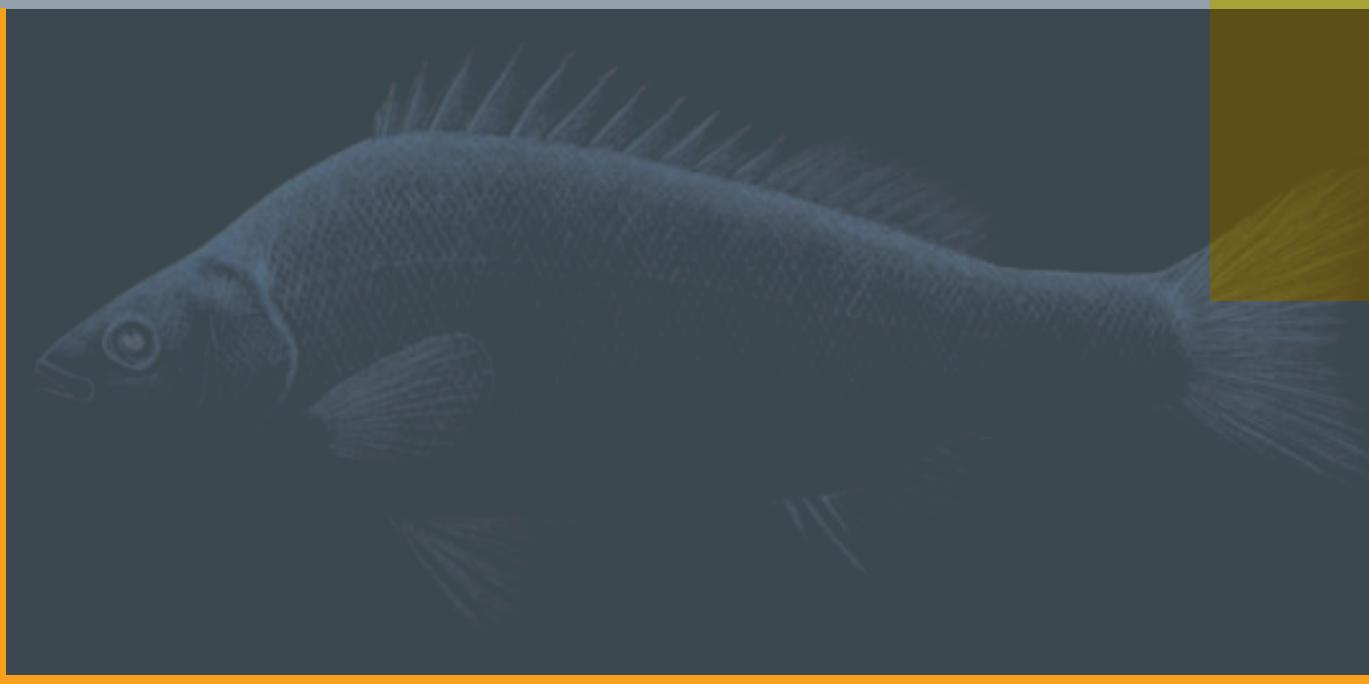
NSW DEPARTMENT OF
PRIMARY INDUSTRIES

Threatened Species Recovery Planning Program

Silver Perch

Bidyanus bidyanus

NSW Recovery Plan



Prepared in accordance with the threatened species provisions of the New South Wales *Fisheries Management Act 1994*

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Cover illustration: Silver perch (*Bidyanus bidyanus*) by Jack Hannan

Acknowledgments

This recovery plan was prepared by the NSW Department of Primary Industries Threatened Species Unit (Rebecca Chapman, Bill Talbot and Sharon Molloy) with the assistance of various people, including Dr Stuart Rowland, Dr Dean Gilligan, Ian Wooden, Lee Baumgartner and Dennis Reid (all of the Department of Primary Industries), Pam Clunie (Victorian Department of Sustainability and Environment) and Dr David Moffatt (Queensland Department of Natural Resources and Mines).

Executive summary

This document is the New South Wales (NSW) recovery plan for silver perch (*Bidyanus bidyanus*). The recovery plan discusses the likely reasons for the decline of silver perch throughout its known range within NSW and outlines measures needed to recover the species and ensure its long-term viability in nature. The plan has been developed in accordance with the requirements of the NSW *Fisheries Management Act 1994*.

The silver perch is a moderately large freshwater fish that has been listed as 'vulnerable' under the NSW *Fisheries Management Act 1994*. It is also listed as vulnerable on the IUCN 'Red List' of threatened species, considered potentially threatened by the Australian Society for Fish Biology, and is listed as critically endangered under the Victorian *Flora and Fauna Guarantee Act 1988* and endangered under the ACT *Nature Conservation Act 1980*. It is also totally protected in South Australia.

Silver perch are native to the Murray-Darling Basin. Historically they were widespread and common throughout most of this region, from the cool upper reaches of streams to the warmer, slow-flowing lowland rivers. However, they have suffered a dramatic decline in abundance and distribution, and only a few remaining self-sustaining populations are known. The most abundant of these occurs in the Murray River downstream of Yarrawonga Weir (and in associated tributaries and anabranches). There are also reports of self-sustaining populations in other rivers, such as the Macintyre and Macquarie Rivers in northern NSW and Warrego River in Queensland, and a translocated population occurs in the Cataract Dam near Sydney. In many other parts of the Murray-Darling Basin, however, silver perch are now absent or rare.

While silver perch have been well studied under culture conditions, there is a significant lack of information on their biology, environmental tolerances or habitat requirements in the wild. This lack of information makes it difficult to be certain of the reasons for the decline of silver perch, although a range of likely factors can be identified.

Silver perch evolved in an environment characterised by extremely variable river flows, including periods of drought punctuated by major floods, and their life history and reproductive strategies are well adapted to these conditions. River regulation and water extraction are likely to have had major impacts on silver perch populations through changes in the size, frequency and duration of floods, the seasonality of flow patterns, reductions in water temperatures and creation of barriers to migration, leading to the loss of spawning cues, negative effects on larval survival and recruitment, and reductions in habitat quality and food availability. Major, wide-ranging threats such as river regulation and water extraction are intrinsically linked with human settlement and land use in the Murray-Darling Basin.

Other threats may include introduced species and diseases, broadscale degradation of riverine and floodplain habitats, water quality problems, incidental fishing impacts and genetic impacts from hatchery-bred and stocked fish.

The silver perch is an important freshwater angling species, and widespread stocking for recreational fisheries enhancement has occurred both within the Murray-Darling Basin and in some coastal catchments outside its natural range. Since 1998 it has been illegal to target or keep silver perch from rivers, although it is still permitted to take them from specified impoundments and private dams where populations are created and maintained by stocking. In many cases stocking does not appear to have established self-sustaining populations and thus may have done little to improve the status of the species in the wild.

Silver perch have also become the basis of a significant and growing aquaculture industry in NSW, currently worth around $2.8 million annually. Large numbers of silver perch are bred each year for both human consumption and stocking. Given the vulnerable status of silver perch in the wild, it is critical to carefully manage hatcheries, grow-out facilities and stocking practices to avoid potential impacts (e.g. through the release or escape of genetically-unsuitable fish) on remaining wild populations.

The NSW Department of Primary Industries (NSW DPI) will coordinate and lead the implementation of this recovery plan, with support from relevant NSW government agencies, universities, councils, and the community. The recovery plan will be resourced by a combination of recurrent and external funding. Many of the actions identified within the plan can be implemented as part of the core functions of the NSW DPI and other public authorities. Implementation of the recovery plan does not require or propose the need for additional recurrent funds. However the implementation of some recovery actions will be subject to securing additional funding from grant programs.

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1. Introduction

1.1 Legislative context

In NSW, the *Fisheries Management Act 1994* provides the legislative framework for the protection and recovery of threatened species, populations and communities of fish, aquatic invertebrates and marine plants.

1.1.1 Listings

The silver perch is listed as:

- Vulnerable under the *Fisheries Management Act 1994* (NSW)
- Threatened under the *Flora and Fauna Guarantee Act 1988* (Victoria), and classified as 'critically endangered' by the Victorian Department of Sustainability and Environment (2003).
- Endangered under the *Nature Conservation Act 1980* (ACT)
- Protected by regulations under the *Fisheries Act 1982* (South Australia)
- Vulnerable by the Australian Society for Fish Biology (ASFB)
- Vulnerable in the IUCN Red List of Threatened Species

1.1.2 Recovery planning

Recovery plans are prepared by the NSW DPI (now incorporating NSW Fisheries) for species, populations and ecological communities listed as endangered or vulnerable on the schedules of the *Fisheries Management Act 1994*. Once it has been finalised and approved, a recovery plan is a statutory document. Ministers and public authorities need to take appropriate actions to implement the measures in the plan for which they are responsible, and to not make decisions that are inconsistent with the provisions of the plan without consulting the Minister for Primary Industries.

Under the NSW *Environmental Planning and Assessment Act 1979*, relevant recovery plans must also be considered by consent authorities (e.g. local councils), determining authorities (e.g. State government agencies), and the Director-General of the NSW DPI (as a concurrence authority) when they are exercising a decision-making function under Part 3, 4 or 5 of the Act.

1.1.3 Critical habitat

Critical habitat provisions are established by Division 3 of Part 7A of the *Fisheries Management Act 1994*. The Minister may declare the whole or any part of the habitat critical to the survival of a species, population or ecological community as critical habitat. Public authorities are required to have regard to critical habitat in exercising any of their functions in relation to any land involved. The *Fisheries Management Act 1994* also establishes offences in relation to damaging critical habitat. Once declared, a species impact statement is mandatory for all developments and activities that are likely to affect critical habitat.

No critical habitat has been declared for silver perch at the time this plan was prepared (January 2006). Any future declaration of critical habitat for silver perch will be published in the Gazette, and in a newspaper with a State circulation.

1.1.4 Environmental planning and assessment

The *Fisheries Management Act 1994* integrates the conservation of threatened species into development control processes under the *Environmental Planning and Assessment Act 1979*. If a planned development or other activity that requires government approval is likely to have an impact on threatened species, these impacts must be considered by the consent and/or determining authority. Where such actions are likely to result in significant impact on a threatened species or its

habitat, a detailed species impact statement must be prepared. The consent or determining authority must then seek the concurrence of the Director-General of the NSW DPI, or in certain circumstances, consult with the Minister for Primary Industries.

Even if a proposed action does not require approval under the *Environmental Planning and Assessment Act 1979*, it may still require approval under the *Fisheries Management Act 1994*. A specific licence or permit may be required if the action will result in harm to threatened species, populations or ecological communities, or their habitat.

1.2 Recovery plan preparation

This recovery plan has been developed in accordance with the requirements of the *Fisheries Management Act 1994* (as outlined in section 220ZN; see Appendix 1).

The plan has been prepared by NSW DPI in consultation with various individuals including scientific experts (see 'Acknowledgments'). While the recovery plan is based on the input of these people, individual components within the plan do not necessarily represent the views nor the official position of all individuals or agencies consulted.

The information in this recovery plan was accurate to the best of the knowledge of NSW DPI at the time of preparation.

1.3 Recovery plan implementation

NSW DPI is the lead agency responsible for coordinating and implementing this recovery plan. However, the success of the plan and the long-term recovery of silver perch is contingent on the assistance, cooperation and involvement of various other organisations and groups who either have an interest in the conservation of the species or whose actions and decisions have the potential to affect its survival. NSW DPI will actively encourage the conservation of silver perch by adopting measures involving cooperative management with relevant government agencies, local councils, universities, research institutions and community and environment groups.

Recovery actions are outlined in section 6.

1.4 Linkages with other recovery and threat abatement plans

Rivers within the Murray-Darling Basin support several other species, populations and communities listed as threatened under the *Fisheries Management Act 1994* and *Threatened Species Conservation Act 1995* (Table 1).

Recovery plans are currently being prepared for several of these species, populations and ecological communities. A national recovery plan for trout cod has been developed and adopted under the *Environment Protection and Biodiversity Conservation Act 1999*.

Recovery activities for these species and silver perch will be cross-linked in some areas as the decline of many of these species is also linked to changes to river flows and degradation of aquatic habitats.

In addition, several 'key threatening processes' (KTPs) of relevance to silver perch have been listed under the *Fisheries Management Act 1994*. These include 'Degradation of riparian vegetation along NSW water courses', 'Installation and operation of instream structures and other mechanisms that alter natural flow regimes of rivers and streams', 'Introduction of fish to waters within a river catchment outside their natural range' and 'Removal of large woody debris from New South Wales rivers and streams'. The preparation and implementation of threat abatement plans for these KTPs should benefit the recovery of silver perch.

Table 1: Threatened fish species (other than silver perch) – and some other threatened fauna – associated with rivers of the Murray-Darling Basin[1]

	Scientific name	Common name	Listing status		
			NSW		National
			FM Act	TSC Act	EPBC Act
Fish:	*Maccullochella macquariensis*	Trout cod	E		E
	Craterocephalus fluviatilis	Murray hardyhead	E		V
	Mogurnda adspersa (western population)	Purple-spotted gudgeon	EP		
	Ambassis agassizi (western population)	Olive perchlet	EP		
	Macquaria australasica	Macquarie perch	V		E
	Nannoperca australis	Southern pygmy perch	V		
Frogs:	*Litoria spenceri*	Spotted tree frog		E	E
Birds:	*Oxyura australis*	Blue-billed duck		V	
	Stictonetta naevosa	Freckled duck		V	
Invertebrates:	*Notopala sublineata*	River snail	E		
Ecological communities:	Aquatic ecological community in the natural drainage system of the lower Murray River catchment		EEC		

E – Endangered
V – Vulnerable
EP – Endangered population
EEC – Endangered ecological community

FM Act – *Fisheries Management Act 1994* (NSW)
TSC Act – *Threatened Species Conservation Act 1995* (NSW)
EPBC Act – *Environment Protection and Biodiversity Conservation Act 1999* (Commonwealth)

1.5 Linkages to the Native Fish Strategy for the Murray-Darling Basin

The Native Fish Strategy for the Murray-Darling Basin is an initiative of the Murray-Darling Basin Commission that seeks to increase native fish populations back to 60% of their estimated pre-European settlement levels over a 50-year period (MDBC 2004). One of the objectives of the strategy is to devise and implement recovery plans for threatened native fish species. Accordingly, the development and implementation of this recovery plan is consistent with the implementation of the Native Fish Strategy. Similarly, many of the actions to be implemented through the Native Fish Strategy will directly and indirectly benefit silver perch and assist in the recovery of the species.

[1] Note:

This is not a comprehensive list; there are many plants and other animals listed under the *Threatened Species Conservation Act 1995* and the *Environment Protection and Biodiversity Conservation Act 1999* that are associated with Murray-Darling river systems.

2. Biology and ecology

2.1 Names

Common: Silver perch

Other names: bidyan, black bream, silver bream, grunter

Scientific: *Bidyanus bidyanus* (Mitchell, 1838)

2.2 Systematic position

The silver perch (*Bidyanus bidyanus*) is one of about 45 species of grunters (family Terapontidae), a group of small to moderately sized carnivorous and omnivorous fish found only in the Indo-Pacific region (Merrick & Schmida 1984).

2.3 Description

Silver perch is the largest member of its family. The species commonly grows to around 30 cm – 40 cm in length and 0.5 kg – 1.5 kg in weight, but are known to attain 8 kg.

(a)

(b)

Figure 1: (a) Adult and (b) juvenile silver perch (Photos: Gunther Schmida / Kris Pitman)

Silver perch have an elongated oval body with a relatively small head, small eyes and a small mouth. The jaws are of equal length with narrow bands of small, pointed teeth along each. They have a weakly forked tail and a single, long-based dorsal fin, the front section of which is spiny and the back section soft. The shape of the body can vary with age, with adults having a deeper and more compressed body than juveniles.

The colour of silver perch can vary depending on water conditions (e.g. water clarity), but they are usually a dark grey colour along the top, changing to silvery-grey on the sides with a white belly (Merrick & Schmida 1984). They can sometimes appear olive-greenish or brown overall with a silvery or golden sheen. Juveniles can be mottled with vertical dark bars (Cadwallader & Backhouse 1983).

Silver perch closely resemble two other terapontid species found in adjoining drainages of the Murray-Darling Basin. These are the Welch's grunter (*Bidyanus welchi*) and the Barcoo grunter (*Scortum barcoo*) (Merrick 1996).

Silver perch are described and figured in Merrick (1996).

2.4 Distribution and abundance

2.4.1 Past distribution and abundance

Historically silver perch were found throughout most of the Murray-Darling Basin, including southern Queensland, western NSW, northern Victoria, the Australian Capital Territory and South Australia (Cadwallader & Backhouse 1983). However, as with many native fish species, there is very little published data on their historical distribution or abundance.

It has sometimes been stated that the distribution of silver perch did not extend to the cool, higher altitude, upper reaches of tributaries of the Murray-Darling[2]. However, silver perch have been recorded as far upstream as Cooma on the Murrumbidgee River (>1000m altitude), and it is likely that they did live or move within the upper reaches of some or most tributaries (S. Rowland, D. Gilligan pers. comm.).

Anecdotal evidence suggests silver perch were previously one of the most common and abundant fish species in the region (Clunie & Koehn 2001a), as do commercial and recreational catch data (see section 3.5). As recently as the early 1970s silver perch were considered to be "widespread and fairly common in the Murray-Darling system" (Llewellyn 1983), although by the late 1970s they were uncommon in the southern tributaries such as the Murray, Murrumbidgee, Edward and Lachlan rivers (S. Rowland pers. comm.).

Over the last few decades silver perch have experienced a significant decline in abundance within the Murray-Darling Basin. This is reflected in the commercial catch data for silver perch (see section 3.5), which show a fairly consistent pattern of decline from the early 1960s onwards in NSW and from the early 1980s onwards in South Australia. Other evidence comes from a comparison of historical data on fish using the Euston Weir fishway, which shows that 93% fewer silver perch used the fishway each year in the early 1990s than half a century earlier[3], when they had been the most abundant fish recorded (Mallen-Cooper & Brand 1992).

2.4.2 Present distribution and abundance

In NSW silver perch are now absent from much of their former range. The most abundant remaining natural population occurs in the central Murray River downstream of Yarrawonga Weir as well as several of its anabranches and tributaries including the Edward River - an anabranch of the Murray

[2] For example, the upstream limits to their recorded distribution have been described as Chinchilla on the Condamine River in southern Queensland; Bonshaw on the Dumaresq River in NSW; Albury on the Murray River in NSW (Merrick & Schmida 1984, Merrick 1996); and Seven Creek and its junction within the Goulburn River in Victoria (Allen 1989).

[3] Between 1939 and 1942, the mean number of silver perch using the fishway each year was 3843, with a maximum of 450 moving through the fishway in one day. By contrast, from 1987-92 the mean number was 281 a year, with a maximum catch of 38 in one day (Mallen-Cooper & Brand 1992).

River that flows through Deniliquin, and the Murrumbidgee River (Figure 3). The central Murray population is considered secure and self-sustaining. Large numbers of silver perch have been recorded moving upstream through the Torrumbarry fishway (Figure 2) and other fishways in the area (e.g. at Euston, Balranald and Yarrawonga Weirs). Angler reports likewise suggest they are quite abundant near Torrumbarry and Barmah (e.g. Clunie & Koehn 2001a). There have also been reports of self-sustaining populations in other rivers, including the Macintyre and Macquarie rivers in northern NSW and the Warrego River in Queensland, mostly from recreational anglers. Little is currently known about the status of these populations.

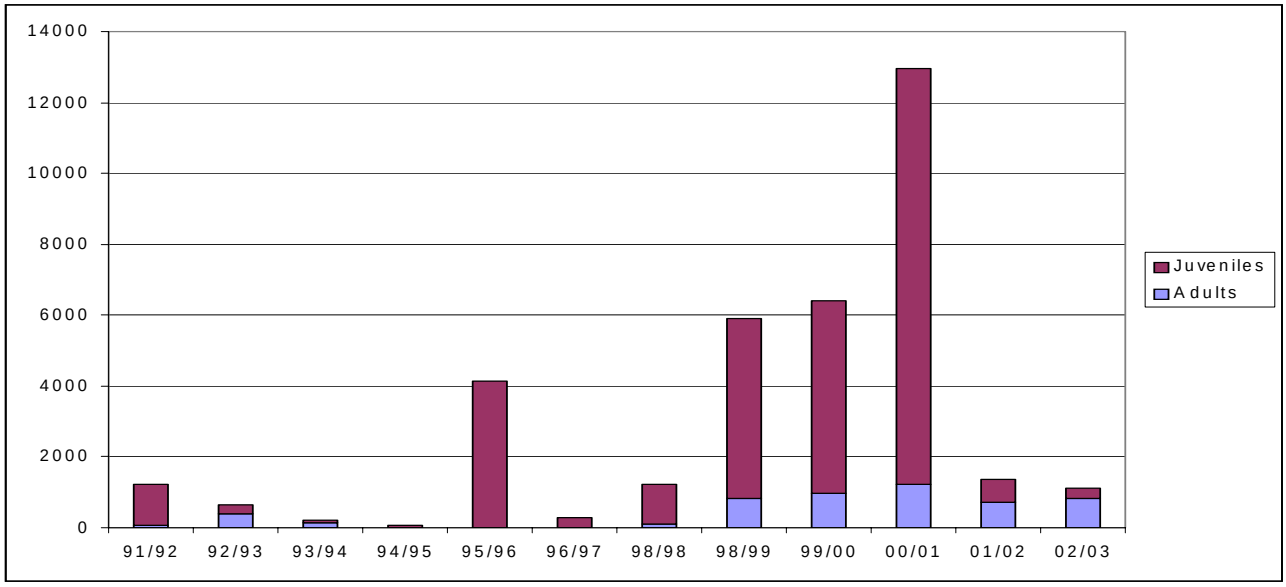

Figure 2: Numbers of silver perch migrating through the fishway at Torrumbarry Weir, 1991/92 - 2002/03 (MDBC, unpublished data)

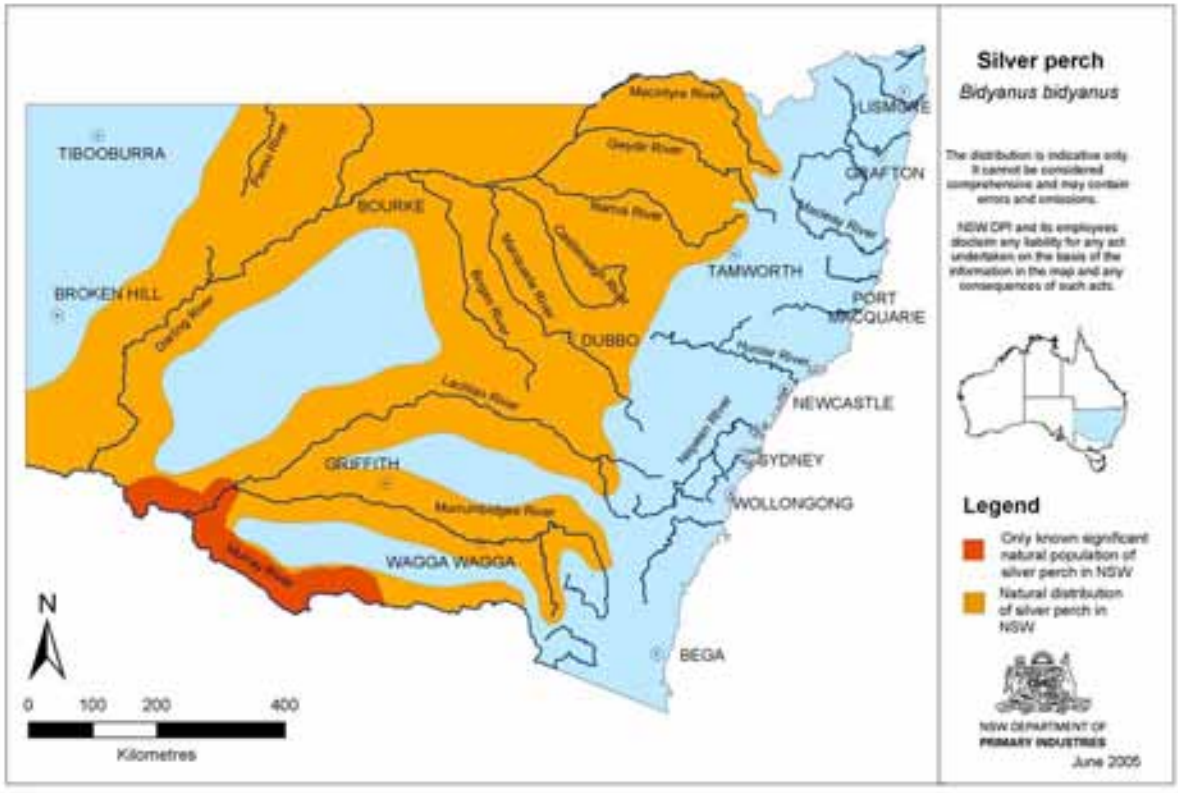

Figure 3: Natural distribution of silver perch in NSW

In other parts of the Murray-Darling Basin, various randomised and *ad hoc* surveys have found very low numbers of silver perch (see Appendix 2). For example, sampling of four sites in each of the Darling and Paroo River catchments between 1992 and 1995 captured a total of 12,639 fish, only 1 of which was a silver perch (Gehrke et al. 1999). Similarly, in the first two years of the NSW Rivers Survey, 20 sites in the Darling and its tributaries were sampled on four occasions. A total of 9,390 fish were captured from this region, including 7 silver perch[4] (Schiller et al. 1997; Faragher & Lintermans 1997). Records from NSW Fisheries' freshwater sampling database (1995-2003) show that silver perch account for less than 0.5% of fish records obtained by NSW Fisheries in all river systems except the central Murray (NSW Fisheries, unpubl. data 2003). However, the sampling design and methods (generally electro-fishing at random sites) mean that areas where silver perch are more abundant may not have been recorded.

Silver perch have been widely stocked within the Murray-Darling Basin and have also been translocated into many areas outside their natural range, including some catchments along the east coast of NSW. A population that was translocated into Cataract Dam near Sydney in the early part of the 20th century is secure and self-sustaining. In most other cases, however, it is not clear whether stocking has succeeded in establishing self-sustaining (reproducing) populations and thus whether it has improved the status of the species in the wild. Stocking of silver perch is discussed in section 3.6.

A summary of available information on the distribution and abundance of silver perch in South Australia, Victoria, the Australian Capital Territory and Queensland can be found in Clunie & Koehn (2001a).

2.5 Habitat

Silver perch have been found in a wide range of habitats and climates across the Murray-Darling Basin, from the cool, clear, gravel-bed streams of the upper reaches to the lower, slow flowing, turbid rivers of the west and north (Rowland 1995a, Clunie & Koehn 2001a). They also occur in lakes and reservoirs.

There is limited information on the specific habitat requirements of silver perch or the extent to which they depend (if at all) on habitat components such as aquatic plants, riparian vegetation or snags (Clunie & Koehn 2001a). It has been suggested that they prefer faster-flowing waters especially where there are rapids and races (e.g. Merrick & Schmida 1984), and they are often seen congregating below rapids and weirs (Allen et al. 2002). However, such congregations may simply reflect the effect of encountering a barrier as they attempt to migrate upstream rather than a preference for rapidly flowing water. The most significant remaining natural population of silver perch occurs in a lowland section of river where habitat such as rapids and races is rare.

It has also been suggested that they prefer open waters rather than areas that are heavily snagged (Cadwallader & Backhouse 1983). While NSW DPI sampling records show that most silver perch have been caught near snags, in impoundments they are often observed in open waters, and do not appear to be as reliant on snag habitat as some other native freshwater fish species (e.g. trout cod).

Silver perch can tolerate a wide temperature range (2º–38ºC). However, aquaculture research has shown that the optimal temperature range for silver perch in commercial production is 23-28°C, with anything above or below resulting in decreased feeding and growth rates. Artificially reduced temperatures in rivers (through cold water pollution from dams) are thought to have affected the reproduction of silver perch and may be one of the primary causes of the species' decline (see section 3.2).

[4] Of the 7 silver perch captured, 4 were from the Gwydir River near Bingara, 2 from the Namoi River near Boggabri and 1 from the Darling River near Bourke.

Figure 4: Silver perch habitat – Darling River (Photo: NSW DPI)

2.6 Life history and ecology

Considerable research has been carried out on the reproduction, diet and performance of silver perch under aquaculture conditions. However, there is far less information for wild populations.

2.6.1 Growth and longevity

Silver perch are known to grow up to about 40 cm in length and 6-8 kg in weight, although fish over 3 kg are rare. Large individuals seem to be less common now compared to several decades ago (Clunie & Koehn 2001a).

Aging and growth studies carried out on silver perch (Mallen-Cooper & Stuart 2003) have found differences in growth rates and maximum size between the sexes (females grow more slowly, but reach a greater maximum size, than males), geographical areas (slower growth in the Warrego River than the Murray River) and habitats (generally slower growth rates in rivers than impoundments).

Silver perch appear to be long-lived, the maximum age recorded for an individual fish being 27 years (Mallen-Cooper & Stuart 2003). Because of slow growth rates, even some old silver perch may be relatively small – for example, the fish from Cataract Dam aged as 27 years by Mallen-Cooper and Stuart (2003) weighed only 1.2 kg. Growth is considerably faster under culture conditions, with fish reaching 0.5–1kg within 2 years (S. Rowland pers. comm.).

2.6.2 Reproduction

Under culture conditions, silver perch reach sexual maturity in two and three years for males and females respectively (Lake 1967c, Rowland 2004). However, fish may take longer to reach sexual maturity in the wild; three and five years (for males and females respectively) have been suggested based on observations of mature gonads (Mallen-Cooper et al. 1995).

Spawning of silver perch occurs when water temperatures reach about 23°C. A rise in water levels can stimulate aggregation and spawning (e.g. Lake 1967a). There is evidence that silver perch migrate upstream before spawning, with large numbers recorded moving through fishways on the Murray between September and April (see section 2.6.3).

It is generally thought that the recruitment of silver perch (and many other native fish) is tied to high flows in spring or summer which stimulate fish to move upstream and spawn, inundate floodplains and produce abundant food for the larvae (e.g. Lake 1967a, Reynolds 1983, Gehrke 1992). Recent

research has suggested that spawning also occurs in non-flood years, with some authors even suggesting that recruitment is greater during these years than during extensive floods. For example, Mallen-Cooper and Stuart (2003) found that the strongest age classes of silver perch corresponded to years when flows were largely contained in-channel, and a recent study on larval drift in the central Murray River found the greatest egg abundances corresponded to periods of stable regulated flows (Gilligan & Schiller 2003). However, more work is needed to compare spawning and recruitment under a variety of flood conditions before the importance of floods can be discounted.

Silver perch have been reported spawning in flooded backwaters of low gradient streams (Lake 1967b), although as the work referred to above suggests, it may also occur within river channels. Spawning has been recorded at sunset with schools of around 50 to 70 fish (Clunie & Koehn 2001a). Silver perch can be quite aggressive during spawning, and some fish may suffer damage to their scales and fins, or even death (Lake 1967a, Rowland 1984).

Fecundity is high, with females often laying 300,000 or more non-adhesive, floating eggs (Merrick 1996). These are mostly released in one spawning, and hatch within 36 hours. After about 5 days, the yolk sac has been absorbed and the larva commences feeding. In aquaculture facilities the larvae have been described as rarely using vegetation or other instream habitat for cover (Thurstan 1991), although whether wild larvae show similar behaviour is unknown. By about the 18th day the larvae have developed into juvenile fish measuring approximately 11 mm (Rowland et al. 1983).

2.6.3 Behaviour and movement

Silver perch readily school, sometimes forming large shoals in open water.

Some research has been undertaken on the movement and migration patterns of silver perch. These show that both adults and juveniles (over one year old) migrate upstream (Mallen-Cooper et al. 1995). One adult silver perch was recorded by Reynolds (1983) as travelling 570 km upstream in the 19 months between tagging and recapture.

Upstream movements appear to be stimulated by rises in water temperature (above about 20ºC) and water level. Immature fish have been observed moving upstream from October to April and adult fish over a shorter period from November to February (Mallen-Cooper et al. 1995). However, the season of migration may vary across the species' range because of differences in climatic factors such as day length and water temperature (Mallen-Cooper et al. 1995, Gehrke 1992).

The reasons for upstream movement are not well understood, but there is indirect evidence that adults move upstream prior to spawning (Mallen-Cooper et al. 1995). It has been suggested that upstream spawning migrations may be a strategy to give the floating eggs time to hatch and develop into larvae capable of swimming against the current before they are washed too far downstream (e.g. Reynolds 1983).

2.6.4 Diet

Silver perch are omnivorous, with a diet including insects, molluscs, small crustaceans, worms, microscopic animals and algae. Zooplankton seems to be the major part of the larval diet, with algae and plants becoming more important in the diet of adults (Clunie & Koehn 2001a). However, it is not clear whether silver perch actually digest the algae or plants, or just the associated fauna (S. Rowland pers. comm.).

2.7 Genetics

Keenan et al. (1995) investigated the population genetics of silver perch in the Murray-Darling Basin, using allozymes[5] as a genetic marker. They identified seven populations, finding no genetic differentiation between two wild populations (Torrumbarry Weir and Cunnamulla), but significantly less

[5] Alternative forms of a protein detected by electrophoresis that are due to alternative alleles at a single locus

genetic variability[6] in three of the stocked populations (Leslie Dam, Wyangala Dam and Grafton hatchery) compared to the wild populations and two other stocked populations (Pindari Dam and Cataract Dam). This is likely to be the result of a small number of fish being used to form the stocked populations (termed a 'founder bottleneck').

More recently, Bearlin and Tikel (2003) studied the population genetics of silver perch, trout cod and Murray cod in the Murray-Darling Basin. They looked at mitochondrial DNA haplotypes in 801 silver perch (553 broodstock and offspring from hatcheries and 248 fish from wild populations). Like Keenan et al. (1995) they found reduced genetic variability in stocked populations and hatchery holdings compared to wild populations.

Despite these studies, the genetics of silver perch remains unclear because of limited sampling of the wild populations and the restricted number of genetic loci examined in both studies (Rowland & Tully 2004; S. Rowland pers. comm.).

Although there is currently no clear evidence of genetic differentiation in silver perch across the Murray-Darling Basin, until further research is conducted a precautionary approach needs to be taken to stocking and other policies with the potential to affect genetic structure.

3. Causes of decline and current issues

Tremendous pressure has been placed on rivers in the Murray-Darling Basin as a result of river regulation, flood mitigation works, drainage of wetlands, water extraction for consumptive uses, intensive agricultural practices involving the use of fertilisers, pesticides and cultivation, widespread land clearing, the introduction of exotic species (e.g. carp) and rising populations in regional centres. This is reflected in the large proportion of native fish species in the Murray-Darling Basin that are listed as threatened under NSW and other State and Commonwealth legislation.

3.1 Lack of knowledge

Although some research has been undertaken on silver perch, much of it has been under aquaculture conditions. There is very limited information available on the species' biology, habitat requirements or responses to particular threats in the wild.

Research undertaken on silver perch was summarised by Clunie & Koehn (2001a). Aquaculture-related research includes work on reproductive biology, techniques for hatchery production, artificial diets, larval development, the success of different stocking strategies, susceptibility to diseases and response to various water quality parameters.

Research on aspects of wild silver perch biology and ecology includes work on movement patterns of adults and juveniles, ability to negotiate fishways, population genetics (section 2.7) and dispersal of eggs.

There is very little information on the reproductive biology and habitat requirements of silver perch or their response to particular threats, although such information is vital to allow a better understanding of the reasons for their decline and as a basis for management decisions. For example, better knowledge of the flow requirements of silver perch could assist in water planning. Further genetic research is also needed to determine the extent of population differentiation and enable management of potential genetic impacts associated with stocking activities.

3.2 River regulation and barriers to fish passage

The Murray-Darling Basin is Australia's most regulated drainage division (Walker 1981), with numerous storages and other structures constructed to regulate river flows and ensure a more reliable supply of water for irrigation, domestic use and industry.

[6] Measured as mean heterozygosity, mean number of alleles and polymorphic loci

River regulation and water extraction throughout the Basin have detrimentally affected the riverine environment as well as surrounding riparian and floodplain habitats, and are likely to have played a major role in the decline of silver perch. While their impacts are complex and interrelated, they fall generally into three main categories; changes to natural flow patterns (including the frequency, extent and duration of flooding), changes to temperature regimes and barriers to movement.

CHANGES TO FLOW PATTERNS, INCLUDING FLOODS

In their natural state, inland rivers such as the Murray were characterised by highly variable flows including a pattern of prolonged droughts punctuated by major floods. Native flora and fauna have become adapted to these flow patterns over millions of years, and periods of low and high flow have important ecological functions.

River regulation has resulted in changes in the size of flows, seasonality of flow patterns; frequency and duration of floods; timing, variability and predictability of flows; rates of rise and fall of water levels; and surface and subsurface water levels. In addition, the diversion of water for irrigation, either by gravity into irrigation canals or by pumping into pipelines or channels, has reduced the overall amount of water in the river for environmental and ecological needs. Of the water that would have originally reached the sea from the Murray-Darling Basin, over two-thirds is now diverted from its rivers each year (Thomson 1994).

These changes may have affected silver perch in a number of ways:

- Since spawning may be triggered by rises in water levels, the capture of high flows, a change in the season of high flows and a reduction in the occurrence of floods[7] may have affected spawning success.
- The release of regular, relatively small flows for irrigation throughout summer may have contributed to their decline by inducing spawning under conditions that are, in many years, unsuitable for larval survival and recruitment. For example, the availability of zooplankton is a critical factor in larval survival under culture conditions, and the same is undoubtedly true in the wild (S. Rowland pers. comm.).
- The construction of numerous weirs and other barriers may have affected the survival of eggs and larvae, both of which have a tendency to sink if there is no water movement (Lake 1967a, 1971). It has been suggested that eggs and larvae which settle out in weir pools or other areas of low flow can show decreased survival because of poor water quality (including low dissolved oxygen levels), and are also prevented from dispersing downstream (Clunie & Koehn 2001a).
- In addition, water diversion from weir pools could potentially result in the removal of many eggs and larvae from the river system (Gilligan & Schiller 2003).
- Some rivers now run at capacity more frequently than in the past, particularly when irrigation waters are being supplied during summer months. This could lead to eggs and larvae being washed too far downstream, and possibly being damaged when they pass over barriers (Clunie & Koehn 2001a).
- Altered flow patterns (including an overall reduction in flow volumes) may have also affected the availability and quality of habitat. For example, silver perch have been recorded in floodplain habitats such as backwaters and billabongs, which have been impacted by changes in the wetting/drying cycle.

Given the numerous demands on water resources, it is impossible to return to pre-development conditions. However, allocation and management of water to provide a greater range of flows that are closer to natural flow regimes are likely to benefit the aquatic environment as well as species such as silver perch which have evolved under these natural conditions (Clunie & Koehn 2001b).

[7] Mallen-Cooper (1993) noted that the number of small floods (5000-10000 ML/day) occurring in the Murray River has declined by half over the last 50 years (Close 1990).

CHANGES TO TEMPERATURE REGIMES

Water held in large impoundments is stratified, with a warm surface layer and a cold, dense bottom layer. When cold water is released from low-level outlets in these dams it can lower river temperatures for many hundreds of kilometres downstream. Such 'cold water pollution' has the effect of reducing water temperatures (by as much as 8-12ºC in spring/summer), reducing annual temperature ranges and delaying the timing of summer temperature peaks.

Cold water pollution affects a significant proportion of river reaches within the Murray-Darling Basin, including downstream of Hume Dam on the Murray, Burrinjuck Dam on the Murrumbidgee, Wyangala Dam on the Lachlan, Burrendong Dam on the Macquarie and Lake Eildon on the Goulburn River. Declines in silver perch populations have been documented in all of these areas (Clunie & Koehn 2001a).

Silver perch are a 'warm-water' native species, with both upstream migrations and spawning triggered, at least in part, by rising water temperatures. Cold water pollution is likely to affect silver perch in various ways:

- Loss of spawning cues, leading to delayed spawning or reduced spawning success.
- Adverse effects on hatching success and survival (T. Ryan pers. comm. in Clunie & Koehn 2001a).
- Impaired general metabolic functioning, feeding, maturation and growth rates (Lugg 1999, Clunie & Koehn 2001a).
- Indirect impacts by lowering the overall productivity of the system and thus reducing available food sources.

BARRIERS TO MOVEMENT

Silver perch, like many other native fish, need to be able to move freely between different areas for feeding, dispersal and reproduction.

However, over the last 100 years numerous barriers to fish movement have been constructed across watercourses, including dams, weirs, levee banks, fords, culverts, stream gauging stations and road crossings. These structures can physically prevent fish passage or create areas of high water velocity that fish cannot negotiate (Clunie & Koehn 2001a).

Barriers prevent the movement of both adult and juvenile silver perch. Even very low weirs may prevent the passage of juvenile fish. Barriers limit dispersal and can prevent recolonisation of stretches of river where silver perch have disappeared, leading to populations becoming restricted to areas downstream of major barriers.

Some of these problems can be overcome through appropriate design of new structures and construction of fishways to allow passage through existing structures. Providing fish passage along significant stretches of river is likely to be a key issue in ensuring the recovery of silver perch. For example, it appears that the length of river unimpeded by barriers to fish passage is one of the major reasons why there is still an important population of silver perch between Torrumbarry and Euston weirs (528 km), as this probably provides sufficient distance for larvae to develop and commence swimming against the current without being washed over a barrier (Mallen-Cooper et al. 1995, Clunie & Koehn 2001a).

3.3 Habitat and water quality

A recent assessment of the condition of rivers in the Murray-Darling Basin suggested that over 95% of the river length assessed was in a degraded environmental condition (Norris et al. 2001). Widespread problems include loss of riparian vegetation, streambank erosion, reduced quality of floodplain habitats and wetlands, removal of snags and other habitat components, increased sedimentation, and water quality problems such as increased salinity and nutrient levels, algal blooms and pesticide contamination.

Broadscale habitat degradation is likely to have contributed to the decline of silver perch in many parts of the Murray-Darling Basin, although there is little information on the importance of specific habitat components to silver perch or the significance of their loss. There is also a lack of scientific data on the tolerance of silver perch to water quality problems encountered in the wild (with the exception of cold water pollution, addressed in section 3.2). In aquaculture, although silver perch are considered quite hardy (S. Rowland pers. comm. in Clunie & Koehn 2001a), exposure to poor water quality can stress the fish and result in increased susceptibility to other threats, such as infection by various diseases (see section 3.3). In the wild, eleven fish kills involving silver perch have been recorded between 1984 and 1999, four in natural waterways and the remainder in farm dams or reservoirs (NSW Fisheries fish kills database). While it is often difficult to determine the cause of such kills, inflows of sediment-laden runoff (resulting in low dissolved oxygen levels) seem to have been responsible in at least two cases.

Some habitat and water quality issues that may affect silver perch include:

- **Degradation of riparian vegetation.** Riparian vegetation has a direct influence on river health through factors such as bank stability, shading, soil conservation, water quality and the availability of food and shelter for many plants and animals. Riparian zones in the Murray-Darling Basin have been widely damaged or cleared for agriculture, forestry, stock grazing, cropping and road construction, and have been further degraded by weed invasions.

  Degradation of riparian vegetation – and its associated impacts on water quality, sediment levels and food sources – may have affected silver perch feeding and reproductive success. It may also have decreased the diversity of habitats, including slower flowing areas, and the availability of woody debris.

- **Loss of aquatic vegetation.** Aquatic vegetation provides important functions for many species, including refuge from predators, shelter from high water velocities, nursery habitat for juveniles, spawning sites, a food source and habitat for invertebrates that are eaten by silver perch and other fishes. It is likely that the composition and abundance of aquatic vegetation has changed since European settlement, with a severe decline in many inland rivers in the last 50 years.

- **Removal of instream woody habitat (woody debris or 'snags').** Trees, trunks, branches or root masses that have fallen or been washed into rivers or streams are important for river ecology. They provide shelter for many species and help in the creation of a range of habitat types including pools, holes and gutters. However, de-snagging has been widely carried out for more than a century to reduce navigation and public safety hazards and flooding risks.

  The importance of snags for silver perch is not known, but it appears they are less dependent on woody debris than other species such as Murray cod, trout cod and golden perch. Silver perch have been recorded in faster flowing open water as well as amongst snags and do not appear to preferentially use snags compared to other habitat components (S. Nicol pers. comm. in Clunie & Koehn 2001a). It is not known if woody debris is important for spawning, but it is likely that it is not since the eggs are semi-pelagic and have been recorded floating downstream.

- **Sedimentation.** Many rivers in the Murray-Darling Basin would naturally have experienced periods of high turbidity, for example during high flows. However, human activities such as agriculture and land clearing have increased sediment levels.

  The impact of increased sediment levels on silver perch is poorly understood. Sedimentation of streambeds, or of still-water habitats such as backwaters, floodplains and weir pools, may affect the survival of silver perch eggs or larvae if they sink to the bottom from lack of water movement. High mortalities of silt-covered eggs have been recorded for some other freshwater fish species (Koehn, DNRE, unpubl. data cited in Clunie & Koehn 2001a).

  High levels of suspended sediments can affect the feeding of some fish by reducing visibility, and can interfere with respiration or even cause suffocation. Increased turbidity may also affect food availability by decreasing light penetration into the water column and thus inhibiting the growth of phytoplankton and aquatic plants and reducing overall productivity.

- **Salinity.** Although large fluctuations in salinity (including some periods of high salinity) occurred historically in the Murray-Darling Basin, the salt load in rivers has increased significantly since European settlement. Large increases in salinity can lead to a decline in diversity of invertebrates, algae, fish and aquatic plants (Clunie & Koehn 2001a).

  Adult silver perch, like many native inland fish species, show a reasonable tolerance to moderate salinity levels. Eggs, larvae and juveniles are less tolerant (e.g. Guo et al. 1993, 1995, Ryan et al. 1999), and it is not known whether salinity has other sublethal or indirect effects on silver perch. While increased salinity levels may not have played a major role in the historical decline of silver perch, it may become an important issue in future.

- **Algal blooms.** Algal blooms are a natural occurrence within inland rivers, although their frequency and intensity prior to European settlement is unknown (MDBC 1994). They are now a common occurrence in reservoirs, rivers and dams through the Murray-Darling Basin and are considered a major water quality problem.

  Toxic algal blooms can cause serious human health problems, fish kills, stock deaths and losses of wildlife (MDBC 1994, Clunie & Koehn 2001a). Little is known about the toxicity of blooms to native fish, and associated problems such as deoxygenation of the water, physical blockage of gills, high pH and high ammonia may be as significant as direct poisoning. Blooms may also affect fish through impacts on the food web (Codd 1995).

  The effect of algal blooms on silver perch is unknown. There do not appear to be any documented cases of mass mortalities of silver perch after major algal blooms, although such blooms may have had sublethal or indirect effects (Clunie & Koehn 2001a).

- **Agricultural chemicals.** While other water quality issues generally receive more attention, there has also been some concern over the environmental effects of pesticide use. Residues of chemicals such as DDT and endosulfan have been found in river water and the flesh of various fishes during water quality monitoring (e.g. Gilbert et al. 1992; Bowmer et al. 1996).

  It is difficult to determine what role, if any, pesticide contamination may have played in the decline of silver perch, since there is little historical documentation of fish kills and only limited information on the toxicology of these chemicals in silver perch. Overseas research has shown that DDT can affect reproduction, physiology and behaviour in a range of aquatic organisms, although no trials have been conducted on silver perch. Although DDT has been banned for over 15 years, the fact that residues persist in aquatic ecosystems is a matter of concern. In trials on the toxicity of endosulfan, silver perch were found to be one of the least sensitive of the six native and introduced species tested (Sunderam et al. 1992). Sublethal effects of this pesticide have not been investigated (Clunie & Koehn 2001a).

3.4 Introduced species and diseases

INTRODUCED SPECIES

A number of non-native species have been introduced into NSW waterways, both deliberately and accidentally, and at least eleven of these have established self-sustaining populations.

Introduced species can impact on native species and freshwater ecosystems through predation (particularly on eggs and larvae); competition for habitat and food resources; habitat degradation; spread of diseases and parasites; and in some cases, hybridisation.

The introduced fish species that may have played a part in the decline of silver perch include:

- **Carp** (*Cyprinus carpio*). First released into inland rivers in the 1870s, carp began to spread rapidly in the early 1970s and are now widespread and abundant in most of the Murray-Darling Basin. They can comprise up to 90% of the fish population in some areas.

  Carp have destructive feeding habits and are widely blamed for increasing water turbidity and siltation, reducing the amount and diversity of aquatic plants, increasing nutrient levels and the incidence of algal blooms, and causing erosion of streambanks, although it is difficult to separate

the impacts of carp from other causes of habitat degradation (MDBC 2000, Clunie & Koehn 2001a).

There is no direct evidence that carp have caused a decline in any native fish species within the Murray-Darling Basin, and many species – including silver perch – had experienced well-documented declines before carp became widespread. It is unlikely that carp directly prey on silver perch, since they mainly consume benthic invertebrates, but they may have affected the species by damaging aquatic habitats and/or competing for resources.

- **Redfin perch** (*Perca fluviatilis*). Redfin were introduced into Australia well over a century ago and now occur across much of the Murray-Darling Basin, except warmer waters in parts of northern NSW and Queensland (Weatherley 1963).

  There is little direct evidence of the effects of redfin on silver perch, and in fact there are some areas where silver perch have declined although redfin are not present (Clunie & Koehn 2001a). Nonetheless, redfin are known to prey on fish and are likely to consume juveniles, larvae and eggs of silver perch as well as other species. Reduced survival of juvenile silver perch has been recorded in impoundments containing redfin (Harris et al. unpubl. data cited in Faragher & Lintermans 1997).

  Redfin are also known carriers of epizootic haematopoietic necrosis virus (EHNV), to which silver perch are susceptible (see below).

- **Gambusia** (*Gambusia holbrooki*). Gambusia were actively introduced into the wild in Australia, particularly in the early part of the 20th century, to control mosquitos. They can reproduce rapidly and are often abundant in warm and slow flowing waters, especially along the margins near aquatic vegetation (McDowall 1996).

  Being a small fish, the main impacts of gambusia are by eating eggs and juveniles and attacking and nipping the fins of larger fish (e.g. Lloyd 1990, McKay et al. 2001). They are unlikely to have contributed significantly to the decline of silver perch, although in areas where they are abundant they may pose a threat by preying on eggs, larvae and juveniles.

DISEASES

Silver perch are known to be highly susceptible to several diseases, including EHNV (Langdon 1989) and barramundi picorna-like virus (Glazebrook 1995) (now regarded as a betanodavirus). EHNV is of particular concern as it is apparently now widespread in NSW and Victoria. Redfin and trout are confirmed carriers of EHNV in the wild, while Murray cod is a carrier in experimental aquaria. EHNV has been shown to kill silver perch and Macquarie perch (*Macquaria australasica*) under laboratory conditions

Diseases such as these have the potential to pose serious threats to native species, causing either mortality (resulting in obvious fish kills) or sub-lethal effects (which may combine with other stresses to affect reproduction, growth or longer-term survival).

There are a number of other diseases (e.g. protozoan, fungal and bacterial diseases) that have been documented as occurring in farmed silver perch (Callinan & Rowland 1995). In general little is known about the prevalence or effects of these diseases in the wild, although protozoan parasites are thought to have been responsible for at least one recorded mass mortality of silver perch, in Bethungra Dam in the Murrumbidgee catchment in October 1999, which involved 197 fish (NSW DPI fish kills database).

Some diseases and parasites of potential concern such as goldfish ulcer disease (Rowland & Ingram 1991), and Asian fish tapeworm (Clunie & Koehn 2001a) occur in introduced species which have a wide distribution in the Murray-Darling Basin, and there is potential for these to affect silver perch. There have also been reports of diseased hatchery fish being transported and stocked into

commercial farms or farm dams, sometimes in entirely different drainages[8] (Rowland & Tully 2004), and this is another potential source of infection for wild populations.

3.5 Fishing

COMMERCIAL FISHING

There was once a significant commercial catch of silver perch within the Murray-Darling Basin. Between 1961 and 1975, for example, they were the fourth most important commercially exploited inland freshwater species (Pollard et al. 1980). During this period NSW accounted for the largest proportion of commercial catches of silver perch (68%), followed by South Australia (28%) and Victoria (4%) (Pollard et al. 1980). However, the only available commercial catch figures for silver perch show a relatively consistent decline from the early 1960s onwards in NSW (see Figure 5) and from the early 1980s onwards in South Australia (Clunie & Koehn 2001a).

Following the collapse of the silver perch fishery in the mid 1980s, commercial fishers in NSW introduced a voluntary ban on landing the species in 1993. In 1998 NSW DPI (then NSW Fisheries) implemented a closure prohibiting the capture and sale of silver perch from riverine habitats. Commercial fishing for other inland native finfish species has also been phased out, with a total ban in place since 31 August 2001.

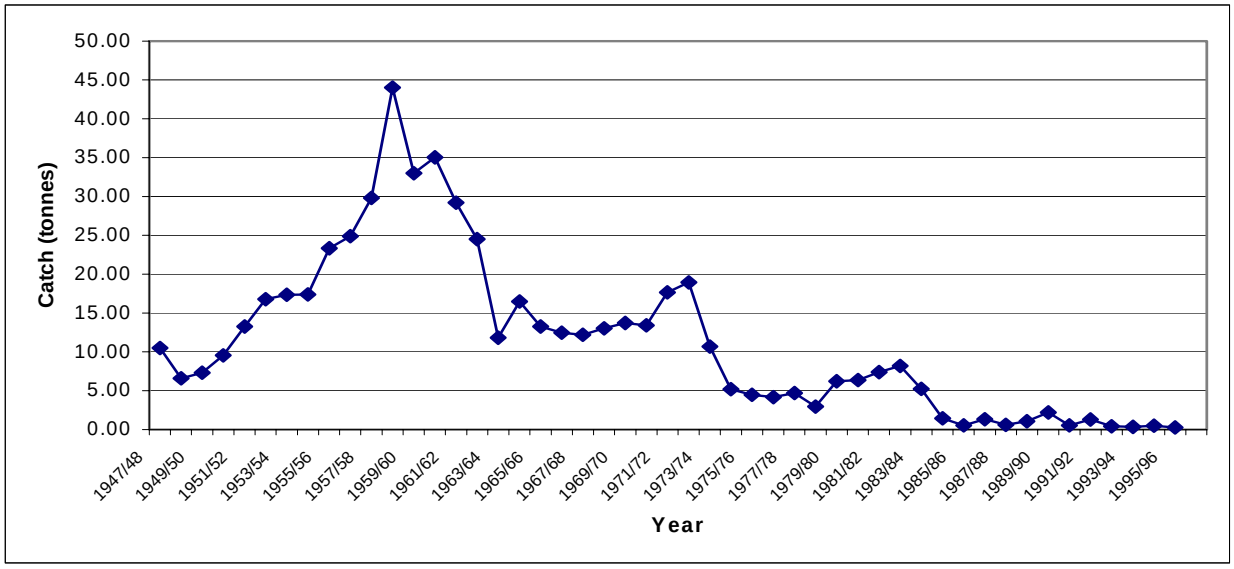

Figure 5: Commercial catch of silver perch in NSW between 1947/48 and 1995/96 (NSW DPI commercial catch data)

[8] For example, silver perch fingerlings heavily infected with the fungus *Aphanomyces invadans* (which causes the disease epizootic ulcerative syndrome or 'red spot') were transported from a commercial hatchery in eastern NSW to a commercial farm in the western drainage (Rowland & Tully, 2004).

Commercial capture of silver perch has also been phased out in South Australia (since 1997) and Victoria (since 1998). There has never been a commercial fishery for silver perch in Queensland (Clunie & Koehn 2001a).

Commercial fishing is not thought to have played as large a part in the decline of silver perch as other factors, particularly changes in the environment due to river regulation. Although it may have been a contributing factor in those parts of the Murray-Darling Basin where it occurred (ie. lower Murray and Murrumbidgee rivers and some of their tributaries), in other areas (e.g. Darling, Lachlan, Macquarie and Barwon rivers) there was no commercial fishery.

RECREATIONAL FISHING

In contrast to the commercial inland fishery, recreational fishing in the Murray-Darling Basin has been increasing. In 1996 there were an estimated 265,000 recreational freshwater anglers fishing in NSW (Pepperell 1996), with evidence to suggest that more than half of these prefer to fish for inland native species. These figures are supported by the results of the more recent National Recreational and Indigenous Fishing Survey, which estimated that there are close to 1 million recreational fishers in NSW (137,000 of whom are based in inland regions), and that freshwater areas account for around a quarter of recreational fishing effort (Henry & Lyle 2003).

Large-scale stockings of silver perch have taken place in various impoundments for put-grow-and-take fisheries. In the late 1980s, O'Connor (1988) reported that silver perch was one of the main species sought by recreational fishers in NSW, although there was subsequently a move away from targeting silver perch, possibly in part because of their widespread decline.

In Australia there are limited data on past recreational fishing catch and effort, making it difficult to determine what impact it may have had on silver perch. Although fishing pressure is generally not considered a key threat, once a species such as silver perch has experienced a significant decline (regardless of the primary causes), it may become more vulnerable to fishing pressure (Clunie & Koehn 2001a).

Because of the decline of natural populations, silver perch became totally protected in NSW rivers in 1998. Silver perch can no longer be targeted in rivers and all fish caught must be returned immediately to the water. Silver perch may be retained when captured from some stocked impoundments; in these cases a size limit of 25 cm and a bag limit of 5 legally-sized fish applies although these regulations are subject to periodic review.

Current conservation issues associated with recreational fishing in areas where wild silver perch occur include:

- **Incidental capture and post-release mortality.** Since anglers continue to fish for other species in inland waters where silver perch occur, some fish continue to be caught incidentally, and a proportion of these will die after release. Many factors affect the survival rate of hooked fish, including the type of hook, stress from capture and handling, time exposed to air, and physical injuries.
- **Mortality from unattended gear such as setlines.** Setlines, which are usually attached to the bank and have only one baited hook, are often used to target Murray cod. Since they are checked infrequently, setlines can cause high levels of mortality and harm to non-target and protected species, including threatened fish and other native animals.
- **Other effects of incidental capture.** Catching and releasing silver perch before or during breeding could also interrupt their reproductive cycle. There is currently a closed season between Yarrawonga and Tocumwal from 1 Sept – 30 Nov, which is designed to protect the main remnant population of the endangered trout cod during its breeding season (and also protects Murray cod). Since the largest remaining population of silver perch occurs further downstream (below Torrumbarry weir), this closure is unlikely to protect breeding populations of silver perch.
- **Illegal capture.** Illegal catch (including the illegal sale of recreational catch and non-compliance with fisheries regulations such as size limits and bag limits) is another issue of

long-standing concern, but one that is difficult to quantify or monitor accurately (Clunie & Koehn 2001a). The fact that silver perch are still permitted to be captured in certain stocked impoundments potentially complicates the compliance issue, because of the difficulty of determining whether a particular fish has been taken from an impoundment or a river (and hence whether it is a legal or illegal catch).

3.6 Aquaculture and stocking

There is now a substantial breeding and aquaculture industry for silver perch in NSW, with large numbers of fish produced each year for fish farming and for stocking into farm dams and impoundments (the latter for put-grow-and-take fisheries). To date there has been no specific conservation-stocking program for silver perch, although this could change in the future if wild populations continue to decline.

Silver perch aquaculture and stocking have the potential, if inappropriately managed, to cause irreversible impacts on threatened wild populations of silver perch through the release of genetically unsuitable fish (including hybrid stocks) and the transfer of disease. Some of these concerns are discussed below.

HATCHERY PRODUCTION AND AQUACULTURE

Silver perch were identified as a suitable species for aquaculture nearly 90 years ago. They have many suitable characteristics including good survival rates, an omnivorous diet, and an ability to be raised at high densities. NSW Fisheries (now incorporated in NSW DPI) began researching hatchery and nursery techniques for silver perch in the 1970s, and ways of intensively farming the species (including grow-out techniques for ponds) in the early 1990s. These technologies have since been transferred to private growers and the commercial production of silver perch is developing into a large industry, with over 1 million fingerlings and around 300 tonnes produced annually in NSW.

Many of the potential environmental impacts from fish farming (e.g. effluent run-off) have been effectively removed by the introduction of comprehensive policies and guidelines for NSW fish farms. An aquaculture permit is required under Section 144(1) of the *Fisheries Management Act 1994* and various permit conditions may apply depending on the nature of the activity. The NSW DPI Silver Perch Policy specifies particular design and operational requirements to ensure that silver perch hatcheries and grow-out facilities are located above flood zones, have zero effluent discharge into natural waterways, and that fish are prevented from escaping. The NSW DPI Silver Perch Policy is being incorporated into whole-of-government Regional Sustainable Aquaculture Strategies. These strategies will further clarify requirements for new aquaculture proposals by setting out best-practice standards in planning and operation for each type of aquaculture facility. New proposals will have to meet these requirements or undergo a full environmental assessment.

However, there are still some major issues in relation to management of hatchery breeding programs, such as the use of too few broodstock (leading to inbreeding) and the production of hybrids (see 'Genetic issues', below), as well as the transmission of diseases into fish farms, farm dams and the wild through the use of diseased fish (see section 3.3). These issues are being addressed through the NSW DPI Hatchery Quality Assurance Program for Murray cod, golden perch, and silver perch (see below).

STOCKING FOR PUT-GROW-AND-TAKE FISHERIES

The first translocations of silver perch were sponsored by NSW Fisheries or by acclimatisation societies. Many of these occurred in the early part of the 20th century, before the potential negative impacts were understood. For example, NSW annual reports from 1915 to 1925 refer to the "rescue and transplantation" of silver perch from flooded river flats near the Murrumbidgee and Darling rivers into various dams and rivers, including some in eastern drainages such as the Nepean River and Cataract Reservoir (Clunie & Koehn 2001a).

However, introductions of silver perch have also occurred in recent years. The success of hatchery production techniques developed by NSW DPI (formerly NSW Fisheries) has led to large numbers of silver perch fingerlings being produced and sold for stocking. In 2001/02 alone some 1.04 million silver perch were produced by private and government hatcheries in NSW for stocking purposes. Hatchery-bred silver perch are stocked into public impoundments by NSW DPI, and sold by commercial hatcheries to angling clubs, acclimatisation groups and others for stocking into private or public dams.

Silver perch have been released into rivers and creeks through their natural range in the Murray-Darling Basin, although the introduction of a ban on catching silver perch from natural waterways has now reduced the incentive for such stockings. They continue to be widely stocked into farm dams and impoundments throughout the Basin. For example, major stockings have been made in recent years in Copeton, Burrinjuck, Wyangala, Split Rock, Keepit, Pindari, Chaffey, Burrendong and Windamere dams (NSW DPI stocking database).

Silver perch have also been stocked into various catchments, impoundments and private dams along the east coast of NSW (i.e. outside their natural range), including the Hunter, Hawkesbury and Nepean river catchments (Harris & Battaglene 1990).

Apart from the fact that it has apparently done little to improve the status of silver perch in the wild, stocking potentially poses some serious conservation issues. Hatchery-reared silver perch may be genetically unsuitable, and their release can harm the genetic integrity of wild populations and result in reduced adaptive potential (Ryman 1981; see also 'Genetic issues', below).

Section 216(1) of the *Fisheries Management Act 1994* prohibits the stocking of fish, or the eggs or fry of fish, into any waters without the consent of the Minister. Consequently all stockings of fish into NSW waters require a permit from the NSW DPI. Stocking of silver perch into specified impoundments within their natural range and the Hunter catchment will generally be permitted in line with the NSW Freshwater Fish Stocking Fishery Management Strategy (NSW DPI 2005). However, proposals to stock the species into rivers within their natural range should not be approved unless the stockings form part of a NSW DPI approved conservation-stocking program. The NSW DPI also requires licensees of fish hatcheries, as a condition on their fish farm permit, to advise clients of NSW DPI policies on fish stockings prior to filling any order, although the extent of compliance is unknown.

CONSERVATION-STOCKING

To date there has been no specific conservation-stocking program for silver perch in NSW. Stocking for recreational fisheries enhancement may have improved the distribution and abundance of silver perch in some areas, however the success of these programs has been patchy (Rowland 1995b). In most cases stocking appears to have had little success in establishing self-sustaining populations, possibly owing to a lack of suitable conditions for natural reproduction of stocked fish or lack of adaptation of hatchery-reared fish to the wild.

Given the continued decline of silver perch, a conservation-stocking program may be required at some point in the future to enhance natural reproduction, restore populations in areas with suitable habitat where the species has declined due to other causes, or re-establish populations in areas where degraded habitats have been rehabilitated (Clunie & Koehn 2001a).

GENETIC ISSUES

Poorly planned breeding and stocking programs have the potential for significant impacts on species such as silver perch that are declining in the wild (Keenan 1995, Keenan et al. 1995). Genetic variation is the raw material for evolution, and thus conserving the genetic diversity of threatened species is critical to their long-term viability. The release of fish with reduced genetic variation or a different genetic composition may harm wild populations and reduce adaptive potential (Ryman 1981).

Hatchery-bred silver perch could come into contact with wild populations in a number of ways; through stocking into rivers which contain remnant wild populations, stocking into impoundments or private dams and subsequent escape into natural waterways (e.g. during floods), or escape of fish from aquaculture facilities. While little (if any) stocking now occurs in natural waterways, and steps have been taken to minimise the risks of escapes from aquaculture facilities, there is still potential for fish stocked into impoundments and farm dams within the Murray-Darling Basin to interact with wild populations.

Potential problems with hatchery-reared fish include:

- **Reduced genetic diversity**. Use of too few broodstock can lead to reduced genetic variation, as well as other problems associated with inbreeding such as poor quality fish and increased frequency of abnormalities. Most hatcheries use the minimum number of broodfish to achieve production targets (usually less than 20), and often these broodfish include siblings from a single hatchery-reared generation (Keenan 1995).
- **Inappropriate genetic composition**. While more work is needed on the genetics of silver perch, there may be some genetic differences between populations from different parts of the Murray-Darling Basin. For example, the NSW DPI Grafton hatchery maintains broodstock of 3 strains; a Murray River strain; a Cataract Dam strain (translocated from the upper Murrumbidgee in the early 20th century) and a domesticated strain originally from the Murrumbidgee River. Although progeny of these strains (including the two 'wild' strains) are available to aquaculturists in NSW, many aquaculturists obtain broodstock from other sources, including populations of unknown origin in farm dams, impoundments or other hatcheries. Aquaculturists cannot source broodstock from local wild populations (as would normally be required where native fish are to be stocked within their natural range) because of the current ban on taking broodstock silver perch from rivers and streams. There is thus little way of ensuring that fish produced for stocking are of an appropriate genetic composition for the area to be stocked.
- **Hybrids**. Interest in developing improved aquaculture strains has led some aquaculturists to produce hybrids by crossing silver perch with two closely related species found naturally in adjacent drainages; the Barcoo grunter (*Scortum barcoo*) and Welch's grunter (*Bidyanus welchi*). The resulting hybrids apparently display the increased vigour typical of many hybrids, but their sterility (or otherwise) has not been confirmed. If these hybrids – or the parent species – were to escape or be stocked into the wild, they could potentially have catastrophic impacts on wild silver perch populations.

The following steps can be taken to maximise genetic variation and maintain natural population structure in conservation and stock enhancement programs:

- Use sufficient numbers of broodfish;
- Breed strains which are local to the area to be stocked; and
- Replace broodfish on a regular basis.

However, such measures tend to be incompatible with the goals of breeding programs for aquaculture, which aim to select for beneficial traits such as higher growth rates and disease resistance, leading to the development of domesticated strains with altered genetic composition. Given these incompatible aims, the fact that silver perch from the one facility are often used for both aquaculture and stocking is of concern.

These problems are exacerbated by the fact that many aquaculturists lack an understanding of the importance of genetic issues and keep poor records. For example, of 46 hatcheries in the Murray-Darling Basin surveyed by Bearlin and Tikel (2003), only one non-government hatchery PIT-tagged their silver perch broodstock and maintained pedigree records.

To address these and other issues (such as diseases), the NSW DPI developed the Hatchery Quality Assurance Program (HQAP) for Murray cod, golden perch and silver perch to provide a framework for best practice and accreditation of native fish hatcheries (Rowland & Tully 2004). NSW DPI is also developing a Broodstock Collection and Management Policy for native finfish in

NSW to place renewed focus on the management of broodstock resources in NSW and to outline the changes required to address resource sustainability issues arising from broodstock collection (NSW DPI in press).

4. Recovery actions to date

4.1 MDBC resource document and recovery plan

In 1996, the Freshwater Ecology Section of the Department of Natural Resources and Environment, Victoria (NRE) received funding from the Murray-Darling Basin Commission (MDBC) and NRE to prepare a recovery plan for silver perch. As a first step, a 'resource document' was prepared which collated available biological information on silver perch and reviewed existing and potential threats to the species (Clunie & Koehn 2001a). The recovery plan (Clunie & Koehn 2001b) was developed with the assistance of an inter-state recovery team. It set out recovery objectives, performance criteria, and 54 recovery actions, many with a research focus. Both reports were finalised and submitted to the MDBC in 2001, but have not been published and there are no specific plans for an implementation program (L. Lloyd pers. comm.).

Many of the recommendations of this 'national' recovery plan have been incorporated into this NSW recovery plan.

4.2 Habitat protection and restoration

There are a range of on-going government programs and initiatives aimed at protecting and/or restoring river habitats, which in turn assist in reducing the various threats to silver perch. Examples include the Water Reform Program, Aquatic Habitat Rehabilitation Program, the Murray-Darling Basin Native Fish Strategy, Landcare and Rivercare programs, the Carp Assessment and Reduction Program and the NSW Salinity Strategy. In addition, Catchment Management Authorities (CMAs) have general functions of carrying out or funding catchment activities in accordance with the *Catchment Management Authorities Act 2003*. This includes preparing catchment action plans that promote Statewide natural resource targets set by the Natural Resources Commission, including biodiversity targets that address threatened species.

4.3 Fisheries management

Silver perch have been totally protected in NSW rivers and streams since 1998. Fisheries officers regularly patrol inland areas to ensure compliance with protective provisions for all threatened species including silver perch.

4.4 Survey and monitoring

There have been no dedicated surveys for silver perch in NSW, although a range of research programs undertaken by the NSW DPI and other organisations have provided valuable incidental data on the presence or absence of silver perch. The Murray-Darling Basin Commission Sustainable Rivers Audit has been developed to benchmark river health across the Murray-Darling Basin and will include systematic, repeated survey of fish communities across the Basin until 2010.

4.5 Community education

NSW DPI has produced information brochures ('Primefacts') summarising available information on the biology, distribution and threats to silver perch.

5. Recovery objectives and performance criteria

5.1 Recovery plan objectives

The overall objective of this recovery plan is to prevent the extinction and ensure the recovery of silver perch populations in NSW.

The specific objectives of the recovery plan are to:

- Increase awareness of the current status of silver perch throughout its range.
- Increase scientific knowledge of the current distribution, ecological and habitat requirements and population genetics of silver perch.
- Protect and enhance remaining natural populations of silver perch.
- Ameliorate the impacts of known major threats to silver perch.
- Minimise any fishing impacts on natural populations through enhanced compliance with fishing regulations and involvement of recreational fishers.
- Improve management of aquaculture and stocking programs.
- Encourage and support the involvement of indigenous communities in the implementation of recovery actions.
- Establish a program to monitor the status of silver perch and evaluate the effectiveness of recovery actions.

5.2 Performance criteria

The success of the plan will be measured against the criterion that:

- Silver perch are delisted from Schedule 5 of the *Fisheries Management Act 1994* within 15 years.

Criteria for evaluating the effectiveness of individual components of the recovery plan are outlined under each recovery action.

6. Recovery actions

The support and involvement of the community will play a crucial role in the success of the recovery plan, and actions to promote community awareness and involvement are included in several different sections (e.g. research, fishing, aquaculture).

6.1 Research and information needs

6.1.1 Collate existing information and conduct targeted sampling to identify the current distribution and abundance of silver perch, including the location of significant natural populations	
1) Compile existing records of silver perch (both scientific and anecdotal) and map the species' current known distribution in NSW. 2) Continue to collect and collate data on silver perch using fishways such as that at Torrumbarry Weir. 3) Continue to collate data on the presence / absence of silver perch collected during incidental and formal surveys including the Sustainable Rivers Audit. 4) Develop a sampling protocol and conduct targeted sampling to identify the location of remaining natural populations of silver perch ensuring that genetic samples (fin clips) are collected from any captured silver perch to support Action 6.1.3. 5) Conduct research to determine the status of identified remnant populations.	
Responsibility:	*NSW DPI [1-5], Australian Museum [1, 3]*
Partners:	*CMAs, universities, MDBC*
Performance criteria	*All existing records entered in the NSW DPI fisheries ecosystems database, and new records added on an ongoing basis.* *Targeted sampling conducted in accordance with agreed sampling protocol.* *Genetic samples (fin clips) collected from all populations surveyed.* *Sites supporting remnant populations identified and status of these populations quantified.*
Timeframes:	*Year 1, ongoing*

6.1.2 Encourage community reporting of silver perch through the Threatened, Protected and Pest Species Sighting Program	
1) Ensure that the Threatened, Protected and Pest Species Sighting Program is widely promoted throughout the NSW section of the Murray-Darling Basin, and encourage reporting of any sightings or accidental captures of silver perch in rivers. 2) Incorporate any information obtained from the public into the species database, available via the web, and use it to assist in mapping the current distribution of silver perch (Action 6.1.1).	
Responsibility:	*NSW DPI [1-2]*
Performance criteria:	*Sighting Program materials distributed throughout the NSW section of the Murray-Darling Basin and contact number provided on all silver perch advisory materials.* *Records obtained through this program added to the NSW DPI fisheries ecosystems database.*
Timeframes:	*Year 1, ongoing*

6.1.3 Conduct genetic research to establish the genetic variability within wild and stocked populations of silver perch in NSW and the origin of extant river populations	
1) In collaboration with a university or other research institution, initiate a project to determine population genetic variation of silver perch in NSW. 2) If possible, establish the origin (wild vs stocked) of identified remnant populations in rivers.	
Responsibility:	*NSW DPI* [1-2]
Partners:	*Universities*
Performance criteria:	*Project to determine population genetic variation of silver perch in NSW initiated in collaboration with a university.*
Timeframes:	*Year 4*

6.1.4 Support research into the habitat requirements and ecology of silver perch and key threats to wild populations	
1) In collaboration with a university or other research institution, initiate a project (or projects) to investigate key areas of the biology and ecology of silver perch to provide information critical to the recovery program (e.g. migration, habitat requirements, factors critical to successful spawning and recruitment, interactions with introduced species, and environmental tolerances). This may include encouraging university students (honours or postgraduate) to undertake relevant projects. 2) Ensure priority is given to research in areas where relatively large, natural populations currently exist, to enable identification of key features of these environments (e.g. key components of flow regimes) and the species' habitat requirements, including use of floodplain habitats.	
Responsibility:	*NSW DPI* [1-2]
Partners:	*Universities, MDBC, Fisheries Scientific Committee*
Performance criteria:	*Key research needs identified.* *Honours or postgraduate research project on an identified key area of the biology or ecology of silver perch commenced.*
Timeframes:	*Year 2, ongoing*

6.2 Habitat protection and restoration

NB: Some of these issues will also be addressed through the development and implementation of Threat Abatement Plans for 'Installation and operation of instream structures and other mechanisms that alter natural flow regimes' and 'Degradation of native riparian vegetation along NSW water courses'.

6.2.1 Actively promote actions to ameliorate the impacts of altered river flows on silver perch, giving priority to areas in the vicinity of remnant natural populations	
1) In consultation with aquatic ecologists, develop guidelines and principles to help determine the ecological needs of silver perch and flow levels required to complete their lifecycle, and distribute this information to water management committees and other relevant agencies. 2) Continue to advocate (e.g. through environmental flows reference groups) increased allocation and improved management of environmental flows, particularly in areas known to support remnant natural populations and at critical phases of the life cycle, and reduced diversion volumes during the spawning and larval period.	
Responsibility:	*NSW DPI [1-2], DNR [1-2]*
Partners:	*CMAs, water management committees, water utilities, MDBC*
Performance criteria:	*Guidelines for government agencies and natural resource management committees prepared (based on best available knowledge) and distributed.* *Ongoing participation in water management committees and promotion of improved flow management to meet ecological needs of silver perch and other threatened species.*
Timeframes:	*Year 2, ongoing*

6.2.2 Continue to work on improving fish passage in the Murray-Darling Basin, encouraging priority to be given to areas that support remnant silver perch populations.	
1) Continue to work on restoring fish passage in the Murray-Darling Basin, for example through the Weir Review Program, Aquatic Habitat Rehabilitation Program and MDBC 'Lake Hume to the Sea' project. 2) Identify the most significant barriers to migration of silver perch on a Statewide basis and seek funding for capital works to provide fish passage at these sites. 3) Work with councils and relevant government agencies to mitigate the effects of other barriers to fish passage (e.g. roads and culverts).	
Responsibility:	*NSW DPI [1-3], DNR [1-3], local councils [1-3]*
Partners:	*MDBC, CMAs*
Performance criteria:	*5 most significant barriers for remnant silver perch populations (Statewide) identified.* *Funding sought for capital works to remove these barriers or restore fish passage at these sites.* *Other barriers to fish passage identified in areas known to support remnant silver perch populations, and negotiations held with relevant councils and/or agencies.*
Timeframes:	*Ongoing*

6.2.3 Promote further investigation and action to address the impacts of cold water pollution	
1) Encourage the development of a strategy for the Murray-Darling Basin to address the need for variable level off-takes or alternative options for large dams where thermal pollution is a problem, including a priority list. 2) Encourage the development of a dedicated NSW Cold Water Pollution Reduction Program, including a program of works and funding options, for whole-of-government endorsement and action. 3) Investigate the contribution of smaller impoundments (e.g. weir pools) to reductions in river temperatures, and low-cost options for their management.	
Responsibility:	*NSW DPI [1-3], DNR [1-3]*
Partners:	*State Water, MDBC*
Performance criteria:	*Murray-Darling Basin cold water pollution strategy developed.* *Proposal for a Cold Water Pollution Reduction Program developed and submitted for whole-of-government endorsement.* *Research on the impacts of lower-level impoundments on water temperatures undertaken.*
Timeframes:	*Year 5, ongoing*

6.2.4 Ensure that management authorities carry out appropriate planning and impact assessment and make management decisions which minimise impacts on silver perch habitats	
1) Ensure that councils, government agencies and other relevant organisations are aware of the location of important areas for silver perch, for example by providing maps of known and potential habitat and the location of significant populations. 2) Provide other relevant information to support appropriate planning and impact assessment, e.g. Environmental Impact Assessment Guidelines. 3) Negotiate with local councils and industry groups regarding the type and scale of development near key areas known to support significant remnant populations of silver perch. 4) Negotiate with relevant authorities to encourage the identification, assessment and modification of natural resource management plans and policies to minimise impacts on stream flows, connectivity of habitats, riparian vegetation and water quality.	
Responsibility:	*NSW DPI [1-4], local councils [1-4], DNR [1-4]*
Partners:	*CMAs*
Performance criteria:	*Information on the location of important silver perch populations and potential environmental impacts provided to councils, government agencies and other relevant organisations.* *Consultation with councils undertaken regarding local environmental plans, development control plans and future urban development plans.* *Relevant land, water and other natural resource plans and policies identified, assessed and where appropriate, modified.*
Timeframes:	*Year 3, ongoing*

6.2.5 Encourage protection and rehabilitation of river reaches known to support important silver perch populations	
1) Encourage community groups, relevant natural resource management agencies, local councils and landholders to protect and rehabilitate riparian vegetation and instream habitats along key river stretches where remnant silver perch populations are known to occur.	
Responsibility:	*NSW DPI [1], DNR [1], CMAs[1], local councils [1]*
Partners:	*Landcare, Rivercare*
Performance criteria:	*Silver perch distribution considered in decision systems informing the allocation of investment and incentives to protect and rehabilitate native vegetation.*
Timeframes:	*Year 1, ongoing*

6.3 Introduced species and diseases

6.3.1 Feed information on the location of silver perch populations into State and national pest management programs	
1) Ensure the location of silver perch populations are considered during the development and implementation of pest eradication and control programs.	
Responsibility:	*NSW DPI [1]*
Partners:	*MDBC*
Performance criteria:	*Information on the location of significant natural populations of silver perch used in prioritising pest control programs.*
Timeframes:	*Ongoing*

6.3.2 Investigate the potential impacts of diseases on wild silver perch populations	
1) In collaboration with a university or other research institution, initiate a project to investigate the occurrence of EHNV and other disease agents in wild populations of silver perch, and assess their potential impacts.	
Responsibility:	*NSW DPI [1]*
Partners:	*Universities*
Performance criteria:	*Research project on the impacts of EHNV undertaken.*
Timeframes:	*Year 7*

6.3.3 Improve disease management protocols for aquaculture facilities to prevent transfer of disease agents to wild populations	
1) Implement the Hatchery Quality Assurance Program to ensure that silver perch hatcheries and aquaculture facilities employ best practice health management programs to minimise the risk of diseased fish being sold, transferred or stocked into the wild.	
Responsibility:	*NSW DPI [1]*
Performance criteria:	*Hatchery Quality Assurance Program developed and implemented.*
Partners:	*Aquaculture industry*
Timeframes:	*Ongoing*

6.4 Fishing

6.4.1 Develop an education program for recreational fishers to improve awareness of the status of silver perch and increase compliance with fishing regulations	
1) Produce information and materials for use by Fishcare volunteers. 2) Produce and distribute information brochures (Fishnotes) and other advisory materials to angling groups and other stakeholders, and make them available in NSW DPI offices and at appropriate functions (e.g. expos, public meetings). 3) Improve recreational fishers' compliance with fishing regulations in priority silver perch areas.	
Responsibility:	*NSW DPI [1-3]*
Partners:	*ACoRF*
Performance criteria:	*Information / materials for Fishcare volunteers (both existing and those in training) produced.* *Advisory materials (e.g. Primefacts) produced and widely distributed.* *Targeted law enforcement and educational actions in areas containing wild silver perch populations.*
Timeframes:	*Year 2, ongoing*

6.4.2 Improve understanding about the traditional and cultural importance of silver perch to indigenous communities	
1) Continue to implement the NSW Indigenous Fisheries Strategy. 2) Encourage and support the involvement of indigenous communities in implementing silver perch recovery actions.	
Responsibility:	*NSW DPI [1-2]*
Partners:	*NSW DPI Aboriginal Reference Group, CMAs*
Performance criteria:	*NSW Indigenous Fisheries Strategy progressively implemented.* *Indigenous communities involved in recovery plan implementation.*
Timeframes:	*Ongoing*

6.4.3 Review and if necessary, amend the fishing regulations to reduce fishing impacts on silver perch	
1) Review the available evidence on impacts of fishing on silver perch and the current fishing regulations to determine the need for any changes, e.g. a seasonal closure to protect spawning populations and/or restrictions on certain gear types.	
Responsibility:	*NSW DPI [1]*
Performance criteria:	*Fishing regulations reviewed and where necessary, amended to reduce fishing impacts on silver perch*
Timeframes:	*Year 3*

6.5 Aquaculture and stocking

6.5.1 Improve the management of silver perch hatcheries and grow-out facilities to minimise the risk of genetic impacts on wild populations	
1) Improve management of genetic stocks through the Hatchery Quality Assurance Program to ensure use of appropriate broodstock and tracking of sale of different genetic stocks. 2) Implement appropriate controls on silver perch farms at the development application stage to minimise the risk of fish escaping into the wild. 3) Develop and implement approvals processes for silver perch hatcheries that recognise different requirements and standards for production for aquaculture as opposed to stocking into the environment.	
Responsibility:	*NSW DPI [1-3]*
Partners:	*Aquaculture industry*
Performance criteria:	*Hatchery Quality Assurance Program developed and implemented.*
Timeframes:	*Ongoing*

6.5.2 Develop an education program targeting silver perch hatcheries to increase awareness of the threatened status of silver perch in the wild and encourage compliance with regulations and guidelines.	
1) Develop appropriate advisory materials (e.g. Primefacts) 2) Incorporate information on the threatened status of silver perch, and the steps that should be taken to reduce impacts on wild populations, in aquaculture advisory programs.	
Responsibility:	*NSW DPI [1-2]*
Performance criteria:	*Advisory materials produced and distributed to all silver perch aquaculturists.*
Timeframes:	*Year 3*

6.5.3 Implement the NSW Freshwater Fish Stocking Fishery Management Strategy to prevent significant impacts from stocking on wild (riverine) silver perch populations.	
1) Conduct research to determine the cumulative impacts of stocking on wild populations. 2) Review and assess stocking proposals to ensure no significant impacts on wild silver perch populations.	
Responsibility:	*NSW DPI [1-2]*
Performance criteria:	*Research undertaken and results used to guide future stocking programs.* *All stocking proposals (for areas other than specified impoundments) reviewed / assessed.*
Timeframes:	*Year 1, ongoing*

6.5.4 Develop a conservation-stocking program using genetically appropriate broodstock and in compliance with the HQAP, broodstock collection policy, and NSW Freshwater Fish Stocking Fishery Management Strategy.	
1) Review genetics information from Action 6.1.3 to ensure genetically appropriate broodstock are collected to form the basis of a conservation-stocking program. 2) Identify and assess appropriate conservation-stocking sites in accordance with stocking review guidelines in the NSW Freshwater Fish Stocking Fishery Management Strategy and having regard to the habitat requirements of the species and the requirements of this recovery plan.	
Responsibility:	*NSW DPI [1-2]*
Performance criteria:	*Research undertaken and results used to guide future stocking programs.* *All stocking proposals reviewed and assessed in accordance with the NSW Freshwater Fish Stocking Fishery Management Strategy and requirements of the silver perch NSW recovery plan.*
Timeframes:	*Year 1, ongoing*

6.6 Evaluation

6.6.1 Establish ongoing monitoring of the status of silver perch and the effectiveness of recovery actions	
1) Use the Sustainable Rivers Audit as a long term monitoring program to assess the ongoing status of silver perch in the Murray-Darling Basin. 2) Complement Sustainable Rivers Audit monitoring with targeted monitoring and survey of the status of remnant wild populations and re-established populations resulting from conservation-stocking programs.	
Responsibility:	*NSW DPI [1-2]*
Partners:	*CMAs, universities and research institutions, MDBC*
Performance criteria:	*Long term monitoring program designed and implemented.* *Results used to assess effectiveness of recovery plan actions.*
Timeframes:	*Years 3, 6, 9*

Acronyms:
NSW DPI – Department of Primary Industries
DNR – Department of Natural Resources
CMAs – Catchment Management Authorities
MDBC – Murray-Darling Basin Commission
ACoRF – Advisory Council on Recreational Fishing

7. Monitoring, evaluation and review

The performance criteria of de-listing silver perch from Schedule 5 of the *Fisheries Management Act 1994* will be the primary measure used to assess the success of the actions within this plan.

The recovery plan recognises the need for a strategically focused monitoring program to enable the effectiveness of recovery actions to be evaluated.

The recovery plan will be audited and reviewed every three years. The audit will determine whether the implementation of recovery actions has occurred and the review will determine the success of the actions in recovering silver perch to a position of viability in nature.

The recovery plan will be subject to major statutory review within ten (10) years from the date of publication.

8. Social, economic and cultural issues

Potential social and economic impacts have been considered during the development of this recovery plan, and the objectives and actions have been formulated with the aim of minimising any potential adverse impacts.

The main social and economic effects are likely to result from management of fishing, aquaculture, water flows and development proposals in general. Overall, however, the effects of the recovery plan are expected to be positive. Continued liaison with anglers, aquaculturists, landholders, local councils and the community will help to minimise any social effects arising from the conservation of silver perch.

8.1 Fishing

Silver perch were previously an important freshwater recreational fishing species in NSW. However there is evidence that they are not targeted as widely as they once were, possibly because of the decline in their distribution and abundance. Currently there is a total ban on taking silver perch from rivers, although they can be kept if caught from specified stocked impoundments. It is unclear whether this dual system has led to confusion among anglers about the legality of catching silver perch.

Although a total ban on catching silver perch would be more easily enforced and arguably of greater benefit to the recovery of the species, the impacts of such a ban on recreational fishers and regional communities have been taken into account in developing this recovery plan. The recovery plan allows for continued fishing for silver perch in impoundments, with increased efforts to improve awareness of the species' status and compliance with fishing regulations. The plan also proposes a review of the current fishing regulations and impacts on silver perch in consultation with recreational fishers. However, even if this review were to lead to future changes to recreational fishing rules (e.g. through a seasonal closure or restrictions on gear types), this would have limited impact compared to the alternative of a total ban.

Recovery actions under this plan will also help to reduce confusion among the recreational fishing community by increasing awareness of the existing fishing regulations. In addition, interested anglers will have the opportunity to become involved in some aspects of the recovery program, for example by becoming trained Fishcare Volunteers.

In the long term, if the recovery program for silver perch is successful there is the potential for possible future legalisation of catch-and-release fishing or controlled harvest fishing for silver perch in inland rivers, which could contribute to the growth of fishing-based tourism and greater economic and social benefits for regional communities.

8.2 Aquaculture

Silver perch are now an important aquaculture species in NSW and the basis of an expanding industry. Silver perch aquaculture is currently managed through the aquaculture permit system, in line with the Department of Primary Industries Silver Perch Policy, although the development of Regional Sustainable Aquaculture Strategies will provide a new, streamlined process for new proposals.

This recovery plan supports the implementation of the HQAP and proposes some steps to improve the management of silver perch hatcheries and grow-out facilities, particularly to minimise the risk of fish escaping into the wild and ensure the genetic suitability of fish bred for stocking into impoundments and farm dams. These actions may result in higher standards for new proposals and/or increased restrictions or compliance pressures on existing facilities. All efforts will be made to ensure that such steps do not have a significant impact on the silver perch aquaculture industry.

Because of the threatened status of silver perch in the wild, it is currently prohibited to take broodfish from rivers and creeks, except by the NSW DPI for research and conservation purposes. Replacement of broodstock is a critical issue for the aquaculture industry, as spawning success declines with repeated hormone inducement treatment, and for maintenance of genetic diversity. The expansion and long-term viability of the silver perch aquaculture industry could well depend upon the ability to procure

additional wild broodstock to prevent inbreeding and enhance the selection of desirable traits (such as disease tolerance, faster growth rates, superior food conversion ratios etc). Thus the long-term objectives of the recovery program should be supported by the aquaculture industry.

8.3 Environmental flows

The effects of river regulation – including changes to river flows and flood patterns, water extraction, barriers to migration and cold-water pollution – are among the key threats to wild silver perch populations. There is a need for the recovery program to work within broader natural resource management programs in NSW to ameliorate the impacts of these changes. In this recovery plan, responsibility has been allocated to all agencies involved in the water reform process, as well as CMAs and public utilities to address these issues.

In NSW, flow management rules (including bulk access regimes and environmental flows) are established through water sharing plans developed under the *Water Management Act 2000*. Water sharing plans have already been gazetted for all major inland regulated rivers in the NSW section of the Murray-Darling Basin, and implementation programs have been developed. The NSW DPI has been involved in this process and has helped to influence allocations of environmental water under bulk access regimes. In some areas (e.g. the Gwydir and Macquarie) the NSW DPI is now participating in discussions to determine the most appropriate delivery of these flows, with a view to supporting the recovery of a range of threatened aquatic species including silver perch.

The development of water sharing plans is designed, among other aims, to provide greater security to water users by defining access rights to water. Each water sharing plan establishes a bulk access regime (BAR) for the extraction of water under access licences. If the BAR is adjusted during the 10-year tenure of the plan, the state government may be liable to pay compensation unless provisions for adjustment are incorporated in the plan.

The decision-making process for the establishment of water sharing plans includes a requirement to undertake a socio-economic assessment of the impact of the plan. In most cases, flow modelling and water use information is limited. The assessments are generally qualitative, using demographic and economic information to indicate the possible impacts on each region's extractive and non-extractive use of water and their trade-offs.

Thus, while the needs of threatened species such as silver perch must be considered in this process, these needs are weighed against other social and economic factors. Since water sharing plans have already been gazetted for all major NSW inland regulated rivers, the impact of this recovery plan may be limited to influencing the delivery of environmental water allocations or the review of plans in the longer term.

8.4 Development

Under the *Environmental Planning and Assessment Act 1979* (section 1.1.2), the potential impacts of a development on any threatened species must be considered by the authorities responsible for its approval. If a major impact is likely, the developer must prepare a species impact statement as part of their proposal. The Director-General of the NSW DPI must also approve any decision about this type of development by a consent authority.

These protective laws may be seen as an economic burden by developers who may be required to contract consultants to prepare a species impact statement as well as bear the costs involved in the delay, conditional approval or rejection of a proposal. The legislation may also represent a burden to consent or determining authorities, if they lack the appropriate expertise and information needed to assess development proposals.

However, these legal requirements arise from the vulnerable status of silver perch under the *Fisheries Management Act 1994*, and are not a consequence of the recovery plan. The recovery plan will help to ease some of the economic effects by distributing relevant information to those involved in the assessment of impacts, particularly to consent and determining authorities.

8.5 Indigenous communities

Fishing has been an integral part of the cultural and economic life of Aboriginal communities since they have been in this land. Fishing has been an important source of food, a basis for trade and an important part of cultural and ceremonial life.

A process to assess the cultural significance of silver perch to local Aboriginal people has started in consultation with Local Area Land Councils and Elders Groups. It will also consider the effects of the recovery program and the level of community interest in participating in recovery activities.

NSW DPI has developed an Indigenous Fisheries Strategy and implementation plan. A primary goal of the strategy is to 'encourage and support the involvement of indigenous communities in the management of the State's fisheries resources' and a key implementation approach is to "acknowledge and address indigenous issues in preparing every fishery management strategy', which includes this recovery plan.

Local Aboriginal groups will be encouraged to take part in activities that are part of the recovery plan. Any proposal that could affect places of cultural importance will need to be discussed in direct consultation with local groups.

9. Implementation and costs

The NSW DPI has a statutory responsibility to prepare and lead the implementation of this recovery plan. However, the success of the plan in recovering southern pygmy perch, purple spotted gudgeon, Murray hardyhead and olive perchlet to a position of viability in nature will depend on the involvement of other agencies, organisations and individuals who have a role in activities that affect the species. Public authorities must take any appropriate action available to them to implement the measures for which they have an identified responsibility in a recovery plan. Similarly, consent and determining authorities must consider relevant recovery plans when exercising decision-making functions under Part 4 & 5 of the *Environmental Planning and Assessment Act 1979*. Such authorities, when considering an activity that may impact on silver perch or its habitat, must consider the provisions of this plan.

The main implementation costs relate to research, community liaison and education, habitat restoration and monitoring. Many of these costs will be met by relevant State government agencies or funded through external grant programs such as the Natural Heritage Trust. Community groups that take part in surveying, monitoring or habitat restoration may also be funded by grants to complement their in-kind contribution.

Wherever possible, recovery activities for southern pygmy perch, purple spotted gudgeon, Murray hardyhead and olive perchlet will be linked to existing government, CMAs or community programs to prevent duplication. Recovery activities may be linked with the MDBC Native Fish Strategy, and Catchment Action Plans prepared by CMAs. Catchment Action Plans will promote Statewide resource condition targets set by the NSW Natural Resources Commission.

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PERSONAL COMMUNICATIONS

1. Lance Lloyd, Murray-Darling Basin Commission, 2003
2. Dr Stuart Rowland, NSW Fisheries, 2003
3. Lee Baumgartner, NSW Fisheries, 2003

Appendices

Appendix 1 Required contents of a recovery plan

Extract from NSW *Fisheries Management Act 1994*, Part 7A

220ZN Contents of recovery or threat abatement plans

(1) Recovery plans

A recovery plan must:

a) identify the threatened species, population or ecological community to which it applies, and

b) identify any critical habitat declared in relation to the threatened species, population or ecological community, and

c) identify any threatening process or processes threatening the threatened species, population or ecological community, and

d) identify methods by which adverse social and economic consequences of the making of the plan can be minimised, and

e) state what must be done to ensure the recovery of the threatened species, population or ecological community, and

f) state what must be done to protect the critical habitat (if any) identified in the plan, and

g) state, with reference to the objects of this Part:

   (i) the way in which those objects are to be implemented or promoted for the benefit of the threatened species, population or ecological community, and

   (ii) the method by which progress towards achieving those objects is to be assessed, and

h) identify the persons or public authorities who are responsible for the implementation of the measures included in the plan, and

i) state the date by which the recovery plan should be subject to review by the Director.

Appendix 2: Some recent records of silver perch from surveys in the Murray-Darling Basin

(Shaded entries indicate no silver perch recorded)

River / Catchment	Site / Sampling	Year	No. Fish Caught		Comments	Reference
			Total	Silver perch		
Dumaresq	Near Mingoola	1997		2		DB Moffatt, unpubl. data from MDBC project R6065
	At "Koarlo" near Boggabilla	1997 1998		1 1		DB Moffatt, unpubl. data from MDBC project R6065
Paroo	Mullawooka Basin	1992-1995	8,217	1	Lake habitat	Gehrke et al. 1995, Gehrke et al. 1999
	Near Caroona	2001		1		NSWF 'Fishfiles' [4]
Macintyre	Above and below Goondiwindi Weir	1990-1991	1,562	2	Both below weir	Thorncraft & Harris 1996
	Near Yetman	1999		1		NSWF 'Fishfiles' [1]
Severn	Near Ashford	1999		2		NSWF 'Fishfiles' [3]
Barwon	Near Collarenebri	1997		1		DB Moffatt, unpubl. data from MDBC project R6065
Gwydir	Near Bingara	1994-1995		3		NSWF 'Fishfiles' [1]
Namoi	Near Boggabri	1996		2		NSWF 'Fishfiles' [1]
	Near Manilla	2001 2002	3,715	1 2		L. Baumgartner pers. comm. 2003
Mooki	Tributary of Namoi, near Caroona	2001				NSWF 'Fishfiles' [4]
Barwon	Near Mungindi and near Collarenebri	1999-2001		3	1 nr Mungindi 1999, 2001; 1 nr Collarenebri 2001	NSWF 'Fishfiles' [2]
	Near Mungindi	2002		1		NSWF 'Fishfiles' [6]
	Above and below Brewarrina Weir	1991	955	0		Mallen-Cooper & Thorncraft 1992
Bell	Weir near the junction with the Macquarie River	1990-1991	66	0		Thorncraft & Harris 1996
Darling	Near Tilpa Near Bourke	2002		1 1		NSWF 'Fishfiles' [5]
	East Toorale, downstream of Bourke	1994, 1998		3		NSWF 'Fishfiles' [1]
	Above and below Bourke Weir	1991	9,178	7	All below weir	Harris et al. 1992
	Above and below Main Weir at Menindee Lakes	1990	2819	0		Mallen-Cooper & Edwards 1990
Lachlan	Near Boorowa Near Forbes	1996 1998		2 1		NSWF 'Fishfiles' [1]
Murrumbidgee	Beavers Creek floodplain	1992-1995	226	1		Gehrke et al. 1995, Gehrke et al. 1999
	17 sites between Burrunjuck and Yanco Weir (surveys for trout cod 1998-2000)	1998-2000	1,413	3	1 at Narrandera, 2 near Wagga	I. Wooden pers. comm. 2003
	Near Balranald	1998		1		NSWF 'Fishfiles' [1]
	Balranald Weir	2000-2002 2003	11,960 7,948	45 44	17 below, 28 above weir Migrating through fishway	L. Baumgartner pers. comm. 2003
	Yanco Creek (tributary near Narrandera)	2001	1,303	1		L. Baumgartner pers. comm. 2003
	Near Bookham	2002		1		NSWF 'Fishfiles' [6]
Wakool	Near Kyalite	1995		1	Observed	NSWF 'Fishfiles' [1]
Murray	Near Millewa	1992-1995	411	1	In river channel	Gehrke et al. 1995, Gehrke et al. 1999

River / Catchment	Site / Sampling	Year	No. Fish Caught		Comments	Reference
			Total	Silver perch		
Murray (cont.)	Above and below Euston fishway	1990-1991	8,990	20	19 above, 1 below fishway	Mallen-Cooper & Brand 1992
	Near Robinvale (Vic)	1998		1		NSWF 'Fishfiles' [1]
	Near Strathmerton	2002		2		NSWF 'Fishfiles' [6]
	Above and below Murtho fishway (SA)	1990-1991	132	7	2 above, 5 below fishway	Mallen-Cooper & Brand 1992
	Yarrawonga Lock	1996-1997	341	73	Fish caught entering fishway	Thorncraft & Harris 1997
	Barham to Yarrawonga (larval drift studies)			1	1 larva, many eggs – mostly upstream of Barmah-Millewa Forest	D. Gilligan pers. comm. 2003

1 Data from NSW Rivers survey, 1994-1999
2 Data from Integrated Monitoring of Environmental Flows project, 1999-2002
3 Data collected by NSW Fisheries for DLWC Border Rivers project, 1999
4 Data collected by NSW Fisheries for DLWC Low Flows project, 2001
5 Data from Fish Habitat Assessment project, 2002
6 Data from Sustainable Rivers Audit, 2002