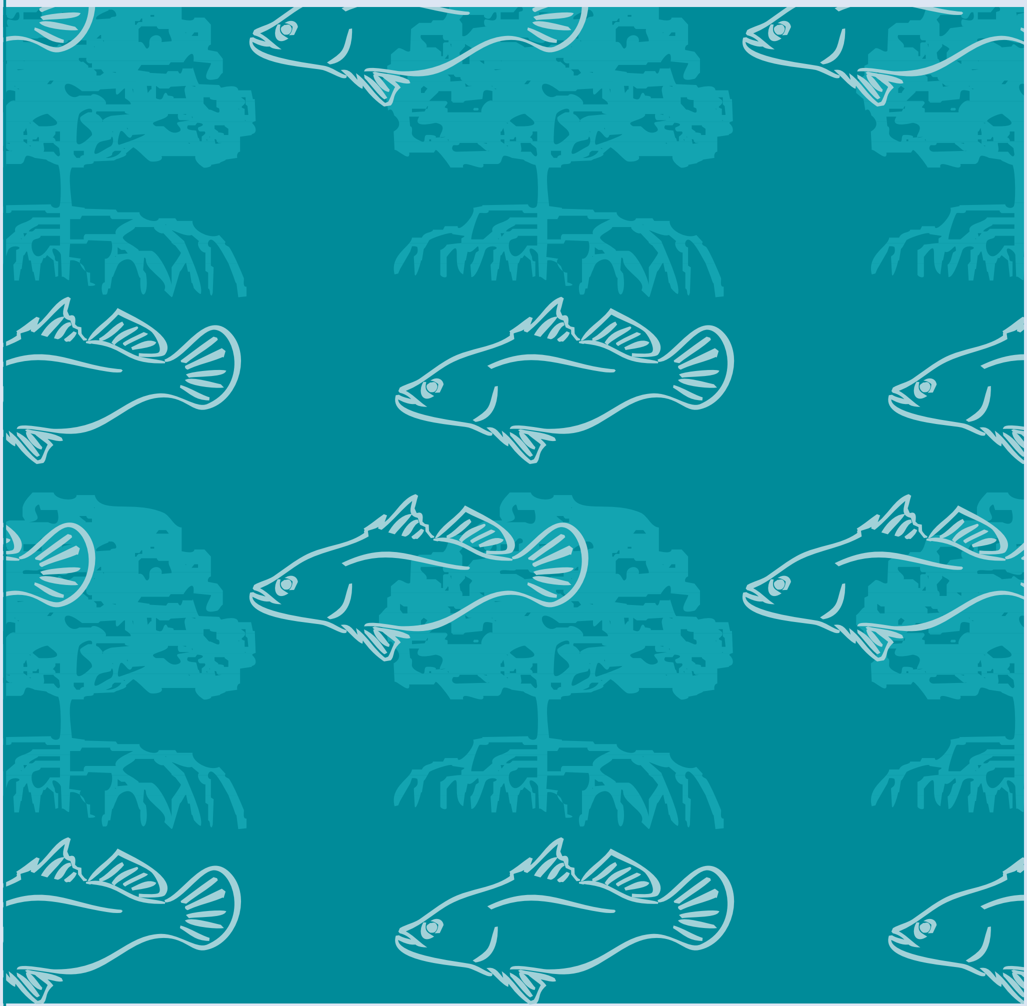
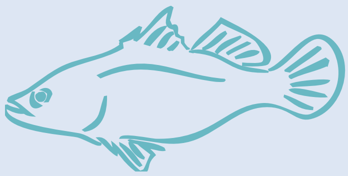
Queensland the Smart State

Fish Habitat Management Operational Policy FHMOP 010

Tidal fish habitats, erosion control and beach replenishment





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Queensland Government
Department of Primary Industries and Fisheries

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Contents

1. Framework for sustainable fisheries

The Queensland Government has a priority of *protecting the environment for a sustainable future*. The Queensland Department of Primary Industries and Fisheries (DPI&F) is the agency responsible for the management of the state's economically and socially valuable fisheries using the *Fisheries Act 1994* (Fisheries Act). The main purpose of the Fisheries Act is to apply and balance the principles of ecologically sustainable development (ESD) to sustain these fisheries. Maintenance of the integrity and natural condition of tidal fish habitats is a critical component of the management strategy to sustain Queensland's fisheries.

DPI&F's fish habitat management framework (Figure 1) includes a statutory role under the Fisheries Act for:

- the protection of marine plants, which sustain fish stocks by contributing material to tidal food webs and by providing habitats
- the declaration and management of declared Fish Habitat Areas (FHAs), where all fish habitats (vegetated and unvegetated) are given significant protection from physical disturbance
- the maintenance of fish passage, which ensures fish can access suitable habitat.

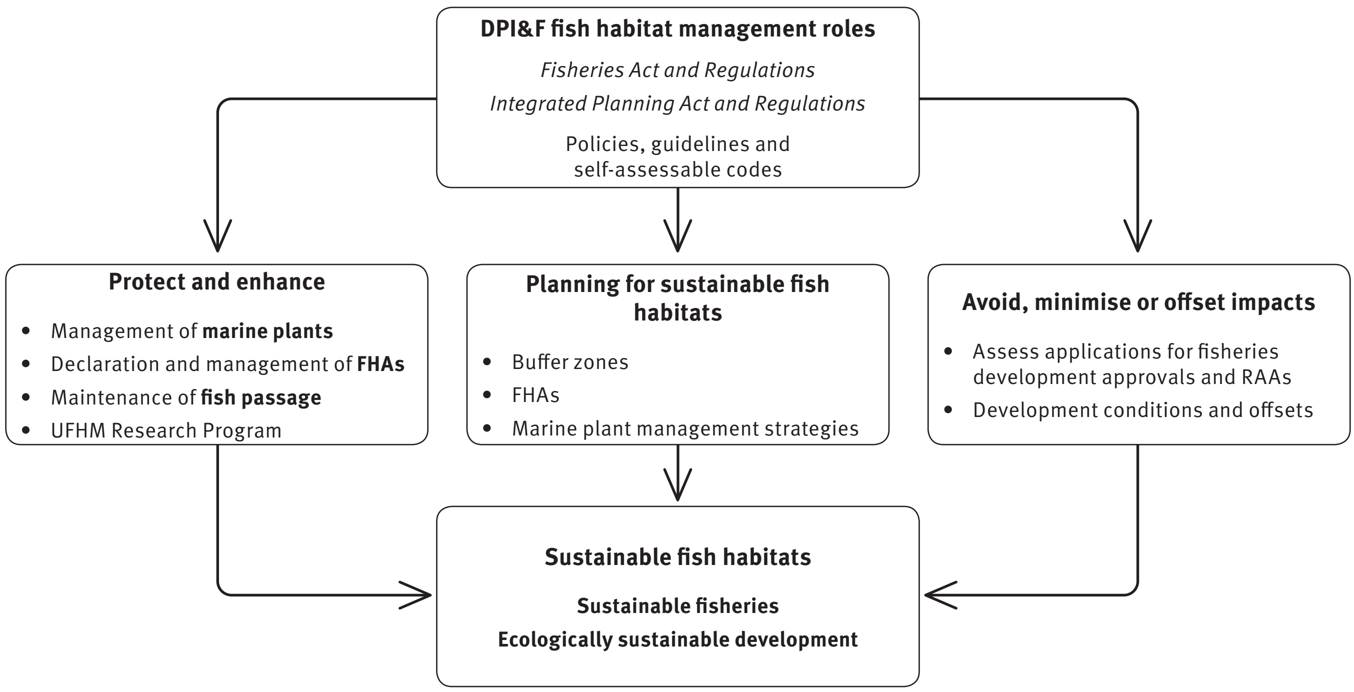

Figure 1. DPI&F tidal fish habitat management framework.

These statutory roles are delivered by assessing and providing comments on applications to disturb fish habitats. Assessment decisions and comments ensure that impacts on fish habitats are avoided, minimised and offset, in order to achieve ESD. DPI&F's operational policies (such as this document) and guidelines aid these decision-making processes and inform stakeholders of DPI&F's management requirements[1].

Beyond its statutory role, DPI&F provides advice in planning and assessment processes and highlights issues of fisheries importance. DPI&F also undertakes and encourages research and education activities, such as the Urban Fish Habitat Management Research Program (UFHM) Research Program.

More information on the department's fish habitat management activities is available on the DPI&F website (www.dpi.qld.gov.au). Refer to Appendix 3 for more information on the DPI&F's role under fisheries legislation, and other legislation relevant to erosion control and beach replenishment.

1 DPI&F also has regard to the *State Coastal Management Plan* when assessing applications.

2. Background

2.1 Tidal fish habitats and shorelines

The diverse mosaic of tidal fish habitats associated with shorelines includes mangrove, seagrass and saltmarsh communities, rocky foreshores, mud flats, reefs and sand bars (for more information on tidal fish habitats, refer to Appendix 2). These habitats and the connectivity between them sustain fish stocks and the fishing industries and communities that depend on them.

2.2 Natural shoreline processes

The nature of shorelines is dynamic—fluctuations naturally occur from the processes of erosion and accretion. The formation of coastal shorelines constantly changes because of these natural processes, especially those caused by storm tides and cyclones. Sand from the shore is often moved by wave and tidal action. However, as long as the sand remains within the active beach (commonly to around 15m below mean sea level in South East Queensland), it may return. In Queensland, littoral transport generally moves sand in a northerly direction along the coastline.

Natural shoreline processes and natural buffers between shorelines and development maintain natural, diverse and productive tidal fish habitats. In estuaries in particular, natural processes provide the dynamic habitat complexity (e.g. undercut banks, shallow flats, snags etc) used by fish.

2.3 Shoreline development

Shoreline development, including for erosion control structures and beach replenishment, can detrimentally impact the condition and function of tidal fish habitats. Such development and other human activities (e.g. boat wash) can also exacerbate erosion.

Historically, the lack of understanding of shoreline dynamics and the importance of fish habitats have resulted in development being permitted close to the shore. In many areas, fish habitats—and any natural buffer to allow natural shoreline fluctuations— have been removed. For example, on parts of the Gold Coast whole sections of coastline were cleared, backfilled and armoured.

The Environmental Protection Agency (EPA) has designated Erosion Prone Areas along the Queensland coast. The intention is for these areas to remain undeveloped, and for coastal processes to be unhindered, to the greatest extent practicable. However, considerable development already exists in many areas and erosion control structures to protect property are supported as a last resort (EPA 2001). In addition, beach replenishment may be carried out in Erosion Prone Areas. Such erosion control measures can impact on fish habitats.

2.4 Increasing need for erosion management

Because of ongoing development near the coast and changing environmental conditions due to climate change, increasing efforts will be required to manage erosion in Queensland.

Increased development is being driven by recent population growth in Queensland concentrated in urban coastal centres, which is higher than in any other state in Australia (Department of Local Government Planning Sport and Recreation 2005). It is estimated that one million people are planning to move to coastal areas within Australia in the next 15 years (National Sea Change Taskforce 2007).

Climate change impacts, such as sea level rise and increases in cyclone frequency and intensity, could significantly influence shoreline erosion. Low lying coastal population and resort centres, and tropical and sub-tropical population centres, which in effect encompass much of Queensland's developed coastal areas, have been identified as particularly vulnerable to the effects of climate change (DEH 2005). More information on the impacts of climate change on fish habitats is provided in Appendix 4.

3. How to use this document

3.1 Scope

This policy document addresses the threats and impacts to tidal fish habitats and natural shoreline processes from the management of coastal and estuarine erosion.

The three ways of dealing with shoreline erosion (although in practice these are often used in combination) are addressed in this policy:

- setting development back from vulnerable areas—erosion buffer zones and managed retreat
- beach replenishment
- erosion control structures.

As beach replenishment may be used for erosion control and/or other purposes, it is dealt with both under general policy provisions and as a specific policy in section 5.

A description of these erosion management and control methods and a discussion of their impacts are provided in Appendix 2.

This policy is not a legal document. It is designed to assist in the exercise of statutory discretion in certain circumstances and provide for consistent implementation and interpretation of the Fisheries Act. For details of fisheries legislation, reference should be made to the Fisheries Act and Fisheries Regulation 1995.

3.2 When to use the policy

This policy alerts DPI&F's stakeholders such as consultants, government agencies, community groups and waterfront property owners to DPI&F's policy position on tidal fish habitat management, erosion control structures and beach replenishment. Stakeholders should use this policy when:

- considering a proposal for shoreline erosion control or beach replenishment
- developing a strategy (e.g. a Shoreline Erosion Management Plan) for shoreline erosion control or beach replenishment.

The policy also provides a transparent and consistent approach to guide Fisheries staff at DPI&F in consideration of erosion control structures and beach replenishment when:

- assessing resource allocation authority and development applications
- providing comment on resource entitlement applications
- providing advice to other government agencies where no approval is required, or for strategic management and planning.

Proposed erosion control structures and beach replenishment works are to comply with *all* relevant policies within this document. However, it is recognised that proposals will arise where adherence to this policy may not be possible due to particular circumstances surrounding a given proposal, for example emergency works. On these occasions, careful documentation of the justification for relaxation of the policy is required.

3.3 Document structure

This document contains a brief background on erosion control in Queensland and policy objectives. Three policies are outlined, each of which include a background discussion and policy positions. These policies are supported by: Best Management Practices (BMPs) to reduce the impacts of erosion control structures and beach replenishment activities (Appendix 1); information on tidal fish habitats and the impacts of erosion control and beach replenishment on these habitats (Appendix 2); relevant legislation (Appendix 3); and a review of the management of climate change impacts on fish habitats (Appendix 4).

3.4 Other relevant fish habitat management documents

Stakeholders and Fisheries staff should also make reference to other relevant DPI&F Fish Habitat Management Operational Policies and Fish Habitat Guidelines. A complete list of these documents is provided in section 6 of this document; copies are available from the DPI&F website (www.dpi.qld.gov.au).

4. Policy objectives

The objectives of this policy are to:

- meet the Queensland Government's priority to protect the environment for a sustainable future
- contribute to the sustainability of fisheries productivity in the long term through the conservation of fisheries resources and tidal fish habitats
- ensure that erosion control structures and beach replenishment avoids, minimises and offsets impacts on tidal fish habitats
- facilitate strategic planning of erosion control structures and beach replenishment that avoids, minimises and offsets impacts on tidal fish habitats and considers long-term erosion threats and possible impacts of climate change on erosion susceptibility
- promote the use of Best Management Practices for erosion control structures and beach replenishment that enhance, or minimise impacts on, fisheries resources and tidal fish habitats
- promote research into Best Management Practices for erosion control structures and beach replenishment that enhance, or minimise impacts on, fisheries resources and tidal fish habitats

5. Policies

The policy positions contained in this document aim to achieve the objectives in section 4, and are in three policy areas:

- maintenance of natural shoreline processes and existing tidal fish habitat values
- use of erosion control works for significant erosion
- beach replenishment and placement of sand for erosion control.

5.1 Maintenance of natural shoreline processes and existing tidal fish habitat values

Background

Natural processes of erosion and accretion, and fluctuations in shoreline alignment over time affect the management of the coast. Both erosion control structures and beach replenishment have the potential to adversely impact tidal fish habitats (refer to Appendix 2 for details). If human activities are the cause of the erosion problem, then it is more effective—and significantly better from a fish habitat perspective—to treat the cause rather than attempt to manage the symptom through use of erosion control structures and beach replenishment.

Investigation into the cause of erosion may provide insight into its management. For example, if boat wash is the main cause of the erosion, then the operation of vessels in a manner that reduces wash may be the key to effective erosion management.

Under the *State Coastal Management Plan* a strategy of retreat is the preferred option in erosion prone areas that are under constant threat of erosion. The retreat option may be most feasible in areas with a low intensity of development.

Predicted sea level rise will require the landward and poleward migration of wetland communities. However, the presence of developed land close to wetlands constrains these migration processes. Saltmarsh communities, which are present in upper intertidal areas, are particularly vulnerable.

Erosion buffer zones allow for shoreline fluctuation and sea level rise, the associated landward movement of wetland communities, as well as avoiding damage to property and infrastructure. The use of buffers has the same outcome as managed retreat—a development free zone that allows for natural processes to continue unhindered and existing tidal fish habitat values to be maintained.

DPI&F's Fish Habitat Guideline *Fish habitat buffer zones* (FHG 003) provides recommended buffer zone widths and information to assist the designation of site-specific buffer zones to protect fisheries resources. The guideline is particularly relevant when planning new development or undertaking strategic planning.

The use of erosion buffer zones and/or managed retreat to protect both wetland communities, as well as coastal property, is the best way to manage erosion from a fish habitat perspective. These options may not always be available or practicable; for example, in areas of high population density and existing development.

This policy position links with the *State Coastal Management Plan's* policies *2.2.1 Adaptation to climate change, 2.2.2 Erosion prone area* and *2.8.2 Coastal wetlands* in terms of fish habitat management.

Policy position

Natural shoreline processes and existing tidal fish habitat values are to be maintained by:

- using erosion buffer zones and managed retreat where
  - there is no 'significant erosion'[2]

  or
  - land based development (e.g. residential buildings, community parkland facilities) is proposed in an undeveloped area

2 Refer to section 5.2 for an explanation of 'significant erosion'.

- treating the cause of erosion, rather than only attempting to manage the erosion through the use of erosion control structures and beach replenishment, where erosion is the result of human activities[3]
- designating buffer zones using the Fish Habitat Guideline *Fish habitat buffer zones* (FHG 003) in conjunction with other state and local government planning guidelines and requirements.

5.2 Use of erosion control works for significant erosion

Background

Coastal and estuarine shorelines are dynamic systems with natural processes of erosion and accretion. The maintenance of these natural shoreline processes benefits tidal fish habitats.

The management of erosion generally involves the use of erosion control structures such as seawalls and groynes, and/or beach replenishment. While beach replenishment may be an effective erosion control tool, it is also used for other purposes, such as amenity. Therefore, it is covered by the general provisions of the policy under 'All activities' and dealt with individually in section 5.3.

Erosion control has the capacity to impact fisheries resources and tidal fish habitats (refer to Appendix 2 for details). However, it is accepted that erosion control is required in circumstances when the erosion impact has become or will become 'significant'.

Proponents of erosion control need to demonstrate that the erosion has become 'significant', meaning the erosion has resulted in, or if left uncontrolled would result in, the loss of one or both of the following in the short term:

- the ability to exercise the existing as-of-right or approved use of the property
- buildings, structures or infrastructure that are not expendable or which cannot be relocated.

Catastrophic events (e.g. storm tides, floods and cyclones) may cause significant erosion that presents an immediate threat to public safety through undermining of dwellings or infrastructure that requires an emergency response. In such cases, the emergency works provisions of the Fisheries Act and *Integrated Planning Act 1997* may apply.

Rights or interests

Proponents wishing to conduct works for erosion control should have a 'level of rights' that is greater than other members of the community. This is because proposed works may impact on the tidal fish habitat and fisheries values of the area and restrict access of the general community to the area.

Examples of demonstrated rights or related interests include:

- the proponent owns the property directly adjacent to the proposed location of a structure
- the works are required to exercise the existing as-of-right or approved use of the land (e.g. works conducted on a term lease with the consent of the tenure holder)
- local government is the proponent and the proposed works are to be conducted on behalf of the community (e.g. on a public foreshore)
- the proponent holds resource entitlement or a resource allocation authority which confers the right to apply for an approval for the works
- the proponent can demonstrate precedent, previous decisions or prior DPI&F approvals or resource allocation authorities for the proposed works or activities.

Erosion control structures

Where erosion control structures such as revetments are proposed adjoining or between existing shoreline hardening structures, it is preferable from an erosion management perspective to maintain a consistent alignment—that is, to 'regularise' the shoreline (Figure 2). Regularisation minimises gaps where erosion may be exacerbated.

3 Human activities that may result in erosion include alteration of flows; construction of marinas, seawalls and groynes; boat wash; clearing of riparian vegetation; and dredging.

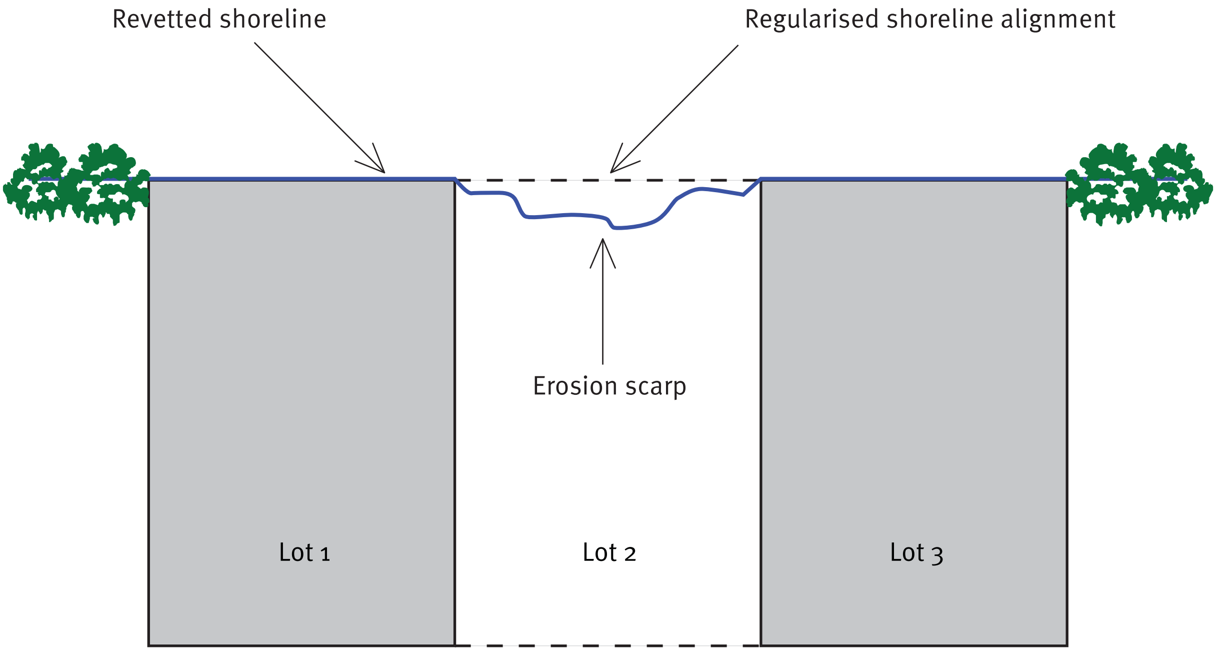

Figure 2. Regularisation of a shoreline.

Erosion control structures, including those made of geotextile materials, to be in place for less than six months are considered to be temporary structures[4].

Erosion control in declared Fish Habitat Areas

Fisheries legislation restricts erosion control works in declared FHAs. Within a management A area, permanent erosion control structures and beach replenishment cannot be approved[5].

The construction of a temporary structure may be approved under Fisheries legislation within both management A and B areas.

This policy links with the *State Coastal Management Plan's* policies *2.1.9 Reclamation 2.2.2 Erosion prone areas* and *2.8.2 Coastal wetlands* in terms of fish habitat management.

DPI&F's entire policy position on works and activities in declared FHAs is outlined in the Fish Habitat Management Operational Policy—*Management of declared Fish Habitat Areas* (FHMOP 002).

Policy position

All erosion control activities

- Erosion management is to be planned through a long-term strategic approach.
- Erosion control measures, including beach replenishment, are supported where the proponent is able to verify that:[6]
  - there is significant erosion
  - there is an inadequate erosion buffer zone
  - managed retreat is not possible.
- Objectives of erosion control works are to be defined and the proposed methods are to be appropriate to achieve the objectives.

4 Note for waterway barrier works different timeframes may apply for temporary structures. For more information visit the DPI&F website at www.dpi.qld.gov.au

5 Structures with a primary purpose of restoring fish habitat may be considered. Refer to the Fish Habitat Management Operational Policy—*Management of declared Fish Habitat Areas* (FHMOP 002) for details.

6 There may be erosion control measures identified in a long-term strategic approach that do not meet these criteria. These measures may be supported if assessed to be the best erosion control and fish habitat management solution in the long term.

- Shoreline erosion is not considered to be an emergency unless:
  - its control is required to remediate an emergency endangering the life or health of a person

  or
  - it threatens the structural safety of a building[7].

- Erosion management measures should be developed to ensure public safety.
- Erosion control works are to:
  - minimise disturbances to tidal fish habitats and fisheries resources
  - result in no further permanent loss of tidal fish habitat (e.g. through reclamation of tidal land)
  - maximise tidal fish habitat enhancement or creation, such as by using fish-friendly design
  - minimise disruption to community use of the area, including fishing.

- Where tidal fish habitats have been disturbed, the site is rehabilitated to the greatest extent possible.
- Best Management Practices are to be applied to all erosion control works. Relevant BMPs are suggested in Appendix 1 of this document.

Erosion control structures

- Erosion control structures are to be located where the proponent can demonstrate a level of rights or interests.
- Seawalls, revetments and other structures parallel to the shoreline are generally to be located as far landward as possible. Minor regularisation of a shoreline may be supported.
- The appropriate location of an erosion control structure adjoining a natural boundary is to be determined through agreement between the proponent, DPI&F, and other relevant government agencies (e.g. NRW, EPA, local government).
- Erosion control structures that will restore or protect tidal fish habitat (e.g. gabions seaward of a mangrove fringe to protect bank stability and the mangroves present) may be located outside the boundary of the property, with the consent of the landowner (most commonly the State of Queensland).

Erosion control structures in declared Fish Habitat Areas

- Within a management B area, a permanent erosion control structure may be supported where it meets the policy positions above and the following criteria[8]:
  - the works location is in part of the declared FHA for which the proponent can demonstrate a level of rights or interests
  - the proposal will have lesser impact on the declared FHA than all other reasonable options
  - the structure is assessed as the best available erosion management solution from both the erosion management and fish habitat management perspectives
  - the structure is located, designed and erected so that it minimises all impacts to the declared FHA, its current fish habitat values and functions, and the community use of the declared FHA.

- Within a management A or B area, a temporary erosion control structure may be supported where it meets the policy positions for a permanent erosion control structure in a declared FHA listed above, and the following criteria:
  - the structure will be in place for the shortest possible time, normally up to a period of six weeks, but in no case longer than six months
  - the structure is appropriately designed such that all of its components are retained within the approved area and can be completely removed from the declared FHA
  - the substrate surface of the declared FHA can be satisfactorily restored[9] following removal of the structure, if relevant.

Beach replenishment

Refer to section 5.3 for DPI&F's policy position on beach replenishment.

7 Refer to s88B of the *Fisheries Act 1994* and s4.3.6 of IPA.
8 For more information refer to the Fish Habitat Management Operational Policy—*Management of declared Fish Habitat Areas* (FHMOP 002).
9 Satisfactory restoration of the substrate surface of the FHA requires restoration of the pre-works surface profile and sediment type and an agreed post-works monitoring and maintenance program (if appropriate to the scale of disturbance). See FHMOP 002 for details.

5.3 Beach replenishment and placement of sand for erosion control

Background

Beach replenishment is an increasingly popular method of erosion control that may also provide for scenic amenity and public recreation. However, beach replenishment has associated impacts on both the extraction and receiving environments.

Beach replenishment is defined as 'the placement of sand along a (beach) foreshore to supplement the *existing* quantity of sand'. The placement of sand on a soft-sediment foreshore is *not* considered beach replenishment—even though some previous proposals have referred to this activity in this manner, it may be more correctly known as 'artificial beach creation'.

Examination of the shoreline either side of the eroded area can help determine the primary sediment type of the area, that is, generally either sandy or soft-sediment. Sandy shorelines are characterised by a predominant sediment composition of coarse sands. Soft-sediment shorelines are characterised by a predominant sediment composition of silt, clay and mud with a smaller proportion of fine sand and other substrate types such as rock or coarse sand bars.

In some estuarine areas, such as the Gold Coast Broadwater and inside the mouth of the Noosa and Endeavour rivers, there is an intermediate interface zone which is between the sandy shorelines subject to high wind and wave energy, and the low energy soft-sediment shorelines in the mid-upper estuary. In these areas sediments are often a mix of fine sands with silt, clay and mud, and are referred to as 'transitional sediment shorelines'. These areas may have particular fish habitat values, including as yabby banks and seagrass beds.

Beach replenishment is used on sandy shorelines in high energy environments such as open coasts and exposed estuarine areas. In these environments benthic floral and faunal communities are adapted to mobile sandy substrates, and are therefore more tolerant to the smothering and abrasive impacts of beach replenishment. Sandy shorelines also contain important tidal fish habitats and fisheries resources such as yabby banks which play an important role in Queensland's fisheries.

Soft-sediment shorelines are found in low energy environments, such as the protected waters of estuaries. Benthic floral and faunal communities in soft-sediment environments are more susceptible to the impacts of sand deposition and abrasion (refer to Appendix 2 for details). Soft-sediment shorelines, unlike sandy shorelines, are not generally subject to a high degree of public recreation usage that requires all tide foreshore access. The placement of sand on soft-sediment shorelines is generally proposed for erosion control, as well as amenity and recreation purposes.

The identification of key tidal fish habitats and fisheries resources along the shoreline will inform strategic decisions relating to erosion control through beach replenishment, and will facilitate the maintenance of a mosaic of tidal fish habitats (e.g. yabby banks, shores with both coarse and fine sand and undercut banks) to sustain fisheries productivity.

Filling of tidal land

Beach replenishment proposals may involve filling tidal land as part of the erosion control strategy; for example, the creation of a dune or beach above HAT which is an integral part of the design. For more information on the filling of tidal land, including reclamation, refer to the Fish Habitat Management Operational Policy—*Management and Protection of Marine Plants and Other Tidal Fish Habitats* (FHMOP 001).

Sand pushing

Sand pushing (also known as beach scraping or beach bulldozing) is similar to beach replenishment, which involves moving a layer of naturally deposited sand from mid-lower intertidal flats to the upper beach, normally with a bulldozer or front-end loader. Sand pushing is a short-term solution that results in a high and ongoing impact to tidal fish habitats because of the disturbance of a large area of the most productive top layers of intertidal substrate. The impact of beach scraping may be greater than that of dredging because of the large surface area of high productivity habitat affected.

Declared Fish Habitat Areas

Fisheries legislation restricts beach replenishment activities in declared FHAs. Declared FHAs are not a source of material for replenishment. The restrictions are outlined below:

- Dredging, extraction or the use of other techniques such as sand pushing to obtain material for beach replenishment is not permitted in any declared FHA.
- Depositing material for beach replenishment is not permitted in management A areas.

DPI&F's entire policy position on works and activities in declared FHAs is outlined in the Fish Habitat Management Operational Policy—*Management of declared Fish Habitat Areas* (FHMOP 002).

This policy position links with the *State Coastal Management Plan's* policies *2.1.9 Dredging, 2.2.2 Erosion prone areas* and *2.8.2 Coastal wetlands* in terms of fish habitat management.

Policy position

Beach replenishment and placement of sand on sandy shorelines

- Beach replenishment is supported on sandy shorelines where[10]:
  - there is significant erosion

  or
  - beach replenishment is required for the protection or effective functioning of erosion control structures.
- Beach replenishment may be supported on sandy shorelines for purposes other than to treat significant erosion where there is a history of ongoing disturbance through replenishment and where public recreational usage of the replenishment area is high.
- Beach replenishment is to be located in an area where the proponent can demonstrate a level of rights or interests[11] (e.g. Council is the proponent and the proposed replenishment area is a public foreshore).
- Replenishment material is to be sourced outside of declared FHAs—a buffer zone of at least 100m is required between the extraction site and the boundary of the FHA[12].
- Replenishment material is to be sourced and placed away from locations where there are marine plants[13], fishing grounds or key habitats of commercial and recreational fisheries importance.
- Filling of tidal land for the creation of a dune or beach of a level above the HAT as part of a beach replenishment program may be supported only where it:
  - is an integral part of the erosion control design

  and
  - will minimise replenishment frequency or impact of ongoing replenishment on tidal fish habitats

  or
  - will remove the need for other erosion control works (e.g. the construction of groynes).
- Filling of tidal land for the creation of terrestrial land and subsequent placement of structures or infrastructure is not beach replenishment, rather a form of reclamation, and is not supported.
- Sand pushing is not supported on any tidal lands.
- All dredging and extraction for beach replenishment is to comply with the Fish Habitat Management Operational Policy—*Dredging, Extraction and Spoil Disposal Activities* (FHMOP 004).
- Best Management Practices are to be applied to all beach replenishment activities. Relevant BMPs are suggested in Appendix 1 of this document.

10 There may be beach replenishment projects identified in a long-term strategic approach that do not meet these criteria. These projects may be supported if assessed to be the best erosion control and fish habitat management solution in the long term.
11 Refer to section 5.2 for more details on 'rights or interests'.
12 An exception may be made where material is sourced from navigational dredging of a channel marked by aids to navigation which is outside of, but less than 100m from, an FHA.
13 For more information, refer to the Fish Habitat Management Operational Policy—*Management and protection of marine plants and other tidal fish habitats* (FHMOP 001).

Placement of sand on transitional sediment shorelines

The placement of sand on transitional sediment shorelines is to be considered on a case-by-case basis, drawing upon the direction of this policy, including considerations of:

- impacts on tidal fish habitats at and in the vicinity of the site
- history of disturbance through replenishment at the site
- public recreational use of the area.

Placement of sand on soft-sediment shorelines

- The placement of sand on soft-sediment shorelines for erosion control purposes is not supported. In these areas natural processes are to be maintained, or other forms of erosion control (hard or geotextile structures) are to be adopted.
- The placement of sand on soft-sediment shorelines to create artificial recreational beaches is not supported.
- The placement of sand on soft-sediment shorelines to maintain an existing artificial recreational beach may be supported under exceptional circumstances for public recreation purposes where there is a history of ongoing disturbance through sand deposition and where public recreational usage of the replenishment area is high (Plate 1).

Beach replenishment in declared Fish Habitat Areas

- Beach replenishment may be approved in a management B area where it meets the other policy positions in this section, and the following requirements:
  - a source of replenishment material for future maintenance can be identified
  - replenishment maintenance intervals will be no more frequent than every two years
  - the proposed location, design, replenishment material and replenishment methods minimise all impacts to the declared FHA, its current fish habitat values and functions, and the community use of the area.

Plate 1. Placement of sand on the soft-sediment foreshore of Pandanus Beach, Wynnum, Moreton Bay, commenced in the late 1980s. (Note: Placement of sand at this site is consistent with the policy due to historic disturbance through sand placement.)

6. References and further reading

6.1 Fish habitat management operational policies

FHMOP 001 Couchman, D and Beumer, J 2007, *Management and Protection of Marine Plants and Other Tidal Fish Habitats*, Queensland Department of Primary Industries and Fisheries, Fish Habitat Management Operational Policy.

FHMOP 002 Derbyshire, K, McKinnon, S and Sheppard, R 2007, *Management of declared Fish Habitat Areas; Departmental Policy Position,* Queensland Department of Primary Industries and Fisheries, Fish Habitat Management Operational Policy.

FHMOP 003 White, M and Beumer, J 1996, *Departmental Procedures for Permit Applications Assessments and Approvals for Insect Pest Control in Coastal Wetlands*, Queensland Department of Primary Industries, Fish Habitat Management Operational Policy, 56pp.

FHMOP 004 Hopkins, E and White, M 1998, *Dredging, Extraction and Spoil Disposal Activities: Departmental Procedures for Provision of Fisheries Comments*, Queensland Department of Primary Industries, Fish Habitat Management Operational Policy, 79pp.

FHMOP 005 Dixon, M and Beumer, J 2002—in revision, *On-site Mitigation and Off-site Compensation for Activities Causing Marine Fish Habitat Loss: Departmental Procedures*, Queensland Department of Primary Industries, Fish Habitat Management Operational Policy, 27pp.

FHMOP 006 McKinnon, S and Sheppard, R 2001, *Fish Habitat Area Declaration and Review: Departmental Consultation Procedures*, Queensland Department of Primary Industries, Fish Habitat Management Operational Policy, 27pp.

FHMOP 007 McKinnon, S, Sheppard, R and Beumer, J 2003, *Fish Habitat Area Selection and Assessment: Departmental Procedures*, Queensland Department of Primary Industries, Fish Habitat Management Operational Policy, 22pp.

FHMOP 008 Peterken, C 2001, *Departmental Procedures for Permit Applications Assessment and Approvals for Water Way Barrier Works*, Queensland Department of Primary Industries, Fish Habitat Management Operational Policy.

FHMOP 009 Mackenzie, J and Dixon, M 2002, *Restoration Notices for Fish Habitats— Formulation and Implementation: Departmental Procedures*, Queensland Department of Primary Industries, Fish Habitat Management Operational Policy, 49pp.

6.2 Fish habitat guidelines

FHG 001 Cotterell, EJ 1998, *Fish Passage in Streams: Fisheries Guidelines for Design of Stream Crossings*, Queensland Department of Primary Industries, 37pp.

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Appendix 1. Best Management Practices

A1.1 Introduction

Where there is significant erosion, an inadequate erosion buffer zone, and managed retreat is not feasible, there may be no option other than to proceed with the construction of erosion control structures or beach replenishment.

Determining the most appropriate type and design of the structure will be highly site- specific, and depends on the objectives of the works. For example, to achieve ongoing protection against storm tides, a structure of a certain height, or beach replenishment of a certain volume and frequency may be required.

The use of Best Management Practices (BMPs) and innovative design is required to minimise the impact on fisheries and tidal fish habitats, and to maximise the potential of new habitat creation or enhancement.

From a fish habitat perspective, erosion control structures (e.g. gabions) that also contribute to maintenance or establishment of bank vegetation (e.g. mangroves) are preferred over structures that are focused at only achieving erosion control.

Fish-friendly[14] design should be incorporated into structures and opportunities for beneficial habitat uses of structures should be capitalised on, where possible.

The manner in which beach replenishment material is sourced and deposited influences the degree of impact on fisheries resources. For example, the use of existing dredging and extraction activities or sites to source replenishment material benefits tidal fish habitats by preventing further disturbance. A review of the impact of erosion control works is provided in Appendix 2.

A1.2 Applying Best Management Practices

Best Management Practices are to be applied after consideration of the appropriate erosion control method (erosion control structure, beach replenishment etc) for the situation. The use of BMPs is a standard development requirement, and therefore may not be used as offsets[15] for unavoidable impacts on tidal fish habitats.

Project proposals and planning for erosion control works, both for individual sites and for broad-scale strategies (e.g. Shoreline Erosion Management Plans prepared by local governments) should incorporate BMPs. Proposals for dredging and extraction[16] for beach replenishment should include BMPs as part of any Environmental Management Plans, Dredge Management Plans or other plan.

Erosion control structures

Investigation of erosion control structure options should be undertaken to identify the option that best meets the policies outlined in this document and the BMPs below.

BMPs to reduce the adverse impacts of erosion control structures include:

- Plan the location and design of structures with consideration of site-specific hydrological and long-shore drift patterns. Often this may require modelling of the coastal processes by a coastal engineer.
- Minimise the length, size and number of erosion control structures, while minimising end effects such as scouring.
- Use design elements that provide habitat complexity (Plate 2).
- Design structures to allow for fish and water movement above the structure during high tides but to prevent stranding of fish (e.g. gabions, or revetments with openings[17]), when structures need to be located in areas with riparian vegetation.
- Design structures to minimise scouring and other hydrological impacts that may cause changes to sediment composition and profiles.

14 For more information on fish-friendly design refer to the Fish Habitat Guideline (FHG 006) *Fisheries guidelines for fish-friendly structures*.
15 For more information on offsets refer to the Fish Habitat Management Operational Policy (FHMOP 005) *Mitigation and compensation for activities and works causing marine fish habitat loss: Departmental procedures*.
16 For more information on dredging, refer to the Fish Habitat Management Operational Policy (FHMOP 004) *Dredging, extraction and spoil disposal activities*.
17 For example, revetments with 0.3m of 'opening' per 1.5m of linear length of structure (SAFMC 1998).

- Increase the amount of intertidal habitat available, with structures to be sloping rather than vertical if this can be achieved without the loss of important natural habitats.
- Enhance structure designs to allow uses such as fishing, while minimising any disturbance of fishing activities in the vicinity.
- Undertake construction outside of target species' key times of biological activity and fishing in the area.
- Use structures that may be modified or removed (e.g. geotextile structures) if required.
- Fill geotextile structures used along shorelines with sand sourced from:
  - above the highest astronomical tide, either onsite or offsite

  or
  - the trench where the structure is to be placed (where applicable).
- Remove geotextile structures used for short-term emergency erosion control if no longer required, unless these are buried beneath sand.

Beach replenishment

Planning for beach replenishment projects should identify a long-term source of replenishment material, the volume of replenishment material required, and the expected frequency of replenishment.

Sourcing dredge material

- In sourcing replenishment material, the hierarchy is:
  1. current dredging or extraction sites if:
     - the material has suitable characteristics (e.g. size, colour, proportion of fines)
     - the material contains levels of toxicants in compliance with the Australian Water Quality Guidelines for Fresh Water and Marine Waters; and/or Queensland Water Quality Guidelines.
  2. historic dredge or extraction sites
  3. sites where material previously deposited elsewhere for beach replenishment has accreted
  4. new dredge or extraction sites.
- Dredging and/or extraction of a large volume of sand less frequently is preferred over small volumes more frequently, as the former allows for recovery of benthic communities between events, and may be more easily scheduled outside of key biological events such as marine plant flowering times and fish spawning aggregations.
- Material is to be sourced from areas that contain dynamic sediments (e.g. the sides of natural channels or other nearshore areas, rather than areas containing stable sediments, such as offshore areas). Benthic invertebrates of dynamic sites recover most rapidly from disturbance.
- Where on-going dredging to source replenishment material is proposed for a large volume of sand over an extended time from a particular site, before and after monitoring of the benthic invertebrate community to detect changes at the extraction site, and in adjacent habitats, is recommended. Changes in sediment composition at the extraction site should also be carefully monitored, as any significant change may be detrimental to benthic invertebrate and fish communities. This monitoring would form part of an Environmental Management Plan and the results would inform future management decisions for the site and for future dredging projects.

Before erosion control works
After erosion control works

Plate 2. Best Management Practices were applied to armour this shoreline of the Mossman River, Port Douglas. The gabions have allowed mangroves to recolonise the shore behind the armouring. Mangroves provide additional shoreline stabilisation.

Dredging/extraction timing and frequency

- Dredging or extraction should not be undertaken more frequently than every two years from the same site to allow time for benthic community recovery between events.
- Dredging or extraction should be undertaken outside of key biological times of the year (e.g. outside of spawning, recruitment and migration times of key fauna and flowering times of seagrass in the area).
- Dredging or extraction of material should be prior to major benthic invertebrate recruitment times (e.g. for Moreton Bay, spring is the major recruitment time), especially for forage species and species of fisheries importance, to enhance recovery times at the extraction site.
- Dredging or extraction should be done during periods of natural seasonal turbidity, where possible.

Dredging/extraction methods

- Minimise the surface area of substrate disturbed (i.e. taking a deep layer over a small area), while:
  - avoiding exposure of a different layer of sediment that may not be compatible to benthic flora and fauna
  - avoiding the creation of deep holes that may persist for more than three months to avoid long term impacts on benthic communities.
- Substrate 'islands' are to be retained if dredging a large area, to aid infilling of the dredge site and recolonisation of fauna from substrate missed by dredging.

Placing of replenishment material

- When large scale (e.g. local government area-wide) and potentially large impact beach replenishment programs are proposed for areas with little previous modification or disturbance, research is recommended to capture information on sediment composition, aquatic flora, and benthic invertebrate and fish communities and the seasonal use of the area for recreational and commercial fishing prior to replenishment. Research should identify important times of the year for species recruitment, breeding, migration and fishing. This information should be used to plan the timing and methodology of replenishment that results in the least impact to fisheries resources and adjacent tidal fish habitats.
- Conduct modelling of littoral transport and sand transport patterns to identify placement areas that would not threaten tidal fish habitats.
- Use replenishment material that is similar in characteristics (size, composition) to that of the natural beach, and with a low proportion of fines (e.g. less than 10% silt/clay composition) to minimise suspended sediment concentrations at the replenishment site.
- Limit the frequency of replenishment to facilitate recovery of benthic communities. Placement of a single large volume of sand less frequently is preferred over small volumes more frequently, as this allows for recovery of benthic communities between events, and may be more easily planned outside of key biological events such as marine plant flowering and fish spawning aggregations.
- Limit the linear length of replenishment area to retain a source of fauna for recolonisation; for example, break the replenishment area into smaller areas with replenished areas feeding sand to non-replenished areas, and non-replenished areas providing 'seed' fauna into replenished areas.
- Minimise the use of bulldozers, front-end loaders and other machinery on the shore to reduce compaction of sand and mortality of benthic fauna.
- Limit the use of sand stockpile sites to avoid further temporary disturbance of tidal fish habitats.
- Material should be deposited:
  - outside of key fishing times of target species in the area
  - during biologically inactive times of the year for flora and fauna of fisheries importance (e.g. outside of spawning, recruitment and migration times of fisheries species and flowering times of seagrass in the area)
  - prior to main benthic invertebrate recruitment times, where known and feasible, which will lead to rapid recovery of these communities at the deposition site.
- Place replenishment material above mean high water spring tides, but not on marine plants, which allows gradual redistribution of the material and allows more time for motile fauna to move away or burrow through the material.
- Material should be placed on the receiving site in a spray of sand and water or in a number of shallow layers (e.g. up to 20cm depth per layer) to maximise survival and vertical migration by resident infauna.
- Replenishment is to be undertaken outside of migration and breeding times of important fisheries and forage fish species.

Appendix 2. Description of tidal fish habitats and the impacts of erosion control and beach replenishment on fish habitats

A2.1 Introduction

Planning of land uses adjacent to waterways should identify the natural movement of waterways as an important development constraint and therefore allow for appropriate buffers to enable this movement to occur. Historically, in some coastal Queensland locations, such planning has not occurred and natural waterway movements are limited by significant adjacent development and infrastructure. This creates pressure in these locations for erosion control.

Methods of shoreline protection generally fall into three categories: erosion buffer zones and managed retreat; beach replenishment; and the use of erosion protection structures—commonly hard structures, but also geotextile structures.

Construction of permanent structures such as groynes, armoured revetments, and seawalls has been until recently the traditional and most commonly used method of preventing shoreline erosion. These 'hard engineering' methods create a physical barrier between the ocean and land and deflect wave and water energy.

The current international trend in shoreline management is away from the use of 'hard engineering' methods of coastal defense which act to restrain coastal processes, and towards 'soft engineering' approaches which recognise the dynamic nature of the coastal environment by utilising these natural processes to advantage (EUCC 1999; Restall et al. 2001).

Soft engineering approaches include beach replenishment and using plants such as mangroves to stabilise shorelines, and the use of geotextile materials including sand fences to trap sand.

Beach replenishment is commonly used on oceanic shores. It is often carried out not only to provide coastal protection but also to enhance visual and recreational amenity (Gourlay et al. 2004). Beach replenishment is often used in conjunction with erosion control structures.

A2.2 Fish habitats

Sandy shorelines

Sandy shorelines have coarse-grained sediment and are found in high energy environments such as beaches, and some estuaries. In these environments benthic flora and faunal communities are adapted to mobile substrates. Hard bottom habitats and bare substrates that are of high ecological value may be present in the nearshore zone of sandy shorelines.

Infauna of sandy shorelines includes small interstitial fauna such as nemerteans, oligochaetes and small polychaetes; and large mobile fauna such as crabs, clams and larger polychaetes (Cooney et al. 2003). Distribution of benthic invertebrates in these environments is patchy and with a high degree of spatial variation. Many species in high energy environments such as sandy shores burrow to avoid being dislodged with wave and tidal action.

Sandy shorelines may be divided into different zones extending seaward, such as the beach zone, the surf zone and the nearshore zone (Nelson 1993). Few detailed studies have been undertaken of Queensland's surf zone benthic fauna. However, in New South Wales these habitats have been well described. James and Fairweather (1996) found that in central New South Wales the upper beach zone is commonly dominated by crustaceans such as isopods, amphipods and ghost crabs. The mid-beach and surf zones are dominated by amphipods, bivalves (e.g. *Donax* spp.), cumaceans (an order of marine crustaceans) and polychaetes, with a high degree of spatial variability among and within zones. The shallow subtidal (nearshore) zone commonly has a high diversity with amphipods, bivalves, gastropods, polychaetes, burrowing shrimps and fishes (Nelson 1993). The dynamic, yet relatively structurally homogenous environments of sandy shoreline waters are commonly dominated by juvenile fish from a small number of species (Crawley et al. 2006). Fish species of fisheries significance found in these waters include sand whiting, sea mullet, yellowfin bream and tailor.

Degree of wave exposure, and the associated steep slope and coarse grain size, are determining factors in infaunal communities, with more sheltered shores supporting higher diversities and abundances (Nelson 1993).

Subtidal vegetation is less common in high energy environments due to a lack of stable substrate. Perhaps the most common type of vegetation is macroalgae, either along rocky shorelines, or growing on hard bottom habitats such as submerged rocky reef.

Detached macroalgae and seagrass material, known as wrack, provide important food and increased habitat complexity for surf zone fauna. The presence and amount of wrack are important factors that contribute to the abundance and diversity of fish species that inhabit surf zones (Crawley et al. 2006).

Soft-sediment shorelines

Soft-sediment habitats are characterised by a predominant sediment composition of silt, clay, mud and some fine sand, with a small proportion of other substrate types such as rock or coarse sand bars, and are relatively low energy environments with low water velocity and tidal action. Where physical and chemical conditions (e.g. water clarity, nutrients, depth, salinity, hydrology and water quality) allow, soft-sediment habitats often contain fringing and submerged marine plants such as seagrass, mangroves, saltmarsh plants and algae, that provide fish habitat and support fisheries productivity.

Seagrasses may grow both intertidally and subtidally in soft-sediment habitats, and form an important food source and shelter for commercial and recreationally significant fisheries species. Seagrass beds are habitats for prawn, mollusc and fish species of economic and Indigenous importance. A number of fisheries species depend on seagrass beds for some part of their life-cycle, including prawns (particularly tiger prawns) and fish (e.g. whiting, garfish and flathead) (Coles *et al*. 1985, 1993). Seagrasses form one of the most productive plant communities (Fonseca 1993), largely due to their very high rate of biomass production.

Mangrove vegetation, also important for fisheries species, often lines soft-sediment shorelines. Mangrove ecosystems form important and widespread habitats along the Queensland coast. A number of fisheries species of economic or Indigenous importance depend on mangrove habitats for some part of their life-cycle. Species of commercial importance include penaeid prawns (particularly banana prawns) (Vance 1996), mud crabs (Williams 1997, 2002), bream, trevally and bait fish such as anchovies and herring (Robertson and Alongi 1996). In dense mangrove areas, extensive root systems may protect juveniles from predation or other threats.

Saltmarshes are an important component of the habitat mosaic of soft-sediment shorelines. These plant communities provide food sources to adjacent estuarine food webs and provide habitat and shelter during tidal inundation. Numerous fish species have been found to inhabit tidal saltmarsh areas during tidal inundation, such as glassfish, perchlets, gobies, yellowfin bream, sand whiting, various mullet and snub nosed garfish (Connolly 1997).

Saltmarshes support a variety of invertebrates, including crabs, prawns, molluscs and insects. The invertebrates are preyed upon by fish during high tides. For example, yellowfin bream feed on crabs and prawns while small fish such as gobies feed on mosquito larvae.

Macroalgae is also an important contributor of food to estuarine food webs. Substrates that appear to be 'bare' often have microalgae interstitially between the sediment particles. Microalgae contribute to fisheries productivity as a major primary producer in the food chain and in some cases as a direct food source for important fisheries species (Alongi 1998).

Tidal flats in estuaries may support diverse and abundant benthic invertebrate communities that are of high importance to recreational and commercial fish species as a food source. In some areas these invertebrates are in great abundance (e.g. worm and yabby banks). Invertebrate communities inhabiting 'bare' soft-sediment habitats often include prawns, bivalves, small crustaceans and polychaetes (Turner et al. 2004).

Studies estimate that approximately 75% (by weight) of all seafood landed commercially in Queensland is derived from species dependent on estuarine habitats during part of their life-cycle (Quinn 1993), although this figure may vary depending on estuary location. Due to the similarity in target species for each fishery, a high proportion of species targeted by the recreational and Indigenous fishing sectors is also dependent on estuarine habitats during part or all of their life-cycles.

A2.3 Overview of erosion control structures

Types of erosion control structures include:

- seawalls
- revetments
- rock walls
- gabions
- groynes
- coir logs
- geotextile structures
- A-jacks.

Erosion control structures such as seawalls, groynes and revetments (Plate 3) have historically been the common methods of preventing shoreline erosion. Any of these structures will affect existing coastal and waterway processes and require careful assessment to ensure that the selected solution will improve the situation rather than make the problem worse or transfer the problem elsewhere.

Innovative erosion control structure designs can achieve objectives of providing erosion control as well as protecting existing tidal fish habitat. For example, the use of rock gabions and A-jacks may be placed seaward of an eroding bank to stabilise the shoreline, which allows sediment to accumulate and encourages mangrove colonisation landward of the structure.

Structures such as seawalls and groynes may also be constructed using sand-filled geotextile bags (Plate 4). The impact of geotextile structures is generally similar to that of hard structures; however, their advantages over hard structures include:

- greater flexibility in design and may be adjusted and realigned
- relatively easier to remove when no longer required
- supporting more epibiota, if not covered with sand (Jackson et al. 2005).

Geotextile structures are used both as a temporary emergency measure, and as a medium term (up to 25 years) solution. The life expectancy of geotextile structures is generally higher when the structure is covered with sand. For this reason, regular beach replenishment is often part of the erosion control strategy where geotextile structures are used on sandy shorelines.

Plate 3. Hard structures, such as this rock wall at Clifton Beach near Cairns, have been commonly used to control shoreline erosion.

Plate 4. A groyne made of geotextile bags, Cottontree Beach, Maroochydore.

A2.4 Summary of impacts of erosion control structures on fisheries resources

Impacts from erosion protection structures generally occur in three stages: during the construction or placement of the structure, during maintenance and ongoing impacts from the presence of the structure. The initial impact is generally the most noticeable and may involve shoreline vegetation removal. Impacts of maintenance tend to be temporary and of a lesser degree than those of the construction. The ongoing impacts, however, may also be considerable. Localised changes to hydrology, sediment characteristics, depth and other environmental variables may occur over time at—and adjacent to—the structure, which in turn alters the composition of aquatic communities in the area.

The impacts of erosion control structures are widely known, and include:

Habitat loss and disturbance

- Direct loss of wetland during construction and isolation of wetland habitats landward of the structures (SAFMC 1998).
- Habitat availability reduction due to the replacement of natural shorelines which are flat with a large surface area of tidal land, with near-vertical structures (Chapman and Bulleri 2003; Byrne 1995). The upper intertidal and landward area is most commonly lost (Dugan and Hubbard 2006).
- Scouring and deepening of soft-sediment habitat adjacent to the hardening structures due to wave action reflecting off the structure (SAFMC 1998). The use of geotextile structures exposed to wave action may result in similar impacts to those of hard structures[18] (NCDCM 2003).
- Gradual, long-term wetland loss by limiting sediment inputs needed for maintenance and expansion of wetlands, by altering the hydrology of the area, and by blocking landward migration as sea level rises (NCDMF 2005; Lewis 2005).
- Reduction in marine plant wracks and driftwood washed onto the shore (Dugan and Hubbard 2006).

Changes to sediment composition

- Changes to sediment composition (primarily a change to coarser sediment) because of increased physical disturbance. This in turn alters the benthic invertebrate and fish community composition of the area (Ahn and Choi 1998).

Introduction of new habitat

- Usually, the primary purpose of aquatic infrastructure is not to provide tidal fish habitat, but it may, nonetheless, do so simply by providing habitat complexity and new substrates for fish to exploit. By incorporating additional fish-friendly features, the structure may provide further opportunities for fish to live, feed and grow (Martin et al. 2005; Wilber et al. 2003; Lincoln Smith et al. 1994).
- Structures may be designed to maximise artificial habitat creation using the principles of fish-friendly[19] design.

Disruption of fishing activities

- Replacement of natural shorelines with rock walls and other revetments may disrupt fishing activities such as bait worm digging, yabby pumping and angling.

Best Management Practices to reduce these impacts are suggested in Appendix 1.

A2.5 Overview of beach replenishment

Beach replenishment involves the placing of sediment on an eroded or degraded beach. Sediment is often sourced from a seaward dredge site, but may also come from land-based sources.

18 If the geotextile structure is covered with sand these impacts may be reduced. However, this approach results in other impacts associated with beach replenishment (see section A2.6).
19 For information on fish-friendly design refer to the Fish Habitat Guideline (FHG 006) Fisheries guidelines for fish-friendly structures.

The replenishment of beaches and foreshores in Queensland is generally proposed to meet community recreational and tourism requirements for sandy beaches and/or as an environmentally favourable 'soft' solution to protection from foreshore erosion.

Considered a relatively simple, cost-effective measure, beach replenishment avoids the risk of damage to adjacent shorelines that can result from use of hard structures such as rock revetments (Piorewicz 2002). Beach replenishment, where used appropriately, can protect coastal structures, restore or create habitat lost through erosion, and provide public space (Greene 2002; Nordstrom 2005).

When compared with traditional hard structures, soft engineering solutions such as beach replenishment may be considered more:

- economical in life-cycle cost
- easily constructed
- environmentally sound
- aesthetically pleasing (Cummings and Basco 1997).

This comparison, however, may not adequately consider the economic and environmental impacts of the dredging of sand for beach replenishment.

Numerous open beaches, estuarine beaches and beaches fringing tidal waterways within coastal Queensland have been the focus of beach replenishment works, with varying degrees of success. In general, beach replenishment is an activity that requires regular maintenance to retain the desired sand volume and beach profile.

Sand replenishment increases the width of land available to accommodate erosion, while at the same time allowing the beach to continue to behave naturally (EPA 2005b). Beach replenishment may encourage development in erosion prone areas, which can further reduce future alternative management options, such as managed retreat (Pilkey 2000 cited in Greene 2002).

Successful replenishment of beaches requires careful modelling and long-term planning. One of the disadvantages of beach replenishment is the requirement for on-going replenishment, as sand is dispersed throughout the active beach system. However, as long as the sand used for replenishment is from outside the beach system there is still an overall gain of sand within the system, rather than a transfer from one part of the system to another (EPA 2005b), a common result of other forms of shoreline protection.

Deposition of replenishment sand is commonly in one of the following methods:

- placing all of the sand as a dune behind the active beach
- spreading the sand over the entire beach profile
- placing sand underwater close to the shore (nearshore replenishment).

Nearshore replenishment is where sandy material is intentionally placed in the nearshore zone of the active part of a beach below the low water mark. This technique recognises the importance of the processes in the nearshore zone in coastal protection and may be a more cost-effective approach to beach replenishment than 'traditional' upper beach replenishment.

Beach replenishment is often used in conjunction with geotextile structures as sand coverage increases the life expectancy of the structure. Beach replenishment is also used with hard structures for protection of the structure (e.g. to reduce undercutting) and to reduce erosive impacts from wave energy against the structure.

Sand bypassing is related to beach replenishment works. Sand bypassing is generally associated with river mouths that have been 'trained' to facilitate safe passage of vessels, and involves the artificial movement of sand from one side of a river or harbour entrance to the other side to replace the natural longshore sediment transport. In practice, sand bypassing may be implemented as a fixed mechanical system (e.g. the Tweed River Entrance Sand Bypass System in South East Queensland/northern New South Wales) or as a program of routine dredging and replenishment.

Training walls commonly trap sand that is moving with longshore drift, causing a build up of sand on the downdrift side, and a 'loss' of sand on the updrift side. Bypassing systems commonly consist of a series of jet pumps on the downdrift side of the training wall that collect sand; the sand is then pumped to the updrift side through a pipe.

Sand pushing is similar to beach replenishment, and involves pushing sand from one part of a beach or shore to another to create a beach for recreational use. The sand is gradually redistributed over the tidal area and therefore the scraping is repeated to maintain the beach profile.

A2.6 Summary of impacts of beach replenishment on fisheries resources

Beach replenishment may have a lesser initial impact on the environment than hard engineering options. However, there is still little known of the long-term and cumulative impacts on the marine environment. Many studies on the impact of beach replenishment are unreplicated, short-term, and may not be scientifically robust (Greene 2002; Nelson 1993; Peterson and Bishop 2005; Nordstrom 2005).

Any form of beach replenishment alters the habitat upon which it is undertaken. However, the degree of alteration and degree of direct or indirect impact to fish habitats is highly dependent on site-specific factors. Beach replenishment does not normally involve direct damage to wetland vegetation, but it does affect 'bare' substrate habitats through smothering and loss of habitat complexity. There is a public perception that 'bare' substrates are not of high importance to economically significant fish and therefore that dredging and beach replenishment would not be of major concern to fisheries. However, research such as that undertaken by Miller et al. (2002), demonstrates that this is not the case. This has implications for the large amount of beach replenishment being undertaken, and the general trend towards replenishment over hard structures.

The greatest impact of beach replenishment is, in the majority of cases, likely to be on the extraction site where material is sourced. Dredging of this material results in almost complete defaunation (Simonini et al. 2005); and recolonisation is largely dependent on larval settlement and immigration (van Dalfsen et al. 2000). Impacts to benthic invertebrate communities at, and adjacent to, the replenishment site are generally short-term (Van Dolah 1996).

Impacts of dredging and sand extraction on fisheries and fish habitats are discussed in detail in the Fish Habitat Management Operational Policy—*Dredging, Extraction and Spoil Disposal Activities* (FHMOP 004) and will therefore be discussed only briefly in this Operational Policy.

The known impacts of beach replenishment include:

Disturbance to benthic faunal communities by dredging for beach replenishment

- Benthic invertebrate communities are often completely defaunated by dredging at the extraction site. After short-term dredging operations, significant recolonisation may take place within three months of dredging, as was the case in Moreton Bay, Queensland (WBM 2004). Other studies in sub-tropical environments indicate benthic 'recovery' within two years (Cooney et al. 2003). In temperate environments, invertebrate communities take longer to recover and are generally substantially restored after 2–4 years (Boyd et al. 2005).
- Benthic invertebrate communities take longer to recover from long-term dredging operations when compared with short-term operations. In temperate environments, recovery after long-term operations may take more than six years (Boyd et al. 2005). However, it is likely that recovery is faster in tropical and sub-tropical environments.
- Recovery of benthic invertebrate infaunal communities is related to the habitat type. Communities of naturally high energy environments such as those subject to high wave or tidal action, are less likely to be in a stable equilibrium assemblage structure under natural (non-dredging) conditions, and recover from dredging disturbance faster (Bolam and Rees 2003; WBM 2004).
- Benthic invertebrate community recovery is related to the size and configuration of the disturbed area. Smaller surface areas with deeper areas of impact are favourable, as benthic invertebrate abundance is greatest in the top 30cm of sediment. Dredging of deep areas maximises recolonisation from adjacent habitats, whereas dredging of a large shallow area depletes potential recolonisers and therefore requires greater recolonisation from larval recruitment, which is linked to seasonal cycles (WBM 2004).
- Increased suspended sediments and sedimentation may result in stress and/or mortality of benthic invertebrates, particularly for filter-feeding organisms (Erftemeijer and Lewis 2006).
- Dredging may damage commercial fisheries such as for bivalves, particularly if commercial species are slowgrowing (van Dalfsen et al. 2000).
- Alteration of benthic invertebrate communities may occur due to temporary changes in depth of habitat. However, deeper habitats may support higher benthic invertebrate abundance and diversity than shallower habitats (WBM 2004).
- Sand pushing, similar to dredging, may result in temporary complete defaunation of the extraction site. However, sand pushing may result in greater impacts than dredging, because of the large surface area of high productivity habitat affected as benthic invertebrates are most abundant in the top layers of sediment.
- Screening of sand to retain the coarser sediments for replenishment (and return the finer sediments to the borrow site) may result in changes to sediment characteristics and benthic communities, if undertaken over a long period of time (e.g. 25 years) (Boyd et al. 2005).

Disturbance to benthic floral communities by dredging

- Removal of benthic flora during removal of dredge material (Erftemeijer and Lewis 2006).
- Increased turbidity, resulting in stress and/or mortality of benthic flora (Erftemeijer and Lewis 2006).
- Smothering of benthic flora from the dredge plume (Erftemeijer and Lewis 2006).
- Alteration of local hydrological conditions may cause instability of substrates and compromise existing benthic floral communities or affect regeneration of benthic floral communities at or near dredge sites.
- Sand pushing, similar to dredging, may result in complete removal/destruction of benthic flora. However, sand pushing may result in greater impacts than dredging, because of the large surface area of intertidal habitat affected, which may have abundant floral communities and very high primary productivity.

Disturbance to fisheries resources by dredging

- Reduction in food availability for fisheries species through defaunation of benthic invertebrates.
- Disruption of adult migration, spawning and feeding through avoidance of turbidity plumes (WBM 2004; Cyrus and Blaber 1992).
- Disruption to fisheries species settlement and recruitment and a reduction in survival of recruits of species of fisheries significance due to smothering from the dredge plume (WBM 2004).

Disturbance to fisheries resources by depositing replenishment material—smothering

- Fauna at the deposition site may be smothered during sand placement (Dolan et al. 2006). However, benthic invertebrates inhabiting intertidal and high energy environments are adapted to disturbance such as storm-generated wave action, sediment transport and turbidity; the impacts of beach replenishment on these communities is generally less than at the dredge site (Greene 2002).
- Smothering and altered dune formations from sand pushing and beach replenishment may result in decreased abundance of large invertebrates that occupy the upper beach, such as ghost crabs (*Ocypode quadrata*) (Peterson et al. 2000).
- Arguably the greatest impact of replenishment is the smothering of habitats such as shallow reefs, algal communities and seagrass meadows by sand migrating offshore (Peterson and Bishop 2005; Nelson 1993). For example, the Tweed River Entrance Bypass System resulted in a reduction in size of Kirra Reef, a nearshore rocky reef, because of smothering with sand.
- Cryptic fish species and newly settled life stages are likely to suffer high mortalities from hard bottom habitat burial, because of their behavioural and morphological characteristics. This is especially true if no similar habitat remains nearby (Lindeman and Snyder 1999).
- Loss of habitat complexity because of burial of inshore hard bottom nursery habitat may lead to increased predation, and lowered growth rates of fish (Hixon 1991 cited in Lindeman and Snyder 1999).

Disturbance to fisheries resources by depositing replenishment material— increased suspended sediment concentrations

- Increased suspended sediment and fine sediment deposition that may result in community changes such as reduced species richness and abundance of benthic invertebrates in both planktonic and benthic foodwebs (Rakocinski et al. 1996) which may in turn reduce the availability of prey for surf zone finfish (Wilber et al. 2003).
- Increased suspended sediment concentrations may result in a short-term reduction in fish abundance during replenishment (Versar 2004).
- High suspended sediment concentrations may damage the gills of fish, and may affect feeding behaviour of visual orienting estuarine fish (Wilber et al. 2003).
- Some fish species congregate in replenishment areas, taking advantage of the increased availability of polychaete and other benthic invertebrate prey (Miller et al. 2002, Wilber et al. 2003).

Disturbance to fisheries resources by depositing replenishment material—changes to sediment, benthic habitat and shore characteristics

- Changes in sediment size at the replenishment site may result in a change in the shore profile and benthic invertebrate communities. Where particle size is increased, beach slope may also increase. Benthic invertebrate species richness and abundance often decrease with increasing particle size (McLachlan 1996).
- The use of material that is finer than at the replenishment site or with a high proportion of silt and clay also has the capacity to detrimentally impact intertidal and offshore benthic communities (Rakocinski et al. 1996). Finer sediment is more compactable and is, therefore, more resistant to burrowing fauna.
- Changes in bathymetry and wave action that affects fish communities.
- Long-term replenishment may result in lower fish abundance. However, it is difficult to isolate the impact of replenishment from natural variability. Additionally, replenishment may affect a large area due to longshore drift (Baron et al. 2004).
- Redistribution of sand with heavy machinery such as bulldozers results in sand compaction and disturbance to vegetation (Speybroeck et al. 2006). This may result in adverse impacts to benthic faunal assemblages and reduced vegetative inputs into the food chain.

Disturbance to fisheries resources by depositing replenishment material—creation of fish habitat

- Constructed sandy foreshores can provide valuable tidal fish habitat (e.g. as a habitat for benthic animals such as worms, bivalves, etc., which are an important food source for some fish species). However, the value depends upon factors such as: profile, stability and sand particle size. The potential fisheries values of an area of replenished foreshore must also be considered relative to the value of the habitat that is being replaced by the introduced, and often short-lived, sandy beach.

A2.7 Erosion buffers and managed retreat

Description of erosion buffers and managed retreat

Shoreline protection measures may be avoided with the use of erosion buffer zones adjacent to shorelines. The use of buffers allows for natural shoreline fluctuations without endangering property.

The importance of coastal sand dunes in providing a buffer from erosion and as a source of sand to replenish beaches is recognised by the EPA and activities involving removing or interfering with coastal dunes may require assessment under the *Coastal Protection and Management Act 1995*, as required under the *Integrated Planning Act 1997* (EPA 2005c).

In undeveloped coastal areas, retreating further inland to avoid damage from erosion and storm tides may be a feasible option. This practice is generally called 'managed retreat'. One notable example of managed retreat is the relocation of Cape Hatteras Lighthouse, North Carolina, USA, to approximately 500m inland from its original position (Greene 2002).

The process of moving existing coastal defences (and any development) further landward to allow for sea level rise and associated fluctuations in wetland distribution is related to erosion buffers and managed retreat. This is sometimes called 'managed realignment' and has been used to restore tidal connectivity and associated wetland communities (e.g. saltmarsh) as an offset for developments elsewhere (Colclough et al. 2005).

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Appendix 3. Relevant legislation

Fisheries Act 1994 and *Fisheries Regulation 1995*

Under the *Fisheries Act 1994* (Fisheries Act) and Regulation, DPI&F has responsibility for conservation and enhancement of the community's fisheries resources and fish habitats using the principles of ecologically sustainable development. This legislation provides for the protection of all marine plants and for the declaration and management of Fish Habitat Areas in which development is restricted.

Works that may be approved for erosion control within a declared FHA are restricted under Fisheries legislation. Permanent erosion control structures and the deposition of beach replenishment material may be permitted only in a management B area FHA. Dredging of material for beach replenishment is not permitted in any declared FHA.

The head of power for the conservation of fish habitats and marine plants is provided by the Fisheries Act. However, the process of assessing and issuing approvals for fisheries-related development activities lies under the integrated development approval system (IDAS) of the *Integrated Planning Act 1997* (IPA).

Certain fisheries development activities require a resource allocation authority (RAA) under the Fisheries Act before an IDAS application may be made. RAAs are issued to the individual while linked to a development approval and identify a specific area for the proposed works.

The following activities require an RAA:

- caged aquaculture (defined as material change of use under IPA)
- commercial collection of dead marine wood from unallocated state land (defined as operational works under IPA)
- works within a declared Fish Habitat Area (defined as building works or operational works under IPA).

Integrated Planning Act 1997 *and Integrated Planning Regulation 1998*

Administered by the Department of Infrastructure and Planning, the IPA forms the framework for Queensland's planning and development assessment legislation.

The main elements of this framework include:

- one system for all development-related assessments by local and state governments—IDAS
- local government planning schemes as the main instrument for planning and development assessment
- state planning policies
- regional planning
- infrastructure planning
- private certification.

Depending on the type of development, DPI&F is an assessment manager or referral agency (concurrence or advice) under IPA and must comply with the strict timeframes for assessment of development applications provided for under IDAS.

The types of fisheries development approvals that may be applied for are provided for in IPA's Schedule 8, Part 1 Assessable development. Activities that do not require a fisheries development approval are listed in Schedule 8, Part 2 Self-assessable development. Fisheries development approvals are issued to the land.

The following activities require a fisheries development approval before these can be legally carried out:

- aquaculture (defined as material change of use under IPA)
- removal, disturbance or destruction of marine plants (defined as operational works under IPA)
- works within a declared Fish Habitat Area (defined as building works or operational works under IPA)
- waterway barrier works (defined as operational works under IPA).

Note fisheries development activities may need an RAA to be issued under the Fisheries Act before an IDAS application may be properly made (see above).

Other relevant legislation

- *Coastal Protection and Management Act 1995*, *State Coastal Management Plan—Queensland's Coastal Policy*
- *Environmental Protection Act 1994*
- *Marine Parks Act 2004*
- *Native Title Act 1993 (Cwth)*
- *River Improvement Trust Act 1940*
- *State Development and Public Works Organisation Act 1971*
- *Transport Infrastructure Act 1994*
- *Land Act 1994*

Appendix 4. Managing climate change impacts on fish habitats

A4.1 Introduction

The term 'climate change' is used to explain the accelerated changes to general weather conditions as a result of increased levels of greenhouse gases in the atmosphere, ozone depletion, air pollution and land clearing, in addition to natural factors.

Accelerated climate change has emerged as a key threatening process with implications for existing tidal fish habitats. Climate change is already impacting on natural systems and is likely to impact further on ecosystems worldwide. Tidal fish habitats that support the fish stocks on which Queensland's fisheries rely are amongst those most susceptible to climate change.

As the interface between land and sea, tidal fish habitats—already stressed as a result of human-induced or other disturbances—are particularly vulnerable to climate change impacts. Additional pressures of climate change are likely to further alter the distribution and function of these key habitats. Fish and marine plants in relatively pristine fish habitats may also be particularly vulnerable if barriers to landward or poleward migration are present.

A broad range of fish habitat management responses are required to effectively deliver on the objective of sustaining the function and diversity of tidal fish habitats to accommodate climate change:

- preserving intact natural habitat (seen as the least expensive and most effective response)
- understanding the inter-annual climate variability and its implications
- developing adaptation programs for landward and poleward habitat shifts
- supplementary management with specific activities for longer-term benefits (e.g. establishing buffers between fish habitats and coastal development)
- adaptive management through review and refinement of practices.

Given the potential scale of climate change and the likely shifts in species' climatic distributions, substantial increases in connectivity across tidal profiles and latitudes may be required, through large-scale buffer corridors and patches of fish habitat. The essential feature is adequacy of inter-connected fish habitats for large-scale ecological processes to continue. This will be achieved through coordination of habitat management across land tenures and uses (e.g. declared FHAs and adjacent vegetation) and across scales (e.g. connecting remnants at one scale or biogeographic regions at another scale).

The management objective of having increased connectivity in the tidal landscape is not new and climate change adds to the priority for meeting this objective. The potential risk that increased connectedness may lead to greater habitat for and movement of pests, weeds and fire also needs to be managed.

A4.2 Key impacts from climate change for fish habitats

- increased mean sea level
- salt water intrusion into ground water and coastal fish habitats
- changes to downstream flows
- increased coastal flooding (e.g. when combined with storm surge)
- increases severity of coastal storms and destruction of fish habitats
- acidification of marine waters.

Particular sensitivities to climate change are likely at local and regional levels, for example:

- tidal foreshores, as these have species stratified across the tide profile and may be restricted in area
- claypans with low relief, where a small change in rising sea level corresponds to a large geographic shift of climate conditions favourable to colonisation by species from adjacent areas
- migratory species as these use a diversity of habitats (e.g. spawning, juvenile, adult)
- species with restricted distributions and limited dispersal ability and reproductive capacity.

The distribution of marine vegetation is almost identical with that of coastal acid sulfate soils (ASS) and may be used as a surrogate for the presence of ASS. In terms of climate change, coastal ecosystems including mangroves, saltmarsh and seagrasses, are among the most vulnerable. In the event of sea level rise, habitat change (e.g. where saltmarshes are replaced by mangroves) and biodiversity loss in inshore areas may impact on the accessibility to habitats used by dependent fisheries species.

The importance of avoiding wetland disturbance has been highlighted in research where CSIRO investigated a connection between wetland drainage and production of greenhouse gases at East Trinity, Cairns, with findings that carbon dioxide and ammonia emissions are generated when intertidal wetlands are drained and ASS exposed (Hicks et al. 1999).

Buffers to protect fish habitat and reduce the loss of habitat biodiversity should be implemented. Buffers will allow for landward migration of tidal habitats as sea level rises. These also serve to protect marine plant communities and their functions as 'carbon sinks', contributing to a reduction in greenhouse gas production and to retain accessibility to inshore nursery habitats for use by species of economic importance to fisheries.

A4.3 The risk assessment process

A risk assessment should be undertaken to establish the context by:

- identifying the stakeholders and their objectives, interests and concerns
- establishing success criteria against which risks to the stakeholders can be assessed
- determining relevant climate change scenarios for the assessment.

A4.4 Climate change considerations during assessment of development applications

Applicants should address the following climate change elements within their application to provide advice on the implications of the proposed development on these elements:

- tidal flow regimes in and adjacent to the site
- distribution of fish habitats
- connectivity of fish habitats
- capacity for landward or poleward migration of fauna and plant species
- dynamics of restricted isolated populations
- effect of the development on resilience of habitats to climate change.

A4.5 Climate change offsets

Response measures that reduce the emission of greenhouse gases into the atmosphere or enhance their sinks, aimed at reducing their atmospheric concentrations and therefore the probability of reaching a given level of climate change.

Conservation of fish habitats will always be the most effective and least expensive means of maintaining these habitats. Offset opportunities to respond to climate change impacts include:

- preventing further land clearing and loss of habitats
- preventing introductions of new invasive species
- maintaining or restoring environmental flows, fish passage and water quality
- preventing or minimising salinity intrusion
- reducing nutrient and sediment flows to adjacent fish habitats.

Additional actions that assist or augment the long-term and natural adaptation of fish and fish habitats to climate change include:

- increasing the connectivity in the fish habitats, including buffers, corridors and 'stepping stones'
- rehabilitating degraded fish habitats, including revegetation of disturbed lands and restoration of waterways
- preserving key habitats that act as reservoirs under future climates

- ensuring marine protected areas are established and managed to allow species to migrate within, to and from them
- translocating species (noting the risks involved).

A4.6 References

Australian Greenhouse Office 2006, *Climate Change Impacts and Risk Management, a Guide for Business and Government*, Department of Environment and Water Resources, Australian Government, Canberra.

Department of Natural Resources and Mines 2005, *Climate Smart Adaptation—what does climate change mean for you?* Discussion Paper, Queensland Government, Brisbane.

Hicks, WS, Bowman, GM, Fitzpatrick, RW 1999, *East Trinity Acid Sulfate Soils, Part 1 —Environmental Hazards*, CSIRO Land and Water, Technical Report 14/99, April 1999.

Glossary

beach replenishment
The placement of sand along a foreshore to supplement the existing quantity of sand. Also known as beach nourishment, beach restoration or beach fill.

benthic
Living on a substrate.

buffer zone
A separation area designated to moderate adverse influences from development construction and operation activities on fish and fish habitats.

declared Fish Habitat Area (FHA)
An area declared under the *Fisheries Act 1994* to be a Fish Habitat Area.

dredging
The permanent, mechanical removal of material of geological origin from subtidal, tidal and permanently, periodically or intermittently submerged non-tidal land (this term does *not* include removal of coral limestone, snags, wood and other predominantly organic material or creation/clearing of drains).

ecologically sustainable development (ESD)
As defined in the *Fisheries Act 1994*:

Using, conserving and enhancing the community's fisheries resources and fish habitats so that:

- the ecological processes on which life depends are maintained
- the total quality of life, both now and in the future, can be improved.

The principles of ecologically sustainable development are:

a) enhancing individual and community wellbeing through economic development that safeguards the wellbeing of future generations
b) providing fairness within and between generations
c) protecting biological diversity, ecological processes and life-support systems
d) in making decisions, effectively integrating fairness and short- and long-term economic, environmental and social considerations
e) considering the global dimension of environmental impacts of actions and policies
f) considering the need to maintain and enhance competition, in an environmentally sound way
g) considering the need to develop a strong, growing and diversified economy that can enhance the capacity for environmental protection
h) that decisions and actions should provide for broad community involvement on issues affecting them
i) the precautionary principle.

erosion control structure
Includes hard and geotextile structures used for erosion control (e.g. revetments, seawalls, groynes).

erosion control works
Includes construction of hard and geotextile structures and beach replenishment for erosion control.

estuary
An area where a freshwater waterway meets the ocean and where salt and fresh waters mix.

extraction site
A site from where replenishment material is extracted.

filling tidal land
The placement of fill to raise the substratum level of submerged or intertidal land to create terrestrial land that is above the level of HAT and free from tidal inundation. See Section 5.3 of this policy, or FHMOP 001.

fish
As defined under the *Fisheries Act 1994*, section 5. Includes, but is not limited to, finfish, crustaceans, molluscs, echinoderms, sponges and worms.

fish habitat
As defined in the *Fisheries Act 1994*, schedule dictionary. Includes land, waters and plants associated with the life-cycle of fish, and includes land and waters not presently occupied by fisheries resources.

fish habitat disturbance
Any activity in a fish habitat that damages or has the potential to damage fisheries resources and fish habitats and alters the natural function of the habitat.

fisheries productivity
The biomass of fish produced in a given area over a given time.

fisheries resources
As defined in the *Fisheries Act 1994*, schedule dictionary. Includes fish and marine plants.

geotextile structure
Geotextile containers filled with sand and placed together to make walls, groynes and other structures for the purposes of erosion control.

habitat
The area or environment in which an organism or group of organisms lives.

hard (erosion control) structures
Structures that stop wave energy reaching the shore, or absorb and reflect the energy (e.g. revetments, rock walls, groynes, gabions).

infauna
Organisms that live within soft-sediment.

interstitial
The small spaces between sediment grains.

intertidal
The area of land between the extent of the highest and lowest astronomical tides.

littoral transport
The movement of material, by waves or currents, in the nearshore zone of the sea or a waterbody.

managed retreat
In the context of coastal erosion, a managed retreat allows an area that was previously above sea level to become flooded. This process is usually in low lying estuarine areas and is often a response to sea level rise.

marine plant
As defined in the *Fisheries Act 1994,* section 8. A plant (a 'tidal plant') that usually grows on, or adjacent to, tidal land, whether it is living or dead, standing or fallen; the material of a tidal plant, or other plant material on tidal land; a plant, or material of a plant, prescribed under a regulation or management plan to be a marine plant. 'Marine plant' does not include a declared plant under the *Rural Lands Protection Act 1985*.

offsets
(Environmental) offsets are positive measures taken to counterbalance negative environmental impacts that cannot otherwise be avoided or minimised. An offset may be located within or outside the geographic site of the development and should be legally secured. Offsets were previously referred to as 'mitigation measures' in DPI&F policy. Refer to FHMOP 005 for more information.

poleward
Towards the north or south pole.

population
A group of organisms of the same species living within a specified region.

precautionary principle
The principle that, if there is a threat of serious or irreversible environmental damage, lack of scientific certainty should not be used as a reason to postpone measures to prevent environment degradation, or possible environmental degradation, because of the threat.

reclamation
See 'filling tidal land' in section 5.3 of this policy, or FHMOP 001.

recovery (benthic)
Restoration or return to a former (or better) state or condition.

recruitment
The influx of new members into a population by reproduction or immigration.

regularisation
The process of making a shoreline more consistent in alignment.

replenishment site
The location where replenishment sand is placed.

rights or interests
See section 5.2 of this policy.

riparian vegetation
Vegetation growing on the bank of a waterway.

sand pushing
The transfer of sand from a natural habitat by pushing or scraping from the lower beach to the upper beach, usually by bulldozers or front-end loaders. Also known as 'beach scraping' or 'beach bulldozing'.

saltmarsh
An intertidal habitat occupied mainly by herbs and dwarf shrubs, characteristically able to tolerate extremes of environmental conditions, notably waterlogging and salinity.

significant erosion
Erosion that has resulted in, or if left uncontrolled would result in, the loss of one or both of the following in the short term: the ability to exercise the existing as-of-right or approved use of the property; and/or buildings, structures or infrastructure that are not expendable or that cannot to be relocated. See section 5.2 of this policy for more information.

soft engineering
Establishment of elements that aims to work with nature by manipulating natural systems which can adjust to the energy of the waves, tides and wind.

substrate
The surface on which an organism lives, including the sea-bed or bed of a waterbody.

tidal land
As defined in the *Fisheries Act 1994*, schedule dictionary. Includes reefs, shoals and other land permanently or periodically submerged by waters subject to tidal influence.

waterway
As defined under the *Fisheries Act 1994*, section 4. Includes a river, creek, stream, watercourse or inlet of the sea.

wrack
Aquatic plants such as seaweed and seagrass washed onto the shore.

Acronyms

ASS
Acid Sulfate Soils

DPI&F
Department of Primary Industries and Fisheries, Queensland

EPA
Environmental Protection Agency, Queensland

ESD
ecologically sustainable development

FHA
declared Fish Habitat Area

HAT
Highest Astronomical Tide

IDAS
Integrated Development Assessment System

IPA
Integrated Planning Act 1997

NRW
Department of Natural Resources and Water, Queensland

RAA
Resource Allocation Authority

SCMP
State Coastal Management Plan

SEMP
Shoreline Erosion Management Plan

UFHM Research Program
Urban Fish Habitat Management Research Program