NSW GOVERNMENT
Department of Primary Industries

Policy and guidelines for fish habitat conservation and management

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This document builds on the 1993 publications entitled “Estuarine Habitat Management Guidelines” and “Freshwater Habitat Management Guidelines” which were edited and compiled by Jenny Burchmore, David Pollard, Margaret Middelton and Rob Willliams. Des Dunstan contributed significantly to the first edition in 1985. It also provides an update on the 1999 version of this document, which was edited by Adam Smith and David Pollard.

It has benefited from the input of a number of experts from within the Department including Sarah McGirr, Allan Lugg, Scott Carter, Marcus Riches, Peter Gallagher, John Pursey, Cameron Lay, Matthew Gordos, Simon Walsh, Tim Gippel, Rob Williams, Dean Gilligan, Patrick Dwyer, Trevor Daly, Gabrielle Holder, Glenn Tritton, Martin Angle, David Coleman, Craig Roberts, Steve Barry, Rebekah Gomez-Fort, Darryl Sullings, Liz Rogers, Bradley Harrison, Adrian Toovey, Cathie Warburton and Andy Stirling.

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Foreword

Fish habitats underpin the productivity of our State's fisheries resources. It is therefore vital that government and the community work together to protect and restore them, in order to sustain our fisheries in the long-term. The importance of fish habitat is recognised in the NSW Government's 10 year plan NSW 2021 which aims to protect our natural environment, including its rivers, wetlands and coastal environments.

This document outlines policies and guidelines aimed at maintaining and enhancing fish habitat for the benefit of native fish species, including threatened species, in marine, estuarine and freshwater environments. It builds on earlier versions which have been in place since the early 1990s.

The document aims to help developers, their consultants and government and non-government organisations to ensure compliance with legislation, policies and guidelines as they relate to fish habitat conservation and management. It can be used to inform land use and natural resource management planning, development planning and assessment processes. It is also a valuable tool to improve awareness and understanding of the importance of fish habitats and how impacts can be mitigated, managed or offset.

Key changes to this version include the adoption of a new definition of 'key fish habitats' to which these policies and guidelines apply. The previous versions applied to all waterways in NSW, regardless of their value as fish habitat. This new policy and guidelines reduces red tape for individuals and farmers wanting to undertake works in gullies or modified waterways, such as canal estates and agricultural and irrigation areas, by removing the need to adhere to these policies and guidelines as these waterways are not captured by this new definition.

The document also provides up-to-date legislative and policy information for planning and development assessment processes, including threatened species assessment and development affecting marine protected areas.

The policies and guidelines are now better tailored to different development activities affecting key fish habitats, such as the construction and maintenance of in-stream structures and barriers, various types of foreshore works and waterfront development, urban streams and stormwater management, sediment extraction in waterways and use of explosives, electrical devices and other dangerous substances in waterways. For the first time it also incorporates more specific policies and guidelines for the protection of freshwater fish habitats.

This version also incorporates the requirements of the former Fisheries NSW Policy and Guidelines for Fish Friendly Waterway Crossings (2003) and the gazetted Fish Habitat Protection Plans No. 1 (General) and 2 (Seagrasses), which are in the process of being revoked. This again reduces red tape and makes it easier for the community to comply with fish habitat protection requirements in one useful document.

This vital resource will feed into a range of NSW Government reform programs including strategic and regional planning processes, the assessment of State Significant Development and Infrastructure projects and other environmental regulation reforms, to ensure the sustainable management, and "no net loss", of key fish habitats in NSW.

I look forward to the continued cooperation of all interested parties in the implementation of this policy.

Dr Geoff Allan
Executive Director, Fisheries NSW

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1. Introduction

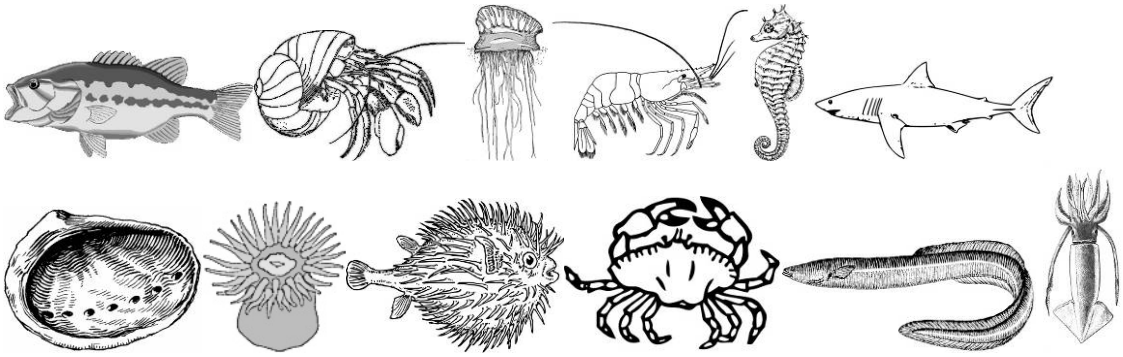
In April 2011, the NSW Department of Trade and Investment, Regional Infrastructure and Services (known as NSW Trade & Investment) was formed. NSW Trade & Investment drives sustainable economic growth in NSW and strives for a strong customer service culture in all areas of service delivery. There are three operational divisions:

- NSW Department of Primary Industries
- Industry, Innovation and Investment Division
- Resource and Energy Division

The NSW Department of Primary Industries' (NSW DPI) purpose is to increase the capacity of primary industries and communities to drive economic growth across NSW. A key result area of NSW DPI's performance is the sustainable management of natural resources, including the conservation and management of 'fish' and their habitats in accordance with the objects of the *Fisheries Management Act 1994*. Where the Act refers to the Director General it is a reference to the Director General of NSW Trade & Investment and where it refers to the Department it is a reference to NSW Trade & Investment. In practice these functions are undertaken by the Director General of NSW DPI and its staff pursuant to delegated authority. NSW DPI is also responsible for:

- managing marine parks (as a member of the Marine Parks Authority) and aquatic reserves,
- rehabilitating fish habitats,
- sustainably managing commercial fishing and aquaculture industries,
- fostering indigenous community involvement in fishing and aquaculture,
- providing recreational fishers with quality fishing opportunities, and
- ensuring there is sustainable and equitable access to fishery resources.

'Fish' - under the *Fisheries Management Act 1994* means marine, estuarine or freshwater fish or other aquatic animal life at any stage of their life history (whether alive or dead). However, it excludes whales, mammals, reptiles, birds and amphibians which are managed under other legislation. Therefore in accordance with the *Fisheries Management Act* the definition of "fish" for the purposes of these policies and guidelines includes not only fin fish (including sharks), but also crustaceans, molluscs, worms, insects and other invertebrates that spend all or part of their life cycle in aquatic habitats.



Fish habitat conservation and management underpins the sustainable management of NSW's fisheries. Their management also contributes to the NSW Government's 10 year plan *NSW 2021* (see 2021.nsw.gov.au/) which aims to protect our natural environment, including its rivers, wetlands and coastal environments. The government is also committed to deliver on 13 state-wide targets for natural resource management by 2015. A state-wide Monitoring, Evaluation and Reporting Strategy is used to gather evidence and measure progress against the state-wide targets. The implementation of the policies and guidelines in this document aims to assist in delivering on several of these targets including[1]:

[1] The numbers against each target are their numbers as per the Natural Resources Commission's state-wide targets for natural resource management (see www.nrc.nsw.gov.au/Workwedo/Standardandtargets.aspx). Some of the targets are not applicable to the Policy and Guidelines.

Biodiversity

1. By 2015 there is an increase in native vegetation extent and an improvement in native vegetation condition
2. By 2015 there is an increase in the number of sustainable populations of a range of native fauna species
3. By 2015 there is an increase in the recovery of threatened species, populations and ecological communities

Water

5. By 2015 there is an improvement in the condition of riverine ecosystems
7. By 2015 there is no decline in the condition of marine waters and ecosystems
8. By 2015 there is an improvement in the condition of important wetlands and the extent of those wetlands is maintained
9. By 2015 there is an improvement in the condition of estuaries and coastal lake ecosystems

Community

12. Natural resource decisions contribute to improving or maintaining economic sustainability and social well-being

This document focuses on the sustainable management of marine, estuarine and freshwater habitats and riparian vegetation which is vital to healthy and productive fisheries. It also outlines policies and guidelines that have been developed to maintain and enhance fish habitat and to address threatening processes for the benefit of native fish species, including threatened species, in marine, estuarine and freshwater environments.

1.1 Who are these policies and guidelines for?

This document focuses on promoting compliance with legislation relating to fish habitat conservation and management. It aims to assist local and state government authorities, proponents of developments and their advisers, and individuals or non-government organisations concerned with the planning and management of our aquatic resources. It can be used to inform land use and natural resource management planning, development planning and assessment processes. It is also a valuable tool to improve awareness and understanding of the importance of fish habitats and how impacts can be mitigated or managed.

- ✓ Local government
- ✓ State government authorities
- ✓ Developers
- ✓ Consultants
- ✓ Non-government organisations
- ✓ Individuals

Not all aspects of aquatic habitat protection and management are covered in this document as a range of other state and local government authorities have control of, or interest in aquatic habitats through protected area management, water allocation and use, catchment and land use management, extractive industries, pollution control, etc. These authorities should be consulted on their respective roles.

1.2 What is the role of these policies and guidelines?

NSW DPI will take these policies and guidelines into account when assessing and either approving or refusing proposals for developments or other activities affecting fish habitats. These policies and guidelines will assist NSW DPI to apply the legislative requirements consistently and fairly to individual proposals. NSW DPI recommends proponents of developments or other activities to submit proposals that address these policies and guidelines.

1.3 What has changed since the 1999 version?

Key changes to this updated version include:

- Provision of up-to-date information on the *Fisheries Management Act 1994* and Fisheries Management (General) Regulation 2010 and how they apply to planning and development assessment processes, including threatened species assessment and development affecting marine protected areas.
- An improved definition of the ‘key fish habitats’ to which these policies and guidelines apply.
- The incorporation of a new classification scheme for the conservation and management of sensitive fish habitat types and waterway classes which may be affected by land use planning and development activities.
- Revised policies and guidelines that are better tailored to guide different development activities to assist those involved in the strategic planning and assessment of future land uses and development. New and revised sections are provided on issues such as fish passage around in-stream structures and barriers, foreshore works and waterfront development, urban streams and stormwater, sediment extraction in waterways and use of explosives, electrical devices and other dangerous substances in waterways.
- Updated references to other relevant natural resource management agencies and legislation related to aquatic habitat management and fisheries conservation.
- More specific information and environmental assessment requirements for the assessment of developments affecting key fish habitats.

- The removal of references to commercial and recreational fisheries and aquaculture management policies and guidelines as these are more appropriately dealt with via other existing publications (available from www.dpi.nsw.gov.au/fisheries).
- Incorporation of the *Policy and Guidelines for Fish Friendly Waterway Crossings (2003)*.
- Integration of the requirements of Fish Habitat Protection Plans No. 1 (General) and 2 (Seagrasses), which are in the process of being revoked.
- More specific policies and guidelines for the protection of freshwater fish habitat.
- Removal of specific reference to listed threatened and protected species of fish and protected areas of aquatic habitat. Up-to-date information on these issues can be sourced from www.dpi.nsw.gov.au/fisheries/species-protection.

1.4 User guide

This document is available in both hard copy and electronic format. Hard copies can be obtained from your local NSW DPI Fisheries Office (see Appendix 5).

The document can be viewed and downloaded (PDF) at www.dpi.nsw.gov.au/fisheries.

Key acronyms used are:

- NSW DPI – NSW Department of Primary Industries
- FM Act – *Fisheries Management Act 1994 (NSW)*
- FM Regulation – *Fisheries Management (General) Regulation (2010) (NSW)*
- EP&A Act – *Environmental Planning and Assessment Act 1979 (NSW)*
- OEH – NSW Office of Environment and Heritage
- Trade & Investment – NSW Department of Trade and Investment, Regional Infrastructure and Services

A glossary of key terms and acronyms, a list of useful tools, guidelines and supporting information, references and key NSW DPI contacts are provided in the appendices.

These policies and guidelines have been developed from sound research and in consultation with stakeholders. Appendices 2 and 4 provide references and sources of information used.

There are six chapters. Different chapters will assist with different aspects of planning or management as outlined below.

Chapter 1	Background information on the document, its use and an introduction to the aquatic habitats and fisheries resources of NSW	Useful context and if you know little about fish and fish habitats you should start here.
Chapter 2	The legislative requirements relevant to planning and development which may affect fisheries or aquatic habitats in NSW	Chapters 2 and 3 outline the things NSW DPI will use to assess a development proposal. It is recommended that you start with these two chapters to understand the legislation and general policies. Chapter 3 will assist you to classify the type of fish habitat you may be affecting. You should then apply the relevant policies and guidelines to that habitat type. Chapter 3 also outlines the environmental assessment information you should gather before submitting a proposal to NSW DPI for review.
Chapter 3	The general policies and classification schemes for the protection and management of fish habitats and outlines NSW DPI's generic information requirements for development proposals affecting fish habitats in NSW	
Chapter 4	Specific policies and guidelines for maintaining and enhancing the free passage of fish around in-stream structures and barriers	These are specific to particular activities affecting fish habitats and fisheries resources. If you are planning to undertake any of these activities you should review the relevant chapter.
Chapter 5	Specific policies and guidelines for foreshore works and waterfront developments	
Chapter 6	Specific policies and guidelines for the management of other activities affecting waterways	

1.4.1 Quick "where to" guide

The list below aims to assist with locating relevant information for common types of development or activities which you may be planning on undertaking. It does not cover all of the activities outlined in the document. If you are unsure, contact your local Fisheries NSW office for assistance (see Appendix 5).

Development/Activity	Relevant section(s)
For ALL developments and activities within or on the banks of a waterway, wetland or estuary in NSW	See Chapters 2 and 3 before you start to find out about the relevant legislation, general policies and guidelines, environmental assessment requirements and to determine what type of habitat you are impacting via the fish habitat classification schemes.
Building a jetty, pontoon or placing mooring	See also section 5.1
Placing a boat ramp or boat shed	See also section 5.1
Repairing or replacing a floodgate	See also sections 4.1 and 4.4
Building a waterway crossing	See also sections 4.1 and 4.2
Building or repairing a dam, weir or regulator	See also sections 4.1 and 4.3
Planning a new subdivision	See also section 6.1
Dredging and mining activities	See also section 6.3
Stabilising a riverbank or coastal foreshore	See also section 5.2
Opening up a coastal lagoon	See also section 6.4
Reporting a fish kill	See section 6.6
Using explosives in waterways	See also section 6.7

1.5 Native fish of NSW


Purple Spotted Gudgeon (G Schmida)

There are over 1000 species of fin-fish in NSW and tens of thousands of species of crustaceans, aquatic molluscs, beachworms, aquatic insects and other aquatic invertebrates – all of which are classified as 'fish' under the FM Act (as per the definition of 'fish' in section 1). More species of fin-fish are found in marine environments than in freshwater environments. The recent Census of Marine Life recorded almost 33,000 marine species in Australian waters and estimated that up to 250,000 marine species may be present.

Several marine fish species, including the Greynurse Shark, White Shark and Black Rockcod have declined in abundance and are now listed as 'threatened' in NSW (see section 2.6.2). In addition, many marine and estuarine species have been listed as 'protected' (see section 2.6.1) including the Ballina Angelfish, Eastern Blue Devil, Elegant Wrasse, Goldspotted Rockcod (Estuary Cod), Queensland Groper, Sandtiger Shark (Herbsts Nurse Shark) and all Syngnathids (i.e. sea dragons, pipefish, etc.).

NSW has an estimated 80 species of freshwater fish including native, introduced, and estuarine species (NSW Fisheries 2001). Of these, approximately 55 are native species that spend the majority of their lifecycle in freshwater. Due to the degradation of river systems and the loss of aquatic habitat, aquatic biodiversity has been declining. A number of fish species, populations and ecological communities have been listed as 'threatened' (see section 2.6.2).

The NSW Rivers Survey (Harris and Gehrke 1997) studied the distribution, diversity and abundance of native fishes in NSW rivers. The survey found only 39 native fish species. Previous surveys in 1983 had recorded an additional 9 species which were not sampled during the NSW Rivers Survey. Also of concern was the finding that approximately 25% of fish found showed evidence of parasites and other diseases (Harris and Gehrke 1997).

Morris *et al.* (2001) reviewed the status of more than 30 species of freshwater fish species found in south-eastern Australia. The report highlighted the conservation concerns for many of the freshwater species occurring in NSW. The main causes of decline in freshwater fishes include:

- habitat degradation due to various forms of water pollution, catchment development and land use-related activities,
- changes to water flow regimes,
- barriers to fish passage,
- the introduction of alien fish species, and
- historical overfishing.

The findings of the second Murray-Darling Basin ecosystem health check also illustrate the continuing concern with the status of native freshwater fish, including in the NSW valleys. Of the NSW valleys in the study only the Paroo was found to have a fish community in good condition, with the Border Rivers fish community in moderate condition. The remaining valleys reported poor to extremely poor fish community condition, with the Macquarie, Lachlan, Murrumbidgee and Upper Murray valleys reporting the worst (extremely poor) fish community condition. The study found that alien fish made up more than half the numbers of fish in ten valleys – with more than 75 percent of fish numbers in the Murrumbidgee valley

comprised of alien species, the bulk being Common Carp. The Border Rivers, Central Murray, Darling and Paroo valleys all had native species contributing more than 75 percent of their total fish numbers. A major part of the native fish biomass came from Murray Cod and Golden Perch and the smaller and more numerous Bony Herring (MDBA 2012).

1.6 Fish habitat conservation and management

'Habitat' is defined under the FM Act as '*any area occupied, or periodically or occasionally occupied, by fish or marine vegetation (or both), and includes any biotic or abiotic component*'. This includes the water column, the substrate (such as sand, mud, cobbles or reef) and other features submerged by water which are used by fish to shelter, access food (such as aquatic vegetation and algae), to breed and which provide territorial markers for migration. A range of government and community programs and activities contribute to the conservation and management of fish habitat, for example, catchment management, water pollution reduction, stormwater management, marine parks and aquatic reserves, RiverCare and many other programs. This document focuses on habitat conservation and management under the FM Act.

One of the primary objects of the FM Act is to conserve fish stocks and 'key fish habitats', a term that is not defined in the FM Act. NSW DPI has attempted to define 'key fish habitats' in Chapter 3 for the purposes of applying the policies and guidelines in this document. Generally 'key fish habitats' include those habitats that are crucial to the survival of native fish stocks. The term excludes man-made habitats, such as agricultural drains and off-stream dams and ponds, and those natural waterways which are dry for the majority of the time or have limited habitat value. See Appendix 3 for detailed descriptions of marine, estuarine, and freshwater 'key fish habitats'.

Aquatic habitats can be described by referring to:

- the natural materials that comprise the habitat (e.g. rocks, coral, gravel, sand and mud),
- the type of vegetation present (e.g. macrophytes, snags, seaweeds, seagrasses, mangroves and saltmarsh),
- the shape and nature of the habitat (e.g. pools and riffles, billabongs, reefs), or
- the overall ecosystem (e.g. wetlands, floodplains, streams, estuaries, lakes, beaches).

Note that fish habitats are not discrete systems but are elements of larger 'open' aquatic systems that are often interconnected by water flow, tides, currents, and the movement of biota, chemicals and nutrients within the water column.

Many fish are reliant on a variety of different habitat types throughout their life cycle. *Connectivity* and *habitat diversity* are critical components of aquatic ecosystems and fish habitats. Some native fish species are naturally migratory and need to move between different habitats. They do this by travelling up and down rivers and by utilising the tributaries, wetlands, floodplains and marine waters that connect different habitat areas.

The abundance and diversity of fisheries resources are subject to both aquatic and terrestrial influences. Some, like cycles of flood and drought, are natural processes whereas others are the result of human activity. The degradation of aquatic habitat is a major threat to the abundance and diversity of native fishes in NSW. As such, a primary objective for conserving fishes is to conserve the habitats that fish are dependent upon for survival.

Aquatic habitats differ from terrestrial habitats and are more susceptible to degradation and loss. The reasons for this include:

- disturbances on land can translate to disturbances to aquatic habitats, but the reverse is very rare. For example, sediments and pollutants carried by overland flow can enter aquatic environments, smothering habitats and reducing water quality.
- aquatic habitats are much more prone to impacts from intense rainfall events or pollution incidents than are terrestrial habitats.
- direct impacts on aquatic habitats at one site can result in indirect impacts occurring large distances upstream or downstream. For example, a chemical spill can impact aquatic environments both at the spill site and downstream, while a weir can impact on fish passage and recruitment both at the site of the weir and for many kilometres upstream.
- recolonisation of disturbed aquatic habitats relies on connectivity with downstream habitat areas. In rivers and streams recolonisation of disturbed aquatic habitats generally occurs from downstream. In-stream barriers may limit the success of recolonisation following major disturbances to local fish populations (e.g. fish kills).
- the extent of aquatic habitats in NSW is significantly less than terrestrial habitats, making them less resilient. Many aquatic habitats are already under stress and therefore cumulative impacts may increase these stressors (Keith Bishop, pers. comm.).

Habitat conservation includes efforts to conserve and protect existing habitat, as well as efforts to rehabilitate degraded habitats. Preservation of habitat is the most cost effective way to conserve fish stocks as it ensures that the environmental elements supporting their existence remain intact. While rehabilitation of degraded habitats is a useful alternative, many methods are still experimental, expensive, require ongoing maintenance and may not fully replicate the ecosystem functions that are lost or degraded.

This document provides details on fish habitat conservation, mitigation, compensation, and rehabilitation measures to support the sustainable management of fish in NSW.

However habitat conservation is not always possible and a key challenge for resource managers is to find the balance between resource use and preservation. NSW DPI works with state and local government to ensure that land use planning incorporates aquatic habitat conservation measures, and that development and activity proposals undergo thorough environmental assessment against the requirements of the FM Act and the policies and guidelines outlined in this document, while also meeting the environmental assessment requirements outlined in the *Environmental Planning and Assessment Act 1979* (EP&A Act).

NSW DPI also ensures that mitigation and compensation measures are in place to redress any adverse environmental impacts to ensure that there is "no net loss" of aquatic habitats (see sections 3.1 and 3.3). Mitigation and compensation may include re-establishing habitat that has been removed or otherwise damaged, re-instating fish passage along waterways (removing barriers or building fishways) and improving water quality, amongst many others.

1.6.1 How will climate change affect fish habitats?

Climate change is predicted to have significant impacts on fish stocks and fish habitats in the medium to long-term. The predicted changes that fish and fish habitat will need to adapt to include:

- an increase in sea level coupled with more extreme weather events/storm surges,
- warmer ocean temperatures,
- ocean acidification,
- a decreasing flow of freshwater to estuaries associated with lower annual rainfall,
- increased potential for droughts,
- higher river temperatures in freshwater areas, and,
- changes in run-off, including flooding frequency and intensity.

Many fish and other species of aquatic fauna in Australian waters are unique, occurring no where else and often having a restricted geographic range. The predicted effects of climate change may result in:

- significant changes to estuarine and nearshore habitat range and distribution,
- change in trophic (food chain) relationships,
- a shift in the recruitment patterns of aquatic plants and animals,
- shifts in the range and distribution of fish and other aquatic species,
- changes in the composition, structure and dynamics within aquatic communities, and,
- disease/health impacts on fish (such as potential for more algal blooms and fish kills).

Impacts on NSW marine biodiversity will be variable and linked to the predicted changes in the principal oceanographic driver on the east coast, the East Australian Current (EAC) (Gibbs 2007). The changing freshwater flows to estuaries and the predicted upstream migration of salt water will alter aquatic habitats and the distribution of plants (wetlands) and aquatic animals (Bunn and Arthington 2002, Hall and Burns 2002 and Schallenberg *et al.* 2003). Tidal wetlands, which are important nursery habitat for fish, will be reduced in extent as their capacity to expand landward as sea level rises is limited by existing coastal development. In estuaries, the growth rate of seagrass is temperature and light dependant; two factors that are predicted to increase resulting in the redistribution of seagrass habitats.

Freshwater aquatic systems are predicted to experience:

- further drying and increased occurrence of drought,
- higher water temperatures
- diminished water flows, that will produce low oxygen levels and increased salinity (Hennessy *et al.* 2007).

Fish in rivers, swamps and floodplains are likely to experience additional impacts as most species have specialised habitat and dietary requirements. Freshwater flows are also a stimulus for breeding in many Australian freshwater fish species and thus the changes in volume and timing of spring floods are predicted to significantly impact on fish recruitment.

The NSW Government is currently researching and developing several policy responses to climate change and sea level rise relevant to fish habitat conservation and management. This document will continue to be revised and updated to reflect these changes as they occur.

1.7 Marine protected areas

The NSW Government is committed to conserving marine biological diversity and to the ecologically sustainable use of marine resources. The Australian Government and all States and territories are working towards establishing a National Representative System of Marine Protected Areas (see www.environment.gov.au). In NSW, the primary goal is to establish a comprehensive, adequate and representative system of marine protected areas that includes a full range of marine biodiversity at ecosystem, habitat and species levels (see NSW Government 2001 and www.mpa.nsw.gov.au).

There are three types of marine protected areas in NSW:

- **Marine parks** are managed under the *Marine Parks Act 1997*. The Director General of NSW Trade & Investment is a member of the Marine Parks Authority which is responsible for the day-to-day operations of marine parks for the Authority. Marine parks help to conserve marine biodiversity and provide opportunities for sustainable fishing, public appreciation and enjoyment. There are six marine parks in NSW at Cape Byron, Solitary Islands, Lord Howe Island, Port Stephens–Great Lakes, Jervis Bay and the Far South Coast from Brush Island near Batemans Bay to Wallaga Lake.
- **Aquatic reserves** are managed under the FM Act by NSW DPI. Aquatic reserves help to conserve marine biodiversity and are important areas for research and education. There are 12 aquatic reserves in NSW, mainly in the Sydney region but also at Cook Island near Tweed Heads and Bushranger's Bay near Shellharbour.
- **Marine areas of national parks and nature reserves** are managed by OEH under the NSW *National Parks and Wildlife Act 1974*.

For more information on marine parks and aquatic reserves, please contact NSW DPI staff at the Marine Parks and Aquatic Reserves Program on 1300 550 474.

For more information on marine areas of national parks and nature reserves, please contact the OEH Information Centre on 131 555.

1.7.1 Proposed development within or in the locality of marine parks or aquatic reserves

The *Marine Parks Act 1997*, associated regulations and zoning plans regulate activities and works in marine parks that may harm animals (including fish), plants and habitats. **Sections 19 and 20** of the Act specify how a proposed development within a marine park or in the locality of a marine park should be addressed under the *Environmental Planning and Assessment Act 1979*.

Similarly, the FM Act, associated regulations and planning notifications for aquatic reserves regulate activities and works in aquatic reserves that may involve taking, disturbing or damaging fish or marine vegetation. **Sections 197C and 197D** of the FM Act specify how a proposed development within an aquatic reserve or in the locality of an aquatic reserve should be addressed under the *Environmental Planning and Assessment Act 1979*.

These policies and guidelines also apply to activities and works in marine parks and aquatic reserves.

1.7.2 Intertidal protected areas

Additional fishing closures have been put in place under Section 8 by NSW DPI under the FM Act to protect intertidal biodiversity on rocky shores. These sites are known as **Intertidal Protected Areas** (IPAs). IPA closures commenced in 1993 in recognition of the importance of protecting whole communities in order to effectively conserve intertidal organisms. The objectives of IPA closures are to:

- protect intertidal community biodiversity and structure;
- provide biological reservoirs of breeding stock so exploited areas nearby can be recolonised or sustained; and
- help ensure harvesting of intertidal invertebrates is undertaken at sustainable levels.

1.8 Artificial habitats

Natural habitats are always preferable to artificial habitats, as they generally contain more species. However, some artificial habitats may also increase the abundance and/or species richness of fish in an area devoid of suitable natural habitat. Examples of artificial habitats that may be suitable for some species of fish include rock groynes, jetties, wharf pylons, oyster lease cultivation structures, shipwrecks and impoundments. Purpose built habitats such as artificial reefs, wetlands, fish attracting devices (FADs) and artificial seagrass units also provide shelter for many invertebrate and fish species. Artificial reefs often substitute for natural rocky reefs by offering shelter and attachment sites for a range of benthic organisms.

In the past, NSW DPI was instrumental in the construction of the Narrabeen artificial reefs, which comprise a number of scuttled ships located over sand substrate in approximately 50 m of water. As well, a number of smaller tyre reefs were trialled with very little success in Port Hacking and Lake Macquarie and such reefs are no longer supported. More recently a number of FADs have been deployed in offshore waters along the NSW coast. These artificial habitats are a popular facility for recreational fishers and can congregate fish in an area. However, there is still ongoing debate about whether they significantly enhance fish populations.

The construction of artificial reefs can potentially pollute the environment, depending on the materials used for their construction. Their placement is also important to ensure that they do not become buried over time, move or become a hazard to navigation, commercial fishing, SCUBA divers or other water users.

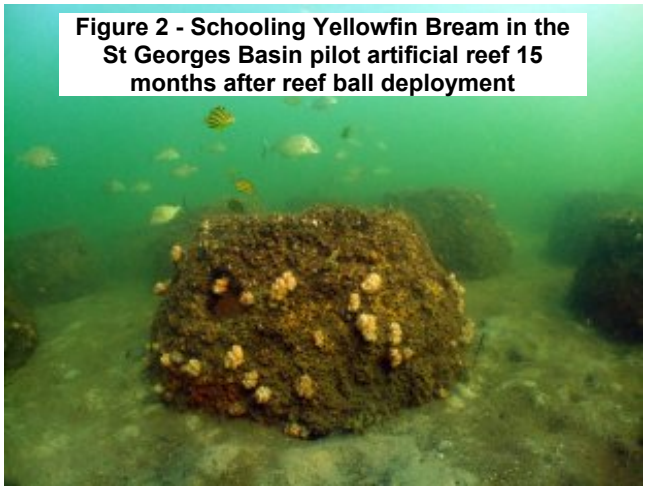


Figure 2 - Schooling Yellowfin Bream in the St Georges Basin pilot artificial reef 15 months after reef ball deployment

NSW DPI's Artificial Reef Project is a major part of the Recreational Fisheries Enhancement Program and includes two components – Estuarine Artificial Reefs and Offshore Artificial Reefs. NSW DPI began to assess the viability of constructing estuarine artificial reefs to enhance recreational fishing opportunities in 2005. A precautionary approach was adopted, with trials undertaken in three Recreational Fishing Havens, including Lake Macquarie, Botany Bay and St Georges Basin between 2005 and 2007. The trials were conducted with "reef balls", specially designed concrete modules developed in the United States which promote marine growth and habitat complexity.

A combination of Baited Remote Underwater Video (BRUV) and dive surveys was used to monitor the recruitment and succession of the fish and epibenthic community associated with the Lake Macquarie artificial reef complex. Complementary surveys of naturally occurring reef systems were used to compare changes in the structure of fish assemblages between the artificial structures and natural reefs in the immediate area. A photographic survey documented the recruitment and succession of the algal and invertebrate community associated with the artificial reefs. Independent angler surveys were also carried out to provide a comparison of catch and effort between artificial and naturally occurring reefs.

The results of this study have provided a clearer understanding of the type of fish and epibenthic assemblages that result from the deployment of an estuarine artificial reef. It is the first study to demonstrate that structures specifically designed as artificial reefs can be effective at extending the habitats of a variety of fish species in temperate estuarine systems in southeast Australia. The study found that the Lake Macquarie artificial reefs were rapidly colonised by a diverse fish community with 51 species observed at artificial reef sites over the two year study period with the majority of the species observed within the first year post-deployment. Resident or 'permanent' species, identified on over 75% of observations on artificial reefs include popular recreational species such as Yellowfin Bream, Snapper and Tarwhine. Recruitment of epibenthic species was also relatively rapid, however, unlike the fish community was characterised by low diversity with only three species groups (filamentous turfing algae, polychaetes and echinoderms) recorded.

Comparisons between artificial and naturally occurring reefs indicated differences in both species diversity and relative abundance. Artificial reefs recorded a higher number of species (28) compared to natural reefs (21). Of the nineteen species observed on both artificial and natural reefs fourteen recorded greater mean relative abundance on artificial reefs. Species contributing most to the differences between groups were Striped Trumpeter, Yellowfin Bream and Snapper. Striped Trumpeter and Snapper were, on average, three times more abundant on artificial reefs than on natural reefs. Yellowfin Bream however, were approximately twice as abundant on natural reefs. Other species making significant contributions were Tarwhine and Yellowtail Scad, both with higher average abundances on the artificial reefs.

An independent angling survey demonstrated the utility of artificial reefs as a possible means of enhancing recreational fisheries. Tarwhine, Snapper and Sand Whiting were the species landed in the greatest numbers at both artificial and natural reefs accounting for between 70 – 75% of the total catch at each location. Total mean catch rates of 5.5 fish per hour on the artificial reefs compared with 3.6 – 4.3 fish per hour at the natural reef sites. Analysis of fish length and fish weight data indicated a variable response between locations and species. Artificial reefs did however record the highest mean weight and length for Tarwhine and Sand Whiting. Although similarities between artificial and naturally occurring reefs were evident, some differences in relative abundances and species diversity of the fish communities were observed. It is unclear whether these differences were a factor of the structural differences of the reef themselves or a result of species succession as the artificial reefs evolve to stable 'climax community'.

A review of similar studies indicates that fish and epibenthic communities may continue to change over an extended period (5 – 10 years) and recommend long term monitoring to obtain a comprehensive understanding of the dynamics of fish and epibenthic communities associated with artificial structures.

The program has now been expanded into other estuaries in Lake Conjola and Merimbula Lake and more are planned.

In October 2011 NSW DPI deployed the State's first offshore artifical reef to improve recreational fishing opportunities. The structure was deployed approximately 1.2 km east of "The Gap" (South Head) in 38 metres of water. The reef is the first Australian designed artificial reef and is the largest purpose built structure deployed in this country. It has a reef volume in excess of 700 m^3. It has an expected life of a minimum of 30 years. The new reef is being monitored by NSW DPI researchers for 3 years using diver surveys and underwater video technology to assess the effectiveness of the reef as a habitat.

For more information on artificial reefs see www.dpi.nsw.gov.au/fisheries/recreational/saltwater/artificial-reefs.

2. Overview of legislation

2.1 Legislation

NSW DPI administers the *Fisheries Management Act 1994* (FM Act) and associated Regulations (FM Regulations). The department has jurisdiction over all fish and marine vegetation in state waters and these powers also extend to Commonwealth waters for some species and fishing methods under the Offshore Constitutional Settlement negotiated between the Australian and State governments. This includes permanent and intermittent freshwater areas and 'water land' below the highest astronomical tide in tidal areas, extending to three nautical miles offshore (or beyond where other legislative powers of the state apply). 'Water land' is defined under the FM Act as land submerged by water: whether permanently or intermittently, or, whether forming an artificial or natural body of water, and includes wetlands and any other land prescribed by the FM Regulations as water land.

The objectives of the FM Act are to conserve, develop and share the fishery resources of NSW for the benefit of present and future generations, and in particular:

a) to conserve fish stocks and key fish habitats, and

b) to conserve threatened species, populations and ecological communities of fish and marine vegetation, and

c) to promote ecologically sustainable development, including the conservation of biological diversity,

and, consistently with these objectives:

d) to promote viable commercial fishing and aquaculture industries,

e) to promote quality recreational fishing opportunities,

f) to appropriately share fisheries resources between the users of those resources, and

g) to provide social and economic benefits for the wider community of NSW, and

h) to recognise the spiritual, social and customary significance to Aboriginal persons of fisheries resources and to protect, and promote the continuation of, Aboriginal cultural fishing.

To meet the primary objectives, Part 7 of the FM Act deals with the protection of aquatic habitats and Part 7A deals with threatened species conservation. Part 7 commonly applies to "integrated development" proposals as defined by the *Environmental Planning and Assessment Act 1979* (EP&A Act) (see section 2.2). However, there are other activities that may not require development consent under the EP&A Act but may still require a permit under Part 7 of the FM Act from NSW DPI (see section 2.3).

2.2 Development approvals

Under Part 4 of the EP&A Act, NSW DPI is a 'determining authority' for local development that requires one or more of the following permits under the FM Act:

- **Section 144** - aquaculture permit (i.e. cultivating fish or marine vegetation for sale/commercial purposes),
- **Section 201** - permit to carry out works of dredging or reclamation (i.e. any excavation within, or filling or draining of, water land or the removal of woody debris, snags, rocks or freshwater native aquatic vegetation or the removal of any other material from water land that disturbs, moves or harms these in-stream habitats),
- **Section 205** - permit to harm (cut, remove, injure, destroy, shade etc) marine vegetation (saltmarshes, mangroves, seagrass and seaweeds),
- **Section 219** – permit to obstruct the free passage of fish.

Any development proposal that requires consent from a local council and one or more of the above approvals is deemed to be *integrated development* under **s91**, Part 4 of the EP&A Act. The integrated development process came into effect on 1 July 1998 and seeks to link development consent for local development matters under Part 4 of the EP&A Act with any associated approval, licence, consent, permission or permit required under other legislation. It is intended to avoid the situation where a proponent of a development obtains permission to proceed from one consent authority but is subsequently refused permission from another consent authority, or is prosecuted for undertaking works that were approved by a consent authority but were illegal under other legislation.

The consent authority (e.g. local council) will forward a copy of relevant development applications to NSW DPI for assessment (see section 2.2.2).

2.2.1 Development activities requiring a NSW DPI permit

Some examples of integrated developments that may require one of the permits listed in section 2.2 above include:

- aquaculture operations (including oyster cultivation, yabbie farms, grow-out ponds, 'fish-out' facilities, but not including aquariums for display or pet shops),
- jetties – where part of the structure includes a rock or concrete structure or revetment (i.e. reclamation) or where marine vegetation may be harmed during construction (e.g. by establishing piles, dredging an access channel, the deck results in shading of marine vegetation),

- boat ramps and boat sheds (i.e. reclamation),
- bridges, culverts, causeways (both piped and unpiped) or other road-crossings of waterways (temporary or permanent) which require placing material on the bed of the waterway (i.e. reclamation) and/or which may obstruct the free passage of fish,
- dams, weirs, floodgates, or levee banks across waterways (i.e. obstruction of fish passage),
- marinas (e.g. dredging for access, reclamation for a wall, harming marine vegetation),
- dredging navigation channels (whether for maintenance of an existing channel or construction of a new one) or to open an intermittently-opening waterway,
- dredging for winning sand, gravel or other materials for private or commercial use,
- channelisation, relocation or realignment of waterways,
- installation of pipelines across a waterway (involving dredging or reclamation),
- installation of stormwater outlets (involving reclamation of the bed or bank of a waterway),
- stream bed or bank stabilisation works (involving dredging or reclamation to halt erosion),
- foreshore stabilisation (e.g. seawalls, retaining walls) where 'water land' may be filled or marine vegetation may be harmed,
- boardwalks or walking tracks that cross intertidal areas, coastal wetlands, seaweeds or seagrasses,
- development that may affect marine vegetation by cutting, removing, destroying, transplanting, shading or damaging it in any way (e.g. trimming mangroves).

2.2.2 Integrated development process

Before the development application is lodged, applicants should refer to these policies and guidelines (see Chapter 3).

When assessing development applications, NSW DPI will make a decision on a case-by-case basis as to whether the proposal should be permitted to proceed. The decision is based on the predicted impacts upon fish populations (including listed threatened species, populations and ecological communities), aquatic habitats, and the commercial and recreational fishing and aquaculture industries, and whether the proposal adequately meets the legislative requirements of the FM Act and the policy and guidelines outlined in this document.

NSW DPI is required to assess the proposal and, in the case of integrated development, if NSW DPI proposes to grant approval it must provide General Terms of Approval (GTAs) to the consent authority (e.g. local council). NSW DPI does not provide GTAs if it decides to refuse to grant the development application. If GTAs are issued and development approval is granted by the consent authority, NSW DPI must issue a permit under the FM Act to enable the proposal to proceed. The permit conditions must be consistent with the GTAs previously provided.

Proposals which are likely to have a significant adverse impact are not likely to be approved in the absence of effective mitigation and/or compensation measures. If NSW DPI decides that the proposal (or part of the proposal) will have a significant adverse environmental impact and should not be approved, it will advise the consent authority. The consent authority is then obliged to refuse development consent.

The consent authority will request a $320 fee payable to NSW DPI for appraisal of integrated development applications. In addition, application and assessment fees for permits are payable when the relevant permit or permission is finally sought from the department. The schedule of fees for permits is included in the permit application form available at www.dpi.nsw.gov.au/fisheries/habitat/protecting-habitats/toolkit#Permit-application-form or contact NSW DPI's Aquatic Habitat Protection Unit regional offices (see Appendix 5 for contact details).

A brochure summarising NSW DPI's requirements for integrated development is available at www.dpi.nsw.gov.au/__data/assets/pdf_file/0006/202695/Integrated-Development-Assessment-Process.pdf

2.2.3 Approval and consultation requirements relating to Part 5 of the EP&A Act

If a public authority (including a local council or state agency) is a determining authority under Part 5 of the EP&A Act, they may still be required to obtain the following approvals or undertake consultation under the following provisions:

- **Section 199** – Under **s199** of the FM Act, the Minister for Primary Industries is required to be consulted over any dredging or reclamation works carried out, or proposed to be authorised, by a public authority (other than a local government authority) (i.e. any excavation within, or filling or draining of, water land or the removal of woody debris, snags, rocks or freshwater native aquatic vegetation or the removal of any other material from water land that disturbs, moves or harms these in-stream habitats).
- **Section 200** – a permit is required for dredging or reclamation work carried out by a local government authority, unless these works are authorised by a relevant public authority (other than NSW DPI) or under the *Crown Lands Act 1989*.
- **Section 205** - permit to harm (cut, remove, damage, destroy, shade etc) marine vegetation (saltmarshes, mangroves, seagrass and seaweeds),
- **Section 219** – permit to obstruct the free passage of fish.

2.2.4 Infrastructure State Environmental Planning Policy (2007)

The State Environmental Planning Policy (Infrastructure) 2007 (known as the Infrastructure SEPP or ISEPP) assists in providing infrastructure by updating planning provisions to improve efficiency and service delivery. The Infrastructure SEPP aims to help state and local government by simplifying the environmental assessment and approvals for essential infrastructure such as education, hospitals, roads and railways, water and electricity supplies.

The Infrastructure SEPP does not switch off the requirement for approvals under the FM Act for works affecting key fish habitat as outlined in sections 2.3.1.

2.3 Other approvals and permits

2.3.1 Other NSW DPI permits

Several other types of approvals are required under the FM Act for activities that are not considered integrated development under the EP&A Act. These include:

- permits to use explosives, electrical devices or chemical substances within a waterway (**clauses 71 to 74** of the FM Regulations – see section 6.7),
- permit for a local government authority to undertake dredging and reclamation works (**s200** of Part 7 of the FM Act)
- licence to harm threatened species or damage their habitat (**Part 7A,** FM Act – see section 2.6.8),
- permit to take fish by any specified method and timeframe from any specified waters for research purposes. For example scientific sampling of fish and other aquatic organisms including sampling undertaken for aquatic surveys required for environmental assessment purposes (see section 3.3.1). Take fish includes: catch or kill; gather or collect; or remove from any rock or other matter or attempt to do so (**s37**, FM Act),
- permits to gather marine vegetation for commercial purposes (**clause 56** of the Fisheries Management (Aquaculture) Regulation 2012 – see section 3.2.3.3)

It is advisable that persons proposing to undertake developments involving such activities discuss the proposal with NSW DPI before lodging an application (see Appendix 5 for contact details).

2.3.2 Approvals from other agencies

Some of the key public authorities that should be consulted to ascertain whether approval is required include:

- Local council in relation to any activity requiring development consent;
- The Crown Land Division of NSW DPI in relation to activities on Crown land requiring ‘landowners consent’ and a licence or in relation to navigation dredging of major harbours and ports.
- The NSW Office of Water within NSW DPI in regard to whether a water licence is required in relation to activities which take water; and whether an approval is required in relation to the use of water, the construction of a water management work or the carrying out of a controlled activity or aquifer interference activity.
- The NSW Office of Environment and Heritage (OEH) in relation to protected areas, threatened species management (other than for threatened species of fish and marine vegetation administered by NSW DPI), cultural heritage issues, air, water and noise impacts, native vegetation, coastal protection and coast and estuary management, climate change and relevant pollution control legislation requirements.
- NSW Roads and Maritime Services in relation to boating infrastructure (moorings, marinas, jetties etc), navigation aspects, waterfront development, road infrastructure and obtaining ‘landowners consent’ where relevant.

The Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) establishes a system of environmental assessment and approval by the Commonwealth for actions that significantly affect matters of national environmental significance. Further information on the **EPBC Act** [2] is available from the Australian Government's website.

In January 2007, the Australian and NSW Governments signed a Bilateral Agreement which allows the assessment regimes under the EP&A Act (Parts 4 and 5 of the EP&A Act) to be automatically accredited under the EPBC Act. This means that separate assessment processes are not required. The **Bilateral Agreement** [3] only covers matters that are determined to be 'controlled actions' by the Australian Government.

[2] www.environment.gov.au/epbc/index.html

[3] www.planning.nsw.gov.au/SettingtheDirection/GovernmentAgreementsandForums/BilateralAgreementwiththeCommonwealth/tabid/283/Default.aspx

If a proposal is likely to have an impact upon any 'Matter of National Environmental Significance' under the EPBC Act, such as:

- heritage values of World Heritage properties
- listed National Heritage places
- wetlands of international importance (Ramsar wetlands)
- Commonwealth-listed threatened species and ecological communities
- listed migratory species

then the proponent has an obligation under the EPBC Act to refer the proposal to the Commonwealth Environment Minister for a decision as to whether the action is a 'controlled action' and therefore requires assessment and approval via the Bilateral Agreement.

Other Commonwealth and State agencies may also need to be consulted and the applicant is responsible for ensuring that this is undertaken.

2.4 General permit conditions

In the event that NSW DPI issues a permit to a person (council, company or individual) to conduct an activity or undertake works, conditions will be placed on the permit to ensure that works cause minimal harm to the aquatic environment.

The following administrative conditions are generally issued with the permit (where relevant):

- A specified NSW DPI contact officer is to be informed at least 3 days prior to the commencement of works.
- All works must be confined to the area specified in the permit and be in accordance with the description of the application submitted to the department.
- A copy of the permit and relevant documentation referenced in the permit must be carried at all times during the works.

In addition, each permit will have tailored conditions that are relevant to the specific activity or works undertaken. If the permit holder fails to comply with the conditions of the permit they may be fined, be issued with a stop work order and potentially prosecuted under the FM Act.

2.5 Planning instruments

Planning instruments such as local environmental plans (LEPs), regional strategies, state environmental planning policies (SEPPs) and development control plans (DCPs) may be developed with regard to these policies and guidelines.

Amendments to current planning instruments, and the development of new planning instruments (including SEPPs and LEPs) must also be consistent with existing state government policy. To achieve policy consistency, local government and the Department of Planning and Infrastructure routinely forward draft planning instruments to NSW DPI for review and comment.

The EP&A Act (see section 2.6) also provides for the consideration of threatened species, populations and ecological communities and critical habitat when drafting planning instruments. If the making of such a plan is likely to affect threatened fish species, populations or ecological communities, or critical habitat, the Director General of NSW Trade & Investment must be consulted.

2.6 Protected and threatened species

2.6.1 Protected fish

Some species of fish have been formally protected because they are naturally scarce or their numbers have been substantially reduced over recent decades. These species are protected under **s19** of the FM Act whereby it is illegal to take or have in your possession a protected fish without a permit under section 37 from NSW DPI. There are also specific fish species identified as 'protected from commercial fishing' under **s20** of the FM Act.

Protected fish species from commercial fishing are listed under **clause 6** of the FM Regulations.

2.6.2 Overview of threatened species legislation

In NSW, legislative responsibility for the conservation of threatened species, populations and ecological communities rests with two agencies: the NSW Office of Environment and Heritage (OEH) through administration of the *Threatened Species Conservation Act 1995* (TSC Act), and NSW DPI through administration of Part 7A of the FM Act.

OEH has responsibility for the conservation of mammals, birds, reptiles, amphibians, terrestrial invertebrates and terrestrial and freshwater plants. NSW DPI has responsibility for the conservation of all 'fish', which by definition also includes freshwater, estuarine and marine aquatic invertebrates (such as crustaceans, molluscs and polychaetes), as well as marine vegetation, including saltmarshes, mangroves, seagrasses and macroalgae.

The Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) provides protection for listed threatened species, migratory species and ecological communities. Further information regarding the provisions of the EPBC Act can be found at www.environment.gov.au/epbc/. Information regarding the TSC Act can be found at the OEH website www.environment.nsw.gov.au/threatenedspecies/.

The FM Act contains schedules of species, populations and ecological communities that have been listed as 'threatened'. Threatened species and ecological communities are listed under four categories: species presumed extinct, critically endangered, endangered and vulnerable. Populations are listed under the category 'endangered'. The FM Act also includes a list of species presumed extinct and 'key threatening processes'. The relevant schedules of the FM Act include:

Figure 3 – endangered Eastern Freshwater Cod (G. Schmida)

SCHEDULE 4 - Endangered species, populations and ecological communities

- endangered species
- endangered populations
- endangered ecological communities
- species presumed extinct

SCHEDULE 4A – Critically endangered species and ecological communities

- critically endangered species
- critically endangered ecological communities

SCHEDULE 5 - Vulnerable species and ecological communities

- vulnerable species
- vulnerable ecological communities

SCHEDULE 6 - Key threatening processes

2.6.3 The listing process

Anyone can nominate for consideration a fish or marine vegetation species, population, or ecological community to be listed as 'threatened', or a process to be listed as a 'key threatening process'. Part 7A of the FM Act establishes an independent Fisheries Scientific Committee (FSC) who is responsible for determining whether any species, populations or ecological communities or threatening processes should be listed in the Part 7A schedules. The schedules are therefore subject to ongoing change and amendment. Please refer to www.dpi.nsw.gov.au/fisheries/species-protection for details on the current listings.

Once a species, population, ecological community or threatening process is listed in the schedules of the FM Act it triggers three main responses:

- the species, population or members of the ecological community automatically become 'protected' and cannot be harmed (unless otherwise specifically permitted);
- in the case of a threatened species, population or ecological community a recovery plan may be developed and, where possible, critical habitat declared. In the case of a key threatening process a threat abatement plan may be developed; and
- potential impacts on the species, population or ecological community must be directly considered during any development consent or other planning approval process under the EP&A Act. In the case of key threatening processes, under **section 220ZS** public authorities must consider the actions identified in relevant threat abatement plans when making decisions.

2.6.4 Recovery planning

The Director-General of NSW Trade & Investment may prepare recovery plans for species, populations and ecological communities listed as critically endangered, endangered or vulnerable under the FM Act. The aim of a recovery plan is to promote the recovery of the species, population or ecological community to a position of viability in nature. The plan outlines actions that government and/or non-government organisations have agreed upon to promote the recovery of a species, population or ecological community.

Draft recovery plans are placed on public exhibition and community comments invited. All comments received are considered before the plans are finalised and approved. Once approved, recovery plans are statutory documents, and consent and determining authorities must consider them when assessing development applications under the EP&A Act (see section 2.6.9).

Draft and final recovery plans can be viewed at www.dpi.nsw.gov.au/fisheries/species-protection/conservation

2.6.5 Declaration of 'critical habitat'

The FM Act also makes provision for the declaration of 'critical habitat' by the Minister for Primary Industries. Critical habitat is defined as 'the whole or any part of the habitat of an endangered species, population or ecological community that is critical to the survival of the species, population or ecological community'. Regulations can be developed to control specific activities in critical habitat areas.

The Minister for Primary Industries identifies critical habitat, which involves extensive consultation with public authorities, landholders and the wider community. Before declaring a critical habitat the Minister must consider the likely social and economic consequences of the declaration. The Minister is also responsible for maintaining a register of critical habitat. Once critical habitat is declared, relevant planning instruments must take note of it and any proposal under Parts 4 or 5 of the EP&A Act that is likely to affect critical habitat requires the preparation of a species impact statement (SIS). Actions that do not require consent or approval under the EP&A Act that damage critical habitat can only be legally undertaken under the authority of a licence granted under the FM Act.

Where aquatic habitats are declared 'critical habitat' under Part 7A of the FM Act, NSW DPI classifies the habitat as TYPE 1 'highly sensitive aquatic habitat' (see section 3.2.1 – Table 1) and the waters as CLASS 1 'major fish habitat' (see section 3.2.2 – Table 2). All NSW DPI policies and provisions relating to these types and classes will then apply (see Chapters 3-6).

Further information, including the register of 'critical habitat', can be viewed at www.dpi.nsw.gov.au/fisheries/species-protection/conservation/what

2.6.6 Threat abatement planning

A key threatening process is defined as 'a process that threatens, or that may threaten, the survival or evolutionary development of a species, population or ecological community of fish or marine vegetation. Once a listing has been made, NSW DPI may prepare a threat abatement plan. Threat abatement plans outline actions to manage threatening processes, explain how the success of proposed actions will be measured and identify authorities responsible for carrying out those actions. Draft threat abatement plans are placed on public exhibition and community feedback considered.

Threat abatement plans inform and influence other planning processes and cannot be ignored by public authorities when making decisions. For example, local councils and other public authorities must consider a threat abatement plan when assessing proposed developments or activities. Threat abatement plans can be sourced from NSW DPI's website at www.dpi.nsw.gov.au/fisheries/species-protection/conservation/what

2.6.7 Priorities Action Statement

Amendments made to the FM Act and TSC Act in 2004 introduced a requirement for the Director-Generals of NSW DPI and OEH to prepare and adopt a Priorities Action Statement (PAS). The PAS sets out the strategies to be adopted for promoting the recovery of each threatened species, population or ecological community to a position of viability in nature and for managing each key threatening process. It also establishes relative priorities for the implementation of recovery and threat abatement strategies and establishes performance indicators to facilitate reporting on the implementation of strategies and their effectiveness.

A separate PAS has been prepared by NSW DPI and OEH. Each PAS will be reviewed every 3 years, and amendments may be adopted following the review. As part of the review process the Director-General of NSW DPI is to report on achievements in implementing the strategies established by the PAS. Once finalised and adopted, NSW DPI will actively seek to implement recovery and threat abatement strategies in consultation with relevant stakeholders.

State agencies, Catchment Management Authorities, community groups, non-government organisations, and members of the public are encouraged to use the PAS as a source of information about the status of threatened species, populations and ecological communities of fish and marine vegetation, and the key threatening processes affecting them. Furthermore, the PAS may be used to identify priority recovery and threat abatement strategies and to guide action at a range of scales and jurisdictions.

NSW DPI's PAS can be viewed at pas.dpi.nsw.gov.au/

2.6.8 Licensing harm to threatened species

Once listed on the schedules of the FM Act, heavy penalties apply for harming a threatened species, population or ecological community or damaging critical habitat unless the activity is specifically permitted. For actions that are likely to result in harm to a threatened species, population or ecological community, a licence may be required.

Part 7A (**s220ZW**) of the FM Act provides for the licensing of actions that are likely to result in:

- harm to a threatened species, population or ecological community;
- damage to critical habitat; or
- damage to a habitat of a threatened species, population or ecological community.

A licence may not be required if the proposal is essential to the carrying out of a development or activity undertaken in accordance with a consent under Part 4, or an approval under Part 5, of the EP&A Act.

Other actions that do not require a 'harm to threatened species' licence include those carried out in accordance with an aquaculture permit, a permit issued under **s37** of the FM Act, or a Ministerial order or interim order made under Subdivision 1A of Division 6 of the FM Act.

In addition, a licence is not required for the carrying out of routine fishing, aquaculture or agricultural activities unless the FM Regulations declare that such activities are not routine. The FM Regulations declare that an activity that results in or is likely to result in the repeated taking of threatened species of fish is not routine.

2.6.9 Environmental impact assessment

A major feature of the threatened species provisions of the FM Act is the integration of the conservation of such species into the development control processes under the EP&A Act. In particular, amendments to the EP&A Act place specific responsibilities on proponents, consent and determining authorities in the fields of environmental planning and development control.

In January 2007, the Australian and NSW Governments signed a Bilateral Agreement which allows the assessment regimes under the EP&A Act (Parts 4 and 5 of the EP&A Act) to be automatically accredited under the EPBC Act. This means that separate assessment processes are not required. The **Bilateral Agreement** [4] only covers matters that are determined to be 'controlled actions' by the Australian Government, including nationally listed threatened species and ecological communities.

Threatened species test of significance – Section 5A (known as the '7 part test')

Section 5A of the EP&A Act lists factors which must be taken into account to determine whether there is likely to be a significant effect on threatened species, populations, and ecological communities or their habitats. Also termed the '7 part test', this consideration assists with the assessment of applications (under **ss 78A, 79B and 79C**, EP&A Act), or environmental assessment (**ss111 – 112** EP&A Act).

Where a proposed development is in the potential range of a listed threatened species, population or ecological community under the FM Act and/or the EPBC Act, and the area has not been declared a critical habitat, the following applies:

- A '7 part test' is completed. If the determining/consent authority determines that the project will not have a significant impact after considering the '7 part test', then the proposal may be accepted, subject to compliance with relevant government policy including those required from NSW DPI in this document.
- If the determining/consent authority determines that the proposed project will have a significant impact via the '7 part test', then a Species Impact Statement (SIS) is required to be prepared, or the proposal may require modification where possible (e.g. changes to construction designs or relocation of the project to another site).
- Modifications to the original proposal require re-application of the '7 part test'. If the modified project still may cause a significant impact, then a SIS must be prepared for the project.

Threatened species assessment guidelines can be viewed at
www.dpi.nsw.gov.au/__data/assets/pdf_file/0006/226536/Threatened-Species-Guidelines.pdf

Species Impact Statement (SIS)

A finding of significance under **s5A** of the EP&A Act will require that the applicant prepare a SIS, if they still wish to proceed with their application. The required content of a SIS is listed in **s221K** of the FM Act. The information from the SIS will be used to make an assessment of the application and determine whether the impacts are acceptable or not.

If a proposal involves critical habitat, a SIS must accompany the development application regardless of whether the **s5A** test identified potential significant impacts.

Prior to the preparation of a SIS, the applicant must obtain the requirements of the Director-General of NSW DPI. These requests should be accompanied by the **s5A** assessment, a copy of the development application and any Statement of Environmental Effects (SEE), Review of Environmental Factors (REF) or Environmental Impact Statement (EIS) that may have been prepared. The Director-General's requirements will outline all matters to be included in the SIS so that a more detailed assessment can be undertaken.

[4] www.planning.nsw.gov.au/SettingtheDirection/GovernmentAgreementsandForums/BilateralAgreementwiththeCommonwealth/tabid/283/Default.aspx

3. General policy – fish habitat conservation and management

3.1 Introduction – general policy

As noted in section 2.1, one of the key objectives of the FM Act is to conserve 'key fish habitats'. 'Key fish habitats' are not defined in the FM Act and sections 3.2.1 and 3.2.2 outlines the approach adopted by NSW DPI to define these habitats to ensure effort and resources are focused on those most important for fisheries conservation. Essentially NSW DPI will focus the application of the FM Act and FM Regulations and the policies and guidelines within this document on 'key fish habitats' as defined in sections 3.2.1 and 3.2.2. Further detailed information on the types and importance of these 'key fish habitats' is included in Appendix 3.

NSW DPI recognises that certain types of activities have varying degrees of impact on key fish habitats and, as such, require different levels of control and regulation. As a general principle, NSW DPI requires that proponents should, as a first priority, aim to **avoid** impacts upon key fish habitats. Where avoidance is impossible or impractical, proponents should then aim to **minimise** impacts. Any remaining impacts should then be **offset** with compensatory works. In order to achieve this, NSW DPI applies the following **general policies** to the environmental assessment of activities that may affect key fish habitats within NSW:

1) **Equity** - Fish and their habitats are important natural resources, and management of these resources must be given equal priority to terrestrial fauna and their habitats and other environmental resources.

2) **Precautionary principle** – If there are threats of serious or irreversible environmental damage to key fish habitats or fisheries resources, lack of full scientific certainty should not be used as a reason for postponing measures to prevent environmental degradation. The decisions of NSW DPI shall be guided by (i) careful evaluation to avoid, wherever practicable, serious or irreversible damage to key fish habitats and fisheries resources, and (ii) an assessment of the risk-weighted consequences of various options (Note: this policy is adapted from the definition of the 'precautionary principle' in the NSW *Protection of the Environment Administration Act 1991*).

3) **Conservation of biodiversity & fish populations** – key fish habitats must be protected when the habitat is important to maintain biodiversity at the ecosystem, species or genetic level or is required to maintain fish populations.

4) **Protected and threatened species** – habitats of protected or threatened fish must be afforded special protection.

5) **Protected areas and critical habitats** – Marine parks, aquatic reserves, intertidal protected areas, significant wetlands (e.g. SEPP 14 coastal wetlands and those recognised under international agreements (e.g. RAMSAR, JAMBA, ROKAMBA and CAMBA wetlands)) and critical habitats will be given priority consideration for protection in the development of plans and in the assessment and determination of development and activity proposals.

6) **Comprehensive environmental assessment** – Impacts (including direct, indirect, on and off-site, short and long-term and cumulative impacts) of any works or activities on fish and key fish habitats are to be assessed in all development and planning procedures. Assessment of alternative options including sites, work methods, timing, etc. shall also be undertaken as part of the assessment to minimise or mitigate potential impacts (see section 3.3 for further details).

7) **No net loss of key fish habitat** – Significant environmental impacts (direct and indirect) are to be offset by environmental compensation. Compensation to offset fisheries resource or habitat losses will be considered only after it is demonstrated that the proposed loss is unavoidable, in the best interests of the community in general and is in accordance with the FM Act, Regulations and these policies and guidelines. Habitat replacement (as a compensation measure) will need to account for indirect as well as direct impacts of development to ensure that there is "no net loss" of key fish habitats (see section 3.3.3 for further details).

8) **Adaptive management** – Scientific research and monitoring programs should be established to quantify the impacts of development and the effectiveness of environmental mitigation and compensation measures. Management should be adaptive to incorporate the findings of these programs.

3.2 Key fish habitat management policies

3.2.1 Habitat sensitivity

NSW DPI assesses activity and development proposals in relation to the general policies stated above and with consideration for the 'sensitivity' of the affected fish habitat. In this context, 'sensitivity' is defined by the **importance** of the habitat to the survival of fish (noting that 'fish' under the FM Act includes all aquatic invertebrates) and its robustness (ability to withstand disturbance).

Sections 3, 4, 5 and 6 of this document provide detailed policy and guideline statements with respect to activities, developments, and impacts on key fish habitats. Table 1 defines those habitats that are considered 'key fish habitats' for the purposes of the application of the FM Act, FM Regulations and the policies and guidelines in this document. The table also includes a **fish habitat sensitivity** ranking which is used within the policy and guideline statements to differentiate between permissible and prohibited activities or developments related to the importance of the '**TYPE**' of key fish habitat.

Table 1 – Key fish habitat and associated sensitivity classification scheme
(for assessing potential impacts of certain activities and developments on key fish habitat types)

TYPE 1 - Highly sensitive key fish habitat:

- *Posidonia australis* (strapweed)
- *Zostera, Heterozostera, Halophila and Ruppia* species of seagrass beds >5m^2 in area
- Coastal saltmarsh >5m^2 in area
- Coral communities
- Coastal lakes and lagoons that have a natural opening and closing regime (i.e. are not permanently open or artificially opened or are subject to one off unauthorised openings)
- Marine park, an aquatic reserve or intertidal protected area
- SEPP 14 coastal wetlands, wetlands recognised under international agreements (e.g. Ramsar, JAMBA, CAMBA, ROKAMBA wetlands), wetlands listed in the Directory of Important Wetlands of Australia[2]
- Freshwater habitats that contain in-stream gravel beds, rocks greater than 500 mm in two dimensions, snags greater than 300 mm in diameter or 3 metres in length, or native aquatic plants
- Any known or expected protected or threatened species habitat or area of declared 'critical habitat' under the FM Act
- Mound springs

TYPE 2 – Moderately sensitive key fish habitat:

- *Zostera*, *Heterozostera, Halophila* and *Ruppia* species of seagrass beds <5m^2 in area
- Mangroves
- Coastal saltmarsh <5m^2 in area
- Marine macroalgae such as *Ecklonia* and *Sargassum* species
- Estuarine and marine rocky reefs
- Coastal lakes and lagoons that are permanently open or subject to artificial opening via agreed management arrangements (e.g. managed in line with an entrance management plan)
- Aquatic habitat within 100 m of a marine park, an aquatic reserve or intertidal protected area
- Stable intertidal sand/mud flats, coastal and estuarine sandy beaches with large populations of in-fauna
- Freshwater habitats and brackish wetlands, lakes and lagoons other than those defined in TYPE 1
- Weir pools and dams up to full supply level where the weir or dam is across a natural waterway

TYPE 3 – Minimally sensitive key fish habitat may include:

- Unstable or unvegetated sand or mud substrate, coastal and estuarine sandy beaches with minimal or no in-fauna
- Coastal and freshwater habitats not included in TYPES 1 or 2
- Ephemeral aquatic habitat not supporting native aquatic or wetland vegetation

Notes: For the purposes of these policy and guidelines the following are **not considered key fish habitat**[5]:

- First and second order streams on gaining streams (based on the Strahler method of stream ordering)
- Farm dams on first and second order streams or unmapped gullies
- Agricultural and urban drains
- Urban or other artificial ponds (e.g. evaporation basins, aquaculture ponds)
- Sections of stream that have been concrete-lined or piped (not including a waterway crossing)
- Canal estates

Example A: NSW DPI will generally not permit harm to *Posidonia australis* (TYPE 1 - highly sensitive fish habitat) because it is a key fish habitat that research has demonstrated rarely regenerates, or regenerates extremely slowly, after being damaged (see section 3.2.3).

Example B: NSW DPI is unlikely to approve dredging or reclamation without strict conditions in a TYPE 1 or 2 habitat that supports gravel beds, snags and other fish spawning areas (see Chapters 4 and 5 and sections 6.1 and 6.3).

[5] Note that if any of these habitats are found to be habitat of a listed threatened species, population or ecological community or 'critical habitat', then they would be considered 'key fish habitat' for the purposes of Tables 1 and 2 and these policies and guidelines.

[2] Ramsar wetlands and Directory of Important Wetlands of Australia can be sourced at www.environment.gov.au/water/topics/wetlands/index.html

3.2.2 Waterway classification

In some instances, NSW DPI assesses proposals in relation to habitat sensitivity **TYPE** (as above) and also waterway **CLASS**. The waterway classification scheme outlined below has been adapted from Fairfull and Witheridge (2003) and factors in the **functionality** of the waterway as fish habitat. This assessment relates primarily to watercourses (freshwater and brackish) and classifies these streams using indicators such as:

- hydraulic geometry (stream shape and size),
- frequency of stream flows (perennial, intermittent or ephemeral),
- presence of aquatic habitat units (pools, riffles, vegetation, snags),
- presence of threatened or protected fish species and other native fish, and
- connection to adjacent habitats (e.g. floodplain wetlands).

Waterway **CLASS** can be used to assess the impacts of certain activities on fish habitats in conjunction with the habitat sensitivity **TYPE**. The waterway **CLASS** scheme can also be used to make management recommendations to minimise impacts on different fish habitats (e.g. section 4.2 - waterway crossings).

Table 2 - Classification of waterways for fish passage

Classification	Characteristics of waterway class
CLASS 1 Major key fish habitat	Marine or estuarine waterway or permanently flowing or flooded freshwater waterway (e.g. river or major creek), habitat of a threatened or protected fish species or 'critical habitat'.
CLASS 2 Moderate key fish habitat	Non-permanently flowing (intermittent) stream, creek or waterway (generally named) with clearly defined bed and banks with semi-permanent to permanent waters in pools or in connected wetland areas. Freshwater aquatic vegetation is present. TYPE 1 and 2 habitats present.
CLASS 3 Minimal key fish habitat	Named or unnamed waterway with intermittent flow and sporadic refuge, breeding or feeding areas for aquatic fauna (e.g. fish, yabbies). Semi-permanent pools form within the waterway or adjacent wetlands after a rain event. Otherwise, any minor waterway that interconnects with wetlands or other CLASS 1-3 fish habitats.
CLASS 4 Unlikely key fish habitat	Waterway (generally unnamed) with intermittent flow following rain events only, little or no defined drainage channel, little or no flow or free standing water or pools post rain events (e.g. dry gullies or shallow floodplain depressions with no aquatic flora present).

Example: NSW DPI will not approve the permanent obstruction of fish passage on a CLASS 1 or 2 waterway (major or moderate fish habitat) (see Chapter 4).

3.2.3 Marine vegetation

Marine vegetation includes saltmarshes, mangroves, seagrasses and marine macroalgae, which provide important habitat for the recruitment, shelter and feeding of a wide range of marine and estuarine dependent species such as Yellowfin Bream, Luderick and Leatherjackets. Saltmarshes, mangroves, seagrasses and macroalgae are fragile and can be easily damaged or destroyed.

Further information on marine vegetation is provided in Appendix 3.

3.2.3.1 Legislation

Sections 204 and 205 of the FM Act and the associated FM Regulations set out provisions to protect marine vegetation (such as saltmarshes, mangroves, seagrass and seaweeds whether alive or dead) from 'harm' on public water land below the astronomical high tide mark or the foreshore of such land. A permit is required from NSW DPI to harm marine vegetation in these areas. 'Harm' under Part 7 of the FM Act means gather, cut, pull up, destroy, poison, dig up, remove, injure, prevent light from reaching or otherwise harm the marine vegetation, or any part of it.

The maximum penalty for harming marine vegetation is $220,000 for a corporation and $110,000 for individuals.

Figure 5 – Saltmarsh and mangroves (J. Hannon)

Proposals that may harm marine vegetation should also be discussed with other approval authorities, such as local council, as the development may also be *integrated development* under **s91** of the EP&A Act (see section 2.2).

The gathering of marine vegetation for commercial purposes requires a permit under **clause 56** of the Fisheries Management (Aquaculture) Regulation 2012 (see section 3.2.3.3).

3.2.3.2 Policy and guidelines for harming marine vegetation

In addition to the general policies stated in Chapter 3, the following specific **policies** apply to harming marine vegetation:

1) NSW DPI will generally not allow harm to live marine vegetation by hand, tools, or mechanical methods (such as weed harvesters) except for maintenance clearing of "fouling" algal growth from existing infrastructure (e.g. ocean pool steps, boat ramp surfaces, boat mooring apparatus etc).

2) NSW DPI will generally not approve any new developments or activities that will harm TYPE 1 and TYPE 2 marine vegetation (see Table 1) without adequate mitigation and compensation measures in place (see section 3.3.3).

3) Where harm to marine vegetation is approved, a management plan will generally be required as a condition of consent, dependent on the scale of the works proposed and the adequacy of the environmental assessment provided with the application.

4) NSW DPI will generally not approve developments or activities that do not incorporate foreshore buffer zones of 50-100 m width adjacent to TYPE 1 marine vegetation and at least 50 m width adjacent to TYPE 2 marine vegetation. Where a buffer zone of at least 50 m is physically unachievable due to land availability constraints, the available buffer width must be maximised to achieve protection of TYPE 1 and 2 marine vegetation (i.e. from edge effects, changes to water quality, flood protection and to allow for climate change adaptation). The buffer zone should not be used for other asset protection purposes (e.g. as a bushfire or mosquito buffer). Please note that this policy does not apply to developments involving maintenance to existing, or construction of new roads or bridges crossing a waterway, but may apply to developments involving roads that are adjacent to, but not crossing a waterway (e.g. new subdivisions, rezoning proposals involving new access roads, new road developments along a new alignment).

5) NSW DPI will not approve the poisoning or ringbarking of mangroves except in accordance with point 6 below.

6) NSW DPI will generally approve the removal of mangroves where they are encroaching into TYPE 1 and 2 coastal saltmarsh habitats.

7) NSW DPI will not approve mangrove trimming for aesthetic purposes (e.g. to preserve a water view). Exceptions will generally only be considered in existing residential canal estates or urban areas where marine vegetation has been historically degraded by ongoing unauthorised harmful activities. Such exceptions in urban areas will be negotiated with the local Council under a joint management arrangement.

8) NSW DPI will approve mangrove trimming and removal adjacent to public and private facilities such as jetties, boat ramps and waterway crossings to allow for safe access, and for maintenance works in connection with electricity supply, stormwater or agricultural drains. Where mangrove removal is required, adequate mitigation and compensation measures will generally be required as a condition of consent (refer to sections 3.1 and 3.3).

9) In the case of the need for emergency works, NSW DPI should be notified of the proposed emergency works prior to their commencement. Basic information such as the location of the proposed works, the need for the works and an estimate of the likely harm to marine vegetation should be faxed or emailed to the nearest NSW DPI office (see contact details in Appendix 5). NSW DPI will generally be able to issue a permit within 3 days of notification via facsimile. The permit will be issued subject to the receipt of full documentation as outlined in sections 3.3 and the relevant permit fee(s) as soon as the works are completed. As most emergency works are of a temporary nature, the full documentation should address how the works will be finalised (where relevant), including any mitigation measures.

10) NSW DPI will generally not approve activities or projects that will harm marine vegetation associated with habitat modification (e.g. creation of sandy beaches for amenity, creation of wader bird habitat and mangroves in other tidal habitats, creation of saltmarsh) unless the activity or project aims to restore a "natural" estuarine habitat that supports the rehabilitation of wader bird or other threatened species habitat in TYPE 1 or 2 coastal habitats. Such activities or projects must provide an approved management plan and demonstrate the availability of funding for implementation of the management plan.

11) NSW DPI will not approve the removal of marine vegetation for private facilities in areas where there are continuous, healthy saltmarsh communities, stands of mangroves or beds of seagrass. Such applications establish a precedent for further requests for additional private facilities by adjoining landholders resulting in cumulative losses of the habitat values of these areas over time. NSW DPI will consider alternative proposals for community facilities servicing multiple users in such situations. Exceptions may include locations where the property can only be accessed by water and there are no public facilities available nearby.

12) Seagrass transplanting will not be supported as an impact compensation measure as the viability of transplanting methods is yet to be scientifically proven for all species (see Ganassin and Gibbs 2008). This policy will be subject to ongoing review as research findings on seagrass rehabilitation methods for different species becomes available. In circumstances where seagrass is likely to be negatively impacted and cannot be avoided or mitigated in line with this section, environmental compensation will be required and calculated in line with the rates stated in section 3.3.3.

13) Oyster aquaculture is required to comply with the relevant seagrass protection provisions of the NSW Oyster Industry Sustainable Aquaculture Strategy (see www.dpi.nsw.gov.au/fisheries).

Guidelines for implementing the above policies include:

a) Mitigation measures for developments along watercourses should include the protection (or establishment) of buffer zones with setbacks measured from the outer edge of the marine vegetation (e.g. for saltmarsh and mangroves - highest astronomical tide level in tidal areas (generally 1.0 m AHD), for seagrasses and marine macroalgae – the outer edge of the seagrass or algae bed).

b) Buffer zones should be clearly delineated (e.g. fences or other markers) and well managed to avoid degradation (e.g. weed and stock access management). They should also not be subject to under scrubbing (e.g. for mosquito control) or other clearing activities that will reduce their value as a buffer zone.

c) Mangrove rehabilitation projects/activities should be undertaken in accordance with the NSW DPI "Mangroves" Primefact (Primefact No. 746) available on the NSW DPI website at www.dpi.nsw.gov.au/fisheries.

d) Where trimming of mangroves is considered for approval, the following points apply:

- Grey Mangroves (*Avicennia marina*) and River Mangroves (*Aegiceras corniculatum)* will generally only be permitted to be trimmed, and only if it will not result in the death of the plant,
- Grey and River Mangroves below 2m in height should not be trimmed,
- Untrimmed mangrove trees should be left at predetermined distances (e.g. 50 m) along the foreshore to maintain bird habitat and shading for lower canopy species.
- Mangrove trimming should occur after the flowering/propagule season has finished and be restricted to branches that do not contain propagules,
- Pneumatophores (peg, knee, stilt roots) should not to be removed or trimmed.

e) Where mangrove trimming or removal for public access is proposed, access ways through the mangroves to the water should be planned to minimise disturbance and to allow for greatest public benefit/shared use.

f) A management plan for harm to marine vegetation should include as a minimum:

- A description of the site, including a map and photos of the location,
- A description of the marine and other vegetation present and quantification of the area and/or number and species of marine vegetation to be trimmed, transplanted, removed or otherwise harmed,
- Details of the methods to be used to trim, transplant, remove or otherwise harm the marine vegetation. For mangroves - this includes the height at which trees are to be trimmed and the timing and frequency of trimming, the source of the seedlings and methods of collection and transplanting and the timing of the removal (e.g. avoiding flowering periods),
- A description of the method and site for disposal of the foliage,
- Mitigating steps and a description of the monitoring program,
- Community consultation undertaken (including with local commercial and recreational fishing representative organisations).

3.2.3.3 Policy and guidelines for the gathering or collection of marine vegetation

In addition to the general policies stated in Chapter 3, the following specific **policies** apply to gathering or collecting marine vegetation:

1) NSW DPI will not allow the collection of living marine vegetation, with the exception of green 'bait weed' (blackfish weed *Enteromorpha* spp. and sea lettuce *Ulva* spp.) for recreational or non-commercial use, without a permit.

2) NSW DPI will generally not issue permits for collecting live or dead seagrass or macroalgae (seaweeds) from the water. Exemptions may be considered for the purpose of scientific research. Collecting will generally not be permitted from declared Intertidal Protected Areas, Aquatic Reserves or Marine Parks (see the NSW DPI website for the location of these protected areas at www.mpa.nsw.gov.au).

3) NSW DPI will generally allow persons to remove up to 20kg/day of dead or dislodged seagrass or macroalgae (wrack) from beaches or the intertidal zone for personal use (e.g. as mulch, fertiliser).

4) NSW DPI will require a person or organisation that wishes to gather or remove quantities of wrack exceeding 20kg/day to apply for a permit under **s.205** of the FM Act and this may be issued on a case-by-case basis.

5) NSW DPI will require a person or organisation that wishes to gather marine vegetation for commercial use to apply for a permit under **clause 56** of the Fisheries Management (Aquaculture) Regulation 2012 and this may be issued on a case-by-case basis. In accordance with this Regulation, permits will not be issued where the marine vegetation is in any area where commercial fishing takes place (unless permitted prior to the fishing taking place in that area), or is on Crown land, in a marked navigation channel or any area in which a public work is being carried out.

6) NSW DPI will require applicants seeking access to marine vegetation resources for any commercial purposes to submit a business case providing a detailed description of the operation and reason for gathering the marine vegetation, including:

- a description of the exact locations where the marine vegetation is expected to be gathered and an estimate of the amount to be collected from each location annually
- the total amount to be collected annually
- methods of collection and processing techniques
- identification of the final product and anticipated sales outlets.

All applications must be accompanied by a Statement of Environmental Effects (SEE). Permits may contain conditions limiting the range, methods of collection and amounts harvested.

Guidelines for implementing the above policies include:

a) Where wrack is causing a public nuisance, NSW DPI will encourage members of the community to work with their local Council to coordinate local solutions, where feasible.

b) For proponents (e.g. Councils, local landholders) wishing to remove wrack that is causing a public nuisance, NSW DPI will generally include a permit condition requiring the wrack to be retained *in situ* by moving it along the foreshore and/or burying it under sand away from areas where it is considered a nuisance. However, where this is not a feasible option, NSW DPI may approve other options to remove and dispose of the vegetation. NSW DPI will also generally include a permit condition requiring a management plan outlining management and disposal arrangements for wrack in areas where it is known to be problematic to the community. The plan, submitted with a permit application for assessment, should outline quantities of wrack to be removed, where, when and how the wrack is to be removed and methods of disposal.

c) Recreational fishers may harvest blackfish weed and sea lettuce (*Enteromorpha* and *Ulva* sp.) for personal use as fishing bait, other than in Aquatic Reserves, Intertidal Protected Areas and within Sanctuary and some Habitat Protection Zones in Marine Parks (see the NSW DPI website for the location of these protected areas at www.mpa.nsw.gov.au). Methods of collection should be non-destructive and care should be taken not to disturb other marine organisms and their habitat. The weed must not then be sold to any other person for any purpose unless under permit.

3.2.4 Riparian and freshwater aquatic vegetation

Protection of in-stream and riparian vegetation along coastal and inland streams of NSW has been identified as a primary action to reduce threats to fish in NSW (Morris *et al*. 2001). “Degradation of native riparian vegetation along NSW water courses” has been listed as a ‘key threatening process’ under the FM Act in recognition of its role in the decline of several threatened species of fish.

Freshwater aquatic vegetation can be damaged directly by foreshore development, stock grazing, sedimentation and erosion, carp fossicking for food in sediment, changed hydrology, in-stream activities, including dredging and reclamation, and also indirectly through shading or incidental manual damage (e.g. from launching or beaching water craft, boat-induced wave action, etc).

Along many rivers (such as the Murray River), recreational use is a key aspect of the tourism industry and the local lifestyle. Demand for waterfront access to rivers can lead to extensive reclamation of river foreshore and increased pressure on aquatic vegetation from the installation and use of foreshore structures and clearing for aesthetic views and foreshore access.

Many freshwater habitats are considered to be moderate to highly sensitive (TYPE 1 and 2 habitats in Table 1) and NSW DPI may not approve certain dredging and reclamation activities (see Chapters 4 and 5 and sections 6.1 and 6.3) due to potential impacts on these habitats.

As outlined in Table 1, sensitive freshwater habitats include freshwater aquatic vegetation such as:

- native freshwater macrophytes and reed beds,
- floodplain wetlands including SEPP 14 coastal wetlands and Ramsar wetlands,
- any aquatic vegetation that is habitat for threatened species or is declared ‘critical habitat’ under the FM Act.

Further information on riparian and aquatic vegetation is provided in Appendix 3.

3.2.4.1 Legislation

The removal of freshwater aquatic vegetation or work that involves the removal of any other material from water land that disturbs, moves or harms freshwater aquatic vegetation is considered “dredging” under the FM Act. Works that involve dredging may require a permit or consultation with the Minister for dredging under **ss199-201** of the FM Act. Under **s199** of the FM Act, the Minister for Primary Industries is required to be consulted over any dredging work before it is carried out, or proposed to be authorised, by a public authority (other than a local government authority).

Under **ss200** and **201** a permit is required for dredging work carried out by a local government authority or person respectively, unless these works are authorised by a relevant public authority (other than a local government authority) or under the *Crown Lands Act 1989*. The maximum penalty for unauthorised dredging is $220,000 for local government authorities or corporations and $110,000 for individuals. If works are carried out in contravention of these sections, the Minister for Primary Industries may, under **s203**, order remedial works to be carried out to rectify any damage caused to fisheries or fish habitat. Permits and approvals may also be necessary from other public authorities (e.g. local Council, the regional Catchment Management Authority) and advice should be sought.

There are several other pieces of legislation that directly or indirectly affect riparian and freshwater aquatic vegetation management in NSW. These include:

- the *Native Vegetation Act 2003* (NV Act) provides for the protection of living native riparian and aquatic vegetation. Development consent or a property vegetation plan may be required to clear riparian or in-stream native vegetation under the NV Act. Please see the OEH website for further information on native vegetation clearing at www.environment.nsw.gov.au/vegetation/index.htm;
- the *Native Vegetation Conservation Act 1997* continues to apply to the clearing of living and dead exotic trees and dead native trees on State protected land, which generally includes the bed and banks of named rivers and creeks in NSW. Specific guidelines have been developed for the clearing of exotic trees and dead native trees on State protected land and these can be accessed from OEH or your regional Catchment Management Authority.
- The *Environmental Planning and Assessment Act 1979* provides for the protection of living native vegetation within urban areas and certain local government authorities specifically exempt from the application of the NV Act.
- the *Threatened Species Conservation Act 1995* – establishes mechanisms for the management and protection of listed threatened species of native flora and fauna (excluding fish and marine vegetation which are managed under the *Fisheries Management Act 1994*) including the listing of threatened species or key threatening processes, the development and implementation of recovery and threat abatement plans, the declaration of critical habitat and the consideration and assessment of threatened species impacts in development assessment processes and natural resource management programs.
- the *National Parks and Wildlife Act 1974* – protects native flora and fauna (excluding fish and marine vegetation which are managed under the *Fisheries Management Act 1994*) in NSW and establishes mechanisms for its protection including the establishment of a system of protected areas, such as National Parks and Nature Reserves, and Volunteer Conservation Agreements with private landholders.
- the *Water Management Act 2000* – a 'controlled activity approval' is required to carry out activities in, on or under waterfront land, which includes the bed and a distance of 40 metres from any river, lake or estuary. An application for a 'controlled activity approval' will be refused if the Minister is not satisfied that adequate arrangements are in force to ensure that no more than minimal harm will be done to any waterfront land as a consequence of the carrying out of the proposed controlled activity (s.97(4)). A water 'management work approval' may be required to authorise a water supply work (e.g. a water pump), a drainage work or a flood work. An application for a water 'management work approval' will be refused if the Minister is not satisfied that adequate arrangements are in force to ensure that no more than minimal harm will be done to any water source, or its dependent ecosystems (including riparian and freshwater aquatic vegetation) as a consequence of the construction or use of the proposed water management work (s 97(2));
- the *Forestry Act 2012*) – which allows for 'integrated forestry operations approvals' to regulate forestry operations;
- the *Rural Fires Act 1997* – which requires the preparation of a bush fire environmental assessment code to streamline the environmental assessment process for proposed hazard reduction work in regional areas;

As noted above, the "degradation of native riparian vegetation along NSW water courses" has been listed as a key threatening process under Part 7A of the FM Act. A threat abatement plan may be developed to outline ways to mitigate the effects of this process (see section 2.6.6) and actions identified within the plan may have implications for integrated development approvals where they occur within the known or expected habitat of a listed threatened species under the FM Act (see section 2.2).

3.2.4.2 Policy and guidelines for riparian and freshwater aquatic vegetation

In addition to the general policies stated in Chapter 3, the following specific **policies** apply to riparian and freshwater aquatic vegetation:

1) NSW DPI will generally not approve or support works that may harm freshwater aquatic vegetation (TYPE 1 and 2 habitats – see Table 1), unless adequate mitigation, rehabilitation and/or demonstrated compensation measures are in place (see section 3.3).

2) NSW DPI will generally require riparian buffer zones to be established and maintained for developments or activities in or adjacent to TYPE 1 or 2 habitats or CLASS 1-3 waterways (see guidelines below). Riparian buffer zones shall be measured from the top of the bank/drainage depression along CLASS 1 to 3 waterways (see Table 2). Please note that this policy does not apply to developments involving maintenance to existing, or construction of new roads or bridges crossing a waterway, but may apply to developments involving roads that are adjacent to, but not crossing a waterway (e.g. new subdivisions, rezoning proposals involving new access roads, new road developments along a new alignment).

3) NSW DPI will require the design of riparian buffer zones to incorporate the maintenance of lateral connectivity between aquatic and riparian habitat. Installation of infrastructure, terraces, retaining walls, cycle ways, pathways and grass verges within the riparian buffer zone shall be avoided or minimised.

4) NSW DPI will generally support proposals that aim to remove willows or other exotic trees or other weeds from the watercourse, followed by rehabilitation with native species. Willows and other exotic trees should only be removed from the stream where stream stability is not unduly compromised.

Guidelines for implementing the above policies include:

a) NSW DPI will assess the width of the riparian buffer zone based on the habitat TYPE and waterway CLASS (see Tables 1 and 2), the possible extent of the disturbance and the susceptibility of the riverbank to erosion. As a guide the following are recommended:

- TYPE 1, CLASS 1: 100 metres
- TYPE 2, CLASS 2-3: 50 metres
- TYPE 3, CLASS 3-4: 10-50 metres

For guidelines on designing filter strips for this purpose (including appropriate widths) please refer to Prosser and Karssies (2001) (see Appendix 2). Advice on protecting aquatic macrophytes in wetlands and shallow lakes can be obtained from Bailey *et al.* (2002) (see Appendix 2).

b) Riparian buffer zones should be clearly delineated (e.g. fences or other markers) and well managed to avoid degradation (e.g. weed and stock access management).

c) Developments should ensure that existing native riparian vegetation is retained to the greatest extent possible in an undamaged and unaltered condition. Revegetation of disturbed areas with local native species should also be considered as part of development controls (e.g. stabilisation of sediment, sediment filters during and post-construction) and mitigation measures. Monitoring should be undertaken to ensure successful establishment of vegetation in these areas.

d) Where establishment or rehabilitation of a riparian zone is required, the rehabilitation strategy should include native in-stream vegetation (macrophytes) and snags where appropriate.

e) Mitigation or rehabilitation measures for developments should include weed control.

f) Willow control guidelines can be accessed at www.environment.gov.au/biodiversity/invasive/weeds/index.html or www.weeds.org.au/WoNS/willows/

3.2.5 Snag management

'Snags' include in-stream woody habitat and large rocks and are essential habitat for many native fish species (see Appendix 3). Removal of snags from waterways can impact upon aquatic biodiversity, waterway structure, ecosystem function and fish populations both directly and indirectly. Direct impacts include the physical loss of habitat for species which rely on snags for resting, feeding or breeding sites. Indirect impacts include a short-term increase in turbidity or a long-term change in stream structure and function. Wager and Jackson (1993) list 'desnagging' as one of the main factors contributing to the decline of the endangered Trout Cod.

Since European settlement, tens of thousands of snags have been removed from streams in NSW to facilitate navigation and conveyance of water. Removal of snags for navigation purposes, and to allow for associated recreational activities such as water skiing, is still conducted today.

Over the past 50 years 'desnagging' has also been undertaken with the intention to improve delivery of water to downstream consumptive users or to reduce the potential impacts of flooding by facilitating unimpeded water flow. While the benefits of desnagging for navigation are clear, there is little evidence to suggest that desnagging improves the hydraulic capacity of rivers. Gippel *et al.* (1991) estimated the hydraulic impact of snags in the Murrumbidgee and Tumut Rivers, and found that in many cases the removal of snags could not be justified on hydraulic grounds alone. Similarly, Young (1991) reported that in-stream woody habitat occurring in the lowland rivers of south-eastern Australia seldom caused significant effects on flood levels.

Snag management can be separated into four categories ranging from low impact to high impact:

- lopping – whereby protruding limbs of in-stream woody habitat are sawn-off and allowed to sink to the river bed,
- realignment – whereby a snag is rotated from its existing position,
- relocation – whereby a snag is physically moved from one location in the waterway to another location,
- removal – the snag is completely pulled from the water (i.e. desnagging).

Snag management is undertaken by state and local government and the community for various reasons including prevention of bank erosion, removal of hazards at waterway crossings, maintenance of channel capacity and removing boating and swimming hazards.

3.2.5.1 Legislation

The removal of woody debris and snags or work that involves the removal of any other material from water land that disturbs, moves or harms woody debris and snags is considered "dredging" under the FM Act. Works that involve dredging may require a permit or consultation with the Minister for dredging under **ss199-201** of the FM Act. Under **s199** of the FM Act, the Minister for Primary Industries is required to be consulted over any dredging work before it is carried out, or proposed to be authorised, by a public authority (other than a local government authority).

Under **ss200** and **201** a permit is required for dredging work carried out by a local government authority or person respectively, unless these works are authorised by a relevant public authority (other than a local government authority) or under the *Crown Lands Act 1989*. The maximum penalty for unauthorised dredging is $220,000 for local government authorities or corporations and $110,000 for individuals. If works are carried out in contravention of these sections, the Minister for Primary Industries may, under **s203**, order remedial works to be carried out to rectify any damage caused to fisheries or fish habitat. Permits and approvals may also be necessary from other public authorities (e.g. OEH, the regional Catchment Management Authority) and advice should be sought.

"Removal of large woody debris from NSW rivers and streams" is listed as a key threatening process under Part 7A of the FM Act. This imposes certain requirements upon authorities when authorising an activity or development that may involve in-stream woody habitat removal (**s5A** EP&A Act). A proposal to remove in-stream woody habitat from an area that is habitat for a threatened species, population or ecological community is likely to significantly affect threatened species and must be specifically assessed with regard to the potential adverse impacts upon that species, population or ecological community. This is normally accomplished by way of a "7 part test" and/or Species Impact Statement (see section 2.6.8). Under **s.220ZS** public authorities must also have regard to the threat abatement plan which has been developed to address this key threatening process. It is important to note that it is an offence under Part 7A of the FM Act to harm the habitat of a threatened species.

Under NSW DPI's Fish Habitat Protection Plan No.1, (HPP No.1 (see www.dpi.nsw.gov.au/__data/assets/pdf_file/0008/202688/FISH-HABITAT-PROTECTION-PLAN-NO-1.pdf) local councils and other public authorities are required to notify NSW DPI of any proposed works which involve the lopping, realignment, relocation or removal of snags. NSW DPI will consider the proposal and then, if potential problems are evident, contact the proponent in order to seek a modification. HPP No.1 makes a concession in the case of urgent works by stating that 'where a snag is causing a hazard to navigation or public safety, and needs to be removed or relocated as a matter of urgency, a public authority may do so without complying with the notification period, but must promptly inform the Minister for Primary Industries of the work undertaken and the reasons for it'.

3.2.5.2 Policy and guidelines for snag management

For the purposes of this policy, a snag is considered to be any piece of woody debris that is both greater than 3m in length and 300 mm in diameter, or any rock larger than 500 mm in two dimensions, that is located within a waterway (either fresh, estuarine or marine) and is, or would be, wholly or partly submerged at a 'bank-full' flow level or highest astronomical tide level. This policy definition does not include exotic plant species, such as willow and camphor laurel trees.

In addition to the general policies stated in Chapter 3, the following specific **policies** apply to snag management:

1) NSW DPI supports the retention of snags within streams (i.e. CLASS 1-3 in Table 2) to the greatest extent possible and will generally not support or approve snag management proposals that do not demonstrate a significant public benefit. In particular, NSW DPI will generally not support or approve the removal of snags purely for aesthetic purposes.

2) NSW DPI will generally not support or approve snag management proposals aimed at improving or enhancing navigability of streams. NSW DPI may, however, agree to proposals which aim to maintain (not enhance) navigability in those areas where there is a long history of boating use, providing the habitat of a threatened species will not be adversely affected and it is not contrary to a recovery or threat abatement plan.

3) NSW DPI will generally not support or approve snag management proposals aimed at improving or enhancing the hydraulic capacity of streams or reducing flood risk.

4) NSW DPI may support or approve snag management proposals which are part of a larger strategy or program to rehabilitate and stabilise degraded streams, providing the proposal aims to minimise the level of disturbance. In particular, NSW DPI will support proposals that aim to remove willows or other exotic trees from the watercourse, and replace them with native vegetation, except in cases where stream stability is likely to be unduly compromised.

5) NSW DPI will adopt a conservative approach to snag management proposals in TYPE 1 habitat areas (i.e. habitats for threatened fish species, populations, or ecological communities) (see Table 1) and will evaluate the environmental benefits of the works versus the potential short-term negative impacts of the works on such habitat areas.

6) NSW DPI will support proposals for reintroduction of snags to waterways where:

   - it can be shown that snags have been removed in the past and are now depleted and it can be done without significant adverse impacts upon other waterway uses, users or waterway stability, or

- riparian vegetation has been cleared and no new source of large woody debris is readily available.

Guidelines for implementing the above policies include the following:

a) Proposals for snag management should:
   - clearly outline the objectives to be achieved,
   - document the action to be taken for each individual snag,
   - detail the methods and machinery to be used, and
   - specify the season or time period over which the works will be carried out.

b) As a general principle for timber snags, **lopping** should be considered as the first priority for the management of snags. Where lopping will not solve the immediate problem, **re-alignment** should be considered as the next possibility, followed by **relocation. Removal** of a snag is the least desirable option and should only be adopted as a last resort. Proposals for snag removal should be accompanied by a 7 part test and/or Species Impact Statement where proposed in areas that are TYPE 1 aquatic habitats (see Table 1 and section 2.6.9).

c) In general, snags that extend for a distance of less than 25% of the total stream width from the bank towards the stream centre should **not** be interfered with. Exceptions may be made for those snags which are causing deflection of water onto the riverbank and causing accelerated erosion. In these cases the snag should be realigned or relocated in preference to being removed.

d) Where snag management is part of a wider stream restoration project, snag removal should be kept to a minimum and if possible re-snagging should be undertaken to enhance the in-stream habitat.

e) Where snags are pointing upstream or at right angles to the bank and are deflecting water towards the bank, they should be realigned to point downstream so that water is deflected towards the centre of the stream. The base (or root wad) of the snag should be placed closely against the bank. However, in areas that are known habitat for Trout Cod, research has found that this species has a demonstrated preference for snags pointing upstream and therefore this guideline does not apply in these areas.

3.3 General requirements for developments

3.3.1 Information requirements

For NSW DPI to assess whether a proposal will have an impact on the environment, proponents must provide adequate and relevant environmental assessment information. In addition to information on the development activity, proponents will be required to provide detailed information in regard to the fish habitats and fish species present.

A. General information required:

- site address and contact details,
- property description (e.g. Lot and DP numbers)
- a clear description of the proposal including details of construction methods and materials,
- **map(s)** of the development area and adjacent areas - this should include nearby waterways, adjacent infrastructure (such as jetties) and land use,
- clear **photographs** of the site (at low and high tide in estuaries), including photographs of any riparian and aquatic vegetation present (including pest species such as *Caulerpa taxifolia*),
- location of any oyster leases or other aquaculture facilities and recreational and commercial fishing areas within the subject waterway (talk to your local NSW DPI Fisheries office for assistance or refer to the Oyster Industry Sustainable Aquaculture Strategy (OISAS) on the NSW DPI website at www.dpi.nsw.gov.au),
- a description of the potential direct and indirect impacts on aquaculture, commercial and recreational fishing from the development,
- a clear description of the physical and hydrological features of the development area (which may extend upstream and downstream of the development site in the case of flowing rivers or tidal waterways),
- approximate depth contours within 20 metres of the proposal,
- a clear description of aquatic environments including:
  - fish in the locality, including threatened and protected species, populations, ecological communities, pest species or presence of 'critical habitat' under the FM Act and EPBC Act,
  - an aquatic and riparian vegetation survey map of the area which shows the location and/or coverage of saltmarsh, mangrove, seagrass, macroaglae, macrophytes, riparian vegetation and snags,
  - description of aquatic habitat **TYPE** on site (see Table 1),
  - description of waterway **CLASS** (see Table 2).
- details of the nature, timing, magnitude and duration of the proposed disturbance to the aquatic environment,

- assessments of predicted impacts upon any threatened species (fish and marine vegetation) (i.e. completion of a 7 part test and/or Species Impact Statement(s) – see section 2.6.9) and other aquatic flora and fauna,
- details of any mitigation measures to limit environmental impacts (see sections 3.3.2 - 3.3.5),
- details of the general regional context, any protected areas, other developments in the area, and/or cumulative impacts,
- a copy of the land owner's consent (e.g. from NSW Roads and Maritime Services (RMS) or NSW DPI's Crown Land Division where on Crown land) where relevant
- notification of any other matters relevant to the particular proposal and of interest to NSW DPI.

The above information would normally be provided in the form of a Review of Environmental Factors (REF), Statement of Environmental Effects (SEE) or an Environmental Impact Statement (EIS). The Department of Planning and Infrastructure has developed a document entitled *Aquatic Ecology in Environmental Impact Assessment* (Lincoln-Smith 2003) which should be referred to by any planners or consultants in assessing aquatic flora and fauna impacts during the preparation of a REF, SEE or EIS (see www.planning.nsw.gov.au/rdaguidelines/documents/NSW%20Aquatic%20Ecology%20in%20EIA%20Guide.pdf).

B. Aquatic habitat assessment

The aim of the aquatic assessment should be to define the presence of 'key fish habitat' within the study site, adjacent areas (upstream and downstream), and the broader regional area (see sections 3.1 and 3.2). There may be a range of potential fish habitats that could be impacted by a particular activity. Some points to consider include:

- geomorphic characteristics of the waterway (i.e. what characteristics of a CLASS 1-4 waterway does it have (see Table 2)? Is it a gully, intermittent stream or major river? Does is it have deep pools or in-stream gravel beds? Is it a wetland? Does the watercourse connect with other watercourses upstream or downstream? What is the slope/gradient?),
- is it mapped as key fish habitat? (see www.dpi.nsw.gov.au/fisheries/habitat/protecting-habitats#KFH for maps of key fish habitat per Local Government Area)
- flow regime of the watercourse (e.g. is it an intermittent or permanently flowing stream? What is the range of water velocity of the flow? What are the maximum and minimum or percentile flows (in megalitres/day) for the watercourse?),
- description of local wave and current regimes (in tidal areas),
- description of the water quality (e.g. discolouration, sedimentation, turbidity, pH, dissolved oxygen, nutrients),
- types of surrounding land use (e.g. agricultural, urban, aquaculture),
- condition of riparian vegetation (i.e. present or absent. Are the species native or exotic? Is the density of vegetation thick or sparse?),
- condition of freshwater aquatic vegetation (i.e. present or absent. Are the species native or exotic? Is the density thick or sparse? Is it continuous or sparse in coverage? What is the aerial extent of major vegetation types? Is the vegetation healthy or degraded?),
- condition of marine vegetation (i.e. information on type, species, shoot density and/or percentage cover, Is the vegetation continuous or sparse in coverage? What is the aerial extent? Is the vegetation healthy or degraded? Is wrack (dead seagrass or macroalgae) present?),
- presence of wetlands nearby (including freshwater wetlands and saltmarsh) (i.e. are the wetlands protected under any legislation (e.g. SEPP 14 coastal wetlands, Ramsar wetlands)?, Are the wetlands in a healthy or degraded condition?)
- substrate type (e.g. rock, sand, gravel, silt, coral reef),
- presence of refuge areas (e.g. adjacent wetlands, upstream pools),
- presence of spawning areas (e.g. gravel beds, snags, reed beds, saltmarshes),
- presence of natural or artificial barriers to fish passage upstream and downstream (e.g. waterfalls, cascades, weirs, dams, floodgates, road crossings),
- types of migratory fish or other aquatic species likely to inhabit the areas (based on known distribution range within the scientific literature),
- timing of construction in relation to any fish migration seasons,
- timing of construction in relation to flow conditions relative to expected wet seasons,
- presence of any listed threatened or protected aquatic species or 'critical habitat' under the FM Act and EPBC Act.

C. Aquatic fauna assessment

For aquatic fauna studies, sites where fish and/or other aquatic fauna are well documented, and no threatened species are recorded, a site inspection and desktop review of the study site and regional area may be the required level of assessment.

The **Atlas of NSW Wildlife (the Atlas)** is the NSW Government's database of flora and fauna records. The Atlas contains records of plants, mammals, birds, reptiles, amphibians, some fungi, some invertebrates (such as insects and snails) and fish. The Atlas also contains known and predicted distributions of vegetation communities, and of endangered populations and key threatening processes listed under the *Threatened Species Conservation Act 1995* and the FM Act.

The flora and fauna records in the Atlas come from various sources including:

- survey data held in the Atlas's in-built systematic survey modules (fauna survey and VIS Flora survey)
- OEH, including data from the Royal Botanic Gardens herbarium database, and from National Parks and Wildlife staff
- data submitted by ecological consultants, research scientists, and others (as part of the scientific licence procedure)
- data provided by other agencies, such as Fisheries NSW, Forests NSW, the Australian Museum and the Australian Bird and Bat Banding Scheme
- historical reports
- the general public.

The Atlas can be accessed at www.environment.nsw.gov.au/wildlifeatlas/about.htm

During the completion of the planning phase for a new project, it may be determined that a **detailed aquatic survey** is required. Detailed surveys are to be undertaken only after direct consultation with NSW DPI as permits are required for sampling aquatic fauna under the FM Act. The Department of Planning and Infrastructure has developed a document entitled *Aquatic Ecology in Environmental Impact Assessment* (Lincoln-Smith 2003) which may also assist in survey design (see www.planning.nsw.gov.au/rdaguidelines/documents/NSW%20Aquatic%20Ecology%20in%20EIA%20Guide.pdf).

Note that a detailed survey may be required:

a) where the project is on a CLASS 1 or 2 watercourse (see Table 2) or where it has been identified that there may be a significant impact on a threatened aquatic species (see section 2.6.9); and/or

b) where the project crosses through, over or within a 'critical habitat' and a Species Impact Statement is required (see section 2.6.9).

3.3.2 Standard precautions and mitigation measures

NSW DPI may require that precautions are taken before, during and after the completion of works to mitigate possible environmental impacts. These precautions are generally placed on permits issued by NSW DPI and/or conditions of development consent issued by local council (see section 2.2) and may include:

- Deployment of environmental safeguards (silt curtains, booms, etc) before, during and as long as necessary after construction of works to ensure there is no escape of turbid water into the aquatic environment. NSW DPI strongly recommends the use of *The Blue Book – Managing Urban Stormwater: Soils and Construction* (Landcom 2004) (see www.landcom.nsw.gov.au/news/publications-and-programs/the-blue-book.aspx) when planning sediment and erosion controls in or adjacent to aquatic environments.
  - Programming of work to ensure that it takes place during low flow periods (freshwater habitats) or during the lower half of the tidal cycle (tidal waterways).
  - Directions on the use of sediment and erosion controls for in-stream works to avoid impacts on water quality and fish passage. For example, where it is not possible to work in the dry (out of the water), a sediment or silt screen may be required around the entire work area, but should not extend across the waterway (as it may obstruct fish passage). Silt screens should be placed to isolate the works area and be attached to the same bank upstream and downstream of the work site. Sediment or silt screens should be inspected daily and maintained to prevent the escape of suspended sediments. Sediment control devices should not be removed until the risk of sedimentation and erosion is negligible and the site has been stabilised or revegetated following construction. Screens or other guards should be carefully removed after the work is completed. Silt screens should generally only be used in still water conditions. When placed in higher flows, water either spills over the top or lifts the curtains.
  - Directions on the use of coffer dams or temporary access tracks to keep disturbance to the substrate and blockages to fish passage to a minimum. The use of temporary dam materials such as sheet piling will reduce impacts on the substrate. Coarse rock confined by gabion baskets or mattresses should be used in preference to sand or soil.
  - Provisions to protect fish during the dewatering process of any coffer dams or the clearing of screens. These should include:
    - discharging water into a bunded or screened site to allow fish to be rescued

  - any fish caught in the dewatering process must be immediately released upstream (fish will want to continue migrating upstream) of the site,
  - pumps and screens must be of a suitable capacity and size, and pump velocities slow enough, to allow fish to escape during the dewatering process.
- Ensuring that foreshore works in estuaries are restricted to calm weather conditions. This helps prevent the suspension of fine sediment particles into the water column and ensures the silt screen is not disturbed by wave action.
- Ensuring that river works in freshwater environments are restricted to periods of low flow.
- Providing direction on the stockpiling of fill or excavated materials on flood prone lands to avoid sedimentation. Particular care should be made in siting stockpiles and dumps. Preferred sites should be situated either above the highest astronomical tide, or be secure from a 1 in 10 year flood and have effective sediment control measures in place to contain any runoff.
- Ensuring that only natural material is used as fill during reclamation works. Contaminated material, tyres, building and demolition rubble or acid sulfate soils (ASS) should not be used as fill in any aquatic environment.
- Directions on the use and maintenance of buffer zones around the immediate area of the proposed works to ensure that sediment is controlled off site and impacts on the surrounding ecosystem are kept to a minimum.
- Ensuring that the area is rehabilitated after completion of works in accordance with a NSW DPI approved method or plan. This may involve establishment of native riparian vegetation.

3.3.3 Rehabilitation and compensation measures

There are two types of activity which can be used to mitigate damage to fish habitat: **habitat rehabilitation** involves repairing damage caused by past activities, and **environmental compensation**, which is the creation or enhancement of fish habitats or fisheries resources in order to compensate for anticipated adverse or actual environmental effects of proposed developments.

Habitat rehabilitation can be either passive or active. After the removal of the damaging or inhibiting factor or structure, some habitats can be left to passive natural processes to rehabilitate the area. The main advantage of passive rehabilitation is its low cost. However, the success is dependent upon the extent of the degradation of the area, the ability of the surrounding environment to supply propagative material, and the prevalence of suitable site conditions that are able to encourage and sustain vegetative growth. The main disadvantage of passive rehabilitation is the amount of time that is required to restore the habitat to its former value, which may be many decades, or never in some instances.

Active rehabilitation can use remedial engineering works (e.g. fishways, gross pollutant traps, removal of barriers), construction of artificial habitats (e.g. artificial reefs), habitat enhancement, restocking, resnagging, removal of exotic species, fencing of stock and revegetation.

Environmental compensation must consider the representativeness and value of different types of habitats. In most cases this will involve judgements based on increased productivity or biodiversity of fish and may involve proposed replacement of one habitat type with another (e.g. replacement of mangroves with saltmarsh). Environmental compensation may include: (i) structures which represent an integral part of the development (e.g. groynes, pylons, artificial waterways), (ii) works which are undertaken as compensation for disturbance of ecologically important habitats (e.g. transplanting vegetation, fishways, environmental flows, removal of barriers to fish passage, removal of polluted areas), or (iii) money to pay for the value of the habitat lost.

A key outcome sought with rehabilitation and compensation measures is to ensure their longevity and ongoing management post initial construction or implementation. NSW DPI may therefore require the negotiation of conservation agreements, rezoning of land or similar to ensure that such outcomes are achieved.

3.3.3.1 Legislation

Under the EP&A Act, the FM Act and the *Water Management Act 2000* (WM Act) there are provisions for the ordering of rehabilitation and compensation works. **Section 220** of the FM Act allows for conditions to be included in permits issued under the Act. The costs are considered to be part of the cost of the development and are to be met by the proponent.

The controlled activities and aquifer interference provisions under Division 6 of the WM Act have provisions for restoring or rehabilitating a water source or its dependent ecosystems.

3.3.3.2 Policy and guidelines for habitat rehabilitation and environmental compensation

In addition to the general policies stated in Chapter 3, the following **policies** apply to rehabilitation and compensation:

1) As noted in general policy 7 in section 3.1, NSW DPI enforces a ‘no net loss’ habitat policy as a permit condition or condition of consent. This may require proponents to conduct habitat rehabilitation and/or provide environmental compensation. A monetary bond or payment may be required to be lodged with NSW DPI to ensure the works are completed in accordance with the permit conditions (see section 3.3.4 below for further information on bonds).
2) NSW DPI calculates habitat compensation on a minimum 2:1 basis for all key fish habitat (TYPE 1-3 in Table 1) to help redress other indirect impacts of development. A greater compensation ratio may be considered if opportunities for compensation are not available in the vicinity of, or of the type of, habitat that has been lost. Please note that

compensation for disturbances to SEPP 14 coastal wetlands (which may include TYPE 1 and 2 habitats) requires approval from the Department of Planning and Infrastructure and a ratio of 10:1 generally applies. This is calculated at the rate of $51/m^2$[26] for marine and freshwater vegetation which equates to $102/m^2$ to meet the 2:1 habitat offset requirement.

3) NSW DPI does not support seagrass transplanting as an impact compensation measure as the viability of transplanting methods is yet to be scientifically proven for all species (see Ganassin and Gibbs 2008). Transplanting may be allowed in future for those species where viability is scientifically proven. In circumstances where seagrass is likely to be negatively impacted and cannot be avoided or mitigated, environmental compensation will be required and calculated in line with the rate outlined in point 2 above.

4) In the case of mangroves and saltmarsh, transplanting the vegetation from the impact site to the compensation site may be required.

5) NSW DPI requires a management plan be developed for any compensatory area of habitat that ensures:

- replanting, transplanting and monitoring methods are documented in accordance with the permit conditions;
- the site is suitable for habitat creation (e.g. is of suitable substrate and depth, not exposed to excessive pollution);
- in the case of revegetation, species used must be endemic to the area and suitable for the site;
- performance indicators are set to adequately measure success of the project over time and to identify where responses are not being achieved.

Guidelines for implementing the above policies include:

a) Opportunities to enhance and/or protect existing key fish habitat, and to avoid direct or indirect impacts on such habitats is preferred and should always be explored as a first option.

b) NSW DPI supports strategic resource investment such that rehabilitation efforts should primarily be invested in areas where there is likelihood of rehabilitation success (key fish habitats with high recovery potential).

c) Subject to point b above, habitat rehabilitation and compensation should take place as close as possible to the site of the impact to achieve 'no net loss' of habitat within the area affected and the catchment as a whole.

d) Pre-development habitat compensation (i.e. prior to disturbance) is recommended over post-development compensation (i.e. after the habitat is lost).

e) Repair of degraded habitat is recommended over habitat creation and should be conducted as close to the site of proposed 'habitat loss' as possible.

f) Transplanting of aquatic vegetation should only be undertaken if an appropriate donor site is available or where re-establishment is likely to be successful (e.g. plants with vegetative growth and fairly shallow roots – e.g. sedges and rushes). NSW DPI recommends that donor sites are selected in consultation with the local Aquatic Habitat Protection Unit staff (see Appendix 5 for contact details). Mangrove rehabilitation projects/activities should be undertaken in accordance with the NSW DPI "Mangroves" Primefact (Primefact No. 746) available on the NSW DPI website at www.dpi.nsw.gov.au.

g) Where affected habitat is less sensitive, secondary compensation may be more appropriate than implementing a 'like for like' habitat replacement policy. For example, in catchments and/or estuaries where the habitat being replaced is not sensitive or under threat, alternative environmental measures may achieve greater environmental gain (e.g. removal of 1 ha of river mangrove might require the transplanting of 2 ha of endangered saltmarsh).

h) Habitat rehabilitation efforts should be directed at achieving the maximum benefits for fish habitat and fisheries. Local councils, government departments, community groups or individuals who wish to rehabilitate degraded marine, estuarine or freshwater aquatic habitats should discuss their proposals with NSW DPI. This will ensure that efforts are directed at key fish habitat areas as a priority, methods used are appropriate and relevant approvals are obtained prior to the commencement of works.

3.3.4 Environmental bonds

The lodgement of an environmental bond may be a permit requirement for developments that i) present a risk of causing significant impact on key fish habitats or fisheries resources and/or ii) require substantial performance in terms of environmental protection/outcomes. The purpose of the bond is to ensure predicted outcomes/proposed mitigation measures are indeed implemented and achieved. Some examples of the types of activities that generally require an environmental bond include developments which may impact on protected areas, protected or threatened species and TYPE 1 and 2 key fish habitats (see Table 1).

[6] This rate is consistent with rates calculated by Costanza *et al* (1997), subject to annual inflation. This rate will continue to be subject to an annual increase in line with the Consumer Price Index per financial year.

On satisfactory completion of the works in accordance with all of the permit conditions and where predicted outcomes/mitigation measures are achieved, the bond or bank guarantee will be returned to the applicant. Failure to comply with permit conditions or to meet performance targets may result in forfeiture of all or part of the bond.

The bond can be in the form of a bank guarantee, bank or personal cheque made payable to NSW DPI. The funds are deposited into the NSW DPI Fish Conservation Trust Fund, established under the FM Act. Cash or cash cheques will not be accepted. NSW DPI will calculate the value of the bond on the basis of the total cost of compensation or rehabilitation of the habitat taking into account the department's "no net loss" and habitat compensation requirements as outlined in section 3.3.3. The department will also factor in any potential contingency costs and inflation rates over the life of the compensation plan.

A monitoring program may also be required as a condition of consent to measure the success of any compensation or rehabilitation requirements (see section 3.3.5). The bond may only be redeemable on the completion of the monitoring program and providing the rehabilitation or compensation measures were successful based on specified performance criteria.

3.3.4.1 Legislation

Section 220 of the FM Act allows for conditions to be included in permits including conditions requiring the permit holder to enter into a bond or guarantee or other financial arrangement for the due performance of the holder's obligations under the FM Act. The Fish Conservation Trust Fund, established under the FM Act, is used for the receipt and refund of environmental bonds.

3.3.4.2 Policy and guidelines for environmental bonds

1) NSW DPI will use the following three general categories to estimate the value of the environmental bonds required:
   - Small-scale development or minor environmental impact - $100's - $10,000's. Examples include construction of jetties, stormwater drains, the removal of less than two square metres of seagrass or 10 mangroves, or the development is within a degraded key fish habitat.
   - Medium-scale development or moderate to major environmental impact - $100,000's. Examples include marinas, sewage outfalls, weirs across a waterway, dredging, construction of a groyne, destruction of TYPE 1 or 2 key fish habitats (see Table 1) including those greater in area or size than outlined above.
   - Large-scale development or significant environmental impact - $1,000,000's or more. Examples include reclamation of water land for commercial gain (e.g. tourist facility, port or airport facility, residential subdivision), disturbance of contaminated material, dam across a waterway, major water diversion.
2) The requirement or category of an environmental bond and the magnitude of the bond will be at the discretion of the Minister for Primary Industries (or delegate). In special circumstances the monetary value of the environmental bond may be negotiated between NSW DPI and the proponent using the above policy as a guide.
3) NSW DPI will refund the environmental bond to the proponent when it has been demonstrated that the conditions of the permit or approval have been satisfied. This will generally require the submission of an environmental monitoring program report by an independent consultant and/or site inspection(s) by staff of NSW DPI. A review will generally occur on an annual basis and the refund will occur after completion of the project and submission of the final monitoring report.
4) If the conditions of a permit or approval are not satisfactorily met, NSW DPI may retain all or part of the environmental bond. If all or part of the bond is retained the proponent may choose to appeal the decision by writing to the Executive Director, Fisheries NSW of NSW DPI. A dispute resolution committee may evaluate the appeal and make recommendations concerning the confiscated bond to the Executive Director, Fisheries NSW to assist with the assessment of the merits of the appeal.
5) NSW DPI may use any retained bond to rehabilitate or enhance key fish habitats (see Table 1), carry out research, or contribute to management or compliance activities that are undertaken by the department, other organisations or individuals. NSW DPI will aim to use any confiscated bond in the water catchment where the damage of fish habitat occurred or fish species were affected, but this may not always be possible.

3.3.5 Monitoring requirements

Monitoring of fish and fish habitats may be required by NSW DPI for several reasons including:

- Assessment of the condition and viability of the fish habitat before approval to conduct works can be given (e.g. in the case of assessing fish abundance and diversity in a given locality);
- To assess the impact on a given fish habitat both ***before*** and ***after*** completion of works (e.g. monitoring growth of seagrass under a jetty);
- To assess the success of rehabilitation or habitat compensation works (see section 3.3.3).
- To assess the accuracy of predictions made about impacts upon fish and their habitats.

Where NSW DPI is concerned that a proposal may damage key fish habitat, scientific monitoring may be required to help determine the extent of any damage and/or the success of any mitigation measures.

Where monitoring is required, protocols must be approved by NSW DPI and must include rigorous experimental designs to allow for thorough statistical analysis, including adequate numbers of control sites, replication and consideration of temporal changes where relevant. Performance indicators or predictions of impacts will also need to be incorporated to determine whether an impact has occurred and to test the significance of the impact and/or to measure the success of habitat rehabilitation or compensation works. The indicators or hypotheses should be quantitative and include predictions of expected change (e.g. 20% loss of seagrass area over a two year period, 3 ha increase in mangrove area in three years following transplanting and seeding program). The program should also outline what remedial actions will be taken if predicted adverse impacts are exceeded.

4. In-stream structures and barriers to fish passage

This chapter consists of eight sections that address NSW DPI's requirements for maintaining fish passage via the design and construction of in-stream structures and the rehabilitation of barriers to fish passage. Section 4.1 outlines the legislation and general policy and guidelines for maintaining and enhancing the free passage of fish in NSW waters. Sections 4.2 – 4.5 outline specific policy and guidelines for the design and construction of waterway crossings, dams, weirs, regulators, floodgates and temporary in-stream works (e.g. coffer damming). Finally, section 4.6 - 4.8 outline policy and guidelines to consider when undertaking in-stream rehabilitation works to ensure that fish passage is maintained or improved.

4.1 Obstructions to fish passage

The free passage of fish within rivers and streams and between estuarine and freshwater environments is a critical aspect of aquatic ecology. Obstructions to fish passage through the construction of dams, weirs, floodgates and waterway crossings can negatively impact on native fish by:

- restricting the migration of spawning fish,
- reducing the dispersal of juvenile fish to new habitat areas,
- limiting the passage of fish between feeding grounds,
- increasing the susceptibility of fish accumulating below barriers to predation and disease,
- fragmenting fish communities and reducing gene flow within fish populations,
- creating unsuitable living or breeding conditions,
- altering the hydrology and water quality of waterways both upstream and downstream of in-stream structures,
- changing species diversity due to local extinctions of some species and altering the abundance of remaining populations.

Maintenance of connectivity between upstream and downstream habitats (longitudinal connectivity) and adjacent riparian and floodplain habitats (lateral connectivity) is an essential part of fish habitat management. Structural barriers, including dams, weirs and road crossings act to impede natural flows and create physical and hydrological barriers to fish movement. In this sense, in-stream structures inhibit *longitudinal connectivity* by isolating upstream and downstream habitats. Levees, floodgates and other off-stream structures (sediment basins, gross pollutant traps and other water treatment devices) that isolate seasonal or ephemeral habitat act to disrupt *lateral connectivity*.

The restoration of fish passage throughout NSW waters is a key aspect of NSW DPI's commitment to improving aquatic ecology and biodiversity and contributes to the delivery of several of the natural resource management targets in the NSW State Plan (see section 1.1). See www.dpi.nsw.gov.au for further information on fish passage restoration work underway in NSW.

4.1.1 Legislation

The FM Act includes provisions to ensure the maintenance and restoration of fish passage as part of the construction of new, or the modification of existing, in-stream structures (**ss218 and 219**). Under **s218** a person (other than a public authority) must give the Minister notice in writing at least 28 days before constructing, altering or modifying any dam, weir, floodgate or similar structure. The maximum penalty for failing to give notice is $22,000 for a corporation and $11,000 for an individual. Under **s218** the Minister for Primary Industries may require a person, private organisation or public authority to provide fish passage where any dam, weir, floodgate or similar structure is constructed, altered or modified. The Minister also has the power to order that fish passages, such as a fishway, be repaired if they are not adequately allowing fish movement in accordance with the original design criteria. The maximum penalty for non-compliance with an order by a person is $220,000 for a corporation and $110,000 for an individual.

The Minister's functions in **s218** of the FM Act have been delegated to various senior positions within NSW DPI. For example the notification requirements in **s218** can be satisfied by notifying NSW DPI. This policy is written on the basis that NSW DPI will receive notifications as required by **s218** of the FM Act.

Under **s219** works within a waterway that may result in the temporary or permanent blockage of fish passage will require a permit from NSW DPI. Blockages to fish passage may include the construction of physical barriers (e.g. dams, weirs, regulators, road crossings, floodgates, coffer dams, silt curtains or nets), the presence of hydrological barriers (e.g. alteration of the gradient of the stream bed or increases in water velocities), or the creation of behavioural barriers (e.g. where water quality or temperature is altered deterring fish passage for some or all native fish species). The maximum penalty for unauthorised blockage of fish passage is $220,000 for a corporation and $110,000 for an individual.

In-stream works that involve dredging or reclamation to remove, decommission or repair an existing structure may require a permit or consultation with the Minister under **ss199-201** of the FM Act. Under **s199** of the FM Act, the Minister

for Primary Industries is required to be consulted over any dredging or reclamation works carried out, or proposed to be authorised, by a public authority (other than a local government authority).

Under **ss200** and **201** a permit is required for dredging or reclamation work carried out by a local government authority or person respectively, unless these works are authorised by a relevant public authority (other than a local government authority) or under the *Crown Lands Act 1989*. The maximum penalty for unauthorised dredging and reclamation is $220,000 for local government authorities or corporations and $110,000 for individuals. If works are carried out in contravention of these sections, the Minister for Primary Industries may, under **s203**, order remedial works to be carried out to rectify any damage caused to fisheries or fish habitat. Permits and approvals may also be necessary from other public authorities (e.g. NSW Office of Water, the regional Catchment Management Authority) and advice should be sought.

The construction of works (including dams, weirs, waterway crossings, floodgates, levees and drains) which impact on flows within waterways may also be "controlled activities" for the purposes of the *Water Management Act 2000*, administered by NSW Office of Water. Planning provisions may also apply in certain circumstances (i.e. Parts 4 or 5 of the EP&A Act). Advice should be sought from NSW Office of Water and relevant local council(s) in this regard.

The Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) establishes a system of environmental assessment and approval by the Australian Government for actions that significantly affect matters of national environmental significance. Further information on the **EPBC Act** [7] is available from the Australian Government's website.

In January 2007, the Australian and NSW Governments signed a Bilateral Agreement which allows the assessment regimes under the EP&A Act (Parts 4 and 5 of the EP&A Act) to be automatically accredited under the EPBC Act. This means that separate assessment processes are not required. The **Bilateral Agreement** [8] only covers matters that are determined to be 'controlled actions' by the Australian Government.

If a proposal is likely to have an impact upon any 'Matter of National Environmental Significance' under the EPBC Act, such as:

- heritage values of World Heritage properties
- listed National Heritage places
- wetlands of international importance (Ramsar wetlands)
- Commonwealth-listed threatened species and ecological communities
- listed migratory species

then the proponent has an obligation under the EPBC Act to refer the proposal to the Commonwealth Environment Minister for a decision as to whether the action is a 'controlled action' and therefore requires assessment and approval via the Bilateral Agreement.

Other Commonwealth and State agencies may also need to be consulted and the applicant is responsible for ensuring that this is undertaken.

4.1.2 Policy and guidelines for fish passage

To mitigate the impacts of obstructing fish passage the following general **policies** apply:

1) NSW DPI will consider habitat TYPE (sensitivity) and waterway CLASS when assessing development proposals that may create barriers to fish passage (see Tables 1 and 2). Permanent or temporary barriers on CLASS 1 or 2 waterways will not be approved unless adequate fish passage is provided. Please note that a temporary barrier to fish passage (including a temporary waterway crossing), is considered to be one that is used for a short time only (generally less than 6-12 months) while the construction of a permanent barrier or waterway crossing is constructed. Once the permanent barrier or crossing is completed, the temporary barrier is then removed.

2) A permit is required for all works that may obstruct the free passage of fish whether permanently or temporarily in TYPE 1-3 habitats (see Table 1).

3) Developments that include one or more of the following aspects will require assessment by NSW DPI to ascertain whether they may create an obstruction to fish passage:

   - any development across the full width of a waterway that creates discontinuity in the flow including dams, weirs, regulators, waterway crossings, pipeline crossings and in-stream rehabilitation measures.
   - any development which increases the mean stream velocity for a given cross-section through the constriction of flow (through pipes, culverts or channelised waterways) or leads to significant reductions in water depth (at wet crossings and causeways) (refer to section 4.2).

[7] www.environment.gov.au/epbc/index.html
[8] www.planning.nsw.gov.au/SettingtheDirection/GovernmentAgreementsandForums/BilateralAgreementwiththeCommonwealth/tabid/283/Default.aspx

- any development which prevents or impedes tidal inundation of a given area (e.g. through the installation or modification of a floodgate or similar structure) (refer to section 4.4).
- any development which will result in the release of water into a waterway at a temperature that differs more than two degrees Celsius from receiving waters.

4) NSW DPI requires that the environmental assessment for all in-stream works address potential impacts on lateral and longitudinal fish habitat connectivity and consideration must be given to potential impacts of barriers (including the construction phase) on threatened species, populations, ecological communities or their habitat (including 'critical habitat') listed under Part 7A of the FM Act.

Guidelines for implementing the above policies include:

a) The timing of any works should be planned so as not to interfere with the possible migration of fish within the waterway. Temporary blockages should not be placed within a waterway during the months of September to March, which are the key months when the majority of native fish are moving to spawn or recruit within NSW waters.

b) The timing of works should coincide with low flow periods within the respective catchment.

c) In-stream works (e.g. pads, coffer dams, sediment controls) should be designed and staged to avoid blocking the entire waterway. If the entire waterway is to be blocked, measures need to be implemented to maintain historic base flow conditions within the waterway (e.g. diversion channel) for the duration of the proposed works.

4.1.3 Information required for assessment

For NSW DPI staff to adequately assess potential impacts of a temporary or permanent barrier to fish passage, the following information should be provided by the proponent in addition to that outlined in section 3.3:

- a clear **map** of the area (minimum 100 m up- and downstream) showing where proposed works will be located, including details of the waterway in relation to the surrounding catchment.
- details on waterway CLASS (see Table 2) and habitat TYPE (see Table 1) in the vicinity of the proposed works.
- information on the flow characteristics of the waterway (e.g. hydrograph of the waterway from nearby stream gauging stations), where available
- the location of **existing** adjacent weirs, dams and other in-stream structures upstream and downstream.
- **design drawings** of the proposed structure showing details of how fish passage will be achieved at the site (e.g. fishway designs).
- for permanent in-stream works, bed level surveys should be provided for the purpose of assessing channel geomorphology and the proponent should use the survey results to predict the impact of the proposed works on channel stability / geomorphology. Bed level surveys should meet the following basic requirements:
  - they should be conducted between the next upstream and downstream riffle zone relative to the proposed in-stream structure, or over a minimum of 100 m either side of the structure. Cross-sections should be spaced at 5m chainage intervals within 20 m either side of the proposed structure and every 10 m thereafter. Additionally, a minimum of five bed levels should be acquired in-stream per cross-section, with levels proceeding to the top of adjacent banks.
  - water height levels must be provided throughout the survey, along with detailed levels of in-stream man-made structures (e.g. invert height of the deck and the base of any culvert cells of waterway crossings, invert height of dam or weir crest).
  - data should be provided in plain form view, as well as in latitudinal and longitudinal cross-sectional views for assessment.
- information on species of fish and other aquatic fauna that occur at the site (see section 3.3.1C).
- specific consideration for any **aquatic threatened species, populations and ecological communities and key threatening processes** that may be affected or exacerbated by this proposal (i.e. 7 part test (see section 2.6.9)).
- clear **photographs** of the site detailing upstream and downstream riparian and in-stream habitat.
- information on hydraulics (e.g. head loss and velocity change) at various flow rates.
- management plan for the operation of the barrier

4.2 Waterway crossings

Waterway crossings (e.g. bridges, causeways, and culverts) can act as barriers to fish passage by creating a physical blockage, a hydrological barrier, or by forming artificial conditions that act as behavioural barriers to fish. The impact of waterway crossings on fish passage will vary depending on a) the design of the structure; b) the nature of flow, debris, and sediment movement in the system; and c) the swimming capabilities of resident fish. In addition to fish passage, the design of a waterway crossing can also impact upon the health of riparian and aquatic vegetation and bed and bank stability.

Fairfull and Witheridge (2003) produced national guidelines that provide a comprehensive overview of the appropriate measures required to plan, design and construct waterway crossings to minimise impacts on fish passage and aquatic habitats. NSW DPI requires that these guidelines be followed by anyone intending to design and construct a waterway crossing in NSW. For engineers, Witheridge (2002) also provides a comprehensive engineering guide to the design and construction of 'fish and fauna friendly' waterway crossings. Both documents were developed with the input of a national steering committee of experts in the field of road design, construction and fish passage.

Table 3 is adapted from Fairfull and Witheridge (2003) and is referenced in the policy statements below. The table summarises the preferred waterway crossing depending on the waterway CLASS. For details on the characteristics of different waterway classes refer to Table 2 in section 3.2.2.

Table 3 - Preferred waterway crossing type in relation to waterway class

Waterway Classification	Minimum Recommended Crossing Type	Additional Design Information
CLASS 1 Major key fish habitat	Bridge, arch structure or tunnel	Bridges are preferred to arch structures.
CLASS 2 Moderate key fish habitat	Bridge, arch structure, culvert[1] or ford	Bridges are preferred to arch structures, box culverts and fords (in that order).
CLASS 3 Minimal key fish habitat	Culvert [2] or ford	Box culverts are preferred to fords and pipe culverts (in that order).
CLASS 4 Unlikely key fish habitat	Culvert [3], causeway or ford	Culverts and fords are preferred to causeways (in that order).

[1] High priority given to the 'High Flow Design' procedures presented for the design of these culverts—refer to the "Design Considerations" section of Fairfull and Witheridge (2003).

[2] Minimum culvert design using the 'Low Flow Design' procedures; however, 'High Flow Design' and 'Medium Flow Design' should be given priority where affordable—refer to the "Design Considerations" section of Fairfull and Witheridge (2003).

[3] Fish friendly waterway crossing designs possibly unwarranted. Fish passage requirements should be confirmed with NSW DPI.

As noted in Fairfull and Witheridge (2003), there are additional factors that must be taken into consideration by those involved in waterway crossing design and construction, including public safety, social and budgetary constraints. Each crossing is therefore assessed by NSW DPI on a case-by-case basis.

4.2.1 Legislation

As outlined in section 4.1.1, waterway crossings will generally require approval or consultation to dredge and/or reclaim under Part 7 of the FM Act. Dredging works may be required to construct the footings or foundations for the crossing. Reclamation works could include the construction and replacement of pylons and abutments for bridges, creation of in-stream construction pads or coffer dams to access the works, or the placement of material in a waterway to construct temporary or permanent waterway crossings. Environmental assessment requirements for such works are summarised in sections 3.3 and 4.1.3.

A permit will also generally be required under **s219** of the FM Act for any works that may result in the temporary or permanent obstruction of fish passage within a waterway. Such obstructions can include silt fencing across waterways for sediment and erosion control and bunding and dewatering works during the construction and maintenance of crossings.

4.2.2 Policy and guidelines for waterway crossings

In addition to the general policies stated in Chapter 3 and section 4.1.2, the following **policies** apply to waterway crossings:

1) Waterway crossings should be designed and constructed in accordance with the national guidelines entitled '*Why do Fish Need to Cross the Road? Fish Passage Requirements for Waterway Crossings*' (Fairfull and Witheridge 2003). This document can be obtained from NSW DPI offices or from the website at www.dpi.nsw.gov.au.

2) Waterway crossing proposals should be consistent with the policy and guidelines for marine vegetation, riparian and aquatic vegetation, snag management, general environmental assessment requirements for developments, fish passage, reclamation of foreshores, sediment extraction and use of explosives, electrical devices and other dangerous substances in waterways outlined in sections 3.2.3 – 3.2.5, 3.3, 4.1, 5.2, 6.3 and 6.7 of this document.

3) Where aquatic habitats are designated 'critical habitat' under Part 7A of the FM Act, then the waters of that habitat will automatically be designated CLASS 1 (see Table 2), and will be subject to the preferred engineering solutions outlined in Table 3 above. A Species Impact Statement (SIS) must also be prepared for the works.

4) Where a waterway crossing development is identified as being in the potential range of a listed threatened species, population or ecological community under the FM Act, and the area has not been declared a 'critical habitat', the development will be subject to a '7 part test' as outlined in section 2.6.9. If the determining/consent authority determines that the project will have a significant impact via the '7 part test', then the proposed project should be modified where possible (e.g. culvert changed to a bridge crossing, or new site selected) and the '7 part test' reapplied. If the modified project still results in a significant impact, then the waterway shall be classified as a CLASS 1 waterway and the preferred engineering solutions outlined in Table 3 will apply. A SIS must also be prepared for the project.

Guidelines for implementing the above policies include:

a) When proactively rehabilitating existing waterway crossings to improve fish passage, efforts should focus on those barriers located at the lowest end of the catchment where the numbers and diversity of fish species is generally greatest. Where feasible, efforts should also focus on TYPE 1 habitats where threatened fish species are known to occur.

b) For waterway crossings incorporating culverts (including low flow culvert cell(s)), a minimum of 300 mm of water should pool through the structure, with a centrally placed low-flow cell being preferable.

c) Waterway crossings should be constructed perpendicular to the flow of the water and should be positioned away from channel bends.

d) The effective flow area under the waterway crossing should be at least equal to the natural or existing flow area of the channel below the deck/crest level of the crossing ("High Flow Design") – See Figure 1 below. Where this is not feasible, the second priority would be to design the culvert such that the effective flow area is at least equal to the natural or existing channel flow area below the roof of the culvert ("Medium Flow Design"). A Medium Flow Design also requires the depth of the deck slab to be minimised. In all cases, the culvert should be designed to maximise the geometric similarities of the natural channel profile from the bed of the culvert up to a flow depth of 0.5 metres ("Low Flow Design").

e) Undertaking construction work from a barge is preferable to construction of an in-stream pad during waterway crossing construction.

f) In the case of the need for emergency waterway crossing repair works, NSW DPI should be notified of the proposed emergency repair works prior to their commencement. Basic information such as the location of the proposed works, waterway CLASS, the need for the works and the construction method should be faxed or emailed to the nearest NSW DPI office (see contact details in Appendix 5). NSW DPI will generally be able to issue a dredging and reclamation permit within 3 days of notification via facsimile. The permit will be issued subject to the receipt of full documentation as outlined in sections 3.3 and 4.1 and the relevant permit fee(s) as soon as the works are completed. As most emergency works are of a temporary nature, the full documentation should address how the crossing will be permanently repaired (where relevant).

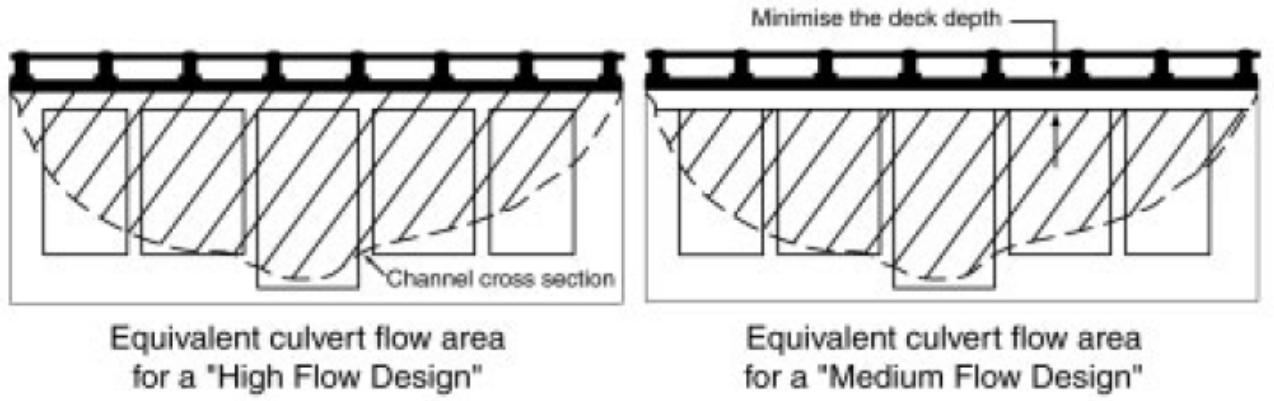


Figure 10 – Culvert flow area required for a high and medium flow culvert design.

4.3 Dams, weirs and regulators

The proliferation of dams, weirs and regulators throughout NSW has had a significant effect on the abundance and diversity of native fish populations (Mallen-Cooper 1996; Thorncraft and Harris 2000; Baumgartner and Lay 2001). Such barriers to fish passage have led to significant declines in, and in some instances localised extinction of, native fish populations (Gehrke *et al.* 2001). As a result, the restoration of fish passage at dams and weirs throughout NSW waters is a key aspect of NSW DPI's commitment to improving aquatic ecology and biodiversity. See www.dpi.nsw.gov.au for further information on restoration work underway in NSW.

4.3.1 Policy and principles for managing dams and weirs

NSW DPI supports the goal of the NSW Weirs Policy (1997) (see www.water.nsw.gov.au/Water-management/Law-and-policy/Key-policies/Key-policies/default.aspx), which is to "halt and where possible reduce and remediate the environmental impact of weirs". This includes the adoption of the following management principles:

- the construction of new weirs, or enlargement of existing weirs, shall be discouraged,
- weirs that are no longer providing significant benefits to the owner or user shall be removed, taking into consideration the environmental impact of removal,
- where retained, owners shall be encouraged to undertake structural changes to reduce the impact of weirs on the environment,
- where retained, owners of weirs with regulatory works shall prepare and adhere to operational plans to reduce the environmental impact of weirs,
- where retained, gates, off-take structures and fishways (see section 4.3.2) on all weirs shall be maintained in good working order,
- wetlands and riparian vegetation adjacent to weirs should be protected from permanent inundation,
- areas of environmental degradation caused by the impacts of weirs upstream and downstream of the weir pools should, where possible, be rehabilitated.

In addition to the general policies stated in Chapter 3 and section 4.1.2, the following **policies** apply to managing dams, weirs, regulators and similar structures:

1) Proposals for new in-stream dams or weirs (e.g. for secure town water supply) will generally not be supported in line with the NSW Weirs Policy. Alternative off-stream storage proposals may be considered on a case-by-case basis, and only in areas where they can be constructed above the 1 in 100 year flood level.
2) NSW DPI requires that all proposals for the construction of, or modification to, dams, weirs, or similar structures be referred to NSW DPI for assessment, except for:
    - minor repairs to existing authorised levee banks protecting urban dwellings,
    - construction of farm dams on first and second order streams (in line with the NSW Farm Dams Policy - see www.water.nsw.gov.au/Water-management/Law-and-policy/Key-policies/Key-policies/default.aspx) or in TYPE 3 or CLASS 4 fish habitats (see Tables 1 and 2), and,
    - construction of off-stream storages (i.e. farm dams) above the 1 in 100 year flood level.
3) The first option considered in all fish passage management issues should be for no in-stream structures. Where an in-stream barrier already exists, NSW DPI recommends the complete removal of the barrier.
4) For the construction or the major modification or alteration of dams, weirs and regulators the construction of a fishway will generally be required (see section 4.3.2).

5) All fishway proposals require the approval of NSW DPI. The appropriateness of a particular fishway and its design specifications will be dealt with on a 'case-by-case' basis.

6) All fishway proposals need to be accompanied by documentation detailing ownership of the structure and demonstrating a commitment to ongoing maintenance.

7) Fishway proposals should incorporate a monitoring program to ensure the design passes the intended range of fish species and sizes. Experimental fishway designs require a more substantial monitoring program to determine their long-term efficacy.

Guidelines for implementing the above policies include:

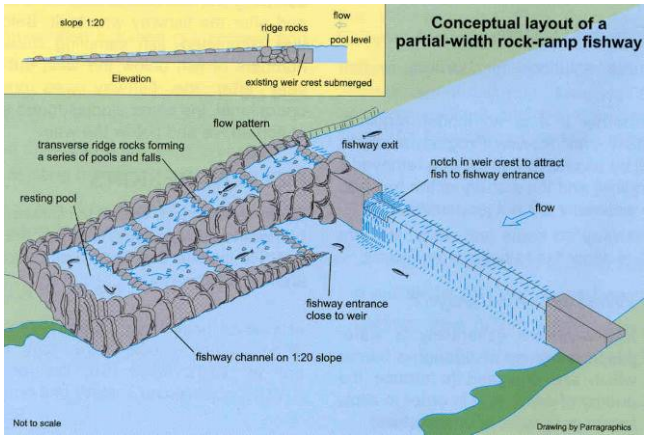
a) Where removal or structural modification, such as a fishway, is not possible or warranted (e.g. CLASS 3 and 4 waterways – see Table 2), operators should aim to maximise the environmental benefit of operations. This may include:

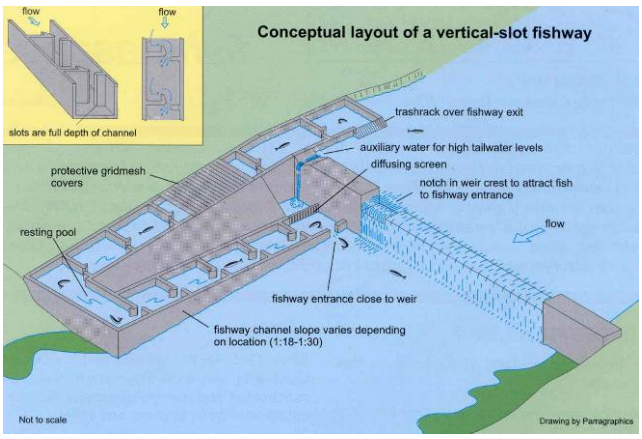
- for regulating structures, maximising the amount of time gates are clear of the water when no pool is required,
- reducing crest levels of structures to minimum acceptable levels to increase drown-out frequency,
- manipulating downstream flows to coincide with known breeding seasons of fish or to gain maximum ecological benefit,
- negotiating an environmental offset within the catchment to address other impacts on fish passage or the protection and rehabilitation of other key fish habitat (see sections 3.3.3 and 4.7).

4.3.2 Guidelines for fishways

Fish can't swim over the artificial drop that weirs and dams create in waterways. One way to get around this is to install ladders, otherwise known as fishways, so that fish can swim up and over the barriers. Fishways are structures that offer an alternative route up a stream for fish normally stranded at the base of a weir or dam. These structures are often made of rock, steel or concrete, and sometimes mimic the shape of a natural channel. The most common fishway designs in NSW are the fish lift (used on high dams), vertical slot and denil (used on weirs up to 6m in height) and rock ramp fishways (used on low weirs).

Given the large number of factors that can influence the success of fish passage, NSW DPI does not use a generic classification system to stipulate a specific fishway option at a particular site. Rather, decisions are based on the specifics of the biology and hydrology of the waterway and the conservation value of the site to determine the most appropriate course of action. NSW DPI will individually assess each development or modification, however, the following factors have a significant impact on the final determination:





A. Biology - The specific biological requirements of a site can influence the preferred fishway design. Biological data needs to be obtained on the types of fish species and size classes present, the presence of threatened species, populations or ecological communities, critical habitat or proximity to known spawning or juvenile fish habitats and the presence of pest species which may impact on native species. Migration patterns and timing of migrations for both native and pest species of fish also need to be taken into account in the operation of the fishway to maximise its effectiveness across the flow regime and to potentially control pest species using the fishway.

B. Hydrology - The magnitude and duration of flows have a significant impact on the most appropriate fishway design for a given site. Sites with significant variation in head and tailwater levels need to account for varying pool levels and fishways should be chosen accordingly. In general, fishways should be designed to operate up to a pre-determined flood Annual Recurrence Interval (ARI). ARI's provide a comparison of the frequency with which a flood will occur, with a 2:1 ARI flood occurring once every two years. Consideration may be given to reducing this figure if there is a significant cost reduction for a slight reduction in operational range.

C. Surrounding habitat - Sites that are within or adjacent to areas of high conservation value require fishways with the greatest confidence in design. Factors that influence the assessment of the surrounding habitat include:

- location in the catchment and proximity to existing barriers,
- extent and quality of riparian vegetation,
- local and regional water quality,
- proximity to potential cold water pollution sources,
- abundance and quality of aquatic vegetation and snags, and
- the extent of surrounding floodplain connectivity.

4.4 Floodgates

Floodgates are erected across permanent or intermittent watercourses (both natural and constructed) for several purposes including: i) to drain the land upstream for agricultural or urban uses, ii) to prevent the land from flooding following rises in the main river system and iii) to reduce inundation of the land by tidal waters. As downstream water levels fall, the head of water behind the floodgate pushes the gate open and drainage occurs down to the level of the base of the floodgate. As the tide or river level rises, water pressure on the downstream side closes the floodgate and saline water intrusion or flooding is prevented.

As with other in-stream structures, floodgates can prevent fish access to spawning and feeding areas, fragment fish populations and interrupt genetic flow, reduce flow levels below those needed for fish survival, alter temperature, salinity and water quality regimes and restrict the access of fishers to fishing grounds.

The construction of floodgated drains through wetlands for flood mitigation and agricultural or urban development purposes also has a number of adverse effects on the environment including:

- exposure and oxidation of Acid Sulfate Soils,
- prevention of brackish water from neutralising acid drainage from adjacent soils,
- draining of wetlands resulting in changes in plant species from native brackish freshwater species (which are tolerant of floods) to dryland grasses and wetland weeds (which die after exposure to flood waters),
- loss of drought refuge capacity for stock,
- provides conditions suitable for the development of toxic drain sediments (known as monosulfidic black ooze or MBOs) that can rapidly deoxygenate the water column when disturbed,
- reduced water quality,
- reduction in biodiversity of flora and fauna,
- increase in in-stream vegetation and consequent reduction in drainage performance.

4.4.1 Legislation

The construction of flood mitigation works, including floodgates, levees and drains, is controlled by the *Water Management Act 2000*, administered by NSW Office of Water. Planning provisions may also apply in certain circumstances to a particular proposal to build structural flood mitigation works such as a floodgate (i.e. Parts 4 or 5 of the EP&A Act). Advice should be sought from NSW Office of Water and relevant local council(s) in this regard.

Under **s218** of the FM Act, a person (other than a public authority) must give the Minister notice in writing at least 28 days before constructing, altering or modifying a floodgate. The maximum penalty for failing to give notice is $22,000 for a corporation and $11,000 for an individual. The Minister for Primary Industries may, by order in writing, require a person (other than a public authority) to provide fish passage if they alter, modify or construct a floodgate. Public authorities are also required to notify the Minister before they approve any such activity. The maximum penalty for non-compliance with an order is $220,000 for a corporation and $110,000 for an individual. A public authority must notify the Minister if it proposes to construct, alter or modify a floodgate and it must provide for suitable fish passage if requested to by the Minister.

The Minister's functions in **s218** of the FM Act have been delegated to various senior positions within NSW DPI. For example the notification requirements can be satisfied by notifying NSW DPI. This policy is written on the basis that NSW DPI will receive notifications as required by **s218** of the FM Act.

4.4.2 Policy and guidelines for floodgates

In addition to the policies stated in Chapter 3 and section 4.1.2, the following **policies** apply to floodgate management:

1) NSW DPI must be notified of the following activities for assessment before any works are carried out:
   - all floodgates which have gradually deteriorated (such that fish are able to pass through them) and are proposed for repair,
   - all floodgates proposed for major repair or modification on CLASS 1-3 waterways (see Table 2) (e.g. replacement of floodgate(s) or structure, redesign of opening mechanisms for the floodgate),
   - any new floodgates (or other construction) that may impede fish passage.
2) NSW DPI will not require notification of:
   - repairs related to accidental damage, vandalism (such as gate removal), or where gates are blocked by material such as logs, rocks or dead stock,
   - minor repairs such as flap, hinge and seal replacement on gates as part of routine maintenance, except where the floodgate has deteriorated and fish passage is occurring (see point 1 above),
   - floodgates that do not involve a waterway (e.g. flood control structures on storage floodways).
3) NSW DPI will generally support the insertion of weir sills into agricultural drains and channels (i.e. non key fish habitats) to raise groundwater levels thereby reducing acid discharge in Acid Sulfate Soil affected areas, thus improving downstream water quality.
4) Where notification to NSW DPI of proposed floodgate works is required, the relevant floodplain management authority or owner of the structure is required to either:
   - Prepare an assessment of environmental issues on a site-by-site basis. This would include individual site assessment for each work requiring approval, or
   - Develop a Best Practice Agreement with NSW DPI. This agreement will allow an improvement in administration arrangements and easier operation for authorities. The agreement can include assessment procedures, approvals for 12-24 month work programs, protocols for opening and closing the gates and review mechanisms, or other details as required.

Guidelines for implementing the above policies include:

a) Flood mitigation structures should only be constructed where there is a compelling need, such as for protection of towns and dwellings. The use of non-structural flood mitigation methods (e.g. re-siting of existing developments away from floodways and agricultural crops and practices capable of withstanding flooding) should be adopted wherever possible in preference to structural methods.

b) Safeguards against disturbance during construction should be adopted such as cross drainage of work sites, safe storage of petroleum and oil containment, and the construction of small temporary levees around the works to intercept sediment loads.

c) Structural flood mitigation should not occur if the region is in an area with potential Acid Sulfate Soils, contaminated sediments, or will result in the draining of a wetland.

d) The removal of redundant floodgates affecting key fish habitats is encouraged in order to reinstate fish passage and improve water quality and aquatic habitat values.

4.5 Temporary in-stream structures

Temporary in-stream structures include coffer dams, construction pads, sediment erosion booms, and drought water retention dams. Temporary in-stream structures can display similar impacts upon native fish as permanent works described in section 4.2 – 4.4 and therefore require similar consideration under the FM Act.

4.5.1 Legislation

The legislation that applies to temporary in-stream works is summarised in section 4.1.1.

4.5.2 Guidelines for temporary structures

The following **guidelines** apply to temporary in-stream structures:

a) Temporary in-stream structures should avoid spanning the full width of the waterway channel to ensure base flow conditions are maintained down the waterway. If a channel spanning structure is required, measures (e.g. diversion channel) will need to be implemented to ensure that minimum base flow conditions are

Kempsey bridge temporary reclamation works (RMS)

maintained. Local stream gauges should be consulted to determine appropriate minimum base flows for the prescribed season that temporary works will be installed.

b) Temporary in-stream structures should not be constructed from unconsolidated, imported earth fill material. Dispersive material (e.g. clays and sands) used in the construction of temporary in-stream structures should be fully enclosed by geotextile, sheet piling, or similar means to limit erosion and sedimentation within the waterway. If using rock fill, the rock should be clean of fines and of suitable size (≥ 150 mm diametre) to avoid erosion. Use of instream bed material will be evaluated on a case by case basis by NSW DPI and will be dependent upon the proponent demonstrating that the project has a net benefit to fish habitat and will not destabilise the waterway channel.

c) Temporary in-stream structures should be inserted during low-flow periods, with management plans being submitted to NSW DPI detailing how high flow events will be managed to limit erosion of the structures and associated sedimentation of downstream waterways.

d) Dewatering of temporary in-stream structure should follow the following guidelines:

- NSW DPI is to be notified 7 days prior to any dewatering activities in order to organise potential fish rescue activities. A separate **s.37** permit may be required from NSW DPI to relocate fish.
- Water is to be pumped a minimum of 30 m away from the waterway and should preferentially not re-enter the waterway. If water is to re-enter the waterway, ANZECC water quality guidelines need to be adhered to with the proponent being required to submit a detailed water quality monitoring program.

4.6 In-stream rehabilitation works

The use of in-stream rehabilitation works to address issues such as bed lowering and erosion, bank stability and loss of riparian habitat plays an important role in the rehabilitation of NSW waters. However some rehabilitation works have the potential to negatively impact upon the passage of native fish.

In relation to in-stream rehabilitation, structures can be classified as barriers to fish passage if:

- works are across the full width of the waterway and create a headloss of greater than 100 mm, or
- works increase the mean velocity or turbulence of stream flow by constricting the waterway area.

4.6.1 Legislation

The legislation that applies to such works is summarised in section 4.1.1.

The most common in-stream rehabilitation works that have the potential to impede fish passage are channel spanning bed control and flow constriction structures. These are used to stop the progression of head cuts and nick points, trap sediment to raise bed level, and in some cases promote localised scouring.

Substantial changes to flow velocity and turbulence can also impede fish movement. As such, in-stream rehabilitation works that do not extend across the full width of a watercourse (such as pin ramps, groynes and revetments) should still be referred to NSW DPI for assessment prior to their construction.

4.6.2 Policy and guidelines for in-stream rehabilitation works

In addition to the general policies stated in Chapter 3 and section 4.1.2, the following **policies** apply to in-stream rehabilitation works:

1) For works on CLASS 1 or 2 waterways (see Table 2):

- responsibility for ownership and on-going maintenance of the structure must be determined prior to the approval and/or commencement of works to ensure that the structure will continue to be adequately maintained,
- all works that create a headloss of greater than 100 mm must be referred to NSW DPI for assessment.

Guidelines for implementing the above policies include:

a) The slope of any associated fishway or in-stream rehabilitation works should be a minimum of 1:20 slope (unless a denil fishway) in freshwater areas within the mid-upper reaches of a catchment and 1:30 in tidal or lower catchment areas. A survey of adjacent areas should be undertaken to determine an appropriate slope for the site.

b) Works should include provisions to prevent percolation of water through the structure and ensure adequate depth is maintained to promote fish passage. Structures should also attempt to maximise depth over low flows to promote fish passage.

c) In-stream structures should be designed in consultation with NSW DPI staff before submitting the proposal to the department for formal assessment.

4.7 In-stream structure removal

The most common in-stream removal works involve redundant or obsolete road crossings, weirs, and floodgates. Where possible, the removal of in-stream structures provides the best possible outcome for fish passage and associated improvements in water quality, riparian health and sediment transport. However, careful attention is required to determine whether the river bed and banks have adjusted over time, and whether removal of the structure can proceed.

4.7.1 Legislation

The legislation that applies to such works is summarised in section 4.1.1.

4.7.2 Policy and guidelines for in-stream structure removal

In addition to the general policies stated in Chapter 3 and section 4.1, the following **policies** apply to in-stream structure removal projects:

1) When undertaking structural removal, the following issues need to be considered during any environmental impact assessment process:
   - assessment of any impacts on threatened species listed under both State and Commonwealth legislation that may have become dependent upon the weir pool,
   - impact of the removal on bed and bank stability,
   - presence or potential presence of Acid Sulfate Soils,
   - impact of sediment mobilisation (if an accumulation exists behind the barrier),
   - impacts on water quality (especially at tidal barriers),
   - impacts on any upstream and downstream water users (e.g. presence of active water licences),
   - whether the barrier is a cultural heritage item (i.e. listed as a heritage item in NSW or nationally), and if so, whether necessary approvals required for its removal have been sought,
   - other legislative obligations and permit requirements under the FM Act and other legislation (outlined in sections 2.2 and 2.3)
2) All proposed removals are to be discussed with NSW DPI and approved by the relevant consent authority prior to the execution of works. NSW DPI staff can provide advice on permit and environmental assessment requirements (see Appendix 5 for contact details).

Guidelines for implementing the above policies include:

a) Spoil material removed from the waterway (e.g. concrete) should be disposed of at a licensed facility and should not be reused within or adjacent to the waterway.

4.8 Fish passage trade-offs

For certain in-stream structures, the location of the works, the nature of the structure or other factors mean that, despite the biological need for fish passage, reasonable cost-effective / practical solutions are not available. In such situations, the biological significance of the site can be considered in view of other high priority fish passage barriers and a 'trade-off' applied. A trade-off involves ensuring equal or more cost-effective fish passage outcomes through transferral of fish passage works from the dam, weir, regulator or floodgate triggering requirements under s218 of the FM Act to an alternative site or sites. The potential need and use of trade-offs is determined on a case-by-case basis in view of socio-economic and biological criteria, including the prioritisation of the site for fish passage intervention. The majority of s218 compliance sites will not require a trade-off.

4.8.1 Policy and guidelines for fish passage trade-offs

In addition to the general policies stated in Chapter 3 and section 4.1, the following **policies** apply to fish passage trade-offs:

1) Notify NSW DPI of proposed in-stream structure works and establish, in consultation with NSW DPI, whether the works trigger **s218** of the FM Act. Provisions of s218 will be enforced for the site in view of the presence of native migrating fish, surrounding habitat, presence of adjacent migration barriers, fish passage options (e.g. fishway), cost-benefit assessment, flow regime, and asset life-cycle assessment.
2) In consultation with NSW DPI, complete investigations into potential fish passage designs for the site. Undertake cost-benefit assessment of providing fish passage at the site, taking into account ecological outcomes, fish passage effectiveness, and projected project expenditure.
3) If incorporating fish passage will not be cost-effective at the original compliance site and greater ecological benefits can be achieved by providing fish passage elsewhere in the catchment, trade-offs can be considered. Project Managers should systematically work through the following checklist to identify opportunities that achieve the best outcome for native fish and fish passage.
4) Trade-off sites must:
   - occur within the same catchment as the compliance site
   - be identified by NSW DPI as a high priority for rehabilitation of a fish passage barrier
   - derive equal to or greater ecological benefit than providing fish passage at the original compliance site. For each potential trade-off site, determine the distance upstream and downstream to the next in-stream barrier
5) Trade-off sites must NOT:

- be a site where planned upgrade works are proposed in the next 10 years that would trigger **s218** of the FM Act

6) Potential trade-off sites need to be discussed and agreed upon in writing by the Minister for Primary Industries or his/her delegate.

Guidelines for implementing the above policies include:

a) If the compliance site is located on a regulated river, the potential trade-off site(s) should also be on a regulated river.

b) The proponent should assess whether the provision of fish passage at several in-stream barriers occurring on the same waterway will provide greater ecological outcomes (e.g. kms of waterway opened) versus addressing fish passage at a single site, assuming relatively equal costs.

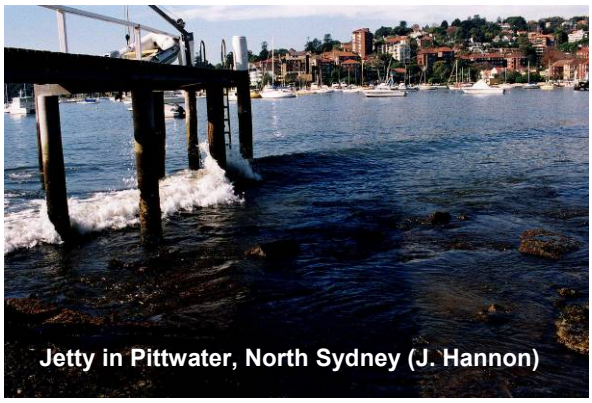
5. Foreshore works and waterfront development

5.1 Foreshore structures

Many areas of foreshore have been extensively modified in the past, leading to the destruction of fish habitats and loss of amenity. Foreshore developments such as marinas, breakwalls, jetties, pontoons, boat ramps and other types of waterfront development have the potential to significantly affect fish habitat during construction and/or operation and are often built at the expense of mangroves, seagrass, riparian and aquatic vegetation and other fish habitats. Foreshore structures can also create safety hazards and/or reduce access for both commercial and recreational fishers to existing fishing grounds. Large numbers of developments have been approved on an ad hoc basis in the past with very little consideration of their cumulative impacts on fish habitat or fishing access. This section outlines NSW DPI's policies and guidelines in relation to typical proposals for foreshore works in marine, estuarine and freshwater environments in NSW.

5.1.1 Legislation

Foreshore works, sediment extraction and waterfront developments may require a permit from NSW DPI under **ss200-201** of the FM Act if construction involves dredging and reclamation activities such as jetties or marinas, pontoons, slipways, boat ramps, groynes and seawalls. Under **ss200** and **201** a permit is required for dredging or reclamation work carried out by a local government authority or person respectively, unless these works are authorised by a relevant public authority (other than a local government authority) or under the *Crown Lands Act 1989*. The maximum penalty for unauthorised dredging and reclamation is $220,000 for local government authorities or corporations and $110,000 for individuals. If works are carried out in contravention of these sections, the Minister for Primary Industries may, under **s203**, order remedial works to be carried out to rectify any damage caused to fisheries and fish habitat.



Jetty in Pittwater, North Sydney (J. Hannon)

Under **s199** of the FM Act, the Minister for Primary Industries is required to be consulted over any dredging or reclamation works before it is carried out, or proposed to be authorised, by a public authority (other than a local government authority).

A permit to harm marine vegetation may also be required under **s205** of the FM Act if marine vegetation is present on site (see section 3.2.3 for policies in relation to marine vegetation). The maximum penalty for harming marine vegetation is $220,000 for a corporation and $110,000 for individuals. The maintenance of swimming pools and enclosures below the astronomical high water mark (spring tide) on public land may also require a permit from NSW DPI for the removal of sand accumulations (dredging) or harm to marine vegetation (**s205**). Finally a permit may also be required under **s219** of the FM Act if the works involve the temporary or permanent restriction of fish passage (see section 4.1) or for the installation of nets or other swimming enclosure materials that may restrict fish passage.

Concurrence or consultation with the Minister for Primary Industries may also be required under ss197C and 197D of the FM Act if the development or works are within an aquatic reserve or likely to affect plants or animals within an aquatic reserve and their habitat (see section 1.7.1). Approvals may also be required from the Marine Parks Authority if the works are being undertaken within the marine or tidal waters of a marine park (see section 1.7).

Prior to consulting NSW DPI, the proponent should discuss the proposal with the Crown Land Division (and/or NSW Roads and Maritime Services in the waters of the Greater Sydney Metropolitan Area) to ascertain whether the proposal is a permissible use of Crown land (where applicable) and whether it requires an occupation licence. The owner of the land (i.e. Crown Land Division or NSW Roads and Maritime Services) is required to give landowner's consent to the lodgement of the development or permit application and this should be obtained prior to lodging the development or permit application with NSW DPI.

The proposal should also be discussed with other approval authorities, such as local council, as the development may also be "integrated development" under **s91** of the EP&A Act (see section 2.2).

Approvals may also be necessary from NSW Office of Water under the WM Act for works within a waterway, on waterfront land (within 40 metres of a waterway) or if works are likely to interfere with an aquifer and advice should be sought.

Many agencies (including NSW DPI (Fisheries NSW, NSW Office of Water and Crown Land Division) and NSW Roads and Maritime Services) and local government have an interest in the approval process for foreshore structures. To assist proponents a whole of government approach to foreshore structure development has been developed to provide a consistent and strategic approval process for priority estuaries. Approval criteria and statutory responsibilities from each agency/council have been combined to form the basis of a domestic foreshore structure assessment decision support model. The model, combined with local knowledge on river use, is then being used to develop a River Foreshore Structure Strategy for those estuaries which have a high demand for foreshore structure development. These strategies will result in greater security for landholders adjoining the river with an interest in building a domestic waterfront structure.

The strategies will also streamline the assessment process for estuarine infrastructure proposals and identify areas where public facilities are required or where shared community facilities may be appropriate.

Contact your local NSW DPI office (see Appendix 5), Crown Land Division office or local Council for further information on whether a River Foreshore Structure Strategy applies to your area.

5.1.2 General policies for foreshore structures

In addition to the general policies stated in Chapter 3, the following **policies** apply to foreshore structures:

1) NSW DPI will generally not support/permit foreshore structures and works in TYPE 1 habitat (see Table 1) unless special circumstances exist. These may include:
    - works that are clearly in the public interest (e.g. emergency access, state significant development or infrastructure, development identified in a strategic planning document (e.g. Estuary Management Plan or similar))
    - proposed works that, by virtue of design and location, are unlikely to have a significant impact, and where the proponent is willing to undertake works to compensate for any fish habitat liable to be lost or damaged (see section 3.3),
    - where property access is only available by water and no other alternative sites exist.
2) NSW DPI will generally not support/permit dredging or reclamation for private foreshore works in TYPE 2 habitat unless the impacts can be mitigated or compensated (see section 3.3).
3) NSW DPI will generally not support/approve private foreshore works where the proponent does not own the land to the astronomical high water mark and/or the development has the potential to restrict access to public land.
4) NSW DPI will generally not support foreshore works that contribute to the further degradation of native riparian vegetation (listed as a key threatening process under the FM Act) (see section 3.2.4).
5) NSW DPI will generally not support/permit foreshore works that will have significant impacts on commercial fishing access (see section 2.1).
6) NSW DPI will require an environmental bond (section 3.3.4) and/or long-term monitoring program (section 3.3.5) where a significant negative impact is likely to occur to TYPE 1 or 2 habitats or where vegetation replanting is undertaken.
7) Foreshore works that extend into a waterway should not restrict fish passage irrespective of the type of aquatic habitats present.
8) During and after construction, precautions must be taken to avoid damage beyond the immediate work area (see section 3.3.2) and allowance should be made for unhindered flow of water to downstream areas.

5.1.3 Surrounding environmental considerations

Individuals and councils wishing to undertake any foreshore works should first consider the following NSW DPI policies at the planning stage in relation to the nature, condition and use of the surrounding environment.

- **Exposure to erosion and sedimentation processes**

Many waterways are subject to strong waves, river and flood flows or currents. Within estuaries, the strongest tidal flows occur within narrow constricted channels (e.g. adjacent to sand spits, reefs or bridges). Within rivers, currents are usually strongest along the outer bank of each bend or meander, and flow velocities are greatest during bank-full flow events.

Marine and freshwater aquatic vegetation can normally withstand moderate exposure to wave action and strong currents as the leaves baffle water movement, while the roots and rhizomes bind the sediment. However, aquatic vegetation located where significant wave action or currents occur can be sensitive to other types of damage - such as boat anchors, mooring chains, wave action from boats, installation of pylons or localised overshadowing.

Dredging associated with foreshore works can alter wave patterns in an area, causing additional habitat damage. Swell, in particular, is prone to being redirected by the process known as refraction (bending). Incident wave speeds depend on water depth therefore changes to seafloor contours can cause waves to be re-directed. This may damage sensitive habitats such as seagrass, either through increased seabed scouring, or by burial under shifted sediments.

- **Habitat condition and connectivity**

Juvenile fish are often reluctant to cross expanses of open bare substrate, with most species displaying a strong preference for habitats such as seagrass and rocky reefs. These habitats provide shelter from predators and a variety of food sources, and therefore provide for optimum growth and survival of juvenile fish. Mangroves and other riparian vegetation also fringe extensive lengths of shoreline, thereby forming habitat ‘corridors’ which facilitate the dispersal or migration of juvenile fish, from the estuary upstream into freshwater (e.g. Australian Bass, Yellowfin Bream, Sea Mullet and Longfin Eels). In the case of bass, the juveniles are likely to migrate first through seagrass and mangroves, then through reeds, and finally through freshwater macrophytes as they make their way upstream.

Foreshore works can compromise such corridors through direct habitat destruction, or by the effects of shading. Juvenile fish may be unable (due to predators) or unwilling (due to instinctive behaviour) to cross gaps in a habitat corridor.

The importance of a particular area of habitat needs to be considered from a regional and a local (site) perspective. The condition of the habitat and where it is located can contribute to its local significance. Aquatic habitats at the limits of their distribution within a river or estuary may play a vital role as 'connecting habitat' for juvenile fish.

- **Shared foreshore facilities**

In some instances, shared facilities (boat ramps, jetties and pontoons) may be a feasible alternative to several adjacent properties each having its own facility. Such an arrangement reduces the risk of undesirable cumulative impacts on aquatic habitats, and is likely to result in considerable cost savings for the owners.

As most waterways in NSW are public land, waterfront development in general should fulfil a public need rather than benefiting a few individuals. The greater the public need and number of beneficiaries, the more consideration will be given to the proposal during the socio-economic assessment of the development. Public access and aesthetic amenity must also be considered.

- **Commercial fishing**

Commercial fishers have a licensed entitlement to access fish stocks within NSW waters using approved methods. Inappropriately located foreshore structures can significantly impact on the livelihood of fishers by restricting their ability to access schooling fish stocks or to use fishing gear in known fishing grounds. Impacts on commercial fishing by inappropriate development has been recognised by the Land and Environment Court in several key decisions and such impacts need to be adequately assessed in any environmental impact assessment for foreshore structure developments.

In particular estuarine fishers target fish species such as Sea Mullet, Dusky Flathead, Luderick and Yellowfin Bream using meshing and hauling nets. Operation of haul nets can be particularly compromised by foreshore structures such as jetties and pontoons. Haul nets are typically up to 750 metres in length and are hauled in an arch around schools of milling fish. Hauling is limited by the geomorphic characteristics of the river, the periodic schooling of viable quantities of fish and the effective operation of the hauler. Prawn haul nets of not more than 40 metres in length (not including haul lines) are also used by estuarine fishers and can only be used in specific geomorphic riverine locations.

Depending upon the river system, commercial fishers may be excluded from parts of the river due to periodic closures to minimise impacts on other waterway users and to ensure the protection of juvenile fish stocks. It is therefore important that further impediments to fishing access are assessed, avoided, reduced and in some cases removed.

- **Recreational fishing**

Recreational fishers require access to waterways to undertake the activity of recreational fishing. In 2002, 30 locations along the NSW coast were set aside for recreational fishing following the removal of commercial fishing effort and are known as 'recreational fishing havens' (see www.dpi.nsw.gov.au/fisheries/recreational/info/rfh for their locations). The purpose of these areas is to improve opportunities for recreational fishing in key areas of significance to recreational fishers. Foreshore structures can both positively and negatively impact on public recreational fishing access and this needs to be considered in the social impact assessment of such proposed works.

5.1.4 Policy and guidelines for surrounding environmental considerations

In addition to the general policies stated in Chapter 3 and section 5.1.2, the following **policies** apply in regard to the surrounding environment of proposed foreshore structure locations:

1) NSW DPI will require the assessment of the potential effects of dredging or reclamation for foreshore structure proposals in areas with strong currents or wave action. Mitigation measures may be required (i.e. underwater structures should be designed to minimise wave refraction, or scouring of the nearby seabed (e.g. by using thin pylons or fish habitat friendly moorings)).

2) NSW DPI will generally not approve proposals for foreshore structures that are liable to promote excessive erosion or sediment build up.

3) NSW DPI will consider proposals within degraded habitat more favourably than proposals in areas of fish habitat that are relatively intact and in healthy condition or have a high potential for rehabilitation.

4) NSW DPI will consult commercial and recreational fishers in regard to the potential impacts of foreshore structures on fishing activities and access and may require the structure to be relocated, modified or refuse approval if impacts are considered significant.

Guidelines for implementing the above policies include:

a) Consideration should be given to the habitat TYPE (see Table 1), condition and function (e.g. corridor values) of surrounding habitat when assessing foreshore structure proposals.

b) Boating infrastructure (jetties, boat ramps, etc) along river foreshores should be located in stable river reaches including:

   - straight reaches where no active bed or bank erosion or sediment build up is occurring,
   - located at the lowest point along a given riverbank to reduce the likelihood of erosion and bank failure,
   - located on inside bends of rivers or areas where sand bars do not develop.

c) Proposals may be considered where the value of the habitat as a corridor is considered low (e.g. a single row of mangroves along a riverbank, small discontinuous patches of TYPE 2 seagrass) and the damage can be compensated (see section 3.3).

d) Possible effects of concentrating associated activities (such as boating) at one specific site need to be considered. For example, the amount of time boats cause shading or the relative amount of traffic generated by the presence of the facility and vessel departure routes will influence NSW DPI's consideration of a proposal.

e) NSW DPI supports the use of shared facilities wherever the associated habitat damage is likely to be less than that which would have been expected from the corresponding set of single facilities.

5.1.5 Foreshore structure design considerations

Once the location of a foreshore structure has been determined in line with the requirements in sections 5.1.2 - 5.1.4, the structure itself needs to be designed to fit in with the natural surroundings. The following issues need to be considered when designing and installing foreshore works in conjunction with other design requirements relating to legal, safety, engineering and aesthetic considerations.

A. Jetties and wharves

The depth at which seagrasses grow within our estuaries varies along the coast. Depending on the clarity of the water, some seagrasses can grow down to a depth of 8 metres at the entrance to the estuary, whereas further upstream in more turbid waters, seagrass beds may be limited to depths of only 1 metre below mean low water mark. In estuaries with very little tidal range, foreshore structures can cause severe shading effects for extended periods.

Similarly in rivers and creeks, aquatic vegetation may occur at different depths and locations depending on the occurrence of favourable conditions for their establishment.

A condition of approval may include the need for a pre-construction survey of seagrass or freshwater aquatic vegetation distribution and health and annual surveys (for at least 2-5 years) following construction of the jetty or wharf.

5.1.6 Policy and guidelines for jetties and wharves

In addition to the general policies stated in Chapter 3 and section 5.1.2, the following **policies** apply to these structures:

1) NSW DPI will generally not approve proposals for permanent berthing over TYPE 1 or 2 seagrass, except within existing canal estates.

2) NSW DPI will generally not approve of proposals for jetties, wharves or similar structures over *Posidonia australis* seagrass, unless special circumstances exist as outlined in section 5.1.2. Measures to address shading of *Posidonia australis* will also not be considered as a mitigation or compensation measure, for non-exempt proposals.

3) Proposals for jetties, wharves and similar structures should incorporate design features to reduce the effects of shading on marine and freshwater aquatic vegetation, where present.

4) NSW DPI will generally not approve stub end jetties that end in or near TYPE 1 or 2 seagrass unless there is 0.9m of water depth over the seagrass all times, except within existing canal estates.

Guidelines for implementing the above policies include:

a) The amount of light reaching aquatic vegetation can be maximised by increasing the height of the structure above the water, reducing the width of the deck to the minimum required for safe access, excluding the use of a pontoon or minimising the size of it and orientating the structure to maximise sunlight penetration under the deck (e.g. north-south orientation is preferred over east-west orientation) (see section 5.1.7 for further guidance on pontoon design).

b) Structures over aquatic vegetation should be decked with mesh, grid or grates of agreed specifications to allow for light penetration. The material chosen should be safe for public access (i.e. non-slip surface, gaps to minimise tripping, etc).

B. Boat ramps, boat sheds, pontoons and sliprails

Boatsheds and boat ramps built along foreshores can cause severe shading and direct habitat modification or loss. Such structures should be located above the highest astronomical tide mark (i.e. 1.0 m AHD) or riverbank so that direct or indirect damage to fish habitat is minimised or avoided. Slip rails cast minimal shadows, and are a preferred alternative to most boat ramp designs.

Pontoons are relatively bulky structures and may also cause shading effects on the seafloor or riverbed. Pontoons, unlike jetties, require the need for flotation which generally precludes the use of meshed decking, or reduces its effectiveness in allowing light penetration.

Sliprails over *Zostera* seagrass (J. Hannon)

5.1.7 Policy and guidelines for boat ramps, boat sheds, pontoons and sliprails

In addition to the general policies stated in Chapter 3 and section 5.1.2, the following **policies** apply to these structures:

1) NSW DPI will generally not approve reclamation for the construction of boat sheds and boat ramps below highest astronomical tide (1.0 m AHD), or on the banks of rivers and streams in an active erosion or sediment deposition zone, unless there is a demonstrated public benefit.

2) NSW DPI will generally not approve private boatsheds, boat ramps, pontoons, sliprails or similar structures that are likely to harm TYPE 1 aquatic habitats (see Table 1) or restrict commercial and recreational fishing access.

3) NSW DPI will only approve the installation of pontoons that overshadow TYPE 2 aquatic habitats if suitable mitigation or compensation measures are employed (see section 3.3).

4) NSW DPI requires that sliprails be constructed so that the end of the sliprails are not located within seagrass and/or there is adequate water depth at low tide to ensure no risk of propeller dredging of seagrass during their use.

Guidelines for implementing the above policies include:

a) Private pontoons for boat mooring should generally not be greater in size than 3.6m x 2.4m and have a minimum clearance of 0.9m between their base and the substrata at lowest astronomical tide.

b) Boatsheds and similar structures may be considered for approval where they are located above the highest astronomical tide or, in freshwater environments, in areas where no active erosion or sediment deposition is occurring.

c) Boat ramps should be designed to allow the movement of water and sand/sediment across or under the structure.

d) Sliprails should be used in preference to timber/concrete sleeper boat ramps. Where a timber/concrete sleeper ramp is permissible, the gaps between the sleepers should be as wide as possible.

e) Where possible, pontoons should be located well clear of vegetated shallows.

f) In some cases, conditions may be placed on permits that restrict the use of pontoons. For example, mooring of boats to irrigation pump pontoons may be prohibited.

g) NSW DPI recommends that all boats avoid anchoring in seagrass beds.

h) NSW DPI recommends that boats avoid travelling across seagrass beds at low tide in order to minimise the potential for propeller damage to the beds.

C. Moorings

Moorings can harm invertebrates and aquatic vegetation, in particular marine vegetation, through the direct removal of vegetation during installation of the mooring blocks, and also by the longer-term effects of vegetation removal from swing chains and shading. Relocating the block to a different location after maintenance, or relocating the block if the size of the vessel changes, can exacerbate damage to aquatic fauna and habitats.

5.1.8 Policies and guidelines for moorings

In addition to the general policies stated in Chapter 3 and section 5.1.2, the following **policies** apply to moorings:

1) NSW DPI will generally not support proposals to install new, replace or relocate existing moorings within TYPE 1 habitats (see Table 1).

2) NSW DPI will only consider proposals to install new, replace or relocate existing moorings within TYPE 2 habitats where appropriate habitat mitigation or compensation measures are employed (see section 3.3) or environmentally-friendly mooring designs are used.

3) The mooring of vessels to mangroves or to other native trees, such as Red Gums in freshwater habitats, will not be approved.

Guidelines for implementing the above policies include:

a) Existing moorings (except navigational aids such as port and starboard markers) in or adjacent to (i.e. within 10 m) of seagrass or mangroves (TYPE 1 and 2) should be relocated out of these habitats over time, or where relocation is not possible, replaced with environmentally friendly mooring apparatus.

b) During maintenance operations of existing moorings, if the mooring block is lifted it should be replaced in the exact same location and the chain shortened to limit damage to marine vegetation. This will generally require the guidance of a diver during the replacement of the mooring block. A record of the location (e.g. diver survey, GPS (global positioning system)) should be taken prior to moving the block to ensure that the mooring is placed in the same position at a later date.

c) Mooring designs should ensure that chains are suspended above the sea floor or riverbed using floats or other devices to avoid damage to aquatic vegetation and bed scouring.

d) Environmentally friendly mooring systems may be used to mitigate some impacts of moorings.

B. Swimming pools and enclosures

Swimming pools situated below the astronomical high water mark, if poorly designed and managed, may present problems in terms of impacts on aquatic habitat, fish passage and water quality. In the case of enclosed hard pool structures (such as ocean rock pools and estuarine tidal baths) the initial construction may damage existing aquatic habitat (by requiring dredging and reclamation) and may also present problems when using chemicals to clean pools that may harm aquatic life. In the case of netted pools, problems may arise in relation to blocking fish passage. Netted tidal pools, if designed improperly, may also act to catch fish and other aquatic animals.

5.1.9 Policies and guidelines for swimming pools and enclosures

In addition to the general policies stated in Chapter 3 and section 5.1.2, the following **policies** apply to swimming pools and enclosures:

1) NSW DPI will generally not approve private enclosed swimming pools below astronomical high water mark. Proposals for public enclosed swimming pools will be assessed on a case-by-case basis.

2) NSW DPI will generally only approve netted swimming enclosures if constructed from corrosion resistant (e.g. stainless steel) material with a mesh size greater than 150 mm and where the nets used are hung horizontally – not diagonally.

3) NSW DPI will generally not approve collapsible nets for swimming enclosures (e.g. using buoys). Such nets may result in inadvertent trapping of fish during low tide.

4) NSW DPI will require a management plan be developed as a condition of consent where threatened or protected fauna listed under the FM Act are known to be present (e.g. syngnathids). The management plan will outline methods for avoiding or minimising impacts on threatened or protected fauna from the installation and maintenance of any swimming pools or enclosures.

Guidelines for implementing the above policies include:

a) Plastic mesh is not recommended for netting swimming enclosures (even though it is corrosion resistant) as the net can be broken during storms and continue to impact on aquatic fauna via ghost fishing.

b) Cleaning regimes for enclosed swimming pools and tidal baths should be designed and executed in a manner that minimises any negative environmental impacts.

c) Authorities and private individuals should be encouraged to develop a management plan to clean enclosed swimming pools in consultation with NSW DPI. Swimming pool cleaning management plans should consider the following points:

- the use of environmentally-friendly cleaning agents that minimise harm to aquatic life.
- utilising alternative methods for cleaning that do not require release of any chemicals into the environment (e.g. mechanical methods, high pressure hosing).
- methods to remove and dispose of sand accumulations in an environmentally sensitive manner (e.g. at low tide using mechanical methods). Removed sand should not be placed on adjacent rock platforms where it can smother aquatic life.

5.2 Foreshore reclamation

Reclamation is where existing aquatic habitat (land submerged by water intermittently or permanently), is filled in or drained to become dry land. Some foreshore works (e.g. seawalls, groynes, channel realignment, beach nourishment and foreshore stabilisation works) are considered to be reclamation.

Reclamation can reduce the tidal prism of an estuary, or change the flow of a river, and this may lead to alterations in waterway morphology (e.g. scouring and sedimentation in differing areas of the estuary or river channel as a result of a change in tidal or river flow respectively), water quality (e.g. through erosion and siltation) and loss of habitat.

Reclamation results in the immediate and permanent loss of fish habitat. Due to the difficulty in transplanting most aquatic vegetation (such as seagrass), rehabilitation or environmental compensation elsewhere is generally not a viable option.

5.2.1 Legislation

Refer to section 5.1.1.

5.2.2 General policies for foreshore reclamation

In addition to the general policies stated in Chapter 3, the following **policies** apply to foreshore reclamation:

1) NSW DPI will generally not support or approve reclamation of TYPE 1 and 2 or CLASS 1-3 fish habitat (see Tables 1 and 2) (including freshwater, estuarine and marine) for private development such as roads, walkways, housing or commercial development, foreshore or beach improvement.

2) NSW DPI will generally not support or approve other reclamation activities impacting on TYPE 1 or 2 habitat (see Table 1) unless the impacts can be mitigated or compensated (see section 3.3).

3) NSW DPI will generally not support or approve the use of contaminated sediment as fill. The use of clean fill free of finer material is required.

4) NSW DPI will generally not support or approve rehabilitation works that require substantial reclamation unless the works will result in a net environmental benefit to fish habitat and/or the works are consistent with an approved strategic plan (e.g. Estuary Management Plan, etc.).

5.2.3 Beach nourishment

Natural processes of wave and sediment movement within estuaries and embayments can be significantly altered by works such as dredging or the construction of bridges, seawalls, wharves, jetties and boat ramps. In highly urbanised estuaries such as Botany Bay, extensive construction has been undertaken along the foreshore involving armouring and hardening of the shoreline and reclamation for major port and airport development. The resultant changes to sediment and wave movement have led to extensive beach erosion.

Beach nourishment (also termed replenishment) involves the introduction of material (generally sand or rock) along a shoreline to provide for protection from storm damage and ongoing littoral drift along foreshore properties.

5.2.3.1 Policies and guidelines for beach nourishment

In addition to the general policies stated in Chapter 3 and section 5.2.2, the following **policies** apply to beach nourishment activities:

1) NSW DPI requires that beach nourishment proposals include an assessment of the potential for shifting sands to affect nearby fish habitat.

2) NSW DPI requires that all beach nourishment proposals give due consideration to the environmental impacts on the borrow area (the location from which sand is supplied).

3) NSW DPI will generally only approve the use of clean sand with similar particle size analysis to that on the beach being rehabilitated.

Guidelines for implementing the above policies include:

a) Proponents of a beach nourishment proposal should provide NSW DPI with the following:

- a map showing the presence of any aquatic vegetation including macrophytes, seagrass or macroalgal beds within 50 m of a proposed site.
- surveyed cross sections showing the beach profile in relation to lowest astronomical tide, mean low water mark, mean high water mark, and highest astronomical tide.
- information on the dominant wave and current directions including any flow patterns which may influence the reworking and dispersal of beach sands at the site.

b) An environmental management plan should be developed for the site outlining mitigation and compensation methods and including pre- and post-works monitoring of fish habitat and aquatic fauna (see section 3.3).

5.2.4 Foreshore stabilisation works and seawalls

Vegetation clearance, agricultural and urban development and altered flow patterns along our coasts, estuaries and rivers have contributed to increased rates of foreshore erosion. Increasingly, there has been a need to protect eroding foreshores from further erosion. This has included works such as the construction of breakwalls, seawalls, retaining walls, groynes and artificial armouring of riverbeds and banks. Projected sea level rise associated with climate change may also see further increased requirement for foreshore stabilisation works to protect assets.

These types of stabilisation structures can protect land from wave action, storm surges and river flows. If, however, they are poorly designed and placed inappropriately they can have deleterious effects on fish habitat.

Many seawalls and retaining walls have been constructed with poor foundations and often collapse. Some designs (e.g. vertical or near vertical concrete or grouted rock walls) cause wave or river flow energy to be reflected and can lead to instability elsewhere. This can trigger a domino effect that eventually requires the armouring of an entire foreshore or riverbank, to the detriment of any fish habitat that originally existed.

Foreshore stabilisation works are also used to protect infrastructure such as stormwater channels and pipe outlets, properties, roads and waterway crossings.

There are many ways to limit or avoid the loss of shoreline or riverbank without artificially armouring it. One of the most effective and easiest ways is to allow existing natural vegetation to grow or become re-established. A naturally vegetated shoreline has many benefits including:

- preventing erosion caused by rain, flow, wind and wave action,
- it is self-regenerating when damaged,
- acting as a filter, by trapping contaminants or excess nutrients before entering the water, and
- supplying food, shade and cover for fish and other aquatic life.

Unrestricted stock access to waterways is a major contributor to bank instability. Effective stock management (such as fencing off the riverbank and providing alternative shade and watering points within the paddock) is strongly recommended. Stock management will also assist in allowing native vegetation to regenerate.

However, there are instances where vegetation alone may not be adequate to stabilise foreshores and harder engineering solutions are required.

5.2.4.1 Policies and guidelines for foreshore stabilisation works

In addition to the general policies stated in Chapter 3 and section 5.2.2, the following **policies** apply to foreshore stabilisation works:

1) NSW DPI will generally not approve the construction of new breakwalls, groynes, seawalls or retaining walls except where there are no feasible alternatives for erosion control and valuable assets are at risk. Modifications or repairs to existing walls or groynes should incorporate designs that reduce wave energy reflection and include restoration of the original shoreline.

2) NSW DPI will generally not approve bank and bed stabilisation works that create a barrier to fish passage (see section 4.5).

3) NSW DPI will generally only approve foreshore stabilisation works (with the exception of groynes) that follow the natural contour of the shoreline. Unnecessary foreshore or stream realignment will not be approved.

4) NSW DPI will generally not approve the use of materials such as tyres, building rubble and other waste materials for foreshore reclamation works.

5) NSW DPI will generally not support the use of vertical retaining walls, gabion baskets or concrete lining for foreshore works. Steep retaining walls comprised of gabions baskets and concrete-lined channels have little fish habitat value. Gabion baskets may also fail over time, infilling downstream habitats.

Guidelines for implementing the above policies include:

a) ‘Soft-engineering’ options (e.g. revegetation) for stabilising foreshores should be implemented along riverbanks and foreshores wherever feasible.

b) Where harder engineering options are required, an integrated approach using planting in combination with natural materials (logs, live stakes, live brush bundles etc.) is preferred.

c) Seawalls should be constructed in accordance with OEH’s “*Environmentally Friendly Seawalls: A Guide to Improving the Environmental Value of Seawalls and Seawall-Lined Foreshores in Estuaries*” (see www.sydney.cma.nsw.gov.au/component/option,com_remository/Itemid,116/func,select/id,51/

d) When using rock (revetment or rip-rap) to stabilise shorelines:

   - rubble should be placed at a gradual angle to minimise bank steepness. This should maximise the life of the slope.
   - rock needs to be sized appropriately so wave or current action will not move it and filter cloth should be placed under the rip-rap to prevent underlying sediments from being washed away. Contact local NSW Office of Water staff for advice on the appropriate materials and design specifications.
   - planting of vegetation, especially deep-rooted species, above, within and immediately behind rip-rap will greatly increase the life of the stabilisation works and provide spaces in which fish can find food and hide from predators.

e) *Casuarina* spp., *Banksia* spp. and *Eucalyptus* spp. are some common plants that have roots that extend deep into the soil. Species such as *Lomandra longifolia* and native grasses can be planted as understorey, with rushes and reeds planted at or in the waters edge to protect the bank toe from erosion.

f) Advice on successful methods of planting native species along banks can be obtained from NSW Office of Water or your local Catchment Management Authority. Methods such as the ‘long-stem tube stock’ technique may increase the survival and growth rate of native riparian plant species.

6. General waterway management

6.1 Urban streams and stormwater

The management of urban streams presents many difficulties in terms of how to conserve and remediate extensive areas that have been degraded while still having consideration for the highly modified nature of these catchments.

Ideally, habitat management and rehabilitation efforts should aim to mimic the natural streams that existed before development occurred. In urbanised catchments, however, the hydrology and sediment input have usually been altered to increase runoff rates and sediment loads. This, coupled with pollutants such as heavy metals, chemicals, nutrients, and litter, can lead to marked changes in the health of streams within urbanised catchments.

The difficulty in rehabilitating highly modified streams is that urban processes which originally acted to degrade the stream still persist. In addition, there is often pressure within established areas to continue the trend of urban infilling at the expense of small remnant ecosystems.

The way stormwater is managed in urban areas has the potential to significantly affect stream condition and aquatic ecosystem health. Vegetated areas replaced by impermeable surfaces (concrete, bitumen paving etc.) lead to increased stormwater runoff and faster delivery of water to streams. Increased stream flows often lead to channel erosion and localised flooding. Elevated levels of pollutants in the stormwater can lead to the destruction of ecological values including the dieback of aquatic vegetation and fish kills (see section 6.6).

To combat localised flooding and water pollution, stormwater management systems are put in place within urban catchments to capture and redirect storm flows away from assets and infrastructure. However, due to the limited amount of available land, it is often the stream itself that is used as the conduit for flood flows and the downstream control point for catchment pollution.

Poorly designed stormwater systems can have harmful effects on fish by affecting the quantity and quality of water moving through the system, as well as the connectivity of the stream system.

NSW DPI aims to protect urban streams from development pressure through the development assessment process and by informing broader natural resource planning process. In addition, the policies and guidelines in this document will be considered when developing planning instruments such as regional strategies and local environmental and development control plans, as well as stormwater management plans and erosion and sediment control plans.

6.1.1 Maintaining fish passage in urban streams

Fish passage in urban areas can be affected by the construction of stormwater treatment devices and discharge channels, or the construction of bed and bank protection works to avoid erosion from increased stormwater runoff from urban areas.

Artificial wetlands are often created to improve water quality at a site or, less commonly, to provide compensatory habitat. Artificial wetlands used as water treatment devices are reasonably common in urban areas. However, if poorly designed, these wetlands can create a barrier to fish passage by the construction of weirs to divert low flows through the wetlands or to pond low flows. In such cases the environmental outcome of improved water quality is negated by the impacts on flow regimes and fish passage within the natural stream.

Other urban stream works that may obstruct fish passage include (but are not limited to):

- any in-stream structures that create a drop or step in the channel greater than 100 mm in height,
- bank or bed works that constrict flow, reduce the cross-sectional area of the stream or cause hydraulic barriers
- the installation of pipes within any watercourse,
- gross pollutant traps, sediment basins and other structures that are placed within a stream.

6.1.1.1 Legislation

Refer to section 5.1.1.

6.1.1.2 Policy for maintaining fish passage in urban streams

In addition to the general policies stated in Chapter 3 and section 4.1, the following **policies** apply to fish passage in key fish habitats (see Table 1) in urban streams:

1) NSW DPI must be consulted in regard to urban stream works that will obstruct fish passage as they may require a permit under the FM Act.

2) NSW DPI will treat artificial habitats that are linked to natural habitats upstream as ‘on-line systems’. As such, NSW DPI will generally require that the created lands provide for connectivity between habitats including continuous fish passage.

3) NSW DPI requires that off-line artificial habitats be designed to have minimal impact on adjacent natural systems or receiving waters. Diversion of flows from natural habitats into off-line artificial wetlands will generally not be approved.

4) NSW DPI requires that detention ponds and other stormwater treatment devices should be located off-stream and at-source to ensure they do not interfere with fish passage.

5) NSW DPI will generally only support the creation of artificial wetlands when they are not at the expense of existing natural habitat.

6.1.2 Water management in urban areas

Unpolluted water is one of the most critical components of fish habitat. Few fish species are able to survive and breed in polluted water. Individual pollution events may lead to fish kills (see section 6.6), while ongoing discharges of contaminated water reduce the viability or productivity of fish habitats and fish populations and their suitability for human consumption.

Built environments present even greater threats in terms of water pollution as a result of inputs from urban, industrial and agricultural sites that generate high sediment, nutrient or chemical discharges. This polluted water may directly enter the system via inadequate drainage systems.

6.1.2.1 Policy and guidelines for water management in urban areas

In addition to the general policies stated in Chapter 3, the following **policies** apply to water management in key fish habitats (see Table 1) in urban areas:

1) NSW DPI will generally not support proposals that damage, destroy or alienate existing key fish habitats in the process of creating new development in urban areas.

2) NSW DPI will require water quality controls used to treat run-off to be located in areas where treatment can occur prior to discharge into the riparian zone and stream channel.

3) NSW DPI will generally not approve proposals to construct new sewage outfalls, stormwater drains and outlet structures that will discharge within 100 m of TYPE 1 and 50 m of TYPE 2 marine vegetation (see Table 1) unless effective compensation is provided.

4) NSW DPI will require the environmental assessment of development proposals in urban areas to address the cumulative impacts on water quality and quantity including the management of stormwater, potential Acid Sulfate Soil and salinity issues, groundwater and land contamination, water volumes and flow velocities.

5) NSW DPI will require new urban development proposals to achieve 'no net impact' upon the receiving waterway from water quality and quantity and flow velocity. NSW DPI therefore requires the environmental assessment of any development proposals to take account of the existing water quality and flow conditions of the receiving waterway.

Guidelines for implementing the above policies include:

a) There are many tools used to achieve water-sensitive urban design, the appropriateness of each being dictated by site characteristics. In general, the objective is to reduce the volume and improve the quality of water leaving a site. OEH has several useful technical documents on water sensitive urban design and stormwater management which can be accessed via www.environment.nsw.gov.au under "stormwater".

b) Development Control Plans developed for urban catchments should include provisions to ensure that there is no net increase in runoff and no reduction in water quality of receiving waters from urban areas.

c) Stormwater treatment devices should be checked and maintained regularly. Management and maintenance plans should be developed and implemented.

d) SEPP 62 (Sustainable Aquaculture) requires the referral to NSW DPI of any proposal that might impact on water quality in an oyster growing area. SEPP 62 can be viewed at www.legislation.nsw.gov.au

6.1.3 Minimising habitat alteration

Habitat modification is wide-spread in the urban setting. The replacement of natural channels with engineered systems has been a common practice in the past. Types of activities that destroy fish habitat in urban streams include:

- channelisation, realignment and piping of creeks,
- installation of retaining walls and concrete lining of waterways,
- removal of in-stream, riparian and marine vegetation,
- removal of gravel beds, snags and other important fish spawning grounds,
- installation of flow regulatory structures (e.g. weirs, sedimentation basins, etc).

One of the most common stormwater conveyance systems used in urban stormwater networks is the grass-lined trapezoidal channel with concrete invert. These channels have been engineered to be hydraulically efficient but in terms of biodiversity conservation, sediment retention, riparian links, and ecological health, these channels have poor performance.

Modified channels (from basic bank armoured creeks to full concrete-lined channels) function as drains and canals rather than natural streams. Due to high flow velocities and the use of artificial materials, many of these channels are devoid of aquatic vegetation and incapable of supporting fish populations.

6.1.3.1 Policy and guidelines for minimising habitat alteration in urban streams

In addition to the general policies stated in Chapter 3, the following **policies** apply to habitat alteration proposals in urban streams:

1) NSW DPI will generally not support or approve the permanent piping or channelising of CLASS 1 2 or 3 waterways (see Table 2).

2) NSW DPI will generally not support or approve permanent realignment works in TYPE 1 and 2 habitats (see Table 1).

3) Temporary piping, channelizing or realignment works may be considered for public infrastructure projects (e.g. public road projects) where the works are short time only (generally less than 6-12 months) and the final construction of permanent works will result in the achievement of NSW DPI's no net loss policy (see section 3.3.3).

Guidelines for implementing the above policies include:

a) If proposed stream works in a given area achieve clear environmental improvements (including fish passage, habitat and water quality outcomes), certain channel modifications may be approved on a case-by-case basis. For example, major stream works may be approved in heavily degraded urban streams that are isolated from key fish habitat upstream and downstream.

b) Where channel modification is approved (e.g. in degraded areas), streams should remain as open channel systems.

c) Channel modification designs should include natural stream features including meanders, pools, riffles, bars and riparian and in-stream vegetation.

d) Rehabilitation of existing streams is recommended as opposed to construction of new channels.

e) Rehabilitation efforts, including the removal of concrete and other artificial stream linings and restoration of stream morphology and vegetation, are supported, particularly in CLASS 1-3 waterways where fish communities and opportunities for fish passage are greater. Such efforts should focus on enhancing the connectivity of the rehabilitation works with other sections of key fish habitat (see Table 1).

6.1.4 Protecting urban riparian vegetation

Riparian vegetation is critical to the health and viability of streams. In urban environments, the riparian zone plays a crucial role as a buffer and filter zone, as well as directly interacting with the stream by providing nutrients, shading, temperature control and stream stability. The protection of remnant vegetation within these zones will therefore act to protect adjacent in-stream habitat.

Armouring of banks to cater for higher flows has often involved the removal of riparian vegetation and the installation of retaining walls or completely lining a creek in concrete. Floodplain development has also led to the removal of riparian corridors in order to increase the area available for urban development. Often these developments take place without any land set aside to act as a buffer against the resultant increase in runoff, sediment and nutrient inputs. Increased runoff volumes and reduced water quality creates aquatic and riparian conditions more favourable to invasive riparian weeds which out-compete native vegetation.

6.1.4.1 Policy and guidelines for protecting urban riparian vegetation

In addition to the general policies stated in Chapter 3, the following **policies** apply to urban riparian zones:

1) NSW DPI requires that developments within urban areas be designed in a manner that protects the natural values of the existing riparian zone and ensures that the protected zone functions as a 'natural' system.

2) NSW DPI will assess urban development proposals on a case-by-case basis but with due regard to the cumulative impacts of development on riparian vegetation and key fish habitat (see Table 1).

3) NSW DPI will require riparian buffer zones to be established and maintained for developments in or adjacent to TYPE 1 or 2 habitats (see guidelines below). Please note that this policy does not apply to developments involving maintenance to existing, or construction of new roads or bridges crossing a waterway, but may apply to developments involving roads that are adjacent to, but not crossing a waterway (e.g. new subdivisions, rezoning proposals involving new access roads, new road developments along a new alignment). Riparian buffer zones shall be measured from:

   - the highest astronomical tide level in tidal areas (generally 1.0 m AHD), or
   - from the top of the bank/drainage depression along CLASS 1 to 3 waterways (see Table 2).

   NSW DPI will require the design of riparian buffer zones to incorporate the maintenance of lateral connectivity between aquatic and riparian habitat. Installation of infrastructure, terraces, retaining walls, cycle ways, pathways and grass verges within the riparian buffer zone shall be avoided or minimised.

Guidelines for implementing the above policies include:

a) NSW DPI will assess the width of the riparian buffer zone based on the habitat TYPE and waterway CLASS (see Tables 1 and 2), the possible extent of the disturbance and the susceptibility of the riverbank to erosion. As a guide the following are recommended:

- TYPE 1, CLASS 1: 100 metres
- TYPE 2, CLASS 2-3: 50 metres
- TYPE 3, CLASS 3-4: 10-50 metres

For guidelines on designing filter strips for this purpose (including appropriate widths) please refer to Prosser and Karssies (2001) (see Appendix 2). Advice on protecting aquatic macrophytes in wetlands and shallow lakes can be obtained from Bailey *et al.* (2002) (see Appendix 2).

b) Riparian buffer zones should be clearly delineated (e.g. fences or other markers) and well managed to avoid degradation (e.g. weed and public access management).

6.2 Water extraction and use

Water extraction and use is an essential function that assists to sustain communities, business and many primary industries. However, the regulation and diversion of river flows for the purpose of supplying water for irrigation, urban and industrial areas and hydro-electric power generation has created widespread adverse effects on aquatic ecosystems and biota. With increasing development, the consumptive use of water continues to escalate in NSW (although water abstraction has been capped in most inland rivers through the Murray Darling Basin Commission Ministerial Cap).

Extraction of water from a stream has an obvious direct impact upon the aquatic environment by reducing the flow and the amount of fish habitat in the stream. Pumping may also directly remove fish from the stream, especially larval fish (see Baumgartner *et al.* 2009). These primary impacts may have secondary impacts. For example, a reduction in stream flow may cause an increase in water temperature and a loss of seasonal or short-term flow variability which can have an impact on fish breeding or migration.

Infrastructure, such as dams and weirs that enable the storage and extraction of water, also has direct and indirect impacts on aquatic ecosystems. Dams and weirs create barriers to fish passage (see section 4.3), alter temperature regimes (see section 6.5) and turn lotic (running water) environments into lentic (still water) systems. These changes can disadvantage native fish while generally benefitting exotic fish species, creating fundamental changes to fish community dynamics. Such influences are believed to be a major cause of the success of alien fish species such as carp and redfin perch, as well as a major contributor to deleterious algal blooms.

Irrigation development creates a major demand for water during the driest part of the year when river flow is naturally low. To meet this demand, water is stored during the winter and spring and released during the summer and autumn. This ‘seasonal flow reversal’ interferes with the growth, productivity and breeding cycles of native fish, aquatic plants and other aquatic biota.

“The installation and operation of in-stream structures and other mechanisms that alter natural flow regimes of rivers and streams” has been listed as a key threatening process under the FM Act (see section 2.6.3). Restoration of the natural flow and temperature regimes in coastal and inland rivers and streams of NSW and the Murray-Darling Basin has been identified as a primary action for reducing threats to freshwater fish in NSW (Morris *et al*. 2001).

6.2.1 Legislation and government initiatives

Since 1995, the NSW Government has been actively implementing the NSW Water Reforms Program, in response to the decline in river health observed throughout the state. NSW Office of Water (within NSW DPI) is the lead government agency for implementing the Reforms Program and is also responsible for the administration of the *Water Management Act 2000* (WM Act). The WM Act is the main piece of legislation dealing with water management in NSW. The WM Act provides for the protection and restoration of the water source and dependent ecosystems in relation to water sharing and water use activities.

NSW DPI works closely with other agencies including OEH in developing and implementing water management policy and planning with the aim of improving riverine health. The NSW Water Reforms Program focuses on:

- better defining water access and use rules to ensure an equitable sharing of a limited resource,
- implementing water trading and pricing reforms to maximise the value gained from diverted water,
- reviewing the management of dams and weirs and other in-stream structures to mitigate their impact on fish passage and river health (see Chapter 4),
- improving the ecologically sustainable management of surface and groundwater,
- developing and implementing Water Quality and River Flow Objectives,
- classifying water sources in terms of risk and conservation value to guide management effort,
- buying back water entitlements for environmental flows (e.g. NSW Riverbank) and releasing environmental water to mimic natural flow variability.

The NSW Government is a partner in the National Water Initiative (see www.nwc.gov.au/nwi) endorsed by the Council of Australian Governments (COAG) in June 2004. The NSW Government prepared its NSW NWI Implementation Plan (see www.water.nsw.gov.au/Water-management/Law-and-policy/National-reforms/default.aspx in 2005 containing specific actions for implementing the eight key elements of the NWI. The plan was accredited by the National Water Commission on 18 August 2006.

The vast majority of inland NSW is within the Murray Darling Basin. In July 2008 COAG signed the Intergovernmental Agreement on Murray Darling Basin reforms. This provided for the establishment of a new independent Murray Darling Basin Authority to oversee the management of the Basin's water resources. The Murray Darling Basin Plan became Commonwealth law in November 2012. The Plan sets new limits on water extraction for each catchment in the Basin.

6.2.2 Policy for water extraction and use

In addition to the general policies stated in Chapter 3, the following **policies** apply to water sharing and water use relating to fish conservation and management. NSW DPI will:

1) ensure that the NSW Water Quality and River Flow Objectives (see www.environment.nsw.gov.au/ieo/ are considered and incorporated into any water management planning processes initiated under the WM Act,

2) ensure that water management planning processes take into account the requirements of threatened fish and marine vegetation and their habitats listed under the FM Act and under Commonwealth legislation,

3) continue to promote the need for flows in regulated rivers that mimic natural flow regimes, the need for establishing 'environmental flows' to maintain aquatic ecosystems, and to support the lifecycle requirements of native fish,

4) generally support efforts to reduce low flow extraction, particularly in unregulated rivers, by allowing access to high flows and storage in off-stream dams,

5) support the review of the operation of dams and weirs within regulated rivers to maximise the opportunities for environmental flow delivery, to enhance opportunities for fish passage, fishway construction, reduce cold water pollution and to improve riverine health (i.e. rehabilitate riparian vegetation, address water quality, maintain low flows and flow variability, control the rate of fall of flow events to avoid bank slumping),

6) support the development, introduction and widespread adoption of strategies to reduce consumption and increase the efficiency of water use,

7) generally support the principle of pricing water at a level which is a true reflection of both the real costs of supplying water and the environmental costs of removing it from the environment,

8) generally not support further water extraction from catchment areas that are known to support populations of threatened species of fish listed under the FM Act,

9) generally not support proposals for water extraction from coastal catchments to feed inland or inter-state rivers.

Other departmental policies relating to water extraction and use can be sourced at the department's website at www.water.nsw.gov.au

6.3 Sediment extraction in waterways

Sand, gravel and silt extraction in waterways is conducted for many purposes, including:

- sale of sand, silt and gravel material for industry use (e.g. construction and building supplies, landscaping supplies),
- supplying material for off-site remediation works (e.g. beach nourishment and spit development),
- creation and maintenance of navigation channels and waterfront access,
- managing estuary entrances, opening coastal lakes, and increasing tidal exchange rates,
- increasing stream channel capacity for flood mitigation and drainage control,
- removing sand slugs and other sediment build up in aggrading rivers and estuaries,
- remediation of contaminated sediments and weed infestation sites, and
- maintenance dredging of oyster lease sites.

Sediment extraction can also be conducted with the specific intent of depleting an area of sediment (see section F below) or to supply another area with sediment. Often these types of extraction works are conducted on a large-scale and involve extensive excavation within or adjacent to a waterway. As such, the potential impacts on fish habitat may be far greater than more discrete dredging activities.

6.3.1 Extraction activities and potential impacts

Depending on the scale of an extraction project and the location of the works, extraction may have substantial impacts on native fish and their habitats.

A. Extraction of material for sale

Sand, gravel and other types of aggregate are often used for road base and building and landscaping supplies. Whilst crushed rock from open cut mines provides a large proportion of the aggregate needed to supply development, fluvial sources (floodplain, river and estuary deposits) continue to be used within the construction industry.

The practice of extracting riverbank sediments has largely ceased, however, extraction industries still source sediment from floodplains (supporting natural floodplain creeks and backwater swamps), within rivers, and in estuaries.

Sand and gravel extraction on banks and riverbeds has been linked to many environmental problems including channel instability, riparian vegetation degradation and destruction of aquatic habitat.

B. Supplying material for off-site remediation works

Sand and gravel is sometimes extracted from waterways for the purposes of rehabilitating adjacent habitats. On a small scale, extraction may include dredging within a channel to realign a creek or to arrest an avulsion (where a river erodes a new flow path). On a larger scale, it may include locally-derived sediment for replenishing sand lost along estuary and coastal beaches (beach nourishment – see section 6.3.3).

The area where sediment is derived for the purposes of rehabilitation elsewhere is often termed the 'borrow site'. Depending on the nature of sediment movement, it may be that the dredging of sand from a borrow site is unsustainable.

C. Navigation channels and waterfront access

For boating activity to occur safely, navigation channels need to be maintained to certain minimum depths and widths to allow for boats to move across waterways without having keels, rudders and propellers hitting substrate in low flow (for rivers) and low tide (for estuaries). Essential public use of the waterways, such as ferry services, take priority over most other reasons for ensuring navigation.

Along many waterways, as foreshore development encroaches on new areas, the demand for boat access to private water frontage continues to put pressure on fringing aquatic habitat. In addition to the impacts of boating infrastructure (such as jetties, moorings and pontoons), creation and maintenance of boat access routes can directly damage aquatic habitats.

The pressure to create waterfront access points have not only lead to the disturbance of existing waterways and their habitats, but also to the artificial creation of waterways for aesthetic and recreational purposes. In the past, the creation of canal estates in estuaries and river or lake estates in freshwater environments has often been at the expense of existing aquatic habitats. In some areas small waterways are in filled to make way for larger artificial water bodies where housing developments can be located to offer water views and water access. Such water bodies can lead to future adverse impacts on water quality, localised flood mitigation, and the environmental values of natural streams and estuary embayments.

D. Managing estuary entrances

The amount of tidal flushing that an estuary receives is partly a function of the size, position and nature of the entrance channel. Entrance channels of some estuaries, particularly coastal lakes and lagoons, are artificially opened (e.g. using excavators) periodically to minimise flood impacts as well as to allow for greater and more frequent flushing of the estuary. Some entrance openings in the past have resulted in localised fish kills from the rapid drawing down of poor quality water into the estuary (e.g. from floodplains, septic systems and stormwater) when the entrance is breached (see section 6.4).

Many coastal lakes in NSW have been permanently kept open to the sea by a combination of entrance channel dredging and by the construction of training walls to maintain the position of the entrance. In terms of diversity and abundance of fish, it is often entrance habitats that are most valuable for fish survival. As such, activities within this zone must be undertaken with caution to avoid disturbing existing habitat, or to cause problems for surrounding habitat in the future.

E. Flood mitigation and drainage control

Drainage works within waterways to increase channel capacity and improve delivery of flows are often undertaken to mitigate the effects of flooding. The practice may include dredging of small streams located on floodplains that have otherwise been functioning as irrigation or drainage channels. Often the clearing of these 'drains' is done with the intention to increase the capacity of the channels to carry excess irrigation waters or to drain floodplains during flood events and drain wetlands.

These channels often support fish habitat such as macrophytes, mangroves and snags. These habitats may act as refuge areas for fish or connecting habitats to allow fish movement between stream channels and floodplain wetlands and billabongs.

'Delving' is a term sometimes used to describe the practice of clearing channels of sediment and vegetation that would otherwise reduce the capacity of the channel to carry water. Delving, along with any activity that removes sediment or marine vegetation from within waterways requires a permit to dredge and/or harm marine vegetation under the FM Act (see section 5.1.1).

F. Stream and estuary rehabilitation works

Rapid accretion of sediment often due to large scale clearing of catchments within river systems can cause substantial degradation to fish habitat (e.g. burial of macrophytes, siltation of gravel spawning beds, infilling of pool habitat). Depending on the volume and depth of aggrading material and sediment pulses (often called 'sediment slugs') this material can substantially alter the morphology of streams by causing widening (via bank erosion) and by leaving a homogenous bed substrate (e.g. sand, gravel) smothering aquatic habitat features such as pools and riffles, in-stream vegetation, and snags.

In estuaries, accelerated sedimentation may lead to the burial of marine vegetation such as seagrasses and macroalgae. In some estuaries sedimentation may be followed by colonisation of mangroves.

To avoid the impacts of sedimentation it may be necessary to extract material before it moves downstream. Remediation extraction in waterways can also include dredging of sediment behind infrastructure such as dams. In the case of dams and weirs to be decommissioned or removed, sediment build up behind the structure, if released, could cause major effects downstream.

G. Remediation of contaminated sediments or weed infestation sites

In some instances, contaminants may be present in sediment within waterways and remediation of the site requires extracting the sediment directly. There may be a build up of heavy metals, chemicals or other contaminants that could eventually be released or leached out into the water column.

In estuaries, measures are often taken to control the build up of malodorous mud (organic rich sediments in estuaries) and wrack (decaying seaweed and seagrass) along the foreshores. Often these sediments accumulate near developed foreshore areas and may be offensive to the public due to the odour emitted from the material. Councils are often requested to dredge sediment and remove wrack from areas that present a health risk or nuisance to the public (see section 3.2.3.3 on wrack removal).

There may also be the requirement to conduct extraction activities in waterways to control the spread of weed species (e.g. removal of alligator weed via dredging).

H. Fossicking in watercourses

Sediments may be extracted in freshwater areas for the purpose of fossicking for gemstones. Gem minerals survive processes of rock weathering and stream transport and, like alluvial gold, collect in crevices in stream beds and in gravel bars on the insides of stream bends. These may be recovered by panning, but it is more common for the gem-seeker to use sieves made especially for this purpose.

Disturbance to the bed of the waterway and the in-stream washing and sorting of materials collected to extract the gemstones can result in direct impacts on aquatic habitats or indirect impacts such as siltation and smothering of in-stream gravel beds and macrophytes. Siltation also reduces water quality for in-stream fauna and can affect the gills of fish, causing respiratory distress or disease.

The NSW Government has released a guideline for fossicking and should be referred to when undertaking any fossicking activities in NSW waters (see www.resources.nsw.gov.au/__data/assets/pdf_file/0007/363544/A-Guide-to-Fossicking-in-New-South-Wales.PDF)

I. Maintenance dredging of oyster leases

Sediments may be extracted from oyster leases in estuaries to maintain water quality and a stable mean water level that varies with each tidal cycle in order to maximise oyster lease production.

6.3.2 Legislation

Refer to section 5.1.1.

For further information on legislation relating to fossicking refer to the “Guidelines for Fossicking” see www.resources.nsw.gov.au/__data/assets/pdf_file/0007/363544/A-Guide-to-Fossicking-in-New-South-Wales.PDF. Please note that fossickers not complying with the FM Act may be liable to on-the-spot fines and penalties of up to $110,000 and for the costs of any aquatic habitat restoration works.

6.3.3 Policy and guidelines for sediment extraction (excluding fossicking)

In addition to the general policies stated in Chapter 3, the following **policies** apply to sediment extraction in waterways:

1) NSW DPI will generally not approve sediment extraction proposals in TYPE 1 and 2 habitats (see Table 1), CLASS 1 or 2 waterways (see Table 2) or that interfere with commercial and recreational fishing or aquaculture activities unless impacts can be adequately mitigated or compensated, or the extraction will result in the rehabilitation of aquatic habitats and fish stocks.

2) NSW DPI will assess extraction proposals with consideration for the following priorities:

   - essential remediation works of contaminated sites and other hazardous situations;
   - maintenance of existing essential navigation channels for public use;
   - stream and estuary rehabilitation purposes;
   - flood mitigation and asset protection for public purposes;
   - non-remediation extraction for private purposes including oyster production, flood control, drainage, navigation, and sale of materials.

3) NSW DPI will generally not approve the creation of navigation channels for private use in areas that support TYPE 1 or 2 habitats.

4) NSW DPI will generally not approve dredging and reclamation to create artificial canals attached to existing waterways. This includes coastal developments and freshwater environments such as artificial lake estates.

5) NSW DPI will require proponents to carefully monitor the impacts of extraction activities including:

- rates of sediment infilling post-works,
- upstream and downstream impacts,
- immediate habitat changes.

6) NSW DPI will require extraction proposals for rehabilitation or remediation works to ensure that the environmental outcomes are positive and that environmental harm does not result.

7) NSW DPI will require the environmental assessment for any extraction proposals to address impacts on borrow sites (areas where sediment is extracted for the purposes of rehabilitating adjacent habitats) in terms of natural replenishment rate and whether the area will be adversely affected by the loss of sediment.

8) NSW DPI will generally not approve the disposal of spoil into the waterway as it can impact on the aquatic environment (e.g. smothering benthic animals and plants, water quality). Disposal of spoil into a waterway may be permitted if procedures comply with OEH guidelines and disposal occurs at recognised offshore dumping grounds.

9) NSW DPI requires that excavation spoil not be stockpiled within 50 m of TYPE 1 and 2 aquatic habitats as it may cause problems with sedimentation and turbidity. Sediment and erosion control measures must be put in place for the management of any spoil disposal sites which have the potential to contaminate nearby waterways.

Guidelines for implementing the above policies include:

a) The following information should be provided with any proposals to conduct large-scale (i.e. > 20 m^3) or commercial extraction activities, in addition to the standard information required for environmental assessments (see section 3.3):

- sediment material sources and rates of supply (i.e. whether rates of sediment accretion on-site are accelerated),
- consideration of flood regime and flow velocities (i.e. natural sediment movement rates and timing in relation to flood events),
- alternative sediment sources/sites – options for alternative methods or alternative extraction sites (preferably off-line extraction),
- adjacent land/water uses (e.g. number of similar works in the system, presence of oyster leases or commercial and recreational fishing areas, local boating activity, etc),
- methods to be employed to extract the material (note that a cutter suction dredge is generally considered preferable to a dragline dredge),
- methods to be employed to control off-site impacts of works (e.g. sediment and erosion control plan).

b) Extraction may be approved in areas that are undergoing degradation from sediment slugs if adequate research is undertaken prior to works. Advice should be sought from NSW Office of Water in regards to suitable study methods.

c) Excavation of sand and gravel beaches on the inside (convex side) of bends in waterways, from the bed of inter riffle areas or from unvegetated sand/mud substrates is less damaging. However, these areas should only be excavated in cases where the banks of the stream will not be undermined and where the rate of removal of material will not exceed the rate of replenishment from the bed load movement.

d) A geomorphic study may be required to determine the nature of sediment and sediment transfer in the vicinity of the proposed extraction site. NSW DPI may not approve extraction activities in estuaries and rivers that will adversely affect the natural sediment and hydrological regime.

e) Sediment to be extracted should be tested for contaminants prior to any works including heavy metals, organochlorines, Acid Sulfate Soils, and toxic dinoflagellates. Contaminated sediment must be disposed of in accordance with OEH guidelines.

6.4 Intermittently closed and open lakes and lagoons (ICOLL) management

Approximately half of the 184 major estuaries in NSW are intermittently closed by entrance barriers. These are referred to as intermittently - closed/open lakes and lagoons (ICOLLs).

Formation and breakdown of entrance barriers to ICOLLs occurs when sediments are moved and redistributed by wind, wave and tidal forces or via elevated water levels in the lake causing the berm to breach. This may occur frequently (e.g. Dee Why Lagoon up to 5 or 6 times per year) or infrequently (e.g. 2 to 3 times per century for Lake Conjola). Around half of these lagoons have their entrances artificially breached from time to time (West *et al*. 1985). The two most common objectives for artificially opening lagoon entrances are (i) to mitigate flooding, and (ii) to improve water quality.

Flood mitigation

With a closed entrance and continuing freshwater inflows from catchment streams during heavy rains, water levels in lagoons can rise to a height considerably above peak tidal levels (commonly 1.5 to 3 m AHD). Where urban and rural development has taken place on, or close to, the fringes of lagoons, rising waters can lead to the flooding of properties, roads, recreational areas and farmlands. Breaching of the entrance barrier may be undertaken to relieve an existing threat or in anticipation of a growing threat of flooding.

Water quality

When an ICOLL entrance closes, the dilution capacity of tidal flushing is lost. Deterioration of water quality can occur gradually through continuing inputs of nutrients and other pollutants from the catchment and from the evaporative concentration of salinity levels within the water. It can also rapidly deteriorate when rising water levels flood septic tanks or sewage infrastructure and release potentially harmful bacteria (e.g. faecal coliforms) into the system. Either way, the lagoon may be rendered unsafe for primary contact recreation (e.g. swimming).

The NSW oyster aquaculture industry is highly dependent on salinity levels, tidal variation (i.e. oysters are set relative to mean water levels for inundation and drying over the average tidal cycle) and water quality. Oyster farming is generally situated in permanently open estuaries or ICOLLs that close infrequently. When an estuary entrance closes there are increased periods of low salinity, higher water temperatures and poor water quality resulting in the potential for disease, reduced growth or mortality of stock resulting in lower oyster production.

Under **natural conditions**, closed ICOLLs break out over a relatively wide range of water levels which is termed the '**natural breakout range**'. A single artificial opening within this range is not likely to have a significant environmental impact since it falls within the expected natural variation. However, over the longer term, numerous mechanical openings or artificially maintained opening at a low level is likely to have a significant environmental impact since the natural frequency and duration of opening will be significantly altered.

In the short term, more frequent openings can lead to the death of aquatic vegetation and upon refilling, lead to conditions of low dissolved oxygen and increased incidence of fish kills. In the long term, the impact will be most visible in the form of shifts in the structure and distribution of fringing native vegetation communities and resulting weed infestation.

It should be remembered that flooding and drying are natural components of the hydrological and ecological processes operating within ICOLLs. They have evolved in response to these forces and should be left to operate as close to natural as possible. Accordingly, while it is understood that under extreme circumstances it may be necessary to artificially breach an ICOLL entrance, this practice should be employed only as a last resort.

Unfortunately, past manipulation of entrance channels has increased the proportion of estuaries at the 'permanently open' end of the scale. This has been achieved by the 'training' of the entrances of many larger rivers and lakes with rock groynes and walls and the regular dredging of many others.

If the ecological features and processes that characterise ICOLLs are to be conserved, it will be necessary to ensure that a representative sample of such systems is also conserved and therefore that interference with the hydrological processes operating within them is minimised.

6.4.1 Legislation

Local councils have a duty to manage water quality and land subject to flooding.

Any works within an ICOLL entrance by an organisation other than the owning or controlling body would require 'landowners consent' as a minimum. The entrance to ICOLLs are often under various ownership, and tenure needs to be clearly established to determine responsibility for entrance management and required approval processes. The majority of ICOLL entrances are Crown land under the jurisdiction of NSW DPI (via the Marine Parks Authority or Crown Lands Division) but some are managed by OEH (e.g. where they occur in coastal national parks or nature reserves). Some ICOLL entrances are public reserves under the control of local councils.

If dredging (including excavation) or reclamation is to be undertaken below the highest astronomical tide, **ss199**, **200**, and **201** of the FM Act may apply. These sections apply to any dredging works carried out in **water land**. For public authorities, other than local councils, the FM Act requires **prior referral** of dredging works to the Minister for Primary Industries for consultation prior to the issuing of any approvals/authorisations. For local councils or persons, the Act requires a **permit** from the Minister for Primary Industries (unless the work has already been authorised under the *Crown Lands Act 1989* or by a local authority*).* The maximum penalty for unauthorised dredging is $220,000 for local government authorities or corporations and $110,000 for individuals.

SEPP 71 (Coastal Protection) overrides other local planning instruments (e.g. local environmental plans (LEPs) and development control plans (DCPs)) and removes some of the decision-making powers of local government for the coastal zone. The broader objectives of SEPP 71 (Coastal Protection) are to ensure responsible development according to the principles of ecologically sustainable development and to protect and preserve native coastal vegetation, the marine environment and rock platforms and other coastal habitats.

6.4.2 Policy and guidelines for managing ICOLLs

In addition to the general policies stated in Chapter 3, the following **policies** apply to ICOLL management:

1) Any proposals to artificially open ICOLLs must be authorised by a permit from the Minister or authorised by NSW DPI or other public authority after consultation with the Minister under the FM Act.

2) NSW DPI supports minimal interference with ICOLL barriers and advocates natural processes being allowed to operate to the greatest extent possible.

3) NSW DPI does not support the artificial opening of an ICOLL unless the proponent can demonstrate that the social, environmental and economic benefits greatly outweigh any potential adverse impacts.

4) NSW DPI supports using estuary management plans and environmental assessment processes to analyse the issues relating to opening a particular ICOLL, and to develop an entrance management plan. Proposals for artificial openings which are to be carried out according to a formulated entrance management plan are more likely to be approved.

Guidelines for implementing the above policies include:

a) Illegal openings should be guarded against by the erection and maintenance of signs near the ICOLL entrance warning people that unauthorised opening is illegal and may result in prosecution.

b) The decision to open an ICOLL should be made on the basis of **factual data** on:

- **verified water levels** and the nature and extent of associated flooding impacts - which should be referenced to a standard datum (e.g. Australian Height Datum) obtained from appropriately sited staff gauges, or automatic water level recorders, and
- **quantitative** evidence of changes to relevant water quality parameters (especially nutrient and bacterial levels) produced by monitoring programs designed specifically to assess water quality pre- and post-opening.

c) In the short-term (i.e. prior to an entrance management plan being put in place), an **interim strategy** for each problematic ICOLL should be formulated, documented and agreed to. The interim strategy should be made in consultation with all relevant natural resource management agencies, representatives of local community interest groups and affected landholders and provide a clear guide to where, when and under what conditions to open the ICOLL entrance. Criteria to be met may include:

- a preset water level above which a breach is recommended;
- a preset range between which a breach is recommended if heavy rainfall is predicted;
- a preset duration of high water level and/or wetland/pasture inundation over which a breach may be recommended;
- other environmental parameters (e.g. avoiding the breeding season of threatened birds such as the Little Tern).

d) The main purpose of the interim strategy should be to account for critical environmental issues and if required, **to facilitate a sanctioned opening at very short notice** (e.g. Coila Lake Entrance Management Policy gives the relevant 'approval' bodies 3 days to respond to a breach request).

e) In the event that the criteria for an artificial opening are met, breaching should be conducted during a falling tide (if possible, around a spring tide) so that the potential for establishing an entrance channel long enough to flush the water body is achieved.

f) In the long-term, local councils and government agencies should aim to reduce the need for artificial manipulation by taking active measures to remove, relocate or otherwise manage items of low-lying infrastructure that currently necessitate breaches below the natural breakout range, and adopting catchment management practices that:

- reduce the inputs of nutrients and pollutants from point and diffuse sources,
- prevent transfer of flood prone and riparian land on the margins of ICOLLs into private ownership,
- prevent the future development or subdivision of flood-prone and riparian lands by adopting appropriate zonings and buffers in relevant land use planning instruments,
- implement community awareness campaigns to gain broad based understanding and support for the environmentally responsible management of ICOLLs.

6.5 Water pollution

Water is the basis of all aquatic habitats (marine, estuarine and freshwater) and provides the medium for most aquatic animals and plants to maintain gas exchange, obtain food, disperse their larvae and to remove metabolic wastes. It also provides the transport system for aquatic organisms to disperse and to recolonise disturbed areas. Nutrients, dissolved oxygen content, pH (acidity), turbidity (clarity), altered temperature, salinity and chemical contaminants are the most important aspects of water quality from a fisheries perspective.

Water quality decline is a major cause of the reduction in fish diversity and numbers in NSW. Pollutants can directly lead to a decline in fish numbers by increasing fish and egg mortality rates, or by reducing the quality of fish habitat. Individual pollution events from accidental spills, over spray of agricultural chemicals or deliberate discharges have caused many fish kills (see section 6.6). Moreover, ongoing discharges of contaminated water reduce the viability and productivity of fish habitats and fish populations and their suitability for human consumption.

Point-source pollution such as that from sewage outfalls, paper mills, factories, abattoirs, gravel-washing plants, dredging, mining, dams, ships and power stations can have a number of adverse environmental impacts. The nature and degree of impact of pollution upon aquatic ecosystems depends on a number of factors, including the type of pollutant, the volume and frequency with which it is discharged, and the assimilatory capacity of the waterway. The impact also depends upon the life cycle stage of the fish species that come into contact with the polluted water. Eggs and larval fish are generally more susceptible than adults. Pollution may also have chronic and sub-lethal impacts. The discharge of acidic water into estuaries where floodplain development has disturbed Acid Sulfate Soils has been shown to increase the susceptibility of fish to 'red spot' disease as the acid water can cause lesions which are then infected by the disease.

Thermal pollution resulting from the release of water from deep layers (up to 15°C lower than surface waters) of large dams has had a profound impact upon the distribution and abundance of native fish species in many coastal and inland river systems. Releases of colder water, while allowing some species such as trout to survive, can mean that temperatures up to 300km downstream may be too low for many native species to grow and reproduce. This can lead to localised depletion of species and reduce the total fish biomass in the system. The lower temperatures can also lead to slow fish growth, limited food production and loss of biodiversity (for further information see www.dpi.nsw.gov.au/fisheries/habitat/threats/cold-water-pollution).

Diffuse-source pollution is generated from catchment runoff and erosion and often creates elevated turbidity and nutrient levels in the receiving waters. Stormwater runoff from roads and other impermeable surfaces in urban areas can carry significant quantities of nutrients, heavy metals, grease and other pollutants. Poor drainage management associated with contaminated lands, Acid Sulfate Soils, and saline areas, can contribute to both groundwater and stream water contamination. High levels of phosphorus and nitrogen can reduce the oxygen levels in water through algal blooms, some of which can be toxic (e.g. blue green algae). Pesticide and herbicide residues can also be transported through surface runoff into adjoining streams from agricultural lands where applied near waterways.

Surface runoff can also increase the amount of suspended material that enters nearby streams, particularly during construction works when soils are exposed, thus increasing turbidity levels in streams and estuaries. Turbidity (siltation) has been found to irritate the gills of fish in extreme cases causing breathing problems and even mortality. Sediment levels can also indirectly affect fish by causing substantial changes to their habitat (e.g. reducing light penetration for macrophytes and seagrass growth, infilling of gravel beds and deep holes etc.). Even changes in the amount of freshwater entering estuaries as runoff can cause habitat decline by killing estuarine vegetation such as seagrass.

6.5.1 Legislation and other government policies and initiatives

The *Protection of the Environment Operations Act 1997* is administered by the NSW Environment Protection Authority (NSW EPA) and local government. Under this Act, it is an offence to pollute waters without a licence. NSW EPA regulates industries (including urban and agricultural ventures) that produce (or have the potential to produce) point source discharges. Local government is responsible for regulating point source water pollution from developments (where they are the consent authority) or council infrastructure, such as septic and stormwater systems and effluent re-use schemes.

NSW DPI has initiated a number of programs to assist agricultural land managers to reduce water pollution, including the Fish Friendly Farms and Fish Friendly Wetlands Programs (see www.dpi.nsw.gov.au/fisheries/habitat/rehabilitating/fish-friendly-farms) and advisory brochures (www.dpi.nsw.gov.au/fisheries/habitat/rehabilitating/living-and-working-on-a-riverbank). These programs and advisory material aim to highlight best practice techniques for managing riparian and in-stream fish habitat and reducing the potential for diffuse pollution from overland runoff or stock access.

The NSW Government has recognised the importance of thermal pollution and has agreed upon a strategy to investigate, and where possible ameliorate, the impact at high priority dams where it is technically and economically feasible to do so. NSW Office of Water, in consultation with other agencies, has developed guidelines to be applied to those high priority dams releasing cold water derived from thermal stratification within the dam where feasibility studies have determined that changes to structures and or operating protocols can technically and economically deliver improved thermal outcomes downstream of large dams.

At some dams, infrastructure for managing cold water pollution already exists and is currently in use. The challenge for these sites is to better manage the infrastructure to optimise the temperature and other water quality outcomes. At other dams, no such infrastructure exists, and the NSW Government is investigating the feasibility of testing new outlet arrangements and technologies to address thermal pollution from high priority dams, such as Burrendong Dam.

NSW Office of Water may issue works approvals under the WM Act to some dam owners/operators. These may include requirements (conditions) to manage cold water releases. The specific requirements will reflect the dam's priority for mitigation measures (as assessed periodically by the NSW Government).

In 2008 the NSW Government released a state-wide Diffuse Source Water Pollution Strategy (DSWP) (see www.environment.nsw.gov.au/water/dswp.htm) to help progress towards the Natural Resource Management (NRM) targets identified in the NSW State Plan relating to water quality. The Strategy prioritises DSWP management actions to provide a coordinated focus and guide investment decisions. It also provides an agreed framework to promote and report on the implementation of DSWP priority management actions and partnerships. A Priority Action Plan (PAP) has been developed to set the framework for delivery of the Strategy.

SEPP 62 (Sustainable Aquaculture) (see www.legislation.nsw.gov.au) requires consent authorities to consider whether developments may adversely impact on oyster aquaculture and allows them to refuse a development application if they are satisfied that the development will adversely affect or impede oyster aquaculture despite any mitigation measures proposed. Water quality guidelines have been developed under the NSW Oyster Industry Sustainable Aquaculture Strategy (OISAS) (see www.dpi.nsw.gov.au/fisheries/aquaculture/publications/oysters/industry/nsw-oyster-industry-sustainable-aquaculture-strategy) to guide decision making by consent authorities. OISAS and the amendments to SEPP 62 aim to maintain, and where possible improve, the environmental conditions required to ensure the long-term security and sustainability of the NSW oyster aquaculture industry.

The Australia New Zealand Environment Conservation Council (ANZECC) has established water quality guidelines which are generally used to assess water quality (ANZECC 2000). These guidelines have been used in the determination of water quality objectives for NSW (see OEH website at www.environment.nsw.gov.au). Water quality

objectives across the state are to be identified as targets in catchment action plans, water management plans and other natural resource management planning processes.

In conjunction with OEH, local councils also develop local stormwater management plans to reduce pollutant loads in stormwater generated within urban areas.

Under the FM Act, NSW DPI has the power to regulate activities that can impact on waterways through the issuing of permits and associated conditions. Where approved, activities such as sediment extraction, dredging and reclamation works, harm to marine vegetation or blockages to fish passage are conditioned to ensure that water quality of receiving waters is protected.

6.5.2 Policy and guidelines for minimising water pollution

In addition to the general policies stated in Chapter 3, the following **policies** apply to minimising water pollution:

1) NSW DPI supports the 'polluter pays' principle.

2) NSW DPI will generally not support or approve any activities or developments that lead to unnecessary and significant pollution of waters and/or result in deleterious effects on native fish or humans via fish consumption. This includes:

   - discharging of effluent (including waste discharge from vessels) directly into TYPE 1 fish habitat, Recreational Fishing Havens, commercial fishing grounds or aquaculture areas (see Table 1),
   - discharging of effluent to any waterway where land application (by irrigation or exfiltration) is a feasible alternative,
   - developments on coastal floodplains which propose to proceed in a manner that will cause exposure of Acid Sulfate Soils and potentially result in acid drainage to estuaries,
   - activities involving the direct spraying of waterways with herbicides (to control plant growth) where other viable alternatives (i.e. manual methods) exist,
   - the construction of waterway infrastructure that will cause substantial (greater than 2^0C) changes in water temperature without appropriate mitigation measures,
   - disposal of contaminants in waterways such as pesticides, heavy metals and pathogens (which can accumulate in fish tissue and affect the health of fish stocks or human health via consumption of affected fish) without appropriate mitigation measures,
   - disturbance of contaminated soils in or adjacent to waterways, that could result in the release of toxicants, without appropriate mitigation measures.

3) NSW DPI will require that buffer zones be established around developments or other sites of activity that may generate significant levels of pollutants (including excess sediment, nutrients, chemicals, and gross pollutants). See section 3.2.4 for details on riparian buffer zones. Please note that this policy does not apply to developments involving maintenance to existing, or construction of new roads or bridges crossing a waterway, but may apply to developments involving roads that are adjacent to, but not crossing a waterway (e.g. new subdivisions, rezoning proposals involving new access roads, new road developments along a new alignment).

4) NSW DPI will continue to work with landholders and the CMAs to improve agricultural land management practices in order to reduce the potential for point source pollution to enter aquatic environments.

Guidelines for implementing the above policies include:

a) Pollution of waterways should be avoided by the:

   - identification of point-source and diffuse pollutant discharges,
   - prevention and minimisation of such discharges,
   - effective treatment of any continuing discharges,
   - disposal of wastes to alternative land sites, or to processing facilities.

b) Measures to achieve no net impact on receiving waters include:

   - controlling sediment at the catchment and local site scale (e.g. protecting existing vegetation, minimising the area of impermeable surfaces, requiring better treatment of road drainage),
   - controlling pollution from urban areas with gross pollutants traps fitted to stormwater drains (ensuring they are 'off-line' - see section 6.1),
   - protecting vegetation buffers around disturbance areas and re-instating native endemic riparian vegetation where possible (see section 3.2.4),
   - controlling stock access to riparian vegetation and waterways,
   - preventing new outfalls and drains from discharging into or within 50-100 m of natural wetlands or seagrass beds (see section 3.2.3.2),

- controlling sedimentation from cleared areas via sedimentation ponds and artificial wetlands (preferably off-line) (see section 6.1).

c) Mitigation measures for controlling water quality in impoundments may include:

- use of a variable level off-take or other cold water pollution mitigation options to maintain pre-impoundment temperature and water quality downstream,
- destratification by aeration methods.

d) Developments or activities should aim to improve or have no net impact upon the receiving watercourse. To measure this, water quality assessments should include analysis of dissolved oxygen, pH, turbidity, temperature, nutrients and salinity as a minimum, and should take into account the existing water quality status of the receiving watercourse.

e) Sediment to be used in dredging or reclamation should be tested for contaminants prior to any works. Contaminated fill or dredge spoil containing toxic substances (i.e. heavy metals, organochlorines, Acid Sulfate Soils, dinoflagellates, etc.) should not be dredged or used in reclamation.

f) Sediment controls along drainage lines should be left in place to control sediment entering a waterway after the construction phase is completed, and until the site has been fully stabilised

g) Use of chemical sprays such as herbicides and pesticides near or within waterways must be done in accordance with legislation administered by NSW EPA and best practice guidelines (see their website at www.environment.nsw.gov.au/epa/). Timing of the use of chemicals should take into account the spawning and migration seasons of native fish (generally from September to March).

6.6 Fish kills

Fish kills (any sudden and unexpected mass mortality of wild or cultured fish) are often perceived to be the result of pollution or contamination of waters, however there may also be natural causes.

NSW DPI maintains a database of fish kills in NSW. It contains over 1400 records dating back to the early 1970s. The data suggests that on average 40 fish kills are reported to NSW DPI each year. Since many smaller kills go unnoticed and others remain unreported, the real number of kills is considered to be significantly larger.


Richmond River Fish Kill 2008

The data suggest that freshwater and estuarine areas are equally affected (each contributing approximately 45% of all kills) whilst oceanic waters contribute to approximately 10% of incidences. The species most frequently affected by kills include Freshwater Mullet, Common Carp, Leatherjackets and Bony Bream. Hardy species such as carp and eels appear to be susceptible to kill events because they occupy marginal habitats that are periodically subject to influences which exceed the tolerance limits of these species.

Particularly problematic areas in NSW include the Richmond River, Murrumbidgee River, Lake Macquarie, the Hawkesbury River and other rivers and estuarine areas in the Sydney metropolitan area.

No cause was identified for 38% of the fish kills in NSW over the last forty years. Of those where a diagnosis was made, the main causes were low oxygen levels (caused by: bushfires, decaying vegetation matter (18% of cases)), pesticide/chemical pollution (8%), high or low temperatures (6%), algae and algal blooms (4%) and acidic runoff (4%). There are also a significant number of incidents attributed to dumping of waste fish or bycatch (8%). A large percentage of kills are caused by several factors acting together (e.g. poor water quality due to industrial or urban pollution predisposing fish to disease or temperature shock).

Three main factors play a major role in fish kills:

- toxicants/pollutants,
- environmental factors (e.g. salinity, temperature, acidity levels, dissolved oxygen levels), and
- infection with disease pathogens.

There are good reasons why fish kills should be investigated and a cause determined including:

- understanding the cause of a kill may help prevent a recurrence. This is especially relevant in an aquaculture situation or where threatened species are involved.
- there may be public health risks associated with a kill, especially where a disease is present within the fish population, or there has been contamination with some form of pollutant.
- a kill may be a sign of a fundamental problem with the habitat which needs to be addressed.
- there may be an opportunity for legal action against individuals or organisations for polluting a waterway.

- the kill may be due to a new disease organism or toxic algae and there is a need to implement quarantine measures or other treatments.

NSW DPI and NSW EPA have developed a protocol for investigating and reporting fish kills to increase our understanding of why they occur and to address their causes (see www.dpi.nsw.gov.au/fisheries/habitat/threats/fish-kills).

The reporting, and subsequent investigation of fish kills may help prevent recurrence of these events. Local councils, other state agencies and members of the general public are encouraged to report any fish kills immediately to NSW DPI or NSW EPA.

6.7 Use of explosives, electrical devices and other dangerous substances in waterways

Explosives and electrical devices are used in water for various reasons including the testing of defence equipment, destruction of abandoned and derelict military ordinance, rock excavation, demolition of old structures, navigation applications (deepening channels/harbours), geophysical exploration and fish sampling.

The use of explosive devices can kill and injure fish and marine vegetation. Extensive damage and mortality to aquatic plant beds can result from underwater explosions. For example, in the late 1960's a seismic survey in Jervis Bay was carried out and left a series of 11 bare circular holes which are still clearly visible in an otherwise healthy *Posidonia australis* seagrass bed. Studies have found that such explosives result in cell wall failure internally in the rhizomes of the plants (Ludwig 1977).

Underwater explosions also produce a pressure waveform with rapid oscillations from positive pressure to negative pressure, which result in rapid volume changes in gas-containing organs. In fish, the swimbladder, a gas-containing organ, is the most frequently damaged organ resulting from underwater blasts (Keevin *et al*. 1997). Species lacking swimbladders or with small swimbladders appear resistant to explosive pressures, however studies have shown that structural abnormalities in fish eggs can occur up to 20 m away from a blast point (Kostyuchenko 1973).

Blasts producing a peak particle velocity (ppv) greater than 13 mm-sec^{-1} in a spawning area (such as gravel beds) during egg incubation season can have devastating effects on species such as Macquarie perch and trout (Kostyuchenko 1973).

Dynamite and explosives are also used in some areas of the world as a fishing method, which not only has deleterious impacts on fish and other aquatic fauna, but can destroy aquatic habitats as well.

Electrofishing is a technique used to passively sample fish within waterways by passing a current through the water that causes a muscle response reaction in fish, effectively stunning them. Electrofishing is used for stock assessment, tagging, catching spawning stock, anaesthetising fish or to remove pest species.

6.7.1 Legislation and standards

It is illegal under **clauses 70-73** of the FM Regulations to use dynamite and other explosive substances or electrical devices in NSW waters without a permit from NSW DPI. The maximum penalty for unauthorised use of such substances or devices is $11,000.

All work using explosives in NSW must be carried out to Australian Standard AS-2187. This requires the person in charge to be suitably trained and qualified and all the explosive works to be planned and carried out in a safe manner.

6.7.2 Policy and guidelines for use of explosives, electrical devices and other dangerous substances in waterways

In addition to the general policies stated in Chapter 3, the following **policies** apply to the use of explosives, electrical devices and other dangerous substances:

1) Sampling of fish using electrical devices requires a permit from NSW DPI. Such applications will be assessed on a case-by-case basis.

2) Sampling of fish using explosives and other dangerous substances will generally not be approved unless it will result in an environmental improvement (e.g. removal of pest fish species from waters where there is a low risk to native fish species).

3) Where the use of explosives and other dangerous substances is required for other purposes, the proponent must be able to demonstrate that the use of such devices is the only method suitable and that alternative methods to undertake the works have been investigated.

4) Use of explosives and other dangerous substances in TYPE 1 fish habitat (see Table 1) or in commercial fishing grounds will generally not be approved.

5) Blast programs must be designed to minimise the impacts on surrounding fish and fish habitat, and any impacts adequately compensated (see section 3.3).

Guidelines for implementing the above policies include:

a) Explosives and other dangerous substances should generally not be used in shallow water (less than 2m).

b) If there is potential for high fish mortality, measures should be in place to reduce impacts including:

- the use of properly designed bubble curtains or physical barriers,
- limiting the timing of blasts to avoid major migration periods, spawning seasons or larval drift,
- using non-explosive noise techniques to move fish from the immediate blast zone.

c) Factors to consider within the blast program for minimising impacts include:

- designing blasts so that they are executed to ensure peak pressures in the water are less than 40 kPa and vibration in gravel spawning beds is below 13 mm/sec (ppv) (see Table 4 below),
- minimising the total weight of explosive charges per shot and the number of shots for the project,
- using angular stemming material of sufficient size in drill holes to reduce energy dispersal to the aquatic environment,
- subdividing the charge, using detonating caps with delays or delay connectors with detonating cord, to reduce total pressure. Avoid the use of submerged detonation cord.
- using shaped charges to focus the blast energy when submerged surface charges are necessary,
- using decking when possible in lengthy drill holes to reduce total pressure.

d) Blasts should be setback from spawning beds to reduce impacts. See Table 4 as a guideline.

Table 4 - Set-back distance (metres) from centre of detonation to spawning habitat to achieve 13 mm/sec standard for all types of substrate (adapted from Wright and Hopky 1998).

Charge weight (kg)	0.5	1	5	10	25	50	100
Set-back (m)	15	20	45	65	100	143	200

Appendix 1 - Glossary and acronyms

Aquaculture – cultivating fish or marine vegetation for the purposes of harvesting for sale or other commercial purpose (e.g. 'fish out') but does not include a pet shop or aquarium.

Aquatic reserves – an area declared by the Minister for Primary Industries as an aquatic reserve, via notice in the Gazette, to conserve the biodiversity of fish and marine vegetation or to facilitate educational activities and scientific research. The declaration must be consistent with the requirements outlined in the *Fisheries Management Act 1994* and associated regulations.

Alien species – a species originating in a foreign country, not native to NSW waters, but is now living in the wild in Australia. The species may have been introduced deliberately or accidentally to Australia.

CAMBA – China-Australia Migratory Bird Agreement – signed with China in 1986

CMA – Catchment Management Authority

Critically endangered ecological community – an ecological community that, in the opinion of the NSW Fisheries Scientific Committee, is facing an extremely high risk of extinction in NSW in the immediate future.

Critically endangered species – a species that, in the opinion of the NSW Fisheries Scientific Committee, is facing an extremely high risk of extinction in NSW in the immediate future.

Diadromous – fish migrating from fresh to salt water or vice versa in order to spawn.

Dredging– includes:

(a) any work that involves excavating water land, or

(b) any work that involves the removal of material from water land that is prescribed by the FM Regulations as being dredging work.

DSWP – NSW Diffuse Source Water Pollution Strategy

EPA – the Environment Protection Authority

EP&A Act – *Environmental Planning and Assessment Act 1979* (NSW)

Endangered ecological communities – an ecological community that, in the opinion of the NSW Fisheries Scientific Committee is facing a very high risk of extinction in NSW in the near future, and is not eligible to be listed as a critically endangered ecological community.

Endangered population – a population that, in the opinion of the NSW Fisheries Scientific Committee, is facing a very high risk of extinction in NSW in the near future. A population is not eligible to be listed as an endangered population if it is a population of a species already listed in Schedule 4 or 4A of the FM Act (i.e. endangered and critically endangered species, population and ecological community).

Endangered species – a species that, in the opinion of the NSW Fisheries Scientific Committee is facing a very high risk of extinction in NSW in the near future, and it is not eligible to be listed as a critically endangered species.

Endemic species – a native species occurring only within one locality, such as a river system, defined zoogeographic region, state or territory.

Estuary management plan - also referred to as a coastal zone management plan. A plan developed as per Part 4A of the *Coastal Protection Act 1979*.

Exotic species – species introduced from other countries or states, which is not native to NSW.

Extinction – a species is presumed extinct, in the opinion of the NSW Fisheries Scientific Committee, if it has not been recorded in its known or expected habitat in NSW, despite targeted surveys over a time frame appropriate to its life cycle and form.

Fish – (in respect to the FM Act) includes fin-fish and other aquatic animal life at any stage of their life history (whether alive or dead) including oysters and other aquatic molluscs, crustaceans, echinoderms, beachworms and other invertebrates that spend all or part of their life cycle in aquatic habitats. This definition does not include amphibians, reptiles, birds and mammals – these aquatic animals are protected under separate legislation administered by OEH.

Fisheries Scientific Committee – an independent Committee responsible for determining whether any species, populations or ecological communities or threatening processes should be listed on schedules 4, 4A, 5 and 6 of the FM Act.

FM Act – *Fisheries Management Act 1994* (NSW)

FM Regulations – Fisheries Management (General) Regulation 2010 (NSW)

Habitat – (in respect to the FM Act) any area occupied, or periodically or occasionally occupied, by fish or marine vegetation (or both), and includes any biotic or abiotic component.

Harm – (in respect of Part 7 of the FM Act): in relation to marine vegetation, means gather, cut, pull up, destroy, poison, dig up, remove, injure, prevent light from reaching or otherwise harm the marine vegetation, or any part of it.

Harm in relation to threatened species (Part 7A of the FM Act) means:

a) in the case of fish—take, injure or otherwise harm the fish, or

b) in the case of marine vegetation—gather, cut, pull up, destroy, poison, dig up, remove, injure or otherwise harm the marine vegetation, or any part of it,

but in any such case does not include harm by changing the habitat of the fish or marine vegetation.

ICOLLs – intermittently closed and open lakes and lagoons

JAMBA – Japan-Australia Migratory Bird Agreement – signed with Japan in 1974

Key threatening process – (in respect of Part 7A of the FM Act) is one which adversely affects threatened species, populations or ecological communities, or could cause species, populations or ecological communities that are not threatened to become threatened.

Marine park – an area declared by the NSW Governor, by proclamation, to be a marine park in accordance with the requirements of the Marine Parks Act 1997 and associated regulations. The area can include any area of waters of the sea or subject to tidal influence, or any area of water, or land, adjacent to such waters, or any area of land within such waters, or any area of land from time to time covered by such waters. The area declared aims to conserve marine biological diversity and marine habitats by maintaining ecological processes in the marine park, provide for ecologically sustainable use of fish (including commercial and recreational fishing) and marine vegetation in the marine park, and provide opportunities for public appreciation, understanding and enjoyment of the marine park.

Marine protected areas – includes marine parks, aquatic reserves and marine components of national parks and nature reserves.

Marine vegetation – (in the case of the FM Act) means any species of plant that at any time in its life must inhabit water (other than fresh water). This includes saltmarsh, mangroves, seagrass and marine macroalgae (seaweeds).

NSW EPA – NSW Environment Protection Authority

NSW legislation – see www.legislation.nsw.gov.au for all current NSW Acts, Regulations and Environmental Planning Instruments

OEH – NSW Office of Environment and Heritage

Priorities Action Statement – a statement that:

- sets out the strategies (recovery and threat abatement strategies) to be adopted for promoting the recovery of each threatened species, population and ecological community to a position of viability in nature and for managing each key threatening process, and
- establishes relative priorities for the implementation of recovery and threat abatement strategies, and
- establishes performance indicators to facilitate reporting on achievements in implementing recovery and threat abatement strategies and their effectiveness, and
- contains a status report on each threatened species, where information is available, and
- sets out clear timetables for recovery and threat abatement planning and achievement.

Protected species – are species of fish that are protected under **s19** of the FM Act whereby it is illegal to take or have in your possession a protected fish without a permit from NSW DPI. There are also specific fish species identified as 'protected from commercial fishing' under **s20** of the FM Act. Protected fish species are listed under **clause 5** of the FM Regulations.

Public authority – a person or body established or constituted by an Act for a public purpose, and includes a local government authority or a State-owned corporation.

Reclamation – any work that involves the placement of any material (sand, soil, gravel, rocks, etc.) to fill in water land or the draining of water from water land for the purpose of its reclamation.

Recovery plan – a plan prepared and approved under Division 5 of Part 7A of the FM Act.

Recruitment – the breeding success of native fish and resultant juveniles reaching sexual maturity.

Riparian vegetation – means vegetation that occurs on the bank of a river, stream or other waterway or waterbody.

ROKAMBA – Republic of Korea-Australia Migratory Bird Agreement – signed with the Republic of Korea in 2006.

Species Impact Statement - means a statement referred to in Subdivision 2 of Division 6 of the FM Act and includes an environmental impact statement, prepared under the *Environmental Planning and Assessment Act 1979*, that contains a species impact statement.

Threat abatement plan – a plan prepared and approved under Division 5 of Part 7A of the FM Act.

Threatened species – generic term that encompasses critically endangered, endangered and vulnerable species.

Vulnerable species – a species that, in the opinion of the NSW Fisheries Scientific Committee is facing a high risk of extinction in NSW in the medium-term future, and is not eligible to be listed as an endangered or critically endangered species.

Vulnerable ecological community – an ecological community that, in the opinion of the NSW Fisheries Scientific Committee is facing a high risk of extinction in NSW in the medium-term future, and is not eligible to be listed as an endangered or critically endangered ecological community.

Water land – (with respect to the FM Act) means land that is intermittently or permanently submerged by water (either naturally or artificially) and includes wetlands.

Wetlands – includes marshes, mangroves, swamps, or other areas that form a shallow body of water when inundated intermittently or permanently with fresh, brackish or salt water, and where the inundation determines the type and productivity of the soils and the plant and animal communities.

WM Act – *Water Management Act 2000* (NSW).

Wrack – seaweed or seagrass floating or cast-up on a beach or foreshore.

Appendix 2 – Other essential tools and guidelines

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NSW Government State of the Catchment Reports (2010) – www.environment.nsw.gov.au/soc/stateofthecatchmentsreport.htm

NSW Office of Water – Guidelines for controlled activities - www.water.nsw.gov.au/Water-Licensing/Approvals/Controlled-activities/default.aspx

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Zann, L.P. (1995). Our Sea, Our Future: Major findings of the State of the Marine Environment Report for Australia. Great Barrier Reef Marine Park Authority & Department of the Environment, Sport and Territories, Canberra.

Tools found at www.dpi.nsw.gov.au

- NSW DPI Part 7 Permit Application Form
- Developer and Council's Toolkit
- Protocol for investigating and reporting fish kills
- Threatened Species – test for significance of impacts (7 part test)
- Threatened aquatic species, populations, communities, and key threatening process listings
- Threatened, protected and alien species sighting form
- Noxious fish and marine vegetation listings
- Marine protected area listings including aquatic reserves and marine parks
- Marine park listings and zoning plans (see also www.mpa.nsw.gov.au)
- NSW DPI (1995) Fish Habitat Protection Plan No. 1: General. NSW DPI, Pyrmont, Sydney.
- NSW DPI (1997) Fish Habitat Protection Plan No. 2: Seagrasses. NSW DPI, Pyrmont, Sydney.
- NSW Oyster Industry Sustainable Aquaculture Strategy
- Primefacts – advisory material on a range of aquatic habitat management and fish conservation issues

Appendix 3 – Key fish habitats

The following are descriptions of key fish habitats in marine, estuarine and freshwater environments. Note that for the purposes of this document the FM Act definition of fish is adopted which includes finfish and aquatic invertebrates.

Marine habitats

The marine environment extends from the intertidal zone to the vast waters of our surrounding oceans, and includes a range of habitats such as the water column, the continental shelf, beaches, rocky and coral reefs, islands of the continental shelf and seamounts. The NSW coastline is 1900km long, of which 65 percent comprises sandy shores, 33 percent comprises rocky shores, and 2 percent comprises muddy shores (Fairweather and Quinn 1995).

Rocky and coral reefs

Rocky reef refers to all areas of rocky outcrops or boulders occurring within marine and estuarine waters below the highest astronomical tide level. Macroalgae and aquatic invertebrates contribute to the physical structure of rocky reef habitats and are therefore considered part of these habitats. Rocky reefs support hundreds of species of aquatic invertebrates including sponges, sea squirts and corals. Some groups of species such as barnacles, sponges and kelps are attached to the reef and are commonly distributed in particular zones, depending on physical factors such as wave action or biological factors such as competition, while other species such as fish are more mobile (Underwood and Chapman 1995). Rocky habitats provide refuge and feeding opportunities for a wide variety of fish. Small fish can escape predators among caves and crevices, while carnivorous species such as black cod and bream can use the rocky habitat as cover to ambush their prey.

Rocky reefs have been impacted through localised effects such as over-harvesting of fish, sewage and stormwater inflow from discharges located in both marine and estuarine waters and sedimentation from changing land use within catchments, particularly near urban centres (NSW Fisheries 2001).

Coral reefs are found in the warmer marine waters of northern NSW while rocky reefs are distributed along the whole coast. Coral reefs extend as far south as the Solitary Islands and Lord Howe Island Marine Parks. Both Marine Parks have extensive areas of coral that cover the rocky sea floor in partly sheltered embayments (Veron 1986).

Coral reefs are characterised by the presence of reef-building or stony corals from the order *Scleractinia*. These corals consist of polyps that build a hard skeleton of calcium carbonate and their tissues contain single celled algae that convert sunlight to organic material that is absorbed by the coral (Australian Coral Reef Society 1993).

The coral reefs of NSW are the most southern coral communities in Australian waters and they are not considered true “reef communities” as they do not form limestone accumulations (Veron 1986). These coral communities provide habitat for a range of flora and fauna including seaweeds, sponges, fish, worms, sea squirts, sea stars, crustaceans and molluscs.

Rocky and coral reefs in NSW are susceptible to pollution from land-based activities including agriculture and urban development and sewage overflows. Dredging can also cause sedimentation which may smother near shore reefs. Recreational and commercial activities such as fishing and SCUBA diving can also harm the sensitive flora and fauna of these habitats if undertaken without incorporating sustainable management practices to reduce impacts. For example, ensuring trawling or anchoring is undertaken over sandy substrates, away from reef habitat, or maintaining neutral buoyancy when diving to avoid fin damage to corals.

Marine macroalgae

Macroalgae are defined as large (macroscopic) algae or seaweeds. Marine macroalgae are important as food and shelter for a large range of fish and aquatic invertebrates. There are many species of seaweed in NSW, including ‘brown’, ‘red’ and ‘green’ seaweed varieties. The most prominent species are the large brown seaweeds such as kelp (*Ecklonia radiata*) and sargassum (*Sargassum* spp.). There is an incredible variety of species, colours, shapes and forms of algae. The brown and red algae are the most species rich, largest (some kelps are over 10 m long) and occur at greater depths than green algae. Red and brown algae are almost exclusively marine species, whereas green algae are found in a variety of estuarine and freshwater environments (although the majority of freshwater green algae are microscopic). Some species of green algae are tolerant to extreme environmental conditions, including pollution.

Macroalgae inhabit the intertidal and sub-tidal regions of estuaries and oceans in shallow depths where light can penetrate. They are typically attached to solid surfaces including rocks, mangroves, snags, shells and artificial habitats such as boat hulls and jetties. They are a major primary producer of coastal regions and form the basis of many food webs and habitat for a range of fish.

Several species of live algae are used for bait or burley by fishers targeting herbivorous fish, such as Luderick, and the two main species of green algae used for this purpose are *Ulva* and *Enteromorpha* spp.

Macroalgae may be impacted by increased nutrient and sediment runoff from land-based activities, in particular agriculture and urban development.

Dead seaweed, which drifts in the water and often washes up onto beaches and estuarine foreshores, is also important as food and shelter for fish (e.g. abalone), and is an important component of the detrital food chain. This dead seaweed (and dead seagrass) is termed ‘wrack’ and contributes nutrients and habitat to foreshore ecological communities, as well as acting to stabilise dune and swale features along exposed foreshores.

Sandy beaches and soft substrata

Sandy beaches occupy a dynamic position between sea and land. There is generally an absence of attached plants because of the mobile nature of sand and the lack of protection from wave energy, but a large number and diversity of animals such as crabs, pipis and worms live in or on the upper layers of sand and microscopic animals live between individual sand grains.

Soft substrata are areas of unvegetated sand or mud that can be shallow (mud flats and sand flats) or found in deeper waters. These substrata are the most common habitat in estuaries. Coarser sandy zones tend to be found in areas subject to strong waves or currents, while fine muds occur in sheltered areas.

Soft substrata can support an abundance of marine life even though they often appear quite barren. In particular, sand and mud flats support a large variety of benthic (bottom-dwelling) invertebrates, including worms, molluscs and crustaceans. These invertebrates are a major source of food for many fish species such as flathead, flounder and whiting.

Soft substrata can be impacted by sedimentation processes, dredging activities and pollution. These habitats are offered some protection in aquatic reserves and marine parks, but impacts can still occur, particularly near major urban centres where sewage, heavy metals and toxic chemical pollution is more likely.

Estuarine habitats

Estuaries are partially-enclosed bodies of water connected to the ocean and are characterised by brackish water derived from the mixing of oceanic and fresh waters. There are approximately 130 large and medium-sized estuaries and embayments along the NSW coast. These estuaries are complex systems comprising interconnected habitats, including seagrass, mangrove, saltmarsh, and reedbeds, as well as shallow sand and mud flats, rocky shores, reefs and deeper zones of fine sediments.

Estuaries support diverse and productive commercial and recreational fisheries and the oyster industry, contributing to the local economies of many regional towns.

Most of the estuaries in NSW are under intense urban development pressure with approximately 80% of the State's population living near an estuary. Some 60% of the State's estuaries are intermittently closed and open lakes and lagoons (ICOLLs) which are sensitive to catchment land use activities and competing estuary uses (Environment Australia 2000a) (see section 6.4).

Estuarine habitat maps are now available for all 154 estuaries in NSW and are available at www.dpi.nsw.gov.au/research/areas/aquatic-ecosystems/estuarine-habitats-maps. They show the location of seagrass, mangrove and saltmarsh habitats within each estuary.

Seagrasses

Seagrasses are flowering plants that live and reproduce entirely within seawater. They occur predominantly in estuaries and sheltered embayments, and grow in the inter-tidal and sub-tidal zones. There are four main types of seagrass: strapweed (*Posidonia australis*), eelgrass (*Zostera* sp. and *Heterozostera tasmonica*), paddleweed (*Halophila* spp.) and sea tassel (*Ruppia* spp.). Eelgrass, paddleweed and sea tassel are relatively common species in NSW. Strapweed is limited to the marine-dominated estuaries and bays of central and southern NSW, and is of particular management concern as it does not readily colonise areas from where it has been eliminated. Populations of *Posidonia australis* in Port Hacking, Botany Bay, Sydney Harbour, Pittwater, Brisbane Waters and Lake Macquarie have suffered such a large reduction in abundance and geographic distribution that they have been listed as endangered populations under the threatened species schedules of the FM Act.

Seagrasses are widely recognised as important fish habitats, particularly as a nursery for juvenile fish. For example juvenile Yellowfin Bream, Luderick and Leatherjackets recruit to, and live in, seagrass habitats. Seagrasses provide a variety of food sources and shelter from predators. They are eaten directly by sea urchins, crustaceans, molluscs and some fish species. Like other estuarine vegetation, seagrasses also trap suspended matter and absorb nutrients, helping to improve water quality. Their rhizomes (roots) help to bind the sediment, thereby providing some protection against wave-induced erosion.

Dead seagrass (as with dead seaweed), even when washed ashore, is an important habitat and food source for small invertebrates. Termed 'wrack', dead seagrass and seaweed often interact with foreshore marine vegetation such as mangroves and saltmarsh by providing nutrients and protection against foreshore wind and wave erosion.

The total area of seagrass in NSW is approximately 161km^2 (Creese *et al*. 2009). The area of seagrass beds can be highly variable seasonally as seagrasses die back during the cooler months and re-establish in warmer months of the year.

Excessive nutrients, turbidity and sedimentation caused by poor catchment management, sewage pollution and urban runoff are the main factors that have contributed to the reduction in area of seagrass (Zann 1995). Seagrass can also be damaged directly by boating-related activities and by dredging and reclamation. Moreover, foreshore structures such as pontoons and jetties can indirectly impact seagrasses through excessive shading. As a result of these impacts, up to 85 percent of seagrass beds in the major estuaries of NSW have been lost in the past 30 to 40 years (NSW Fisheries 1997). Such losses have contributed to the decline in abundance and diversity of fish in the coastal zone.

For more information see www.dpi.nsw.gov.au/__data/assets/pdf_file/0019/203149/seagrasses-primefact-629.pdf and www.dpi.nsw.gov.au/__data/assets/pdf_file/0004/437728/Endandgered-populations-of-Posidonia-australis.pdf

Mangroves

Mangroves are trees that grow in many NSW estuaries. They are generally confined to sheltered shorelines that are subject to regular tidal inundation. *Avicennia marina* (Grey Mangrove) and *Aegiceras corniculatum* (River Mangrove) are the two most common species with a further three species occurring along the northern NSW coast.

Mangrove areas are important habitat for fish, crabs, birds and other animals. The trees provide large amounts of decomposing material (such as leaves and timber), which provide food for small invertebrates. In turn, these 'detritivores' provide food for fish and other animals. Fish feed among mangroves at high tide and seek refuge within channels of permanent water as the tide recedes. Fallen timber, aerial roots and crab burrows all add to the structural complexity of mangrove habitat, and provide shelter and feeding opportunities.

Mangrove forests help to maintain water quality by trapping sediments and by recycling nutrients. Mangroves also act as buffers for adjacent wetlands (such as *Melaleuca* sp. forests) and protect foreshores from erosion.

Mangroves cover an area of approximately 126km^2 in NSW (Creese *et al.* 2009) and over half of this area is found in the Sydney-Hunter region. Most mangrove stands appear to be healthy, however dead and dying mangroves often occur locally where tidal exchange has been impeded by foreshore structures such as floodgates, culverts and levee banks (NSW Fisheries 2001). Some areas have also been degraded due to dumping of domestic and industrial waste, grazing by stock, poisoning or clearing and trimming for coastal views. Some mangrove (typically only Grey Mangrove) areas in NSW may be expanding - most likely due to sedimentation and elevated nutrients in estuaries. In these instances mangrove expansion is not always seen as beneficial, especially if the increased area of mangrove is at the expense of other habitats such as saltmarsh.

For more information see www.dpi.nsw.gov.au/__data/assets/pdf_file/0020/236234/mangroves.pdf

Saltmarshes

Saltmarsh refers to a collection of herbaceous plants and low shrubs that can tolerate high soil salinity and at least occasional flooding by seawater (Morrisey 1995). Saltmarshes occur within most NSW estuaries, and usually grows between the mean and maximum (highest astronomical tide) high-tide levels (i.e. landward of mangroves) in areas too salty and dry for mangroves. The main species in NSW are samphire (*Sarcocornia quinqueflora*), couch grass (*Sporobolus virginicus*), and rushes (*Juncus* spp). The number of species of saltmarsh plants increases on the south coast of NSW (Adam *et al*. 1988).

Although the fish fauna of this habitat is not as diverse as seagrass and mangrove habitats, saltmarsh plays an important role as a juvenile habitat for species such as bream and mullet. Studies by Thomas and Connolly (2001) found that up to 41 species of fish can inhabit tidal saltmarsh areas. These included commercial species such as Yellowfin Bream, Sand Whiting, various species of mullet and Snubnose Garfish. The most common fish were small species such as perchlets and gobies, which are important in the estuarine food chain as a source of food for larger fish and birds. Common Galaxias (*Galaxias maculatus*) have been recorded depositing their eggs in saltmarsh, and other aquatic species such as crabs are commonly found in saltmarsh.

Saltmarsh communities fulfil many of the ecological roles discussed above for seagrasses and mangroves, particularly during higher tides. These include acting as a filter for nutrients in waterways, and also as a binding agent to prevent erosion of foreshore areas.

Saltmarsh is found in many estuaries of NSW and covers a total area of approximately 72km^2 (Creese *et al.* 2009). However the overall area of saltmarsh is contracting. A study by Wilton (2002) of mangrove and saltmarsh dynamics in nine NSW estuaries found that saltmarsh loss ranged from 12 to 97 percent, largely due to landward mangrove incursion. This occurs where saltmarsh is restricted along its landward edge by urban development or elevated topography. This may also be associated with changing patterns in annual rainfall, tidal regimes or sea level. Its areal extent can be threatened by sedimentation and the transgression of mangroves into these areas. Over time such areas may be replaced by mangroves (Saintilan and Williams 1999). Invasion of saltmarsh areas by Spiny Rush is also an emerging issue warranting further examination.

Many areas are also degraded, particularly those near urban centres, due to drainage, reclamation, dumping, runoff, excess nutrients, use of off-road vehicles, weed invasion and unrestricted stock access.

For more information see http://www.dpi.nsw.gov.au/fisheries/habitat/publications/protection/coastal-saltmarsh

Coastal lagoons

Approximately half of the 130 major estuaries in NSW are intermittently closed by entrance barriers. These are referred to as intermittently - closed/open lakes and lagoons (ICOLLs). Under natural conditions, the frequency and duration of closure of estuarine lagoons is influenced by factors such as the morphology of the entrance site, exposure to 'longshore drift', the size of the catchment, the volume of the estuary, the volume of water exchanged over a tidal cycle and prevailing climatic conditions.

Permanently-open estuaries generally support mangroves, a range of seagrass species, saltmarsh vegetation in fringing wetlands, and sometimes extensive beds of molluscs such as oysters. In contrast, ICOLLs tend to have no (or few) mangroves and few seagrasses, but may have an abundance of the aquatic macrophyte sea tassel (*Ruppia* spp.), higher

densities of some algal species and fringing wetlands with *Casuarina* spp., *Melaleuca* spp., and brackish rushes and reeds.

As many species of estuarine fish and prawns breed in oceanic or coastal waters and enter estuaries from the ocean as larvae and juveniles, the fish recruitment process for coastal lagoons is complex and partially controlled by when, and for how long, the entrance is open. Spring/summer lagoon openings tend to favour fish species such as Tarwhine, Sand Whiting, Luderick, leatherjackets and prawns, while an autumn or winter opening favours Yellowfin Bream, Dusky Flathead and Mullet.

Analysis of commercial fish catch data for NSW south coast estuaries demonstrates that ICOLLs are frequently more productive than permanently open estuaries in terms of their commercial fish production, producing a greater weight and dollar value of fin-fish and prawns per unit area per year (Gibbs 1997).

Estuarine reefs, sandy beaches and soft substrates

Rocky reefs are common sub tidal habitats along the exposed coast of NSW and in some sheltered estuaries, mainly south of Forster. Rocks and other hard surfaces provide attachment space for a wide range of sessile species (algae and invertebrates) which in turn create further habitats for numerous species of fish. Rocky reef habitats are also important for maintaining recreational fisheries and many are popular diving sites (Creese *et al.* 2009).

Over the last 10 years, numerous studies have examined the development of invertebrate and algal assemblages on estuarine reefs and compared natural reef habitats to artificial hard surfaces such as seawalls, pontoons and pilings, particularly in Sydney estuaries. There is good evidence that many artificial structures create habitats that are distinct from intertidal or subtidal natural rocky reefs, most notably because many invasive species colonise artificial structures. This is a serious concern given that the numbers of artificial structures are increasing in urbanised estuaries and along intertidal foreshores, and in many instances these structures are replacing and fragmenting natural habitats (Creese *et al.* 2009).

Shallow mud flats, sand flats, beaches and deeper soft substrate areas are the most common habitats in estuaries. They support a very diverse benthic (bottom-dwelling) community, including worms, crabs and yabbies. This, in turn, provides food for many fish species such as flathead and whiting.

Threats to sandy beaches and soft substrates in estuaries include dredging for navigation and the sourcing of fill for urban and industrial development and diffuse pollution resulting in coating of substrates with sediment and pollutants from upper catchment areas. Recreational use of these areas can also impact on substrates by trampling on benthic invertebrate habitat and compaction of soils.

Estuarine reefs can be affected by point and diffuse water pollution affecting the aquatic biodiversity colonising the reef with flow on impacts to dependent fish and invertebrates and recreational use (e.g. SCUBA diving, anchor damage).

Freshwater habitats

Freshwater environments include rivers, streams, lakes, dams, billabongs and wetlands. Habitats identified throughout the length of a river or stream include pools, riffles, snags, gravel beds, undercut banks, wetlands and riparian vegetation, as well as microhabitats within these zones.

Stream flow in NSW rivers is highly variable and many waterways flow intermittently or only during floods or after heavy rain. Native freshwater fish species have adapted to this variable flow regime by opportunistically migrating and breeding as flow conditions dictate.

As part of a National Land and Water Resources Audit, Norris *et al.* (2001) presented results for the ecological condition of Australian rivers. The findings for NSW included the following:

- 13% of river length was ‘severely impaired’ signifying that 50-80% of the animal types have been lost.
- 97% of the assessed river length was degraded; 68% moderately, and 30% substantially.
- more than 70% of the assessed river length was affected by changes to the physical habitat, largely due to the loss of riparian vegetation and changes to the bed load condition.
- over 84% of the assessed length had elevated loads of suspended solids, and 95% with elevated total phosphorous loads.

These findings highlight that freshwater habitats in NSW are under intense pressure from historic and current catchment activities and land use impacts.

Wetlands

Wetlands are important ecosystems for fish, reptiles, amphibians, plants, birds and humans. Wetlands are natural flood mitigation devices; they absorb, recycle and release nutrients; they are ‘filters’ that improve water quality; and they increase the productivity of associated aquatic and terrestrial ecosystems. Moreover, freshwater wetlands provide feeding, spawning and/or nursery areas for many species of freshwater fish and birds.

There are several types of freshwater wetlands in NSW including permanent, temporary and man-made wetlands. Permanent wetlands include some billabongs (e.g. backwaters along the Murray River) and shallow inland lakes (e.g. Lake Cowal, Lake Peery). Temporary wetlands include most billabongs, seasonal freshwater swamps (e.g. Belmore

Swamp, near Kempsey on the NSW mid north coast) and ephemeral creeks. Man-made wetlands include artificial water storages (e.g. Menindee Lakes), farm dams and urban artificial wetlands.

Freshwater wetlands can support a variety of vegetation types including trees such as *Melaleuca* spp. (paperbarks or eucalyptus, redgums) and an understorey dominated by sedges (e.g. *Cyperus* spp.) and rushes (e.g. *Juncus* spp.) Most freshwater wetlands in Australia are naturally dry at times, and productivity and diversity decline if water levels are not allowed to fluctuate.

For more information see www.dpi.nsw.gov.au/fisheries/habitat/aquatic-habitats/wetland

Floodplains

River floodplains, when inundated, are important habitats for aquatic fauna and flora. Floodplains vary in width and, as in the western plains of NSW, once flooded, can remain inundated for many months. The frequency of floodplain inundation naturally varies across the State, however, over the last century the frequency, extent and duration of flooding has been reduced by river regulation and water extraction.

When floodplains are inundated, nutrients (mainly carbon inputs drive the system) are released, plankton blooms develop and aquatic invertebrates thrive. Fish spawning success and larval survival increase. Recharge and flushing of floodplain wetland systems allows movement of fish in and out of inundated floodplain habitats.

Some species of fish such as Silver Perch, Golden Perch, Bony Herring and Spangled Perch can spawn on the inundated floodplain and its channels. Once hatched, the larvae develop rapidly. The dynamics of the food web are such that small zooplankton and insect larvae are stimulated by the flood peak. Successful fish recruitment is greatly enhanced by natural flood conditions.

For more information see www.dpi.nsw.gov.au/fisheries/habitat/aquatic-habitats/freshwater#Floodplains

Riparian vegetation

Plants growing alongside rivers and creeks are termed *riparian vegetation*. This vegetation stabilises riverbanks, stops erosion and subsequent siltation, and contributes organic matter (including snags) to the stream. The riparian zone also partially filters out pollutants, such as soil, pesticides and fertilisers, being carried towards the waterway.

Rivers are dynamic and changes in channel morphology will occur even under natural conditions – riparian vegetation however provides localised stability. The roots of trees bind and stabilise the soil and, together with snags, help to maintain the general channel shape, including essential habitat features such as pools, riffles and backwaters.

Streams with well-developed riparian vegetation generally have a higher biological productivity than those without trees along their banks. Material falling from trees provides food for crustaceans and aquatic insects, which in turn provide food for fish. More than half of the diet of predatory fish may come from insects falling into the stream from the riparian zone. Overhanging trees provide shade, which regulates water temperature (often critical for fish survival) and can create a dappling effect to camouflage fish from predators.

Non-native plant species in waterways can lead to many problems including the rapid spreading and choking of the channel, out-competing native trees, and shading of understorey native shrubs, reeds and grasses. Feeding opportunities for fish may also be reduced. The deciduous leaf fall of alien species, such as willow, is added seasonally and broken down in water over a relative short timeframe (14-26 days), whereas the harder leaves of Eucalypts and other native trees are gradually shed into the water year-round and take much longer to decompose. Feeding trials in Australia have indicated that some aquatic invertebrates prefer native gum leaves to willow leaves. Leaf biofilms of native gum leaves supported a higher density and diversity of diatoms, and greater densities of bacteria (Schulze and Walker 1997).

For more information see www.dpi.nsw.gov.au/fisheries/habitat/aquatic-habitats/freshwater#Riparian-vegetation. For descriptions of native riparian vegetation within a specific catchment in NSW, refer to your local Catchment Management Authority website via www.cma.nsw.gov.au.

In-stream vegetation

In-stream vegetation is very important to fish. Many fish lay (deposit) eggs around in-stream aquatic vegetation. In-stream vegetation may include trees, sedges and rushes (emergent macrophytes), submerged macrophytes and algae. Some trees such as *Melaleuca* and *Casuarina* spp. can grow within channels and provide fish habitat by creating bars, islands and pools along the bed of the stream. The tree roots stabilise sediments and the exposed vegetation increases channel roughness (thus slowing flows). Some sedges such as *Baumea* spp. and *Lomandra longifolia* grow directly along the lower part of banks and provide excellent slope protection and capture nutrients.

Macrophytes (including submerged and emergent species) act as a nutrient sink and source, stabilise sediments, and provide habitat for fish and other aquatic organisms. Freshwater and brackish species provide small fish with feeding opportunities and shelter. Typical submerged plants in rivers include *Vallisneria gigantea* (ribbonweed) and *Potamogeton* spp. (pondweeds). Free floating plant species are not commonly found in flowing streams.

Common native emergent species in NSW include *Phragmites australis* (common reed), *Typha* spp. (cumbungi) *Bolboschoenus fluviatilis* (marsh clubrush), *Schoenplectus mucronatus*, *S. validus* (river clubrush), *Triglochin procerum* (water ribbons) and *Persicaria* spp. (Sainty and Jacobs 1994). Some species, such as *P. australis and B. fluviatilis*, often form a link between estuarine habitats such as seagrasses and freshwater habitats such as ribbonweed. These beds of ribbon weed may function as migration corridors for diadromous fish (species that migrate between saltwater and

freshwater throughout their lifecycle), and are therefore critical to the recruitment success of some fish species such as Australian bass.

Snags

"Snags" is a term used to describe large woody debris from trees and shrubs, including whole fallen trees, broken branches and exposed roots that have fallen or washed into a waterway and are now wholly or partially submerged by water. Snags also include submerged large rocks (of greater than 500 mm in two dimensions). Snags tend to accumulate in freshwater and upper estuarine areas and form one of the most important habitat components for fish within streams by:

- providing flow refuges for fish (i.e. places to rest out of the main current flow),
- providing cover for fish (i.e. sites to hide from predators, interact with competitors, or avoid direct sunlight),
- providing 'markers' to designate territorial boundaries for species that move or migrate within the river system (e.g. Murray cod and golden perch),
- providing breeding sites for species such as river blackfish and Murray cod which lay adhesive eggs onto hard substrates,
- providing substrate for algal, biofilm, fungal, bacterial, benthic plants, macroinvertebrates and vertebrate communities to colonise,
- providing organic enrichment by capturing detritus and contributing to secondary production as the debris degrades,
- stabilising sediments and armouring the stream bed and banks, thereby preventing stream erosion, and providing structure in alluvial systems, and
- increasing the physical habitat complexity of the stream.

Many native fish use snags for general purpose habitat and will almost always be found in or near snags in rivers. These habitats are synonymous with native fish species such as Trout Cod, Murray Cod, Twospine Blackfish, Eastern Freshwater Cod and Golden Perch. Some smaller fish species use snags for refuge and shelter from predation, and are often found shoaling around rocks, fallen trees and branches (e.g. Olive Perchlet, Australian Smelt, Crimsonspotted Rainbowfish).

Snags contribute to fish habitat by deflecting (dissipating) currents and creating eddies in flow. Large woody debris creates flow variability by forming relatively still areas and zones of increased flow. Flow variability allows for fish to rest away from strong currents, and promotes benthic diversity by providing surfaces for algal growth and creating localised variations in substrate (i.e. fine silts settle in still areas, while all but the larger gravels may be scoured out where currents are strongest).

For more information on snags see www.dpi.nsw.gov.au/fisheries/habitat/threats/woody-debris

Stream channels and substrates

In many rivers, deep pools provide important fish habitat and refuge areas. As the flow in rivers decreases in drought, fish retreat to pools to wait for the return of higher flows. Even after prolonged droughts, fish will rapidly recolonise a river provided these refuge areas are available. Other channel habitats such as undercut banks, rock ledges, snags, reed beds, backwaters and riffles offer a variety of habitats for fish.

The biodiversity of streams is also dependent on substrata complexity. The bed of the river may be comprised of bedrock, gravel, snags, sand or mud, and may provide breeding grounds for different fish species. Gravel habitats are generally much more productive than equivalent areas of sand or mud. The spaces between the stones are inhabited by invertebrates, and provide small fish with refuge from predators and strong currents. Gravels also provide a surface for algae to grow, which, in turn, is eaten by many invertebrates and some fin fish. Gravel beds are used as spawning habitat for a variety of freshwater fish, including Macquarie Perch and Freshwater Catfish.

Appendix 4 - References

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Appendix 5 - NSW DPI contacts

Contact details for regional NSW DPI Aquatic Habitat Protection Unit staff who can assist with inquiries relating to fish habitat conservation and management:

Region	Catchments Covered by the Region	Postal Address	Phone	Fax
Greater Darling	Barwon-Darling, Gwydir, Namoi, Bogan, Macquarie, Castlereagh	Aquatic Habitat Protection Unit NSW DPI 4 Marsden Park Rd CALALA NSW 2340	(02) 6763 1255	(02) 6763 1265
Greater Murray	Murrumbidgee, Murray, Lower Darling	Aquatic Habitat Protection Unit NSW DPI Unit 3, 556 Macauley Street ALBURY NSW 2640	(02) 6042 4213	(02) 6021 0113
North Coast and Border Rivers	The Border Rivers and the coastal catchments from the Tweed to Hastings catchments	Aquatic Habitat Protection Unit NSW DPI 1243 Bruxner Highway WOLLONGBAR NSW 2477	(02) 6626 1269	(02) 6626 1377
Central	Coastal catchments from Manning to Central Coast	Aquatic Habitat Protection Unit NSW DPI Locked Bag 1 NELSON BAY NSW 2315	(02) 4916 3931	(02) 4982 2306
Sydney Metropolitan Area	Hawkesbury-Nepean and Sydney Metropolitan Area catchments south to the Hacking River	Aquatic Habitat Protection Unit NSW DPI Locked Bag 1 NELSON BAY NSW 2315	(02) 4254 5527 (02) 8437 4933	(02) 4225 9056
South Coast & Lachlan	Coastal catchments from Wollongong to the Victorian border and the Lachlan	Aquatic Habitat Protection Unit NSW DPI PO Box 97 HUSKISSON NSW 2540 or PO Box 17 BATEMANS BAY NSW 2536	(02) 4428 3401 (02) 4478 9103	(02) 4441 8961 (02) 4472 7542

For information or advice on undertaking developments or activities within or adjacent to a marine park or aquatic reserves, please contact NSW DPI's Marine Parks and Aquatic Reserves Program on 1300 550474.