FISHES *on Cotton Farms*

A GUIDE TO NATIVE FISH AND HABITAT MANAGEMENT FOR NORTH-WEST NSW

Australian Government | MURRAY–DARLING BASIN AUTHORITY

Cotton Catchment Communities CRC

Australian Government
Department of Agriculture, Fisheries and Forestry
National Landcare Programme

Namoi Catchment Management Authority

NSW Government | Industry & Investment

Natural Heritage Trust
Helping Communities Helping Australia
A Commonwealth Government Initiative

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DISCLAIMER: The information contained in this publication is based on knowledge and understanding at the time of writing (September, 2009). However, because of advances in knowledge, users are reminded of the need to ensure that information upon which they rely is up to date and to check currency of the information with the appropriate officer of Industry and Investment NSW or the user's independent advisor.

Cover Photo: Greg Kauter

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Acknowledgments

Fishes on Cotton Farms spawned from discussions during the 2008 Native Fish Awareness week, an initiative of the Murray-Darling Basin Authority's Native Fish Strategy. Industry and Government representatives recognised the importance of engaging the wider community in natural resource management. Our native fish species were seen as the perfect lure to achieve this goal, with the additional aim of bringing more fish back to our waterways.

The project has been a collaborative effort between government, community groups and landholders. Funding for the guide was provided by the Murray-Darling Basin Authority, Cotton Catchment Communities Cooperative Research Centre, Department of Agriculture, Fisheries and Forestry, Namoi Catchment Management Authority, and Industry and Investment NSW (I&I NSW).

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Introduction

Cotton production is one of Australia's most important agricultural industries. It supports several regional economies, including those in the north-west region of NSW. A great deal has been said about the potential impact that this intensive industry may have on the surrounding environment and as such, land managers in the region are working to ensure that biodiversity in agricultural areas is maintained as part of a profitable production system. Sustainable land management includes best management practices, which aim to reduce the impact cotton production can have on the environment. Landholders are now looking for further guidance and assistance to better manage their natural systems and the animals that live within them.

The aquatic and riparian environments go 'hand in hand' with cotton production. The plants and animals that these systems support can provide a good indication of the health of that system. This is particularly true for fish populations. Native fish are very sensitive to environmental change, and the distribution and abundance of native fish species can reflect the condition of the surrounding land. The cotton industry is now working closely with natural resource managers to develop and implement 'fish friendly' practices that improve the health of rivers and waterways. It is now more widely accepted that protecting and improving the condition of riparian lands, rivers, creeks and wetlands, is a key component of sustainable land management.

By observing and monitoring fishes in and around cotton farms, land managers and the wider community will be able to discover first hand the benefits of implementing best management practices.

ABOUT THIS BOOK

A wide variety of programs are underway throughout the state to implement fish friendly works and raise awareness about the plight of our native fish species. These programs are guided in the Murray-Darling Basin by the Native Fish Strategy. The Native Fish Strategy is a Basin wide partnership between state and federal jurisdictions, coordinated by the Murray-Darling Basin Authority (MDBA), that aims to sustain viable native fish populations and communities throughout the Basin. At a local level, the Strategy is being aided by a range of rehabilitation projects, including the Namoi Aquatic Habitat Initiative (NAHI). This is a community driven collaborative project between Namoi Catchment Management Authority (CMA) and Industry and Investment NSW (I&I NSW), and aims to improve fish habitat and bring back native fish to the Namoi.

The success of these programs relies heavily on the continued involvement of community members, including landholders and recreational anglers. To ensure that this continues in the local area, it is hoped that this *Fishes on Cotton Farms* book will inform, encourage and motivate landholders to conserve native fish that are dependent on the health of the rivers, creeks, wetlands and back swamps on their properties. It is also anticipated that the book will serve as a useful guide to engage local landholders and anglers, informing them of the fish species that are expected to occur in the local area and what they can do to help conserve and enhance native fish populations.

The Macquarie Marshes are internationally recognised for their contribution to biodiversity.

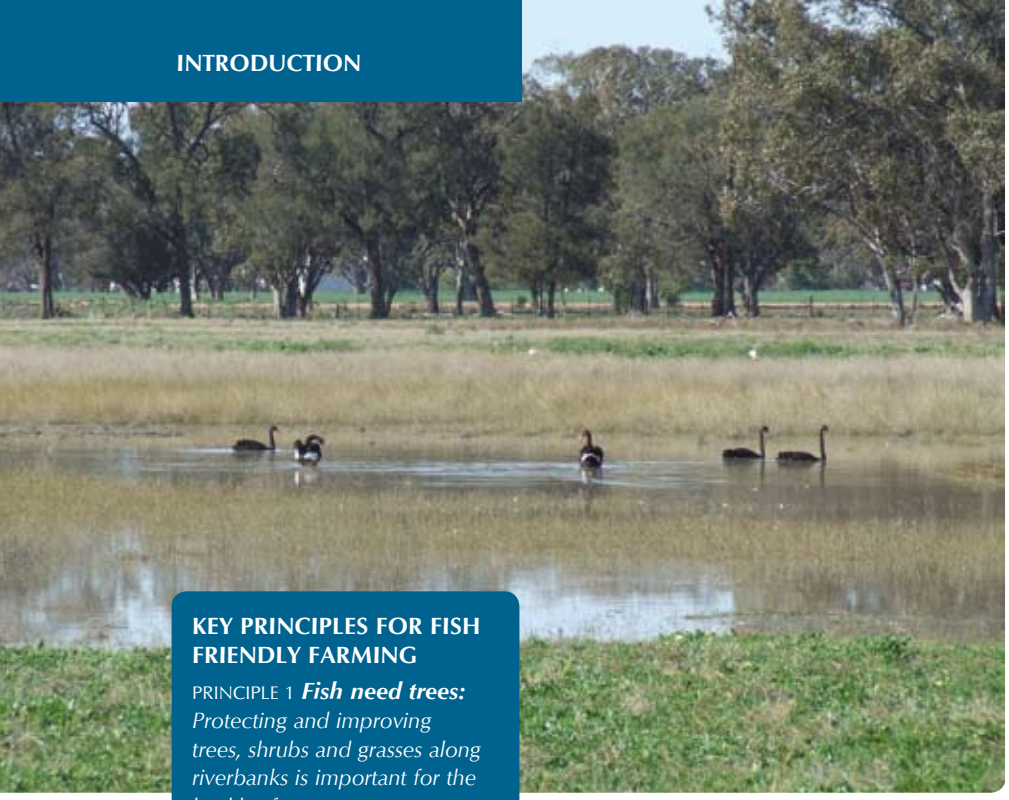
The cotton producing region of eastern Australia. *Map reproduced with permission from the Cotton CRC.*

THE REGION

This guide covers native and alien fish that are known or expected to occur in the cotton growing Macquarie – Barwon region of north-west NSW, focussing on the Gwydir, Namoi and Macquarie river valleys. The region is bordered by the rugged Warrumbungle, Nandewar and Great Dividing ranges, whilst the lowlands are dominated by fertile alluvial floodplains. Each distinct landscape area provides a diverse array of habitat for native fish species.

The north west region of NSW is dotted with lagoons and billabongs and dissected by red gum-lined rivers. Major waterbodies include the Gwydir, Mehi, Namoi and Macquarie rivers and the Ramsar listed Gwydir wetlands and Macquarie Marshes. Flow regulation of these systems is provided by Copeton Dam in the north, Mollee, Gunidgera and Weeta weirs on the Namoi, and Burrendong Dam in the west.

Extensive areas of the region are devoted to the production of cotton on the floodplains, and grazing practices in the riparian and woodland communities.



KEY PRINCIPLES FOR FISH FRIENDLY FARMING

PRINCIPLE 1 ***Fish need trees:*** *Protecting and improving trees, shrubs and grasses along riverbanks is important for the health of our waterways.*

PRINCIPLE 2 ***Help fish get connected:*** *Fish need free passage in our waterways to feed, breed and find a suitable home.*

PRINCIPLE 3 ***Keep irrigation fish free:*** *Stay informed of new research to make irrigation fish friendly.*

PRINCIPLE 4 ***Protect your fish nurseries:*** *Maintain or restore wetland and billabongs to improve natural breeding grounds for our native animals.*

PRINCIPLE 5 ***Keep it messy:*** *Increase habitat complexity to increase the opportunities for native fish to use a waterway.*

PRINCIPLE 6 ***Fish for the future:*** *Fish sustainably to protect our native fisheries, and get involved in habitat rehabilitation projects.*

MORE THAN JUST A GUIDE

In addition to the common species guide, this book provides a series of guiding principles for sustainable, 'fish friendly' landscape management. These principles will help maintain and enhance native fish habitats, whilst ensuring sustainable agricultural production. The principles are based on knowledge acquired from research in agricultural landscapes throughout the Murray-Darling Basin. The management actions described under each principle are closely aligned to best management practices (BMP) recommended for property management.

When you undertake property planning and monitoring activities for BMP, you may wish to refer to these sections to get some ideas for the future enhancement of the natural areas on your property.

USING THE FISH FIELD GUIDE

The layout of the fish field guide section is described in the diagram below.

'Threatened species' and 'alien species' are laid out in a similar manner, but more detail is provided about the importance of threatened species and the impact of alien species.

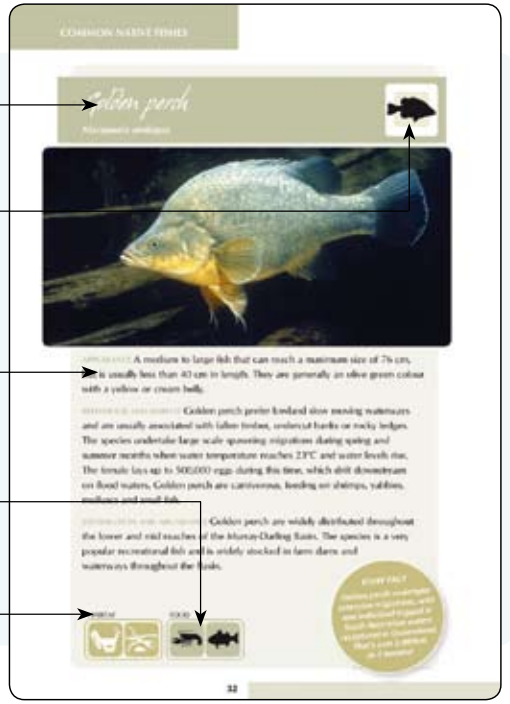
Recommended common name *- standardised name for the fish and the name used in most field guides.*

Size icon *- indicating relative size of the fish compared with several well-known species (see explanation on page 10).*

Description of the fish's ***appearance, behaviour and habitat*** *preferences.*

Food icon *- shows the preferred diet of the species; refer to the icon guide on page 10 for detail.*

Habitat icon *- the habitats where you are most likely to see the fish. Refer to pages 8 and 9 for more detail.*



Habitat categories

The fish species found in the north-west NSW region have been assigned a primary habitat category to assist in identifying and locating individuals. These categories represent a range of habitats that are found within rivers, creeks, wetlands and billabongs, and may vary within the region, and are described in more detail below.

Some fish species will occur in more than one habitat type during their lifecycle, and the icon used in this guide shows the most preferred or dominant habitat category for a species. For more information about other habitats used by a fish, please read the species description.

STILL AND SLOW FLOWING WATERS

Optimal habitat for shoal forming species, particularly for native species that prefer slower waters to fast flowing water.

VEGETATION

Aquatic and riparian vegetation provides important habitat for smaller bodied species, offering protection, shelter and a food source. Aquatic vegetation may also play an important role during breeding.

LARGE WOODY DEBRIS

Large woody debris, or 'snags', form critical habitats by providing shelter, protection and food sources. Snags are particularly important habitat for larger fish and specialist species such as the iconic Murray cod.

ROCKS

Large rocks and gravel substrate provide important habitat for smaller species, offering protection from predators and shelter from fast flow. The surface of rocks and gravel substrate may also play an important role during breeding.

POOLS

Large and small pools provide optimal habitat primarily for solitary species. Deep pools allow fish to shelter from fast flows, and may also offer a refuge site during times of low water levels.

SIZE ICONS

GUDGEON
less than 10 cm

SPANGLED PERCH
10 to 20 cm

GOLDEN PERCH
20 to 30 cm

MURRAY COD
larger than 30 cm

FOOD ICONS

PLANKTONIC ORGANISMS

AQUATIC MACRO-INVERTEBRATES

TERRESTRIAL INSECTS

VEGETATION

FISH

Size guides

A size icon has also been assigned to each fish species to assist in identifying individuals. The **average size** of each fish is related to a well-known species and is indicated by a silhouette of the well-known species. The meaning and indicative size range of the silhouettes is shown here.

Food preferences

With each fish species description there is a set of food icons, representing the diet of each species. These icons provide a general guide to preferred food items for a species and are by no means definitive.

Fish friendly farming

Demonstrating you are a fish friendly farmer will bring recognition from your neighbours and peers.

INTRODUCTION

To survive and thrive, native fish need clean water, shelter, food and room to move. Maintaining or improving these elements for fish, while still ensuring the floodplain is viable and productive, is a complex challenge. Your approach to the task will vary with your property management objectives. This section provides simple, yet effective principles which, when deciding to farm in a fish friendly manner, will assist in achieving these objectives.

The principles outlined in this section may also enhance the ecosystem for more than just native fish, providing additional benefits for other aquatic and terrestrial animals. The information provided in the 'fish friendly farms' section encourages you as a land manager to consider potential off-farm impacts of farming practices in conjunction with those which influence the environment on-farm.

Additional information and guidelines on riparian land management on cotton farms is available in the comprehensive *Managing riparian lands in the cotton industry:* a resource for people in the cotton industry to assist them in improving riparian land management on cotton farms *(Lovett et al. 2003).*

Riparian management

PRINCIPLE 1

Fish need trees!

Riparian land includes the riverbank and land adjoining creeks and flood-runners, areas surrounding dams and lakes and also the floodplain, including billabongs and wetlands that connect to the river in times of flood.

Riparian land is generally the most productive part of the landscape, and acts as the last line of defence for the waterway from land-based activities. The health of riparian land directly influences the health of the waterway, so it is often a fine balancing act between sustaining production while maintaining the condition of these sensitive lands.

For native fish and other aquatic life the grasses, shrubs and trees growing in these areas assist in the regulation of the waterway.

Native fish often use cues such as water temperature as a trigger for different life history stages. Spangled perch *(Leiopotherapon unicolor)* ***is known to breed from November through to January when temperatures exceed 20°C.***

Snags or large woody habitat are essential for breeding and feeding for fish such as the iconic Murray cod *(Maccullochella peelii peelii)****. Murray cod spend more than 80% of their time within 1 metre of a snag.***

Trees provide shade to the waterway, helping to maintain an ambient water temperature. Shade provides a dappling effect on the water's surface, offering protection from overhead predators. Shade also reduces the build up of nuisance aquatic weed. Excessive weed growth can reduce the amount of light penetrating the water, and as weeds start to break down oxygen is used up, which can ultimately lead to fish kills.

Riparian vegetation acts as a natural buffer slowing down run-off, allowing sediments, nutrients and soil-bound particles to become trapped. This 'polishing' effect ensures high sediment loads do not enter the waterway and smother native fish habitat.

Deep-rooted native vegetation helps bind riverbank soils, reducing the rate of bank erosion and loss of precious productive soils to the river. Soil erosion can increase water turbidity (the muddiness of the water), reducing water quality.

Riparian vegetation provides an important food source for aquatic life. Fallen leaves, fruits, insects and twigs form an essential component of in-stream food webs. Undercut banks and exposed roots, in addition to fallen timber, also provide essential habitat for fish and other aquatic species.

Intact riparian vegetation also benefits property productivity: providing windbreaks for crops; shade and shelter for stock, and; helping reduce the loss of productive soils.

REMEMBER
Riparian lands often require different management strategies to other areas of the landscape.

MANAGEMENT OPTIONS

- ✓ Maintainand improve riparian land health
- ✓ Protectexisting riparian lands that are in reasonable condition this is easier and more cost effective than restoring a degraded area
- ✓ Enlargeriparian buffers, to provide habitat for wildlife, including aquatic species such as fish, a minimum width of 30 metres is recommended

MANAGEMENT ACTIONS

- ✓ Assess and map the health and species of existing riparian vegetation
- ✓ Control stock and traffic access using alternative watering points and/or fencing
- ✓ Allow native understorey shrubs and trees to grow
- ✓ Control invasive weeds such as willows
- ✓ Leave a grassy buffer zone between the paddock and riparian area
- ✓ Widen riparian areas by allowing natural regeneration or actively planting native trees and shrubs in the buffer zone
- ✓ Retain and re-establish snags in the waterway

Replanting trees and shrubs native to your area will assist the rehabilitation of river banks. This 'riparian buffer' will help protect native fish habitat.

Providing off-stream water points for stock is an effective way of reducing impact on sensitive areas.

River connectivity

PRINCIPLE 2

Help fish get connected

A meandering river connects different features across a landscape. *Guy Roth*

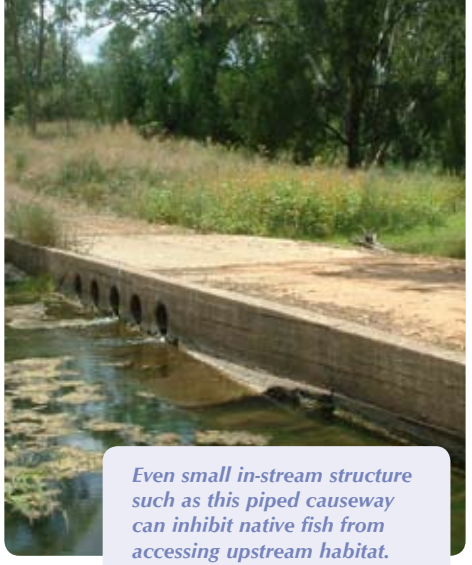
'River connectivity' is the degree to which waterways and waterbodies are linked across a landscape. In some cases connectivity may be almost continuous such as a main stem river, or discontinuous such as ephemeral tributaries or billabongs that are recharged during times of flood.

Many native fish using inland waterways migrate to different habitat at key stages in their life cycle, such as to breed, avoid predators and competitors, and to find feeding grounds. It is vital to ensure fish have access to these different habitat areas.

Unlike Northern hemisphere fish such as trout and salmon, our fish are not strong or very agile swimmers. They are often unable to negotiate obstacles such as small waterfalls (as little as a 10 cm drop) or turbulent water.

Small native fish, such as the endangered purple spotted gudgeon (Mogurnda adspersa)*, will often use densely vegetated backswamps for food and breeding. These backswamps may only be connected to the main stem river during high floods.*

A rise in river level is used by some native fish such as golden perch or yellowbelly (Macquaria ambigua) *as a trigger for migration. Yellowbelly undertake long upstream spawning migrations (as much as 2000 km), during spring and summer floods.*



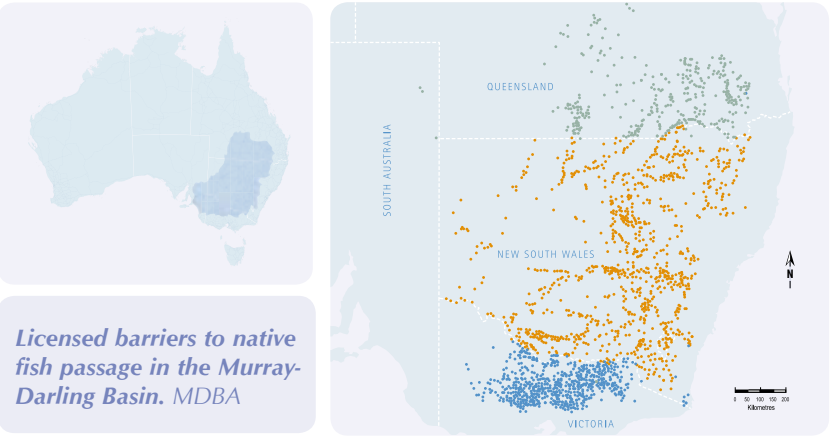
Even small in-stream structure such as this piped causeway can inhibit native fish from accessing upstream habitat.

The construction of dams, weirs and regulating structures, poorly designed road crossings and block banks across floodplains have reduced connectivity and prevented fish from accessing essential breeding and feeding habitat.

These structures also affect the downstream movement of native fish, with adult fish actively avoiding going over weirs. Mortality levels are higher in drifting fish larvae that pass through undershot weirs, which release water beneath a series of gates.

Over 4,000 licensed barriers have been identified in the Murray-Darling Basin. This figure is likely to be considerably higher when privately owned structures, which are yet to be identified, are considered. The collective impact on native fish through restriction to habitat is considerable.

These structures may also bring changes to natural flow regimes. Changes such as reduced downstream flows, reduction in frequency or volume of bank topping flows that connect billabongs and wetlands, or a variation in the time of year when flows are released, can all affect the breeding and feeding opportunities of native fish.



Licensed barriers to native fish passage in the Murray-Darling Basin. MDBA

Installing large BOX CULVERTS which are set into the bed of the creek improved fish passage at this causeway.

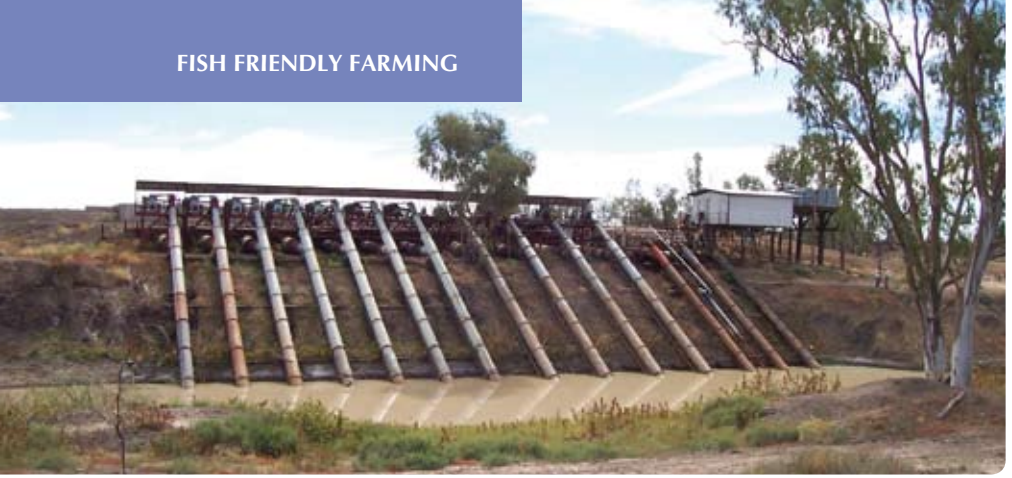
MANAGEMENT OPTIONS

- ✓ Maintainand improve river connectivity

MANAGEMENT ACTIONS

- ✓ Seekadvice to see if existing structures are fish friendly
- ✓ Removestructures that are no longer required
- ✓ Makeexisting structures fish friendly using fishways on weirs and culverts through block banks and causeways
- ✓ Forany new structures ensure passage is provided for fish.
  Options can include: box culverts and pipes through crossings and block banks, bridges or arch structures and fishways or fish ladders on weirs.

REMEMBER
Permits are required for works that are conducted instream. Advice about fish-friendly structures and legislation requirements can be obtained from I&I NSW (Fisheries).



Irrigation systems and native fish

PRINCIPLE 3

Keep irrigation fish free!

Some more resilient species such as native Australian smelt *(Retropinna semoni)* ***and bony bream*** *(Nematalosa erebi)* ***may form sustainable populations in the canal and on-farm storage environments. However their ability to return to the main river system and contribute to a diverse fish community is limited. Channelised habitat usually favours alien species such as carp*** *(Cyprinus carpio)*.

Irrigation is essential for farmers and communities in north west NSW. The two major types of water extraction methods used in the region are canal systems and direct pumping.

Canal systems with regulatory weirs and diversion channels, can potentially affect native fish in ways similar to those outlined in the 'River Connectivity' section. Migrating fish are restricted from accessing preferred habitat and food, whilst native fish larvae and juveniles could be diverted from the main river channel.

Pump systems, which extract water from rivers into on-farm storages, may also affect native fish populations. The pumps themselves could extract or divert fish away from appropriate habitat. Fish of all size classes may also be susceptible to injuries or death during this process.

Research is currently underway to reduce the potential impact of irrigation systems on native fish in the Murray-Darling Basin. It is anticipated that the results from these studies will improve irrigation management practices by developing engineering solutions and operational improvements that reduce the effect on native fish.

Management strategies being considered are already implemented with some degree of success in other countries (e.g. USA). These strategies include aligning extraction times with non-critical times for native fish and larvae migration by altering the operations of irrigation diversions, using behavioural exclusion devices, or installing fish screens to reduce extraction and divert fish back to the river.

MANAGEMENT OPTIONS

✓ Improveand implement fish friendly irrigation practices

MANAGEMENT ACTIONS

✓ Stayinformed of new research into irrigation systems and native fish, adopting management recommendations as appropriate and seeking funding opportunities from local NRM groups, such as your CMA

✓ Alignextraction times with non-critical times for native fish and larvae migration (see migration table below for more information)

MIGRATION CALENDAR FOR NATIVE FISH SPECIES OF NORTH WEST NSW

Please note that while these are indicative critical times for fish passage, localised movements by all species need to be facilitated year round.

NATIVE SPECIES	MIGRATION TIMES											
	J	F	M	A	M	J	J	A	S	O	N	D
Australian smelt	■								■	■	■	■
Bony bream	■	■								■	■	■
Carp gudgeon	■								■	■	■	■
Darling R hardyhead	■	■							■	■	■	■
Fly specked hardyhead	■	■								■	■	■
Freshwater catfish	■	■								■	■	■
Golden perch	■	■							■	■	■	■
Mountain galaxias									■	■	■	■
Murray cod	■									■	■	■
Murray-Darling rainbowfish	■	■							■	■	■	■
Olive perchlet										■	■	■
Purple spotted gudgeon	■	■									■	■
River blackfish	■									■	■	■
Silver perch									■	■	■	■
Spangled perch	■	■									■	■

Wetland and billabong management

PRINCIPLE 4

Protect your fish nurseries

For small fish such as the native carp gudgeon** (Hypseleotris sp.), **which is found in slow-flowing or still waters in areas of submerged aquatic vegetation, the loss of a wetland means a reduction in habitat. This could have indirect consequences for larger fish species such as golden perch which prey on these small fish.

Wetlands are low-lying areas inundated with water on a temporary or permanent basis. Most cotton farms support a range of natural and artificial wetlands including billabongs, floodplain swamps and forests, lagoons and water storages.

These landscape features perform many important ecological functions. They provide a service similar to riparian buffer zones as highlighted in the 'Riparian management' section; capturing sediments and nutrients from water before it drains into the main waterway. Nutrients are transformed into beneficial components and, along with carbon, are released into rivers and creeks, replenishing them with the basics for aquatic food webs.

Wetlands also provide essential breeding and nursery habitats for many native fish species and migratory birds.

Most wetlands in NSW have been modified to some degree, with over half have them being significantly altered. Wetland modification includes clearing of vegetation, draining them of water, reduction of flows or continual saturation, all of which disrupts natural wetting and drying regimes.

Loss of wetlands in the landscape has severe implications for native fish, amphibians, reptiles and terrestrial animals including migratory birds.

Landholders can improve the aquatic habitat of artificial wetlands and on-farm storages to support aquatic and terrestrial life. Incorporating different habitat aspects in storages, such as islands, shallow areas, deep water and vegetated sections, can improve these systems. Artificial water storages can also provide a natural filter system for sediments and nutrients, improving water use efficiency and water quality on properties. For more information please see the Cotton CRC factsheet, *Design principles for healthy waterways on cotton farms.*

Carefully managed wetlands can provide essential habitat to many fish, frogs and migratory birds.

On-farm storages may provide suitable environments for aquaculture enterprises. Research funded by the Cotton CRC has shown that cage culture of silver perch in irrigation systems could produce more 'crop per drop' of water used for irrigation, while producing considerable amounts of fertilizer as by-products.

For more information see the Cotton CRC or the I&I NSW Fish in farm dams primefact.

MANAGEMENT OPTIONS

- ✓ Maintain and improve existing wetlands and billabongs
- ✓ Restore former wetlands and billabongs
- ✓ Enhancehabitat in artificial wetlands

MANAGEMENT ACTIONS

- ✓ Ensure flow into natural wetlands is sufficient to maintain natural regimes and water tolerant vegetation
- ✓ Manage stock access carefully, particularly during critical periods of inundation and when seeds are setting
- ✓ Plantand encourage riparian and aquatic vegetation
- ✓ Retainsnags in natural wetlands and establish woody habitat in artificial wetlands
- ✓ Incorporatedifferent habitat aspects into artificial wetlands, such as islands, shallow areas, deep waters and vegetated margins
- ✓ Useon-farm storages and distribution systems as natural filters to remove sediments, nutrients and pesticides from water on-farm

Habitat complexity

PRINCIPLE 5

Keep it messy

Rivers and creeks which are rich in habitat support a wide variety of wildlife.
Jane Macfarlane

'Habitat complexity' refers to the variety of shelter available for fish and other aquatic species in a river or waterbody. More diverse and complex habitat will support a greater diversity and abundance of native fish. Native fish use different habitat types and areas at different life history stages. They have evolved with the natural Australian riverine landscape - complete with fringing aquatic vegetation, deep refuge pools, shallow riffle zones, overhanging trees, large woody habitat and waterbodies that periodically dry up. Many native fish are classed as habitat specialists due to their use of a range of specific habitat types.

More complex and diverse habitat provides more areas for native fish and other wildlife such as turtles, yabbies, platypus and frogs to shelter and breed. For example, it may look 'messy' but fallen timber in a river, creek or wetland provides essential habitat for native fish.

Fringing vegetation and sedge-like plants provide in-stream habitat, and feeding and breeding areas for smaller fish, such as Australian smelt (Retropinna semoni)*, which lay their small adhesive eggs in aquatic vegetation.*

Alien species such as carp and goldfish tend to 'make do' with whatever habitat is around, often thriving in disturbed habitat. As such, these habitat generalists, if given a chance, will out-compete native fish for food and shelter. By increasing habitat complexity, you increase the opportunities for native fish to establish and use an area.

Reintroducing wood into waterways provides instant habitat for fish. These 'engineered log jams' will also assist in stabilising the river bank.

REMEMBER
More habitat = more fish!

MANAGEMENT OPTIONS

- ✓ Maintaincomplex diverse habitat on your property
- ✓ Considerwhat your property can provide to native animals in your area

MANAGEMENT ACTIONS

- ✓ Retain'messy' riparian and aquatic habitat areas with complex vegetation and woody debris
- ✓ Letsleeping logs lie or, if needed, seek advice to realign problem snags
- ✓ Seekadvice on reintroducing woody habitat into waterways
- ✓ Control stock and vehicle access to riparian areas and protect these areas from disturbance
- ✓ Re-establishriparian areas with plantings of grasses, understorey shrubs and overstorey trees

Fishers for Fish Habitat

PRINCIPLE 6

Fish for the future

Fishers of all ages have a role to play in the future of our native fisheries.

One in four people in NSW identify themselves as a recreational fisher. Fishers tend to have a strong affinity with, and large knowledge of the rivers, creeks, lakes and wetlands they fish in. As a large section of the community who enjoy the riverine landscape, there is also an opportunity for fishers to be proactive in securing and enhancing native fisheries for the future. Practicing sustainable fishing and limiting the impact on fisheries resources and the environment can assist in the long term survival of native species.

More and more anglers are practicing catch and release. Some are only catching enough fish for their immediate needs while others with a strong conservation commitment are releasing fish they could legally keep.

It is responsible practice to return fish to the water with the best possible chance of survival. Guidelines have been developed by I&I NSW (Fisheries) to maximise a fish's survival when released. These guidelines include minimising the amount of time the fish is out of the water, using wet hands when handling a fish, removing hooks as quickly as possible, and using fish friendly landing nets. Other tips on maximising fish survival after capture, as well as current bag and size limits can be obtained from www.dpi.nsw.gov.au/fisheries.

The Narrabri Amateur Fishing Club have helped organised several carp musters in Narrabri and Boggabri to teach the local community about the impacts of carp and other issues affecting the river whilst having fun fishing! The events have been a great success with over 800 people attending and 1.5 tonnes of carp removed from the river system.

Many anglers also realise the benefits of getting involved with improving and protecting fish habitat. These enthusiastic individuals and clubs undertake habitat improvement projects, such as planting and protecting river bank and aquatic vegetation, giving something back to the sport they enjoy.

Getting involved in community based monitoring programs is a great way to learn more about the health and condition of your local waterways and native fish. Dave Kelly

MANAGEMENT OPTIONS

- ✓ Identify things you or your fishing club can do to improve habitat in your local fishing spot
- ✓ Teachfellow fishers and younger generations about fishing sustainably
- ✓ Getinvolved in habitat improvements and get your hands dirty!

MANAGEMENT ACTIONS

- ✓ Onlycatch sufficient fish for your immediate needs, practising safe release methods when returning fish to the water to maximise survival
- ✓ Disposeof all litter responsibly, including bait bags and used fishing line
- ✓ Follow NSWfishing rules and regulations when fishing
- ✓ Join the Fish Habitat Network and get involved in projects that improve fish habitat (for more information about the Fish Habitat Network contact your local I&I NSW Fisheries office)

Common native fishes on the floodplains

There have been 15 freshwater native fish species recorded in the cotton growing regions of northern NSW. This represents nearly one third of all native fish found within the Murray-Darling Basin. The low numbers of native fish found in north west NSW reflects the poor health of the surrounding riparian and aquatic habitat.

This section contains photos and brief descriptions for 11 common native species observed in the region. The remaining four species are discussed in the Threatened Native Fish section, reflecting their conservation concern. Further information about the recreational fishing rules and regulations for these native species can be found on the I&I NSW (Fisheries) website www.dpi.nsw.gov.au/fisheries.

Australian smelt

Retropinna semoni

APPEARANCE A slender, silvery and largely transparent small fish that can reach a maximum length of 10 cm, but are more commonly between 4 cm and 6 cm. Australian smelt do not tolerate handling and care is required to avoid mortality.

BEHAVIOUR AND HABITAT Form large shoals near the surface of slow moving or still water, or around vegetation and woody debris. Aquatic vegetation, woody debris and sediment are also important sites for laying eggs, which sink and adhere to the substrate during spring and early summer months. Australian smelt are carnivorous, and the diet largely consists of insects, micro-crustaceans and algae. The species are often preyed upon by larger fish.

DISTRIBUTION AND ABUNDANCE The Australian smelt is one of the most widespread and abundant species throughout many coastal and inland waterways. They are generally found in lowland streams.

HABITAT

FOOD

FISHY FACT

Freshly caught individuals emit an unusual cucumber-like fragrance.

Bony bream

Nematalosa erebi

APPEARANCE A medium sized, silvery iridescent fish that can reach a maximum length of 47 cm, but are more commonly found between 12 cm and 20 cm. The species have a large, deeply forked tail.

BEHAVIOUR AND HABITAT Commonly found in the shallows of slow flowing waterways, including rivers, creeks and large floodplain lakes. The species can form large shoals near the bottom of a waterway, feeding on algae, small invertebrates and organic matter. A large number of small eggs, between 33,000 and 880,000 are released in still waters during October to February.

DISTRIBUTION AND ABUNDANCE Bony bream are one of the most widespread and abundant native fish of inland Australia. In NSW they are most common in lowland waterways of the Murray-Darling Basin system, and were the most abundant native species recorded in the Namoi and Border Rivers/ Gwydir catchments.

HABITAT FOOD

FISHY FACT

Bony bream form an important part of the diet for larger fish, including Murray cod and golden perch.

Carp gudgeon

Hypseleotris spp.

APPEARANCE A small fish that can reach a maximum length of 7 cm, but are more commonly around 4 cm. The upper portion of the fins often develops an orange-red colour that is bordered by a bluish-white stripe.

BEHAVIOUR AND HABITAT Carp gudgeons are usually found around aquatic vegetation of slow moving waterways. Spawning is triggered by a rise in water temperature over 21°C, when the female will lay up to 2,000 small adhesive eggs on a submerged hard surface. Carp gudgeons feed primarily on aquatic invertebrates, insect larvae and plant matter.

DISTRIBUTION AND ABUNDANCE Carp gudgeons are widespread throughout the Murray-Darling Basin, commonly found in waterways of the mid to lower altitudes. The species forms a significant part of the native fish community in the north-west waterways of NSW.

HABITAT FOOD

FISHY FACT

The male carp gudgeon looks after the eggs, guarding them from predators and fanning them free of sediment.

Darling River hardyhead

Craterocephalus amniculus

APPEARANCE A slender, dusky gold small fish that can reach a maximum length of 5.5 cm. The species have a small mouth, thin lips and a large silvery eye.

BEHAVIOUR AND HABITAT This species prefers slow flowing, clear waterways, where they take cover in the vegetated margins or over gravel substrate. Spawning spans from September to February when large, clear eggs are deposited on aquatic vegetation. The Darling River hardyhead feed on small aquatic insects and crustaceans.

DISTRIBUTION AND ABUNDANCE The range of this species is restricted to the northern Murray-Darling Basin, in the upper reaches of the Darling River. The species is relatively common in the Peel, Namoi, Cockburn and Macintyre catchments.

HABITAT FOOD

FISHY FACT

The Darling River hardyhead was only recognised as a species in 1990.

Flyspecked hardyhead

Craterocephalus stercusmuscarum fulvus

APPEARANCE A small, slender fish that can reach a maximum length of 8 cm, but are more commonly between 5 cm and 6 cm. The body colour of the species varies between localities; however there is a dusky stripe that extends along the length of the body.

BEHAVIOUR AND HABITAT A shoal forming species that is often found in calm lowland waterways, usually associated with aquatic vegetation or gravel substrate along the margins of shallow water. Spawning occurs between October and February, when only a small number of eggs, usually below 100, are laid over rocks or vegetation. The species usually feeds on small insects, micro-crustaceans and algae.

DISTRIBUTION AND ABUNDANCE The species is widely distributed in lowland waters of the Murray-Darling Basin, being more common towards the northern part of its range. It was formerly abundant in the southern part of the system, but has suffered a significant reduction and is now considered rare in this part of its range.

HABITAT FOOD

FISHY FACT

Flyspecked hardyheads form an important part of the diet of larger fish, including golden perch and waterbirds.

Golden perch

Macquaria ambigua

APPEARANCE A medium to large fish that can reach a maximum size of 76 cm, but is usually less than 40 cm in length. They are generally an olive green colour with a yellow or cream belly.

BEHAVIOUR AND HABITAT Golden perch prefer lowland slow moving waterways and are usually associated with fallen timber, undercut banks or rocky ledges. The species undertake large scale spawning migrations during spring and summer months when water temperature reaches 23°C and water levels rise. The female lays up to 500,000 eggs during this time, which drift downstream on flood waters. Golden perch are carnivorous, feeding on shrimps, yabbies, molluscs and small fish.

DISTRIBUTION AND ABUNDANCE Golden perch are widely distributed throughout the lower and mid reaches of the Murray-Darling Basin. The species is a very popular recreational fish and is widely stocked in farm dams and waterways throughout the Basin.

HABITAT

FOOD

FISHY FACT

Golden perch undertake extensive migrations, with one individual tagged in South Australian waters recaptured in Queensland. That's over 2,000km in 3 months!

Mountain galaxias

Galaxias olidus

APPEARANCE A small sized fish that can reach a size of 14 cm, but are commonly found between 7 cm and 8 cm. Displays a variable body pattern, ranging from stripes to blotches or no markings at all.

BEHAVIOUR AND HABITAT Inhabit a range of aquatic habitats, preferring pools in slow moving waterways with gravel or sandy substrate where they can be found amongst rocks or logs. Spawning occurs mainly in spring, where a small number of eggs are laid on the underside of stones in shallow riffle areas. Mountain galaxias consume a range of prey, including aquatic insects, crustaceans, molluscs and terrestrial insects.

DISTRIBUTION AND ABUNDANCE Mountain galaxias are widely distributed throughout the Basin, found in moderate to high elevations. However, whilst they may not be common in cotton growing regions, they may also be located in lowland habitats.

HABITAT

FOOD

FISHY FACT

Form a major dietary item of trout, and the presence of trout in upland systems may restrict the distribution of mountain galaxias.

Murray cod

Maccullochella peelii peelii

APPEARANCE Australia's largest freshwater fish, the Murray cod can reach a maximum length of 180 cm but has an average length of 40 cm. The species can be identified by its cream coloured belly and green mottled pattern on the body and head.

BEHAVIOUR AND HABITAT Murray cod are associated with deep holes in waterways that provide cover such as woody debris, overhanging vegetation or rocks. Spawning migrations occur in spring when water levels rise, prompting fish to move up to hundreds of kilometres upstream. Eggs are laid onto logs or rocks and the male guards them during incubation. The species is a solitary 'ambush' predator that feeds on other fish, crustaceans, molluscs and frogs.

DISTRIBUTION AND ABUNDANCE Murray cod have a wide natural distribution throughout the Murray-Darling Basin and were formerly very abundant in the lower reaches. Threats such as overfishing and habitat degradation, especially the removal of snags, have reduced the distribution and abundance of Murray cod and the species was listed nationally as threatened in 2003.

HABITAT FOOD

FISHY FACT

Snags provide a very important home for Murray cod, with adults often returning from spawning migrations to the same log it left from.

Murray-Darling rainbowfish

Melanotaenia fluviatilis

APPEARANCE A small bodied fish that can reach a maximum length of 9 cm; however they are more commonly found less than 7 cm. The colouration of the species varies with sex, age and habitat, but they are generally a silvery colour with a greenish iridescence.

BEHAVIOUR AND HABITAT Form large schools just below the surface of slow moving waters, or around vegetation and woody debris, and are also found in wetlands and billabongs. Aquatic vegetation is also an important site for laying eggs, which attach via adhesive threads, usually during the spring and summer months. The species is essentially carnivorous, feeding on aquatic and terrestrial invertebrates.

DISTRIBUTION AND ABUNDANCE Murray-Darling rainbowfish were formerly widespread throughout the Basin, but are now only patchily recorded in sections of the Murray, Murrumbidgee and Macquarie Rivers, as well as tributaries of the Darling system. They are generally found in waterways of middle and lower catchments.

HABITAT FOOD

FISHY FACT

Rainbowfish are a tropical group, and the Murray-Darling rainbowfish is the southern most species of the group.

River blackfish

Gadopsis marmoratus

APPEARANCE A medium sized fish that can reach a maximum length of 35 cm, but are commonly between 20 cm and 25 cm in length. The species is a pale olive-green to almost black colour with a diffuse marbled pattern.

BEHAVIOUR AND HABITAT Found in a range of habitats, from small streams and fast flowing rivers, to slow moving murky streams and dams. They are usually associated with instream cover such as woody debris, aquatic vegetation or boulders, and are a bottom dwelling nocturnal species. Spawning occurs between October and January, when adhesive eggs are usually laid inside hollow logs. The river blackfish is an opportunistic carnivore that consumes terrestrial insects, crustaceans and other fish.

DISTRIBUTION AND ABUNDANCE Found throughout the Basin, the river blackfish is known to occur in the Macquarie, Gwydir and Namoi systems. Its range is usually restricted to the mid and upper reaches of these systems.

HABITAT

FOOD

FISHY FACT

The 'hairs' under the river blackfish's chin are its pelvic fins, which have been reduced to a pair of fine, white filaments.

Spangled perch

Leiopotherapon unicolor

APPEARANCE A medium sized fish that reaches an average length of 15 cm, and can reach a maximum length of 25 cm. They are usually silvery-grey in colour with numerous noticeable brown spots.

BEHAVIOUR AND HABITAT An extremely hardy species that can occupy a range of habitat including rivers, creeks, dams, bore drains and intermittent streams. Spawning occurs when water temperatures are above 22°C during November to February where up to 100,000 eggs are laid on the bottom of shallow pools during the night. Spangled perch are primarily carnivorous, eating aquatic insects, crustaceans and fish, but also feed on some plant material.

DISTRIBUTION AND ABUNDANCE Spangled perch are one of the most widespread native freshwater fish in Australia. In the Murray-Darling Basin it mainly occupies the northern and western sections, and is only rarely found in southern waters after extensive flooding.

HABITAT

FOOD

FISHY FACT

Spangled perch have amazing dispersal abilities and have been recorded swimming across flooded paddocks and along wheel ruts on tracks during heavy rain!

Threatened native fishes on the floodplains

The native fish described in this section have been shown by research and historical records to be under significant stress from landscape management pressures. As such these species are listed as threatened in NSW waters.

Pressures associated with habitat loss, river regulation, and competition and predation by alien species have affected the population of these species. Implementing management options discussed in this book will help to encourage the return of these key native fish.

Freshwater catfish

Tandanus tandanus

SPECIES SIGNIFICANCE **Freshwater catfish in the Murray-Darling Basin have been listed as an endangered population in NSW. River regulation and the resulting loss of billabongs and lagoons; interactions with alien species; habitat degradation, including the removal of aquatic vegetation; coldwater pollution that restricts spawning, and; increased siltation that degrades spawning sites are thought to have a significant impact on freshwater catfish in the Murray-Darling Basin.**

APPEARANCE A medium sized species that can reach a maximum length of 90 cm, but are usually found to be 50 cm or less in length. Four pairs of barbels surround the mouth and the species also posses an eel-like tail.

BEHAVIOUR AND HABITAT A bottom dwelling species that prefer slow moving waters of rivers or creeks. Spawning occurs during spring and summer following a complex courtship which usually involves forming nests of gravel and pebbles that can be up to 200 cm in diameter. The eggs are laid in the nests and guarded by the male fish until hatched. Catfish are opportunistic carnivores, with the diet consisting of aquatic insects, yabbies, molluscs and small fish.

DISTRIBUTION AND ABUNDANCE Catfish have a wide natural distribution throughout the Murray-Darling Basin, particularly in the lower, slow-flowing waterways. The species has suffered significant declines in most systems and is no longer common in many areas where it was once abundant.

HABITAT

FOOD

Olive perchlet

Ambassis agassizii

SPECIES SIGNIFICANCE **The western population of this species is recognised as an endangered population in NSW. Predation by alien species, such as gambusia and redfin perch; habitat degradation, including the removal of vegetation and snags; river regulation and fluctuations in water levels, and; coldwater pollution that restricts spawning are thought to have a significant impact on the survival of olive perchlet.**

APPEARANCE The olive perchlet is a small, oval shaped fish that is olive to semi-transparent in colour with a moderately large mouth and very large eye. The species can reach a maximum size of 8 cm, but are commonly below 5 cm in length.

BEHAVIOUR AND HABITAT Habitats include the vegetated margins of slow-flowing warm waterways. The species may also occur in large numbers that congregate around woody debris and aquatic vegetation. Spawning occurs during spring and summer, when small adhesive eggs attach to aquatic plants and rocks on the streambed. They are carnivorous fish that eat a range of micro-crustaceans, aquatic and terrestrial insects, and occasionally small fish.

DISTRIBUTION AND ABUNDANCE Natural range of this species includes coastal streams of northern NSW and tributaries of the Murray-Darling River system. It has undergone a significant decline throughout most of the Basin. It is found in only a few locations in NSW, including being locally abundant in the Border Rivers system.

HABITAT

FOOD

Purple-spotted gudgeon

Mogurnda adspersa

SPECIES SIGNIFICANCE **Purple-spotted gudgeons are now recognised as an endangered species in NSW. Predation by alien species, such as gambusia and redfin perch; habitat degradation, particularly the removal of vegetation, and; fluctuations in water level as a result of river regulation negatively affecting recruitment are thought to have a significant impact on the survival of purple-spotted gudgeon.**

APPEARANCE The purple-spotted gudgeon is a small bodied fish that can reach a maximum length of 15 cm, but are more commonly between 6 cm and 12 cm in length. The species is an attractive fish that has a brownish back with a series of blue blotches towards the tail and numerous red and white spots on the sides.

BEHAVIOUR AND HABITAT Prefers slow moving waterways with deeper habitats that have shelter provided by aquatic vegetation, woody debris and rocks. Spawning occurs in summer, where after an elaborate courtship by the male, adhesive eggs are deposited in a single batch on a hard surface. The male then stays to guard and fan the eggs until they hatch. They are slow moving, ambush predators that feed on small fish, macroinvertebrates, tadpoles and worms.

DISTRIBUTION AND ABUNDANCE Formerly distributed throughout the lower to mid slopes of the Murray-Darling Basin, the species has undergone significant decline, and is now presumed extinct in South Australia and Victoria. There are still patchily distributed populations in the northern part of the Basin, particularly in the Border Rivers, Moonie River and Condamine-Balonne systems.

HABITAT

FOOD

Silver perch

Bidyanus bidyanus

SPECIES SIGNIFICANCE Silver perch are listed as a vulnerable species in NSW waters, meaning that it is illegal to take them from natural waterways; however limited recreational fishing is allowed in stocked impoundments. Threats including river regulation, which has disrupted spawning migrations, thermal pollution and interactions with alien species such as carp and redfin are thought to have impacted significantly on the silver perch population.

APPEARANCE A medium to large sized fish, the silver perch are commonly 35 cm in length, but can reach a maximum length of 50 cm. The body colour is usually a greyish colour with a lighter colour belly.

BEHAVIOUR AND HABITAT Silver perch prefer turbid, slow moving waterways that provide cover with aquatic vegetation and woody debris. Spawning occurs in spring and summer, after large schools migrate upstream in response to increased water flows and temperatures. Silver perch have an omnivorous diet, consisting of aquatic plants, insects, molluscs and worms.

DISTRIBUTION AND ABUNDANCE The natural distribution of the species covers most of the Murray-Darling Basin, excluding the upper reaches; however natural populations of silver perch have declined over most of their natural range. The species is artificially bred in a number of hatcheries throughout the state and is widely stocked in farm dams and reservoirs.

HABITAT

FOOD

Alien fishes on the floodplains

The absence of a suitable riparian buffer may increase erosion and decrease water quality, creating habitat more suitable for alien fish.

There have been four alien fish species recorded in the cotton growing regions of northern NSW. This represents a third of the alien fish species found throughout the Murray-Darling Basin. The large numbers and often aggressive nature of these species have had a significant impact on native populations causing damage to habitats, increasing competition and predation, and introducing diseases and parasites. Management of alien species needs to focus on reducing these impacts on native fish. The control of these species needs to be part of an integrated aquatic rehabilitation program.

This section contains photos and brief descriptions for the four alien species observed in the region, highlighting the impact these species can have on native fish.

Common carp

Cyprinus carpio

IMPACT ON NATIVE FISH **Carp have been blamed for a range of aquatic habitat problems. Their feeding habit suggests that they may be increasing turbidity levels and reducing water quality. Their high abundance and hardiness indicates that they are successfully competing with native fish for food and habitat. As a result of these impacts, carp are considered a noxious species in NSW.**

APPEARANCE A medium to large sized fish that can reach a maximum length of 120 cm. Common carp possess distinctive thick, fleshy lips with two pairs of barbels, and are usually olive-green or brownish in colour.

BEHAVIOUR AND HABITAT Carp are usually found in slow flowing waterways with disturbed habitat. They are tolerant of a wide range of environmental conditions, being able to survive pollutants, turbidity and low dissolved oxygen levels. Spawning occurs during spring and summer. Carp are prolific breeders, with mature females able to produce up to 1.5 million eggs, which are adhesive and laid in clumps amongst vegetation. Carp have a diverse diet that consists of molluscs, crustaceans, zooplankton, plant matter and detritus, which are sucked from sediment on the bottom or banks of waterways, with the inedible sediment expelled through the gill openings.

DISTRIBUTION AND ABUNDANCE Carp are native to Asia, and were first introduced into Australian waterways in the mid 1800's; however it wasn't until the 1960's that carp rapidly spread throughout Australia's inland waterways. They are primarily found in rivers and creeks of the slopes and lowland catchments but some may be found in upland streams.

HABITAT

FOOD

Gambusia

Gambusia holbrooki

IMPACT ON NATIVE FISH **Gambusia is an aggressive species, actively attacking juvenile fish and nipping their fins, leading to the spread of disease and reducing their growth rates. Gambusia also prey on the eggs of native fish and frogs. They have been implicated in the decline of at least 9 native fish species and more than 10 frog species in Australia. Their prolific breeding and ability to survive a range of environmental levels has also seen the species reach plague proportions in many waterways.**

APPEARANCE A small bodied fish that can reach a maximum size of 6 cm, with females being much larger than males. Usually have an olive or brownish coloured back and a silver belly, with the female also possessing black blotch on the side of the body.

BEHAVIOUR AND HABITAT Commonly found in slow moving warm waters and are often associated with the edges of waterways or aquatic vegetation. They can tolerate a wide range of water temperatures, oxygen levels and turbidity. Breeding occurs during the warmer months and occur up to nine times a year, with the female producing between 50 and 300 live young at a time. Gambusia is an aggressive primarily carnivorous species, with the diet consisting of freshwater invertebrates and terrestrial insects.

DISTRIBUTION AND ABUNDANCE Native to North and Central America, gambusia was introduced into Australian waterways as a biological control for mosquitos in the 1920s. However, mosquito larvae are not a primary food source for the species, and the fish has since colonised the majority of inland waterways being widespread and abundant across the Basin.

HABITAT

FOOD

Gold fish

Carassius auratus

IMPACT ON NATIVE FISH **Goldfish are generally treated as a benign alien species; however they still impact on native species by actively competing with them for food and habitat. Goldfish are also often found with the parasitic copepod Anchorworm, which infests a range of native fish species, and are responsible for introducing the 'Goldfish ulcer' disease into Australia.**

APPEARANCE Goldfish are a small to medium sized species that can reach a maximum size of 40 cm, but are commonly found to be approximately 15 cm in length. They are usually an olive-bronze to gold colour, with silvery-white belly. Goldfish are distinguishable from carp by the absence of barbels around the mouth.

BEHAVIOUR AND HABITAT Generally prefer slow flowing waterways, often associated with submerged aquatic vegetation, and can tolerate a range of conditions, including high water temperatures, high turbidity and low dissolved oxygen levels. Spawning occurs during summer months when eggs are laid amongst aquatic vegetation. Goldfish feed on crustaceans, plant matter and organic material.

DISTRIBUTION AND ABUNDANCE Goldfish are native to eastern Asia and were first introduced into Australian waterways during the 1860's when they were used as an ornamental fish. They are now widespread throughout the Murray-Darling Basin, partly as result of them being used as live bait, and are often found in large numbers.

HABITAT

FOOD

Redfin perch

Perca fluviatilis

IMPACT ON NATIVE FISH **The species is the main host for the highly infectious epizootic haematopoietic necrosis virus (EHNV), which is characterised by sudden high mortalities of fish. The virus can affect several native fish species, including Macquarie perch, silver perch and mountain galaxias. Redfin perch are also prolific breeders and aggressive predators enabling them to compete with native fish for habitat and food.**

APPEARANCE Redfin perch are a medium sized fish that are commonly found around 40 cm in length, but can reach a maximum size of 60 cm. They are easily distinguished by their bright red pelvic and anal fins, and have an olive-green back with six black bands on their sides.

BEHAVIOUR AND HABITAT Generally found in slow moving waters such as lakes and billabongs that have an abundance of aquatic vegetation. Spawning occurs during spring when thousands of eggs are laid in gelatinous ribbons amongst woody debris and vegetation. They have a diverse carnivorous diet, which may consist of crustaceans, molluscs, zooplankton and small fish, including the introduced gambusia and trout species but also native species such as western carp gudgeon and juvenile golden perch and Murray cod.

DISTRIBUTION AND ABUNDANCE Redfin perch are native to Europe and were first introduced into Australia for recreational fishing purposes in the mid 1800's. They are widely distributed throughout the Basin, particularly in the temperate portions.

HABITAT

FOOD

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www.dpi.nsw.gov.au

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Regional contacts

FISH HABITAT AND FISHING

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Industry and Investment NSW – **Inverell**
127 Otho Street
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Phone: 02 6722 1388; Fax: 02 6722 4733

Industry and Investment NSW – **Tamworth**
4 Marsden Park Road, Calala, NSW 2340
Phone: 02 6763 1100; Fax: 02 6763 1173

CATCHMENT MANAGEMENT

Border Rivers – Gwydir
Catchment Management Authority
15 Vivian Street
PO Box 411, Inverell, NSW, 2360
Phone: 02 6728 8020; Fax: 02 6728 8098
Website: www.brg.cma.nsw.gov.au

Central West
Catchment Management Authority
141 Percy Street
PO Box 227, Wellington, NSW, 2820
Phone: 02 6840 7800; Fax: 02 6840 7801
Website: www.cw.cma.nsw.gov.au

Namoi
Catchment Management Authority
35-37 Abbott Street
PO Box 546, Gunnedah, NSW, 2380
Phone: 02 6742 9220; Fax: 02 6742 4022
Website: www.namoi.cma.nsw.gov.au

COTTON INDUSTRY

Cotton Catchment Communities CRC
Locked Bag 1001, Narrabri, NSW 2390
Phone: 02 6799 2471
Website: www.cottoncrc.org.au

Cotton Research and
Development Corporation
PO Box 282, Narrabri, NSW 2390
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