Fish Habitat Guideline FHG 003

Fisheries Guidelines
for

FISH HABITAT BUFFER ZONES

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FHG 001:
Cotterell, E.J. (1998) *Fish Passage in Streams: Fisheries Guidelines for Design of Stream Crossings*, Department of Primary Industries, Queensland, Fish Habitat Guideline FHG 001, 37 pp.

FHG 002:
Hopkins, E., White, M. and Clarke, A. (1998) *Restoration of Fish Habitats: Fisheries Guidelines for Marine Areas*, Department of Primary Industries, Queensland, Fish Habitat Guideline FHG 002, 44 pp.

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Bavins, M., Couchman, D. and Beumer, J. (2000) *Fisheries Guidelines for Fish Habitat Buffer Zones*, Department of Primary Industries, Queensland, Fish Habitat Guideline FHG 003, 37 pp.

See also the Fish Habitat Management Operational Policy Series and Fish Habitat Codes of Practice Series.

These Guidelines provide a technical information base to assist in the negotiation of site-specific buffer zone refinements during discussion of issues when assessing development proposals. Development of these guidelines has been in response to a demand for information on Fisheries requirements for buffer zones from natural resource managers, Local Government planners, developers and conservation agencies.

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Executive Summary

From a fisheries perspective, the legislation in Queensland provides several mechanisms to assist in the management of fisheries habitat including protection of marine plants and declaration of Fish Habitat Areas. Buffers zones are recognised as a valuable and legitimate planning tool in the development and protection of terrestrial habitats bordering fish habitats. The provision of adequate buffer zones is promoted and recommended within guidelines and policy documents. Queensland Fisheries Service (QFS) Department of Primary Industries, has adopted a generic policy position which recommends a minimum buffer width of 100 m (incorporating natural vegetation and other buffer elements) set back from the level of Highest Astronomical Tide (HAT) in tidal areas. In freshwater areas, QFS recommends a minimum 50-metre setback (incorporating natural vegetation and other buffer elements) from freshwater habitats. These generic buffer widths are considered a 'starting point' from which site specific requirements can be negotiated.

As part of a whole-of-government response to the issue of buffer zones, protection of fish habitats and other wetlands is being targeted by a number of government agencies. For example, the Department of Natural Resources (DNR) has recently released a Native Vegetation Management Policy and Guidelines for clearing native vegetation on freehold and leasehold lands.

The Fisheries Guidelines for Fish Habitat Buffer Zones (FHG 003) provides the technical background for the generic recommended buffer zone widths. The Guidelines provide an information base to assist in the negotiation of site-specific buffer zone refinements during discussion of issues when assessing development proposals. The Guidelines provide current information and advice on buffer functions and recommended buffer zone widths, based on available scientific studies and existing buffer policies.

Buffer zone width may be assessed using either a fixed width or a variable width determination. In terms of ease of identification, fixed width buffer zones are easier to apply and to enforce with the additional benefit that their implementation does not require a specialised ecological knowledge. However, fixed-width buffer zones do not consider site-specific requirements such as adjacent development or land-use intensity, and site specific conditions (e.g. soil type, slope, vegetation type/density). The use of variable-width methodology may sometimes be more appropriate for selecting an effective buffer zone width. Use of this methodology will require greater expenditure of time and financial resources, and a higher level of training of agency staff for assessment and implementation of the agreed buffer width (Castelle *et al.*, 1994).

There are four key steps involved in the selection, design and implementation of an effective buffer zone width:

1. Confirmation of the need for a buffer zone (Fisheries identifies issues with proponent);
2. Determination of the minimum buffer zone width that will prove effective in reducing the impacts between fish habitats and adjacent land uses (Fisheries negotiates with proponent);
3. Provision of appropriate vegetation or structures (buffer elements) to fulfil the required functions of the buffer zone (proponent is responsible – advice from Fisheries); and
4. Implementation of a management plan to ensure the integrity of the buffer zone is monitored and maintained (landowner / body corporate / local authority is responsible).

Once the required functions of the buffer zone are identified, an effective buffer zone width for the site can be determined. Important initial considerations in assessing site-specific buffer zone width are:

- The buffer zone should not be viewed as an area for treatment of stormwater, sediment or erosion control associated with development activities.
- Landowners and stakeholders must be identified and involved in site assessment and effective buffer zone design and implementation.
- Tenure and ownership details should be confirmed as responsibility for implementation and maintenance of the buffer zone rest with the landowner.
- The costs and benefits of the establishment of a buffer zone should be considered, with the identification and promotion of benefits of a buffer zone to landowners and stakeholders.

Fisheries policy recommends the implementation of buffer zones and / or other protective measures for every land-use change or development adjacent to marine or freshwater fish habitats. Implementation of appropriate buffer zones will assist in meeting the objectives of the *Fisheries Act 1994* in ensuring the long-term sustainability of Queenslands fisheries resources.

Naturally vegetated transition zone between terrestrial vegetation and marine fish habitat. FHG 003 seeks to protect these areas through the provision of buffer zones.

1.0 Introduction

Background

The importance of vegetated buffering habitats landward of wetland habitats has long been recognised as being essential for protecting and maintaining the integrity of fisheries resources. Wetland habitats (e.g. mangroves, seagrasses and floodplains) and riparian vegetation perform integral and essential roles in the life cycles of many commercial, recreational and traditionally fished species through the provision of physical habitats and resources for breeding, spawning, grow-out, feeding, and protection from predation.

> *When a development threatens to impinge directly on a wetland one of the first issues to arise is how much "buffer" is needed between the wetland and the development in order to protect the wetland's value and the values of the fisheries habitat* (Lane, 1991).

Wetland habitats and their adjacent riparian lands are subject to increased pressures through urban development, agricultural expansion and encroachment onto the terrestrial and wetland vegetation adjacent to the aquatic environment. This has lead to degradation of these habitats and adjacent lands and the decline of resources previously supported. Concurrently, the use of adjacent lands as vegetated 'management' buffer zones between these wetland habitats and areas of development is becoming increasingly recognised as an important management tool in the long-term protection of the integrity and quality of wetlands (inland and coastal) and river systems.

Despite extensive scientific literature on the functions and design of buffers, and a general consensus of the value of these zones and their direct importance to the environment, there is still much conflict and debate as to their most appropriate design and implementation. The origins of this debate and the lack of a standard environmental planning model for buffer zone use and design relate directly to the variable nature of the buffer zone itself. The appropriate buffer zone width will vary according to the natural composition of the buffer zone, its functions, its geographic and geomorphic location, and the nature of the conflicting resource use issues (Cacho *et al.*, 1996).

Importance of buffer zones to fisheries

Buffer zones are defined as vegetated filter strips or zones located between natural resources and adjacent areas subject to human alteration (Castelle *et al.*, 1994). These zones provide a wide variety of ecological functions and benefits including flood control, improvement of water quality, stabilisation of the shoreline, erosion control, and provision and protection of fish and wildlife habitats.

The main objectives for the establishment of a management buffer zone between fish habitats and areas of development or land use include:

- ***Long term protection of fish habitats and the integrity of fisheries resources*** - The establishment of a disturbance free area (buffer zone) adjacent to fish habitats,

which benefits and retains biological and physical processes providing protection of the fish habitat from the potential impacts of urban or agricultural development.

- ***Provision of public access to fisheries resources*** - Appropriate buffer zones provide a separation distance between tenured land (residential, industrial, and agricultural) and fish habitats and assist in clarifying the boundaries of property.

- ***Landward progression of tidal lands with respect to natural erosion and predicted Greenhouse impacts*** – The goals of the Environmental Protection Agency's position paper on coastal management in Queensland (*Queensland's Coast: Managing its Future*, December 1999) specify that:

  '*A buffer zone of sufficient width should separate new development from the foreshore and coastal wetlands, to accommodate physical coastal processes including the potential long-term impacts of changes in shoreline position, climate change and the greenhouse effect.'*

  Rivers and other waterways are also dynamic systems that change course over time through the natural processes of erosion and accretion. Appropriate buffer zones protect adjacent land-uses and infrastructure from the impacts of this natural movement.

- ***Economic benefits to fisheries*** – Protection of fish habitats through the provision of a protective management buffer will ultimately benefit fisheries production, by maintaining the integrity of fisheries resources and reducing impacts of vegetation loss, nutrient, pesticide or metal pollution and erosion and sediment loss to the aquatic environment. Resulting in an improvement in the water quality, food and habitat resources available for fish species and leading to an increase in fish production, ultimately benefiting the commercial and recreational fisheries and their dependent industries.

See Appendix 1 for a tabular presentation of the fisheries benefits of buffer zone implementation.

Economic benefits of buffer zones

Buffer zones perform a range of important ecological functions. However, an efficient buffer zone may also provide significant economic benefits to those (ie. government and landowners) who own the buffer. Benefits will vary depending on the type and function of the buffer zone and agricultural or other activity carried out on the property.

Incentives offered by State and local governments to sections of the community who participate in the protection and revegetation of riparian lands and wetland bordering habitats include: rate rebates; tax deductions; subsidies for fencing and other restoration materials and lease payment reductions. Schemes that may benefit the Landholder include voluntary agreements such as the Land for Wildlife Conservation Scheme administered by eleven Queensland local councils.

Buffer zones form part of various sustainable land use and natural resource management schemes and programs, providing direct benefits for the protection of fish habitats. For example, the Department of Natural Resources *Native Vegetation Management Policy and Guidelines* (1999) aims to encourage good land management practices and protect native vegetation (the policy supports retention of riparian buffer zones and includes an incentive package and education program).

Free advice and assistance on the retention / rehabilitation of natural vegetation for landowners in both rural and urban areas is available through local and state government agencies and programs such as Landcare and Bushcare. Specialist Community Nature Conservation Extension Officers of the QPWS provide landowners and community groups with technical advice and assistance on managing bushland and property planning and the development of Nature Refuges.

The benefits to industry and landowners include compensation (in the form of financial incentives such as rate rebates) for areas set aside for the purpose of wildlife and habitat protection. Other incentives include long-term improvements in farm productivity and the positive enhancement of urban and rural communities. Further discussion on the economic benefits of buffer zones is provided in Appendix 2.

2.0 Responsibility for establishment and maintenance of buffer zones

Responsibility for the establishment and maintenance of fish habitat buffer zones rests with the landowner, body corporate or management authority on whose land the buffer zone is located.

The information in these Guidelines provides the background for the generic recommended buffer zone widths to assist in the negotiation of site-specific buffer zone refinements. These Guidelines should be referred to during discussion of issues when assessing development proposals. The Guidelines provide current information and advice on buffer functions and recommended buffer zone widths, based on available scientific studies and existing departmental policies. (Alternative buffer zone designs, management plans, monitoring procedures and protective measures must support a variation from the generic buffer zone widths.)

Appendix 3 provides a form for use by QFS officers when undertaking assessment of development proposals.

Fisheries Act and policies

The objectives of the *Fisheries Act 1994* and *Fisheries Regulation 1995* incorporate the intent and benefits of buffer zones (including the protection of creek and foreshore habitats) within its fish habitat conservation measures. This legislation provides for the '*management, use, development and protection of fisheries resources and fish habitats and the management of aquaculture activities, and for related purposes'*.

Current QFS policy supports the retention of a minimum buffer width of 100 m (incorporating natural vegetation and other buffer elements) set back between development and the level of Highest Astronomical Tide (HAT) in tidal areas,

especially if adjacent to a Declared Fish Habitat Area. In freshwater areas, QFS recommends a minimum 50-metre setback (incorporating natural vegetation and other buffer elements) between development and freshwater habitats. These generic buffer widths are considered a 'starting point' from which site specific requirements can be negotiated.

The Fish Habitat Management Operational Policy for Marine Plants (FHMOP 001, April 1996 edition) states in its Policy Principles (S.5) that: -

'Mitigation measures will be considered for every proposal and may include a) Inclusion of buffer zones whenever feasible (e.g. 100 m buffer zones between site boundary and marine plants or tidal lands)'.

The Fish Habitat Management Operational Policy for the Management of Fish Habitat Areas (FHMOP 002, September 1996 edition) in Queensland outlines the departmental policy position concerning the protection and management of fish habitat. Section 4B of FHMOP 002 relates to the establishment of buffer zones in Fish Habitat Areas. The current policy provides primarily for marine areas as no freshwater Fish Habitat Areas have been gazetted to date.

'A disturbance buffer (buffer zone) of appropriate dimensions should be established around any declared Fish Habitat Area to:

a) allow successful mitigation of impacts proposed to abut a declared Fish Habitat Area,
b) provide public access to a declared Fish Habitat Area,
c) allow for anticipated landward progression of marine plants associated with forecast Greenhouse impacts, and
d) protect the integrity of fisheries habitat within the boundaries of a declared Fish Habitat Area.'

Policy revision
Please note that both FHMOP 001 and FHMOP 002 are currently being revised and updated. QFS officers must ensure they are referring to the latest edition of these policy documents when undertaking assessments. Contact QFS Brisbane to receive the latest information on policy updates.

Appendix 4 lists Queensland legislation, policies and guidelines related to the provision and protection of buffer zones.

3.0 Technical information on design and functions of buffer zones

Buffer zone width is one of the most important characteristics of an effective buffer zone. Criteria (modified after Castelle, 1994) that will influence buffer width requirements include:

1) **The value, functions and sensitivity of the wetland will determine the level of protection required.** Systems that are highly sensitive to disturbance or

perform important fisheries functions (e.g. FHAs) will require larger buffer zones.

2) **The intensity of the adjacent land-use or land-use impacts.**
3) **The characteristics of the buffer zone such as slope and vegetation cover**. The effectiveness of the buffer zone will depend on the specific characteristics of the site being assessed. This will include type of soil; degree of soil compaction; width of the zone; area contributing to run-off; the slope of the land within and adjacent to the buffer zone; and the coverage, type and quality of the vegetation.
4) **The specific buffer functions required.** The effectiveness of a buffer zone to remove sediments, nutrients and other pollutants will increase with the width of the buffer.
5) **The location of the buffer zone in terms of climate and rainfall.** Buffer zone requirements will also vary according to the climatic zone (temperate/sub-tropical/tropical) and rainfall at the site.

Buffer size and function

Table 1 Assessment of required buffer functions

	Priority			
Buffer function	**Low**	**Med**	**High**	**Min. buffer width range required for function (m)**
Protection of fisheries species diversity and distribution • Continuous lines of vegetation • Connectivity between marine & FW areas • Migration pathways				5 - 106
Protection of ecological buffer • Bank / bordering / floodplain / tidal vegetation • LWD (structure, carbon cycling) • Productivity inputs (leaf litter etc)				5 – 100
Filtration of nutrients/pesticides/heavy metals • Sediment bound • Soluble • Spray drift				 9-61 5-262 40-300
Water quality • Sediment filter / control • Stormwater run-off filter / control • Provision of shading effects				 30-90 30-90 15-30
Stabilisation of bank erosion				5-125
Pedestrian access to fisheries resources				5-10
Provision of other wildlife habitat • Wildlife corridors • Protection of remnant vegetation				 15-45 5-100
Mosquito & midge control				Pest problems likely within 5km of breeding sites
Other: _____				

Table 1 is part of the assessment form for buffer requirements attached in Appendix 3. It is reproduced here as a guide to the decision making process for assessing buffer

requirements for development proposals. The table provides a synthesis of buffer functions and widths derived from Australian and international examples. If a function has a higher priority, then the minimum buffer width for that function should be higher in the range depicted.

A summary of an international literature review on buffer zone performance by Castelle *et al.* (1994) and other key research findings are outlined below:

a) ***Function - Sediment removal and erosion control***
Sediment removal requires buffer zone widths of 9 – 61 m.

- The ability of vegetated filter strips to remove sediment varies according to the site characteristics of vegetation type and density, type of soil, slope and placement of the filter. For example, a site with high rainfall, medium soil erodibility, high slope and poor vegetation cover will require a grass buffer zone width of greater than 30 m to remove sediment effectively.
- Grass filter strips are more effective at removing coarse sediments and aggregates than clay-sized or fine organic particles. The velocity of flow and particle size affect the time sediments remain in suspension and hence the width of the filter strip required to trap them
- Assessment of an appropriate buffer width or design should take into account whether the cause of the erosion is natural or anthropogenic (man-induced).
- Management of the buffering habitat should work with the natural ecology and alterations of the river.
- The extent and type of erosion depend on the interaction of the stream bank vegetation with a range of geomorphological, geotechnical, hydrological and hydraulic factors.
- The relationship between buffer width and percent sediment removal has been found to be non-linear. For example, an increase in the sediment design criteria from 90 to 95% on a 2% slope would double the buffer zone width requirement from 30.5 to 61 m.

b) ***Function - Excess nutrient and metal removal***
Nutrient and metals removal required widths of between 5 and 262 m depending on the slope, water velocity and type of vegetation used in the filter.

- Buffer zones are effective in reducing levels of nutrients and heavy metals entering waterways by direct filtering and plant uptake.
- Depending on the measures being used, buffer zones between 30 and 90 m were effective at removing from 50 – 92% of nutrients from run-off of adjacent activities such as feedlots and silviculture
- Feedlot experiments found the level of Nitrogen, Phosphorous and Potassium can be reduced by up to 80% by installing buffer zones of 91.5m width at 0.5% slope and 262 m width at 4.0% slope. In a US coastal region, wooded riparian buffers were effective at removing 80% of excess P and 90% of excess N, mostly within the first 19 m.
- In studies looking at animal waste treatment, it was concluded that a 1:1 ratio of buffer area to waste area (e.g. the cumulative surface area of poultry cages) was sufficient in reducing nutrient run-off to background levels. This ratio was also

sufficient for reducing non-point source pollution of animal waste concentrations by 90 to 100%.

c) ***Function - Maintaining streambank/riverbank stability***
A minimum of 5 m of vegetated buffer is required to protect riverbank stability.

- The *Guidelines for Queensland Streambank Stabilisation with Riparian Vegetation* recommend a naturally diverse and dense vegetation community within a buffer zone width determined by the minimum width of 5 m (the *basic allowance*) plus the *height allowance* and the *establishment allowance*. An example of a 'decision tree' is provided in the guidelines to assist the determination of riparian zone widths.
- It should also be acknowledged that erosion processes are natural and even healthy vegetated streambanks are not static, and should not be expected to remain unchanged by erosive forces over time. Moreover, when stabilising streambanks, the erosion process and the extent of vegetation should be matched

d) ***Function - Moderation of stormwater run-off***
Buffer zone widths of 30 m or more were found to be effective in preventing significant water quality impacts to wetlands.

- Vegetated buffer zones provide resistance to overland flow, reducing velocity and channelization and increasing infiltration of nutrients and sediment trapping. Grassed buffer zones, or buffers with a mix of shrubs and grasses are better able to moderate storm water run-off than treed buffers with little groundcover.

e) ***Function - Moderation of water temperature***
Water temperature moderation required 15 to 30 m of buffer.

- Vegetated buffers adjacent to a waterbody provide shade and help to moderate the water temperature, assisting in maintaining a lower water temperature in summer and temperature decreases in winter. This allows for a more constant level of oxygen in the water that is beneficial to aquatic organisms.
- Vegetated buffer zones also provide structure for fish to use for ambush or for hiding from predators.

f) ***Function - Protection of fish habitat diversity and species distribution***
Buffer widths of 5 to 106 m are required to maintain buffer zone habitat diversity.

- Vegetated buffers are critical for providing for water quality by preventing or slowing the input of excess nutrients and sediment and through moderation of water temperature by shading.
- Fish use bank vegetation for migration routes and in-stream structures such as roots and snags (large woody debris) for breeding, resting and feeding.
- Buffer vegetation provides leaf litter and other source material for in-stream primary production and carbon cycling.
- Continuous vegetation provides low stream velocity, feeding and resting areas for many small and juvenile species. Movement of fish species (critical for completion of life cycles) is interrupted by changes in habitat cover and light intensity.

- Larval golden and silver perch have been found to respond strongly to light gradients, water flow and river red gum leachate. Silver perch gradient responses were significantly more variable than golden perch which may result in silver perch being more widely distributed in flood plain habitats. Golden perch were more attracted to river red gum and may have a closer association with inundated red gum than silver perch (Gehrke, 1990).
- Studies have found that increased sedimentation from logged, unbuffered stream banks clogged gravel streambeds and interfered with salmonid egg development. With buffer strips of 30 m or greater, salmonid eggs developed normally.

g) ***Function - Protection from spray drift***
Protection of fish habitats from spray drift required buffer widths of 40 – 300 m.

- The Department of Natural Resources (Qld) Planning Guidelines for Separating Agricultural and Residential Land Uses (1997) recommends a minimum open land separation distance of 300 m and a 40 m minimum separation distance of vegetated (treed) buffer between agricultural and other land uses.
- Vegetated buffers are effective at capturing up to 80% of pesticide spray when applied upwind of a single row of trees. The height of the tallest mature tree should be 1.5 times the spray release height, or the height of the target crop or vegetation, whichever is higher. Suitable species should be selected for the floodplain that tolerate periods of inundation (e.g. *Casuarina* sp.).

h) ***Function - Mosquito/midge control***
Queensland Health is promoting a requirement for barrier zones to be adopted where new developments may be affected by adjacent mosquito and midge breeding areas. The width of the barrier zone is dependent on a range of factors including development design, existence of natural barrier zones and species of biting insect.

Studies have shown that problems from biting midges and mosquitos (particularly salt marsh species) are most intense within 5 km of the breeding site.

4.0 Setting up a buffer zone

Local Government Planning Schemes and site-specific development plans should include policies or objectives directed toward the protection of important natural resources. This includes consideration of the broad criteria developed in this document for confirming the need, design, establishment and maintenance of a buffer zone in areas adjacent to fish habitats.

The steps involved in applying these criteria for buffer zone requirements include:

Step 1. Confirmation of the need for a buffer zone which includes identifying detrimental impacts (existing and potential) between fish habitats and developed or developing areas.

Step 2. Determination of the buffer design that will prove effective in reducing identified impacts between fish habitats and adjacent land uses (site characteristics, buffer functions, width).

Step 3. Provision of appropriate vegetation or structures (buffer elements) to fulfil the required functions of the buffer zone.

Step 4. Implementation of a management plan to ensure the buffer zone will be monitored and its integrity maintained.

IMPORTANT CONSIDERATIONS

- Landowners and stakeholders should be identified in initial negotiations and involved in buffer zone assessment, design, establishment and maintenance.
- The costs and benefits of the establishment and maintenance of a buffer zone should be considered, and relayed to landowners and other stakeholders.
- Reaching agreement with landowners and stakeholders on buffer zone widths is extremely important to achieve effective buffer zone design, establishment and maintenance.
- All development activities including the treatment of stormwater run-off and sediment or erosion control should be contained within the development site. The buffer zone should not be viewed as a treatment area for these activities.

Step 1: Confirmation of the need for a buffer zone

The first step is to identify the stakeholders, find out the land use for the site and confirm the need for a buffer. Buffer zones are recommended to:

a) Protect fish habitats from existing adjacent land-use impacts e.g.:
- i) Residential/urban development – insect pest control, flood mitigation, run-off
- ii) Heavy/light industrial – contaminated storm water run-off, point source pollution (heavy metals, oils, dust, etc)
- iii) Intensive agriculture – spray drift, nutrient/pesticide/fertiliser
- iv) Broadscale agriculture - grazing impacts, trampling, erosion, waterway fouling

b) Protect fish habitats from land-use changes e.g.:
- i) Proposed new development of an area adjacent to fish habitat
- ii) Change of tenure from Crown lease
- iii) Declaration of new FHAs
- iv) Provision of public access to fisheries resources
- v) Clarification of boundaries between freehold and public open space

c) Provide for the protection of fish habitats through planning processes by:
- i) Protecting the long-term integrity of fish habitats from the potential impacts of urban development or agriculture

ii) Establishing and protecting disturbance free areas adjacent to fish habitats
iii) Considering the landward progression of tidal lands and movement of riverbanks with respect to natural erosion or predicted Greenhouse Effect.

Discussions with landowners or stakeholders will also assist in identifying and prioritising problems (such as bank erosion) perceived as a threat to their activities. By addressing the needs of landowners and other stakeholders there should be greater understanding of the benefits of buffer zones and hence a sense of ownership is achieved.

Alternative management measures

In some situations, the available minimum buffer zone width may not be available or may not be sufficient to deal with the identified impacts (for example, rising sea levels, natural erosion of a riverbank) on fish habitats. In these situations it may be necessary to propose alternative management measures in addition to those provided by a buffer zone. Management measures may include the provision of fencing, vegetative barriers, open water, signs, piers, and boardwalks (over marsh areas or other wetlands).

Marked changes in elevation (for example, bluffs, steep slopes) may also act to increase the effectiveness of the buffer zone.

Vegetated barriers and fences are effective control measures for restricting pedestrian, domestic pet or livestock access.

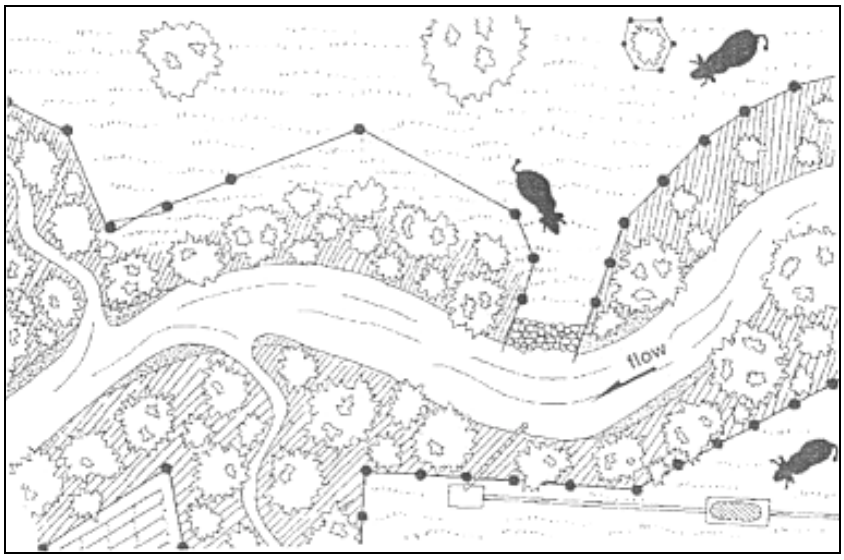


Figure 1 Two types of controlled stock access.

Stock access can be controlled through: a restricted access point (top of diagram), a single strand electric wire fence can be placed across the access path in the stream to prevent stock from moving up or downstream; and an off-stream watering point (bottom of diagram). From Karssies and Prosser (1999).

For further advice on mitigation options and alternatives that are acceptable to fisheries, refer to the Fish Habitat Mitigation Policy (draft) and the current Fish Habitat Management Operational Policies.

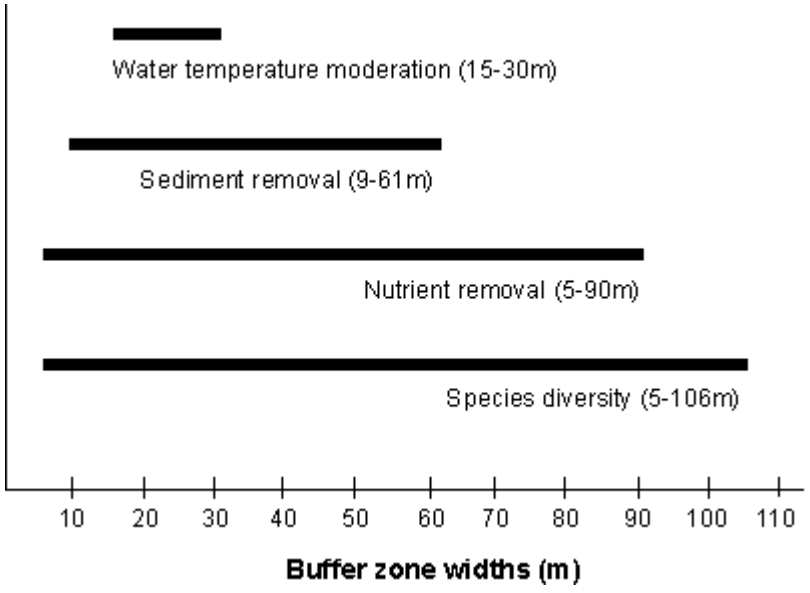
Step 2: Determination of the minimum width for the buffer zone

QFS policy sets out the minimum generic buffer zone widths required for fish habitat protection. However, an effective buffer width is one that mitigates all (or most) of the impacts that have been identified, and provides benefits for each function the buffer is to perform. Larger buffer zone widths may be required to effectively address impacts, particularly in areas adjacent to sensitive fish habitats.

The next stage in buffer zone width determination requires identification of the specific impacts (existing and potential) that need to be addressed by the buffer zone. Buffer performance criteria will vary on a site-by-site basis depending on:

i) The sensitivity of the adjacent fish habitat (e.g. the presence of a FHA, or an important fish breeding, feeding, nursery habitat or migration route)
ii) The intensity of the adjacent land-use (e.g. intensive agriculture, grazing, residential, industrial or natural)
iii) The potential impacts of the adjacent land-use on fish habitats (e.g. smothering of important fish habitat due to erosion and sedimentation from land; algal blooms and low oxygen environments due to nutrient enrichment from land-based sources)
iv) Site-specific characteristics such as slope, soils type, erosion, vegetation type and cover etc.

Figure 2 Range of (minimum) buffer widths for providing specific buffer functions.
Adapted from Castelle *et al.* (1994) *Wetland and Stream Buffer Size Requirements – A Review*, J. Environ. Qual. 23:878-882.



It is important to look at the context of the proposed buffer zone and the type of impact(s) it will control. Buffer zone function is both the mitigation of an impact and the maintenance of fisheries values. The function requiring the greatest width will determine the minimum width of the buffer zone.

Assessment of required buffer zone functions
Table 2 can be used as a checklist to identify which land use impacts exists and which of those a buffer will mitigate. This list is important as different impacts require different width buffers. Where there are several impacts, the buffer width is based on the impact that requires the greatest amount of buffer.

Table 2 Impacts mitigated by buffer zones

Impacts	Agriculture	Residential	Industry	Grazing
Access				
Public access to fish resources restricted	✓	✓	✓	✓
Trampling		✓		✓
Physical				
Erosion and sediment loss	✓	✓	✓	✓
Flood mitigation	✓	✓	✓	
Irrigation	✓			✓
Exotic vegetation	✓	✓		✓
Removal of vegetation	✓	✓	✓	✓
Chemical				
Nutrients	✓	✓	✓	✓
Pesticides	✓			
Heavy metals		✓	✓	
Spray drift	✓			
Odour	✓	*	✓	
Mosquito/midge problem		*		

***** *Natural wetlands may develop significant odours and insects that may impact on residential amenity; appropriate buffers provide protection from these.*

The width of an effective buffer will vary according to the local and regional conditions of the site. Assessment of the site should also include the collection of baseline site-specific information such as:

- Topography (soil type, slope).
- Erosion/deposition processes (existing and potential).
- Nature of vegetation (percentage cover, quality – weeds/native).
- Climate – (temperate/sub-tropical/tropical)
- Rainfall

Step 3: Selection of appropriate buffer elements to fulfil required buffer functions

Vegetation
The recommended Fisheries position for buffer zone vegetation is natural (ie native to the area) vegetation throughout the minimum recommended width (100 m from HAT and 50 m from freshwater wetlands).

The benefit that different types of vegetation including grasses, trees and shrubs, provide, will vary according to the required function. All or one of these vegetation types may be required to provide appropriate buffer functions. Table 3 contains information on the capacity of each vegetation type to act as an effective buffer element and to control particular impacts. As a general rule, multi-species vegetated buffer zones which contain high quality, natural habitats are most successful at providing effective buffer functions.

Table 3 Relative effectiveness of different vegetation types to control impacts.
(Adapted from Dosskey *et al.* (1997) Agroforestry Notes: *How to design a riparian buffer for agricultural land*, USDA Forest Services and Natural Resources Conservation Service; and DNR (1997) *Planning Guidelines Separating Agricultural and Residential Land Uses*)

	Vegetation Type		
Benefit	**Grass**	**Shrub**	**Tree**
Stabilisation of bank erosion	L	H	H
Sediment filter	H	L	L
Filtration of nutrients/pesticides			
Sediment bound	H	L	L
Soluble	M	L	M
Spray drift	L	H	M/H
Enhancement of aquatic habitat			
Water temperature moderation	L	M	H
Stormwater run-off filter	H	L	L
Flood protection	L	M	H
Aesthetics and visual diversity	L	M	H
Economic benefits	M	L	M
Provision of wildlife habitat			
Range/pasture wildlife	H	M	L
Forest/woodland wildlife	L	M	H

Relative effectiveness levels: L= Low; M= Medium; H= High

Although grass filter strips have been proven to be most effective for trapping sediment, buffer zones with native vegetation are more valuable to fisheries production through the input of leaf litter, insect drop and woody debris essential for in-stream primary production and fish habitats.

Step 4: Implementation of a management plan

The implementation of a management plan is an essential step in the design, establishment and maintenance of an effective buffer zone. A buffer zone management plan should address the following:

- Identify site-specific buffer zone function requirements and buffer elements.
- Identify available incentives for establishment and retention of buffer zones (e.g. rate rebates, tax relief, subsidies for tree planting and fencing etc).
- Develop agreed performance criteria to measure success of buffer zone in mitigating impacts.
- Agree in writing who is responsible for the establishment and on-going maintenance of buffer zone (usually the landowner, body corporate, lease manager or local authority).

- Determine actions to control degrading influences – e.g. weed and rubbish removal strategy, water quality control measures, erosion, sediment and point-source pollution control, pedestrian, vehicle, domestic and livestock access control.
- Develop a revegetation/restoration strategy if required (see below).
- Develop a protocol to assess the success of the buffer zone in mitigating impacts against agreed performance criteria.
- Review whether the buffer zone width is appropriate based on results of assessment and monitoring.

Restoration of buffer zones
Where functions have been degraded to the extent of affecting the adjacent fish habitats, a restoration plan will need to be incorporated into the management plan for the buffer zone. Steps for the restoration plan are:

Step 1	Identify baseline conditions and degrading factors – *Weeds, sedimentation sources, erosion, stormwater inputs, discharges/leachates, vegetation cover*
Step 2	Identify extent of disturbance within the buffer zone
Step 3	Set restoration objectives for reinstating an effective buffer zone – *Rubbish removal, weed, erosion and sediment control, water quality improvement, revegetation, habitat creation*
Step 4	Determine resource allocation – *Funding, project costing, responsible body*
Step 5	Determine and obtain relevant approvals/permits – *DPI, EPA, DNR, Local Councils*
Step 6	Formulate restoration plan – *Plan removal of degrading factors*
Step 7	Develop revegetation strategy (if necessary)
Step 8	Implement restoration plan
Step 9	Assess and monitor site – *Monitor plant survival and growth, troubleshoot problems*
Step 10	Report results
Step 11	Maintain restored site

Adapted from Hopkins *et al.* (1998) *Restoration of Fish Habitats: Fisheries Guidelines for Marine Areas*, FHG 002, DPI.

Also see Appendix 5 (Important fish habitats) and Appendix 6 (Pressures and threats to buffer zones and fish habitats) for additional background information.

5.0 Managing fish habitat buffers

Maintenance of buffer zone habitats

Buffer zone design should ensure the separation of conflicting land uses whilst avoiding the need for any special maintenance requirements. However, some ongoing maintenance may still be required in the form of replanting, thinning, fire protection management, removal of weeds or litter clearance in order to maintain their buffering efficiency.

Responsibility
The tenure or ownership of the land where the management and maintenance of a buffer zone is required will determine the management responsibility:

- Public ownership – local government and other agencies will be responsible for overseeing maintenance;
- Private ownership –maintenance is undertaken by the landowner/tenant with respect to local laws, development conditions, or environmental protection agreements.
- Joint tenure arrangements – in this instance the body corporate is responsible for maintaining the common area, including any roads or building present in the common area, and responsibility for control of fire and noxious weeds.

Changes over time
An important consideration for the on-going maintenance of buffer zones is the changes that may happen over time to buffer zone effectiveness. Land-use changes can have direct impacts (negative and positive) on an established buffer. A study undertaken by Washington State Department of Ecology (Cooke, 1992 *Wetland buffers – a field evaluation of buffer effectiveness in Puget Sound*) showed that more than 90% of the 21 sites studied were altered over time (between 1 and 8 years). Of those buffers altered, 76% were altered negatively with smaller buffers showing greater loss of buffer function and reduction in buffer size. The study showed that overall, buffers are subject to a reduction in size over time and that larger buffers were more resilient to the impacts of land-use changes on buffer zone functions.

The effect of land-use change on adjacent, established buffer zones needs to be considered as part of the on-going management strategy for the buffer. The buffer zone width may need to be changed (expanded or reduced) to accommodate or maintain desired buffer functions.

Best management practices for the protection of fish habitats

The presence of buffer zones will reduce the impact of development or agricultural practices on fish habitats. However, adoption by farmers and landowners of best management practices (BMPs) will maximise the benefits of buffer zones. The following information is a brief summary taken from Land and Water Resources Research and Development Corporation (LWRRDC) Riparian Management Factsheets. Other sources of information on best practice techniques include industry standards and Codes of Practice, Landcare and Integrated Catchment Management organisations, Natural Resource Management agencies, Local Government Authorities and environmental education institutions.

Irrigation and fertiliser application
Application of fertilisers to crops should be timed to ensure maximum uptake and minimum loss of nutrients through leaching and volatilisation. Application of fertiliser should avoid periods of intense run-off such as during periods of flooding or high rainfall. Greater uptake of fertilisers by cane and crops and reduced leaching can be achieved by placing fertiliser within the soil or under trash rather than by broadcast application. Greater efficiency of crop uptake of nitrogen-based fertiliser (urea) is also achieved through the frequent application of smaller quantities.

Adoption of industry Codes of Practice such as the Code of Practice for Sustainable Cane Growing in Queensland (CANEGROWERS) and the development of strategic Fish Habitat Codes of Practice (QFS, DPI) will assist in the protection and enhancement of fish habitats.

Managing stock access to grazing areas

Controlling and managing stock access and grazing pressure is one of the most important and effective management actions landowners can undertake to protect riparian vegetation and fish habitats. Reducing stock access to the streambank through fencing or limited access will greatly reduce the impacts of trampling and overgrazing. The development of animal tracks result in increased erosion and damage to river systems as well as direct fouling by stock of wetlands.

Studies in the US have shown an increase in the fattening of calves watered through piped outlets. Providing off-stream watering points has other benefits for the farmer including ensuring good water quality for stock and prevention of stock losses through animals trapped in mud and drowning.

Farming practices

Adoption of BMPs such as laser levelling, contour ploughing and minimal tillage and retention/enhancement of remnant native vegetation by landowners will provide positive benefits for the landowner and fish habitats. Incentives, both financial and non-financial have been used successfully in Australia and overseas to encourage greater uptake of environmental best practice for natural resource management.

Mobbs (1996) cites several Australian examples where local government has provided substantial incentives to landowners to reverse land degradation. These include rate rebate and tax incentive schemes, as well as subsidies for fencing materials and tree planting programs.

In April 2000, the Queensland Government announced a financial assistance package for landholders, community groups and local government to improve vegetation around waterways in the Queensland section of the Murray Darling Basin. Incentives include cash or 'in-kind' assistance for 50% of rehabilitation costs incurred for activities such as fencing, tree planting and weed control. The State and Federal government jointly fund the 'Fish Habitats' initiative. The Fish Habitats Project Officer will provide technical support for rehabilitation projects and is based at the DNR Dalby office.

6.0 Glossary

Acid sulfate soils (ASS): Soil and sediment containing iron sulfides (principally iron pyrite) or containing acidic products of the oxidation of sulfides. When exposed to air oxidation of sulfides occurs. When the soil's capacity to neutralise the acidity is exceeded, sulfuric acid is produced (Ahern *et al.* 1998).

Buffer area: The area of land separating adjacent land uses from wetlands and fish habitats, which is managed for the purpose of mitigating impacts from one use on the other. A buffer area consists of a *separation distance* and one or more buffer elements.

Buffer element: A natural or artificial feature within a *buffer area* that mitigates a negative impact. A buffer element may include open ground, grassed areas, natural vegetation or a physical barrier.

Buffer zone function: The ability of the buffer zone to mitigate an impact(s) and maintain fisheries values.

Ecological buffer: The natural, transition zone bordering aquatic habitats. May be vegetated or non-vegetated (e.g. mudflats, saltpans, dunes, sandbars).

Fish: An animal (whether living or dead) of a species that throughout its life cycle usually lives in water (fresh or saltwater); or in or on foreshores; or in or on land under water and includes molluscs, crustaceans, marine mammals, coral, fish and the spawn, spat or eggs of fish. "Fish" does not include crocodiles, animals protected under the *Nature Conservation Act 1992* or animals prescribed under a regulation not to be fish (*Fisheries Act 1994* S.5).

Fish habitat: Includes land, waters and plants associated with the life cycle of fish, and includes land and waters not presently occupied by fisheries resources *(Fisheries Act 1994* S.4).

Fisheries resources: Includes fish or marine plants (*Fisheries Act 1994* S.4).

Highest Astronomical Tide (HAT): The highest level that can be predicted to occur under average meteorological conditions and any combination of astronomical conditions. This level will not be reached every year, and is less than the extreme levels that can be caused by storm surges.

Large Woody Debris (LWD): Snags and large woody debris (LWD) such as sticks, branches, trunks and whole trees that fall into rivers and streams. LWD is essential for provision of in-stream habitat for aquatic animals and is important from both an ecological and geomorphic/hydraulic viewpoint (see LWRRDC's riparian lands management newsletter RIPRAP, Edition 16, 2000).

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

Open Space: *'Land and/or water that has its surface area open to the sky and is totally or predominantly undeveloped-is an essential component of our urban and rural environments as it serves a number of basic human and ecological needs.*

- *Maintains natural processes and protects environmental sensitive areas, cultural heritage and valuable natural resources;*
- *As a design element, can provide a visually pleasant landscape which contributes to scenic quality and environmental amenity;*
- *Provides outdoor recreation opportunities.'*

(SEQ 2001 Open Space and Recreation Policy Paper Regional Planning Advisory Group, 1993).

Rehabilitation: Returning to a state where natural succession can continue the recovery process and allow fisheries values of the site to be returned.

Riparian vegetation: Vegetation growing on the bank of a watercourse.

Separation distance: The total linear distance between a hazard source and a fisheries resource.

Tenure: The holding and possessing of property.

Tidal land: Includes reefs, shoals, mudflats and sandbanks and other land permanently or periodically submerged by waters subject to tidal influence (*Fisheries Act 1994* S.4).

Waterway: Includes a river, creek, stream, watercourse or inlet of the sea (*Fisheries Act 1994* S.4).

Wetland: 'Areas featuring permanent or periodic/intermittent inundation, whether natural or artificial, static or flowing, fresh, brackish or saline, including areas of marine water, the depth of which at low tide does not exceed six metres.' (Ramsar Convention, 1971).

7.0 Acronyms

ASS	Acid Sulfate Soils
DNR	Department of Natural Resources, Queensland.
DPI	Department of Primary Industries, Queensland.
FHA	Fish Habitat Area
FHMOP 001	Fish Habitat Management Operational Policy 001 (Couchman *et al.*, 1996)
FHMOP 002	Fish Habitat Management Operational Policy 002 (Zeller and Beumer, 1996)
HAT	highest astronomical tide
LWD	Large Woody Debris (branches, snags, logs)
PASS	Potential acid sulfate soils
QASSIT	Queensland Acid Sulfate Soils Investigation Team
QEPA	Queensland Environmental Protection Agency
QFS	Queensland Fisheries Service
S.	Section

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Appendix 1 Fisheries benefits of buffer zone implementation

Implementation of a buffer zone should protect the ecological buffer and fish habitats from the potential negative impacts of adjacent development.

Buffer zone function	**Benefits to Fisheries**	**Threats to buffer function**	**Impacts to fisheries with removal of buffer function**
Streambank stability and erosion control Vegetated buffer zones provide an improvement in riverbank stability through establishment and maintenance of natural bank vegetation	• reduced sedimentation protects fish eggs and in-stream vegetation from smothering , reduces infilling of deep water holes and fish refuges	• natural erosion due to flow of river/stream over time • vegetation removal • overgrazing and trampling by cattle • impacts of edge effects causing degradation of vegetation community – encroachment of weeds, uncontrolled access, illegal dumping of rubbish, fire damage etc.	• increased sedimentation leading to smothering of fish eggs and in stream vegetation, • suspended sediment clogs the delicate respiratory gills of fish and benthic invertebrates • in-filling of deep water holes and fish refuges
Moderation of stormwater flow and flood mitigation	• healthy vegetation slows the flow of water, protects soil from scouring and erosion and thereby protects fish habitat from the impacts of sedimentation	As above	As above

Buffer zone function	Benefits to Fisheries	Threats to buffer function	Impacts to fisheries with removal of buffer function
Provision of habitat and food resources If adequate natural vegetation does not exist, revegetation of stream/riverbank or bordering vegetation may be required Establishment of snags, overhanging trees etc	• provides material for instream and nearshore primary production • provides shading of habitat for fish and their food organisms • overhanging vegetation moderates water temperature providing a more suitable habitat for the life stages of fish species (eggs, juveniles and adults). • vegetation also provides protection from predation • provides important food sources in the form of 'insect drop' from overhanging vegetation	vegetation removal including:- • Removal of snags from river/stream bed • loss of overhanging and adjacent vegetation	• Increase in water temperature due to lack of shading associated with reduction in dissolved oxygen levels in water and the subsequent progressive death of sensitive aquatic organism including fish and their food organisms • Reduction in shading or protective vegetation leaves fish more visible to predators such as birds • Reduction in input of material to support instream and nearshore primary productivity
Enhance migration corridors Buffer zones support the retention of continuous lines of vegetation linking marine and freshwater habitats, essential for fish migration.	• provides structure and shelter/shaded areas along stream banks and in estuarine channels which allow the movement of fish species • continuous lines of vegetation are important in linking freshwater and marine habitats	• removal or fragmentation of bank or bordering vegetation • construction of bunds, tidal barrages or other barriers to fish movement • channelisation, de-snagging and piping of streams	• loss of migration paths and access to spawning/nursery areas and subsequent reduction in fisheries resources • reduction of fish habitats

Appendix 2 Economic benefits of buffer zones

Buffer zones perform a range of important ecological functions that are beneficial to the surrounding environment. However, the presence of an efficient buffer zone habitat may also provide significant economic benefits to government, landowners or farmers on whose land it stands. These benefits will vary depending on the type and function of the buffer zone and activity carried out on the property.

Highlighting the economic benefits of buffer zones to farmers/landowners will provide additional incentive for re-establishment and maintenance of buffering habitat. Through the establishment of buffering habitats in conjunction with the use of Best Management Practices, damage to fish habitats should be reduced.

- **Economic benefits to fisheries** – Protection of the ecological buffer through the provision of a protective management buffer will ultimately benefit fisheries. Through maintaining the integrity of these resources and reducing impacts of vegetation loss, nutrient, pesticide or metal pollution and reducing the impacts of erosion and sediment loss to the aquatic environment, the benefits for fish species will include an improvement in the water quality and food and habitat resources available. This will result in an increase in fish productivity and ultimately benefit the commercial and recreational fisheries.

- **Economic benefits to government -** Through the protection and maintenance of existing vegetated buffers government expenditure will be reduced on projects to re-vegetate riverbanks, stabilise riverbanks for erosion prevention and the implementation of additional methods for floodwater control (see Appendix 7 – Case Study 3)

- **Economic benefits to landowners**
  Stabilisation of river banks – Prevent loss of valuable farming and grazing land

  Increased capital value of property – There are many examples, particularly with the advent of Landcare, where native vegetation cover along watercourses has increased the capital value of a property (Fielder, 1996).

  Reduction in cane rat habitat –Native rats have been found to cause significant damage to sugarcane crops in areas where streambanks are dominated by weeds and grasses (their preferred habitat). Revegetation and restoration of streambank habitat with trees has been found to significantly reduce the coverage of weeds and grass habitat through shading and subsequently reduce populations of rats in the area. The decline in rat numbers will also reduce the need for additional rat 'control' measures such as bait or pesticides.

  Improvement in milk production – Research has found that cattle drinking from piped water sources generally gain weight faster and show improved milk productivity compared to those drinking from unprotected riverside areas. This may be related to the effect of bacteria or bovine pathogens in the water, contaminated by cattle fouling further upstream

  Protection of stock – Loss of dairy or beef cattle may occur when uncontrolled grazing of streambanks occurs. Incidents of cattle falling down steep banks or drowning in silted creeks have been reported. Through fencing of the buffering habitat adjacent to the water resource, and the provision of designated watering areas incidents of stock loss can be reduced

  Reduced damage by floodwaters – Vegetated buffers reduce the impact of severe storm and flooding events. Property damage through erosion, sediment loss from banks and scouring is less severe in areas that retain a buffer zone.

Crop improvement – Vegetated buffers act as a windbreak. Vegetation improves microclimate and habitat for beneficial insects and predators acting as a natural pest management control.

Agroforestry – Agroforestry can allow for selective harvesting of riparian vegetation (e.g for timber and other bush products such as pharmaceuticals, leaves, oils, fruit and seeds) while maintaining a continual, well-vegetated buffer zone (Fielder, 1996).

Tax incentives –The Commonwealth government has provided a number of tax incentives designed to encourage the rehabilitation of degraded areas of land. These are available to landowners that are involved in primary production for taxation purposes (Refer to the Australian Taxation Office for a definition of what constitutes "a business for taxation purposes").

- **Economic benefits to the community -** Improvements in the quality and quantity of fish resources through an improvement in water quality, fish habitat and available resources.

  - Buffer zones for fish habitat protection contribute to the long-term sustainability of fisheries resources.
  - Provision of buffer could also include the provision of public access to waterways, and an improvement in access for recreational fishing.
  - Replenishment of groundwater supplies.
  - Reduces the risk of disturbance of acid sulfate soils and associated costs to the community for their remediation and effects of long-term adverse impacts from acid run-off (loss of productive land, destruction of fish habitats, loss of fisheries resources, degradation of aquatic habitats, loss of biodiversity, infrastructure damage etc).
  - Provides protection for residential, agricultural and urban development from the effects of sea level rise associated with the Greenhouse Effect and the effects of flooding associated with storm events.
  - Allows for natural progression of waterways and river mouths over time.
  - Provides setback from mosquito and midge habitats (disease vectors).
  - Provides a setback from odours caused by natural events such as mangrove seed fall or decomposition of seagrass wracks.
  - Provides windbreaks and microclimate benefits for residential and agricultural land.
  - Provides a barrier to chemical or dust drift between agricultural/industrial and residential estates.

Appendix 3 Assessment of buffer requirements

Assessor: _____ **Date:** _____

Site Location: _____

Proposal description: (state if private or public development) _____

_____

1. Fisheries values

a) Vegetation present (marine/riparian/floodplain)

Type: _____ % Area cover: _____

Pristine ❑ Little disturbance (10%) ❑ Disturbed (50%) ❑ Very disturbed (90%) ❑

Weed species infestation: Heavy ❑ Moderate ❑ Light ❑

b) Declared Fish Habitat Area adjacent? Y ❑ N ❑

If Yes, Identify name of FHA _____

c) Importance to recreational, indigenous and commercial fishing

Access to fishing grounds ❑ Important fish breeding/nursery/feeding area ❑

Adjacent to fish migration path ❑ Timing / season of migration _____

Other ❑ _____

2. Objectives for establishment of a buffer zone

a) Future planning (QFS recommended minimum separation distance)

Marine (minimum separation distance from HAT)	100 m
Freshwater (minimum separation distance from high bank)	50 m

b) Land-use change

i. Proposed development of area adjacent to fisheries habitat ❑

ii. Change of tenure of buffer zone ❑
Freehold to Crown ❑
New FHA ❑
Provision of public access to fisheries resources ❑
Other ❑ (please specify) _____

iii. Removal of perceived tenure rights ❑

iv. Change from proposed residential to community area/open space ❑

c) Protection of fish habitats from existing impacts of adjacent land uses

Residential/urban development ❑ Industrial ❑ Agricultural ❑

d) Provision of separation distance to provide residential/urban areas with:

Mosquito control ❑ Odour control ❑ Public open space ❑

Other ❑ _____

3A. Assessment of required buffer functions (tick)

Buffer function	Priority: Low	Priority: Med	Priority: High	Min buffer width range required for function (m)
Protection of fisheries species diversity and distribution • Continuous lines of vegetation • Connectivity between marine & FW areas • Migration pathways				5 - 106
Protection of ecological buffer • Bank / bordering / floodplain / tidal vegetation • L W D (structure, carbon cycling) • Productivity inputs (leaf litter etc)				5 – 100
Filtration of nutrients/pesticides/heavy metals • Sediment bound • Soluble • Spray drift				 9-61 5-262 40-300
Water quality • Sediment filter / control • Stormwater run-off filter / control • Provision of shading effects				 30-90 30-90 15-28
Stabilisation of bank erosion				5-125
Pedestrian access to fisheries resources				5-10
Provision of other wildlife habitat • Wildlife corridors • Protection of remnant riparian vegetation				 15-45 5-100
Mosquito & midge control				Pest problems likely within 5 km of breeding sites
Other:_____				

3B. Assessment of other site-specific characteristics

a) Soil Type

Sandy ❑ Clay ❑ Loam ❑ Other ❑ Slope (%) _____

b) Rainfall

High ❑ Medium ❑ Low ❑

4. Other comments _____

_____

_____

5. <u>Recommendation</u>

Buffer zone width required: _____

Functions: _____ _____

_____ _____

Appendix 4 Relevant legislation

This table lists current (at time of printing) Queensland legislation, policies and guidelines that relate to the provision and protection of buffer zones.

Agency	Legislation/ policy	Specific buffer requirements
Qld Fisheries Service DPI	***Fisheries Act* 1994 and *Fisheries Regulations* 1995**	QFS policy recommends '*A minimum buffer width of 50 m incorporating established natural vegetation or other buffer elements, between developments and freshwater creeks and 100 m between developments and tidal lands, especially adjacent to Fish Habitat Areas. However, the width of buffer zones is not specific and is determined on a case by case basis. These buffer provisions should be accommodated within the site for the protection of coastal fisheries resources, and may require enhancement where habitat degradation is significant.'* The provisions of the *Act* include • **The protection of marine plants** The value of marine plants to fisheries production is recognised and complete protection is extended to all marine plants irrespective of tenure. Any disturbance or removal of marine plants from these habitats requires a permit (under section 51 of the *Act*), which will not automatically be granted. • **Declaration and management of FHAs** This provision establishes protection for key fisheries habitats in marine and freshwater environments ensuring the physical and chemical nature (including water and soil) and integrity of the environment (including shallow water banks and channels, seagrass and mangrove communities and other marine plants and tidal wetlands) are protected. Any developments or disturbance to the FHAs require a permit and are restricted to those that will have minimal impact to the ecology of the habitat. • **Restoration of damaged or destroyed fish habitats** A Restoration Notice may be issued when the value of the fishery has been compromised, or the quality or integrity of the fish habitat has been adversely impacted. A Restoration Notice is only issued where a person is suspected, on reasonable grounds, of causing disruption, damage or pollution to fisheries, fishing or fish habitat through the placement or outletting of polluting matter on land, in waters, on marine plants or in fish habitat.
DNR	***Land Act 1994*** ***Land Regulations 1995***	Part 6 of the *Land Act 1994* sets out the Queensland Government's requirements for tree management on land on which the trees are owned by the State. The Broadscale Tree Clearing Policy for Leasehold Land (December 1999) sets out requirements for the protection of remnant vegetation on leasehold land. Vegetated buffer widths of a minimum of 50m are required around wetlands, lakes or springs. Eight

Agency	Legislation/ policy	Specific buffer requirements
		Performance Requirements and Acceptable Solutions are set out in the Policy. The policy for tree clearing on freehold land was being updated at time of printing. Part 4A of the *Land Act 1994* refers to "Land of high nature conservation value. 24C. (1) This section declares, for section 253 of the Act, definition "critical area", paragraph (a), land that is of high nature conservation value. (2) The land that is declared that – (a) is within 50 m of a non-tidal watercourse or lake; (b) is within 500 m of a point the highest astronomical tide reaches on a watercourse; or (c) is within 1 km of the high water mark at the coastline
DNR	***Water Resources Act* 1989 *and Water Resources Amendment Act* 1993**	This *Act* provides for licensing of private extraction and permitting of disturbances to the bed and banks of watercourses. This *Act* controls the management of rivers and streams, and the maintenance of the physical integrity of the watercourse. The *Water Resources (Watercourse Protection) Regulation 1993* refers to the destruction of vegetation in a watercourse, excavation in a watercourse and placing of fill in a watercourse.
DNR	***River Improvement Trust Act* 1940 *River Improvement Trust Regulation* 1998**	This *Act* provides for the protection and improvement of the bed and banks of rivers, the repair and prevention of damage to the bed and banks of rivers and the prevention or mitigation of inundation of certain land by floodwater from rivers.
EPA	***The Beach Protection Act* 1968** Note: this legislation is being be phased out and addressed by the Coastal and Protection Management Act	This is currently the only legislative control with provisions for the implementation and maintenance of buffer zones to protect areas (excluding freehold or leasehold land) prone to erosion control within Queensland. Provisions for the maintenance of freehold or leasehold land require that an area to be rezoned should either be surrendered to the State, or if retained by the owner, that the owner should maintain the area to protect against wind or tidal erosion (Section 67 of the *Harbours Act*)
EPA	***Coastal Protection and Management Act* 1995**	This Act provides for the protection, conservation, rehabilitation and management of the coast including its resources and biological diversity. Section 59. Coastal building line (1) A regional plan, regulation or notice that declares a control district may fix a line (a "coastal building line") for the district. (2) An approval to build under the Building Act 1975 must not be given to build a structure completely or partly seaward of the coastal building line.

Agency	Legislation/ policy	Specific buffer requirements
		(3) However, the minister may, in writing, state that the subsection (2) does not apply to a structure, if the minister is satisfied- (a) The structure is not contrary to the coastal plan for the district; and the building of the structure is not likely to have a detrimental impact on coastal management.
EPA	**Position paper on coastal management in Queensland** Note: This position paper, which was brought out for public comment in December 1999 precedes the draft State Coastal Management Plan which will be produced under the *Coastal Protection and Management Act* 1995	The State Plan will apply to the coastal zone including '*coastal waters and all areas to the landward side of coastal waters in which there are physical features, ecological or natural processes or human activities that affect, or potentially affect, the coast or coastal resources'* (Coastal Act S.1). The coastal zone may also include extensive catchment areas where activities may have impacts. Proposed provisions listed in Part 2 *Principles and Policies* of the Position Paper include: P. 23, principle 3: 'Riparian vegetation along watercourses of the coast should be managed in accordance with the following criteria: - (a) it should be protected and rehabilitated to provide long-term ecological functions to watercourses, coastal wetlands and marine areas, including • as an important biological filter, • as streambank protection (e) The width of riparian areas should be appropriate to support their intended function, being greater for rivers, coastal wetlands and larger tributaries. The width of the riparian areas needs to take account of potential external impacts, including pest plant invasions, lopping and spraying as part of property and roadside management and other impacts of adjacent land uses, and (f) Areas adjacent to watercourses should be recognised for their economic benefits for retaining or enhancing riparian vegetation in terms of fisheries production etc. P. 23 principle 4: When assessing development applications relating to any coastal wetlands-either in, adjacent to, or upstream of-consideration should be given to: (e) Whether the proposed development or activity is located on land in, or adjacent to, a coastal wetland or part of a wetland; determining the appropriate buffer width necessary to safeguard the functions of the wetland (q) Potential to transfer the area of coastal wetland to public ownership or otherwise commit it to conservation management
DCILGPS	***Building Act* 1975**	Regulations on the clearance or disturbance to buffer zone area are provided in Standard Building Law; Part 9.2 (1) "*..a local government may, by local law, prohibit the construction of all or any classes of building or other*

Agency	Legislation/ policy	Specific buffer requirements
		structures within a distance, specified in the local law, of any reserves, lakes, canals, rivers, other waterways or the like situated wholly or partly within its area or of any foreshore abutting upon its area."
DCILGPS	***Integrated Planning Act* 1997**	This Act identifies buffer zones as "*valuable features*" in the Core Matters for Planning Schemes (Schedule 1(c)) for consideration in the process for making or amending planning schemes. "valuable features" refers to: -*'resources or areas that are of ecological significance (such as habitats, wildlife corridors,* ***buffer zones****, places supporting biological diversity or resilience, and the features contributing to the quality of air, water (including catchments or recharge areas) and soil.*'
NSW Fisheries	**Aquatic Habitat Management and Fish Conservation: Policy and Guidelines**	General policies for aquatic habitat management recommend the maintenance of buffer zones at least 30 m wide, with the preservation of their vegetation and natural features, and the establishment of new buffer zones when waterfront land is rezoned. Buffer zone width may be increased to 100 m or greater for the protection of ecologically or visually sensitive areas. Buffer zones may need to be protected by fences or marked by signs. *5.2.3 Policy for marine and estuarine waterfront development* (d) NSW Fisheries may not approve of any new structures over or within 10 m of subtidal or intertidal marine vegetation such as mangroves and seagrasses because of the impact of shading and associated damage caused by boats. Additional supporting structures such as pylons or fences will not generally be approved if they directly damage marine vegetation (g) "Soft" (vegetated) options for mitigating effects of erosion etc., rather than "hard" (rock wall) or artificial (geotextile fabric) should be used. *5.2.5 Guidelines for freshwater waterfront development* These activities must comply with the general policy for Aquatic Habitat Management in Section 1.2 and the following specific policies: (a)To the greatest extent possible, riparian vegetation should be retained in an undamaged and unaltered condition (b)The recommended buffer distance of 30 to 50 m should be increased wherever possible, especially when the riparian zone is unstable, liable to erosion or the proposed development is particularly threatening. Buffer zones should be clearly delineated by fences or other markers. Grazing stock should be generally excluded to promote growth and regeneration. If it is

Agency	Legislation/ policy	Specific buffer requirements
		not possible to establish a 30 m buffer zone, a lesser distance may be appropriate, providing that it is carefully managed and protected

Current legislation is available from URL: www.legislation.qld.gov.au or contact GoPrint (Government Printing Office) at Wooloongabba (ph 3246 3500).

Appendix 5 Important fish habitats

Tidal wetlands
Tidal wetlands, include mangroves, salt marsh and seagrass communities act as ecological buffers at the interface of the land and sea, marking the transition zone between terrestrial and marine vegetation. These areas provide coastal protection as well as acting as a vegetative buffer between areas of development and the aquatic environment thereby enhancing fish productivity. The roles of these wetland habitats in the life cycles of fisheries resources has been well documented (Coles *et al.*, 1987; Connolly, 1999; Haywood *et al.*, 1995).

Riparian vegetation
Streams, rivers and creeks bordered with well-developed riparian vegetation are generally associated with higher levels of productivity that those where the banks are devoid of trees or other bordering vegetation. The bank vegetation with associated logs, branches and debris are ideal feeding, breeding and nursery grounds for many fish species (for example the river blackfish and the Murray cod). Bank vegetation provides numerous functions that are directly and indirectly beneficial to fisheries resources including: -

- Reduction of sediment input from land to the aquatic environment – The presence of vegetation stabilises riverbanks reducing the potential for excessive erosion and subsequent siltation of essential spawning grounds, and the destruction of food sources such as aquatic invertebrates
- Vegetated buffer strips partially filter out pollutants such as pesticides and fertilisers;
- Provide snags (large woody debris) for instream habitat diversity, colonisation by algae and associated epi-fauna, food sources and cover for protection of fish from predators and ambush sites for predators;
- Provide shade, which lowers water temperature and is often critical for fish survival as the cooler water retains higher oxygen levels. Shading also provides camouflage from predators (through the dappling effect of the vegetation on the water surface);
- Streamside vegetation and overhanging trees increase primary productivity and benefit aquatic fauna by providing a source of nutrients and food through falling leaves, detritus and insect drop.

Melaleuca forest
Melaleuca forests are classified as a major “wetland” vegetation type, although they have undergone extensive clearance in the past largely for agricultural development. They are found in low lying coastal plains and contribute to estuarine productivity through detritus, which is flushed out during periods of flooding (Greenway, 1998). They also provide nursery and feeding ares for important fish species such as barramundi which move into these areas during wet season flows (Russell and Garrett, 1985).

Appendix 6 Pressures and threats to buffer zones and fish habitats

The condition and water quality of rivers and coastal waters is an indicator of the 'health' of the surrounding catchment area. Many catchment areas are subject to increasing pressures through clearance for agricultural and urban / industrial development, forestry operations and expansion of aquaculture operations. Removal of vegetation and changes in land-use practices has led to substantial increases in the sediment, pesticides, heavy metals, solar radiation and nutrients entering aquatic environments.

River Improvement Practices
Alteration and reshaping of urban waterways includes modification of drainage systems, infilling or relocation of minor streams and construction of infrastructure across floodplains (bridges, culverts, roads, power lines, pipe lines etc.), river straightening, removal of snags, concreting of the banks and channelisation. These practices provide for increase in streamflow, recreation, transportation and ease of maintenance. However, they can also prove detrimental to the environment leading to increased erosion of waterways and banks, disruption to wildlife corridors, removal of overhanging bankside vegetation and resulting in overall degradation of the riparian zone (EPA *State of the Environment Report*, 1999).

Land Clearance and Development
The development of urban areas and infrastructure and the expansion of agricultural areas may lead to impacts or disruption to wetland habitats and their buffers. The ecological services provided by these resources may be compromised through the clearance and cultivation of riparian lands to the edge of the aquatic environment, and the use of farm management practices that may adversely impact the waterway or remaining vegetation.

Riparian ecosystems have been subject to clearance for flood mitigation, expansion of agriculture (especially sugar cane) and agricultural practices such as stock grazing, pesticides and fertiliser application and irrigation. Loss of riparian vegetation along the banks of streams can remove habitat and functions critical to the health of fisheries resources. Remnant riparian or bordering vegetation without an adequate buffer is degraded over time by 'edge effects'.

Grazing Pressure
Grazing has been identified as a significant factor in the degradation of wetlands and bordering riparian vegetation in Queensland. Introduced grazing stock such as sheep and cows exert direct pressure on wetland vegetation, soils and receiving water quality through grazing, trampling and fouling. Resulting in soil degradation and increased erosion, which may lead to changes in the vegetation cover, reduce wildlife habitat for native fauna, and alter patterns of primary and secondary production. For Queensland it is estimated that in 1995 less than 10% of the 93,000 km of stream frontage was fenced to protect from grazing animals.

Greenhouse Effects
The Greenhouse Effect is predicted to have a range of widespread impacts on the environment affecting ocean temperature, rainfall, cyclone patterns and rising sea levels. The Greenhouse Effect would have several implications for the coastal shoreline causing it to move landward due to the predicted rise in sea level and resulting in increased recession of the shoreline due to increased storm and cyclone activity, higher waves and increased water levels. The implications in respect of the ecological and management buffers are that the ecological buffer (mangroves, etc.) will move further landward. The QFS policy of establishing buffering habitat 100 m above HAT will therefore be affected.

Impacts on Buffer Zones and Fish Habitats

As a result of the above pressures the natural wetland buffer becomes fragmented, degraded or eliminated with a corresponding reduction in the quality of the vegetation and wildlife habitat. The subsequent effects of increased bank instability and erosion, increased stormwater and agricultural run-off, accelerated pollution levels and sediment input will lead to a reduction in the diversity of terrestrial and aquatic species.

Erosion

The erosion of topsoil from catchment land and subsequent deposition to the aquatic environment can be extremely destructive to fisheries habitat diversity and productivity. Increased sedimentation can affect critical life stages of the fish when eggs are subject to smothering by silt. In areas where sedimentation has reduced the roughness of the streambed lower fish numbers have been recorded.

Nutrients

A combination of land clearing, high catchment run-off potential and high applications of Nitrogen and Phosphorus based fertiliser provide an opportunity for leaching and erosion of topsoil, leading to sediment bound nutrient losses from land to streams and estuaries and eventually to inshore waters of the Great Barrier Reef lagoon. This may damage long-term sustainability of inshore fish habitats, including seagrass beds and coral reefs and their dependent fisheries resources, especially where the nutrient balance is disturbed or the concentrations increased. Increased levels of nutrient (particularly nitrogen and phosphorus) may lead to algae 'blooms' which may choke waterways and smother aquatic vegetation further reducing light penetration to fish habitats.

Acid sulfate soils

Acid sulfate soils (ASS) are naturally occurring soils and sediments containing iron sulfides (e.g. iron pyrite). When iron sulfides are exposed to air, oxidation takes place and sulfuric acid is produced when the soil's capacity to neutralise the acidity is exceeded. As long as the sulfides remain under the water table, oxidation cannot occur and the soils are quite harmless and can remain so indefinitely. Disturbance (e.g. by excavation, drainage or mangrove removal) can generate huge quantities of sulfuric acid (1.5 tonnes for every tonne of ASS oxidised). Acid leaching into waterways after heavy rain has severe impacts on fish habitats, fish and crustaceans. Major impacts affecting fisheries include

- acidification of waterways – pH as low as 2
- concentrations of dissolved heavy metals (e.g. iron and aluminium) toxic to most plants and fish
- habitat modifications (e.g. prolific growth of acid tolerant water plants and substrate smothered by iron precipitate)
- reduced growth/moulting and spawning success of fish and crustaceans
- chemical barriers to fish migration
- Fish kills and red spot disease.

The combination of degraded habitat, declining fish health and fish kills reduces fish populations in areas affected by acid water leading to loss of income for the fishing, oyster and aquaculture industries. Impacts from the disturbance of ASS have been associated with sugarcane farm expansion and major developments on the Wet Tropic Coast and in southeast Queensland.

Acid sulfate soils are a major issue for coastal zone agriculture and development involving drainage of low-lying land.

Appendix 7 Case studies

Case study 1 – Allied Estates Planning & Environment Court Appeal Decision

In summary, Allied Estates application to rezone and develop land adjacent to Lake Doonella (a declared Fish Habitat Area) in Noosa was refused by Noosa Shire Council. The developers then made appeal to the Planning and Environment Court (P & E Appeal No 3235 of 1998). The major issues in the appeal were:

1. Whether the proposal would represent
   a) an unnecessarily adverse intrusion upon the area's environmental values particularly:
      - the water quality of Lake Doonella and the Noosa River catchment
      - the area's existing flora and fauna
   b) an unwarranted visual intrusion
2. Whether the proposal conflicted with formally expressed planning strategies that intended to:
   a) ensure the matters referred to in (1) are avoided
   b) achieve appropriate and orderly development in the area
3. Whether the proposal would be likely to give rise to unacceptable difficulties in respect of traffic
4. Whether there was sufficiently demonstrated need for the proposal

Of interest from a fisheries perspective is that one of the grounds on which the development application was refused, concerned the implementation of adequate buffer width to set the development back from the Lake and creek banks. Noosa Shire Council, in its Strategic Plan had identified that the shores of Lake Doonella should have a buffer width of 250 m.

Consultants for the developers advised on various techniques and designs to attempt to meet stormwater and sediment control requirements so as not to worsen the quality of water entering the lake and creek. A revised development plan was proposed which had reduced building densities and a buffer width of 114 m of open space to the foreshore of the lake. QFS policy at the time required a minimum of 100 m setback of natural vegetation.

The Appeal was refused. In making his decision, the Judge found the proposed development would represent a substantial departure from the balance struck in the strategic planning of Noosa Shire Council; that the onus of showing the proposal should be approved rested on the applicant, and that this onus had not been discharged.

In his decision, the Judge also stated that simply showing that it is possible for an engineering solution to achieve a 'no worsening' result may not be sufficient. In his view …..*'The generous separation distances provided by the designation in the Strategic Plan may be taken to allow for many contingencies beyond what might be overcome by skilled engineering design'*.

In other words, buffer zones are an insurance policy and wider buffer zones provide greater insurance are therefore better able to protect sensitive areas in most cases.

Case study 2 – Coombabah wetlands

Early in 1997, residents from the recently developed Monterey Keys housing estate situated on the Gold Coast, complained about a foul odour emanating from the Monterey Keys lake and nearby

Coombabah wetlands area. The residents believed that the odour came from an inefficient sewage treatment plant, discharging its effluent into the wetland.

The site underwent a series of inspections and investigations from DPI, Gold Coast City Council and Environmental Protection Agency officers. The results of these investigations suggested that the odour problem was not associated with effluent disposal in the wetlands, but was being generated from decaying mangrove seeds. The mangroves were producing fruit that was accumulating and rotting in the wetlands. As there was very little flushing from the tides or rainfall, the decaying seeds were not flushed away.

The residents were not satisfied with the explanation that the odour was caused by a natural event and demanded some action be taken to alleviate the problem. The smell, particularly at night when there was little wind, was considered unbearable. As the area of concern is a Declared Fish Habitat Area, strict provisions would be applied to any proposed trials to enhance flushing into the area. A dredging proposal was developed. An application to undertake dredging within the FHA was justified on the basis of controlling mosquito breeding in the area. Both QFS and EPA refused the proposal due to impacts of the dredging activities.

The result is an on-going natural, seasonal event that will continue to cause some distress to nearby residents. This problem clearly illustrates how the community and fisheries would have benefited from the retention of an appropriate buffer zone between the development and the wetlands.

Case study 3 – Hypoxia solution through Mississippi River basin wetland restoration

This is a summary of an article by William J. Mitsch (1999) entitled 'Hypoxia Solution Through Wetland Restoration in America's Breadbasket', printed in the *National Wetlands Newsletter*, Nov-Dec 1999, pp. 9-14. Since the 1980s, seasonally severe and persistent hypoxia (low dissolved oxygen conditions) has been measured in an area or 'dead zone' of up to 20,000 square kilometres offshore of where the Mississippi River discharges into the Gulf of Mexico. The watersheds of the Mississippi and its tributaries encompass 1.2 million square miles or 40% of the lower 48 states which are also important agricultural production areas.

Studies have focussed on nitrogen control in the inland areas, as coastal waters are nitrogen-limited and because loading of N has increased several fold in the Mississippi Basin since WWII. Research recommends the restoration or creation of 5 million acres of wetlands and 19 million acres of riparian buffers to attain a 40% reduction of Nitrogen leaving the Basin. Restoration of this scale would involve 23 states and cover 1.2 million square miles and would make the restoration of the Everglades, which involved only 1 state and an estimated cost of $US 8 billion, look like a 'tea party'.

The author goes on to say *'We cannot afford to lose the opportunity to hydrologically repair a significant part of the nation's largest watershed while solving a serious water pollution problem along our southern coast'*. The Mid-west has lost over 80% of its wetlands and riparian vegetation. The effects of loss of vegetation and unsustainable farming practices have had a direct and catastrophic effect on the fisheries resources of the Gulf of Mexico. Million dollar fish and prawn industries have been lost. The retention and implementation of buffer zones has been proven to be vitally important to sustaining the health of aquatic systems.

The above case study highlights the high costs of restoring a buffer to rectify a problem which may have been avoided by early and timely retention of lands to maintain buffer zone functions before development occurs.

Appendix 8 Queensland Fisheries Service contacts

DPI Call Centre 13 25 23
(Hours Mon-Fri 8am –8pm)

QFS Website
www.dpi.qld.gov.au/fishweb/

Brisbane City

Queensland Fisheries Service
Department of Primary Industries
GPO Box 46
(80 Ann Street)
BRISBANE QLD 4001

Phone: (07) 3224 2249
Fax: (07) 3224 2805

Southern region (NSW / Qld border to Sarina)

Southern Fisheries Centre
Queensland Fisheries Service
Department of Primary Industries
PO Box 76
(13 Beach Road)
DECEPTION BAY QLD 4508

Phone: (07) 3817 9500
Fax: (07) 3817 9555

Northern region (Sarina to Qld / NT border)

Northern Fisheries Centre
Queensland Fisheries Service
Department of Primary Industries
PO Box 5396
(38-50 Tingira St, Portsmith)
CAIRNS QLD 4870

Phone: (07) 4035 0100
Fax: (07) 4035 1401