Drainage Waterway Management in North Queensland – A Fisheries Perspective

A. Clarke
Queensland Department of Primary Industries, Northern Fisheries Centre, PO Box 5396, Cairns Qld 4870

Introduction

Regardless of size, all waterways can contribute to fisheries productivity by providing spawning, nursery and feeding grounds and fisheries dispersal routes. This paper discusses the various habitat requirements of commercially and recreationally targeted fish species utilising north Queensland's waterways, including waterways modified for drainage purposes.[1] It has as its basic premise the concept that floodplain management can incorporate fisheries' requirements, even when a catchment's hydrological characteristics have been largely modified, without compromising other stakeholders' interests. For an equitable sharing of natural resources to occur, however, all stakeholders must work towards incorporating fisheries habitat requirements into drainage waterway design and management where ever possible.[2]

Economic Value of Queensland Fisheries

The commercial fishing sector is the fifth largest primary producer in Queensland and is valued at around $400 million annually.[3] The industry directly employs 6000 people with another 2000 employed through fisheries' product marketing (Williams 1997). The value of the commercial fishery between Bowen and Tully alone has been estimated at over $26 million annually (13 000 tonnes) (Ludescher 1997).

Recreational fishing also plays an important economic role. Using the Bowen to Tully area as a representative example of north Queensland's recreational fishing activity, 75% of boats launched in this area go fishing and catch an average 7.4 fish per day (Ludescher 1997). On a statewide scale, Queensland's recreational fishers are estimated to spend about $400 million on fishing each year, own approximately $450 million worth of fishing equipment and boats and their annual catch is estimated to be worth $50 million in commercial value (Williams 1997).

At the same time, declines in the resource have become apparent, particularly in coral trout, some mackerel species and barramundi (Ludescher 1997; Williams 1997). Loss of habitat is a likely contributing factor. Freshwater and brackish habitats have suffered up to 60% loss in some north Queensland catchments since settlement (Russell 1986) and in the lower catchment, many tidal habitats have been systematically bunded and reclaimed. When it is considered that a significant proportion of targeted species utilise fresh, brackish and tidal areas and that estuaries, in particular, operate to support 75% of Queensland's commercial and recreational fish species for at least part of their life cycle (Couchman et al. 1996) then such losses must be of concern to fisheries sustainablity.

Waterways – Fisheries Requirements

Fish Migration

For many of Queensland's commercially and recreationally targeted fish species, survival to maturity is highly contingent on food and habitat availability, predation rates, disease and luck (Russell 1986). To overcome the enormous odds of surviving to adulthood, many species release

[1]A brief description of well known north Queensland's commercially and recreationally targeted fish species and their links with estuarine and freshwater waterways and wetlands is included as attachment 1.
[2]Detailed waterway designs are not included in this document but references to appropriate design and maintenance techniques are provided in attachment 2.
[3] Market values are included.

large numbers of eggs during spawning times. Whilst the timing of spawning events is in itself a contributing factor to survival, a small increase in survival of fertilised eggs often means a large increase in recruitment into the fishery (Ludescher 1997). Simple measures such as protecting and enhancing access to fisheries' nursery and development areas, therefore, can make significant contributions to adult populations of targeted species.

Conversely, a small decrease in survival at the juvenile stage can be detrimental to the fishery. Weirs, dams, pipes, bund walls, flood and tide gates all act to inhibit access of fish to breeding, nursery, adult, tidal and freshwater habitats and then adversely affect regional fisheries productivity. High velocity flows can also inhibit fish movement. Velocities of over one metre per second can act as an effective barrier to fish migration (Hogan et al. 1994). Increased velocities can be caused by narrowing structures, removal of snags, straightening or removing the 'roughness' from channels, or dredging in the lower catchment. The unnaturally rapid drainage of nursery swamps via agricultural drains, before juveniles have grown and moved into adjacent rivers, will also serve to reduce fish migration necessary to sustain local productivity.

Fisheries Habitat Variety

Distinctive larval, juvenile and adult life strategies of many fish species often requires specific habitats. Juvenile and adult habitats may be separated by large distances and vary markedly in physico-chemical characteristics i.e. depths, salinities and substrates. The successful maturation of fish species is dependent on the availability **and** accessibility of all relevant habitat types.

Waterways should comprise of a variety of habitats to variously provide shelter, feeding and/or spawning sites for all fish species likely to utilise the waterway. Shelter can take many forms, either as overhanging vegetation, snags, rocks, sand banks weed beds or deep holes. Other forms of habitat, in particular bends, meanders and riffles, not only provide a variety of shelter types but also act to slow water velocity, and can thereby assist fish access as well as acting to reduce erosion and sedimentation.

Examples of habitat diversity required for specific times in the life cycle of important fish species include the clear, shallow, fast flowing, rocky pools as spawning sites of sooty grunter; mangrove lined estuaries as nursery sites for barramundi, grunter, banana prawns, mangrove jacks, crabs and mullet, and; brackish and freshwater lagoons connected by waterways as juvenile and grow out areas for barramundi, mangrove jack, sooty grunter, eels and jungle perch.

Food Sources

A variety of habitat is not only important for shelter, nursery and spawning sites, but provides suitable conditions for hunting and grazing. Fisheries food sources such as algae, molluscs, smaller forage fishes and crustaceans also require specific environments. Freshwater areas are often the site of high plankton productivity; essential food for many larval and juvenile freshwater species. The high primary and secondary productivities in downstream estuarine mangrove systems and shallow water seagrass beds supports complex food webs, that in turn support many commercial and recreational fish species. Even the availability of fruits, leaves and roots from aquatic and riparian vegetation can contribute to fisheries productivity by providing a source of energy to the lower food chain.

Water Quality

Acceptable water quality is a critical requirement for fisheries productivity. Most fish species in this region require an aquatic environment where oxygen levels are greater that five ppm, pH levels generally between 5.5 and 8, and an aquatic medium relatively free of pollutants. As critical levels for each of these parameters are approached, the level of fisheries productivity tends to fall (Russell pers. comm. 1997).

Water quality is largely influenced by storm water run-off. Storm water can carry a number of pollutants and other chemicals that in turn affect fisheries productivity. Fertilisers in solution can increase nutrient loadings within waterways that may encourage algal blooms. These blooms can in turn deplete oxygen levels (Raisin and Mitchell 1995) and lead to fish avoidance or death. Pesticides and herbicides can affect the health and reproduction of aquatic fauna and flora. Excess sediments can clog waterways, increase turbidity and have direct and indirect impacts on instream biota (Clarke et al. 1996).

In low lying areas of where drainage patterns have been modified the disturbance of acid sulphate soils can severely effect water quality. Storm water flowing through oxidised acid sulfate soils can leach sulfuric acid into nearby drainage waterways. The resulting lowered pHs release toxic levels of aluminium and heavy metals (if present) into solution. Acid leachate can lead to the fish disease 'red spot' or epizootic ulcerative syndrome (EUS), a potentially fatal fish disease (Sammut et al. 1995).

Waterway (riparian) vegetation plays a critical role in the maintenance of water quality. Stream bank and aquatic vegetation serves to trap waterborne sediments and filter nutrients (Boto et al. 1978) as well as providing shade to regulate temperature, physical structure to stabilise banks and channels, leaf litter for invertebrate (insect) production and oxygen for the healthy functioning of fisheries habitat. In order to successfully manage drainage waterways' water quality, stakeholders' recognition of the downstream effects of certain activities e.g. that drainage practices having a large role in the control of acid sulfate effects on fisheries and clearing riparian vegetation removing an important buffer for fisheries resources, will assist in the retention and enhancement of fish habitats.

Habitat Management – Fisheries' Requirements

To support and protect Queensland's fishing industries, coastal planning processes must take into account the fact that drainage waterways play a major role in fisheries productivity. Fortunately, the protection of these areas can occur without compromising drainage requirements and may in fact provide desirable features within the flood plain landscape. To protect the productivity of north Queensland's fish stocks, however, all coastal waterways' stakeholders should undertake the following commitments:

1. Incorporate into waterway design and modification the following features:
   - fishways at fish barriers
   - provision of a diversity of, and access to, fisheries' habitats suitable to endemic fish populations
   - stormwater and discharge controls
   - appropriate riparian zones.
2. Identify and protect existing wetlands on the basis of their current or potential contributions to fisheries productivity.
3. Identify and manage acid sulfate soils.
4. Develop acceptable options to draining wetlands as solutions to residual drainage problems.
5. Rehabilitate degraded waterways and wetlands as a matter of urgency, particularly freshwater areas, not only for fisheries' benefit, but as retention basins to mitigate coastal flooding and recharge areas for groundwater.

Acknowledgments

I wish to thank Mr John Russell and Dr John Beumer for criticising early drafts of this manuscript.

References

Boto, K.G. and W.J. Patrick Jr 1978. Wetland Functions and Values: The State of our understanding, *In* Proceedings of the National Symposium on Wetlands.

Clarke, A., L. Johns, W. Richards and R. Coles 1996. Cairns Drainage Waterway Management Report. Northern Fisheries Centre. Queensland DPI, Cairns.

Couchman, D., D. Mayer and J. Beumer 1996. Departmental Procedures for Permit Applications and Approvals for Marine Plants.

Hogan, A. and P. Graham 1994. Tully-Murray Floodplain Fish Distributions and Fish Habitat. Freshwater Fisheries and Aquaculture Centre, DPI Walkamin.

Ludescher, C M. 1997. Fisheries Resources between Bowen and Tully: an Inventory. Prepared for the Townsville Zonal Advisory Committee and the Queensland Fisheries Management Authority.

Raisin, G.W. and D.S. Mitchell 1995. Diffuse Pollution and the Use of Wetlands for Ameliorating Water Quality in the Australian Context.

Russell, D.J. 1986. Review of Juvenile Barramundi (*Lates calcarifer*) Wild stocks in Australia, *In* Proceedings of an International Workshop held at Darwin NT Australia.

Russell, D.J. and P.W. Hales 1995. Stream Habitat and Fisheries Resources in the Johnstone River Catchment. QDPI Information Series Q193056.

Sammut, J., M.D. Melville, R.B. Callinan and G.C. Fraser 1995. Estuarine Acidification: Impacts on Aquatic Biota of Draining Acid Sulfate Soils. Australian Geographic Studies 33(1): 89–100.

Swales, S. 1982. Environmental Effects of River Channel Works Used in Land Drainage Improvement. Journal of Environmental Management 14: 103 –126.

Williams, L.E. (ed.) 1997. Queensland's Fisheries Resources: Current Condition and Recent Trends 1988–1995. Queensland DPI.

Watson R.A., R.G. Coles and W.J. Lee Long 1993. Simulation Estimates of Annual Yield and Landed Value for Commercial Penaeid Prawns from a Tropical Seagrass habitat, North Queensland, Australia. Aust. J. Mar. Freshwater Res. 44: 211–219.

Attachment 1. Important Commercial and Recreational Fish Species that Utilise Estuarine and Freshwater Areas

Barramundi (*Lates calcarifer*)
Barramundi migrate as juveniles upstream into fresh water from around July to November. Adults spawn along the coast line generally during the wet season. Breeding is usually timed to allow juveniles to move upstream into nursery swamps that form during the wet season. Barramundi start life as males and at around 85 cm in length change to females. This species are ambush predators and prefer slow moving, murky waters and aquatic features where they can lay in wait.

Mackerel (*Scomberomorus commerson*)
The larvae and juveniles of this species inhabitat inshore and estuarine areas. They feed at these stages first on plankton then smaller prey fish. They then move inshore to river mouths and beaches and feed on fish.

Blue salmon (*Eleutheronema tetradactylum*)
The juvenile and adult blue salmon inhabit estuarine and coastal waters. As adults these fish are carnivores feeding on prawns and fish etc.

King salmon (*Polydactylus sheridani*)
King salmon are bottom feeders and prefer the lower reaches of tidal waterways as well as tidal flats.

Mangrove Jack (*Lutjanus argentimiculatus*)
Juveniles of this species inhabit estuaries and have been found 130 km upstream. This species is thought to spawn offshore.

Grunter, barred (*Pomadasys kaakan*), **spotted** (*Pomadasys argenteus*)
Both these species inhabit mangrove lined waterways and coastal flats as adults and juveniles. It is believed that grunter aggregate to spawn in channels through coastal sand banks at the mouths of rivers(Garrett 1997 pers. comm.).

Red emperor (*Lutjanus sebae*)
Red emperor juveniles are sometimes found in mangrove areas (Ludescher 1997)

Finger mark perch (*Lutjanus johnii*)
Finger mark perch inhabit coastal waters as well as rocky coastal reefs.

Shark
Whaler sharks are the main shark fishery in north Queensland. Shallow seagrass and mangrove lined waters are critical nursery and pupping habitats. The abundance of the food source in these area is the likely reason for their presence in these areas.

Mullet (*Mugilidae*)
Larval mullet move from the plankton stage to settle out in mangroves. Sea mullet (*Mugil cephalus)* juveniles move up stream into freshwaters. Other mullet such as stay in estuaries and coastal waters. Mullet adults spawn at sea or in estuaries.

Mud crab (*Scylla serrata*)
Mud crab larvae spend approximately 3 weeks in the plankton and then move inshore as megalopa. Adults lie and grow in estuaries.

Banana prawns (*Peneaus mergiuensis*), **leader prawns** (*Peneaus monodon*)
These species settle out in mangrove as juveniles and will remain there until monsoonal rains flush them offshore. Leader prawns have been found in the upper tidal limits of creeks.

Tiger prawns (*Peneaus esculentus* and *P. semisulcatus*), **king prawns** (*Peneaus latisulcatus* and *P. longistylus*)
Tiger prawns and king prawns settle out in seagrass as juveniles. The value to the tiger prawn fishery of the Trinity Inlet seagrass beds alone was calculated in 1993 at $1.2 million annually (Watson et al. 1993).

Jungle perch (*Kuhlia rupestris*)
Jungle perch migrate into upper tidal areas to spawn. Waterways will therefore interfere with the life cycle requirements of this species, as well as other fish species e.g. barramundi, mangrove jack and mullet.

Sooty grunter (*Hephaestus fuligosus*)
This species can withstand wide range of temperatures, pH's and short-term turbidities. They spawn in summer when water levels start to rise through the effect of monsoon rains. Sooty grunter require rocky, shallow, fast flowing, clear freshwater pools to spawn.

Prey fish (bait fish)
Fish that form the diet of commercially and recreationally targeted fish species, for example mullets, gudgeons, herrings, sardines, pony fish, bony bream etc. are as important to fisheries productivity as the targeted fish themselves. Whilst some of the smaller drainage waterways may not appear to provide habitat for larger commercial and recreational fishes, they often support significant populations of the fish species upon which the larger predators feed. For this reason it is vital that even the smallest of waterways is also protected and managed for its fisheries values.

Attachment 2. Relevant Rehabilitation Documents

Adams, M.A. and I.W. Whyte 1990. Fish Habitat Enhancement: A Manual for Freshwater, Estuarine and Marine Habitats. Prepared for the Government of Canada. Department of Fisheries and Oceans.

Clarke, A., L. Johns, W. Richards and R. Coles 1996. Cairns Drainage Waterway Management Report. Northern Fisheries Centre, Queensland DPI, Cairns.

Clarke, A. and L. Johns 1997. Cairns Waterway and Wetland Rehabilitation Guide. Northern Fisheries Centre, Queensland DPI, Cairns.

Ellis, M.M. 1986. Erosion silt as a factor in aquatic environments. Ecology 10: 29–42.

Environmental Best Management Practices: Erosion and Sediment Control 1994. Brisbane City Council, Brisbane.

Erosion Treatment for Urban Creeks : Guidelines for selecting remedial works 1996. Brisbane City Council, Brisbane.

Hogan, A. and P. Graham 1994. Tully–Murray Floodplain Fish Distributions and Fish Habitat. Freshwater Fisheries and Aquaculture Centre, DPI Walkamin.

Integrated Maintenance Manual for Waterways, Wetlands and Open Drains 1997. Planning Section, Planning and Development Branch, Dept of Works.

Newbury, R.W. 1993. River rehabilitation with soft engineering, pp. 89–90 *In* Ecology and Management of Riparian Zones in Australia. LWRRD Corporation Occasional Paper series No. 05/93.

Nunnally, N.R. 1978. Stream renovation: an alternative to channelisation. Environment Management 2(5): 403–411.

Riley, S.J. and M. Abood 1995. Impact on water quality of gross pollutants, *In* the proceedings from 'Planning for Creative Stormwater Management', Sydney, September 1995.

Sydney Coastal Councils 1992. Stormwater Pollution Control Code for Local Government. Prepared for Sydney Coastal Councils by members of the Sydney Coastal Councils.

Urban Stream Rehabilitation Principles and Guidelines 1996. Brisbane City Council. Report prepared under National Landcare Program.