PART 2 COMMUNITY CONSULTATION AND STAKEHOLDER LIAISON

Community and stakeholder views form an integral component of the NSW estuary planning process. For this study, community and stakeholder views have been sought in a number of ways including;

- ***Community Meetings*** – open public meetings have been held at the Hat Head SLSC to inform the local community of the commencement of the study (May 2008) and to provide an opportunity for the residents of Hat Head to comment on the content of the Estuary Management Study including the objectives, issues raised, and priorities for management (December 2008).
- ***Korogoro Creek Working Group*** – This group is a local liaison group convened as a sub-group of the Macleay Estuary Management Committee in 2006. Draft documents and materials such as the community survey have been provided to the working group for comment.
- ***Community Surveys*** – A community survey was distributed to the local community via the Hat Head post office in mid 2008. The survey expanded upon a survey conducted for the Data Compilation and Process Study in 2006/2007 and asked respondents to rank a number of *Values* of the estuary and *Threats* to those values in order of priority. These priorities have been used to assist the determination of priorities for the management of key issues identified in the estuary management study. The findings of the community survey are presented in *Section 2.1* below.
- ***Direct comment on draft documents*** – The Community Survey and the Draft Korogoro Creek Estuary Management Study have been provided directly to members of the Macleay Estuary Management Committee for review and comment. The Survey and draft study have also been available for download via the Kempsey Shire Council website (http://www.kempsey.nsw.gov.au/estuarymanagement.htm#).
- ***Media releases*** – Media releases advising the general public of the commencement of the study, the availability of the community survey, and the release of the Draft Estuary Management Study have run in local papers over the course of the study.

2.1 Korogoro Creek Estuary Management Study Survey 2008

In June 2008 a survey was developed and distributed to canvas community and stakeholder perceptions of the values associated with the Korogoro Creek estuary and potential threats to it. A sample survey is included as an appendix to this report (*Appendix 1*). The survey was designed to extract the maximum information about perceived values and threats. The survey asked respondents to rank identified **threats** (from 1 to 18) and **values** (from 1 to 19) and to suggest any new threats and values and to comment on the survey itself.

In total 69 surveys were returned. Of the 69 surveys;

- Six were returned with the Values side incorrectly filled out;
- Three were returned with the Threats side incorrectly filled out;
- Eight contained comments about the survey itself. Of the eight comments, two were positive comments about the comprehensive nature of the survey and six were negative comments that the survey was too long, too confusing or too broad.
- Forty-five were filled out entirely.

2.1.1 Analyses

The surveys were analysed to develop a ranking of values and threats that could be used in the prioritisation of management strategies. The mean ranking for each value and each threat was considered the most valuable statistic. The median ranking and the standard error of the mean are represented in *Figure 2-A* to demonstrate the quality of the statistics.

The number of responses received for each value and each threat was also calculated. This represents as an alternative measure of community interest in, and knowledge of, particular values and threats for comparison.

Rankings – Korogoro Creek Estuary Values

The Values were ranked by their mean as per *Figure 2-A*, the Value considered most important having the lowest number for its mean ranking. Notably, the order of ranking is very similar if the median is used to describe the survey responses. When ranked by the number of responses received the Values were ranked as per *Figure 2-B*.

Five of the six most important Values, when ranked by mean, are also within the six most important Values when ranked by number of responses received. The same can be said for the least important Values.

The standard errors are quite large relative to the means, indicating a high level of variability in the opinions of those surveyed. However, the standard errors are relatively homogenous for the Values surveyed. This factor, in combination with the high degree of concurrence between the two ways of analysing the data, indicates that the statistics are meaningful and that the information gathered in the survey is valuable.

Figure 2-A Korogoro Creek Values Ranked by Mean Community Opinion

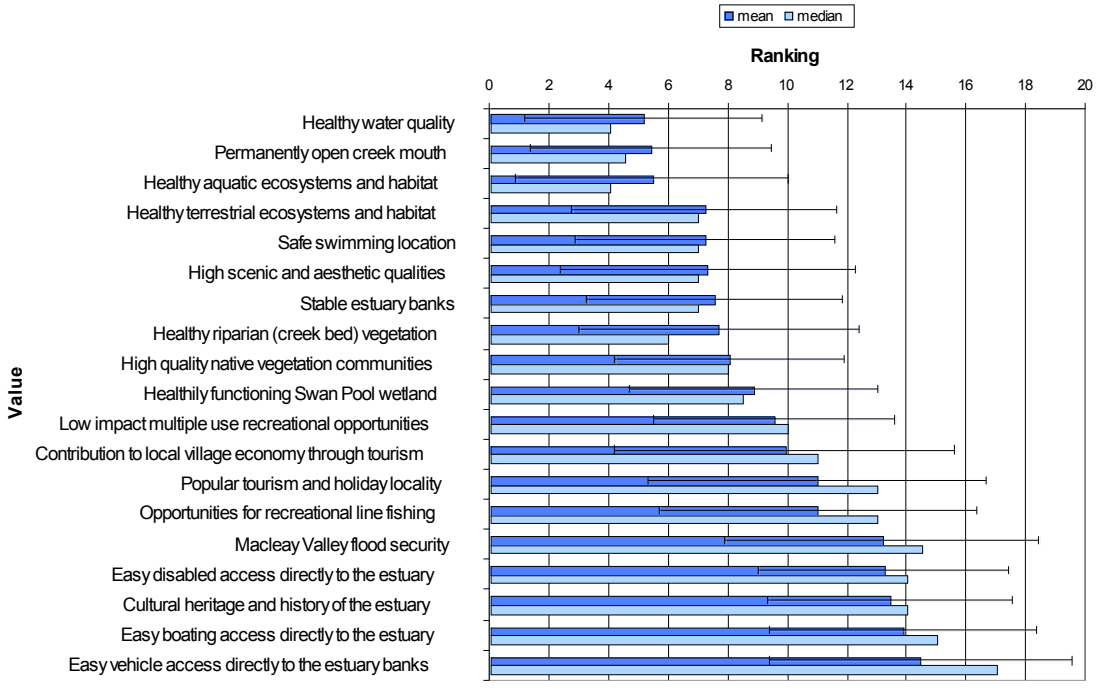
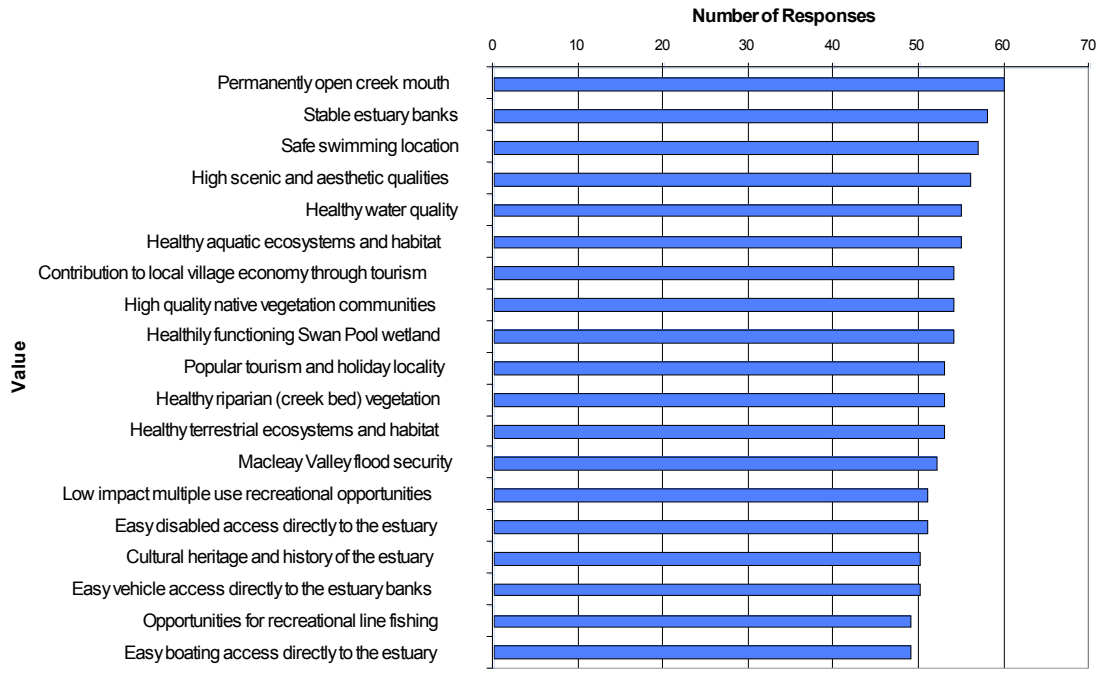


Figure 2-B Korogoro Creek Values Ranked by Level of Community Response



Rankings – Threats to Estuary Values

The Threats were ranked by their mean as per *Figure 2-C*, the Threat considered most important having the lowest number for its mean ranking. Once again the order of ranking is very similar if the median is used to describe the survey responses. When ranked by the number of responses received the Threats were ranked as per *Figure 2-D*.

Only three of the six most important Threats, when ranked by mean, are also within the six most important Threats when ranked by number of responses received. Of the least important Threats, there is a higher degree of concurrence.

The standard errors are quite large relative to the means but are, once again, quite homogenous for the threats surveyed. Once again this factor, and the relatively high level of concurrence between the two methods of analysis indicate that valuable information about community perceptions has been gathered.

Figure 2-C Threats to Korogoro Creek Ranked by Mean Community Opinion

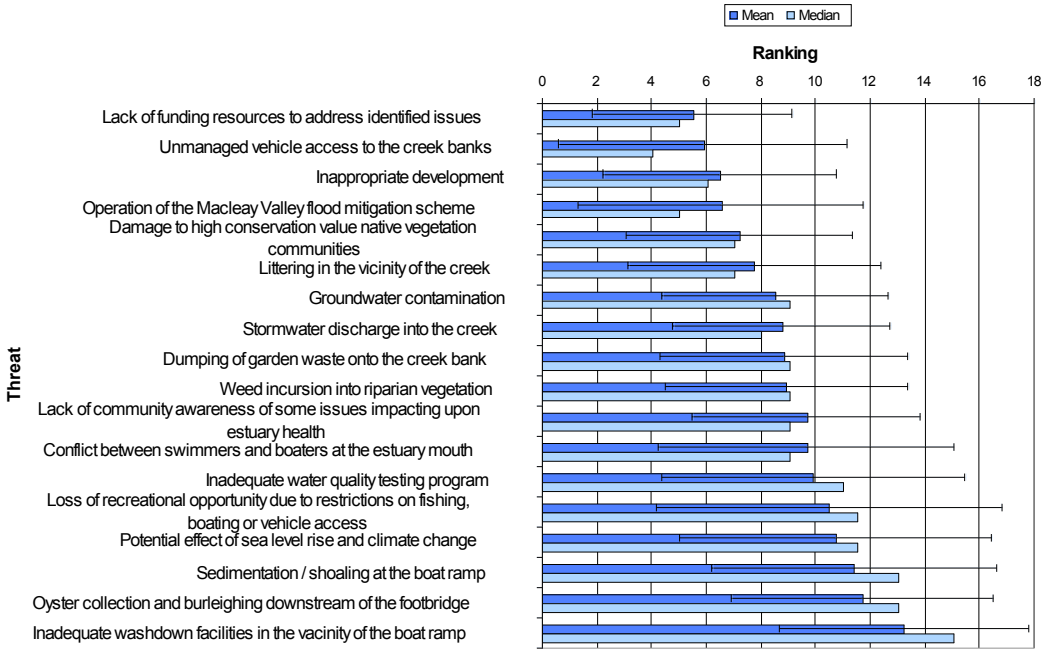
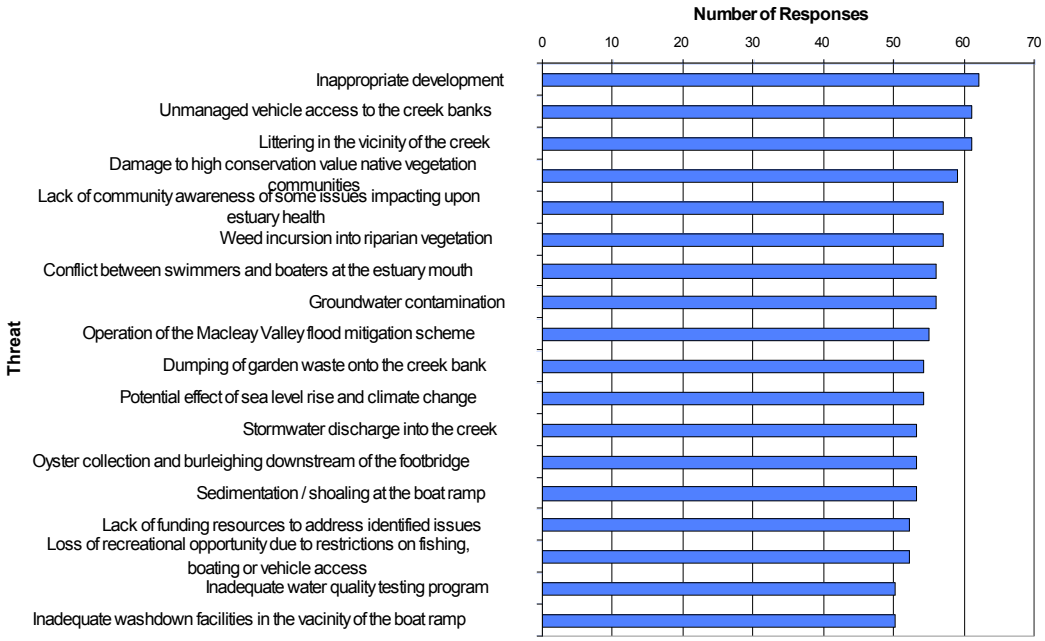


Figure 2-D Threats to Korogoro Creek Ranked by Level of Community Response



Additional Values and Threats

A space was provided on the survey forms for respondents to name and rank any additional values or threats they thought appropriate. A large number of respondents chose to fill out this part of the survey but in many cases the values or threats written down were already adequately represented in the survey body or were not suitable for consideration as either values or threats.

The following original values were suggested;

- The value of the creek as a location for the study of fish behaviour and responses to sea temperature change; and
- The value of the riparian zone as an educational resource to teach locals and visitors about indigenous survival techniques and 'bush tucker'.

The following original threats were suggested;

- The threat of horses in the creek to bank stability, water quality and recreational amenity;
- The threat of commercial fishing in the mouth of the creek;
- The threat of a lack of policing of regulations and guidelines and an increase in visually obtrusive signs to replace policing personnel;
- The threat of free roaming domestic dogs to native wildlife;
- The threat of jet skis using the creek;
- The threat of a lack of community support for management efforts;
- The threat of people ignoring signs and regulations;
- The threat of motorised boating upstream of the boatramp; and
- The threat of overfishing by recreational fishers, including collection of tropical species and damage done by line fishing downstream of the boat ramp;

Other Suggestions

In addition to the new threats and values and the comments about the survey itself, some suggestions were made about the creek management. These included;

- A suggestion that Gap Road is too narrow for roadside parking, so some parking must be made available for people wishing to reach the creek bank if vehicle access is to be restricted;
- A suggestion that vehicle access needs to be managed to the creek banks but that access to fishers should be retained;
- A suggestion that the river could be zoned to separate boats, swimmers, fishers and to include a 'no go, no take' protection zone. Another survey suggested that boats should have right of way downstream of boatramp;
- The suggestion that if the flood mitigation scheme is to continue that a separate pathway to the ocean be constructed;
- A suggestion that the footbridge needs some work;
- A suggestion that an opportunity exists to educate users and visitors via a pamphlet to be distributed from the caravan park office;
- A suggestion that if flood mitigation is to continue then some active regeneration of habitat should be undertaken to mitigate the impacts; and
- A suggestion that disabled access, benches and barbeques should be included on the Gap Beach side of the creek;

2.1.2 Discussion

The survey was designed so that values and threats that had been identified through prior consultative processes could be ranked in importance. This can be done in two ways, by ranking each value and threat with regard to the number of responses it received or with

regard to the average response from those received. For the values, a high level of correlation was found between the two methods of analysis. For the threats there was some correlation between the results of the two methods of analysis. All threat and value categories received a large number of responses (between 49 and 62 from 69 surveys). The low level of variation (less than 20%) indicates that the values and threats are understood relatively well and considered important by the community. It also indicates that mean ranked values are probably the best way to rank the values and threats

The survey presented the values and threats as options divided into three general groups; economic, social and environmental. The results indicated that the values that generate the most community interest generally fall within the environmental category. The top four values, and eight of the top ten, were from the environmental category. Interestingly, the results indicated that the community perceptions of threats to the creek are from all categories.

A comparison with the 2006-2007 community survey (Telfer, 2007) yields a generally high level of concurrence. Though the surveys were created to generate different information, the following points can be made;

- In 2006/7 community survey, the major issues of concern were littering, bank erosion and uncontrolled vehicle access to the southern bank. This result was echoed neatly in this new survey, where stable banks was among the highest rated values and littering and uncontrolled access were among the highest rated threats.
- Swimming was ranked in the 2006/7 as the most frequently undertaken activity. Accordingly, a safe swimming location was among the most important values identified in this survey and healthy water quality was ranked as the number one value. Conflict between swimmers and boaters was not rated among the most important threats.
- The values rated most important in the 2006/7 survey were a permanently open creek mouth, healthy estuary ecosystem and safe swimming location. The value considered least important was vehicle access to the creek bank. These findings have been directly verified in this survey.
- The 2006/7 survey identified the issues of greatest and least concern to the community, finding litter, vehicle access to the southern bank, bank erosion and habitat protection the highest rating issues. The latest survey identifies litter and vehicle access to the southern creek bank as major threats to the creek and healthy aquatic and terrestrial habitats as important values.

The survey generated important information for the management of Korogoro Creek. Community perceptions of identified values and threats have been ranked. The rankings of threats developed to assist with the creation of an estuary management plan are contained in *Table 1*.

Table 1 Community perceptions of values and threats ranked with respect to importance.

	Values	***Threats***
Most Important	Healthy water quality	Lack of funding resources to address identified issues
	Permanently open creek mouth	Unmanaged vehicle access to the creek banks
	Healthy aquatic ecosystems and habitat	Inappropriate development
	Healthy terrestrial ecosystems and habitat	Operation of the Macleay Valley flood mitigation scheme
	Safe swimming location	Damage to high conservation value native vegetation communities
	High scenic and aesthetic qualities	Littering in the vicinity of the creek
Moderate Importance	Stable estuary banks	Groundwater contamination
	Healthy riparian (creek bed) vegetation	Stormwater discharge into the creek
	High quality native vegetation communities	Dumping of garden waste onto the creek bank
	Healthily functioning Swan Pool wetland	Weed incursion into riparian vegetation
	Low impact multiple use recreational opportunities	Lack of community awareness of some issues impacting upon estuary health
	Contribution to local village economy through tourism	Conflict between swimmers and boaters at the estuary mouth
Least Important	Popular tourism and holiday locality	Inadequate water quality testing program
	Opportunities for recreational line fishing	Loss of recreational opportunity due to restrictions on fishing, boating or vehicle access
	Macleay Valley flood security	Potential effect of sea level rise and climate change
	Easy disabled access directly to the estuary	Sedimentation / shoaling at the boat ramp
	Cultural heritage and history of the estuary	Oyster collection and burleying downstream of the footbridge
	Easy boating access directly to the estuary	Inadequate washdown facilities in the vicinity of the boat ramp
	Easy vehicle access directly to the estuary banks	

PART 3 REVIEW OF ESTUARY PROCESSES

3.1 Critical Processes Driving Estuary Health

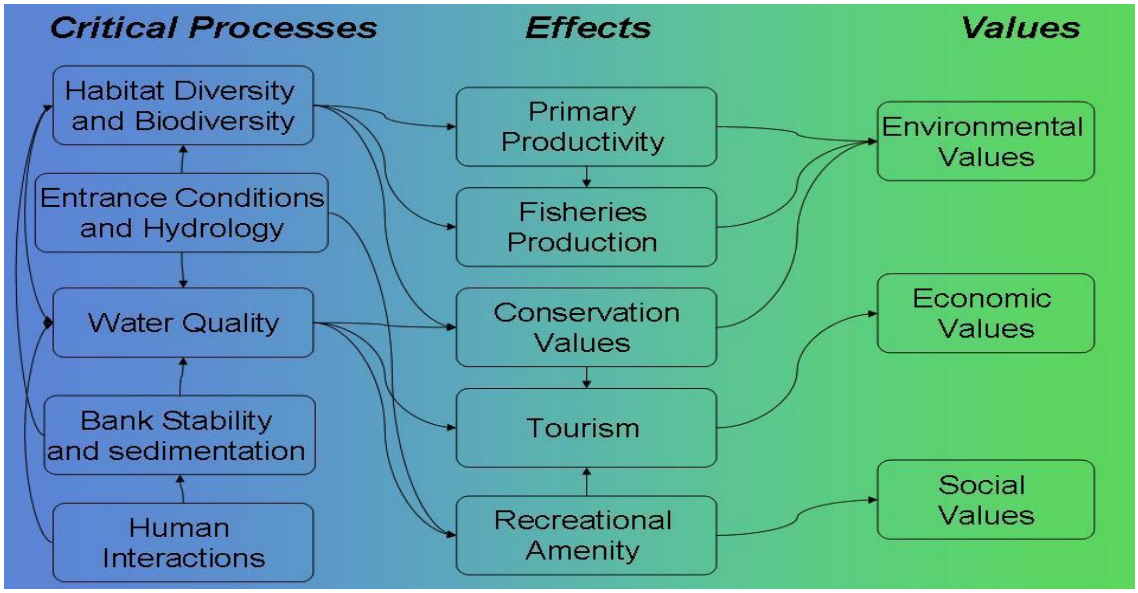
Estuaries provide a wide number of ecological, social and economic functions. They are an essential link in the chain of fisheries production. They are centres for tourism and recreation across most NSW coastal areas. Estuaries serve as habitat for many and varied species of conservation interest. Due to the varied habitats inherent to most estuaries they are known for being areas of high biodiversity. These functions are often dependent on the health of the specific estuarine system. Measures of estuary health are many and varied but rarely specific. With regard to the estuary functions and health of the Korogoro Creek estuary the following aspects will be considered:

- How well does the estuary meet the community's economic, social and recreational needs?
- How well does the estuary perform its ecological functions?
- How healthy is the estuary environment in terms of water quality and biodiversity?

Some of these aspects can only be measured in terms of the expectations of stakeholders and the community. The results of community and stakeholder surveys have been analysed in *Part 2* of this study.

The processes critical to the function and health of the Korogoro Creek estuary include entrance conditions and hydrology, bank stability and sedimentation, habitat diversity and biodiversity, water quality, and human use interactions. The relationships are complex with the processes displaying a degree of interdependence and are most easily described as a simplified conceptual diagram, such as *Figure 3-A*. For example, habitat diversity is dependent on both entrance conditions and bank stability. Habitat diversity is also directly connected to biodiversity and thus has an impact on the conservation value and productivity of the estuary ecosystem, and so on and so forth.

Figure 3-A Schematic of Interactions between critical processes.



3.1.1 Entrance Conditions and Hydrodynamics

Unlike many small Intermittently Closed and Open Lagoons and Lakes (ICOLLs) along the NSW coast, the Korogoro Creek entrance is considered to be permanently open having not closed in living memory (Telfer 2007). The state of the entrance appears to be maintained by the orientation of the headland, offshore currents swell and wind conditions, tidal movements and the intermittent operation of the Macleay Valley Flood Mitigation Scheme. Shoaling at the entrance is also influenced by these factors and at times the entrance has almost closed. Shoaling in the vicinity of the boat ramp has necessitated the removal of sands by the Council in the past but such action is infrequent and not well documented.

The permanently open entrance conditions are fundamental to the health of the Korogoro Creek system. The open entrance influences:

- *The flushing time of the estuary*. Tidal flushing times are entirely dependent upon the status of the entrance to the estuary.
- *Water quality*. Water quality with respect to ecosystem protection and recreational use of estuary waters is dependent on the tidal flushing of the estuary.
- *Recreational amenity*. The above mentioned positive effects on water quality improve the opportunities for primary contact recreation and recreational harvest of fish and shellfish. The permanently open entrance also makes Korogoro Creek a reliable access point for ocean going recreational craft.
- *Estuarine ecology*. The permanently open entrance allows the free movement of oceanic species. This ensures a constant supply of juvenile fish and allows the estuarine organisms that breed in the open ocean opportunity to migrate. The increased salinity associated with constant tidal incursion has a positive effect on the species diversity of fish, invertebrates and algae.
- *Sedimentation*. The rate of infilling of the estuary with marine sourced sands is determined in part by the entrance geometry as well as littoral sand transport, ocean currents, tides, and regularity of flood flows conveyed through the creek.

The hydrology of the Korogoro Creek system is dominated by tidal flushing. The tides influence the entire length of the estuary and maintain the creek in a well mixed and well flushed state. Tidal flushing is estimated to be within 1-2 days across all tidal cycles, though the potential for stratification in the water column is greatly increased in upper reaches during neap (smallest tides) cycles.

Freshwater flows, from groundwater and runoff, in the estuary are estimated to be 13 – 14% of the tidal prism. This would increase markedly for short periods during times of flood when the Swan Pool is drained. The time for the estuary to be flushed via freshwater flows could be greater than 7 days in the upper estuary, depending on flows. This estimate is based on crude data and could be improved with a more accurate understanding of the complicated hydrological and groundwater interactions characteristic of the catchment (MHL 2007).

3.1.2 Bank Stability and Sedimentation

The threats to estuary health and function associated with bank erosion include a reduction in riparian habitat extent and quality (including saltmarsh), sediment deposition and gradual infill, increased suspended sediment/turbidity, associated threats to aquatic vegetation such as seagrasses, physical effects on fish and invertebrates such as gill clogging, and a reduction of the flood mitigation potential of the creek.

Bank stability is therefore critical to:

- *Estuarine ecology*. The maintenance of relatively clear waters enhances the growth of aquatic plants via enhanced light penetration and a reduction in smothering. Physical effects of turbidity on aquatic fauna are also reduced. In some areas of the creek, stable banks protect saltmarsh habitat.
- *Recreational amenity*. Although not the major source of sedimentation in the estuary, sediment from bank erosion contributes to channel infilling which can impact upon the recreational amenity especially for those boating or swimming.
- *Economic values*. The ability of Korogoro Creek to carry floodwaters from the upper Macleay floodplain would be reduced with further sediment infill. The economic value of the creek as a tourist drawcard is also dependent upon recreational amenity and ecological values.

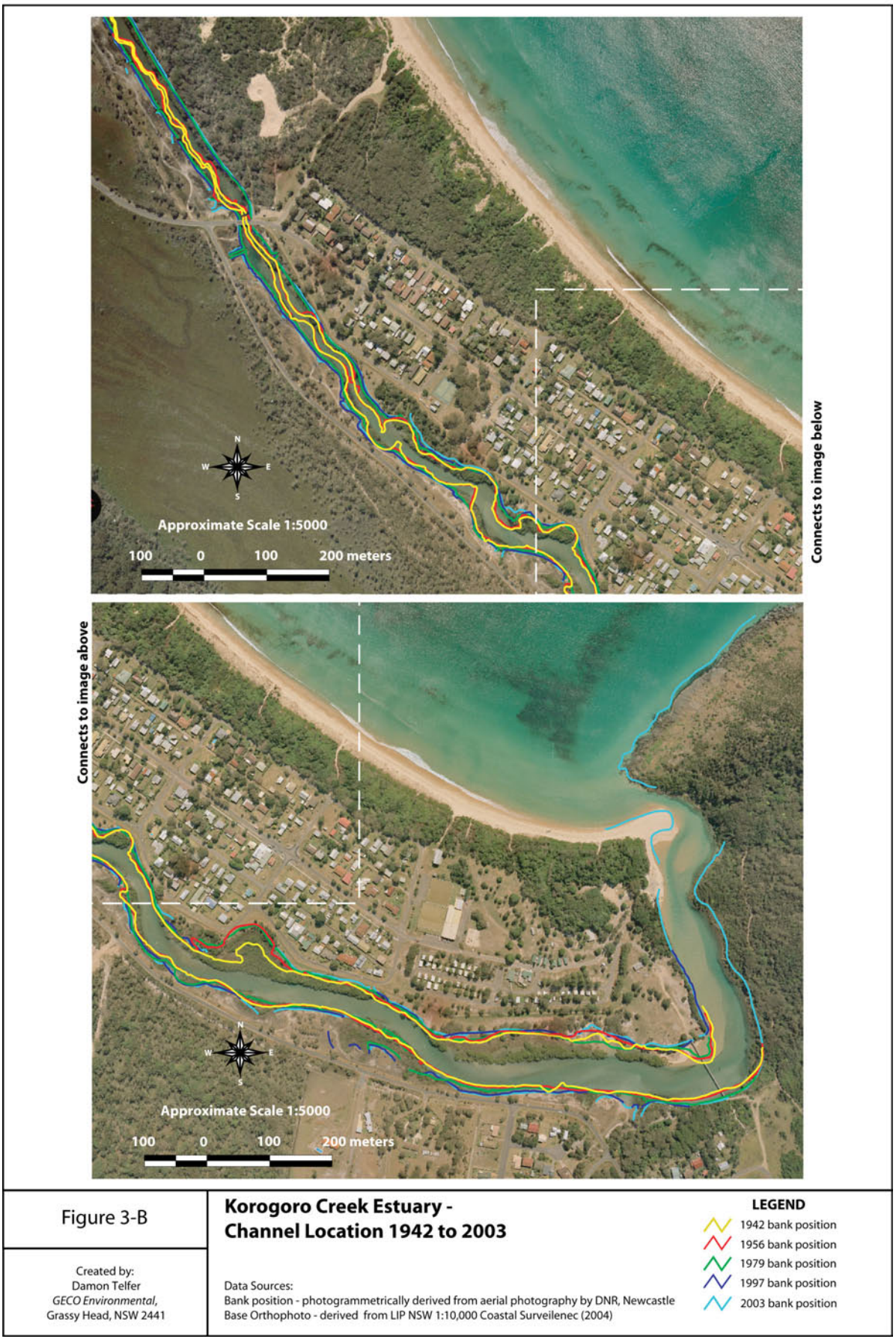
Analyses of historic aerial photograph records over the period 1942 to 2004 indicate that there has been significant widening of the channel, particularly in the reaches above the traffic bridge and in the reach between the traffic bridge and the footbridge (*Figure 3-B*). Upstream of the traffic bridge the increased width is directly attributable to flood mitigation with the widening and extension of the natural channel to the Korogoro Cut. Between the traffic bridge and the footbridge the widening is most likely caused by a combination of factors including increased scour during flood mitigation operation, tidal scour, wind waves, decreased riparian vegetation, and impacts associated with access.

Over this time period, the ingression of marine sands has also increased with the marine tidal delta extending some 830m further into the estuary (Telfer, 2007; see *Figure 3-C*). Such ingression is a natural process occurring over time, the rate of which is dependant upon the littoral transport of sands up the coast of NSW, offshore and tidal currents, entrance conditions including sand supply and degree of “openness”, and the frequency of flushing freshwater flows which transport sediments back into the ocean.

Despite the recorded changes in channel width, bank erosion mapping in 2007 identified that over 90% of the banks of Korogoro Creek can be considered stable (Telfer, 2007; see *Figure 3-D*). None of the erosion identified was considered severe, which is defined as erosion that is extensive and ongoing with no natural recovery mechanisms apparent. Only a small proportion of stable banks were identified as bedrock or stabilised by bank erosion works. In general, the results indicate that the banks of Korogoro Creek are mostly stable. The stability of the estuary banks are one of the many factors accounting for the health of the estuary.

3.1.3 Ecology, Habitat and Biodiversity

Korogoro Creek estuary has a rich variety of habitats supporting a range of aquatic and terrestrial flora and fauna. The habitat types identified in the Estuary Processes Study (Telfer 2007) include riparian woodlands and heaths, wetlands, mangroves, seagrass, saltmarsh, intertidal sand and mudflats, rocky shores, some macroalgae and channel areas (*Figure 3-E)*. A current list of threats to each of these habitat types is given in *Table 2*. The wide diversity of habitat types is essential to overall biodiversity and is reflected in the diverse faunal assemblages found. A limited faunal survey observed 48 fish species, 9 crustacean species and a marine reptile. A variety of birds, some protected by international treaties and/or NSW government legislation, also visit the estuary.


Connects to image below
Approximate Scale 1:5000
100 0 100 200 meters
Connects to image above
Approximate Scale 1:5000
100 0 100 200 meters
Figure 3-B
Korogoro Creek Estuary -
Channel Location 1942 to 2003
Created by:
Damon Telfer
GECO Environmental,
Grassy Head, NSW 2441
Data Sources:
Bank position - photogrammetrically derived from aerial photography by DNR, Newcastle
Base Orthophoto - derived from LIP NSW 1:10,000 Coastal Surveilenec (2004)
LEGEND
1942 bank position
1956 bank position
1979 bank position
1997 bank position
2003 bank position

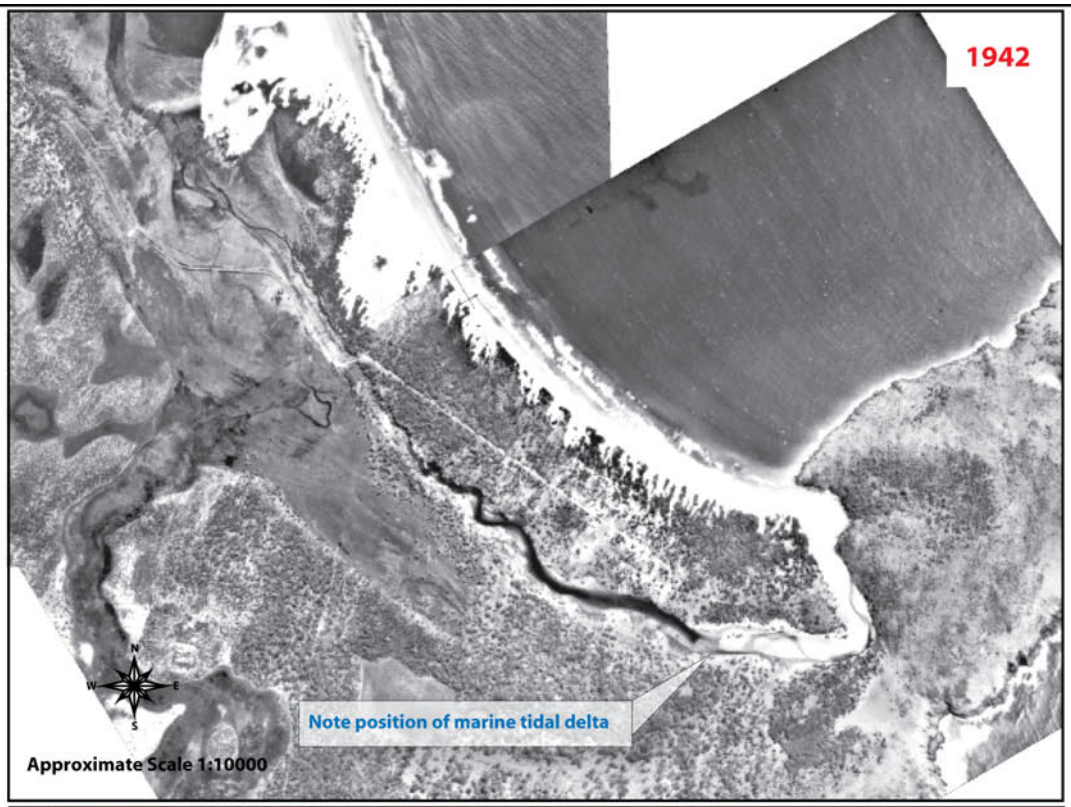


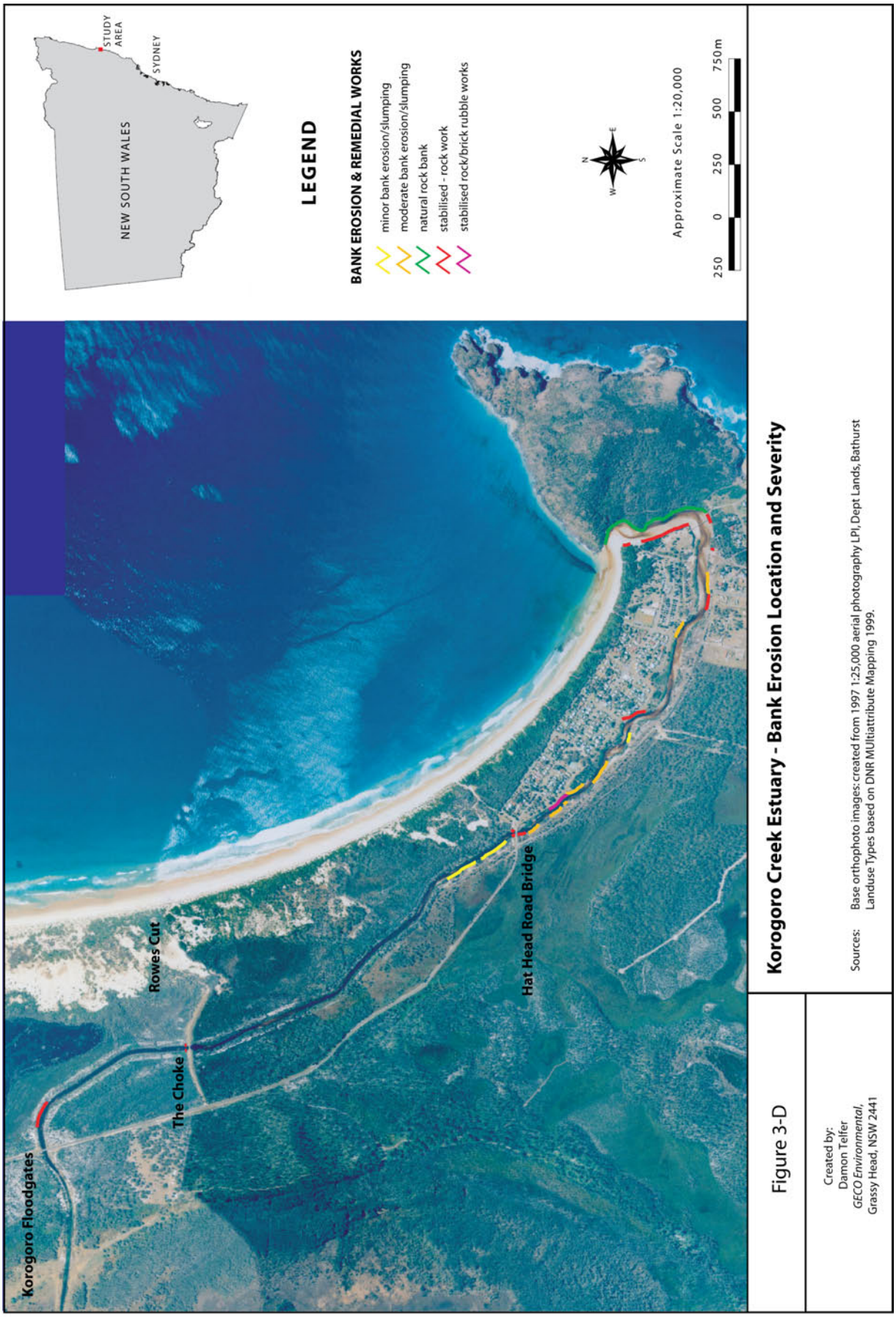
Figure 3-C

Changes in channel sedimentation between 1942 and 2003

Created by:
Damon Telfer
GECO Environmental,
Grassy Head, NSW 2441

Base orthophoto images created from:
2003 1:25,000 aerial photography LPI, Dept Lands, Bathurst &
1942 aerial supplied by United Photo & Graphic, Melbourne

LEGEND
1942 bank position


STUDY AREA
SYDNEY
NEW SOUTH WALES
LEGEND
BANK EROSION & REMEDIAL WORKS
minor bank erosion/slumping
moderate bank erosion/slumping
natural rock bank
stabilised - rock work
stabilised rock/brick rubble works
N
W
E
S
Approximate Scale 1:20,000
250 0 250 500 750m
Korogoro Floodgates
The Choke
Rowes Cut
Hat Head Road Bridge
Figure 3-D
Korogoro Creek Estuary - Bank Erosion Location and Severity
Created by:
Damon Telfer
GECO Environmental,
Grassy Head, NSW 2441
Sources: Base orthophoto images: created from 1997 1:25,000 aerial photography LPI, Dept Lands, Bathurst
Landuse Types based on DNR MUltiattribute Mapping 1999.

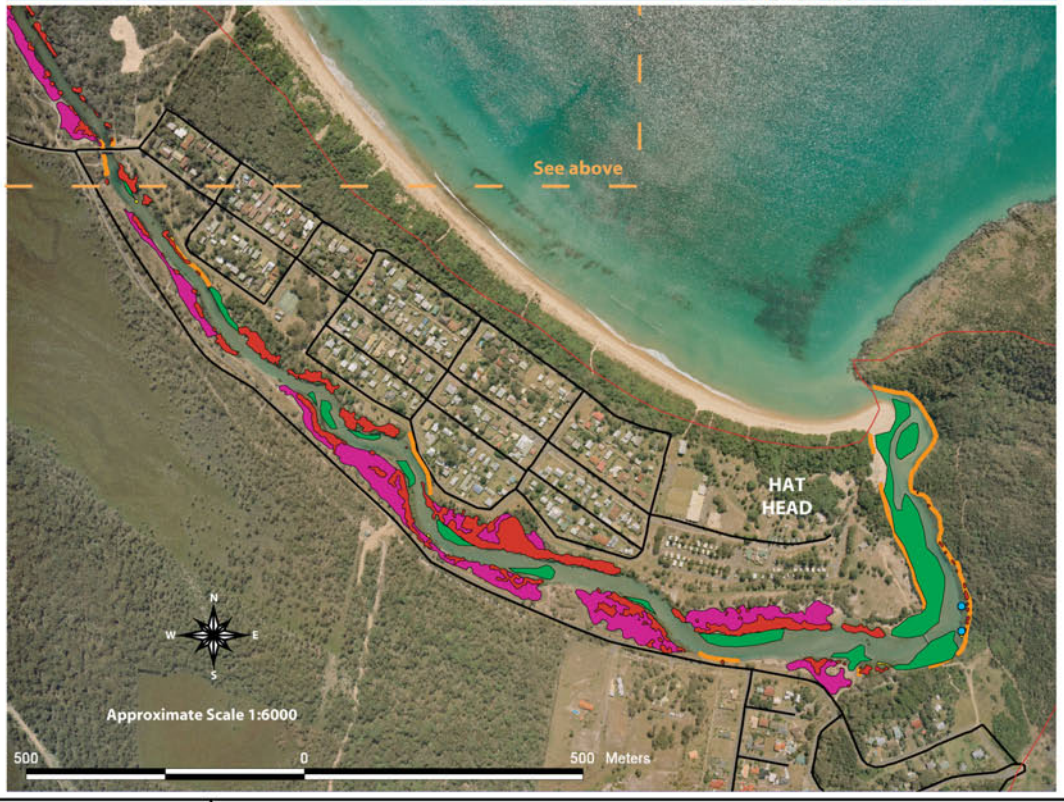


Figure 3-E

Korogoro Creek Estuary - Aquatic Habitat Types

Created by:
Damon Telfer
GECO Environmental,
Grassy Head, NSW 2441

Data Source:
Aquatic Macrophytes - Dept Primary Industries Fisheries
Orthophotos - derived from LIP NSW images (2003,2004)
Roads - Dept Environment and Climate Change

LEGEND

Approximate Catchment Boundary
Roads

ESTUARINE HABITATS

Mangrove
Seagrass
Saltmarsh
Intertidal sand/mud flats
Rocky shore/boulder fields
Seaweed

The diversity of habitats and associated biodiversity are critical to the overall health of the Korogoro Creek System. Some of the values associated with biodiversity are;

- *Overall Productivity*. Mangroves, seagrass, riparian vegetation and saltmarsh are some of the primary production systems found in the estuary. The overall abundance of these features accounts for the wide diversity and richness of life in the creek.
- *Recreational Amenity*. Recreational activities enhanced by opportunities for contact with wildlife include fishing, swimming, snorkelling, canoeing/kayaking, bushwalking and picnicking.
- *Economic Values*. The wide diversity of fauna present and the overall productivity of the Korogoro Creek system are significant tourist drawcards. Tourism is an important industry in the Hat Head township and the greater Macleay area. In addition, many of the fish species identified in the Estuary Processes Study were juveniles of species of economic importance. Korogoro Creek is part of a chain of estuarine fish nurseries which support fisheries throughout the state.
- *Water Quality*. The riparian vegetation, mangroves, saltmarsh and seagrass habitats all have a role in maintaining the (generally) acceptable water quality of the Korogoro Creek estuary. The vegetation plays an important role in nutrient cycling as well as trapping sediment from the water column and diminishing the erosive forces of strong tidal and flood flows and wind driven waves.
- *Conservation Values*. Biodiversity is protected under NSW legislation at the community, species and genetic levels. Protected species and ecological communities found in Korogoro Creek include Saltmarsh, the loggerhead turtle (*Caretta caretta*) and a variety of bird species. Anecdotal evidence suggests that Black Cod (*Epinephelus daemelii*) have also been observed.

Table 2 Key Estuarine Habitats and Associated Threats

Habitat Type	***Threat***	***Nature of Threat***
Coastal Saltmarsh	▪ Vehicle Access ▪ Erosion and associated landward migration of mangroves ▪ Stormwater discharge ▪ Sea level rise	*MAJOR* Saltmarsh is an Endangered Ecological Community protected under state legislation.
Mangroves	▪ Operation of Flood mitigation scheme ▪ Creation of informal access to creek from town areas ▪ Stormwater drainage ▪ Sea level rise	*MODERATE* Mangroves are well represented in Korogoro Creek and threats are most likely to interfere with recruitment though sea level rise could pose more significant threats due to the constraints on migration by levees.

Habitat Type	*Threat*	*Nature of Threat*
Seagrass	▪ Sedimentation ▪ Entrance Closure	*MODERATE* Seagrass is a protected habitat and is relatively scarce in the Korogoro Creek estuary.
Intertidal Mudflats	▪ Flood Mitigation ▪ Sea level Rise	*MODERATE* The sudden influx of poor quality water is particularly lethal to less mobile invertebrates such as those inhabiting mudflats.
Intertidal Rocky Shores	▪ Sea level rise ▪ Oyster collection and burleying	*MINOR* The frequency of oyster burleying behaviour is unknown and wild oyster populations appear to remain relatively healthy.
Channel Areas	▪ Flood Mitigation	*MODERATE* Sudden influx of poor quality, deoxygenated water is damaging to free swimming fish.
Wetlands	▪ Sea level rise ▪ Over-drainage associated with flood mitigation ▪ Changes to natural wetting/drying cycles ▪ Stock access	*MODERATE* Wetlands play an important part in the overall health of the Korogoro Creek system. Past changes to the hydrology of local wetlands with the construction of levees, channels and floodgates have significantly altered local ecology. Over time, some systems have reached new dynamic equilibrium.
Riparian Heaths and Woodlands	▪ Weed infestation ▪ Damage associated with recreational access	*MINOR* Whilst both weeds and human interactions are having a negative impact on riparian vegetation, they occur over relatively small areas of the creek banks.

3.1.4 Water Quality

Water Quality in Korogoro Creek generally meets ANZECC (2000) criteria for the protection of aquatic ecosystems and NHMRC (2008) guidelines for primary contact recreation. Despite this, there are occasional incidences of poor water quality, including high Total Nitrogen and high faecal coliform counts. Incidences of poor water quality are largely mitigated by tidal flushing, which is reliant on the permanently open entrance conditions. There is a strong potential to improve the water quality in Korogoro Creek. A reduction in poor quality catchment inputs is a realistic goal and may result from small improvements to stormwater management and to the operation of the flood mitigation system.

The values associated with good water quality, and those likely to benefit from improvements in water quality are;

- *Estuarine Ecology*. The ecological aspects of estuary health are dependent on water quality. Well oxygenated water of pH between 6.5 – 8.5 is appropriate to maintain and protect biodiversity. Low suspended sediment values are important to maintain the health of aquatic plants as habitat and as primary producers in the system.
- *Recreational Amenity*. Good water quality enhances opportunities for primary and secondary contact recreation, and also for the recreational harvest and consumption of fish and shellfish.
- *Economic Values*. The perception of Korogoro Creek as a safe, clean environment for swimming is key to the attractiveness of Hat Head as a tourist destination.

3.1.5 Recreational Use and Access

Whilst recreational use and access are not critical estuarine processes in themselves, some activities do nevertheless impact upon the healthy functioning of the estuary. Conversely, passive recreational values have consistently rated highly in local community and visitor surveys and it is reasonable to suggest that the opportunities provided by the creek for recreation provide a strong motivation for protecting the creek's health.

In many respects the nature of the creek limits some of the impacts associated with recreational use common to other small to medium sized estuaries on the mid north coast. For instance, the shallow shoaled nature of the creek means that motorised boats rarely use the area above the footbridge, reducing the potential for wave wash to impact the banks. However, other attributes such as the sensitive nature of the coastal saltmarsh on the southern creek bank foreshore make it susceptible to access related impacts.

3.1.6 Catchment Management

The Korogoro Creek catchment area is mostly undeveloped except for the small village of Hat Head which occupies approximately 4% of the catchment. 63% of the catchment is protected in the Hat Head National Park and approximately 92% of the catchment area is natural or near natural native vegetation.

Despite the near natural state of the catchment, the estuary is in fact significantly modified as a result of flood mitigation works that occurred in the early 1960s. The flood mitigation works involved the connection of the natural watercourse to the Swan Pool through lengthening, widening and deepening of the channel upstream of the traffic bridge; the installation of floodgates at the Korogoro Cut; the construction of levees along both banks of the creek; the installation of the flow restriction device known as "The Choke"; and the

construction of Rowe's Cut as an ocean outflow. Unidirectional stormwater outlets have also been installed in the town areas and for the drainage from the swamp forests on the southern bank of the creek.

The major catchment inputs to the Korogoro Creek system are now from the Swan Pool area, surrounding bushland, the town and the dune disposal of treated effluent from the Hat Head sewage treatment plant (which interacts with the creek through the groundwater system, with an estimated 60% of discharged effluent reaching Korogoro Creek: NSW DPWS, 1999). Stormwater from the village area is estimated to contribute less nutrients to the creek system than the much larger area of bushland. Insufficient information exists to assess the contribution of stormwater relative to other forms of pollution in the estuary.

The condition of the catchment affects estuary health in a number of ways;

- *Water quality*. Despite the catchment area being generally well vegetated, reduced riparian vegetation and clearing associated with development in the town area have reduced capacity for sediment and pollutant removal from stormwater runoff before it reaches the estuary waters. Drainage projects on the floodplain also increase the efficiency of runoff and increase the release of poor quality water into receiving areas such as the estuary.
- *Estuarine ecology*. Korogoro Creek is well flushed by tidal flows with even the upper reaches of the creek likely to be flushed within 1-2 days. However, water quality monitoring has recorded acid and deoxygenated water in the upper reaches at times.
- *Bank stability and sedimentation*. During periods of operation of the flood mitigation scheme the creek can flow at bank full (ie. full channel) height for several hours. The erosive force of these flows far exceed those that would have naturally occurred prior to flood mitigation and can cause extensive damage to estuary banks and significant scouring of channel bed features such as bars and shoals.
- *Economic values*. Despite the impacts of flood mitigation upon Korogoro Creek and the township of Hat Head, the flood security for the broader Macleay Valley is enhanced by the scheme. The scheme allows for large areas of the Macleay to be farmed productively and protects many floodplain townships from nuisance flooding.

3.2 Information and Knowledge Gaps

The Data Compilation and Processes Study (Telfer, 2007) identified several gaps in the available information and knowledge base that could potentially limit the development of the Estuary Management Plan for Korogoro Creek. These included;

1. Information on the current stormwater quality and volumes and its effects on estuary water quality, and future effects on water quality under various modelled development scenarios.
2. Ongoing impacts on the groundwater resource and on estuary water quality related to the disposal of tertiary treated effluent into the dunes north of Hat Head.
3. Quantification of the contribution of the Swan Pool wetland to poor quality water in the upper reaches of the estuary (acid, low dissolved oxygen, and high nutrients).
4. Quantification of the effects of climate change and sea level rise on the estuary

Whilst all four identified knowledge gaps are considered important to the management of the estuary, issues pertaining to *Knowledge Gap 3* are currently being pursued through a

separate management planning process involving NSW NPWS, Kempsey Shire Council, and affected landholders (eg. Smith, 2002 and NPWS, 2007).

Updated information relevant to *Knowledge Gaps 1*,*2* and *4* are provided in the following sections of this study (Part 4).