RIDING THE WAVE TO SUSTAINABILITY; A FISHERIES PERSPECTIVE.

[1] Samantha Miller & [2] Ross Quinn

[1] Fisheries Resource Officer, Queensland Fisheries Service, Department of Primary Industry, Queensland Australia
[2] Acting Regional Manager (South), Queensland Fisheries Service, Department of Primary Industry, Queensland Australia

Abstract

Intertidal and estuarine areas are essential breeding, foraging and refuge habitats for the majority of seafood species. The future viability of the commercial, recreational and traditional fishing industries relies on the sustainable management of these habitats.

The Fisheries Act 1994 allows protection of habitats that directly support fisheries. The Act protects all Marine Plants and core areas of valuable fisheries habitat as Fish Habitat Areas (FHAs). The Act also protects against restrictions to fish movement and fish migrations within waterways.

Dredging, spoil disposal and riverbank protection works have the potential to permanently alter fish habitats and significantly impact upon dependent fisheries. Management of these activities requires a strategic, collaborative approach involving all stakeholder groups. The development of novel designs can ensure that fisheries interests are addressed.

Key Words: dredging, erosion, fish habitat, fisheries, management mitigation, spoil disposal.

Why are intertidal fish habitats important?

Shallow water and intertidal habitats are among the most productive fisheries environments. Approximately 75% of seafood species (by weight) and 80% (by value) that are commercially landed in Queensland require estuarine habitats for at least one stage of their life-cycle (Quinn 1993).

For fish and fisheries, estuarine habitats provide key environments for the production of food organisms. Estuaries support complex food webs and a diverse and abundant fauna that are important in the diet of fisheries species, such as worms, crustaceans, and bivalves. Intertidal habitats provide a significant input of nutrients and energy into food webs through the breakdown of vegetation.

The shallow water and turbidity associated with estuaries provide a refuge from large predators (which cannot gain access to shallow areas) and predators which hunt visually. A diverse range of habitat types and structural complexity also adds to the shelter available in estuarine environments.

Estuaries also function as nurseries for the larval and juvenile stages of many fisheries species because of the abundance and diversity of food and shelter from predation. These nursery habitats allow juveniles to grow rapidly and achieve a size beyond the catching ability of most predators.

Many of the fisheries resource values of estuaries are connected with marine plants, such as seagrass and algal beds, mangrove wetlands, and saltmarshes. Intertidal wetlands such as seagrasses and mangroves may be described as 'power houses' of estuaries and inshore coastal areas. They support complex food webs as well as releasing nutrients for offshore plankton production. Intertidal vegetation such as mangroves and saltmarshes provide feeding, shelter and nursery areas for fishery species (fish and crustaceans). In addition, tidal wetlands can maintain water quality by sediment trapping and nutrient stripping, provide a buffer between other land uses, reduce erosion, and protect from floods. Marine plants also support terrestrial wildlife by providing food and roosting areas, and may be a source of timber and charcoal production (particularly in Asia), as well as having aesthetic value.

However, it is not only vegetated habitats that are required to ensure sustainable fisheries production. Intertidal estuarine sand banks are known to function as feeding and spawning areas for several species of commercial fish. Sandy and muddy habitats contribute to diversity and complexity at a number of different spatial scales and contribute to overall measures of biodiversity within an ecosystem.

Surf beaches and shallow sandbars at estuary mouths function as spawning sites for many finfish species (eg Bream, Whiting, Flathead, Dart), allowing dispersal larvae into nursery environments. Adult fish generally congregate at sandbars prior to breeding and spawning. The offspring of these spawning activities after a planktonic stage re-enter estuaries and shallow water habitats, so that the juveniles may take advantage of estuarine nursery habitats.

Sand bars and mud flats are also important foraging habitats supporting high densities of invertebrate animals that are an important component of the food chain. Unvegetated sandy areas can support high densities of invertebrates such as small bivalves and bait worms, as well as soldier crabs, prawns, yabbies and other crustaceans, which are the principal prey items for fish of economic significance. Many commercially and recreationally important fish species are adapted to forage in sandy and muddy sediments (e.g. whiting *Sillago* spp and flathead *Platycephalus* spp). Various species of mullet feed on muddy foreshores by scraping the thin film of algae and microscopic fauna from the surface, leaving characteristic feeding scars, which are clearly visible at low tide. The relatively high turbidity in shallow estuarine waters provides a measure of protection from predation for juvenile and larval fish even in unvegetated habitats such as mudflats.

How do we manage fish habitats?

QFS policy objectives are to ensure the long-term protection and sustainable management of Queensland's marine plants and fish habitats, in keeping with the principles of Ecologically Sustainable Development (ESD), the Precautionary Principal, the Government's 'No Net Loss' objective and other natural resource management legislation.

QFS is responsible for carrying out statutory obligations to protect and manage marine plants and fish habitats under the *Fisheries Act 1994*. The *Fisheries Act 1994* objectives include the following:

(a) ensuring fisheries resources are used in an ecologically sustainable way
(b) achieving the optimum community, economic and other benefits obtainable from fisheries resources
(c) ensuring access to fisheries resources is fair.

The *Fisheries Act 1994* allows protection of habitats that support fisheries. Preservation of significant tidal wetlands is achieved through Marine Plant legislation. Core areas of high value fisheries habitat, including a range of linked habitats such as mangroves, adjacent seagrass beds, and unvegetated sandbars, are protected through the declaration of Fish Habitat Areas (FHAs). Waterway barrier works legislation protects against restrictions to fish movement and fish migrations within waterways. QFS also has the ability to address unauthorised damage to fisheries habitats, such as the release of polluting matter, through Restoration Orders.

All **Marine Plants** in Qld are protected under the *Fisheries Act 1994* against removal destruction, or damage. Marine Plants are defined as any plant which usually grows on or adjacent to tidal lands (up to Highest Astronomical Tide), whether living or dead, standing or fallen, or material of such a plant. Marine plant protection occurs *irrespective* of land tenure. Marine Plants include mangroves, salt marsh plants and succulents, salt couch, seagrass, and algae. Any intention to remove, destroy or disturb marine plants requires a Permit under Section 51 of the *Fisheries Act 1994*.

Fish Habitat Areas (FHAs) may be declared under the *Fisheries Act*, and provide a higher level of protection for land associated with estuarine and river systems even if no Marine Plants are present. FHA 'A' management provide 'strict' protection. FHA 'B' management are a more flexible protection but there are still restrictions on permitted activities. FHAs do not restrict fishing activities, but protect against structural disturbances to the habitat. Fisheries policies denotes certain activities as 'allowable', 'conditional' or 'incompatible'. Any intention to perform works within a declared Fish Habitat Area requires a Permit under Section 51 of the *Fisheries Act 1994*.

Approval is required under the *Fisheries Act* (Section 126) for any **waterway barrier** or restriction to fish movement. Waterway barrier works include the building of or modifications to dams, weirs and other barriers across a waterway (a river, creek, stream, watercourse, tidal inlet etc). Barriers may also include temporary bunds. The *Fisheries Act 1994* applies in both freshwater and tidal reaches. The Fishway Coordinating Committee (DPI Inland Fisheries and DNR) advise on approvals and possible requirements for fish ladders.

The issue of permits is not automatic and may be refused if assessment of the application finds that the loss of fisheries resources cannot be justified. Each application is assessed on its own merits and in consideration of QFS Policies (refer to www.dpi.qld.gov.au/fishweb for full list of Policy documents). QFS management strongly supports mitigation measures where loss of habitat is approved. Mitigation measures may include minimisation of disturbance, alternative works methods or designs, wetlands exchange, or fisheries habitat enhancement. For further information refer to McKinnon and Sheppard, 1997, QI97127.

Habitat restoration and rehabilitation requirements may be imposed for "unauthorised disturbance" or for the non-compliance with any Permit condition, term or restriction by the issuing of a "Restoration Order" under Sections 124 or 125 of the Act. Similarly, any release of "polluting matter" into the marine environment that impacts upon fisheries habitats or fisheries resources may be the subject of a Restoration Order.

Where are fisheries habitats most at risk?

Any reduction in habitat functions through the alteration or loss of fisheries habitats will directly impact upon the dependent fish species. Consequently, loss and alteration of habitats will directly impact upon the commercial, recreational and traditional fishing industries that these habitats support.

Reduction in habitat functions may occur through direct loss of habitat, such as vegetation clearing, dredging, and reclamation of intertidal areas. Indirect impact may occur through deterioration of water quality due to polluted or sediment-laden stormwater runoff, increased freshwater input, or release of acid water. Habitat functions may also be impaired if connectivity with tidal flow is restricted by bunds or weirs.

The following diagram provides a clear demonstration of the implications for loss of fisheries habitat on dependent fisheries. This graph indicates the marked drop in annual catch of the prawn *Penaeus japonicus* in the Seto Inland Sea, Japan, as the cumulative area of non-vegetated intertidal habitat decreased.

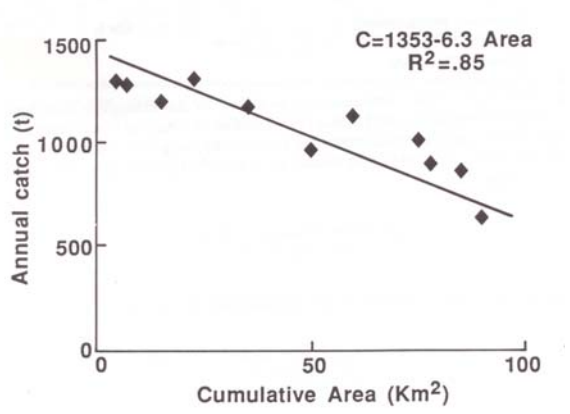

Figure 1. Decline in Shrimp yields in Japan related to reclamation of tidal lands (Doi *et al*, cited in Blamey 1992)

Dredging and reclamation of intertidal habitats are major challenges to fisheries habitat management today. Extensive areas of shallow intertidal habitats in Queensland and throughout Australia are under increasing pressure from activities such as dredging. Since dredging can alter current strength and flushing rates, thus changing patterns of sediment transport and deposition, even relatively minor dredging activities have the potential to produce wide-ranging and long-term impacts on the characteristics of the waterway.

Dredging activities may impact upon the breeding and spawning migrations of fish as well as upon fisheries habitat. Turbid plumes, noise and vibration from dredge equipment may have significant impacts on the distribution of fish and may alter the direction or delay the timing of reproductive migrations.

Reclamation through deposition of spoil in the intertidal area or armouring of river foreshores results in permanent loss of fisheries habitat. A key problem for fisheries management is the slow and incremental loss of habitat through numerous separate proposals for erosion protection within a waterway. Intertidal habitats along riverbanks are an important interface between the land and the river and are often the only foraging and refuge areas available to fishery species using the river. A certain amount of erosion is a natural process and contributes to the structural complexity and habitat quality of estuarine waterways.

Revetment of riverbanks may also transfer the erosion problem by creating scour in adjacent, unprotected stretches of riverbank. This issue is currently the focus of a study by Queensland Transport and Environmental Protection Agency between Lake Cooroibah and Lake Cootharabah, in the Noosa River.

How can we best protect fisheries habitats?

Three broad categories of activities having the potential to disturb fish habitats will be discussed separately. Firstly general infrastructure works such as outlets, culverts, drains and similar construction activities will be considered. Secondly dredging and spoil disposal will be discussed. Finally the issue of revetment of riverbanks for erosion protection will be addressed.

1. Infrastructure

Operational activities such as drain clearance and construction of culverts and outlets are generally fairly well managed by observation of ‘best practice’ procedures and site management plans endorsed by the local authority. Provided the disturbance is minimised as far as possible and managed to prevent water quality impacts, the levels of disturbance are generally in keeping with QFS policies.

This increasing level of user awareness and compliance is reflected in the production of ‘Code of Practice’ Permits which allow local authorities and Main Roads to undertake the majority of day-to-day activities, within certain restrictions, rather than apply for a separate Permit in every situation (refer to Mayer, *et al* 2000, FHC002).

It should be noted that best practice procedures need to constantly evolve as ‘science’ provides better understanding of the values of habitats to fisheries productivity and better technological solutions are developed to address environmental concerns.

2. Dredging and spoil disposal

Certain dredging and spoil disposal activities are not supported by QFS policies because

they are likely to result in unacceptably high levels of disturbance that are not justified by the benefits. In particular, deposition of spoil in the intertidal area is not generally supported because alternative options are available, in the form of non-tidal spoil disposal areas. From a QFS viewpoint there is generally no over-riding requirement for spoil to be deposited on tidal lands. Placement of spoil to 'nourish' eroded beaches may be considered appropriate as a coastal protection measure in some circumstances.

QFS recommend a strategic approach be taken to identifying requirements for dredging and identifying suitable areas to be set aside for the disposal of spoil generated from both capital and maintenance dredging. Strategic dredge management plans should be supported by the collection of appropriate information on the nature and extent of habitats to be altered, the likely impacts on hydrology and channel morphology, and impacts to fishing activities within the subject area.

Potential impacts to fish reproductive movements may be mitigated through the timing of dredging activities. Ideally works should be timed so as to avoid the most biologically important spawning and recruitment periods. QFS generally recommends the periods from February to April and from September to October as having the least impact to fish spawning. If it is not possible to confine dredging activities to these 'windows', QFS recommends cessation of dredging for the day of the full and new moon, and for two days prior to and two days following the day of the full and new moon. Fish reproduction is strongly influenced by lunar phase and the full and new moons are regarded as times of peak activity. Further information may be obtained from Hopkins and White, 1998, FHMOP004.

The 'No Net Loss' policy requires habitat rehabilitation and creation programs to replace destroyed and damaged vegetation and thus maintain fisheries productivity. 'Habitat exchange' may be considered as mitigation for loss of fisheries habitat. QFS is currently investigating a habitat exchange case study in the Noosa River, where dredge spoil was used to construct intertidal fish foraging habitats as an 'offset' for the loss of sandbar habitats in the dredge source area. The purpose of the dredging program was to nourish an eroding shoreline, and the construction of a wide intertidal foreshore was requested by QFS as opposed to 'hard' erosion protection measures such as revetment walls or rock groynes. The fisheries values of this constructed area are being examined by the University of Queensland. Preliminary results indicate that the created habitat is used by a similar diversity and abundance of fish species as natural reference areas within the estuary

Figure 2. Created intertidal areas showing presence of feeding activity by soldier crabs.

3. Revetment

QFS policies only consider revetment in areas where there is demonstrable threat of loss. Even in such circumstances, a Permit to disturb habitat may be refused if the impacts cannot be justified. Revetment is not considered appropriate for amenity purposes, for example to create a linear edge treatment for a development. Revetment is also not supported if it is associated with appreciable reclamation by filling of intertidal areas.

QFS recommends the adoption of a strategic approach to erosion remediation works wherever possible. Ideally the entire waterway or large sections of a river should be mapped, to balance areas where habitat may be lost with other areas where habitat is retained in its natural state. Early involvement of all stakeholders and approving agencies

can minimise conflicts from individual proponents with QFS policy requirements, and can assist in addressing the problem of slow and incremental loss of habitat.

Alternative designs should be explored wherever possible to minimise the impacts to marine plants and intertidal habitats. In some circumstances it may be possible to alter the original design so as to preserve some natural intertidal features and thus retain some of the habitat functions. Recent erosion protection works within the Brisbane River have experimented with options such as placement of loose soil around exposed mangrove roots, and placement of structures behind mangroves rather than removing all vegetation.

In the situation illustrated below, rock gabions were placed beyond the mangroves and a strip along the intertidal zone was left bare. The rock wall was discontinuous, to allow fish to access the intertidal foraging area on high tides and to allow transport of leaf litter into the river system. QFS will continue to monitor the success of these lesser-impact options to determine their merit as mitigation for habitat loss.

Development of 'best practice' for the mitigation of habitat loss from riverbank armouring will require ongoing collaboration between industry and fisheries management. Several novel engineering solutions have been proposed to better meet fisheries objectives whilst achieving sufficient erosion protection.

QFS objectives for riverbank protection may be defined as follows:

- minimal loss of Marine Plant biomass
- balance between 'hard' armouring and retention of natural sediment
- prevention of accelerated scouring in adjacent areas

Figure 3. Rock gabions, Brisbane River, placed in front of the mangroves providing protection from erosion.

Conclusion

Valuable fisheries habitats are under increasing pressure from coastal developments, with subsequent threat of loss to dependent fisheries. However, there are a number of mitigation options that can substantially minimise the loss of habitat functions. Designers and planners within the public works industry are encouraged to collaborate with fisheries management in the development of sustainable solutions.

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Author Biography

Samantha Miller is employed by Queensland Fisheries Service, Department of Primary Industries. As a Fisheries Resource Officer, she is involved in the assessment of coastal developments and other approvals under the *Fisheries Act* for marine habitat disturbance. Samantha has experience with a range of habitat and fisheries resource issues, and in particular coastal dredging and beach nourishment activities. She is currently undertaking a PhD through the University of Queensland, examining the relationships between fishery production and habitat types.

Postal Address: Ms Samantha Miller, Southern Fisheries Centre, PO Box 76, Deception Bay, Queensland 4508.

E-mail: samantha.miller@dpi.qld.gov.au

After completing his degree, Ross Quinn was employed in a teaching position for 7 years during which time he completed his PhD examining the behaviour and feeding ecology of the soldier crab. From this position, Ross, joined the fisheries section within the Department of Primary Industries in 1982. During his employment within fisheries, Ross has been involved in research into the use of habitats by fishes and more recently has been involved with heading the Section dealing with the management of fish habitats, which support fisheries productivity.

Postal Address: Dr Ross Quinn, Southern Fisheries Centre, PO Box 76, Deception Bay, Queensland 4508.

E-mail: ross.quinn@dpi.qld.gov.au