aquaculture, urban bushland, coastal protection and rural lands.

### Comprehensive Coastal Assessment Toolkit

To support local councils in developing LEPs and long-term strategies in line with the NSW coastal policy, regional strategies and other policies, orders and directions, the NSW Government developed the Comprehensive Coastal Assessment Toolkit. The toolkit provides datasets and decision support tools to assist in undertaking strategic land-use planning.

### Regional level

With the population of Sydney set to increase by 1.1 million in the next 25 years, the NSW Government is planning now for Sydney's future through the Metropolitan Strategy. It supports continuing economic growth while balancing social and environmental impacts. Subregional planning will translate some of the objectives of the Metropolitan Strategy to the local level. A number of draft subregional plans have been prepared.

Other relevant regional level planning activities include:

- Central Coast Regional Strategy (applies to part of the Hawkesbury–Nepean region)
- Sydney Regional Environmental Plan No. 20 – Hawkesbury–Nepean River
- 2001 Hawkesbury–Nepean Statement of Joint Intent

- Georges River Catchment Regional Environmental Plan No. 2
- Sydney Regional Environmental Plan No. 17 – Kurnell Peninsula
- Sydney Regional Environmental Plan (Sydney Harbour Catchment)
- Cooks River Foreshore Improvement Program
- the Department of Planning, in conjunction with DECCW, will prepare a Section 117 direction on how the management of stormwater is to be considered in the development of LEPs.

Catchment action plans (CAPs) and supporting investment programs are the key regional documents that coordinate and drive the effort to improve natural resources. The CAPs describe the whole-of-Government approach to address each of the state-wide targets at the regional level, and specify regional targets and activities to contribute to the achievement of the state-wide targets.

The Hawkesbury–Nepean Catchment Action Plan can be found at [www.hn.cma.nsw.gov.au/topics/2181.html](http://www.hn.cma.nsw.gov.au/topics/2181.html).

At the regional level the Hawkesbury–Nepean CMA is undertaking the following activities in relation to the estuaries and coastal lakes theme:

- building capacity in riverside and estuary catchment communities and targeting riverbank stability, marine debris and land management issues and isolated estuary communities
- supporting implementation of the Lower Hawkesbury and Pittwater EMPs and Coastal Management Plans. Actions include saltwater wetland protection and restoration, erosion control on estuary foreshores, seagrass protection and education and seagrass friendly moorings. In 2007–08 the program included:
  - protection of Dangar Island seagrass (Hornsby/Gosford Councils)
  - control and eradication of bitou bush (Pittwater Council)
  - mapping, protection and restoration of saltmarsh (DECCW, Gosford/Hornsby and Pittwater councils, Coastal Environment Network and landholders)
  - removing derelict boats (Hornsby Council, Land and Property Management Authority)
  - managing recreational pressures to improve estuarine water quality in priority oyster aquaculture areas (oyster industry, DECCW)
  - supporting Waterwatch in the Gosford area (Central Coast Environment Network, Hunter–Central Rivers CMA)
- supporting strategic and coordinated public/private partnerships to protect and restore priority vegetation communities in the coast and estuary landscapes
- supporting the environmental sustainability of fishing and aquaculture industry groups by implementing relevant environmental management strategies.

A draft of the Sydney Metropolitan CAP has been developed and is currently being considered by the Minister.

At the regional level the Sydney Metropolitan CMA is undertaking the following activities in relation to the estuaries and coastal lakes theme:

- a boating and recreational fishing strategy to reduce the spread of marine pests
- improving estuaries and coastal lakes – mapping and on-ground works
- a marine pest risk assessment



- mapping estuarine vegetation outside Sydney Harbour
- Sydney Harbour riverine corridor ecology education and guidelines
- mapping in-stream freshwater aquatic vegetation of the Parramatta River
- Sydney Harbour seagrass and other estuarine vegetation mapping, database and guidelines
- the Tide to Table Project.

### **Local level**

Local government plays a key role in protecting the health of estuarine ecosystems through a number of mechanisms, including land-use and strategic planning, development controls and policies covering erosion and sediment control and water-sensitive urban design, provision and upgrading of reticulated sewerage systems, management of septic systems, and preparation and implementation of stormwater management plans and EMPs.

Organisations working with the Hawkesbury–Nepean CMA on significant local activities in the catchment contributing to better estuary outcomes include Coastcare, Landcare and Bushcare; Hornsby, Pittwater and Gosford councils; NSW Food Authority, Coastal Environment Network, HCRCMA, Oceanwatch, Broken Bay Oyster Association, NSW Farmers oyster industry, NSW Maritime, DECCW and Industry & Investment NSW.

In the Sydney Metropolitan region, a number of other groups are undertaking significant work that is contributing to better outcomes for estuaries and coastal lakes including:

- Canterbury Council – estuarine mapping project and vegetation management plan
- University of New South Wales – research into the state of Botany Bay and Georges River (sediments and foraminifera)
- National Parks Association – HarbourKeepers
- NSW Wader Study Group – bird monitoring
- NSW Wader Study Group – habitat improvement for wading birds, and community education
- Coastal Environment Centre, Narrabeen – community education on coastal issues.

## Further reading

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Published by: Department of Environment, Climate Change and Water NSW, 59-61 Goulburn Street, PO Box A290, Sydney South 1232.

Ph: (02) 9995 5000 (switchboard). Ph: 131 555 (environment information and publications requests).

Ph: 1300 361 967 (national parks, climate change and energy efficiency information and publications requests).

Fax: (02) 9995 5999. TTY: (02) 9211 4723.

Email: [info@environment.nsw.gov.au](mailto:info@environment.nsw.gov.au) Website: [www.environment.nsw.gov.au](http://www.environment.nsw.gov.au)

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