Tahbilk Lagoon carp management plan

A sub-component of the Tahbilk Native Fish Demonstration Site

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1.0 Objective of the consultancy

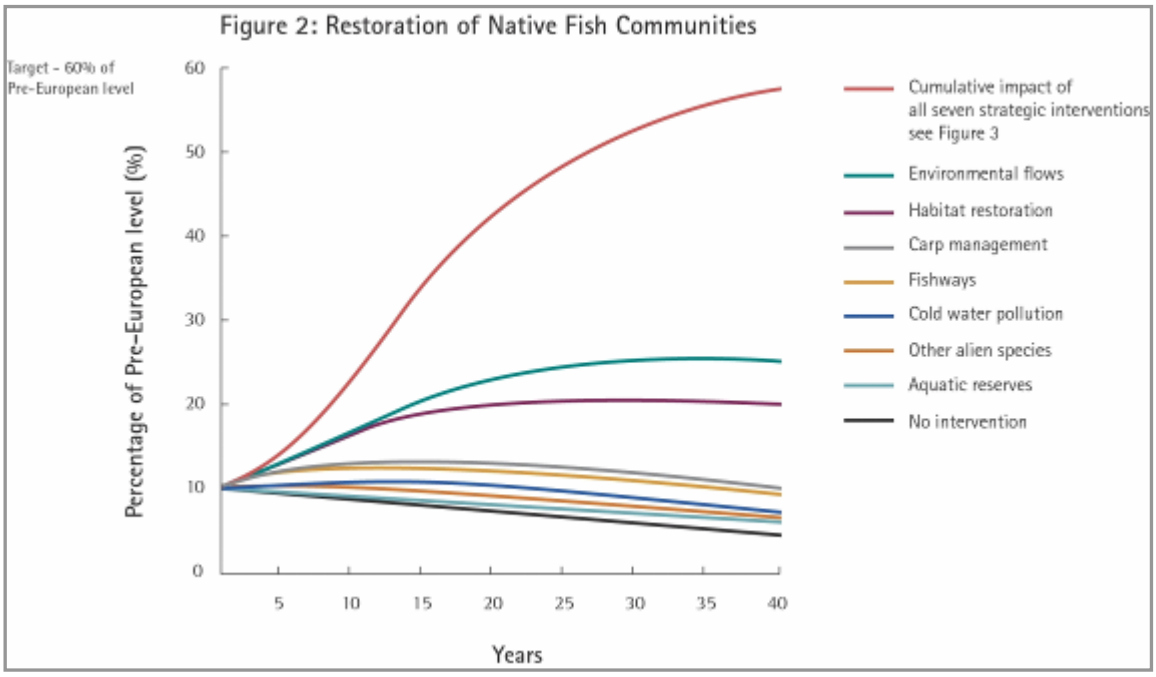
To develop a ready-to-implement, community-based carp management program to test and demonstrate the effectiveness of intensive and integrated application of a range of carp management techniques to address the carp problem at an on-ground, pragmatic level.

2.0 Introduction

The Murray-Darling Basin Commission (MDBC) has supported Victorian Department of Sustainability and Environment to develop and showcase a demonstration site in the Goulburn River catchment. As a sub-component of the demonstration site, the MDBC has supported a project to develop a plan to manage the damage due to carp in the broader context of habitat restoration.

The Native Fish Strategy for the Murray-Darling Basin recognises that recovery of native fish populations will require a suite actions undertaken in combination (MDBC 2002) The major factors that have caused the decline in native fish populations in the Basin are discussed in the report *Conceptual model to guide investments for restoring native fish in the Murray-Darling Basin;* Report by the expert panel convened by the Murray-Darling Basin Commission, January 2002 (Figure 2). The key factors that they identified are:

- Allocation of environmental flows;
- Habitat restoration
- Abatement of cold water pollution
- Provision of fishways
- Establishment of aquatic reserves
- Carp management
- Management of other introduced fish species that are threatening native fish communities.



The committee concluded that none of the strategic interventions, if taken singularly, has the capacity to recover native fish communities of Basin from the current level of 10% to beyond 25% of their pre-European level. There is a the potential to increase native fish communities to approximately 60% of their pre-European level if all interventions were undertaken in combination although the time frame would be 50 – 60 years.

2.1.1 The role of pest management in demonstration reaches/sites

With respect to managing the damage due to carp and other alien species, the committee concluded that these need to be addressed on a case-by-case basis as the strategies and options for applying them will change with the location and local constraints. For example, the committee noted that upland areas of the Basin which includes the Tahbilk Lagoon Demonstration site, habitat restoration combined with fishways are considered to be the most cost effective interventions that could be undertaken to reduce the population density and dame due to carp and other alien species.

2.2 The demonstration reach/site concept

To begin, the Tahbilk demonstration *site* does not qualify as a demonstration “reach” and is not one of the three reaches receiving demonstration reach funding in Victoria. Although the Tahbilk site has not been formally assessed or identified as a demonstration reach it does essentially meet those criteria.

The demonstration reach/site aims to showcase the concept through undertaking a range of management interventions to show the cumulative benefits of river rehabilitation on native fish populations. Currently rehabilitation projects are relatively thinly spread across the Basin. The aim of the demonstration site is to bring a suite of these

interventions together at one place to maximise and demonstrate the benefit of multiple actions. Direct community involvement and leadership is essential to the success of the demonstration site approach. The community should be involved in site selection, plan development and with the management interventions. Ideally they should also be involved in show casing and monitoring the effectiveness of the interventions (Barrett 2004; Barrett and Ansell, 2005).

The Goulburn Broken CMA has embraced these principles for the demonstration site in the Goulburn River. The plan for managing carp and other alien species has been developed as part of the broader demonstration site process.

A list of the potential interventions to restore native fish populations in the Tahbilk Lagoon demonstration site is presented in Table 1.

List of potential rehabilitation actions include (in no particular order):

- restoration of flow to the Tahbilk Lagoon
- riparian fencing to keep stock out, with or without limited grazing
- off stream watering for stock
- control of Mexican Lillie
- woody weed control, particularly willows
- bank stabilisation to control erosion hotspots
- in stream habitat complexity rehabilitation including rock/cobble and LWD introduction
- management of alien fish and other pests
- fish passage enhancement such as fishway construction
- fish migration barrier removal at several road crossings
- restriction or removal of non-seasonal stream flows
- negotiated allocation of impoundment water for environmental flow
- reconnection with Goulburn River to re-establish viable native populations
- scientific research to investigate key aspects of native fish ecology, particularly for catfish

3.0 Managing the damage due to alien fish and other pests

3.1 Introduction

Introduced fish and other aquatic organisms are but one of several factors that influence the biotic and a-biotic health of the aquatic systems in the Murray-Darling Basin (MDB). Almost invariably a number of threats need to be addressed in combination through an integrated program in order to improve the health of native fish populations and other aspects of the MDB. This integrated approach to management is the basis of the River Restoration Programs being undertaken by the MDBC in cooperation with state agencies (MDBC, 2003; Barrett and Ansell, 2003).

This guide focuses on the damage and management of introduced, mainly non-native, aquatic animals, primarily fish. However, it is also recognised that other animals including invertebrates such as crustacea used for aquaculture, reptiles such as the red-

eared slider (*Trachemys scripta*) and amphibians such as the cane toad (*Bufo marinus*) have the potential to damage aquatic systems. Thankfully there are no established non-native reptiles or amphibians in the MDB. Some terrestrial animals also can influence aquatic health. For example, feral pigs and domestic stock can damage riparian zones and disturb sediments at the waters edge. Some native aquatic animals also have potential to damage the MDB through their introduction from outside their natural range. They include crustaceans such as red-claw (*Cherax quadricarinatus*) and marron (*Cherax tenuimanus*) and native fish that have been translocated primarily for recreational fishing or for aquaculture. A national policy has been established to guide the translocation of live aquatic organisms (MCFFA, 1999). Of major concern is the impact they could cause through hybridisation with similar species or between sub-populations of the same species and the potential impacts from the establishment of animals into drainages where they did not occur naturally.

What makes an animal a pest? Pests may variously be destructive, noisy, a nuisance, out of place or simply not wanted. An animal is considered to be a pest because it is in conflict with human interests. A more precise definition of a pest is those animals *that cause significant damage to a valued resource* (Olsen, 1998). The pest status of an introduced fish can change with time, between areas or according to the perception of the assessor. Trout are an example. They are viewed by some groups as a pest because of the damage that they cause to native fish (Cadwallader, 1996). To other groups they are a highly valued resource for recreational fishing. In response, State fishery agencies still stock waterways in the MDB with trout and protect them during their breeding season. Under this definition of a pest, native animals such as marron and red-claw that have established outside their natural range due to aquaculture might become a pest in some situations (DRNE, 2002).

A list of introduced fish that are established in the MDB is shown in Table1.

Table 1 Introduced fish that occur in the Murray-Darling Basin

Introduced fish (Scientific and common name)	**Distribution in the MDB**
Carassius auratus Goldfish	Widespread
Cyprinus carpio Common Carp	Widespread
Gambusia holbrooki Eastern Mosquito fish or gambusia	Widespread
Misgurnus anguillicaudatus Oriental weatherloach	Widespread in the ACT, southern NSW and Victoria.
Oreochromis mossambicus Mozambique tilapia	Recorded in West Creek, Toowoomba (Rachel MacKenzie, Qld DPI, pers comm 2000). Believed not to have established.
Oncorhynchus mykiss Rainbow trout	Widespread from southern Qld through NSW and Victoria. Mainly limited by high water temperatures. Annually stocked.
Oncorhynchus tshawytscha Quinnat salmon	Non breeding; maintained by annual stocking
Perca fluviatilis Redfin perch	Widespread
Rutilus rutilus Roach Ac VIC, NSW 1860–80	Very restricted distribution in

	parts of Victoria
Salmo salar Atlantic salmon	Non breeding; maintained by annual stocking
Salmo trutta Brown trout	Widespread from southern Qld through NSW and Victoria. Mainly limited by high water temperatures. Annually stocked.
Salvelinus fontinalis Brook trout	Possibly some isolated self sustaining populations in NSW. Limited annual stocking
Tinca tinca Tench	Mainly southern NSW and Victoria

References: DNRE (2002); MDA and NCPFTF (2004)

3.2 Nature of the threat posed by Alien fish in the Murray-Darling Basin

The success of introduced pest fish in Australia is due to aspects of their biology, habitat changes that provide them with good conditions, combined with few diseases and relatively few predators. Most introduced fish produce large numbers of eggs and can breed several times a year. Hence they can rapidly recover their numbers following drought or control operations. Most pest fish can also withstand a variety of conditions that would be unfavourable to native fish. For example, the weatherloach can breed in running or impounded waters, tolerate a wide range of temperature conditions and withstand low dissolved oxygen waters and even extended exposure out of water (ARIER, 2002).

Similarly, common carp can tolerate poor quality water and withstand salinity levels of at least 30% that of sea water (Koehn et al. 2000). Changes to the MDB that have been detrimental to native fish but which can be tolerated by many introduced fish include the creation of barriers to movement like dams and weirs, reduced natural flows, reduced intensity and frequency of flooding, cold water pollution due to bottom releases from dams, removal of snags and increased salinity and nutrient levels. Unlike many of our now rare native animals, most pests thrive in human disturbed areas.

3.2.1 Extent and severity of the threat including biological impact

Introduced fish can damage the native fish populations, other fauna and their habitat in several ways. Summary reviews on the damage that pest fish are believed to cause to Australian freshwater systems can be found in Arthington, 1989; 1991; Arthington and Mckenzie, 1997; DNRE, 2002; Koehn and Mackenzie, 2004; and Bomford and Glover, 2004, MDBC 2006). Also see reviews by Cadwallader (1996) for salmonids; Koehn et al, (2000) for carp; NPWS, (2003) for gambusia; and ARIER (2002) for the weatherloach.

Not all introduced fish are necessarily a significant pest. Most of the evidence for their damage is based on observations and the occurrence of native organisms in the gut of introduced predatory fish. Predation of native fish by introduced fish is alone, only an indication that there may be a problem, not necessarily that the introduced fish is a pest. The key issue is whether the level of predation is sufficient to cause a significant decline

in populations of native fish. Most native fish in the MDB had declined prior to the establishment of carp (Koehn et al, 2000) and many other introduced fish. Consequently, other factors have been a major cause of the decline. This is not to say that introduced fish have not been a major additional cause for the decline. They may for example, be an important factor in keeping native fish populations low. Sound studies are required to better quantify the damage so that the extent and intensity of management required to reduce the level of damage to an acceptable level can be determined.

Damage due to fish and other pests include:

- Hybridization
- Habitat disturbance
- Competition
- Direct predation
- Disease

For more information refer to Best Practice Framework Appendix

3.2.2 Summary of the nature of the threat

In summary, while introduced fish can and probably do damage the health of the MDB system and its fish fauna, studies to date on the extent of the impact are unclear. Other changes to the system had caused a decline in native fish populations well before some of the major pest fish such as carp had established. Nevertheless, where practicable, it is advisable to reduce the density and thereby hopefully, the damage due to those non-native fish that are likely to be of most concern such as carp. Even more importantly, major effort should be put into preventing other species that are likely to establish in the MDB and become a pest. Tilapia is a prime example of such a species.

4.0 Principles of integrated pest management

Until recently, the attitude towards pests was to try and kill as many as possible. Each year hundreds of thousands of carp are trapped, poisoned or caught by fishermen. The hope has been that if there was sufficient concerted effort to remove as many carp and other pest fish as possible, they could be all but eliminated or even eradicated. However, we now know that it is unlikely and unrealistic that established pest fish can be eradicated, that is, every last animal removed. The possible exception is in some local situations where the populations are isolated and relatively low (Koehn and McKenzie, 2004; Lintermans, 2004). Several conditions need to be met for eradication to be possible (Bomford and O'Brien, 1995; and Olsen, 1998). It is sobering to note that no established widespread pest has ever been eradicated from Australia.

Controlling the damage due to pest animals including fish to an acceptable level is much more complicated than simply reducing pest numbers (See Figure 1, Principles that underpin effective management of pest fish and other pests). Before commencing management of pests, it is important to have a clear understanding of the problem that pest fish are thought to cause and to develop and implement strategies to achieve that outcome or combination of outcomes. The problem may be disturbance of the breeding habitat of native fish, fouling of waterways due to periodic die off of carp, poor water quality or complaints from recreational fishers that all they seem to catch is carp. Killing

pest fish might be the best way, but excluding carp from important native fish breeding sites or re-snagging sections of river to provide cover and breeding habitat for native fish may be better and more cost effective in the long run, especially given the capacity of pest fish to rapidly recover their numbers (MDBC, 2002; 2003). In other cases, the problem may be based on a misconception and the best strategy may be a targeted education program.

Koehn and Mackenzie (2004) provide an excellent review of the issues and approach required for effective management of pest fish in Australian freshwater systems. Several strategic planning documents including the Queensland Pest Animal Strategy (Qld DPI, 2002), the Action Plan for Alien Species in the MDB (MDA, 2003), the Native Fish Strategy for the MDB 2003-2013, and guides for setting priorities and developing local management plans (Braysher and Barrett, 2000; Braysher and Saunders, 2003) provide the basis for a systematic and strategic approach to managing pest fish.

Principles that underpin to the approach to successful management of pest fish[1]

Understanding the following principles and how they influence the management of pest fish is essential the development and implementation of an effective program.

1. *A pest is a human construct.*
    - People decide whether a fish is a pest. What is a pest fish to one person may be a valuable resource to another. For example, conservationists may see trout to be a pest in upland native streams but a valued resource in a recreational fishing lake. Similarly immigrants from Europe may have eaten carp as a table fish in their home country or been involved in 'coarse' fishing competitions for them. In planning to manage the impact of an animal, it is important to understand the attitude of key groups toward it. If they value them or don't care one way or the other, then they may have little interest in their management. Consequently:
2. *All key stakeholders need to be consulted and actively engaged in the development and implementation of the plan.*
    - It is important to understand the attitudes of all the key relevant stakeholders toward the pest fish and their management. This helps to determine who has the problem, what is the extent of the problem, what they want from management and what constraints there are likely to be on management.
3. *Rarely can pest fish be eradicated (that is every last individual eliminated).*
    - Once a pest such as carp has become established and is widespread, eradication is rarely possible. No established pest has ever been eradicated from mainland Australia despite intensive effort, many millions of dollars and supported by powerful legislation that requires pests to be controlled. Therefore:
4. *Management of pest fish needs to focus on the outcome – what is desired from their management.*
    - Since most pests cannot be eradicated, the focus then becomes how much effort should be put into their management. This requires an understanding of the damage that they cause. Damage can be social, economic, environmental or a combination of these. When developing a management plan, it is important that the damage caused by pest fish is defined as clearly as possible with the focus of the management plan being on reducing this damage to an agreed acceptable level. Ideally, the success of the management plan is measured against this outcome – not the numbers of pests remaining – although it needs to be acknowledged that accurately monitoring a reduction in damage can be difficult.

[1] These principles apply to both aquatic pests such as carp as well as terrestrial pests.

5. *Managing the damage due to pests requires a whole of system approach.*
    - Given the principles in points 1 to 4 above leads to the concept that the focus of pest fish management plans needs to be on the desired **outcome(s).** However, pests are but one of several factors that can influence the outcome – e.g. carp affects the status of native fish but so do many other factors. A manager needs to decide where to put resources to achieve the desired outcome – carp management, improving water quality, restoring bank stability, reducing cold water pollution, removing barriers to movement or, more likely, a combination of these. (See Fig 1).
6. *Our understanding of these complex and dynamic systems is imperfect – hence planning needs to incorporate the management of risk.*
    - *U*nderstanding and quantifying the factors that affect pest fish management and the long-term conservation of native fish communities is complex. We do not know how all the system operates and how it will respond to management intervention. In other words **our understanding of these complex and dynamic systems is imperfect**. Consequently, management needs to incorporate an understanding of the consequences of risk – the risk that we make the wrong assumptions about the system. This can take several forms: making decisions about how best to manage a particular pest fish situation; assessing the risk of new imports of aquarium fish to determine whether they may become a new pest; or another factor might be the primary cause of native fish decline.
7. *It is essential to monitor the result of the intervention and evaluate the results against the stated outcomes (as objectives) and evaluate them and the program.*
    - Because we cannot be certain whether our management intervention will achieve the desired outcome, it is essential that we monitor the result of the intervention and evaluate the results against the stated outcomes (as objectives) and evaluate them and the program (see section on Monitoring and Evaluation for more detail).

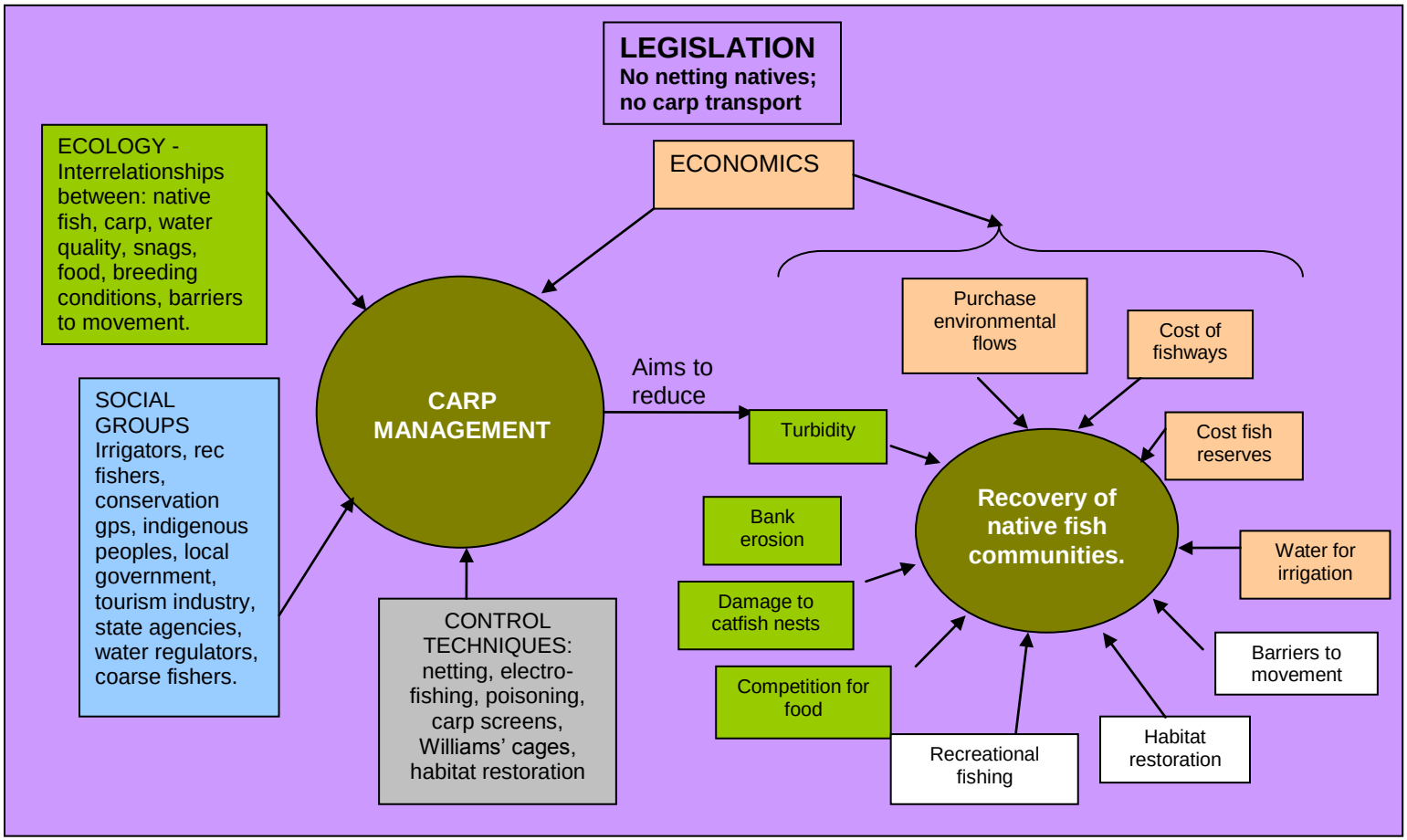


Figure 1 : Many factors besides carp and other pest fish influence the recovery of native fish communities.

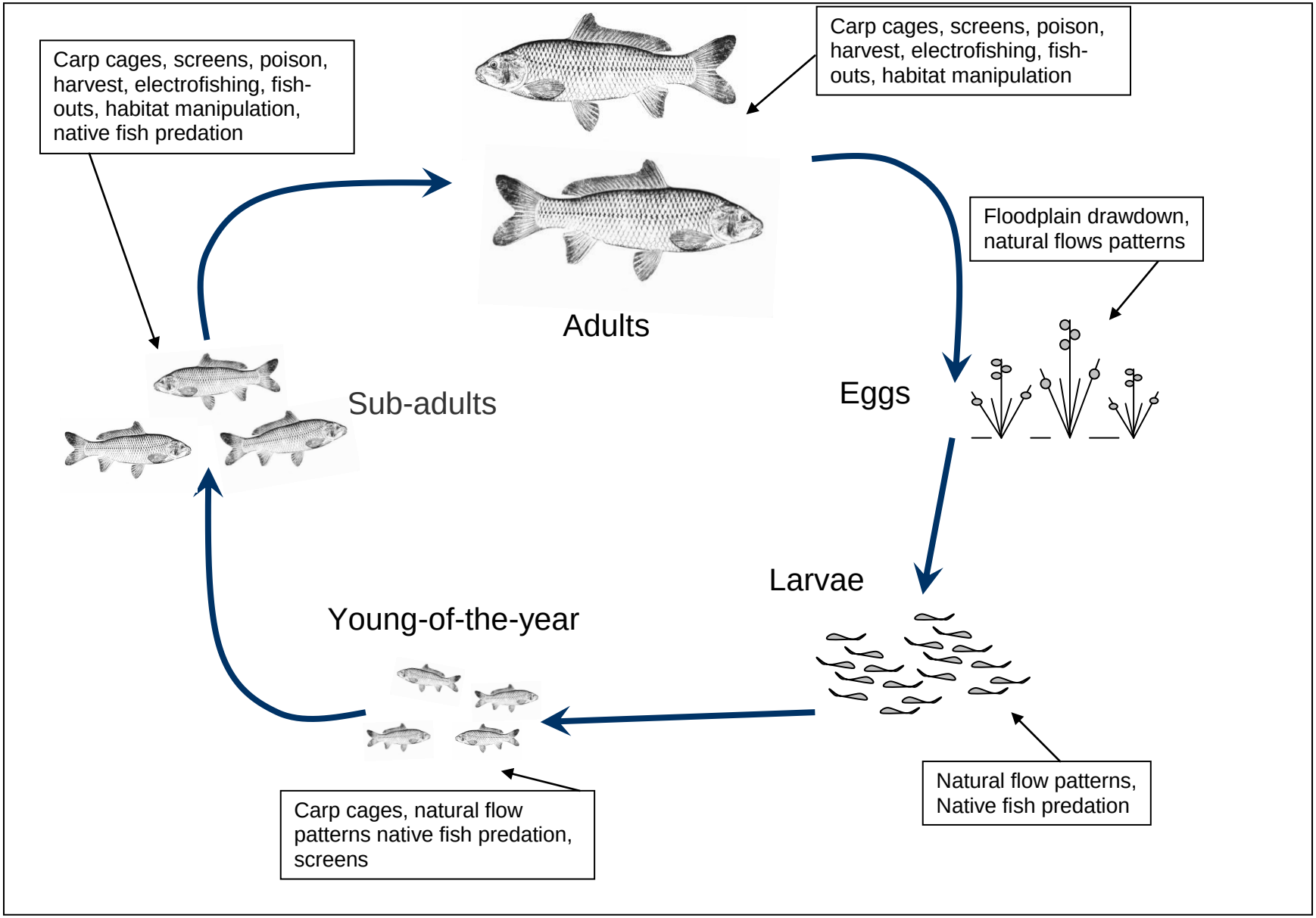


Figure 2: Life-history stages of common cap and their specific control measures.

5.0 The Tahbilk Lagoon Demonstration site

5.1 Selection of the site.

The Tahbilk lagoon demonstration site was chosen because it met several key criteria for demonstration, including:

- Be in a prominent location with easy public access so that the works could be readily show-cased.
- Have supportive local landholders, preferably members of active catchment planning groups.
- Have several interventions that could be show-cased and where no one major factor that can not easily be addressed dominating the site
    - E.g. severe cold water pollution.
- Contains a reasonable variety and population of native fish.

Description of the area

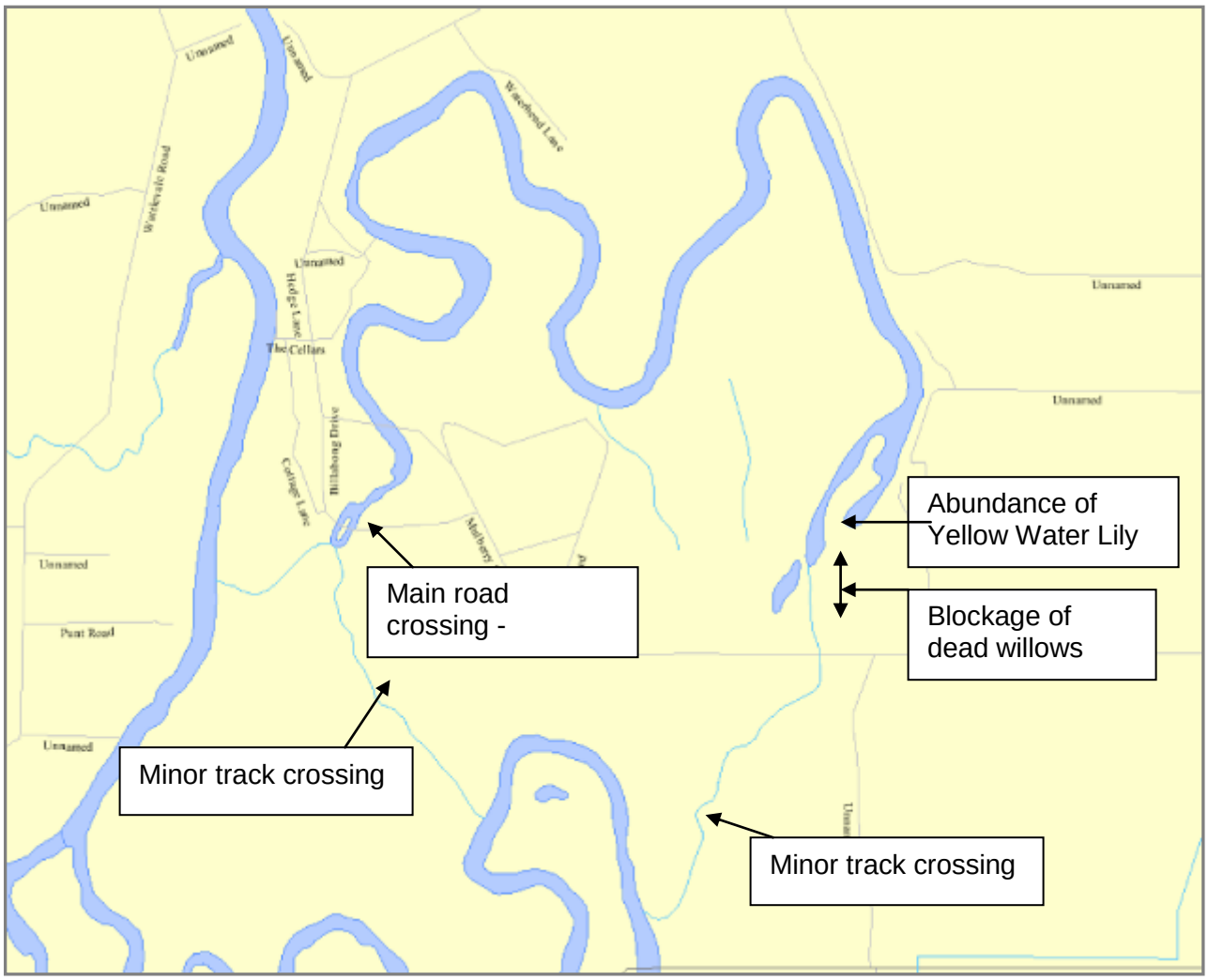
The Tahbilk Lagoon is situated in central Victoria, near the town of Nagambie in the upper ponded waters of Goulburn Weir the Nagambie township. Tahbilk Lagoon is approximately 5 km long and covers an area of approximately 400 acres of water and is classified as a Deep Freshwater Marsh according to the DSE 1994 Wetland Categories. Stock grazing occurs in some areas with consequent erosion, weed infestation and impacts on water quality, however in other areas the riparian zone is relatively intact (Clunie et al. 2008).

Tahbilk lagoon displays a mosaic of habitat components, including large woody debris, fringing vegetation (Spikerush *Eleocharis* spp, and Rushes *Juncus* spp), and aquatic species (Ribbonweed *Vallisneria gigantea*, pondweed *Potamogeton* sp and milfoil *Myriophyllum* sp). In addition the threatened Watershield *Brasenia schreberi* is also common in the Tahbilk lagoon (Clunie et al. 2008).

5.1.1 The geographic extent of the site x demonstration site

The area considered for the demonstration site and the associated carp management plan is shown in Fig. 3.

Figure 3: Geographical area where the Tahbilk lagoon demonstration site will occur. Picture from Pam Clunie (Victorian DSE).



1) Vision for the site

To enhance the ecological values and waterway health of the Tahbilk lagoon through undertaking complimentary actions within the site while demonstrating the benefits of such actions.

5.2 Objectives of the Demonstration Site

The objective is to improve to improve the health and ecology of Tahbilk Lagoon and resilience of key threatened species, by

1. Improving the connectivity between river and wetland environments (for example, through removal of barriers to fish passage and flows);
2. Improving water quality and hydrology to favour native ecology
3. Improving environmental flow management for the Tahbilk wetland and associated floodplain environments;
4. Improving the condition of riparian and aquatic habitats;
5. Increasing the populations and abundance of native flora and fauna, specifically water shield and freshwater catfish;
6. Reducing the impacts from pest plant and animal species within Tahbilk lagoon.
7. Increasing awareness of the activities - what we are doing, what we are trying to do;
8. Improving community capacity to assist with management of the site;
9. Demonstrating, through education, best practice techniques for environmental rehabilitation and water use;
10. Using the site as a demonstration to the community and other groups so they can learn from this in undertaking their own initiatives.

5.2.1 Objectives of the carp management plan

To major objectives for the site are 1) to reduce the impact of carp on key environmental values in Tahbilk Lagoon (including water quality, native fish communities and aquatic vegetation), 2) to reduce the abundance of carp, 3) to limit opportunities for carp recruitment, 4) to limit carp movements within the lagoon and emigration/immigration rates with the Goulburn River, 5) to promote awareness and increase involvement of the local management agencies and community stakeholders

5.3 Native fish and other wildlife values for the site

5.3.1 Summary of native and introduced fish in the demonstration site

Information on the native fish community in Tahbilk Lagoon is available from three major sources (Brumley et al. 1987, McGuckin 2002, Clunie et al. 2008). A fish species list is shown in Table 2, other native fish species might occasionally visit the Tahbilk Lagoon including Macquarie perch, river blackfish, Murray cod and silver perch. The Tahbilk Lagoon contains an important population of freshwater catfish, a species listed under the Victorian *Flora and Fauna Guarantee Act* 1988. Murray rainbowfish also occur in the lagoon and although these are reasonably common in the lower Goulburn and Broken systems there are few other data concerning their abundance in Victorian streams.

5.3.2 Other wildlife values of the site

In addition to the native fish of Tahbilk Lagoon there are three species of freshwater turtle occur in the area. These are broad-shelled River turtle (*Chelodina expansa*) long-necked turtle (*Chelodina longicollis*) and short-necked turtle (*Emydura macquarii*). Other species of threatened wildlife that might occur in the area are powerful owl *(Ninox strenua*), grey-crowned babblers *Potamostomus temporalis*, hooded robin (*Melanodryas cucullata*), diamond firetail (*Stagonopleura guttata)* and lace goanna (*Varanus varius)* (Pam Clunie and Nick Clemann, Vic. DSE, pers. comm.) However, there is still a need to complete further survey work for aquatic macrophytes, frogs (particularly growling grass frog) and terrestrial fauna (Mike Smith ARI, pers. comm.). Little is known of the Tahbilk Lagoon invertebrate community.

It is important to note that many animals might use the Tahbilk wetlands as a link between riparian habitats of the Goulburn River and adjacent agricultural areas. Hence, there is a need to consider an integrated system by considering areas greater than the lagoon system.

5.3.3 Vegetation values of the site

In the Tahbilk Lagoon threatened flora include buloke (*Allocasuarina luehmannii*) and common joyweed (*Alternanthera nodiflora*) and the nationally threatened little scurf pea (*Cullen parvum*). In addition there is an abundant population of the threatened watershield (*Brasenia schreberi*) and these flora values are described in greater detail by Clunie et al. (2008).

Tahbilk Lagoon and the broader Goulburn River weir pool are also infested with yellow water lily (*Nymphaea Mexicana*) control has been limited to spraying. However, the abundance of the pest plant can be attributed to lack of flow, elevated nutrient levels and sedimentation. These plants pose some risk during die off events due to consequent oxygen depletion in the water column. Control of Mexican Lillie is a priority under the G-MW storage Plan for Lake Nagambie (G-MW 1998).

Table 2: List of fish species in Tahbilk Lagoon (after Clunie et al. 2008) or those that might occur.

Species	Common name	Key threats in the Basin
**Bidyanus bidyanus*	Silver perch	flow regulation, barriers to movement, cold water pollution, and unknown impacts of stocking on the gene pool of remnant populations
**Craterocephalus stercusmuscarum*	un-specked hardyhead	loss of habitat and floodplain connectivity, barriers, thermal pollution, increased salinisation of deflation basin lakes and predation and competition for habitat from introduced fish species such as Carp, Redfin Perch and Eastern mosquito fish
**Gadopsis marmoratus*	River blackfish	habitat degradation, particularly de-snagging and sedimentation that has reduced available cover and filled the interstitial spaces in the cobble substrate, and introduced fish species such as trout
Galaxias rostratus	Flat-headed galaxias	predation by trout and sedimentation of spawning sites
Hypseleotris spp	Carp gudgeons	loss of aquatic vegetation as habitat and sites for egg attachment and parasite infestation
**Maccullochella peelii*	Murray Cod	River regulation, barriers to migration and loss of critical habitat are the major threats to Murray Cod. De-snagging has significantly reduced the optimum habitat for cod in the Basin
Macquaria ambigua	Golden perch	River regulation, thermal pollution, flow alteration, barriers to upstream spawning areas
Melanotaenia fluviatilis	Crimson-spotted rainbow fish	River regulation, altered flows and competition from mosquito fish
Philypnodon grandiceps	Flat-head gudgeon	loss of habitat and limited information on the biology
**Retropinna semoni*	Australian smelt	barriers to movement & predation from exotic species may pose risks
Tandanus tandanus	Eel-tailed catfish	competition with Carp, loss of suitable breeding habitat, barriers to movement and thermal pollution
Carassius auratus#	Common goldfish	
Cyprinus carpio#	common carp	Do not occur above Glenlyon and Coolmunda dams
Gambusia holbrooki#	Gambusia	
Tinca tinca	Tench	Rare in lagoons
Perca fluviatus#	Redfin perch	These are rare in the system and only occur in cooler sections.

* denotes species that could occur in Tahbilk wetland, #: denotes alien species

6.0 Threats to the values of the demonstration site

6.1 Threats presently affecting the site

6.1.1 How do carp affect the values of the demonstration site

Carp can affect the natural values of Tahbilk Lagoon in a variety of ways, these include directly disturbing the nests of freshwater catfish, competing with native fish for food and space, damaging macrophyte beds and in re-suspending sediment and nutrients (Koehn et al. 2000). In addition carp can directly impact on watershield (Clunie et al. 2008).

Carp also dominate the biomass of large bodied fish within the Tahbilk Lagoon and can occasionally be observed in large numbers (Bob McMaster, Tahbilk estate, pers. comm.). The impacts of carp, in re-suspending nutrients, also possibly encourages further growth of Mexican water lillie. Some areas of the Tahbilk Lagoon are subject to low dissolved oxygen and carp can better exploit these conditions than most other native fish.

6.2 Identification of priority areas for action within the demonstration site

6.2.1 Constraints for action

Local constraints to carp management actions within Tahbilk Lagoon include:

- not impacting on native fish and water plant communities (particularly catfish and water shield),
- a lack of flows into/exiting the system,
- the presence of road crossing barriers to fish movement,
- G-MW water management in Goulburn River is primarily tailored for irrigators, domestic supply and recreational activities

7.0 Recommended interventions to manage carp and other alien species

The are several priority actions for managing carp in the Tahbilk Lagoon. These include:

1. Restore passage for native fish (and carp) by modifying the road crossings
2. Install carp harvest systems (Williams' cages) at key road crossings
3. Restore regulated flow to the Tahbilk system by removing woody weeds and re-connecting with the Goulburn River (regulators might be considered)
4. Install carp screens at key locations (inlet & outlet regulators)

7.1 Broader Goulburn River catchment

7.1.1 Carp in farm dams and off channel habitats

Carp and other potential pest fish often occur in some farm dams and other water bodies that feed into the demonstration site. They are potential sites for continued reinfestation of the waterways where carp management is proposed. As far as is practicable, those dams with carp should be identified and the treatment of the dams to kill carp negotiated with the landholders. This is best undertaken through a combination of netting, electro-fishing with follow up poisoning where appropriate. This should be undertaken as part of a comprehensive awareness and understanding about River Restoration and the demonstration site.

7.1.2 Barriers to fish movement

An inspection of all road crossings as potential barriers to fish movement has been undertaken and recommendations for fish passage restoration made (Clunie et al. 2008 part B). There are three major road crossing barriers within the Tahbilk wetlands and these have been prioritised for retro-fitting of full-stream width culverts. These areas will be amenable as carp removal stations and should be considered for Williams' Mark V carp separation cages as part of the modification. A key consideration will be the practicality of routinely maintaining the separation cages to remove and dispose of the trapped carp.

7.1.3 New introductions of alien species

The threat of new introductions of alien species is high. For example, Tilapia were known to have been released into the upper MDB in the late 1990s although apparently they didn't survive (Braysher and Barrett 2001). Other species of concern such as several species of oriental weatherloach are likely to enter the Tahbilk Lagoon in future and a Rapid Response Strategy is needed to respond to and eliminate new incursions on unwanted exotic aquatic species. The Arthur Rylah Institute are currently involved in developing a national Rapid Response Strategy (Jim Barrett, MDBC, pers. comm.) The risk that exotic fish pose and the potential for them to establish through the release of unwanted aquarium fish should be incorporated into the awareness and understanding strategy for all demonstration sites. It is suggested that the Tahbilk café, a high profile public site, could be used to locate information about the risk of exotic fish and how they can establish from aquarium releases.

7.1.4 Stocking of rivers and dams

Native fish such as Murray Cod and Golden perch are often stocked in waterways within the Basin. The impact of native fish stocking in the rivers is not clear although there is concern that stocking of rivers may have significant adverse effects on the system. Studies are required to determine and quantify the impact. However, stocking has the potential to introduce carp and other exotic species such as red fish perch as contaminants of the water used to transport the fish for stocking. Where stocking continues, those responsible should contact the suppliers and ensure that they have robust arrangements to prevent carp and other unwanted exotic fish being included in the transport water.

7.1.5 Management of other Alien species

There is little potential to manage the damage due to other alien species that occur in the site. The species of most concern, other than carp, are redfin perch and eastern gambusia. The impact of redfin on catfish is their direct predation and potentially as carriers of the EHN virus, though more data are needed. Within impoundments where redfin are absent then freshwater catfish populations appear to benefit (Pam Clunie, DSE, pers com). Currently there are no effective strategies to manage these species other than to restore native fish habitat and hence populations. Native predatory fish might then reduce the density of eastern gambusia. New research at the Arthur Rylah Institute will also provide further ecological data for which to plan control efforts (Zeb Tonkin, ARI, pers. com)

Foxes prey on semi-aquatic fauna such as freshwater turtles. The extent of their impact on the conservation of turtles is not known. If significant populations of turtles occur in areas where they are easily accessed by foxes, consideration should be given to targeted fox management. See Saunders et al (1993) for techniques and strategies for managing foxes.

7.1.6 Management Techniques

There are a range of techniques and strategies that can be used to control the damage due to introduced fish (see Best Practice Framework Appendix). Further research might increase the efficiency of the techniques, but current methods are unlikely to be replaced by high-tech, “magic bullets”, at least not in the short term. Effective control of pest fish damage is possible provided the available techniques are applied strategically, usually in combination and taking into account the range of other factors that influence the biotic and a-biotic health of the river system.

7.2 Tahbilk Lagoon Demonstration site on-ground actions

7.2.1 Management Unit 1

In past pest management plans it is usual to break the site into smaller geographic units for management. However, the Tahbilk Lagoon site, at 5 km, is relatively small and hence is not further sub-divided. Tahbilk Lagoon therefore constitutes Management Unit 1.

Several key issues need to be addressed to complement any actions to control carp. These issues include: restoring connections with the Goulburn River and more natural flows to the Tahbilk Lagoon, improving fish passage at road crossings, management of pest plants (primarily willows and Mexican lillie), improving riparian health, improving in-lagoon habitat (woody debris and cobbles) and improving the lagoon water quality. These initiatives will likely improve conditions for native fish and increase ecosystem resilience.

7.2.1.1 Action 1: Flow management and fish passage

Rationale for action

The major priority is the protection and enhancement of the present Tahbilk ecological values (e.g. catfish and water shield) while identifying opportunities for appropriate carp control. For example, avoiding major works to control carp during the spring/summer catfish breeding season.

How it will achieve desired outcome

Restoration of flow to the Tahbilk Lagoon is likely to enhance water quality and stimulate spawning and recruitment of native fish. G-MW and the GBCMA would need to investigate the most appropriate method for restoring natural flows (i.e. a small regulator). Flow should be managed in an adaptive manner so that access to marginal wetlands is limited, as these areas are preferred carp spawning habitats. Removal of the three road crossing barriers is also likely to enhance movement and potentially spawning opportunities for native fish. See Clunie et al. (2008 part B) for more detail on fish passage priorities.

Risks and mitigating actions

Two major risks are inherent in ecosystem restoration through re-instating natural flows and fish passage. These are: (1) higher passing flow could alter catfish and water shield ecology. (2) higher flow could increase opportunities for carp spawning and movement into and throughout the lagoon.

Higher passing flows should be avoided for water shield (Rolf Weber, DSE pers. comm.) and potentially catfish. To mitigate the first risk to water shield and catfish populations a sophisticated and adaptive plan for flow management needed to be undertaken. We suggest small passing flow to improve water quality is needed rather than significant spring rises in water level. Major water level increases should be avoided in summer. The ability to flush water does reduce the risk of catfish entrapment in poor water quality in case of a catastrophic event (e.g. lillie dies off, pesticide spill, black water event).

7.2.1.2 Action 2: Installation of integrated carp harvest and screening systems

Rationale for action

Carp control strategies for Tahbilk Lagoon should be pragmatic but also low impact in terms of potential affects on native fish and plants. Therefore we do not recommend complete Lagoon drawdown and drying. We suggest a combination of wetland rehabilitation and carp screening/removal will be the most viable long-term way of controlling carp and their impacts.

How it will achieve desired outcome

1). Install Williams carp separation cage on upgraded road crossing near the Wetlands café (Figure 2 & 3). 2). Install carp vertical-bar screens (35-40 mm internal diameter) on any inlet/outlet regulators. Institute a carp removal program for spring and summer while also monitoring and releasing any large-bodied native fish (e.g. catfish) from the Williams' cage. Other non-native fish collected in the Williams' cage can also be removed.

Risks and mitigating actions

The major risk when undertaking screening and carp removal via cages is the by-catch of native fish (primarily catfish) or air breathing aquatic animals (e.g. birds, turtles & platypus). The apparatus need to be carefully designed and operated to limit entrapment of non-target animals. This includes liberator ramps for the regulator and daily monitoring for the Williams' cage. A detailed operating manual and appropriate permits are required. It is envisaged that Tahbilk Estate staff operate this equipment under authority and regular supervision from the appropriate NRM agencies.

Management plan development process.

7.2.2 Who was consulted and when and how

Key stakeholders and managers were consulted in two on-site meetings chaired by DSE. These meetings were held on 28 February 2008 and 17 April 2008. A range of participants were invited to attend, including: Goulburn-Murray Water, GBCMA, Tahbilk Estate winery, DSE, Adjoining Landowners, Greening Australia, Parks Victoria, Nagambie Landcare group, Nagambie Angling Club (VRFish), DPI Fisheries, Broken Creek Field Naturalists Club, Bird Observers' Club of Australia, the Shire of Strathbogie and Field and Game Australia.

Other documents relevant to the present plan include the draft G-MW Tahbilk Lagoon Management Plan and the Lake Nagambie Storage Management Plan (G-MW 1998). This draft plan summarises the existing roles and responsibilities of management authorities, and outlines some key existing issues.

Tahbilk winery Pty Ltd, established in 1860, has freehold title over a significant area of land around the Tahbilk lagoon and plays a key role in the management of the site. The Tahbilk winery is also preparing a Tahbilk Management Plan which addresses improvement to biodiversity and on-ground actions include fencing, revegetation, weed control, filtering of runoff into the lagoon (Bob McMaster pers. comm.).

Figure 4: O'Neil's crossing at Tahbilk Lagoon, crossings provide natural constrictions and areas for carp removal.

Figure 5: A Mark V Williams' carp separation cage, these devices might be used in a targeted manner at Tahbilk Lagoon.

8.0 Recommendations

The Tahbilk Lagoon has important ecological values and is an excellent site for demonstrating an integrated on-ground pest management strategy. In addition to rehabilitating key aspects of the Tahbilk Lagoon: water flow, pest plants, riparian plants, in-lagoon habitat, water quality and passage barriers we suggest a practical carp management strategy.

The central components of the strategy have been developed while considering the risk to the ecological values of the site and hence some practical carp control methods are not recommended (e.g. complete lagoon drying, poison, nets) at this stage. Instead we recommend the integrated lagoon restoration approach above be instituted in a staged manner. Then complementary actions to limit the impacts of carp through their basic biology can be rolled-out in an adaptive manner. These include:

1) Williams' cage
- Install a Williams' separation cage on the main Tahbilk café road crossing
- Institute a formal monitoring, reporting, maintenance and disposal program for carp collected from the Williams' cage
- Daily monitoring of the cage to provide baseline data on native fish populations
- Transferring the Williams' cage to other key road crossings or flow control devices as required.
- Formalise responsibilities for daily operations (e.g. Tahbilk Estate staff)

2) Sophisticated flow control
- Investigate options for restoring flows to Tahbilk Lagoon (G-MW & GBCMA)
- Install carp vertical-bar carp screens at key flow control structures
- Develop a flow management plan for Tahbilk Lagoon to limit carp recruitment and maximise benefits for native ecology

3) Adaptive management of carp and community demonstration
- To combat the inherently flexible life-history of carp an adaptive management approach is needed. The carp plan and on-ground control methods should be adapted as necessary and results documented
- The. Tahbilk Lagoon is an excellent site to demonstrate flow management, Williams' cages and other rehabilitation initiatives. It is important to demonstrate these to the community with signage and other initiatives.

4) Monitoring and evaluation
- Demonstrate changes to the health of Tahbilk Lagoon with a targeted monitoring and evaluation program (see below).
- Installation of PIT tag readers for long-term carp and native fish applications.
- Form a small multi-agency team to lead restoration initiatives.

9.0 Monitoring and evaluation

Natural systems are complex and our understanding of them is imperfect. We can never know for certain what the outcomes of a pest management program will be. As the program progresses and monitoring data accumulates, we increase our general knowledge of the system and can better understand what the consequences of any management strategy might be. Perhaps there is concern that there will be an unintentional affect of management on a non-target species. Careful monitoring will help address this issue (See box 1, Principles).

Monitoring is the systematic collection of information on the progress of a pest management program. It is an invaluable tool for management and provides the necessary information to evaluate the program. *Evaluation* is the comparison of the results from pest management against the agreed objectives of the program. There are two main forms of monitoring: Operational monitoring and performance monitoring.

Operational monitoring aims to assess the efficiency of management. It is concerned with the how management was undertaken and addresses such questions as what was done, where and at what cost. By increasing the efficiency of management, more resources can be available to manage other pests, areas or the damage due to other factors such as bank instability thus increasing the cost effectiveness of management.

Performance monitoring aims to assess the effectiveness of the management strategy and asks whether the strategy reduced the damage to an acceptable level. If the objective was not met, the management strategy may need to be modified or the initial pest problem reassessed to determine whether factors other than pest animals were the causes of the problem.

Most funding agencies require some form of monitoring and evaluation so they can determine whether the funds have been well spent. Clearly, if there is no hard evidence that the program objectives are being achieved, it will be difficult to make a case for continued funding. Satisfying funding agencies is a valid reason for setting up a good monitoring and evaluation component to a pest management program but it is not the only, or even the most important, reason. Monitoring and evaluation are also invaluable tools for the program manager.

Some reasons for monitoring and evaluation include:

- To determine whether the damage caused by carp was reduced to the desired level by the management program.
- To provide feedback to those involved in the program and to maintain their engagement.
- To determine the efficiency of the program and how it might be made more efficient.
- To satisfy funding agencies and to justify continued funding and to seek additional funds.
- To determine whether carp actually caused the damage or that other factors were significant or more important.
- To obtain information for promotional material.
- To increase understanding of the impact of carp and use it to refine future management.

Much care needs to be given to data collection. It is important determine what data to collect, when, where, how often, and exactly how to collect the data. Start by making a list of the data you wish to have, and begin filling in how you will get it. A good start is to set out the costs of data collection. Some monitoring data, such as assessing the satisfaction of recreational fishers about the results of management may be relatively easy to obtain. Other data such as determining the initial population size of the carp population and how it changes as a result of management, or the breeding success and recovery in native fish populations require specialised methods and hence more effort and cost – and are very difficult to determine.

An important rule to remember is not to try and collect as much data as you can, regardless of its value. Not only is this expensive, but often the data is of poor quality and cannot be analysed.

As our knowledge of most natural resource systems is imperfect, appropriate monitoring can help to address some of these gaps in knowledge. In other words, management can be used as an experiment to obtain relevant information. This often called "*adaptive management*". It is a strategy that helps to cope with the problem that there will always be missing information and unexpected responses to actions taken during a pest management program. In these studies it is essential to set up the monitoring program with clear timelines and check points when results are reviewed and changes to the program are made if necessary.

Collecting data that will allow the success of the management strategy to be determined depends on the program but, again, it does not need to be complicated. Exceptions are where there information is required by research scientists to answer major gaps in knowledge of the system. For these cases, it is best done in cooperation with a research agency. It is usually not the main concern of a strategic pest management manager.

Where it is practicable, try to incorporate monitoring into the management regime for the area. For example, during a regular run to check equipment or crops on the property. Also consider using community groups to collect information. While not always possible, involving tourists, neighboring property owners, or waterwatch volunteers to help to engage the community in the management program can then be used to assess satisfaction on the outcomes of management.

The recommendations of the present report and that of the recent fish survey (Clunie et al. 2008) have been integral in developing an integrated 'Caring for Our Country' project proposal. This type of proposal should utilize the monitoring and evaluation principles outlined above.

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