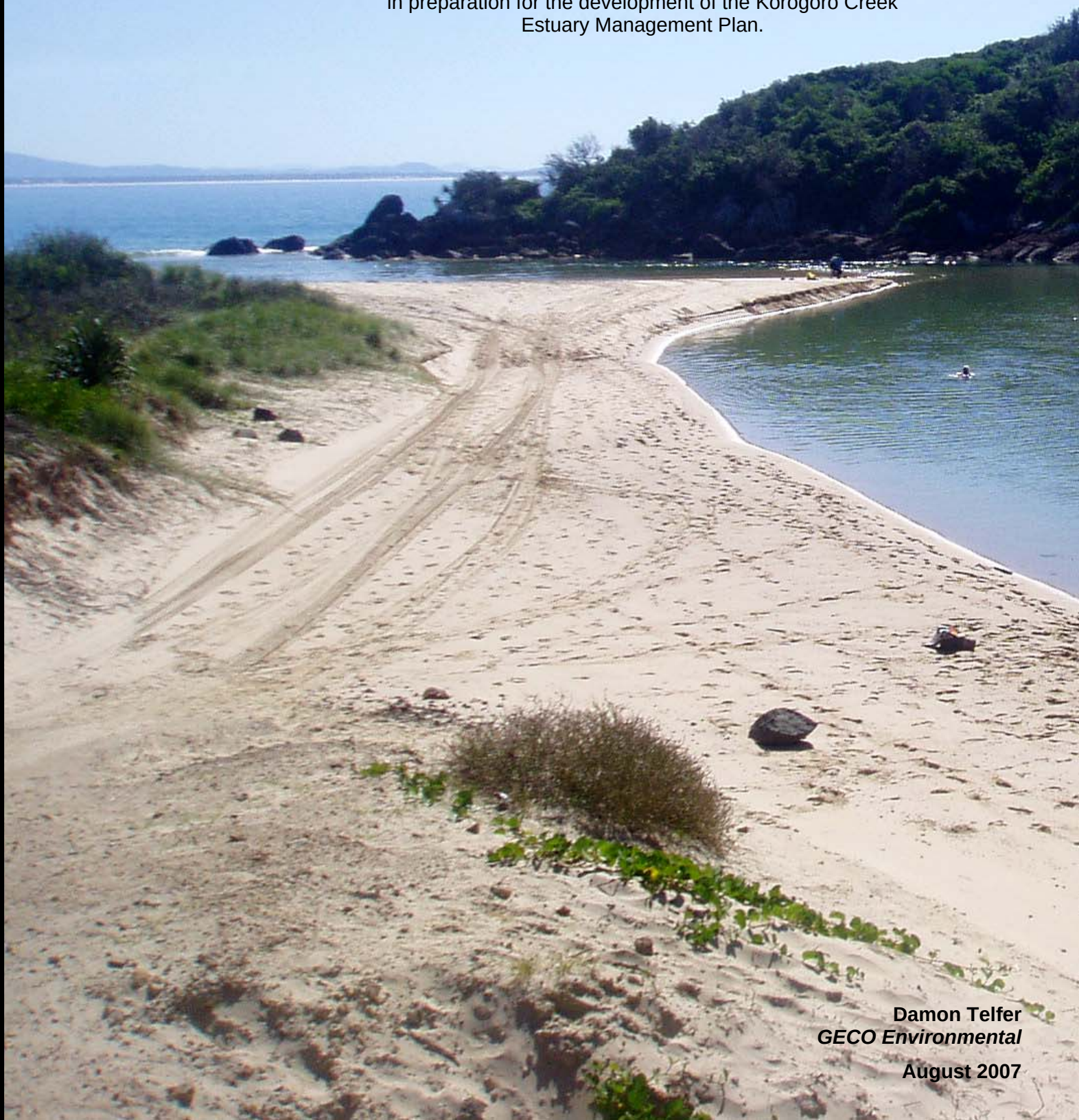
Korogoro Creek Estuary Data Compilation and Processes Study Report

A report reviewing the existing data
and estuarine processes of the Korogoro Creek estuary,
in preparation for the development of the Korogoro Creek
Estuary Management Plan.



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August 2007

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Cover Photo: Korogoro Creek Entrance, Hat Head

ACKNOWLEDGEMENTS

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EXECUTIVE SUMMARY

This Report represents two stages of the NSW Government's Estuary Management Planning Process (EMPP) for Korogoro Creek, namely the Data Compilation and Review Study (Stage 3) and the Estuary Processes Study (Stage 4). The Report was commissioned by Kempsey Shire Council and has the following aims and objectives;

- To identify and collate all available existing data sources of relevance to the management of the Korogoro Creek estuary (including reports, proceedings, journal articles, digital data sets, aerial photographic records, etc) and compile into a web-accessible electronic register.
- To review the data sources to determine their usefulness and adequacy for addressing the issues identified by the Council (including issues identified by the EMC, DECC, and the community).
- To determine gaps in the data and information set that are potentially limiting to the development of the Estuary Management Plan.
- To undertake a Processes study to identify the catchment, hydrodynamic, entrance, geomorphological, ecological, and water quality processes driving estuary function and health
- To make recommendations as to what additional datasets or investigations are required to be collected during subsequent stages of the EMPP, particularly the Estuary Management Study and Plan phases (Stage 5 and 6)

Key Findings of the Data Compilation and Process Study

Community Values and Issues Survey

Thirty-two percent of the surveys distributed were returned indicating a relatively high level of interest in the survey (71 from 220 distributed). Approximately 14% of residents responded to the survey which is believed to be quite high given that surveys were not delivered directly to residents but were distributed through third party means.

Respondents placed a high level of importance on a permanently open estuary mouth, a healthy estuary, a safe swimming location and native foreshore vegetation. Vehicle access to the creek bank was not viewed as important by about 2/3rd of respondents.

Respondents were generally happy with pedestrian and boating access to the estuary but were unhappy with disabled access (particularly beach access) and less happy with vehicle access to the creek bank (particularly the southern creek bank).

The health of Korogoro Creek was generally perceived to be in good to very good condition with the exception of bank stability which was considered by half of respondents to be in poor to very poor condition.

The three issues attracting the highest level of very concerned responses were litter/rubbish, bank erosion, and uncontrolled vehicle access to the southern creek bank. When the level of very concerned responses was considered in addition to concerned responses the highest rating issues became litter/rubbish, habitat protection, and bank erosion. The three issues of least concern were bait collection in the creek, indigenous cultural heritage, and poor water quality after flooding.

Catchment Processes and Nutrient Loadings

The results of the Catcment Management Support System model run suggest total loads of 4355±1188kg TN per year and 235±86kg TP per year, however these figures should be considered indicative only and not absolute. The largest contributor of nutrients to the Korogoro Creek system is the swampland area of the Swan Pool. This factor should be treated with caution as the Swanpool is likely to only be a significantly contributor to the creek in times of flood. The next largest contributor in terms of landuse is

bushland, which forms a large part of the total catchment. Of interest also, is the contribution from the Dune discharge of effluent, approximately 23% of Total Nitrogen. No suitable data exists to compare the relative contribution of septic systems to nutrient loads prior to the commissioning of the sewerage treatment plant.

The nutrient levels that have been measured in the waters of Korogoro Creek would suggest a greater nutrient load than has been calculated here. This may be partly explained by the following factors:

- The equations used to calculate attenuation rates and time of travel for the CMSS model may not accurately represent the Korogoro Creek catchment.
- No suitable information exists for the contribution of benthic sediments to nutrient levels in Korogoro Creek. It is likely that some elevated levels of nutrients exist in the sediments of Korogoro Creek as a result of septic treatment of sewage in Hat Head village but this requires further investigation.

Geomorphic Condition

The current morphology of the estuary can be broken into two broad process zones reflecting differing degrees of fluvial, tidal and marine interaction. They are the *Marine Tidal Delta Process Zone* which extends from the mouth to the approximate extent of the tidal delta, and the *Modified Estuarine Basin Process Zone* which extends from the end of the delta to the floodgates at Korogoro Cut.

The Korogoro Creek estuary has been significantly modified as a result of flood mitigation works. The extent of channel change has been greatest in the upstream reaches of the Modified Estuarine Basin Process Zone (above the town bridge) with flood mitigation extending the length of channel by ~2100 m and a minimum 4 fold increase in channel width. Downstream of the bridge increases in channel width ranging from 1-249% can be attributed directly to flood mitigation (1956-1979) compared with average width variability of 120% prior to flood mitigation (1942-1956). Post flood mitigation (1979-2003) the channel has continued to expand its width with average increases of 17%. The effect of flood flows being diverted down the creek during broader Macleay valley flooding is though to be the primary contributor to post works channel expansion although reduced bank vegetation cover, tidal scour, concentrated access impacts, and wind generated wave erosion are also contributing effects.

Bank erosion mapping (2007) reveals that 91% of the estuary banks are considered stable. 8.2% of banks are stable as the result of bank protection works such as rock revetment whereas 5.8% are stable due to bedrock outcropping into the bank (ie. Southern bank below the footbridge). Channel reaches below the town bridge are the most affected by bank erosion. Most erosion is considered to be minor (ie erosion processes assessed to be dormant and natural recovery processes occurring) or moderate (erosion processes considered to be dormant but no natural recovery evident). No severe erosion was recorded. Evidence of scouring post the March 2001 floods is evident in the upper reaches but most areas are now thickly covered with regenerating mangroves, swamp oaks and other riparian vegetation including bitou bush.

Sedimentation patterns in the estuary show a distinct differentiation broadly in line with the identified process zones. The Modified Estuarine Basin process zone is predominantly characterised by extensive reaches of sediment accumulation with the major areas of scour correlated with channel constrictions located below “The Choke” and in the vicinity of the town bridge. The channel bed in this zone is relatively planar and homogeneous with sediments dominated by organic muds and sandy muds. The Marine Tidal Delta Process Zone is characterised by shorter reaches of alternating scour and deposition which represent the extensive shoaling within this zone. Bed features are heterogeneous with multiple dune formations on the bed and sediments mostly composed of coarse-grained marine sands. Aerial photographs comparisons over the period 1942 to 2004 lend weight to anecdotal reports of channel infilling in the estuary. Unfortunately, due to the lack of historical quantitative hydrographic or cross-sectional data it is not possible to confirm the processes or determine the scale of sedimentation or the rate of infilling.

Entrance Conditions and Behaviour

The entrance of Korogoro Creek estuary is permanently open and untrained. The orientation of the headland and long shore currents off Korogoro Point interrupt the littoral and along shore sediment transport processes by creating a relatively protective environment with low wave energy. As such, shoaling patterns are more influenced by swell and wind directions (entrance shoals building under north-east conditions and reducing under southerly conditions) and tidal cycles. Intermittent large floods also affect the entrance with scouring occurring during the prolonged flows associated with the operation of the flood mitigation scheme. Build-up of sand deposits in the vicinity of the boat ramp has at times necessitated the removal of sand by Council. The regularity of such works is not known. Sea level rise and climate change have the potential to significantly affect entrance conditions and the estuary as a whole with the major effects being alterations to foreshore alignment and stability, increased coastal flooding, salinity intrusion into the estuary and aquifers, altered tidal regimes, changed sedimentation patterns inundation and displacement of wetlands and lowlands, and changes to ecological processes and functioning. The range and extent of impacts specific to Korogoro Creek cannot be quantified at this time.

Estuary Hydrodynamics

A water balance for the estuary has been determined. The water balance estimates show that flushing from the tidal influence dominates the flows in the creek whilst groundwater and catchment runoff provide freshwater flows. It is also clear that evaporation does not play a large role in Korogoro Creek as there is not a large amount of surface area. Evapotranspiration in wetland areas may be significant.

The hydrodynamic analysis estimated estuary flushing times using two methods, both of which show that flushing mechanisms within Korogoro Creek are dominated by tidal circulation. The *tidal prism method* suggests that at both springs and neaps, tidal flushing times at all locations are very short to within 1-2 days. This calculation is somewhat dependent on the mixing efficiency - the estuary was assumed to have a reasonably high value, 0.7, as the tidal prism is significantly greater than the low tide estuary volume. The *freshwater fraction method* suggests flushing times increase with distance from the ocean and could be greater than seven days in the upper reaches. This estimate is based on one sampling event and a crude estimate of the freshwater inflow and hence could be improved by collecting more salinity and inflow data.

Overall the creek is dominated by tidal flushing as the tides influence nearly the entire length of the creek to the closed floodgates. This tidal flushing maintains the creek in a well mixed state. There are, however, scenarios in which the tidal influence may be reduced, for example during the semi-monthly neap cycle in which the tidal range is at its lowest. The decreased tidal range means that there is a decrease in the forces driving both the exchange of water with the ocean and the mixing between ocean and estuarine water, the combined result being less flushing of the creek during this cycle. During the neap cycle there is more potential for stratification at deep sections in the creek particularly if this coincides with a low rainfall period. Tidal influences is also significantly reduced during the operation of the flood mitigation scheme when large volumes of water are discharged down the creek over extended periods (>24 hours).

Water Quality

Water Quality in Korogoro Creek is generally acceptable. Regular tidal flushing mitigates many of the impacts of poor water quality from point and diffuse sources within the Korogoro Creek catchment. The input of acidic water from over drainage of the sulfidic sediments in the Swanpool is the likely cause of pH levels below the lower limits set by the ANZECC (2000) guidelines but these are rarely low enough to be considered highly toxic to marine life. Levels of dissolved oxygen measured at low tides present a possible barrier to sensitive biota.

Elevated concentrations of nutrients, particularly nitrogen and ammonia, have existed within Korogoro Creek since the beginning of monitoring in 1994. These cannot be linked to a specific source, as there are no obvious trends indicating the effect of sewage treatment and the dune disposal of effluent on the Korogoro Creek system. Despite this, the most recent data do suggest that close monitoring of nutrient

levels would be prudent. At present, typical symptoms of eutrophication such as algal blooms and excessive epiphytic growth are not visible. Chlorophyll-a levels are elevated and warrant further investigation. Faecal coliforms rarely reach levels of concern for recreational users but at times could be considered a constraint to the collection of shellfish for human consumption. There is no indication of problems associated with trace metals. Drainage of the Swanpool into Korogoro Creek not only provides a source of acidic and deoxygenated water but also greatly increases the nutrient load.

The acceptable water quality levels depend heavily on the fact that Korogoro Creek remains open. A significant closure would certainly result in increased acidity and decreased dissolved oxygen along with elevated levels of nutrients and faecal coliforms. The result would be greatly reduced recreational amenity and deleterious effects on fish, invertebrates and seagrasses.

Estuarine Ecology

A large body of information exists for the flora and fauna of the Korogoro Creek catchment. This is primarily due to the fact that most of the catchment lies inside the boundaries of the Hat Head National Park. There is a good dataset available describing the distribution of vegetative habitats but very little information about the fauna of Korogoro Creek and general ecological processes.

Field visits for this study revealed diverse habitat forms, and diverse and abundant fish. Mangroves are the dominant and most important habitat type represented in the Korogoro Creek estuary.

Many of the fish species observed spend a part of their lifecycle outside of the estuarine environment. Recruitment of fish to Korogoro Creek primarily occurs between late winter and early summer. Some species of tropical origin are likely to recruit later in the summer. Anecdotal evidence suggests that these species die or migrate during the winter. At present, there are no impediments to recruitment of fish from the ocean but there is limited access to some traditional habitat areas due to the effects of flood management. The potential effects of entrance management are difficult to predict without a specific proposal.

The health of the Korogoro Creek estuary is largely dependent upon the entrance remaining open. An extended closure would most likely result in a temporary reduction of fish abundance and diversity. In combination with reduced tidal flushing, increasing water levels and associated effects this would be considered a reduction in estuarine health. It is, however, likely that Korogoro Creek would return to equilibrium relatively quickly after the entrance was re-opened. Improvements to the health of Korogoro Creek could be achieved through the management of water quality and of Saltmarsh areas.

Estuarine Access

Issues associated with uncontrolled vehicle access to the southern bank of the estuary below the town bridge were raised in all three phases of community consultation. As a result access tracks in this area were mapped via aerial photograph interpretation and access points determined using a handheld GPS. 10 separate access points were identified. Impacts associated with uncontrolled vehicle access included;

- Extensive damage to Coastal Saltmarsh, an *Endangered Ecological Community* listed under the Threatened Species Conservation Act 1995
- Impacts on vegetation and low banks particularly where tracks cross small tidally inundated flats. Damage is worse where flow is concentrated during heavy rain and in boggy areas.
- Damage to the levee where vehicles attempt to negotiate the steep climb back onto Gap Road.

Extensive tracks were also observed in the Hat Head National Park north of the town bridge however these have not been mapped as part of the study.

Key Issues and recommendations for future management.

Community identified issues

Stormwater volumes, quality, and associated impacts were not able to be assessed in this study (see *Catchment Processes* below for recommendations)

The levels of litter and rubbish and strategies for reducing litter and rubbish were not identified. It is recommended that the Estuary Management Plan review this issue.

The specific effects of flood mitigation and flood management on the health of the creek could not be addressed due to a lack of specific data and the absence of large flow events during the study. It is recommended that this issue be reviewed during the Estuary Management Planning phase.

Climate Data

With the exception of an analysis of the likely effects of climate change on Korogoro Creek estuary no further investigation is required.

Catchment Processes

Information on stormwater impacts is inadequate. In particular;

- There is no data available on stormwater discharge volumes or quality
- The current water quality testing regime is unlikely to identify specific stormwater quality issues

Water quality testing of stormwater discharge during high rainfall events and peak holiday periods is recommended.

A specific stormwater study under KSC Urban Stormwater Management Plan is recommended.

The nutrient levels that have been measured in the waters of Korogoro Creek would suggest a greater nutrient load than has been calculated here. This may be partly explained by the following factors:

- The equations used to calculate attenuation rates and time of travel for the CMSS model may not accurately represent the Korogoro Creek catchment.
- No suitable information exists for the contribution of benthic sediments to nutrient levels in Korogoro Creek. It is likely that some elevated levels of nutrients exist in the sediments of Korogoro Creek as a result of septic treatment of sewage in Hat Head village but this requires further investigation.

Bank Erosion

Mapping of bank erosion has been completed. It is recommended that priorities and appropriate strategies for rehabilitation of unstable creek banks be determined in the Estuary Management Plan.

Sedimentation

Despite evidence supporting changes in sedimentation patterns and channel infilling the changes in sedimentation are not able to be quantitatively determined. In terms of overall sedimentation, the processes responsible are large scale and little can be done to reduce the ingress of marine sediments into the channel. No further investigation of system wide sedimentation is recommended.

In terms of shoaling at entrance and in the vicinity of the boat ramp, it is recommended that options for management of sedimentation in the

vicinity of the boat ramp be investigated for the Estuary Management Plan.

Estuary Hydrodynamics

Although some scenarios used were idealised it is considered that the information on estuary flushing is of adequate quality for a system of this size and complexity to proceed with the Estuary Management Planning phase.

More accurate information on freshwater flows would assist in refining the water balance estimates.

The information on stratification and mixing is considered adequate for a system of this size and complexity.

Entrance Behaviour

The science of climate change is evolving rapidly. It is clear that there is significant potential for extensive impacts on estuarine systems such as Korogoro Creek and its catchment. Despite the obvious implications on estuary management planning, the quantification of the effects of climate change and sea level rise are considered to be outside the scope of the Estuary Management Planning Process. It is recommended that the KSC work with the NSW Government to determine likely scenarios for climate change associated impacts and adopt a proactive approach to identifying risks to both coastal ecosystems and the towns and villages they support.

Water Quality

The assembled water quality data is quite comprehensive. The few knowledge gaps remaining are:

- Intensive sampling of water quality during drainage of the Swanpool. This would greatly assist in determining the effect of flood management on Korogoro Creek by quantifying the extent of reduced pH and Dissolved Oxygen and the effects of turbulence resuspending sediment. This would also assist in determining the nutrient load from the Swanpool area.

- Analysis of water quality upstream of the floodgates would give a better idea of the effects of seepage when the floodgates remain closed.

- There is no data indicating the effects of sediment processes on Dissolved Oxygen and Nutrients. This would assist in determining the cause of elevated nutrient levels and low dissolved oxygen.

- Detailed investigation of the causes and effects of elevated chlorophyll-a levels.

- Detailed modelling of the likely effects of entrance closure on the ecosystem.

Local ecotoxicity data, indicating the response of local biota to elevated contaminant levels, would assist in determining the significance of exceedances of ANZECC (2000) water quality guidelines.

At present, monitoring of chemical and physical surface water quality variables in Korogoro Creek is limited to one sampling event every six months with only one site analysed. This may not be sufficient to detect trends in water quality over time.

Estuary Ecology

The distributions of major weeds along the estuary have been mapped. In addition, it has been identified that several native riparian vegetation communities are degraded including areas of Coastal Saltmarsh (impacted by bank erosion and access impacts) and Paperbark communities (which are showing poor recruitment and regeneration). It is recommended that priorities and appropriate strategies for weed control and riparian regeneration be determined in the Estuary Management Plan.

Field surveys and database searches have recorded the range of flora and fauna likely to occur in the catchment and along the estuary. It is recommended that future surveys be directed at determining actual occurrences of threatened/endangered species along the creek and issues for their management where they occur.

It is recommended that issues related to the collection of tropical fish and with bait collection in the creek be addressed in the Estuary Management Plan in consultation with NSW DPI Fisheries.

Estuary Health

The health of the Korogoro Creek estuary is considered to be good when measured against available biotic factors, acceptable with regard to habitat extent and distribution, acceptable with regard to water quality indicators, and good with regard to ecosystem integrity.

Additional data that would assist with assessing the health of Korogoro Creek includes:

- Some measures of sediment quality, focussing on denitrification efficiency and contaminant levels.
- A study of the temporal and spatial variability of benthic invertebrates.
- A detailed study of temporal variation in seagrass, Saltmarsh and mangrove habitats.
- Investigation of the circumstances surrounding reported fish kills in conjunction with NSW DPI Fisheries.

Estuary Access

Uncontrolled vehicle access to the southern bank of the estuary below the town bridge is impacting bank condition, bank stability, and Coastal Saltmarsh Endangered Ecological Communities. Although not investigated, vehicle access to the western bank above the town bridge in Hat Head NP is likely to be having a similar affect on Saltmarsh communities.

It is recommended that mechanisms for reducing these impacts be investigated in consultation with the Hat Head community, KSC, DECC, and NSW NPWS as a part of the Estuary Management Plan.

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