PROPOSAL FOR THE ESTABLISHMENT OF RECREATIONAL FISHERIES IN VICTORIA FOR THE BLUENOSE OR TROUT COD

Maccullochella macquariensis

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Cover Photograph: A sign of things to come. A happy angler with a recently captured trout cod taken in the Ovens River near Peechelba. *(photo: Adam Bosley)*

Acknowledgments

Two decades ago the dream of having recreational fisheries for trout cod was just that – a dream. Perilously close to extinction, the species was hanging on in two small populations totally protected in a triage like operation. Due to the efforts of fisheries biologists and managers, techniques have been developed for the artificial propagation of the species and additional populations created. A long list of names are deserving of acclamation, including Dr. Phillip Cadwallader, Dr. Stuart Rowland, Geoff Gooley, Gary Backhouse, Stephen Thurston, Mike Rimmer, Dr. Brett Ingram, Mark Lintermans, Dr. Dean Gilligan, Dr. John Koehn, Dr. John Douglas and Simon Nicol amongst many others who have made worthwhile contributions. It is these people we thank, above all, for saving this fish and for providing future generations with the potential of experiencing one of Australia's, and perhaps one of the world's great freshwater sporting fish

Members of Native Fish Australia have contributed in various ways to the conservation of the trout cod, such as Will Trueman, Graeme Creed, Ron Lewis, Nick Thorne, Colin Luker and Angus Moore. A number of people have assisted in the preparation and review of this document providing constructive criticism including Heath McKenzie, Simon Kaminskas and Ray Clifford. Adam Bosley and Ray Clifford made available many of the photographs used in this report and provided up to date information on trout cod captures in the Ovens and Murray Rivers as well as canvassing the views of local residents on future trout cod fisheries. Bill Willis and other anglers from the upper Murray area have also provided their thoughts. These people we also thank.

Native Fish Australia particularly wishes to thank Will Trueman for his contribution to the preparation of this document. Without his tireless efforts it would not have been possible.

In preparing this document detailed assessment of potential stocking sites would not have been as rigorous without the use of the Victorian Water Resources Data Warehouse website. This project of the Victorian state government is dedicated to disseminating up to date information on Victoria's water resources, including basic environmental data, reports and the findings of regular stream health surveys. That government agencies are not only able to conduct such environmental audits but freely place them in the public domain is a testament to the health of our democracy. They are to be applauded for being so forthcoming with their information. A significant amount of data used in this report was sourced from this site and we, in great appreciation, fully acknowledge this source.

Similarly the Victorian Department of Primary Industries and Fisheries Victoria website has also been utilised as a source of up to date information on the latest fish stockings and the state of recreational fisheries. Once again we thank a government agency for its communication with its stakeholders and fully acknowledge it as an information source used in the preparation of this report.

This proposal is largely intended to deal with recreational fisheries for Victorian anglers. The Murray River is of great importance to Victorians and while from the statutory perspective is under the control of the New South Wales authorities is increasingly being jointly managed in a cooperative manner for all users. This report discusses some options for part of the Murray River and is being submitted to Victorian authorities with the wish that they convey our proposals through the appropriate channels and utilising the appropriate protocols to New South Wales managers and their peak angling bodies for consideration.

We would like to thank the angling public for tolerating some of the inconveniences created in managing critical trout cod fisheries in the past. In particular we wish to allay fears of some members of the trout fishing fraternity of wholesale changes to their sport. It is hoped that objective consideration of the proposals contained within will indicate that the proposals are moderate, modest and designed to avoid the best trout fisheries within the state. The general approach is of enhancing recreational fisheries, not replacing them. NFA's desire is to reach common agreement with groups representing trout anglers to end the controversy and acrimony surrounding the debate on how our mid and high altitude freshwater fisheries should be managed. This plan is intended to be a starting point for discussions between angling groups so that we can work together co-operatively for the common good of all anglers within the state.

Finally we wish to thank those pioneers that championed the cause of the trout cod in its darkest hours. These include the late Barney Kipping, the late Gordon Winter, Dr. Bryan Pratt and Rod Harrison amongst many. It is hoped that the dream of recreational trout cod fisheries will come to fruition whilst some of these people are still around to see it.

Native Fish Australia (Victoria) Inc., August 2006

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Summary

In the past, when more abundant, the trout cod, *Maccullochella macquariensis*, together with its close relative the Murray cod, *M. peelii peelii*, formed important parts of the commercial fishery of the Murray-Darling system. It was recorded widely throughout the southern half of the Murray-Darling system, but historical evidence suggests it was most abundant in transitional lowland/foothill and upland habitats. While often overshadowed by its better known relative there are some surviving records indicating that trout cod were popular targets of anglers in some areas.

Throughout the nineteenth and twentieth centuries the trout cod underwent a drastic decline in distribution and abundance so that by the 1980's only two self-supporting populations remained, with a single population surviving in Victoria in Seven Creeks near Strathbogie. Since that time the species has been the subject of a recovery program by DSE Victoria and its counterparts in NSW and the ACT, with some success. Evidence for the development of recruiting populations of trout cod in NSW, the ACT and Victoria, as well as the establishment of other significant populations with the potential to reproduce, suggests that the conservation status of the species is improving.

The trout cod, whilst remaining enigmatic to most anglers, is becoming recognised as a potentially outstanding sportfish having gained an almost legendary reputation as a ferocious, powerful predator that freely takes artificial lures and flies. The trout cod can therefore be considered an asset of untapped potential for recreational angling and the economic benefits, which come from this activity. Introduction of trout cod to mixed recreational fisheries may be useful for those waters showing high seasonal temperature fluctuations, particularly elevated summer temperatures at moderate to high altitudes such as impoundments. Stocking trout cod could enhance summer angling when trout activity is reduced due to high temperature supporting excellent winter trout angling in waters without a closed season for trout, when trout cod activity is suppressed by low temperatures. Notwithstanding its potential to enhance existing fisheries, the trout cod has the potential to develop dedicated recreational fisheries similar to iconic species such as Barramundi, Australian bass and the introduced brown and rainbow trouts.

Recently, DPI Victoria has suggested the possibility of developing a recreational fishery for trout cod to promote the angling attributes of the species and enhance community awareness. It is understood that the water under consideration is Lake Kerford near Beechworth. A precedent exists in the form of the recreational fishery for the Mary River cod, *M. peelii mariensis,* in Queensland which is also endangered and enjoys similar legal protection to that of the trout cod.

The National Draft Recovery Plan for the Mary River cod specifically provides for recreational fisheries for that species to facilitate its objectives and encourage community participation and ownership in the recovery process. The current National Draft Recovery Plan for trout cod prepared in 1998 does not specifically discuss the use of recreational fisheries as a tool to achieve its objectives, though it strongly advocates angler involvement in the process. It is understood that consideration is being given in the new draft for the development of recreational fisheries for trout cod as with the Mary River cod and this is reflected in the recent N.S.W. Draft Plan.

This document reviews candidate waters for stocking with trout cod as has been suggested by anglers from time to time. Most of these waters already provide some type of recreational fishery and the proposed stocking of them with trout cod is to be viewed as an enhancement of these fisheries rather than their replacement. Waters considered for the establishment of fisheries within five years are given priority and identified as short term candidates. Additional waters of high merit are identified as having potential for the establishment of fisheries within ten years and are identified as medium term candidates.

Conservation stockings of trout cod have included streams, large rivers and artificial impoundments, with success and failures in all three types of habitat. These three types of water represent distinctive recreational fishing opportunities. Considering a range of criteria including: the number of fish required, the potential of stocked fish to survive, the potential to link up with other populations, management and enforcement, angling opportunities and community benefit, a number of waters have been identified and are recommended for the establishment of recreational trout cod fisheries.

These waters are:

1. Short Term (within 5 years)

- 3000-5000 fish p.a. stocked into Lake Kerford or Lake Sambell, catch and release initially for 3-4 years then a bag limit of one fish;
- Additional stockings of trout cod to take place in Lake Dartmouth and the Goulburn River near Murchison for conservation purposes leading to angling in the medium term.

- The Ovens River to be opened to legalised catch and release angling for trout cod generally or at least between the Everton road bridge and Oxley flats road and Boorhaman and the Peechelba road bridge for a trial period of 3 years.
- If the catch and release proposal is not adopted in the Ovens River then it is recommended that 2000 fish p.a. be stocked into Koetong Creek, catch and release initially, possibly progressing to a bag limit of one fish, depending upon sustainability.

2. Medium Term (within 10 years)

- If significant recruitment occurs in the Ovens River population then a bag limit of one fish to be introduced with supplementary stockings if needed to maintain the population against angling pressure and/or closure of the river downstream of Wangaratta to angling during the spawning season for both cod species.
- Priority to be given to establishment of a fishery in the upper Murray River, if agreed to by NSW bodies, supported by stocking of around 10 000+ fingerlings p.a.
- 5000 – 10000 fish p.a. stocked into the upper Buffalo River or possibly the Yea River (subject to investigation and consideration of the resident Macquarie perch populations) bag limit of one fish.
- 10000 – 20 000 fish p.a. stocked into either Lake Dartmouth or Lake Hume, increasing as fingerling production increases, bag limit of one fish.
- 5000 – 10000 fish p.a. stocked into Lake Buffalo.
- 2000 -5000 fish p.a. stocked into Cudgewa Creek, bag limit of one fish.

3. Long Term (10+ Years)

- General legalisation of trout cod angling with similar regulations to the Murray cod fishery, dependant upon improved conservation status of the trout cod as required in the state and national trout cod recovery plans.
- Stocking of Lake Eildon.
- Stocking of lower Mitta Mitta, lower Campaspe and mid Goulburn Rivers if research determines their existing thermal regimes to be suitable or if their thermal regimes are improved in the future.

Anglers fishing the Ovens River are regularly capturing trout cod (photo: Adam Bosley)

Introduction and History

Maccullochella macquariensis is a large freshwater fish once found in the rivers and streams of the Murray River catchment in Victoria. The first museum specimen captured in the Macquarie River near Bathurst, whilst named *Grystes brisbanii* and illustrated was not formally described until 1829 and named *Grystes macquariensis*. Ongoing debate as to its relationship with the Murray cod, *M. peelii peelii*, was clarified in 1972 when it was finally definitively identified as a separate species (Berra & Weatherly 1972).

The trout cod has been described under a variety of common names to distinguish it from the Murray cod including 'Mungee' or 'Munnjie' by indigenous peoples of the Tumut and possibly the upper Murray and Mitta Mitta region. 'Cod-perch' or 'Murray perch' was used by some professional fishermen in the second half of the nineteenth century. 'Bluenose' or 'blue cod' was in use in Victoria prior to 1908. Mitta cod was used by some anglers in the Mitta Mitta River system at least during the 1960 & 70's and the term 'trout cod' was most probably created by David Stead in 1909 and remains in common use until the present time (Trueman 2006).

The trout cod was once widely distributed and at least locally abundant in parts of the riverine plains, foothills and upland sections of the eastern half of the Murray-Darling catchment in Victoria. In the past, when more abundant, the trout cod together with its close relative the Murray cod formed an important part of the commercial fishery of the Murray-Darling system as well as being a target for recreational fisherman (Cadwallader & Gooley 1978, McKenzie 1982, Rhodes 1999, Trueman 2006).

Subsequent to European settlement, the trout cod underwent a massive decline in distribution and abundance so that, by the early 1970's in Victoria, it could only be reliably taken from two populations, one in the Seven Creeks near Strathbogie and the other in Lake Sambell near Beechworth (Berra & Weatherly 1972). Small relic populations survived in the Mitta Mitta, Buffalo, King and Ovens Rivers in Victoria, the upper Murray and upper Lachlan Rivers in New South Wales and the upper Murrumbidgee in the A.C.T. at this time. In addition a small population in the Murray River below Yarrawonga weir recovered after significant flood events in the early 1970's and has been the focus of subsequent data gathering and recovery efforts (Douglas et al 1994, Trueman 2006).

Trout cod from the Mitta Mitta River, upstream of the Dart River junction, circa 1973
(Photo: T. Kelly)

A number of authors have reviewed the possible causes for the decline of the trout cod including overfishing (Douglas et al 1994; Brown et al 1998), changes to river flows and thermal regimes (Cadwallader 1978, Koehn 2001), barriers to movement and migration (Koehn & O'Connor 1990), bushfires and copper sulphate poisoning polluting catchments (Cadwallader 1977; Rhodes 1999), siltation and de-snagging (McKenzie 1982; Koehn & O'Connor 1990) and competition with and predation from introduced fish (Cadwallader 1977; Cadwallader 1996).

In some cases historic accounts indicate single events (e.g. copper sulphate poisoning, bushfires) have decimated trout cod populations. Such transient disturbances are reported to have allowed both salmoniids and redfin to occupy trout cod habitat, which was not recolonised. Rapid declines of some upland native fish populations containing trout cod subsequent to the introduction of salmoniids suggests that, in higher altitude waters, their introduction may have been a major factor. The general pattern in the demise of the trout cod is of slow decline with a range of events contributing to population fragmentation and extinction (Cadwallader 1977, Rhodes 1999, Trueman 2006).

The original distribution and habitat preferences of the species have been a matter of some contention in recent times. A number of sources of information have been used in attempts to map the former distribution and abundance of the trout cod and infer its habitat preferences. These include museum specimens held in collections, considered a reliable source for inferring distribution, formal scientific writings and publications, and reports of anglers. Lake (1971) suggested that trout cod preferred the 'cooler upper reaches' of the Murray Darling system most probably sourcing this information from professional and recreational fishermen and a manuscript of researcher J.O. Langtry. Cadwallader and Gooley (1984) reviewed the past and present distributions of the species within Victoria, utilising museum specimens, the published literature and angler reports. They reported the trout cod to have been widely distributed in Victoria with a concentration of reports from the Barmah lowland region extending into the upland regions of the Murray River and its eastern tributaries.

Trout cod were reported to be common in the Upper Mitta Mitta River prior to World War 1. This photograph is of the Mitta Mitta near Angler's Rest in 2006 and this area is probably close to the upper altitudinal limit for trout cod.
(photo: Nick Thorne)

More recently, some of the reports for trout cod distribution utilised by these authors have been questioned (Baxter 1986, Douglas et al 1994) and it has been suggested that some angler reports of trout cod have been the result of misidentification. Some authors have proposed that there is little evidence to support Lake's statement and that 'anecdotal' evidence may be of little or no benefit when trying to identify the habitat preferences of the species in the past. This together with anecdotal data that trout cod may be most active at water temperatures exceeding 25°C has been used to support this contention (Douglas et al 1994, Brown et al 1998). Other authors have suggested that very high temperatures may be detrimental to trout cod (eg Merrick and Schmida 1984) and fish held in both tanks and ponds have perished when temperatures have exceeded 25-27°C for extended periods (observations of NFA members). No peer reviewed study on the general temperature tolerances and temperature preferenda for trout cod has been published to date.

The occurrence of trout cod at higher altitudes and more remote localities has been clouded by the impact of the gold rush on the freshwater habitat of these areas as well as access of these areas to early naturalists. Rhodes (1999), using information sourced first hand from anglers, reported significant trout cod populations in the Murray River at Wodonga, the Kiewa River between Mullindolingong and Tawonga, the Indi River and the upper reaches of the Mitta Mitta River including the Big River. J.O. Langtry in his survey of the Murray River and its tributaries in 1949-50 (Cadwallader 1977) confirmed the existence of significant trout cod populations in the Murray between Barmah and Corowa, and in the Ovens River as well as parts of the Murrumbidgee River. He could not find a single reliable report of trout cod being present in the lower Murray River in the previous fifty years and the species was considered by that time to be rare downstream of Echuca.

A comprehensive review of all historical records of the trout cod incorporating published material, government records, photographs, newspaper articles and personal accounts is being undertaken and is almost completed (Trueman 2006). The evidence collected confirms Rhodes (1999) information and the statements recorded by one angler on the distribution and abundance of the 'bluenose' in some waters in Victoria (McKenzie 1982). It can be concluded that the original distribution proposed by Cadwallader and Gooley (1984) is largely accurate. It appears that trout cod and Murray cod varied in their relative abundance within that range but, at least in some waters, the former was the dominant species of cod encountered by anglers. Either or both species were present in some upland waters with 'bluenose' being reported to have been common in one Victorian River at elevations approaching 800 metres.

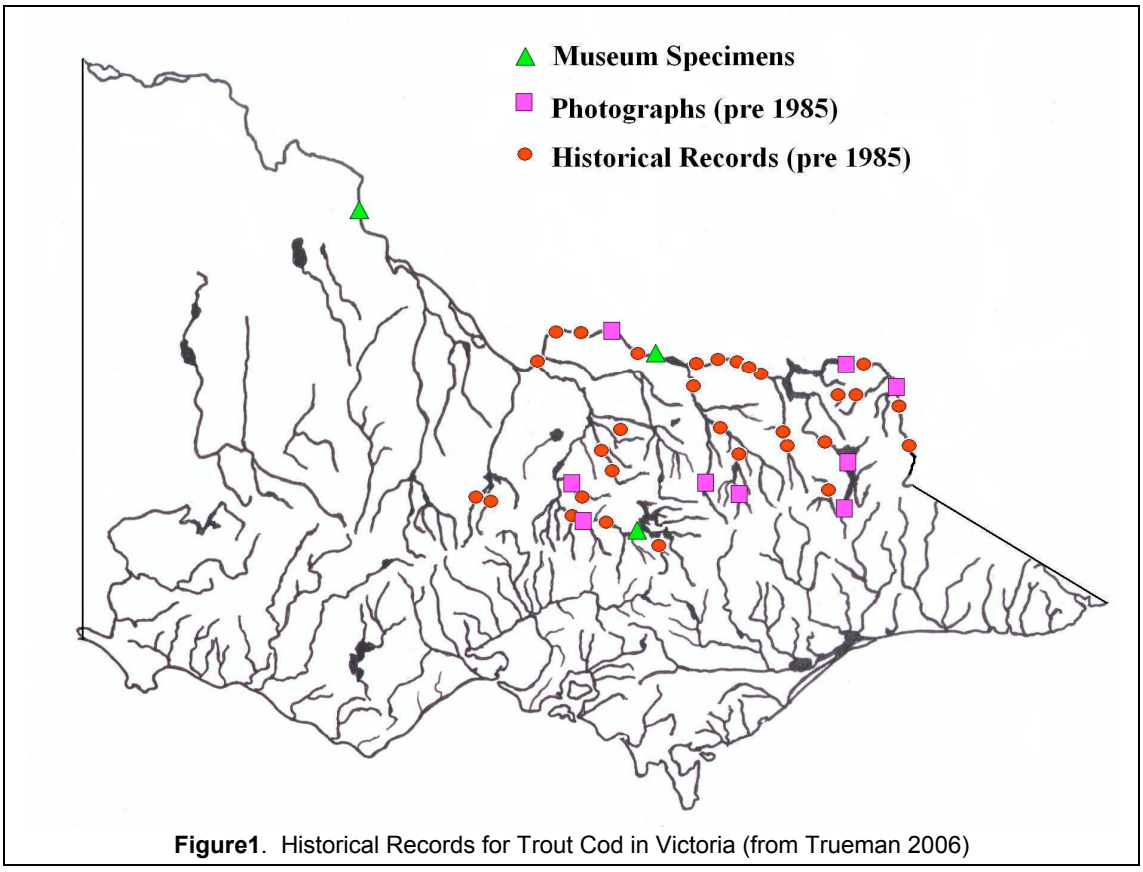


Figure1. Historical Records for Trout Cod in Victoria (from Trueman 2006)

The habitats in which trout cod have been reported to be found in the past fall into distinctive environments:

1. Major foothill rivers of low gradient on the floodplains heavily infested with red gum snags (Murray River at Brimin, Burramine, Barmah; Ovens River at Peechelba);
2. Streams originating on granite plateaus, populations living over rock substrate with modest gradients up to significant waterfall barriers in upland areas, downstream occupying sand and rock substrates with significant redgum snags (Seven Creeks below Gooram Falls, Hughes Creek below Dropmore falls);
3. Modest to large foothill/upland rivers, in some cases with significant gradients and high flow rates during flooding limiting snag accumulation, large pools with gravel substrate or deep rocky holes within gorge areas (Goulburn River from Cathkin to Eildon, Mitta Mitta River from Mitta Mitta to Hinnomunjie, Murray River from Burrowye to Towong, Buffalo River from Nug Nug to Abbeyard);
4. Modest to small upland to montane rivers and streams with significant gradients, gravel pools with boulders interposed between runs (Big (Mitta Mitta) River, Big (Goulburn) River, Indi River , Kiewa River near Tawonga, upper Cudgewa and Berringama Creeks).

Current Status

With the identification of the serious decline of the trout cod, a range of actions have been implemented to conserve the species including habitat protection and a total ban on angling. Internationally it is listed as an Endangered species (IUCN 1988) and in Victoria it is listed as a threatened species under Schedule 2 of the *Flora and Fauna Guarantee Act* 1988.

An action plan was developed in 1988 outlining threatening processes and management activities to be undertaken to improve the conservation status of the species (Reed 1993). The Trout Cod has been listed as Endangered under the Australian Government *Environment Protection and Biodiversity Conservation Act* 1999 (EPBC Act). The first national Recovery Plan for the Trout Cod was prepared in 1994 (Douglas *et al.* 1994), and revised in 1998 (Brown *et al.* 1998).

Since the mid 1980's, recovery programs employing stocked juveniles by Victorian authorities and its counterparts in NSW and the ACT, have enjoyed increasing success (Brown et al 1998, Douglas & Brown 2000, Holder et al 2005). Technology for the artificial reproduction of the trout cod has been available for nearly twenty years (Rimmer 1987, Ingram & Rimmer 1992). However, the actual conditions required for spawning and recruitment in the wild remain unclear, though knowledge is continually improving (Koehn & Harrington 2005, Gilligan & Schiller 2003). It has been reported that spawning takes place when temperatures exceed 15°C with an optimum around 18°C (Koehn 2001, Koehn & Harrington 2006). The peak spawning month in the Murray River below Yarrawonga is November. Early researchers (Cadwallader 1977) reported trout cod spawning in some waters in late September while spent female trout cod have been captured in the Seven Creeks in Late December (Trueman 2006) so the actual spawning season appears to depend upon the local thermal regime. Temperatures below 15°C have been suggested as impacting upon egg and larval survival (Lyon et al 2002).

Stocking strategies for the trout cod have been evolving since their inception based on perceived success or failure of previous stockings. In some cases stocked populations have shown no sign of recruitment for some years with evidence of reproduction appearing over a decade after stocking (Douglas & Brown 2000, Gilligan 2005). The recent rationale has been on stocking fewer locations with larger numbers of fish particularly in larger waters containing more diverse habitat (Douglas et al 1994; Brown et al 1998; Bearlin et al 2002). In New South Wales there is a strong correlation of stocking success with stocking number in the Murrumbidgee River with 44% of fingerlings being released in the lowland zone, 28% in the slopes zone, 17% in the upland zone and 11% in the highland zone (Gilligan 2005).

There is published evidence of stocked populations that are becoming self-supporting through natural reproduction in the Murrumbidgee River near Narrandera and Bendora Dam in the Australian Capital Territory (Lintermans 2005, Gilligan 2005). There is also some evidence for spawning of stocked trout cod in the Murrumbidgee River in the ACT near Angle Crossing (Gilligan 2005). In Victoria there is evidence of reproduction in stocked populations from the Ryan's Creek, the Goulburn River near Murchison and the Ovens River (Brown et al 1998; Douglas & Brown 2000; Koster et al 2004, Border mail 10/6/2006). Some significant populations of stocked trout cod have become established, such as in the Ovens and Goulburn Rivers and possibly Lake Dartmouth. From angler reports there is evidence of some reproduction occurring in. the Broken catchment and the upper Murray River area. The status of the stocked Victorian populations as reported in publications and conveyed to NFA by anglers (in italics) is presented in Table 1 below.

Several management issues have been identified from conservation stockings of the trout cod. Monitoring of stocked populations at times has revealed that juveniles may disperse away from the stocking area both downstream (Douglas et al 1994) and upstream (Ovens system, A. Bosley, pers. comm.). It is known that trout cod stocked into the Murrumbidgee River in the A.C.T. have moved downstream and then upstream into the Goodradigbee River. Initial reports suggested, by the failure to catch released fish, that stocked fish dispersed when reaching a size of 250-300 mm (Brown et al 1998). Radio-tracked hatchery fish have at times behaved very differently from wild fish and in some cases on-grown two year old fish have exhibited high mortality when stocked into waters containing resident trout cod populations and therefore known to be suitable for trout cod (Jekabson 2006).

Table 1. Locations Stocked By Victorian Authorities & Results

(Angler reports presented in italics)

** denotes advanced fingerlings stocked

Water	Years Stocked	Number Stocked	Current Status
Ryan's Creek	1987-91	8000	Good numbers of fish recovered in surveys, up to 1.3 kg by 1993 (Douglas et al 1994); Naturally recruited juveniles captured; Population'disappeared' due to angler removal (Douglas & Brown 2000).. *Reliable reports of anglers catching juvenile tc in the Hollands Creek 2005, possibly originating from a relic population in Ryan's Creek into which it drains*
Hughes Creek	1987-91	1610**	Fish initially survived and were recovered in 1992 (Douglas et al 1994); *Anglers report captures in section adjacent to Hughes Creek rd 1993-94. No further reports*
Koetong Creek	1988-92	8,510	Good numbers recovered in surveys 1990-93, growing to 918 g by 1993. *Anglers report catching tc in the lower reaches of Koetong Creek and adjacent waters of Lake Hume 1996 to present.*
Buffalo Creek	1989-93	9,950	No fish recovered
Broken River	1990-94	11,450	*Regular reports of anglers catching tc upstream of Benalla from 1997. Recent reports of Juveniles (2005) from Hollands Creek may be from Ryan's Creek or a population in the Broken River.*
Coliban River	1990-94	10,450	Initial survival of stocked fish reported by an NFA member.
Buffalo River	1991-94	3,550**	*Reports of anglers catching tc upstream of the Buffalo River dam 1995 – 2000. Recent reports of tc below the dam could be from this stocking or fish moving upstream from the Ovens River.*
Rose River	1991-93	1,850**	*No reports, but reports from Buffalo River may include fish from this stocking.*
Mitta Mitta River & Lake Dartmouth	1993-96	46 400	*Reports of anglers catching tc in the Mitta Mitta River upstream of Lake Dartmouth to Hinnomunje rd bridge 1996. One fish known to have been taken to a shop in Omeo for identification; Regular reports of anglers catching trout cod in Lake Dartmouth weighing up to several kg.*
Goulburn River	1993- 97	58 550	Good recovery of fish. Evidence of reproduction from 2002 onwards. Population adversely affected during a fish kill (Koster et al 2004*). Recent angler reports of small trout cod being taken.*
Ovens River	1997 - 04	259 240	*Anglers report tc outnumbering Murray cod catches in section below Wangaratta 2005. Fish reported common in Everton area, and in the King River below Moyhu. Confirmed captures near Bright in the Ovens, near Edi in the King and below the Buffalo River dam. Unconfirmed captures reported from the Buckland River and the King River near Whitfield.*

While in some cases the 'disappearance' of stocked trout cod may have been produced by movement of the fish out of the area other explanations have been proposed. Increasingly there is evidence that large trout cod are more difficult to capture using methods such as electro-fishing and netting even in localities known to contain numbers of fish such as Seven Creeks and the Murray River (Douglas et al 1994). The difficulty in capturing more mature fish may arise from a more gregarious nature when juvenile evolving to a more solitary, cryptic lifestyle. In impoundments it is believed that the larger fish seek out deeper water (Brown et al 1998) and this may be true in riverine environments. Angling has proved to be a reasonably useful method with NFA being called upon to assist in a number of population surveys. NFA's Native Fish Challenge (part of NSW Fisheries Angler Catch Research program) has been conducted on the Murray River between Lake Mulwala and Cobram annually since 1995. The results from this activity, including species identification and length measurements, are recorded. Anglers report captures of stocked trout cod exceeding 5-7 kg in a number of other waters.

The disappearance of stocked fish has also occurred as a result of illegal removal by anglers. The early stocking protocol was to release trout cod fingerlings for four consecutive years and then cease stocking to monitor for reproduction and recruitment. However, this may have allowed these populations, having initially reached the critical mass of mature fish needed for reproduction, to decline through illegal fishing. Fish are known to NFA to have been removed by anglers from the Ryan's, Koetong and Hughes Creeks and the Buffalo and Mitta Mitta Rivers and a number of other waters (Lintermans et al 2005). Douglas and Brown (2000) reported the extinction of the Ryan's Creek population through illegal fishing despite evidence of reproduction and recruitment.

There is increasing evidence that the natural trout cod population in the Murray River below Yarrawonga is expanding and moving downstream as far as Echuca and into the Edwards River (R. Clifford, pers. comm.). There has previously been concern for this population as there had been some evidence for a lack of recruitment in some years (Brown et al 1998). It is possible that the fish being caught are stocked fish dispersing downstream from the Ovens River. However, the scale and speed of the expansion suggests that there has been enhanced natural recruitment in recent years, possibly through improved hydrological management of the river.

The Murray River trout cod population is expanding downstream
(Photo: Ray Clifford)

Although significant populations of trout cod have become established in some areas and reproduction has occurred, the potential for calamity still exists. In the case of the Goulburn River at Murchison success appeared to have been achieved with the establishment of a considerable number of adult fish and the capture in 2003 of larvae and one year old juvenile trout cod in the area. However, since an unexplained massive fish kill downstream of the Goulburn Weir in January 2004 in which trout cod were known to have died the status of the population remains uncertain (Koster et al 2004). The recent capture (December 2005) of a 35 cm trout cod at Murchison (Phil Stathis, pers. comm.) may indicate that progeny from that population have survived.

Bushfires in the upper Ovens catchment while temporarily impacting on water quality do not seem to have adversely affected the trout cod population in that system. Nonetheless the potential for disaster remains for all

populations and security for the species will only be guaranteed when a significant number of populations are established in different environments, preferably with some ability to move between these locations.

Given all the information of the recovery programs for the trout cod of the past twenty years it can be concluded that the conservation status of the species has shown some improvement. With the establishment of at least several additional recruiting populations there are positive signs for the long-term survival of the trout cod. Some major issues still remain, such as the long-term persistence of stocked populations, and the Murray River and Seven Creeks populations exhibit concerns for regular recruitment and dispersion (Brown et al 1998). Nonetheless there is genuine hope that in the near future the conservation status of the trout cod will be improved with the potential for some type of regulated angling created (Holder et al 2005).

Recreational Angling

In the past when more abundant, the trout cod and its close relative the Murray cod formed important parts of the commercial fishery of the Murray-Darling system. Murray cod was, and remains, an important target of recreational fishes and there are some surviving records indicating that trout cod too were popular targets of anglers in at least some areas (McKenzie 1982, Rhodes 1999).

In contemporary times with the development of modern sportfishing techniques the species, while remaining enigmatic to most anglers, is becoming recognised as a potentially outstanding sportfish by those fortunate enough to have encountered them. It has gained an almost legendary reputation as a ferocious, powerful predator that freely takes artificial lures and flies. As such its perceived status as a potential sportsfish compares favourably with iconic species such as Barramundi (*Lates calcarifer*), Australian bass (*Macquaria novamucleata*) and the introduced salmoniids. The trout cod can therefore be considered an asset of untapped potential for recreational angling and the economic benefits which come from this activity (Porter 1989).

There is evidence that the current stockings of large numbers of trout cod for conservation purposes in the Ovens and Murrumbidgee catchments combined with the ban on angling or attempted angling for the species is having a negative impact on the image of the species with recreational anglers. This is in sharp contrast to the Mary River cod (*M. peelii mariensis*) which, while also listed as endangered, has been stocked into a number of impoundments where it can be targeted by anglers. Currently within Queensland there is a bag limit of one fish from prescribed stocked waters and no take from streams within the natural range of the Mary River cod. Some stocked impoundments are adjacent to these streams and catch and release angling in the latter is legal in satisfying 'no take', though not promoted. This action has created positive angler perceptions for this species and a high community profile (Lintermans et al 2005).

Trout cod aggressively attack flies and lures giving them enormous angling potential
(photo: Adam Bosley)

In the larger rivers, such as the Ovens and Murrumbidgee, where Murray cod are the primary target of anglers, there are reports of the trout cod being considered to be a 'pest' (Fishnet.com postings, Lintermans et al 2005). Anecdotal reports to NFA members on the Murray River below Yarrawonga suggest that some anglers deliberately kill trout cod because of this perception. With the species dispersing over large distances within these systems there is little prospect of enforcement officers controlling such activities.

Trout angling is an important economic activity in Australia including many areas of Victoria. Some trout anglers have a negative perception of trout cod stocking for a number of reasons. Firstly, in a number of areas adjacent to trout cod stockings the liberation of trout by DPI Victoria has previously been halted (King River below Lake William Hovell, Ovens River below Bright, Ryan's Creek). Despite evidence that in most seasons natural recruitment of trout is sufficient to sustain these trout fisheries, in these waters there is a perception that these fisheries are under threat. The proposed stocking of brown trout into the Buckland River to assist that

population in recovering after bushfires, despite the presence of trout cod in the Ovens system and indeed in the Buckland River, should be reassuring to trout anglers. The negative image of the trout cod is exacerbated by the fact that the waters are being stocked with a fish which cannot be the target of angling (King Valley News & Issues, 4/6/2002).

Secondly, there is a fear of many trout waters being returned to the trout cod. While it is true that there is evidence that some contemporary trout waters were formerly populated by trout cod, there were others, e.g. above significant barriers or outside the Murray-Darling catchment, that were not. Further, many original trout cod habitats have been drastically modified by human activity so that it is unlikely that in the foreseeable future that they could once again contain self sustaining populations of this species. However, despite these facts the perceptions of some Murray cod and trout anglers may be working against the conservation goals of current recovery stocking activities for trout cod. This can be as simple as not reporting captures of trout cod which is information of great value to those managing recovery efforts.

There is increasing evidence that, through recovery stocking programs, the risk of extinction of the trout cod has diminished and its conservation status has improved and should continue to improve within the Australian context. Therefore, anglers have requested that some type of angling for the trout cod in Victoria should be considered. Indeed, it has been foreshadowed that some form of highly regulated angling may be considered in New South Wales, in the near future, with further relaxation of controls if widespread recovery takes place within fifteen years (Holder et al 2005, Lintermans et al 2005). Considering the example of the Mary River cod, there appears to be no justifiable obstacle to the immediate creation of catch and release or controlled harvest fisheries for trout cod in designated waters.

The Victorian Branch of NFA considers the development of regulated recreational fisheries for trout cod to be highly desirable and feasible in the near future, with the proviso that such activities should not adversely impact current recovery activities. Moreover, we see potential benefits from the development of such fisheries to the economy, the public perception of the trout cod, and scientific knowledge of the species as well as the potential of enhancing current conservation activities.

Legal Aspects

The trout cod is listed internationally as endangered on the IUCN Red List of Threatened Species (IUCN 2003). Federally, it is listed as endangered under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* and is considered critically endangered by the Australian Society for Fish Biology. Interstate the trout cod is listed in New South Wale and the Australian Capital Territory under their respective acts of parliament. In Victoria, the trout cod is listed as a threatened species under Schedule 2 of the *Flora and Fauna Guarantee Act* 1988 and current angling regulations prohibit the taking or the attempt at taking trout cod by angling.

The Macquarie perch, *Macquaria australasica*, is also listed under the *Flora and Fauna Guarantee Act* 1988 as a threatened species. The act provides for the issue of permits to allow activities not impacting upon conservation goals to take place. In the case of Macquarie perch the Recreational Inland Angling License has been prescribed as a permit for holders to take by angling and retain Macquarie perch from three nominated waters by regulation (Dartmouth Dam, Yarra River & Upper Coliban Dam) under certain conditions (size & bag limits, closed season).

The legal example of regulated angling for a species listed under the *Flora and Fauna Guarantee Act* exists in the case of Macquarie perch and can be used as a model for the legalisation and regulation of recreational trout cod fisheries within the existing legal framework. A national example exists in Queensland with the Mary River cod, which is listed under the *Environment Protection and Biodiversity Conservation Act 1999* as endangered. The National Draft Recovery Plan for the Mary River cod specifically provides for recreational fisheries for that species to facilitate its objectives and encourage community participation and ownership in the recovery process. While enjoying the same conservation status as the trout cod, Mary River cod have been stocked into a number of impoundments for dual conservation/recreational angling goals where it can be targeted by anglers under controlled harvest conditions. This action has had positive effects on community awareness and angler value for this species without significantly impacting conservation goals (Lintermans et al 2005).

The current National Draft Recovery Plan for trout cod (Brown and Nicol 1998) does not discuss the use of recreational fisheries as a tool to achieve its objectives, however, it strongly advocates angler involvement in the recovery process. That DPI Victoria are considering the establishment of a recreational fishery for trout cod in Lake Kerford demonstrates that such a fishery is possible within the objectives of that plan. It is understood that consideration is being given to including in the new National Draft Recovery Plan the specific development of recreational fisheries for trout cod as developed with the Mary River cod. The recent N.S.W. Draft Plan (Holder et al 2005) also foreshadows the development of recreational fisheries for trout cod.

It can be concluded that there are no legal obstacles to the introduction of controlled recreational angling for the trout cod in Victoria and that precedents exist. Careful consideration however, will have to be given towards the conditions for permit holders (ie, anglers holding the recreational licence) so that negative impacts on populations of trout cod stocked for conservation purposes are avoided or minimised. In proposing the action of legalising highly regulated angling for trout cod within Victoria, potential impacts interstate need to be taken into account.

At this point in time a fishery based on keeping angled fish for consumption needs to be considered. The ability to retain even a single trout cod within an angler's possession could cause problems with individuals potentially taking fish surreptitiously from protected waters and claim to have taken them from 'open' waters. No doubt this potential exists in Queensland with the Mary River cod where anglers are permitted to have one in their possession taken from designated waters, some of which are adjacent to wild populations protected with a 'no take' regulation.

A potential for conflict could be created interstate with anglers in those areas claiming legitimate possession of 'Victorian' trout cod. Even if possession was still illegal in other states interstate offenders may avoid conviction under the Australian Constitution through 'free trade and intercourse' provisions. Therefore any move to legalising the controlled taking, possession and removal of trout cod from nominated waters will have to be carefully considered in consultation with interstate management authorities.

Possible options for trout cod fisheries include catch and release, designed to minimise any loss of fish from a population, or controlled harvest fisheries regulated by closed seasons and size and bag limits. Catch and release fisheries for trout cod would expose many anglers to the species and have a positive effect on their perceptions. While largely preserving a stocked population it is acknowledged that catch and release fishing may have some impact on the population through angling induced mortality. For a significant number of anglers this would be welcomed as many anglers similarly release most of the Murray cod that they capture (Lintermans et al 2005). However, amongst some anglers the retention of fish for consumption is important and only through the ability to keep fish would their perception of the trout cod improve.

Clearly the greatest ambiguity lies in identifying fish held in an angler's possession, away from the capture location, as coming from a recreational fishery allowing possession or removal from a protected conservation population. For some time fingerling trout cod have be marked chemically to allow identification of fish produced through natural recruitment (Brown & Harris 1995). There is the possibility of marking fish stocked for controlled harvest to distinguish them from fish stocked for conservation purposes or wild fish with no mark. This would not provide any advantage in the field to enforcement officers attempting to identify illegally taken fish. However, if it is publicised that the fish are chemically marked and that they can be identified as part of a prosecution brief then this may act as a deterrent to those anglers considering the removal of fish from conservation populations

Given the current circumstances, it would appear relatively simple to develop catch and release fisheries for trout cod within the short term, say five years, without compromising recovery efforts. Controlled harvested fisheries may be possible, given the similar circumstances of the Mary River cod which is in at least a precarious position as the trout cod. In fact, it is difficult to argue against controlled harvest in waters well away from those receiving conservation stockings when a similar example has worked with the Mary River cod. If the Ovens River population shows evidence of recruitment then some sort of controlled harvest fishery will be necessary in the future to improve the perceptions of local anglers.

It would be prudent though as a first step to develop catch and release fisheries for trout cod and then introduce controlled harvest or put and take fisheries as a second step while stocked populations are developed and assessed. Similarly catch and release or even controlled harvest from conservation stockings in waters such as the Ovens River and Lake Dartmouth may be possible they if they show good recruitment. Given the advances in the conservation efforts directed towards the species it is conceivable that such scenarios could be viable within the short to medium term.

Criteria for Recreational Fisheries

The stated aims of this proposal are to identify suitable waters and recommend the development of recreational trout cod fisheries in them. Due to the fears of some stakeholder groups such as trout and Murray cod anglers it is considered an opportune time to present some short, medium and long term proposals for recreational fisheries to include trout cod. This will allow the opportunity for these various groups to work together to form long term goals in a cooperative environment, without fear of a hidden agenda. The outline of such goals at this point in time may help to dispel the perception that trout fisheries are under threat.

In addition by providing recreational fisheries for trout cod in the short term, particularly in areas not too far distant from recovery stockings, this may provide some sort of 'compensation' to anglers, particularly Murray cod and possibly trout anglers, being impacted by those activities. In addition these new fisheries may provide economic and social benefit to those communities adjacent to these waters.

NFA believes that, philosophically, as a long term goal at least one native fish 'corridor' should be created in northern Victoria reflecting assemblages of fish along its length and at various altitudes representing what was present before European settlement. Such a corridor would be open to angling and may well incorporate mixed fisheries of native and valuable introduced fish but be managed primarily in the interest of the native fish. Barrett (2005) described the concept of a 'demonstration reach', a section of river where a coordinated attempt is made to address the major fish community and environmental degradation issues. Such actions include improvements to environmental flows, riparian vegetation, fishway construction and barrier removal, alleviation of thermal pollution, re-snagging and control of detrimental alien species such as European carp.

The lower section of the Ovens River, downstream from Wangaratta to the Murray River, has been designated a Heritage River because of the quality of its floodplain habitat and its significant Murray cod population (Cottingham et al 2001). Given that the Ovens River catchment is largely unregulated and has few barriers to fish migration the lower Ovens and one major tributary such as the Buffalo River would be good candidates for a demonstration reach or native fish corridor.

Another candidate, while technically not within Victoria, is the Murray River upstream of Lake Hume. From one perspective, the upper Murray appears less desirable than the Ovens option as the Hume Dam provides an insurmountable barrier to the movement of fish. In addition it does have a disturbed thermal temperature regime from irrigation waters from the Snowy Mountains scheme (Ryan et al 2002). Nonetheless it remains attractive due to the great length of foothill and upland habitat and the freedom of barriers upstream of Lake Hume. From this perspective the upper Murray is perhaps an even better candidate than the Ovens River, at least for foothill/upland species such as trout cod, Macquarie perch and Murray cod. A desirable corridor would include part of the upper Murray River and the lower reaches of a tributary creek. Other Rivers in Victoria have significant barriers and/or have been drastically altered from their original conditions through irrigation and habitat degradation.

In addition NFA believes that a similar corridor should be created in east Gippsland to preserve assemblages of native fish in the coastal drainage such as bass, grayling, blackfish, tupong and a range of galaxias. It is emphasised that these corridors would be open to angling. The selection of such corridors is not the purpose of this report, such a proposal in itself requiring a large quantity of environmental data and extensive consultation with all stakeholder groups. However, by stating a generational goal for the future NFA believes that it may allay fears of wholesale change to trout fisheries.

Other than these waters and any identified for specific conservation needs NFA believes each water should be managed on a case by case basis to provide the best angling opportunities, whether they be with native fish, introduced fish, or realistically in many other cases mixed fisheries. NFA accepts the concept of classification of waters as suggested by some angling groups provided that basic conservation objectives are met and native fish anglers are provided with some quality foothill and upland fisheries.

Apart from a couple of designated native fish corridors NFA believes the development of a range of regulated recreational fisheries for trout cod to be feasible in terms of short, medium and long term goals. These include the provision of one or two dedicated trout cod fisheries and options for providing mixed fisheries or supplementing existing mixed fisheries. In all cases there is the overriding proviso that such activities should not adversely impact current recovery activities. Collected data could then be used to develop models for managing angling activities in all areas for this species.

A number of other waters have been put forward to NFA as possible trout cod fisheries in various forums by individuals and other groups. These include Lake Eildon, Lake Dartmouth, Lake William Hovell, Lake Buffalo, Lake Sambell, Lake Kerford, Lake Eppalock, Goulburn River (Trawool-Nagambie), Lake Hume and the Murray River upstream, Buffalo River (above the dam), Mitta Mitta River (both above & below Dartmouth Dam), Cudgewa Creek, King River upstream of Lake William Hovell, Broken River (both upstream and downstream of Lake Nillahcootie), Yea River, Yarra River, Campaspe River, both upstream and downstream of

Lake Eppalock, Hughes Creek (between Dropmore & Ruffy) and the Seven Creeks (upstream of Polly McQuinns Weir).

In identifying potential waters for the development of recreational fisheries many factors need to be considered. These factors may be different from those considered as requirements for conservation stockings, as the primary goal is to develop recreational fisheries. However, wherever possible recreational stockings should complement current conservation activities. NFA considers the following criteria need to be considered when identifying potential waters for the establishment of recreational trout cod fisheries.

Such fisheries should:

1. Not have significant adverse affects on conservation stockings by Victorian authorities either directly or indirectly;
2. Not have significant adverse effects on populations of native fish of conservation significance such as Macquarie perch and Murray cod;
3. Must be within the known former distribution of the species, or at least within the catchment of a previous confirmed population or an existing translocated population;
4. Have environmental conditions (eg temperature, cover, minimal predators) indicating a high probability of stocked fish surviving;
5. Have the potential to establish a population which is at least partially self supporting through natural recruitment;
6. Require modest fingerling numbers, in the short term, so as not to require significant increases in production by the Snobs Creek facility, thereby minimising costs;
7. Ideally be located in a catchment which contain natural or stocked populations of trout cod so that juveniles leaving the stocking area can link up with and recruit into these populations;
8. Be accessible to anglers, but ideally have sections with difficult access to provide refuge from angling activities to support recruitment;
9. Be strategically positioned for access by researchers, managers and enforcement officers;
10. Ideally be close to regional centres which can receive economic benefit;
11. Ideally should have minimal impact on existing recreational fishing opportunities;
12. Lend themselves to a range of sportfishing techniques including bait, lure and both wet and dry fly fishing, at least in the long term;
13. Provide opportunities for valid scientific studies into the impact of recreational angling and exotic fish species on trout cod populations as well as providing additional information on the habitat requirements and biology of the species.

Management of Recreational Trout Cod Fisheries

Trout cod are known to be highly susceptible to angling - this having been suggested as one of the causes for its decline in some locations (Douglas et al 1994). This property is however, a double-edged sword acting against conservation of the species but giving it the potential to develop reliable and exiting recreational fisheries. Even though the aim of the proposed fisheries is to provide angling, conservation of stocked populations remains important. This is so as to give such fisheries the potential where possible to be self supporting, rather than just be put and take, as well as meeting general conservation objectives. Therefore the types of fisheries envisaged, and associated management practices, need to take these principles into account.

The fishery likely to have the least impact on a stocked population is a catch and release fishery where all fish must be returned unharmed to the water immediately after capture. However, return to the water does not guarantee survival as angled fish can sustain fatal injury through internal damage by hooks or external damage through rough handling (Muoneke & Childress 1994). Previous experience of NFA members in capturing trout cod brood stock indicates very high survival rates of angled fish if handled correctly.

Mortality of captured fish is most likely to occur when bait fishing if the hook lodges in the sphincter at the back of the throat, while fish completely ingesting hooks generally survive. If catch and release fisheries are envisaged for trout cod it may be desirable to employ an artificial lure only regulation to reduce the risk of hook ingestion. Such regulations have been applied to some trout fisheries in the past with general angler acceptance. Similar acceptance for a lure only regulation for a trout cod fishery is only likely to enjoy such acceptance if it is the principle species present, i.e. a dedicated fishery. However, if catch and release fisheries for trout cod in existing mixed fisheries are to be legalised in the short term then a regulation requiring those anglers specifically targeting trout cod to use flies and lures could be applied. This would minimise loss of trout cod through increased angling pressure specifically targeting them. Anglers targeting other species could continue to use other methods with minimal net change to the angling mortality rate.

Occasionally trout cod suffer cramp after capture possibly through acidosis created by excessive muscle activity, especially when the fish is landed without the use of a landing net. Experienced NFA members have learnt to recover such fish through massage but this could not be expected from the general angling community. Rough handling can lead to external damage and ultimately fatal fungal and bacterial infections. For these reasons it is possible that even in a catch and release fishery for trout cod, angler induced mortality could reduce the population over time if there is no stocking or natural recruitment. Ongoing stocking may be required to replace fish lost through this cause and illegal removal, the latter of which could be a significant problem as suggested in the case of Ryan's Creek (Douglas & Brown 2000).

Controlled harvest fisheries for trout cod pose the same problems as those encountered in the management of existing Murray cod fisheries. Size regulations and bag limits designed to give Murray cod the opportunity to reproduce have resulted in strongly biased size distributions within populations. Even though anglers are believed to voluntarily release over 77% of the Murray cod that they catch their activities have been demonstrated to have significant effects on populations such as distorting the distribution of year classes within the population (Nicol et al 2005a). A similar result can be expected with stocked trout cod populations in controlled harvest fisheries.

Population viability analysis allows managers to develop regulations for controlled harvest fisheries to ensure their sustainability and such analysis are being conducted on Murray cod in the Murray River (Todd et al 2005, Nicol et al 2005a). Such monitoring and analysis of controlled harvest trout cod fisheries will be required to adjust stocking programs and regulations. However, some basic regulations can be proposed at this point in time with the knowledge that is currently available.

If controlled harvest of trout cod from dedicated fisheries takes place in the future then, as previously discussed, there is the potential for removal of fish from conservation populations. At the present time there is a bag limit of two Murray cod in Victoria. To limit the potential impact it is proposed that, until the conservation status of the trout cod significantly improves, that a bag limit of one fish be applied to controlled harvest trout cod fisheries.

With regards to size limits Murray cod currently have a minimum size limit of 50 cm, this limit being imposed on the basis that at this size many fish will have had the opportunity to reproduce to least once (Nicol et al 2005a). Trout cod are reported to breed at a smaller size than Murray cod reaching sexual maturity at 3-5 years in a weight range between 0.75 and 1.5 kg. Male trout cod as small as 35 cm have been found to be mature, while females may be mature at 43 cm (Brown et al 1998).

In principle a smaller size limit could be imposed for trout cod but given the fact that some anglers have difficulty or are unwilling to distinguish between the two types of cod it is proposed that the same size limit be applied to both species. This may provide individual trout cod with a number of opportunities to reproduce prior to their harvest by anglers. However, if in some cases trout cod grow rapidly then the situation could arise

where even fish 50 cm long will have not had the opportunity to reproduce. A good case can be made for having a size limit of 60 cm for both species of cod. Given the fact trout cod under certain conditions may become dispersive, it may be appropriate to allow harvest at a smaller size prior to dispersion if 'put and take fisheries' are developed. This will in the future require consideration on a case by case basis.

At the present time a closed season (September 1 – November 31) for the taking of Murray cod is applied to protect populations during reproduction. Murray cod, as well as trout cod, are known to be susceptible to angling prior to spawning. In addition it has been demonstrated that handling cod species prior to spawning can lead to resorption of ova and after spawning could lead to nest abandonment (Rowland et al 2005). In the case of the trout cod population in the Murray River below Yarrawonga a total ban on angling within that water during the breeding season has probably benefited both cod species.

Given the hope that populations of trout cod established for recreational angling may reproduce it would seem adequate to apply the same closed season to this species as is applied to Murray cod. The practical value remains questionable given the fact that angling can continue within mixed fisheries and trout cod, and indeed Murray cod, can be inadvertently captured. This is unavoidable in mixed fisheries. However, where dedicated fisheries for either Murray cod or trout cod are established and are not managed as 'put and take' fisheries it would be desirable to ban angling in those waters containing those fisheries within the reproductive season. In fisheries with cooler thermal regimes it may be necessary to have a closed season encompassing December as is utilised for the Macquarie perch population in Lake Dartmouth.

Another management issue is the preservation of genetic diversity in stocked populations of trout cod. Recent management plans (eg. Holder et al 2005) have outlined protocols in the use of broodstock to maximise genetic diversity in founder populations of trout cod being established through stocking. While the proposed development of recreational fisheries for trout cod has a stated goal of making the species available to anglers, populations created to provide these fisheries will also make a significant contribution to its conservation. A lack of genetic diversity has been identified in recovery plans as a potential threat to the recovery of the trout cod. Given that some of the potential waters for the creation of new fisheries are contiguous or adjacent to conservation populations fingerlings utilised to create these fisheries must be produced using the protocols in the recovery plans.

In summary it is proposed that initially the same size limit and closed seasons are applied to controlled harvest fisheries for trout cod as is currently applied to Murray cod, but a bag limit of one fish be imposed. In the future if fisheries are created where trout cod and Murray cod are the principle angling species then consideration should be given to closing such waters to angling for a few months to protect breeding fish. Peak groups representing trout anglers advocate bans on angling in trout streams to protect spawning trout. Designated trout waters are totally closed to angling during the trout-spawning season in Victoria. Anglers can continue to fish in open waters containing mixed fisheries but not take trout. If such actions are applauded as sound management then equally support should be forthcoming for closing a small number of waters containing dedicated recreational fisheries for trout cod and other natives during the reproductive season. As in the existing model for mixed fisheries containing trout, angling could continue during the native closed season in mixed fisheries, as is currently the case.

Environment & Habitat

Previous conservation stockings of trout cod have included streams, small to large rivers and artificial impoundments. All three types of habitat have examples where stocked fish have survived as well as failed. Brown et al (1998) suggested that some of the failures of stocked fish that have occurred have been due to inappropriate selection of waters and that the fish have done best in larger water bodies with diverse habitat. Indeed the failure of stockings of trout cod in the Coliban River may be attributed to extremely high temperatures and low dissolved oxygen levels in subsequent years (dissolved O_2 down to 1.5 ppm in 1991 and 1.8 ppm in 1999, maximum temperatures exceeding 30°C). However, caution has to be exercised in considering past examples due to the different stocking regimes employed and the survey methods used.

Streams, rivers and impoundments represent distinctive types of recreational fishing opportunities. Each type of water body has its own advantages and disadvantages, which need to be considered. Angler familiarity with trout cod largely comes from the Murray River population and the Seven Creeks population in the past when the sections containing trout cod were open to angling. While Lake Sambell at Beechworth is reported to have contained a thriving trout cod fishery after world war two (Trueman 2006) few people alive can recall it and these is no contemporary example available for comparative purposes. However, the recent reports of regular catches of trout cod from Lake Dartmouth may provide some sort of future model for impoundments particularly if the fish reproduce.

Streams have the disadvantage that they have limited capacity to sustain angling pressure particularly if fish are being removed from the population or suffer significant mortality from angling activities. However, those that have fished the Seven Creeks in bygone years and caught trout cod on artificial lures and flies rate those experiences highly. If a stream fishery can be established for trout cod it is considered to be a wonderful opportunity to showcase the angling attributes of the species for modest effort. Examples of stocked fish being recovered include the Ryan's and Koetong Creeks while stockings apparently failed in the Buffalo Creek and middle reaches of the Hughes Creek.

Rivers are larger and with more diverse habitat than streams consequently have a greater ability to withstand angling and environmental pressures. At the present time anglers, targeting Murray cod, catch trout cod in larger rivers such as the Murray River below Yarrawonga and the lower Ovens, lower Goulburn and upper Murray Rivers. Due to their nature these rivers lend themselves to bait fishing and boat-based lure casting and trolling but less so to fly-fishing and lure casting from the bank. It is considered that smaller upland rivers with clearer water may provide greater opportunities for a wider range of angling techniques. NFA considers that stocking a modest river at greater elevation than those containing existing populations would showcase the angling attributes of trout cod as well as returning the species to a habitat that was one of its former strongholds.

Lakes represent quite different angling environments to streams and rivers. While they do provide land based fishing opportunities modern sportfishing practices often centre on bait, lure casting or trolling from boats. There is little past experience to judge the potential of trout cod impoundment fisheries. Lake Sambell had a small fishery from 1928 to 1970 where anglers targeted fish by bait fishing from the bank. The stocked population in Bendora Dam is not accessible to anglers through its use as a domestic water supply. Some stocked trout cod have been captured in Lakes Dartmouth and Talbingo. The nature of an impoundment fishery remains speculative but can be compared perhaps to that achieved with Murray cod in waters such as Lake Eildon. Impoundment stocking does have the advantage that the fish can be confined to a limited area for monitoring and assessment if the water selected is modest in size.

Ideally, from the perspective of gaining maximum information for modelling future recreational fisheries as well as comparing habitat requirements, attempts should be made to establish separate fisheries in examples of stream, upland river and impoundment environments.

In selecting waters for the development of recreational fisheries the potential for the stocked fish to survive is paramount with secondarily the potential to breed and recruit. The latter characteristic may be important for sustaining the fishery and supporting long term conservation goals, although some fisheries may require ongoing stocking. There is limited biological data available on the tolerances of trout cod to environmental parameters such as temperature and dissolved oxygen. Available data suggests that reproduction requires temperatures exceeding 15°C with an optimum around 16-18°C to be maintained in the spawning season some time from late September to late December (Koehn & Harrington 2005, Trueman 2006). Some preliminary computer models, based on the Murray River below Yarrawonga, have been developed representing temperature regimes under which successful spawning and egg and larval survival can occur (Todd et al 2004). Instream cover such as snags, boulders and underwater ledges are known to be important habitat requirements (Nicol et al 2005b).

In the absence of specific data it is perhaps useful to holistically consider environments in which contemporary trout cod populations occur. In Victoria there are significant populations surviving in Seven Creeks and the Murray (technically in NSW), Ovens and Goulburn Rivers. Reproduction is known to have occurred in all four waters and ongoing recruitment in Seven Creeks and the Murray River. These waters can be used as guides for identifying waters suitable for the development of recreational fisheries.

Apart from survival, temperature also influences the activity of trout cod and hence the quality of the angling. In the past, NFA members have caught trout cod year round, in both the Murray River and the Seven Creeks. Based on actual temperature measurements recorded by NFA members and relating catches to the temperature regimes in the Murray River and Seven Creeks the quality of angling correlates well with water temperature. Trout cod have been captured by anglers when water temperatures have been well under 10°C, and as low as perhaps 5°C, but aggressively attack lures when temperatures exceed 15-16°C.

Therefore temperature regimes not only can be used to identify waters where stocked trout cod may survive and reproduce but may also be indicative of the potential quality of the angling and duration of the angling season. Indeed introduction of trout cod to recreational fisheries may be useful for mixed fisheries showing high seasonal temperature fluctuations particularly elevated summer temperatures at moderate to high altitudes including many impoundments. By stocking trout cod, excellent summer angling could be provided when trout activity is reduced due to high temperature and excellent winter angling provided by trout, in designated impoundments not covered by a closed season for trout, when trout cod activity is suppressed by low temperatures.

Some general environmental data for these waters containing significant trout cod populations is presented in Table 2 below and average maximum monthly water temperatures compared in Figure 3 below. In the case of the Ovens River, data on the section between Myrtleford and Everton has been presented even though the much of the trout cod population in this system is downstream of Wangaratta. Regular angler captures indicate the presence of good numbers of trout cod immediately downstream of Rocky Point and, being further up the river, it is considered that environmental parameters in this area may provide some sort of guide for foothill/upland type habitat requirements.

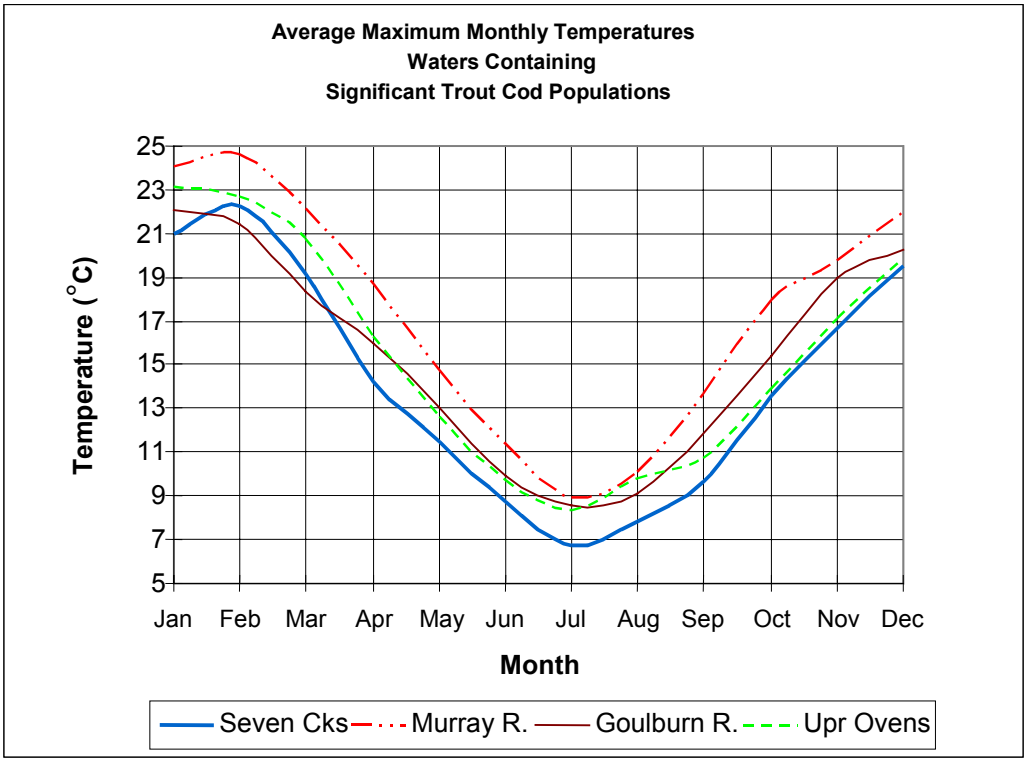


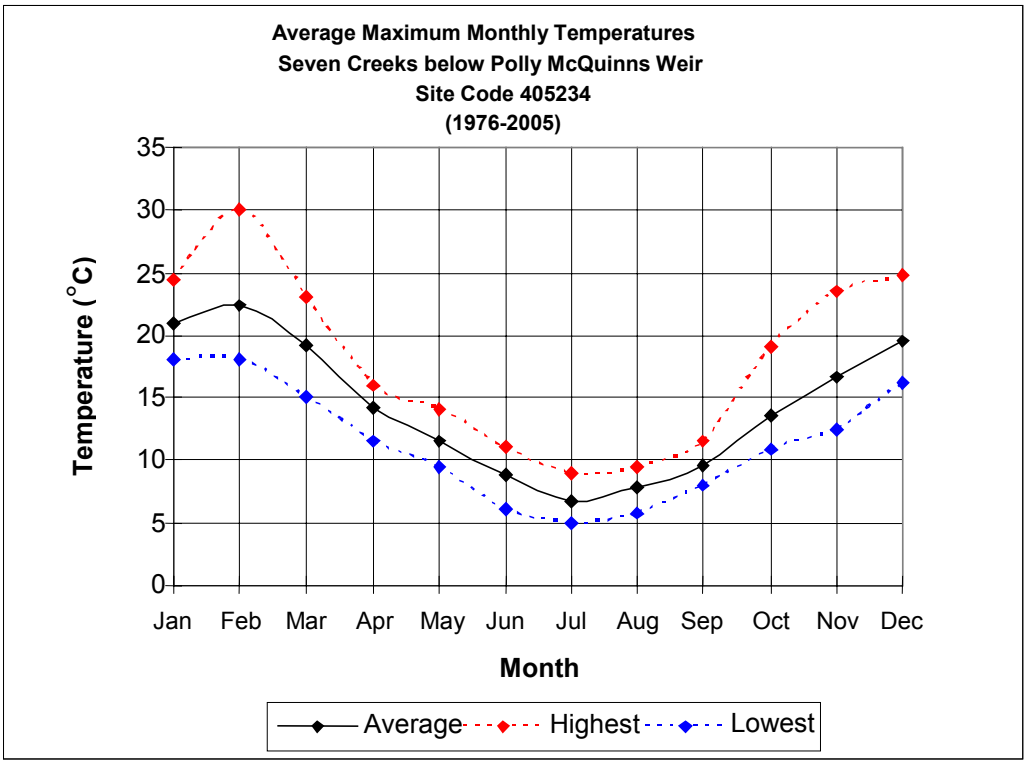
Figure 3. Maximum Water Temperatures for Recruiting Trout Cod Populations

Table 2. Environmental Data for Significant Trout Cod Populations

(** extremely low dissolved oxygen levels, not recorded, are believed to have occurred in the Goulburn River, resulting in a fish kill)

Parameter	Seven Creeks Below Polly McQuinns Weir	Murray River Yarrawonga - Tocumwal	Goulburn River Murchison	Ovens River Myrtleford- Everton
Min-Max Average Daily Flows (ML/day)	19 (March) - 222 (September)	7684 (March) – 26532 (September)	509 (March) - 6447 (September)	512 (March) - 7084 (September)
Minimum Recorded Dissolved Oxygen (ppm)	3.70	6.40	4.00 **	6.8
Max-Min Temperature Range (ºC)	30.0 - 5.0	28.0 - 7.5	26.5 - 7.2	26.7 - 6.80
Mean October Max. Temperature (ºC)	13.6	17.9	15.4	13.9
Mean November Max. Temperature (ºC)	16.6	19.8	19.0	17.1
Mean December Max. Temperature (ºC)	19.5	22.0	20.2	19.9
Number of Months Mean Maximum Temperatures Exceed 10ºC	8	10	9	9
Number of Months Mean Maximum Temperatures Exceed 16ºC	5	7	6	6

Figure 4. Maximum Water Temperatures for Significant Trout Cod Habitats



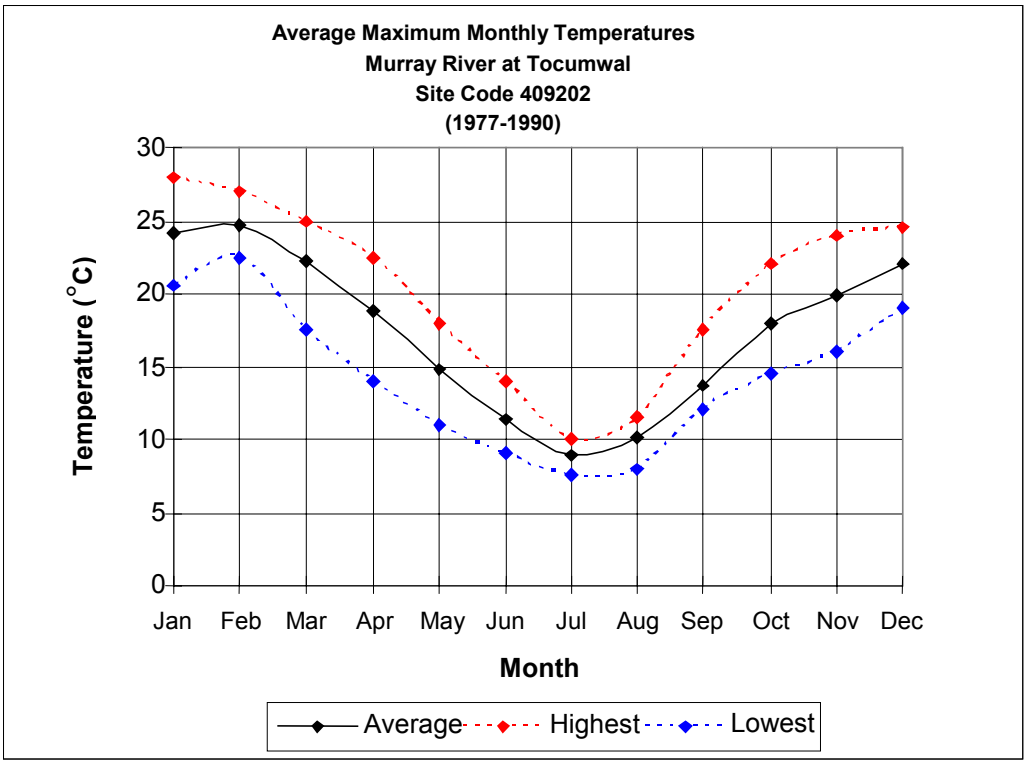
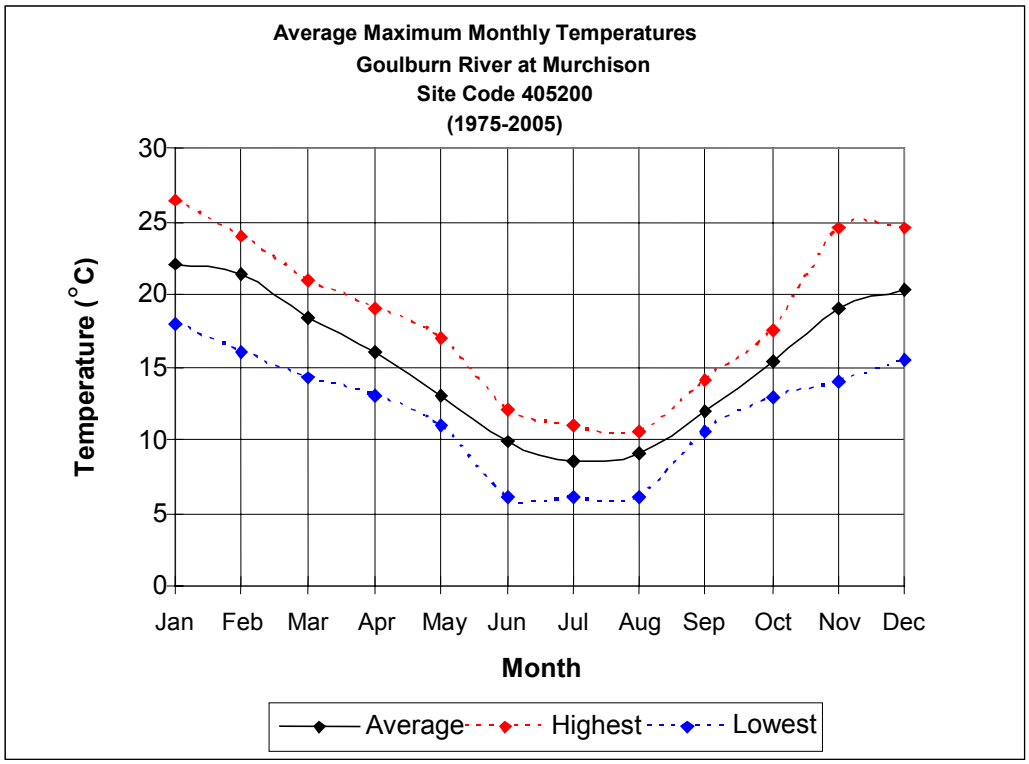
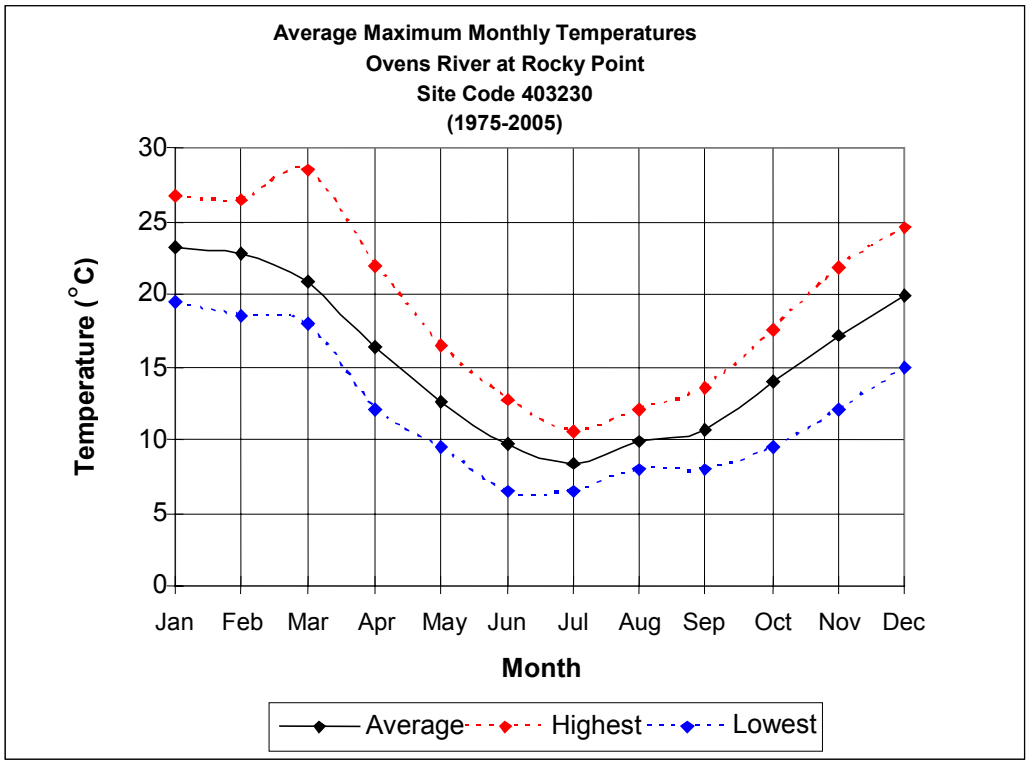


Figure 4 (cont…)





Seven Creeks is the smallest watercourse containing a significant trout cod population. Once or twice in its history flows have become greatly reduced during drought conditions placing the population at risk with a temperature of 30°C being recorded on one occasion. Therefore in selecting waters for the development of recreational fisheries Seven Creeks can be considered the model for a minimum flow regime necessary to support a trout cod population. In comparing the four waters the Seven Creeks exhibits the highest and lowest recorded temperatures reflecting its small size and elevation. Under these conditions the trout cod population has been self-supporting since the early 1920's. Therefore waters reflecting similar temperature and flow regimes should be suitable for stocking with trout cod.

Of the four waters, Seven Creeks exhibits the lowest average water temperatures in the spawning season. Koehn and Harrington (2001) reported that temperatures in excess of 15°C are required for spawning of trout cod with an optimum somewhere from 16°C to 18°C. Preliminary environmental modelling for trout cod spawning has been undertaken (Todd et al 2004). The models are based on limited data derived for the Murray River population, which exists under a highly regulated flow regime. These models appear to suggest that spawning may be limited to the period from late September to the end of November. However, it is known that trout cod have spawned in the past in the Seven Creeks up until late December (Trueman 2006). The temperature requirements of trout cod eggs and larvae have not been reported in detail. However, it is known that for Murray cod that the lethal temperature for eggs and larvae lies somewhere between 12°C and 15°C and significant survival is unlikely to occur if temperatures are below 15°C (Todd et al 2005).

Given that Seven Creeks exhibits the lowest maximum water temperatures (average 16.6°C) during what is believed to be the peak month for spawning (November) it may be a useful yardstick for assessing potential stocking sites. Similarly with a cooler temperature regime it may be a useful model for considering the potential for spawning failure. Assuming similar tolerances for the eggs and larvae of trout cod as to that reported for Murray cod, a useful benchmark may be that if maximum water temperatures fail to reach a maximum of 15°C in November and December that spawning is likely to be a failure. In Seven Creeks in 16% of years, maximum temperature have failed to exceed this threshold in November but have always exceeded it in December.

From the point of view of recreational angling, Seven Creeks has the fewest months of the waters containing significant populations where maximum water temperatures exceed the 16°C threshold for aggressive lure taking by trout cod (5 months). Given past angler recognition of the quality of the fishery, this again provides a useful benchmark for considering the quality of angling likely to be produced by stocking candidate waters.

Despite its size, Seven Creeks provides a significant quantity of instream cover in terms of rocky features whereas the other three waters mainly have cover in the form of wooden debris. In particular, many small streams may not have the instream cover density present in Seven Creeks. Even in larger water bodies, less cover could imply reduced population densities with a consequent reduction in reproductive potential as well as lowering of angler catch rates. Therefore when assessing waters for potential trout cod fisheries the presence of instream cover is an important consideration. Other features of the section of Seven Creeks containing the trout cod include significant bankside vegetation providing shade, debris and food items and a gradient sufficient to mitigate siltation introduced further upstream in degraded areas of the catchment.

In recent years, the Victorian Government has been carrying out regular surveys of stream health throughout Victoria measuring parameters such as stream flows, barriers to fish movement, instream wooden debris, bank stability and the quantity and quality of the riparian vegetation[1]. The data is combined to produce a series of scores or indices rating the health of the stream in terms of its hydrology, physical form and catchment vegetation. This information can be used to compare candidate streams and rivers for trout cod stocking in terms of specific criteria as well as the general health of the catchment and potential for threatening processes such as siltation. With this information and the criteria outlined previously for recreational fisheries for trout cod, many potential waters have been eliminated. Environmental information, together with temperature data, and descriptions of the existing recreational fisheries sourced from the DPI Vic website (Tunbridge & Rogan 2006) have been used to compare candidate waters in the following sections.

[1] http://www.vicwaterdata.net/vicwaterdata/data_warehouse_content.aspx

Stream Fisheries

Small streams, due to their low carrying capacity, have limited ability to satisfy the self-sustaining criteria as they can be adversely affected by relatively low angling pressure. Any trout cod stream fishery needs to be viewed as a 'catch and release' or a 'put and take' fishery requiring ongoing stocking. However, a stream based trout cod fishery is appealing for a number of reasons. Firstly, because they are of limited size stream fisheries require relatively low numbers of juveniles to become established. Successful stockings of the Ryan's and Koetong Creeks occurred with around 2,000 fish per annum (Douglas et al 1994).

Secondly, because they are small habitats, they lend themselves to research as part of the goals of current recovery plans. These include the importance of habitat structure and location, the impact of angling, and the effects of predation and competition by introduced fish such as trout and redfin (Brown et al 1998, Holder at al 2005). They are also suitable for partitioning, exclusion experiments and site comparisons satisfying the guidelines proposed by Cadwallader (1996) for investigating interactions between trout cod and exotic fish species.

A trout cod captured by Mick Dwyer in the Ovens River near Peechelba
(photo: Adam Bosley)

Thirdly, being relatively small water bodies, alterations to their fishery are less likely to invoke adverse public reaction unless close to populated areas. They also lend themselves readily to bait, lure and traditional fly-fishing techniques. Such a stream or small river fishery is an excellent means by which to promote the outstanding sportfishing qualities of the trout cod. As a consequence of their small size streams generally exhibit low diversity in terms of angling species. Therefore in some cases a section of stream identified for creation of a trout cod fishery would be dedicated primarily to angling for that species though in some cases the existing mixed fishery would persist. Specific regulations for maintaining that fishery could be developed without adversely affecting angling in general.

This is important for a number of reasons. Firstly it is proposed that consideration be given for a stream to be stocked with trout cod within five years for recreational angling. Within the short term, anglers may not be in a position to keep their catch of trout cod, but this may change in the medium term. Secondly, if a stream fishery is to be established for recreational angling purposes, it should be given the best possible chance of being at least partially self-supporting through natural recruitment. Therefore, not only may the stream initially be a catch and release fishery, it may require additional management regulations to enhance the chances of captured fish surviving after release and protecting fish during the spawning season.

The candidate streams considered for potential recreational stream fisheries for trout cod are the Ryan's Creek above Loombah weir, Koetong Creek in Mount Lawson State Park, Cudgewa Creek from Briggs Gap Lane to the Murray River junction, and the Hughes Creek between Ruffy and Tarcombe. Of the four creeks, Cudgewa Creek and Hughes Creek up to the Dropmore falls are known historically to contain trout cod while the other two contain trout cod from previous stockings.

Ryan's Creek, Koetong Creek and Hughes Creek were stocked with trout cod by the Victorian authorities during the period 1988-92 with survival of stocked fish appearing to be good in the case of Ryan's Creek and excellent in the case of Koetong Creek (Table 3 below). In Hughes Creek advanced fingerlings were liberated at Bungle Boori and recovered for a number of years and then disappeared. Evidence of reproduction of the Ryan's Creek population was obtained (Douglas & Brown 2000) and recent angling reports suggest that further reproduction may have occurred. Angler reports of small trout cod being caught in Lake Hume adjacent to its confluence with Koetong Creek may suggest that a reproducing population could exist in that stream.

Table 3. Sampling of Stocked Trout Cod Streams (from Douglas et al 1994)

Stocking Site	Number Stocked	Year Sampled	Number Captured	Weight (g)
Ryan's Creek	8000	1990	24	6 – 400
		1992	6	16 – 23
		1993	8	75 - 1300
Hughes Creek	1550	1990	3	54 – 424
		1992	8	38 – 102
		1993	0	
Koetong Creek	8510	1990	47	
		1993	25	132 - 380

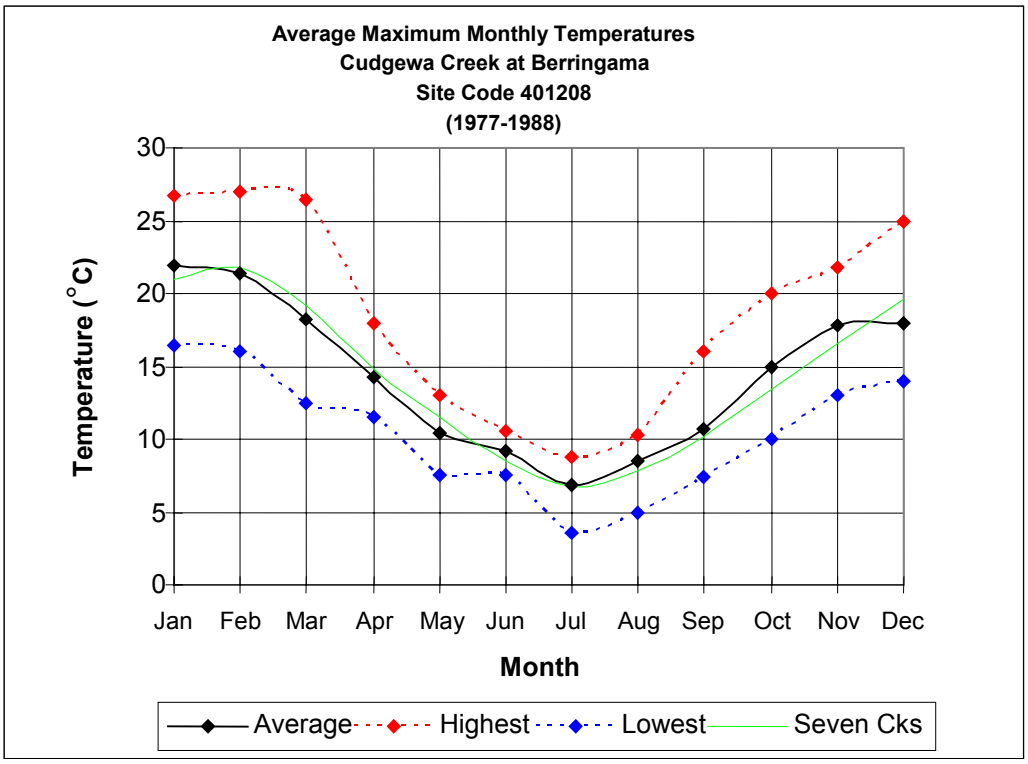
The section of Hughes Creek being considered for a recreational fishery is well upstream of the original stocking site, which was in a badly silted section of the stream containing limited depth and cover. A small number of trout cod released by an angler in the Hughes Creek below Ruffy are known to have survived for a number of years (McKenzie 1982) and this is the only practical guide as to the likely success of a stocking in this section of the Hughes Creek. The section of creek upstream of the Dropmore falls is outside the historical range of trout cod.

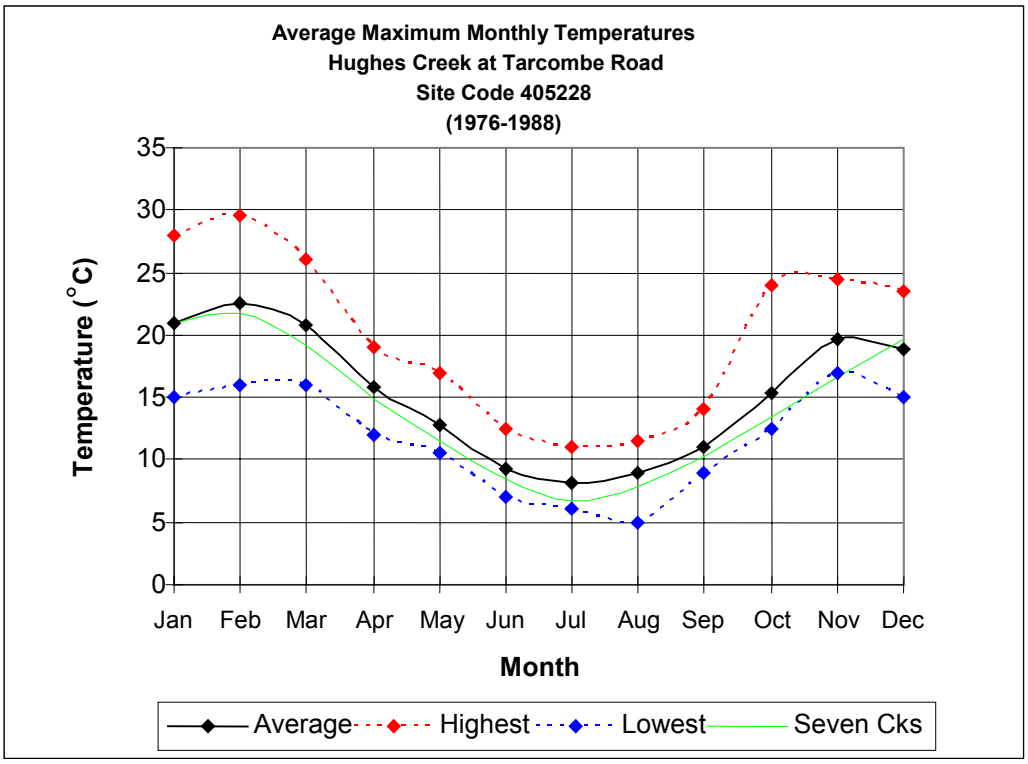
The Cudgewa Creek has no history of being stocked with trout cod, so survivability of stocked fish remains unknown. In the 1970's the creek was the source of reported captures of trout cod (Cadwallader & Gooley 1984) and it is known that trout cod were present in one of the headwater tributaries and the upper reaches until about 1930 (Trueman 2006). The creek is known to contain a small population of Murray cod in its middle and lower reaches and has recently been stocked with that species. The Cudgewa Creek flows into the Murray River in an area containing a stocked trout cod population. It warrants consideration for stocking based on the possibility that it may have once held trout cod but more significantly, liberated fish have the potential to move downstream and be recruited into the upper Murray River population.

A range of environmental data on the candidate streams is presented in Table 4, (next page):

Parameter	Seven Creeks Below Polly McQuinns Weir	Koetong Creek	Ryan's Creek	Cudgewa Creek	Hughes Creek
Data Reference Localities	Reach 20, Site code 405234	Reach 13	Reach 17, site code 404235	Reach 16, Site codes 401229, 401208	Reach 39, Site code 405228
Min-Max Average Daily Flows (ML/day)	19 (March) - 222 (September)	28 (March) - 400 (September)	4 (April) - 54 (September)	111 (March) - 855 (September)	28 (March) - 511 (August)
Minimum Recorded Dissolved Oxygen (ppm)	3.70	NA	NA	7.10	4.80
Max-Min Temperature Range (^{o}C)	30.0 - 5.00	NA	NA	27.00 – 3.70	29.50 – 5.00
Mean November Max.Temperature (^{o}C)	16.6	NA	NA	17.43	19.63
Hydrology Rating (max 10, stress)	NA	9SL	9SL	8SL	5SL
Large Wood Rating (max 4)	NA	2.3	4	1	3
Fish Barriers (0 – 4)	NA	4	0	4	0
Physical Form Rating (max 10)	NA	7	8	6	4
Streamside Vegetation Score (max 10)	NA	2	8	4	4

Figure 5. Mean Monthly Maximum Water Temperatures for Candidate Streams





As a guideline on the size of habitat, Seven Creeks appears to be a useful yardstick with which to compare candidate streams. Flows have been sufficient to maintain the trout cod population despite droughts, though in the 1983 drought flow almost ceased. Therefore any candidate stream for a trout cod fishery should have an annual discharge at least comparable to that of Seven Creeks and have similar instream cover and catchment characteristics.

Considering the data the streams in best overall condition are Koetong Creek and Ryan's Creek (above Loombah Weir). Both these streams have forested catchments in the areas proposed for stocking whereas the Hughes and Cudgewa Creeks flow through cleared grazing land. Koetong, Ryan's and Hughes Creeks are rated good to excellent for instream wooden debris and all three contain rocky features providing additional refuge, particularly Koetong Creek. Catchment vegetation is considered excellent for the Ryan's Creek and fair for the other three. The low rating for the Koetong Creek comes from the disturbed nature of the regrowth forest surrounding it. The section of Koetong Creek proposed for stocking has good streamside vegetation providing bank stability and future instream wooden debris.

Unfortunately temperature data is unavailable for two streams. Koetong Creek rises on the western side of the same range as the Cudgewa Creek and given its altitude and flow is considered to have a similar temperature regime to the latter. Cudgewa Creek, and by inference Koetong Creek, appear to have similar or slightly warmer thermal regimes to that of Seven Creeks, suggesting that conditions should allow spawning and recruitment of trout cod in most seasons. Ryan's Creek is at a similar altitude to that of the trout cod habitat in the Seven Creeks and the confirmed reproduction of stocked trout cod indicates that conditions may be suitable for reproduction in some years. Ryan et al (2001) suggested that there is some potential for thermal pollution in the Ryan's Creek as a consequence of releases from the McCall-Say weir. Hughes Creek exhibits a warmer thermal regime than Seven Creeks and can experience relatively high late summer temperatures. Nonetheless, temperatures appear to be suitable for supporting a reproducing trout cod population.

When compared to the lowest monthly discharge of Seven Creeks of (March = 19 ML/day), Koetong Creek (March = 28 ML/day), Hughes Creek (March = 28 ML/day) and Cudgewa Creek (March = 111 ML/day)) have greater discharges while Ryan's Creek (April = 4 ML/day) is significantly lower. This suggests that the latter may be at risk during severe drought but this is ameliorated by the presence of the McCall-Say and Loombah Weirs which can provide residual water bodies in extreme conditions. This does indicate however, that the available instream habitat in Koetong, Hughes and Cudgewa Creeks may be larger than in Ryan's Creek. The hydrological rating for the Hughes Creek of 5SL suggests there is a significant risk of low summer flows which could place a stocked trout cod population at risk. The ratings for the other three streams suggest that summer flows are more reliable.

Available stream length (estimated here in a straight line) is another important consideration. In the case of Koetong Creek the length of stream available for a fishery, from the junction of Koetong Creek track and Mount Lawson road to the confluence with Lake Hume is in the order of 15 km, about half of this being totally enclosed in Mount Lawson State park. For Ryan's Creek the section from Whisky Creek junction to Loombah Weir is about 8 kilometres in length. Cudgewa Creek from Briggs Gap road to the Murray River has a length of approximately 20 km, while Hughes Creek from the boatholes area below Ruffy to the Dropmore falls is about 8 km. Therefore Koetong and Cudgewa Creeks, with a greater length of suitable habitat, may have a greater ability to withstand angling pressure.

Access to the Koetong Creek is by the Koetong Creek road, an unsealed dirt road crossing the creek upstream of Mount Lawson State Park. Koetong Creek track follows the creek downstream for about a kilometre to a camping and picnic area. At the end of the camping area a locked gate prevents public access further down the track which is adjacent to much of the creek within the park, though in places moving some distance way from the creek. Another locked gate towards the downstream end of the park limits public access from this direction. Therefore the creek is accessible to anglers but will require hiking or wading throughout much of its length within Mount Lawson State Park, thus limiting angler pressure. However, Koetong Creek track provides good access to management and research vehicles.

In the case of Ryan's Creek access is provided by the Upper Ryan's Creek road, an unsealed dirt road, to Loombah Weir above which there is little access until a number of dirt tracks meet Ryan's Creek in the Whisky Creek area. Hughes Creek has little access in the proposed section for stocking, it largely flowing through private property. The main access points are at the Boatholes road and Dropmore. Cudgewa Creek is highly accessible, being paralleled along much of its length by the sealed Tintaldra road, though extended stretches are surrounded by freehold grazing land.

Ryan's and Hughes Creeks can therefore be considered less accessible than Koetong Creek, with Cudgewa Creek being the most accessible. In the case of Ryan's Creek the most easily accessed location is at the Loombah Weir. It appears from the original stockings into Ryan's Creek that Loombah Weir was an important habitat for the trout cod. Both Loombah and McCall-Say Weirs, being domestic water supply storages, are

closed to fishing. Therefore stocking of the Ryan's Creek could compromise management of these storages through increased angler activity. Similarly, activities involved in studying trout cod - introduced fish interactions may also be restricted.

Other important considerations are the existing recreational fisheries in these waters. Table 5 below summarises the existing recreational fisheries in the candidate streams and recent stockings. At the present time, the upper Hughes Creek provides limited recreational fishing opportunities. Ryan's and Koetong Creeks provide some trout fishing, the former being more notable and has been the recipient of a recent trout liberation. While some trout populations exist in the section of Koetong Creek proposed for stocking it is thought that bulk of the trout population is present in the upper reaches. The Cudgewa Creek is a popular mixed fishery with a self-sustaining trout fishery in the upper reaches and in the lower reaches provides some angling for wild Murray cod and recently has been stocked with that species. Stocking this water with trout cod creates the potential for confusion with anglers in identification, particularly if the trout cod have to be released.

Table 5. Existing Recreational Fishery Details for Candidate Streams for Recreational Trout Cod Stockings (from Tunbridge & Rogan 2006)

Water	Current Fishery **	Recent Stocking History
Koetong Creek	Carries brown trout to 1.2kg but mostly small fish, some rainbow trout to 300g in the headwaters, blackfish, & redfin.	
Ryan's Creek	Contains mainly small brown trout av. 220g, occasional rainbow trout and blackfish. A good trout stream above McCall Say Weir but access is limited and fishing is difficult because of overhanging bank vegetation.	500 brown trout 2005/6
Hughes Creek, between Ruffy & Tarcombe	Contains some brown trout, abundant blackfish.	
Cudgewa Creek	Contains mostly brown trout to 900g (av. 480g), some rainbow trout to 450g, abundant blackfish. Also contains Murray cod	5000 Murray cod 2005/6

There is evidence that once trout cod reach 30-50 cm in length that they may become dispersive, in some cases moving downstream (e.g. Murrumbidgee River) and upstream (e.g. Ovens/King Rivers,). In other cases stocked fish have remained highly localised (Douglas et al 1994). The reasons for these movements are unclear though juveniles may be naturally dispersive. The movements of larger fish could be driven by competition for habitat as the fish become less gregarious and approach maturity.

This has two consequences for a trout cod stream fishery. Firstly, high densities can be maintained until the fish achieve this size range and this has been previously demonstrated in Koetong Creek and to a lesser extent in Ryan's Creek. Therefore excellent angling should be achieved within three to five years with numbers of fish in the 300 – 600 g size range. After this, population densities may decline, particularly if instream cover is inadequate for larger fish. Ongoing stocking may be required to maintain sufficient fish densities to provide quality angling.

The second consideration of dispersion is where the fish may end up. One of the criteria outlined previously is that, if possible, fish introduced through recreational stocking should be able to disperse to areas targeted for conservation stockings.

In the case of Ryan's Creek there may be a relic trout cod population immediately downstream in the lower Broken catchment produced by previous conservation stockings. The Broken River enters the Goulburn River at Shepparton and stocked fish dispersing downstream could link up with the population in the Goulburn River near Murchison. However, the distance is considerable, in excess of 100 km, and the status of the Goulburn River population remains unclear since the 2004 fish kill (Koster et al 2004).

Koetong Creek flows into the Murray arm of Lake Hume near Bungil. A number of reports of trout cod captures have occurred in this area of the lake in the past decade, these fish probably having originated from the early Koetong Creek stockings. Additional captures have occurred 20 km further upstream where the Murray River enters the lake near Talmalmo probably from fish released in the Murray River upstream. Therefore fish stocked into the Koetong Creek have the potential to link up with the population established through conservation stockings in the upper Murray River.

Cudgewa Creek flows directly into the Murray River near Tintaldra, an area with a stocked trout cod population. The Hughes Creek flows into the Goulburn River above the Goulburn Weir upstream of Tahbilk, the nearest trout cod population being near Murchison as previously discussed. Fish dispersing from Hughes Creek would have to travel over 50 km downstream to recruit into the Goulburn River population, with no possibility of movement back upstream due to the Goulburn Weir barrier.

Considering these facts stocked trout cod that disperse downstream in the Cudgewa and Koetong Creeks have a significant probability of recruiting into the upper Murray River population. In the case of Ryan's and Hughes Creeks there is little prospect of fish stocked into these waters contributing to other populations and they would effectively remain isolated populations.

In terms of management and public support benefit Ryan's Creek, being close to Benalla, is accessible to researchers and enforcement. However, it previously has been of interest to trout anglers and having been recently stocked with trout targeting it for development of a trout cod fishery could be unpopular. Similarly Cudgewa Creek is currently a popular fishery for trout in the upper reaches and a mixed fishery in the lower reaches. There could be an adverse reaction to the imposition of regulations for a trout cod fishery in these two waters. In the case of Koetong Creek there appears to be less angler interest and in the upper Hughes Creek very little. Development of regulated trout cod fisheries in these two waters is less likely to impact negatively with anglers.

In terms of community and economic benefit, Ryan's Creek is adjacent to Benalla, Koetong Creek has Wodonga and Tallangatta as the nearest centres, Cudgewa Creek has again Wodonga and Tallangatta and additionally Corryong as centres, and the Hughes Creek is close to Seymour, Avenel and Euroa. These areas could benefit through the spin offs from the angling activity. In particular there is the opportunity for fishing guides to take advantage of a new fishery. However, it has to be acknowledged that due to the limited size of the proposed fishery that the economic benefits will not be large, but could be important to smaller communities near the candidate fisheries.

Considering all these factors the best candidate for a pilot trout cod stream fishery appears to be the Koetong Creek. It has good habitat, water supply, water quality and catchment characteristics, offers limited angling opportunities at present and has demonstrated track record of stocked trout cod surviving. In addition dispersing fish can contribute to the upper Murray population via Lake Hume. It has been the subject of previous management actions to protect the catchment habitat (Reed 1993, Douglas et al 1994) and because of the low angling pressure, is unlikely to induce severe public criticism with the introduction of any angling regulations deemed necessary to establish and maintain the fishery.

The Mount Lawson State Park with the Koetong Creek camping ground and picnic area as an access point could provides a fine focal point for a day trip or weekend for both dedicated anglers and family groups. Aesthetically the forest and rocky environment is reminiscent of the Seven Creeks and adds to the fishing experience. It is well suited to guided angling activities. Limited access to the public is an advantage for reducing angling pressure while access is available for management and enforcement activities via the Koetong Creek track. With two access points within the State Park, limited signage would adequately inform anglers of the necessary regulatory information. Such activities fit in with the goals of the current Management Plan for the Mount Lawson State Park (Parks Victoria 1998). Koetong Creek is easily the best candidate for the establishment of a recreational trout cod fishery in the short term. It would also be a good candidate for the establishment of a Macquarie perch population, through translocation or hatchery produced fingerlings, to reintroduce the species to the upper Murray region.

The upper Hughes Creek generally is in poorer condition than Koetong Creek but, due to its relative isolation, if stocked is similarly unlikely to invoke an adverse community reaction. It also has the drawback of not being close to an adjacent trout cod population and low summer flows could place stocked fish at risk in severe droughts. Ryan's Creek has potential through evidence of past reproduction, but the size of the habitat in the stream, save for the two weirs, is limited and the best habitat in the weirs is inaccessible to anglers. Further it is acknowledged as having previously enjoyed some popularity with Benalla trout anglers and, considering the recent trout stockings, restrictions on angling activities in this water may prove unpopular.

The Cudgewa Creek has less suitable instream habitat than the Koetong Creek and is considered unsuitable for a pilot stream fishery at the present time due to its popular mixed fishery. However, due to its potential to supply dispersing fish into the upper Murray population, and vice versa, it remains attractive. In the medium term when the conservation status of the trout cod is secure and controlled harvest angling for the species is acceptable the Cudgewa Creek would be a very good candidate for trout cod releases to enhance its mixed fishery. Like Koetong Creek it would also be a good candidate for reintroducing Macquarie perch to the upper Murray region.

Summary

Of the creeks considered, the Koetong Creek stands out as the best short term candidate for the development of a recreational stream fishery for trout cod. If such a fishery is developed, in order to reduce mortality of angled fish consideration should be given to applying a regulation to this water that artificial lures and flies be permitted only, at least in the section of creek totally enclosed within the Mount Lawson State Park. Cudgewa Creek represents a very good medium term candidate for the inclusion of trout cod in its mixed fishery. The section of Hughes Creek upstream from Tarcombe remains a candidate though the reliability of its water supply is a cause for concern. Despite the past success demonstrated in Ryan's Creek, it is not considered a good candidate for the development of a recreational fishery for trout cod.

Dropmore Falls on the Hughes Creek
(Photo: Stephen Kerris)

River Fisheries

Compared to streams, rivers are generally larger bodies of waters with more reliable flows making them resistant to drought, changes in water temperature and providing a larger and generally more diverse habitat. The classification is rather arbitrary, with some of the larger streams rivalling the smaller rivers in terms of annual discharge. In general, rivers have a greater capacity to withstand sudden environmental impacts, can produce larger fish and are more likely to support self-sustaining fish populations.

While some rivers once held significant trout cod populations, many have been greatly modified by human activities. Impoundments provide barriers to fish movement, fragmenting populations, as well as altering flow regimes and thermally polluting the water downstream. In addition, except for their upper catchments, the valleys are the subject of intense agricultural activity. These changes have made many of the state's rivers more suitable for introduced fish than the original inhabitants and these now often are the basis of important recreational fisheries. Therefore there is some challenge in identifying suitable rivers to be candidate trout cod fisheries.

At present there may be four rivers within/adjacent to Victoria supporting substantial trout cod populations. Stocked populations exist in the Ovens River and the Murray River upstream of Lake Hume as well as the natural population in the Murray River between Yarrawonga and Echuca. A population existed in the Goulburn River downstream from the Goulburn Weir but its status is unclear since the 2004 fish kill. A stocked population may also exist in the Mitta Mitta River upstream of Dartmouth Dam. Of these waters trout cod are known to be frequently captured by anglers from the natural Murray River population and the stocked population in the Ovens and regularly turn up in angler's catches in the upper Murray River.

At the present time it is illegal to even attempt to angle for trout cod and as previously discussed this has adversely affected the image of the fish. Given the evidence that trout cod appear to be recovering in some locations the issue of legalising some form of angling in areas where trout cod are regularly captured needs to be considered. A pragmatic approach would be to promote or at least legalise a catch and release fishery in a section of one river where the species is abundant to improve public perceptions and support for stockings.

The Murray downstream from Yarrawonga is very heavily fished by anglers and both species of cod enjoy protection through the ban on angling during the reproductive season. Despite the angling pressure the trout cod population appears to be increasing and dispersing with fish now regularly being caught downstream to Echuca and in the Edwards River. It appears that existing management practices in that stretch of river are more than adequate at protecting the Murray River trout cod population.

The Ovens River population is also dispersing upstream to Bright and into the King and Buffalo Rivers with anglers reporting trout cod to be dominating their catches in some sections. Small fish are regularly captured and reproduction and recruitment is known to be occurring, but the scale of it is unknown. It is understood that Victorian authorities intend to continue stocking the Ovens system for a few more seasons and then will review the status of the Ovens River trout cod population. NFA would suggest that consideration should be given to at least in the short term legalising catch and release for trout cod within the Ovens River now that the population shows evidence of recruitment.

Given the fact that anglers are frequently catching trout cod in the Ovens system at present, the total ban on angling seems irrelevant. Consultations by NFA with some local anglers have revealed that they would welcome the creation of an impoundment fishery for trout cod in Lake Kerford. However, they have strongly expressed the view that in the short term their preference is for legalisation of catch and release angling for trout cod in at least a portion of the Ovens River. They consider this to be a necessary first step in improving the image of the fish in the local area. They also advocate that ongoing stocking will be supported if, in the medium term (five to ten years), a bag limit of one fish can be introduced. Public support for additional protective measures such as seasonally closing at least part of the river to angling as in the Murray River model would be forthcoming if anglers could keep at least one fish. This would benefit the resident Murray cod population as well as the trout cod.

Legalisation of catch and release in a section of the Ovens River appears to NFA to be a sensible compromise that may enhance the local image of the trout cod. This would parallel the successful Mary River cod model in developing local community support for the recovery program and public ownership. Local fishing guides doing canoe trips could benefit as well as showcasing the angling attributes of the trout cod. It is acknowledged that additional angler activity could increase capture related mortality of stocked trout cod and so it may be prudent that only one or two short stretches of river be made available to minimise the potential impact on the population. The impact could be further reduced by requiring those anglers targeting trout cod for catch and release to use artificial flies and lures to reduce gut hooking. The effects of angler impact on the population could be closely monitored. Realistically given the fact that the Ovens River is already a popular angling water the increase in capture related mortality may be negligible.

In identifying a suitable stretch of the Ovens River for catch and release fishing it is considered desirable to eliminate the area near Myrtleford which may be critical for upstream dispersion into the Buffalo River and the area adjacent to the King River junction for similar reasons. Local anglers report regular captures from Everton down to Lake Mulwala, with the section between Everton and Wangaratta being ideally suited to canoeing. It is recommended that the section of the Ovens River between the Everton road bridge and the Oxley flats road and a second stretch from Boorhaman to the Peechelba road bridge be open to catch and release fishing for trout cod. This would still leave the vast majority of the trout cod population in the Ovens system protected under the angling ban. It is proposed that this be established for a trial period of three years. In the medium to long term the Ovens system could be promoted as a premier trout cod fishery. The alternate is to consider developing a fishery in rivers well away from the Ovens population and this is considered below.

Philosophically NFA desires one day to see somewhere in the state's north east a native fish 'corridor' with environments replicating the original conditions as far as practicable to that prior to European settlement. This would encompass fish assemblages from low to high altitudes with the ability for the fish to move relatively freely. Such a corridor would ideally be connected to the Murray River for movement elsewhere into the Murray-Darling system. The ability of the fish to move along the corridor would provide a potential for populations to recover along its length as a result of local disasters such as bushfires, etc. Angling would be permitted and indeed promoted within the 'corridor' subject to the necessary management controls required to maintain its health and viability.

The Ovens River at Rocky point currently supports a significant population of stocked trout cod.
(photo: Adam Bosley)

A section of river identified and recommended for the establishment of a recreational fishery for the trout cod could be part of a future corridor but it is not a prerequisite. The proposition of a corridor requires thorough research and consultation with all relevant stakeholder groups and is beyond the scope of this report. The intention of this section of this report is to identify sections of rivers suitable for stocking with trout cod to be a part of a mixed fishery. However, if there is a presence of other native fish species such as Macquarie perch, river blackfish or Murray cod then the addition of trout could would be aesthetically pleasing.

In identifying candidate rivers for stocking the potential for fish to survive and provide a range of contemporary sportfishing options is critical. Therefore, water with good flow and, of equal importance, good clarity are important so that lure and fly-fishing are possible for much of the year. Generally this implies foothill and upland rivers at higher altitudes than the lower Goulburn /Ovens populations. An additional consideration is size as rivers selected for a recreational trout cod fishery should be sufficiently large to provide diverse habitat

with deep holes and cover for refuge but small enough that the number of fingerlings required is modest, say 5000-10000 fish per annum.

Like streams, small rivers lend themselves to a range of investigations on trout cod biology. Similarly, they should not only be accessible to anglers but ideally have stretches with more difficult access to provide sections of reduced angling pressure. Smaller rivers reviewed as candidates for trout cod stocking are the Buffalo River between Abbeyard and Lake Buffalo, the Yea River between Glenburn and Yea and the Campaspe River downstream of Lake Eppalock.

The larger candidate rivers include the Goulburn River between Trawool and Nagambie, the Mitta Mitta River upstream of Lake Dartmouth to Hinnomunjie, the Mitta Mitta River downstream of Lake Dartmouth to its confluence with Lake Hume. Even though it is technically a New South Wales water the Murray River upstream of Lake Hume is also considered, as it appears to have merit and Victoria owns the south bank! Because of their size all four stretches of river are probably precluded as a short-term candidate for a trout cod fishery due to the number of fingerlings that may be required. However, they should be reviewed and given consideration for the medium term, 5-10 years.

Tables 6 & 7 below summarise environmental parameters and existing recreational angling opportunities in small and large candidate rivers.

Table 6. Environmental Data for Small Candidate Rivers
(Seven Creeks data included for comparative purposes)

Parameter	Seven Creeks Below Polly McQuinns	Ovens River Myrtleford - Everton	Yea River Glenburn - Yea	Buffalo River Abbeyard - Dam	Campaspe River
Data Reference Localities	Reach 20, Site code 405234	Reach 4, Site code 403230	Reach 55, Site code 405217	Reach 35, Site code 403222	Reach 5, Site Code 406207
Min-Max Average Daily Flows (ML/day)	19 (March) - 222 (September)	512 (March) - 7084 (September)	47 (March) - 615 (September)	37 (March) - 1149 (August)	15.17 (August) - 283.14 (March)
Minimum Recorded Dissolved Oxygen (ppm)	3.70	6.8	3.20	6.00	3.50
Max-Min Temperature Range (°C)	30.0 - 5.00	26.5 - 6.80	24.50 - 4.70	24.00 - 1.80	- 6.5
Mean November Max.Temperature (°C)	16.6	18.00	15.50	14.86	14.40
Hydrology Rating (max 10, stress)	NA	4SL	5SL	9SL	0WL
Large Wood Rating (max 4)	NA	1.3	2	1	3
Fish Barriers (0 – 4)	NA	4	0	0	0
Physical Form Rating (max 10)	NA	4	5	3	4
Streamside Vegetation Score (max 10)	NA	5	7	7	5

Table 7. Existing Recreational Fishery Details of Small Candidate Rivers (from Tunbridge & Rogan 2006)

Water	Current Fishery	Recent Stocking History
Yea River, downstream of Glenburn	Contains brown trout to 600g, abundant blackfish to 300g, redfin to 350g, mountain galaxias, Australian smelt, occasional Macquarie perch to 450g, carp, goldfish and occasional rainbow trout.	Not stocked with trout as the fishery is considered to be self supporting. Stocked with Macquarie perch in the early 1990's.
Buffalo River, upstream of dam	Contains mostly brown trout to 2kg (av. 450g), abundant blackfish, redfin, rainbow trout, goldfish, and Macquarie perch in the deeper pools up to and above Abbeyard. Trout cod also present from stockings 1992-93. Golden perch stocked into Lake Buffalo since 2002 may move up into the Buffalo River.	Trout spawn in the river and are therefore not stocked. There has been no stocking of any fish into the upper Buffalo River in recent years.
Campaspe River	Contains brown trout to 2kg occasional rainbow trout, redfin to 900g, golden perch, goldfish, tench to 1.7kg, and carp to 5kg. Some Murray cod are also present in the deeper pools. Occasional Macquarie perch are reported to occur but this has not been confirmed.	The section of river immediately downstream of the wall of Lake Eppalock carries a self-sustaining population of brown trout. After a trial stocking period (1995-97) with brown trout it was decided to cease stocking trout in this area. Recently stocked with 40,000 golden perch and 10,000 Murray cod

Yea River

The Yea River is a candidate due to its proximity to Melbourne. Temperature, water quality and catchment data suggests that it may be suitable for including trout cod in its existing mixed fishery though comparatively it exhibits a lower thermal regime in summer than the Seven Creeks. Analysis of temperature data indicates that temperatures may be suitable for spawning and recruitment in at least 40-50% of seasons suggesting the potential for a stocked population to become at least partially self supporting (Figure 6 below). Similarly, this temperature regime is likely to generate at least four months (December to March) of aggressive trout cod feeding and excellent angling.

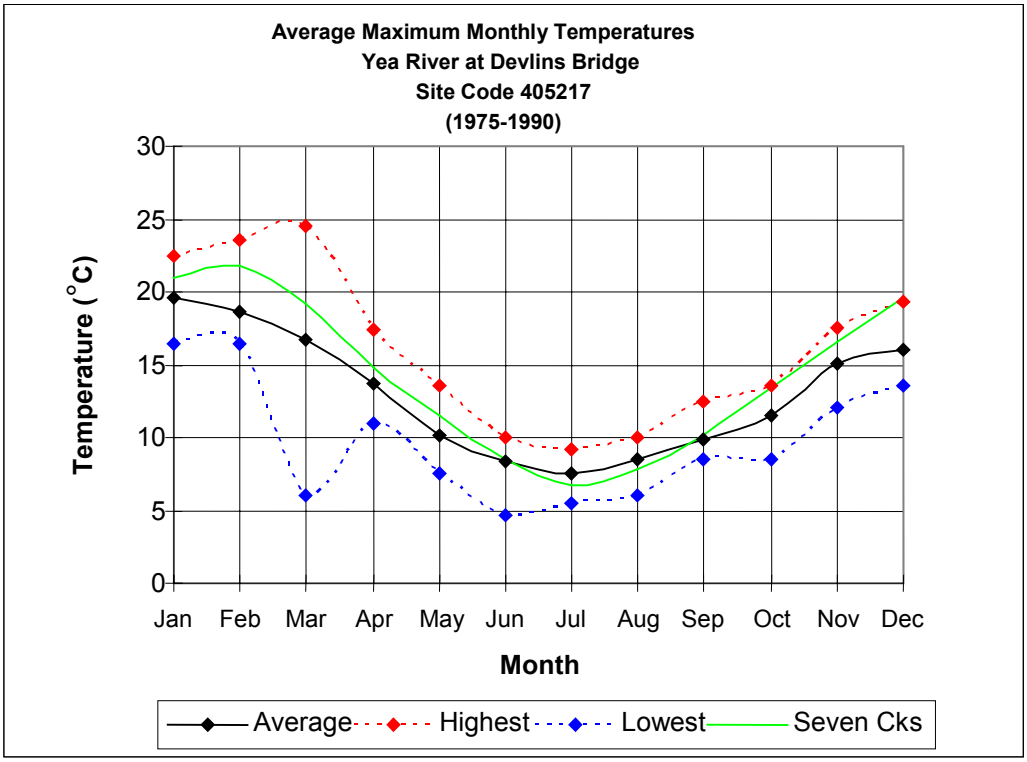


Figure 6. Yea River: Mean Maximum Monthly Water Temperatures

Having greater flows the Yea River is less likely to be susceptible to the adverse effects of droughts than Seven Creeks. While this river does not have the extensive instream rocky features of Seven Creeks, rock features do exist in short stretches and a rating of 2/4 for instream wood in a waterbody of this size suggests that sufficient habitat may exist to support a moderate to good population density. The catchment condition is considered to be reasonable though extensive areas of agricultural land exist surrounding the section proposed for stocking. Streamside vegetation is very good (rating 7/10) supporting good bank stability and a future source of stream debris.

The river is accessible in several places via the Melba highway and adjoining roads though stretches may require some hiking or wading for access. While the upper reaches experience considerable pressure from anglers targeting trout the section between Devlin's Bridge and Yea is perhaps less heavily fished due to restricted access through private property. Therefore the potential angling pressure may be moderate to high depending upon the location. A disadvantage of the Yea River is that if stocked fish disperse they cannot easily enter and recruit into another trout cod population. The section of the Yea River proposed for stocking is separated by a distance of over 100 km from the trout cod population in the Goulburn River at Murchison.

Currently the Yea River supports a popular trout fishery in its upper reaches above Glenburn (Table 7) and further downstream provides significant mixed fishery angling opportunities. Due its closeness to Melbourne the Yea River would be excellently positioned to promote the angling qualities of the trout cod with the residents of the state's largest population centre. And given the environmental conditions in other nearby rivers it is probably the best if not the only river to do this in close to Melbourne. Another advantage of the Yea River is its relatively small size indicating that only modest numbers of fingerlings would be required to establish a fishery. Based on the results achieved in some creeks previously discussed somewhere between 2000 and 5000 fingerlings per annum may be sufficient to establish and maintain a fishery.

A negative factor could be that given that, in the short term, the trout cod fishery may require catch and release, NFA would not like to see the trout cod labelled again a 'nuisance' by anglers intent on a meal. Because of the popularity of the Yea River with anglers there is some potential for this to occur. Given that the Yea River is a considerable distance away from conservation populations of trout cod there is merit in creating a controlled harvest fishery for the species in this water along the lines of the Mary River cod model. Perhaps after an initial catch and release period immediately after the first stocking a bag limit of one fish could be introduced.

Similarly there could be an adverse reaction from trout anglers if they perceive that their fishery in the Yea River is under threat. If the Yea River is stocked with trout cod, it will have to be made clear that the intention is to create additional angling opportunities downstream from the best trout sections in the headwaters area. There is no proposal to replace or alter the existing upstream trout fishery. However, given that most trout angler activity is centred on the reaches of river upstream from Devlin's bridge and that the section proposed for stocking is less heavily fished this may not be a significant issue. In fact the addition of an outstanding sporting fish to this section of river may be welcomed even if the fish are to be released after capture, at least in the short term.

Overall the Yea River appears to be a good candidate.

Buffalo River

The Buffalo River between Abbeyard and Buffalo dam is considered a candidate for a number of reasons. Firstly, it is within the Ovens catchment, so stocked trout cod dispersing downstream can recruit into the conservation population. Therefore stocking of this water can in part be considered an extension of the existing conservation program in this catchment.

Secondly, the capture of small numbers of trout cod by anglers, including juveniles, in the Buffalo River demonstrated the existence of a relic population that persisted into the early 1980's (Trueman 2006). The Buffalo River population was physically isolated from the rest of the catchment by the Buffalo River dam constructed in 1965 and reputedly anglers took some large specimens in the early 1970's. It would appear that trout cod populations persisted in rocky upland rivers such as the Buffalo and Mitta Mitta longer than in any other habitat in Victoria. This holds out the promise that, whatever factors caused their decline, environmental conditions may be suitable in these habitats for re-establishing trout cod populations.

Thirdly, the barrier present on the river in the form of the Buffalo Dam of around 31 meters is similar to that at Yarrawonga Weir which could see the successful application of fish lift technology. This could make trout cod populations continuous above and below the dam in the Buffalo/Ovens Rivers. This may represent the only realistic opportunity within Victoria to provide a corridor representing the original habitat and fish assemblages from the lowlands of the Murray River into upland habitats.

Environmental conditions in the Buffalo River appear to be good for the establishment of a trout cod fishery. Some of the fish stocked in the early 1990's are known to have survived and were subsequently caught by anglers. The temperature regime in the upper reaches of the section proposed for stocking is cooler than that in the Seven Creeks and slightly cooler than that in the Yea River (Figure 7 below). Long term temperature data indicates that successful spawning and recruitment is likely to occur in about 30% of seasons, due to considerable variations in temperatures between years. This figure most probably increases in the warmer waters closer to the dam. This could give a stocked population the potential to become self supporting but it may not be able to withstand the pressure of a harvest fishery without ongoing stocking. Similarly this temperature regime is likely to generate at least three to four months (December to March) of aggressive trout cod feeding and excellent angling.

Having greater flows than both Seven Creeks and the Yea River, the Buffalo River can be considered resistant to all but the most severe of droughts and long term flow data supports this. This river does not have extensive instream wooden debris (rating 1/4) due to its gradient and consequent rapid flood flows but it does contain some deep pools with rocky features, which may provide sufficient habitat to support a moderate population density. The catchment condition is considered to be good being largely forested with good streamside vegetation (rating 7/10) and the river is largely accessible by dirt road though stretches may require some hiking or wading for access. Due to this accessibility angling pressure could be high along some stretches, particularly with campers during holiday periods. An advantage of the Buffalo River is that if stocked fish disperse they can easily enter and recruit into the Ovens River population which is known to have dispersed upstream to the Myrtleford area and into the lower Buffalo River.

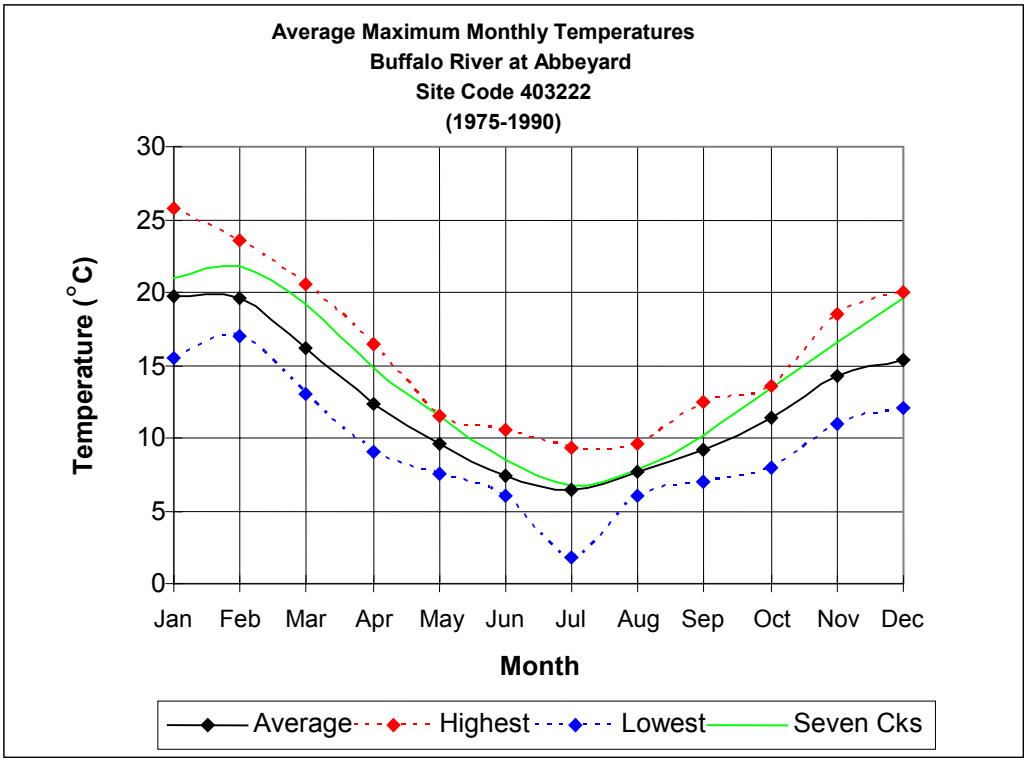


Figure 7. Buffalo River: Mean Maximum Monthly Water Temperatures

The higher altitude tributaries of the Buffalo such as the Catherine River support popular trout fisheries. However, the section of river proposed for trout cod stocking (between Abbeyard and the dam) is away from the best trout fishing areas. Past surveys have suggested lower trout densities in this section than the upper reaches. There is no intention to interfere with these high altitude trout fisheries and this information needs to be made clear to placate the fears of trout anglers if the fishery is to be established. The section of river proposed for trout cod stocking currently supports a mixed fishery based on trout, redfin and some Murray cod and golden perch. Significantly, a population of Macquarie perch created through conservation stockings now exists in the upper reaches near Abbeyard (Tunbridge & Rogan 2006).

Trout cod taken on a dry fly from the upper Buffalo River near Abbeyard in December 1980
(photo: W. Trueman)

There is the possibility that inclusion of trout cod in this fishery could generate some adverse angler reaction locally given the reaction of some to the trout cod stockings in the Ovens River. However, while historically anglers have occasionally taken Murray cod as far upstream as Dandongadale, these fish have contributed little to the recreational fishery in the upper Buffalo River. More reliable captures of Murray cod have been taken downstream of the dam, which has received significant stockings in the past decade and even this is not in the class of the lower Ovens cod fishery.

It is understandable where there is a high expectation of catching a Murray cod, as in the lower Ovens, that incidental captures of trout cod could prove annoying. In the upper Buffalo where Murray cod are rare captures the introduction of trout cod to the fishery should not evoke such an intense negative response. Indeed the addition of trout cod to the fishery as an intended target for anglers opens up new opportunities for anglers and fishing guides as well the commercial benefits that come from the creation of a new fishery. Being in the Ovens catchment, a Buffalo River trout cod fishery could provide an alternate source for the attention of local anglers wishing to encounter the species, even on a catch and release basis, which is currently prohibited with the Ovens River trout cod population.

The recent stocking of Murray cod into Lake Buffalo does have potential implications for any trout cod fishery in the upper Buffalo River. Buffalo dam has generally been considered a 'disappointing' recreational fishery (Tunbridge & Rogan 2006) which despite stockings in the past with both species of trout and more recently golden perch has not seen significant improvement to its largely redfin-based fishery. If both Murray cod and trout cod are present in the river with the former allowed to be taken by anglers there appears to be potential for confusion with anglers and subsequent enforcement problems.

The simple solution, if both species of cod are to be stocked, would be to apply a bag limit of one for any species of cod taken upstream of the Buffalo Dam wall. However, this action may cause problems enforcing the no take regulation for trout cod in the adjacent Ovens River. Alternately, if trout cod are stocked into the upper Buffalo River it may be prudent to cease Murray cod stockings in the dam to remove confusion. However, this action is likely to further raise the ire of local cod anglers, irritated by their perception of interference to the Ovens cod fishery.

The least controversial course of action may be to continue the Murray cod stockings for harvest while establishing an initial catch and release fishery for trout cod in the upper Buffalo River. Anglers of the Ovens region are by now largely familiar with the identification and legal status of the trout cod and so a reasonable level of compliance can be expected. However, local anglers have expressed to NFA a preference for catch and release fishing for trout cod in the Ovens River rather than the Buffalo. They advocate stocking the Buffalo with trout cod for controlled harvest fishing as their first preference.

Previous stockings of the Buffalo River, utilising small numbers of yearling fish, were unsuccessful in establishing a significant population. Given the reported mortality of on-grown trout cod in other waters and the tendency of stocked trout cod to disperse this may not be surprising. The discharge of the Buffalo River is greater than that that of the Yea River and it would be reasonable to expect that at least 5000 fingerlings per annum may be required to establish and perhaps maintain the fishery. Survival of stocked fish may be enhanced if trout and possibly redfin present at stocking sites, with the potential to prey upon fingerlings, are removed by electro-fishing and relocated to other nearby waters for the use of anglers. If deemed desirable NFA would be willing to assist in such activities. In fact the Buffalo River because of its size would be good candidate to trial an upland mixed fishery containing trout cod and trout and study their interactions.

All things considered, the upper Buffalo River is a good candidate for the establishment of recreational trout cod fishery and may be the best candidate in an upland environment. Its size makes the outlay required for stocking moderate with the advantage that if a population of trout cod becomes established it can be considered an extension of the current Ovens River conservation population.

Campaspe River

The proximity of the Campaspe River to Melbourne makes it a candidate for the inclusion of trout cod in its recreational fishery. Upstream from Kyneton it supports a popular trout fishery and downstream to the waters of Lake Eppalock it is believed to have previously contained a population of trout cod (Cadwallader & Gooley 1984). The section of river immediately upstream of Lake Eppalock along with the Coliban River on face value would therefore appear to be candidates for stocking with trout cod. However, perusal of environmental data suggests that these rivers experience periods of stress due to reduced flows. As a consequence, water temperatures can be high and dissolved oxygen very low on occasions in late summer (DNRE 2006). They are therefore not considered in this report.

The Campaspe River downstream of Lake Eppalock has a drastically altered thermal regime, which has had a significant negative impact on native fish populations for a considerable distance (Ryan et al 2001). Temperature data suggests that while stocked trout cod may survive in this stretch of river in most seasons the fish are unlikely to spawn and the depressed temperature regime is likely to result in reduced angling quality.

The poor hydrology rating for this stretch of the Campaspe River (0/10WL) is a result of the highly regulated irrigation flow regime with low flows expected in winter as water is retained in Lake Eppalock. The instream wood rating of 3/10 suggests the existence of sufficient instream cover to maintain a reasonable population

density of trout cod. Catchment data suggests that while the river flows through grazing land there is sufficient vegetation to maintain bank stability and provide future instream cover.

The recreational fishery downstream of Lake Eppalock is mixed with a small self-supporting population of brown trout immediately downstream of the dam. A considerable effort has gone into stocking Murray cod and, more recently, golden perch into this stretch of river. This has resulted in some success, though the greatest improvements to angling opportunities for these species has been well downstream. Given the existing thermal conditions trout cod stockings may result in disappointing returns.

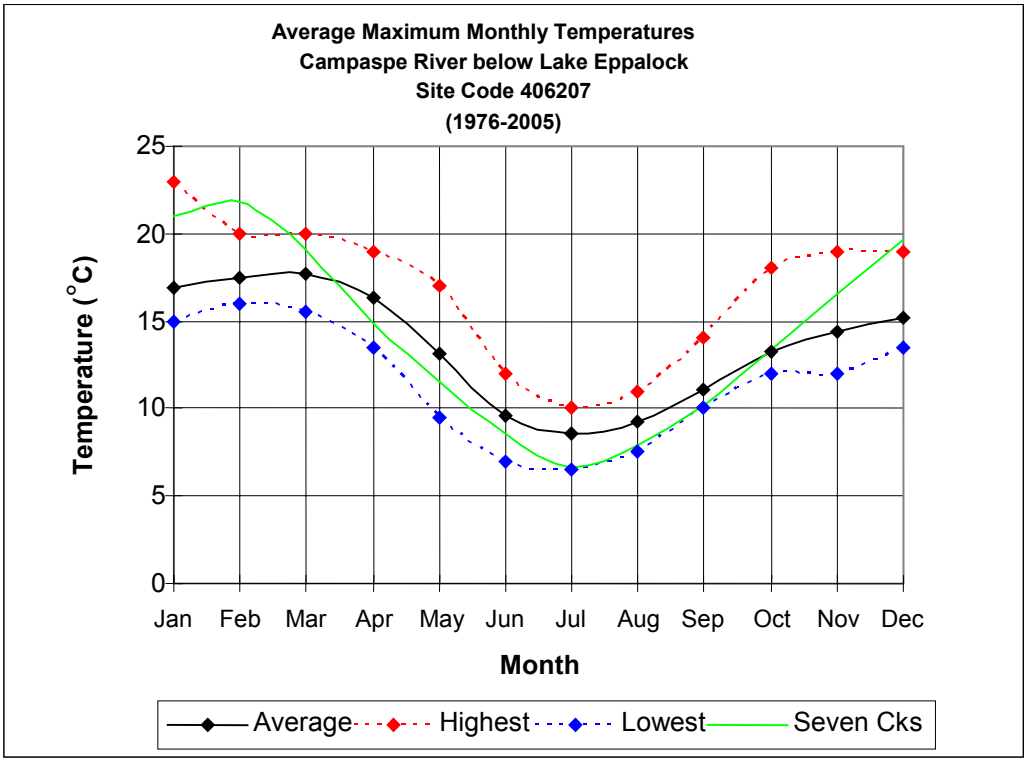


Figure 8. Campaspe River: Mean Maximum Monthly Water Temperatures

At this point in time the Campaspe River is not considered a good candidate for the establishment of a trout cod fishery. However, if the temperature regime were to be ameliorated in the future, the quality of the habitat suggests that a good fishery could be established with the potential to link up with Murray River population via Echuca. As the existing thermal regime supports a very small downstream trout fishery, alterations are far less likely to be contentious than in the nearby extensive and popular Goulburn River trout fishery.

Table 8 Environmental Data for Large Candidate Rivers

(Seven Creeks and Ovens River data included for comparative purposes)

Parameter	Seven Creeks Below Polly McQuinns weir	Ovens River Myrtleford - Everton	Mitta Mitta River Hinnomunjie	Mitta Mitta River Tallandoon	Goulburn River Trawool - Nagambie
Data Reference Localities	Reach 20, Site code 405234	Reach 4, Site code 403230	Reach 26, Site code 401203	Reach 1, Site code 401204	Reaches 10&11, Site code, 405201& 052900
Min-Max Average Daily Flows (ML/day)	19 (March) - 222 (September)	512 (March) - 7084 (September)	307 (March) - 2992 (October)	1394 (April) - 5743 (October	1751 (May) - 8015 (February)
Minimum Recorded Dissolved Oxygen (ppm)	3.70	6.8	7.00	6.70	3.70
Max-Min Temperature Range (°C)	30.0 - 5.00	26.5 - 6.80	25.00 – 2.00	25.00 - 6.00	24.90 – 7.09
Mean November Max.Temperature (°C)	16.6	18.00	13.59	16.75	15.35
Hydrology Rating (max 10, stress)	NA	4SL	8SL	3SL	0SL
Large Wood Rating (max 4)	NA	1.3	1	1.3	2.5
Fish Barriers (0 – 4)	NA	4	0	4	0
Physical Form Rating (max 10)	NA	4	4	7	4
Streamside Vegetation Score (max 10)	NA	5	6	5	3

Table 9. Existing Recreational Fishery Details of Large Candidate Rivers

(from Tunbridge & Rogan 2006)

Water	Current Fishery	Recent Stocking History
Mitta Mitta River, between Dartmouth & Hnnomunjie	A Departmental survey in 1993 found small numbers of brown trout av. 400g, abundant blackfish and numerous Macquarie perch in the middle reaches	
Mitta Mitta River, downstream of Dartmouth	Carries predominantly brown trout to 3kg (av. 130g), occasional redfin (most common just upstream from Tallandoon), a few blackfish, very occasional rainbow trout, some carp, goldfish, southern pygmy perch and occasional golden perch enters the river from Lake Hume.	10, 000 Murray cod 2005/6 Contains a self-sustaining population of trout and is not stocked.
Goulburn River, between Seymour & Nagambie	Contains mostly redfin to 1.8kg (av. 220g), some brown trout to 3.6 kg (av. 1.5 kg), tench, carp, goldfish and Murray spiny crayfish. May still contain a few Murray cod and golden perch. Main target species are redfin & trout.	

Upper Mitta Mitta River

The upper Mitta Mitta River historically is believed to have contained a substantial trout cod population (Rhodes 1999) which had all but disappeared by the second world war, but persisted into the 1970's in the section inundated by Dartmouth Dam (Tunbridge 1978, Trueman 2006). A significant number of trout cod (46,000) were stocked into the river in the early 1990's as well as into Dartmouth Dam. However, given the length of the river and capacity of the dam this may have been an inadequate number of fish given recent results in the Goulburn and Ovens Rivers. There is evidence of stocked trout cod surviving in the river with fish being captured as far upstream as the Hinnomunje road bridge and captures regularly reported in the dam itself. The reproductive status of this population is unknown though captures of fish weighing less than a kilo a decade after the last stocking suggests that some reproduction and recruitment may have occurred.

Temperature, water quality and catchment data indicates that it may be a suitable candidate for including trout cod in its existing mixed fishery though, comparatively, it exhibits a significantly lower thermal regime than Seven Creeks. Analysis of temperature data indicates that temperatures may be suitable for spawning and recruitment in November in 13% of seasons though the figure is much better for the month of December being nearly 50%. If, like the existing Macquarie perch population, trout cod are capable of spawning in December then there appears to be some potential for a stocked population to become at least partially self-supporting. This may be more likely if they can reproduce in the warmer waters of Lake Dartmouth. Similarly this temperature regime is likely to generate at least four months (December to March) of aggressive trout cod feeding and excellent angling.

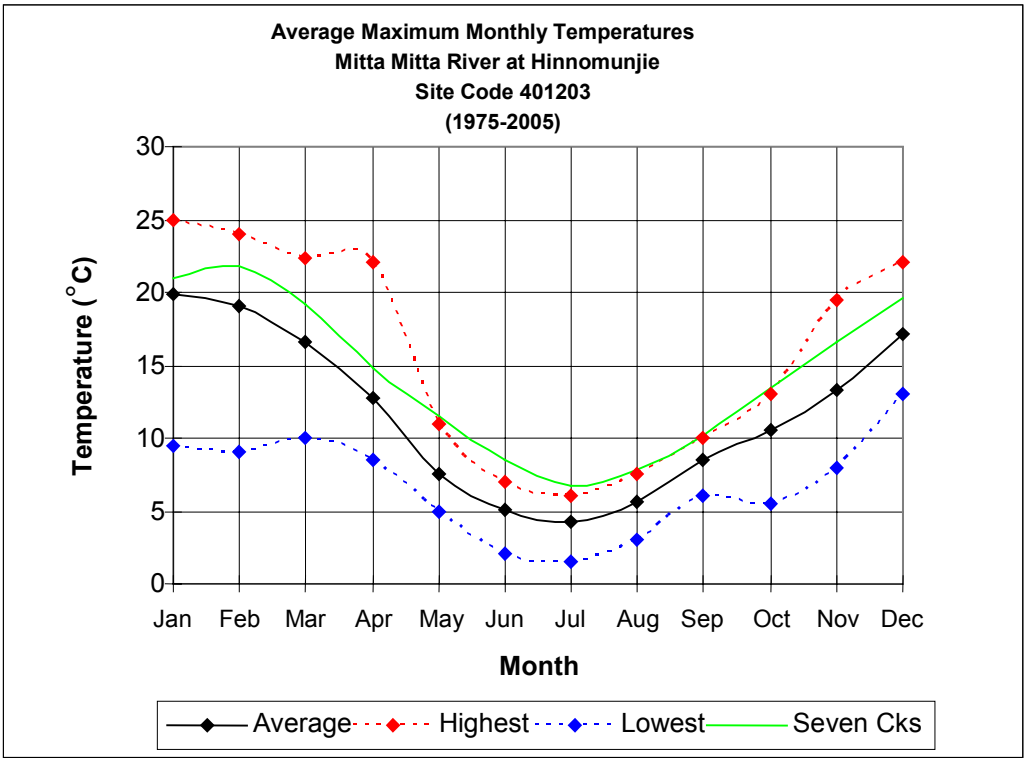


Figure 9. Upper Mitta Mitta River: Mean Maximum Monthly Water Temperatures

The large catchment ensures reliable flows in this stretch of the Mitta Mitta River and, in terms of available habitat, is largely unaffected by droughts. This river does not have extensive instream wooden debris (rating 1/10) due to its gradient and consequent rapid flood flows but it does contain some deep pools with rocky features which may provide sufficient habitat to support a moderate trout cod population density. The catchment condition is considered to be reasonable, although some areas of grazing land exist surrounding the section proposed for stocking. Extensive areas of catchment are located within state forest. Streamside vegetation is good (rating 6/10) supporting good bank stability and a future source of stream debris.

The river is accessible in one location by bitumen road at Hinnomunjie and by adjoining dirt roads and tracks. There are lengthy stretches of river that are relatively isolated requiring hiking and wading for access. Where accessible the river is the focus of anglers targeting trout particularly near Lake Dartmouth though the better trout angling is considered to occur in the major tributaries upstream. The potential angling pressure is

considered to be light to moderate depending upon the location. A disadvantage of the upper Mitta Mitta River is that Lake Dartmouth is a significant barrier to dispersal downstream. This section of the Mitta Mitta River is separated by a distance of over 150 km from the trout cod population in the Murray River above Lake Hume and it is unlikely that larger fish would survive the 180 meter high descent over the spillway.

Currently the river supports a trout fishery, though more popular in the upper reaches, (Table 9) and further downstream Lake Dartmouth provides a significant mixed fishery, though the focus of most anglers is the two species of trout. Given that the Mitta Mitta River is a considerable distance away from conservation populations of trout cod there is merit in creating a limited harvest fishery for the species in this water along the lines of the Mary River cod model. If this water is stocked with trout cod, it may be feasible, after an initial catch and release period, to introduce a bag limit of one fish.

The Upper Mitta Mitta River is a large water body which would require annual stockings similar to what is taking place in the Ovens River at the present time, ie circa 30,000 p.a . Ongoing stockings of large numbers of juveniles would be required to establish and maintain a recreational fishery and such a commitment cannot be justified in the short term. The river contains an abundance of juvenile trout with the potential to prey upon stocked trout cod fry. The importance of this effect, and possible solutions to it, are best investigated in smaller water bodies where the numbers of fish required are much lower.

The upper Mitta Mitta River is not considered a good short-term candidate particularly when the impacts of trout on stocked fingerlings remain unknown. However, in the medium to long term it may be a good candidate. Further investigation of the status of this population and in particular of that in Dartmouth Dam may warrant reappraisal of the situation. If a population has become established, consideration may have to be given to a resumption of stockings to increase densities of adults to improve the chances of spawning and recruitment. In this case additional stockings may be justified from the conservation perspective.

Lower Mitta Mitta River

The Mitta Mitta River downstream of Dartmouth Dam, while a substantial river, is of shorter length than the section upstream of the dam. Therefore the potential exists to establish a fishery with reduced numbers, say 10,000 fish per annum, when compared to the Goulburn or upper Mitta Mitta Rivers. It is known to have held a population of trout cod until the 1970's (Tunbridge 1978, Trueman 2006) which has disappeared subsequent to changed conditions resulting from the commissioning of the Dartmouth Dam (Koehn et al 1995).

Temperature, water quality and catchment data suggests that it may be a suitable candidate for including trout cod in its existing mixed fishery however, the effects of coldwater releases on the thermal regime are apparent. Analysis of temperature data indicates that temperatures may be suitable for spawning and recruitment in less than 50% of seasons. Treadwell et al (2006) modelled the potential for trout cod reproduction in this stretch of river using the Murray River model and suggested that reproductive success could be considerably less than this figure. In recent years drought conditions have resulted in elevated temperatures which, combined with the short data collection period since irrigation releases commenced, may make the temperature regime appear more suitable than it is in the long term. Depending upon irrigation flows a succession of failed spawning seasons is quite likely to occur. The current temperature regime could generate at least five months (November to March) of aggressive trout cod feeding and excellent angling depending upon the individual season.

The irrigation releases, supported by tributary streams, ensure reliable flows in this stretch of the Mitta Mitta River. The river contains some instream wooden debris (rating 1.3/4) which combined with deep pools containing rocky features suggests there is sufficient habitat to support a moderate trout cod population density. The catchment condition is considered to be good though extensive areas of grazing land exist surrounding the section proposed for stocking . Streamside vegetation is reasonable (rating 5/10) supporting some bank stability and a future source of wooden debris.

The river is accessible along much of its length via the Omeo Valley Highway and is crossed by a number of roads. Lengthy stretches of the river are surrounded by private property. Where accessible the river is the focus of anglers targeting trout particularly in the upper reaches towards Lake Dartmouth and this stretch of river is considered to be one of the better trout fisheries in the state. In the mid to lower reaches there exists a mixed fishery the main targets being trout, redfin and a few Murray cod. The potential angling pressure is considered to be light to moderate depending upon the location. An advantage of the Mitta Mitta River is that stocked trout cod have the ability to disperse downstream and recruit into the population in the Murray River above Lake Hume.

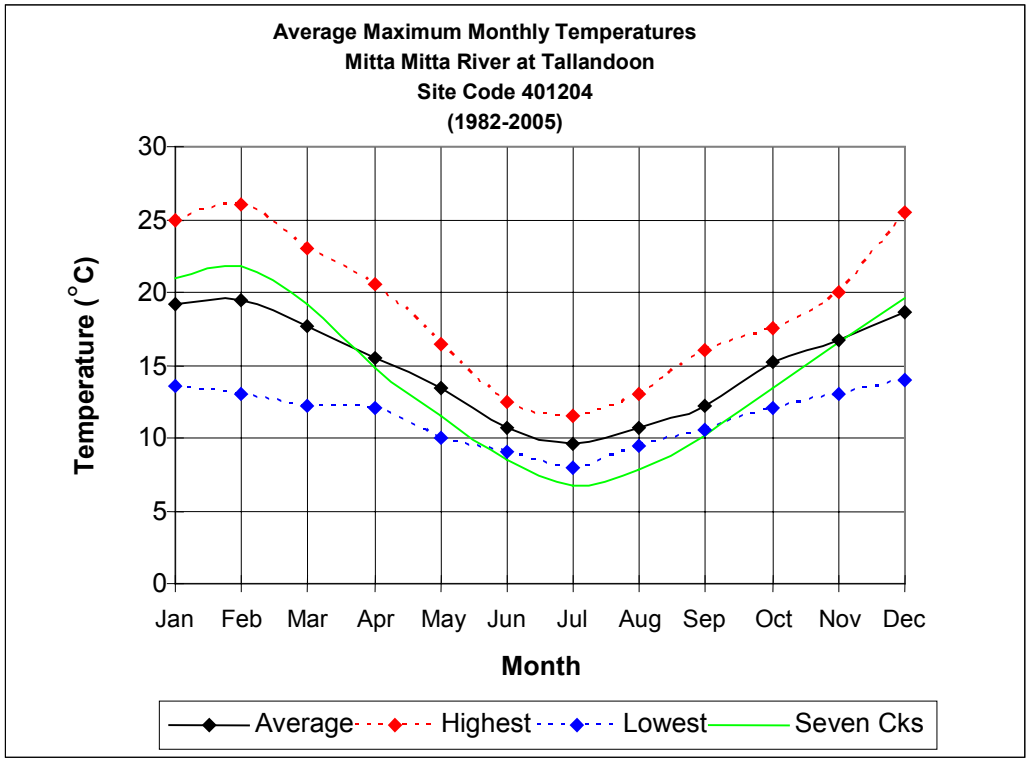


Figure 10. Lower Mitta Mitta River: Mean Maximum Monthly Water Temperatures

The lower Mitta Mitta River has been identified as one of those rivers proposed for potential amelioration of the thermal pollution from coldwater releases. Preliminary modelling suggests that existing conditions may be suitable for the reproduction of trout cod in some seasons in this stretch of river but an improved temperature and flow regime could increase reproductive success to around 50% of seasons (Treadwell et al 2006).

Equally important such modelling suggests that while such changes may impact upon the trout fishery the overall effect may be minor to negligible (Treadwell et al 2006), particular in the upper reaches of this stretch of river. This holds out the hope that it may be possible to introduce such changes improving conditions for native fish populations in the middle to lower reaches of thermally polluted rivers while maintaining existing trout fisheries immediately downstream of dams. Given that modelling suggests that this may be feasible in the lower Mitta Mitta River NFA believes that this should be further investigated.

If potential alterations to the water take-off at Dartmouth Dam are undertaken in the future, environmental conditions may be more suitable for establishing a trout cod fishery in the lower Mitta Mitta River. The establishment of a population in this river has the potential to link up with the stocked trout cod population now residing in the Murray River upstream of Lake Hume. The lower Mitta Mitta River may have merit as a future recreational fishery for trout cod but until environmental conditions are further evaluated it cannot br recommended as a short term candidate.

Middle Goulburn River

The Goulburn River between Trawool and Nagambie is on face value an appealing water to include trout cod as part of its mixed fishery due to its proximity to Melbourne. It has been drastically modified by irrigation releases from Lake Eildon which have greatly altered natural flow patterns and thermally polluted the river. Gippel and Finlayson (1993) provided a detailed report on the effects of Lake Eildon on downstream temperatures in the Goulburn River. They suggested that rather than carrying out works on the outlet towers of Eildon dam to alter the thermal regime of the river that the river should be managed as a cold-water fishery. They also advocated that the financial resources necessary to carry out the necessary works may be better spent on a larger number less degraded rivers. Ryan et al (2001) considered that the topic of ameliorating the thermal pollution in the Goulburn River requires serious consultation and consideration.

The temperature data (Figure 11) indicates that stocked trout cod may survive in the Goulburn River downstream of Trawool. This is demonstrated by the capture this year of a trout cod near Molesworth by an NFA member (P. Berner, personal communication). The possibility of natural reproduction and recruitment is questionable and uncertain with the existing temperature regime. Of significance is the rapid drop in water

temperatures in early summer coinciding with irrigation releases from Eildon Dam. Ongoing research investigating the reproduction and recruitment requirements of the trout cod in the Murray River below Yarrawonga will help clarify the potential for a fishery in this section of the Goulburn. Until these details are understood and in view of the large number of juveniles required the Goulburn appears to be an unsuitable short-term candidate.

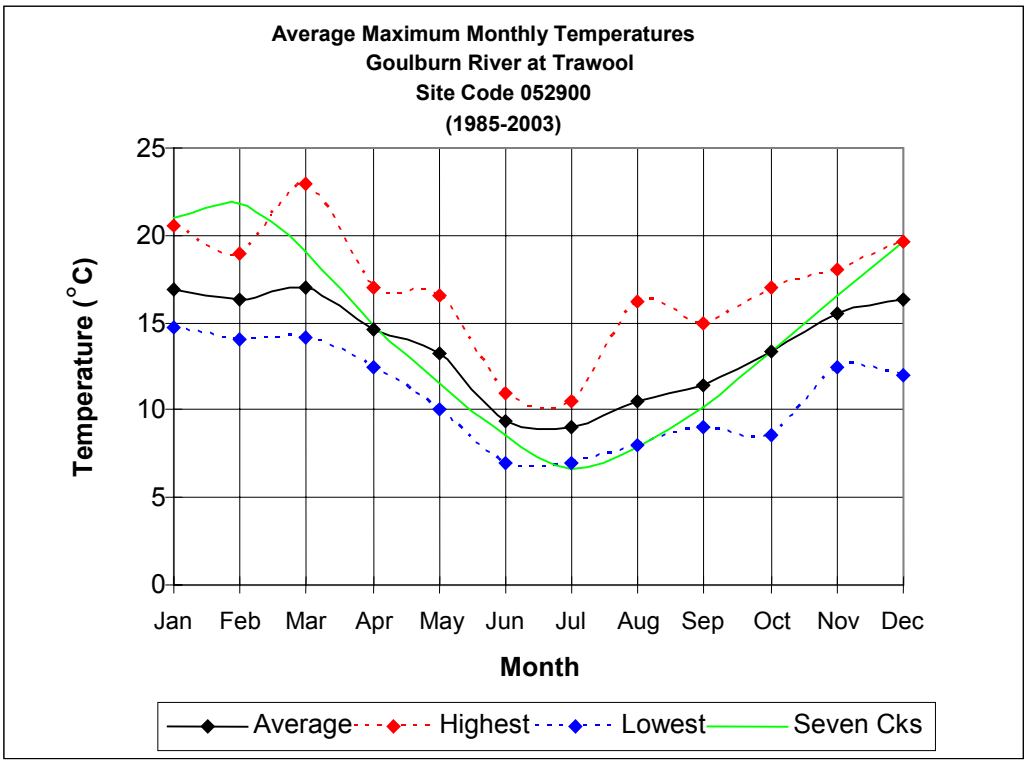


Figure 11 Middle Goulburn River: Mean Maximum Monthly Water Temperatures

Given the proximity of the Goulburn River to Melbourne, its well deserved reputation as a popular and probably our premier trout fishery supported with stockings of large fish into Eildon pondage, and that the flows having been altered for fifty years there is some pragmatism in Gippel and Finlayson's proposition. However, two factors need to be considered with respect to the Goulburn River fishery. First is the fact that the thermal pollution has a significant impact downstream as far as Nagambie. For over two decades local anglers at Nagambie have been trying to establish a recreational fishery for Murray cod and golden perch through stocking. The aspirations of these people and their fishery need to be considered.

Secondly, relic Macquarie perch populations exist in the King Parrot and Hughes Creeks which could benefit if populations could become established in the Goulburn River near their confluence. NFA therefore concurs with maintaining a cold water trout fishery between Eildon and the Homewood/Trawool area. However, if investigation demonstrates that it is logistically and financially feasible to improve the temperature regime downstream without significantly impacting the trout fishery, then this is desirable. The modelling previously discussed for the Mitta Mitta River suggests that such a concept is plausible. The ideal situation for the Goulburn River would be to have a cold water trout fishery downstream to the Homewood/Trawool area, a transitional fishery down to Seymour and a warm water fishery downstream from Seymour.

If it can be demonstrated through modelling that a suitable temperature regime can be created to maintain the existing trout fishery at least as far down as Homewood, then modifications may be acceptable to the fishing community. In addition, such a proposal would have to be financially viable and justified by a cost benefit analysis. Given the fact that the Goulburn River is the largest tributary of the Murray within the state such proposals need to be considered. Otherwise, the money may well be better spent elsewhere assisting native fish where the obstacles are less daunting. NFA hopes that in demonstrating its pragmatism with the Goulburn River fishery that such a philosophy will be reciprocated by other angling bodies, particularly those representing trout anglers, when ideal candidate rivers for trout cod are identified.

At the present time, the middle Goulburn River is not considered to be a suitable candidate for the creation of a trout cod fishery. Detailed modelling concluding that stocked fish would survive and prosper is required to justify the liberation of large numbers of fingerlings required into this water.

Upper Murray River

The Murray River resides within the state of New South Wales and is technically beyond the scope of this report, which is dedicated to investigating potential trout cod fisheries within Victoria. However, in past years management activities have involved the liaison and cooperation of the fisheries departments of both states. Recently DPI Victoria has assumed management responsibility for Lake Hume, which straddles the state boundary.

The Murray River upstream of Lake Hume is included here as from the perspective of Victorian anglers it may be the best candidate to create an extensive foothill to upland native fishery. Earlier in this report was expressed NFA's aspiration of seeing at least one upland native corridor created in the future. The best candidate within Victoria appears to be the Ovens/Buffalo River corridor. However, the dam on the Buffalo River and the size and length of river upstream of the dam limits the potential of the Buffalo River.

The Hume Dam for all practical purposes isolates the upper Murray from the Murray- Darling system downstream. Upstream of Lake Hume is several hundred kilometres of river without any barriers to fish movement. This stretch of river once carried a thriving trout cod population with some fish surviving until around 1970 and perhaps even later (McKenzie 1982, Rhodes 1999, Trueman 2006). Therefore the potential exists within this stretch of river to recreate large populations representing the assemblage of fish originally found in this type of habitat, namely the two species of cod, Macquarie perch and blackfish.

Limited published temperature data is available for this stretch of river and some thermal pollution from the Snowy Mountains scheme affects the river, particularly in autumn (Sherman 2005). The data suggests that the thermal regime resembles that of the Seven Creeks or is perhaps a little warmer. Therefore it would appear that conditions are suitable to support the reproduction of trout cod. The fact that this stretch of the Murray River has maintained a reasonably healthy population of Murray cod up until the present time also supports its suitability for trout cod.

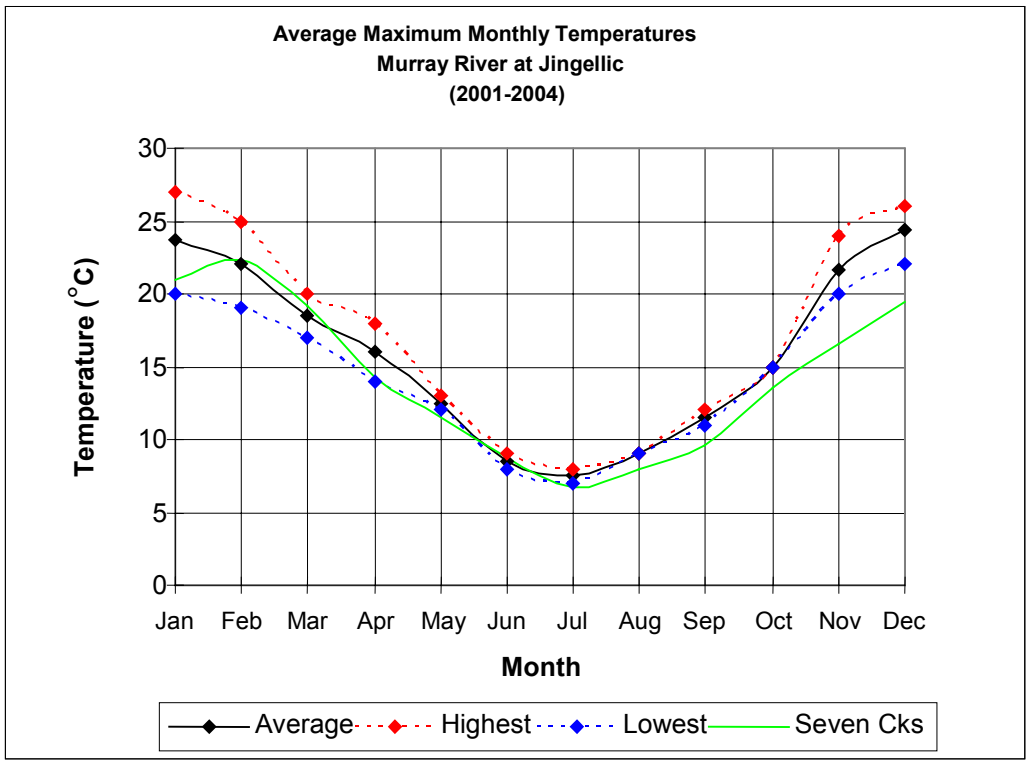


Figure 12. Upper Murray River: Mean Maximum Monthly Water Temperatures

The upper Murray River was the focus of initial releases of a relatively small number of trout cod by NSW Fisheries and stocked fish are known to have survived (Douglas et al 1994). Recently there have been reports of small trout cod being captured by anglers upstream of Lake Hume, as well as large fish over 5 kg, suggesting that some reproduction and recruitment may have occurred. In light of the recent success achieved in establishing trout cod populations in the Ovens and Murrumbidgee Rivers it appears that the numbers initially stocked into the upper Murray may have been insufficient to create a substantial population given the size and length of the river.

For these reasons, the upper Murray River, from the perspective of Victorian anglers, may be the best candidate for a substantial foothill/upland river trout cod fishery. Its size lends itself to the establishment of a large population, which could sustain significant angling pressure. It may well be that one large river fishery is superior to several smaller ones. The quality of the water lends itself to all sportfishing techniques, and being well away from the conservation populations in the Ovens River and Murray downstream of Yarrawonga may be suitable for an early controlled harvest fishery.

The upper Murray River stands out, for Victorian anglers, as the best candidate for a future foothill/upland riverine trout cod fishery. Annual stockings of around 10-30 000 fingerlings per annum could create a substantial fishery while also satisfying conservation objectives. Given the fact that the existing fishery is popular and that the intention is to improve the image of the trout cod with anglers it may be necessary to consider this fishery to be a controlled harvest fishery from the outset. The application of the existing size limit of 50 cm to both species of cod with a bag limit of one fish for trout cod would probably be reasonably well received by anglers. A brief period of catch and release fishing while the population becomes established may also be acceptable. The upper Murray River between Lake Hume and Towong would also be an excellent candidate of a native fish corridor, possibly incorporating the lower reaches of the Cudgewa Creek. We urge Victorian and NSW authorities to consider this proposition.

Summary

The best short-term candidate for a recreational fishery for trout cod within Victoria is the Ovens River. Anglers are frequently catching and releasing trout cod in the Ovens system with little apparent impact upon the population. NFA recommends that consideration should be given to legalising catch and release for trout cod within the Ovens River or at the very least in a short stretch of the Ovens River in order to generate an improved local perception of the species. In the medium term a controlled harvest fishery is desirable if the population becomes self-supporting. This, combined with seasonally closing at least part of the river to angling would benefit the Murray cod population as well as the trout cod.

The alternate is to consider developing a fishery in another river away from the Ovens population. The Buffalo River upstream of Buffalo Dam and the Yea River downstream from Glenburn appear to be the most attractive rivers out of all the candidates for establishing recreational trout cod fisheries in the short term. The Buffalo River, being within the Ovens catchment, has the advantage that dispersing fish can recruit into the conservation population within that catchment. The Yea River remains a strong candidate due to its proximity to Melbourne.

Of the larger rivers, other than those discussed or already targeted with conservation, some have altered thermal regimes which may make them unsuitable for the establishment of recreational fisheries for the trout cod. Of the larger rivers the outstanding candidate, while technically not in Victoria, is the Murray River upstream of Lake Hume. In the medium term, it is recommended that significant stockings of this section of river are undertaken to create a recreational fishery utilising the controlled harvest concept regulated with a bag limit of initially one fish.

Impoundment Fisheries

With the proposed stocking of Lake Kerford by DPI Victoria with trout cod for recreational fishing, the potential of impoundments to support such fisheries needs to be considered. Lake Sambell provides the only historic example of an impoundment trout cod fishery. It was created through the translocation of 'cod' from the Ovens River at Brookfield near Everton in 1928 (Cadwallader & Gooley 1984). By the time of world war two the lake supported a thriving fishery with individual specimens being caught in excess of 11 kg. At this time the principle capture method employed by anglers was bait fishing.

Juvenile trout cod where regularly captured by fishing and through anglers seine netting for bait (Trueman 2006). Confirmation that Lake Sambell contained a self-supporting population comes from four juvenile museum specimens (lengths 250-265 mm) collected in 1960 (Berra 1974). The granite substrate together with the regular rise in water level of the lake in spring may have produced good conditions for spawning and recruitment.

In later years the Lake Sambell fishery declined with catches of trout cod becoming less frequent. Reported alterations to the outlet of the lake resulted in the level of the lake rising and stabilising, which may have reduced the recruitment of fish. A fish kill in 1970 may have resulted from water inundating contaminated mine tailings resulting in a release of toxins. Apart from the unconfirmed capture of one fish in the late 1970's there has been no subsequent evidence of a resident trout cod population in Lake Sambell and it is considered to be extinct (Douglas et al 1994, Trueman 2006). Lake Kerford is more a less a larger version of Lake Sambell existing some distance upstream of Lake Sambell on Spring Creek.

Trout cod have also been reported to have established self supporting populations in two impoundments, namely Bendora Dam and Cataract Dam (where in the latter they have hybridised with Murray cod). It remains unclear whether the species can spawn under the relatively static conditions found in impoundments or that access to riverine conditions upstream is required. While Murray cod spawn reliably in hatchery ponds, to date there has not been a single example of trout cod doing so. Bendora and Cataract Dams have significant streams entering the lakes, which may provide suitable habitat for spawning. Lake Sambell is fed by the Spring Creek entering the lake over a granite ledge which trout cod could probably not ascend suggesting that they can reproduce under conditions of minimum flow. Bendora and Cataract Dams are managed for potable water and are closed to recreational anglers so offer no guidance for recreational fishery development.

In selecting impoundments to be candidates for trout cod fisheries, characteristics similar to those outlined previously for rivers need to be considered, such as the size of the water body, the environmental qualities, existing angling opportunities and potential contribution to conservation goals. Initially the first impoundment stocked is likely to be a small one. This is necessary due to the limited resource in terms of fingerling numbers available and the lack of knowledge on the requirements of trout cod in impoundments. The proposal by DPI Victoria to stock Lake Kerford near Beechworth is a modest first step, this body of water being relatively small at 24 hectares. It would appear to be a sensible choice for creation of a trout cod fishery based on the Lake Sambell experience and being of small size would require relatively small numbers of fingerlings to become established. While it has supported a limited trout fishery in the past, recent stockings with golden perch have greatly improved the fishery.

Given that requirements for trout cod reproduction in impoundments are unknown, those candidates selected for stocking, if possible, should have in-flowing rivers with environments potentially suitable for reproduction. Ideally, if the impoundment is adjacent to or within a catchment where conservation populations of trout cod exist, then fisheries established in these waters have the potential to contribute to recruitment of these populations. From the community perspective, candidate impoundments should contain mixed fisheries where the introduction of trout cod can be viewed as an additional angling opportunity. Stocking of trout cod into impoundments considered single species fisheries, such as for trout, are more likely to invoke an adverse reaction as the existing fishery may be perceived to be under threat. Table 10 below outlines the surface areas of candidate impoundments and their existing recreational fisheries.

Like rivers, impoundments come in the small and large varieties. Small impoundments are better short to medium term candidates as they would require relatively low numbers of fingerlings to be stocked to establish fisheries. Larger impoundments are discussed as medium or long-term candidates for inclusion of trout cod in their fisheries due to the greater number of fingerlings required. Lake Dartmouth may be an exception as follow up stockings may be justified from the conservation perspective to support the small population already present.

Lakes Kerford, Sambell, Buffalo and William Hovell have small surface areas and all three lie in the Ovens catchment which could create potential problems. If limited harvest fisheries are created in them, the problem discussed earlier of identifying fish illegally taken from the conservation population in the Ovens River could arise. On the positive side with Lakes Buffalo and William Hovell outflowing directly into rivers containing

trout cod populations created through conservation stockings there is the advantage of individuals dispersing or juveniles produced recruiting into these populations.

Lake Sambell, with a surface area of 6 ha would probably require 500-1000 fingerlings per annum to establish and maintain a fishery. Having previously supported a trout cod fishery, it appears on face value to be an attractive proposition. It supports a popular mixed fishery containing native and introduced species and experiences high angling pressure due to its size and position. Given these facts it may not be capable of once again becoming a self-supporting fishery but will probably require ongoing stocking and management as a put and take fishery.

The major drawback with Lake Sambell may come if an attempt is made to establish a catch and release fishery. Due to the fishing pressure and the predominance of bait angling mortality rates for stocked fish are likely to be reasonably high. In addition catch and release in such a small waterbody may not be welcomed by anglers particularly if they perceive that trout cod stockings take place at the expense of species they could retain such as golden perch and trout. Overall Lake Sambell appears to be a very good candidate for a controlled harvest trout cod fishery but a poor candidate for catch and release.

The nearby and larger Lake Kerford shows similar potential to Lake Sambell. With a surface area four times greater than Lake Sambell, it has the capacity to support a much large trout cod population. In addition being outside the confines of Beechworth, it is likely to experience lower fishing pressure. Catch and release fishing is more likely to be accepted in this water being outside Beechworth at least as a short-term measure while the stocked fish grow and perhaps are given a chance to reproduce. If a defined period of catch and release were to be followed by controlled harvest through a bag limit of one fish there is likely to be community acceptance. Lake Kerford appears to be a more sterile water than Lake Sambell and a number of individuals have suggested to NFA that it may not contain a sufficient food resource to support a significant trout cod population or produce high growth rates. Lake Kerford may be a better candidate than Lake Sambell, if a strictly catch and release fishery is to be developed, but the latter may produce a better although smaller fishery. NFA supports the creation of a trout cod fishery in either water.

Lakes Buffalo and William Hovell support mixed fisheries, which include native fish but are dominated by redfin and trout. They are comparable in size (341 and 113 ha respectively) and so potentially are capable of developing fisheries with annual stockings of 5 000 – 10 000 fingerlings per annum. Trout cod are known to have been present in the Buffalo River upstream of the lake until the early 1980's and similarly in the King River downstream of Lake William Hovell (Trueman 2006). Temperature regimes in the in-flowing rivers are probably suitable for trout cod reproduction though the King is significantly cooler than that the Buffalo River in spring. Both contain submerged wooden debris as well as rocky features so overall habitat appears to be good. Both contain significant redfin populations with the potential to prey upon recently released fingerlings.

Lake Buffalo is reported to be a relatively poor fishery with the bulk of the catch being redfin while Lake William Hovell is better regarded with some good catches of trout (Tunbridge and Rogan 2006). In particular the King River upstream of the dam through to its headwaters is a popular trout fishery. Angler reaction to trout cod stockings in these two waters may be mixed, depending upon the angling regulations imposed. Given that there is some local displeasure at conservation stockings of trout cod in the Ovens River it would need to be made clear that the aim of such stockings would be principally for recreational angling and that the fish can be specifically targeted by anglers. It would also have to be emphasised that the goal of the stockings is not to replace existing fisheries but to provide additional opportunities for both anglers and local commerce. The establishment of the recreational impoundment fisheries for trout cod has the potential to draw many anglers particularly if fish can be retained.

The greatest contention lays in the angling regulations needed to manage these fisheries in these two lakes. Total protection of the trout cod by catch and release may only exacerbate some perceptions of nuisance status amongst some anglers. Limited harvest with a possession limit of one would overcome this but generates potential conflict with the local conservation population, as discussed earlier. Also as discussed previously, fish stocked for limited harvest can be chemically marked so that illegally taken fish can be identified or at least the implied threat of doing so exist.

The recent stocking of Lake Buffalo with Murray cod has the potential to create confusion if different regulations are imposed to manage stocked trout cod. This was discussed earlier in the section on the upper Buffalo River. If selected for stocking with trout cod, this confusion could be avoided through the cessation of Murray cod stockings though at the risk of antagonising anglers. A better alternative may be to have common regulations on this water for both species requiring the trout cod fishery to be a limited harvest fishery from the time of establishment. Alternately it may be simpler to focus on creating a catch and release trout cod fishery in the river upstream of the dam and maintain Murray cod stockings in the dam for harvest. It is likely that if the upper Buffalo River is eventually stocked with trout cod that some fish will disperse downstream and enter the Buffalo Dam fishery.

It would appear that out of Lakes Kerford, Sambell, Buffalo and William Hovell that Lake Kerford is perhaps the best candidate for the establishment of an impoundment trout cod fishery in the short term, particularly if the fishery has to be catch and release. Being isolated from the conservation population in the Ovens and lower King Rivers is an advantage for enforcement of regulations intended to protect that population. Lake Buffalo is an excellent medium term candidate more so for the development of a controlled harvest fishery. Stocked fish can colonise the river upstream and juveniles recruit into the Ovens River downstream. Stocking Lake Buffalo is likely to be less contentious than stocking Lake William Hovell. It appears to be ideally suited for the inclusion of trout cod within its existing mixed fishery in the medium term.

Lakes Dartmouth, Eildon and Hume are large water bodies and, using as a guide the fingerling numbers used to establish the Murray cod fishery in Eildon, would require many tens of thousands of fish to be stocked annually. While these waters have potential for including trout cod in their mixed fisheries in the future, they may not be short term candidates as the commitment of large numbers of juveniles without a high probability of success cannot be justified. Trials with trout cod stocked in smaller impoundments may clarify the potential of these waters for future stockings. Lake Dartmouth may be an exception as the existing population produced through conservation stockings may require additional stockings in the short term to become self supporting.

Lakes Eildon and Hume support diverse mixed fisheries which include native species such as Murray cod and golden perch as well as the introduced trouts and redfin. At the time of stocking Lake Eildon with Murray cod there was some adverse reaction from anglers who perceived that the trout fishery was under threat in that water. Today the move is generally applauded. Given the positive angler response to the stocking of native fish in these waters the introduction of trout cod to these fisheries is unlikely to be controversial. If at the time of stocking the intention is to create a regulated harvest for trout cod, then their introduction is likely to be welcomed by anglers. Both of these impoundments have in-flowing rivers which previously supported trout cod populations and so there appears to be a potential for reproduction.

Lake Hume since September 2004 has been the management responsibility of Victorian authorities. Like Lakes Eildon and Dartmouth the number of fish required to establish a significant trout cod fishery in this water in the short term is prohibitive. However, it does have merit for a number of reasons. Firstly, it is known that the two major in-flowing rivers, the Murray and the Mitta Mitta, contained small numbers of trout cod in the 1970's and there were unconfirmed captures of fish in the lake around this time (Trueman 2006). Secondly, current conditions in the lake are favourable for trout cod survival as demonstrated by the angler captures of fish in areas of the lake adjacent to the Koetong Creek and upper Murray River stockings. Thirdly, any stockings of trout cod into Lake Hume may support the stocked population existing in the Murray River immediately upstream of the lake.

With the possibility that trout cod populations may be established in the lower Mitta Mitta River in the future and are established in the upper Murray River, there is the potential to create a fishery extending several hundred kilometres centred on Lake Hume. This would provide resistance to extinction of the fishery caused by local catastrophe and heavy fishing pressure and enhance the conservation status of the species. Lake Hume can be ruled out for establishment of a recreational fishery for trout cod in the short term for logistical reasons, but stands out as a long term candidate.

Lake Dartmouth is nominally a mixed fishery, which previously consisted of Macquarie perch and the two trout species. In recent years the Macquarie perch fishery has declined somewhat, at least in terms of the size of the fish if not numbers, and the attention of most angler activity is towards trout. The regular reports of trout cod captures from this water suggest that the limited stocking from earlier years has had some success. If this population reproduces, a self-supporting fishery may eventually develop. This population clearly requires further investigation as to its status and follow up stockings may be required to support it.

If the Lake Dartmouth population fails to recruit successfully then a strong case can be made for establishing a put and take fishery within this water. A potential fishery already exists, but there is some adverse angler reaction to the inability to retain the fish. In addition the trout cod have the potential to impact upon the European carp population with possible benefits to the trout and Macquarie perch populations. It would appear that Lake Dartmouth may be the best candidate after Lake Kerford to receive trout cod stockings for recreational angling. If this is done with the stated intention of developing a controlled harvest fishery with a bag limit of one fish then there is more likely to be acceptance of a predetermined introductory period of catch and release angling.

Table 10. Existing Recreational Fishery Details for Candidate Impoundments for RecreationalTrout Cod Stockings (from Tunbridge & Rogan 2006)

Water	Surface Area (Ha)	Current Fishery	Recent Stocking History
Lake Kerford	24	Contains redfin, a small self-sustaining population of brown trout, tench and goldfish. Trout stocking in the past has been unsuccessful. More recent stockings of golden perch are yielding fish up to 1kg.	Stocked with 5000 golden perch 2006
Lake Sambell	6	Contains mainly redfin to 900g, blackfish, golden perch and tench.	1000 rainbow trout 2005/6 Stocked annually with golden perch and rainbow trout.
Lake Buffalo	341	contains some brown trout to 2kg, rainbow trout to 500g, reasonable-sized redfin some to 1kg, goldfish, some Macquarie perch and possibly an occasional trout cod. Occasional captures of Murray cod. and stocked golden perch.	10 000 golden perch 2005/6 1000 Murray cod 2005/6 Trout spawn in the Buffalo River and Yarrarabula Creek above the lake and provide ample recruitmt.
Lake William Hovell	113	Contains abundant redfin to 1.5kg (av. 400g), brown trout to 1kg, (av. 450g), some large blackfish and possibly some Macquarie perch although no recent records.	Not stocked due to natural recruitment of trout
Lake Dartmouth	6 400	Contains primarily brown and rainbow trout, with abundant carp and some Macquarie perch and blackfish.	Not stocked due to natural recruitment of trout
Lake Hume	22 600	Predominant angling species are redfin to 1.6kg, brown trout to 2.5kg, carp to 5.2kg, golden perch to 4kg, an occasional Murray cod to 15kg, a very occasional silver perch, and goldfish.	25,000 brown trout 2005/6 10 000 rainbow trout 150 000 golden perch 2005/6
Lake Eildon	13 750	Contains abundant redfin, roach & carp, with some brown and rainbow trout, Murray cod, golden perch and a few Macquarie perch.	200 000 golden perch 2005/6 50 000 Murray cod 2005/6

Conclusion

Lake Kerford due its size and position stands out as the best initial candidate for the inclusion of trout cod in its recreational fishery, particularly if it is deemed necessary to maintain a period of catch and release. NFA fully supports DPI Victoria's proposal to stock this lake for recreational angling. Lakes Sambell and Buffalo are excellent short to medium term candidates but would probably require limited harvest fisheries rather than catch and release if trout cod stocking is to be positively received by the community.

Of the larger impoundments, Lake Hume stands out from the conservation perspective due to its potential to support the existing trout cod population in the upper Murray River and potential future population in the lower Mitta Mitta River. Thus, the creation of a recreational trout cod fishery in this water has the potential to enhance the conservation status of the trout cod. However, its distance from Melbourne is a disadvantage for the recreational angling population of Victoria the bulk of which resides in or near Melbourne.

A similar situation exists with Lake Dartmouth, which is very isolated from Melbourne. However, a potential recreational fishery already exists in Lake Dartmouth and serious consideration has to be given towards supporting its development.

Due to their proximity to Melbourne, Lake Eildon and possibly Lake Eppalock are attractive potential long-term candidates for trout cod stocking. However, stocking these waters may contribute little to the overall conservation status of the trout cod.

Recommendations

At the present time, there appears to be no legal impediment to the establishment of recreational fisheries for the trout cod in Victoria. A precedent has already been set in the case of Macquarie perch and a national example exists in the case of Mary River cod. Controlled harvest (bag limit 1 fish) is permitted for stocked Mary River cod in impoundments, some of which are in proximity to wild populations, and catch and release (no take) angling is technically legal within at least part of its natural range. Given that the Mary River cod is in at least as precarious a position as the trout cod there seems little reason why, at the very least, catch and release fisheries for trout cod cannot be established in Victoria in the short term.

Similarly, using the Mary River cod example it is hard to argue against having controlled harvest fisheries created and supported by ongoing stocking. The creation of such fisheries is needed to permit angler appreciation of what is, to most, an enigmatic fish with perceived high potential, but viewed to be of little value at present. After nearly twenty years of trout cod stocking, anglers are openly cynical about trout cod ever becoming legal angling targets and show open hostility towards recovery efforts particularly when trout cod dominate their catch in waters like the Ovens River.

Anglers in waters stocked with trout cod could be a valuable information source for managers on the health of these populations, particularly since traditional survey methods have been reported to have trouble locating mature fish. Very large trout cod, exceeding 7 kg, are being captured by anglers from stocked populations but are going unreported as are juveniles clearly produced from natural recruitment. Such information is of great value to biologists and managers but is not being made available to them. Anglers are reticent to supply information on trout cod captures with an eye on the regulations making the attempted 'taking' of trout cod illegal or that if stocked trout cod populations flourish that access to waters will be restricted. The current situation where conservation efforts are perceived to conflict with recreational angling is counterproductive.

Recreational fisheries for trout cod could support and enhance existing fisheries with consequent economic and social benefits to regional communities and the state as a whole. The options for such fisheries can be reviewed in terms of short term (within 5 years) and medium term (within 10 years) options. Based on feedback we have gained from some anglers, NFA believes that the single most productive action the Victorian state government and its national counterpart could take to improve community perception of the trout cod would be to legalise catch and release angling in the Ovens River, or at least two very short sections of it, for a trial period of three years. Such action will clearly demonstrate to the local community that, in the fullness of time, the stocking of trout cod in the Ovens River will provide the types of economic and social benefits advocated in existing state and national trout cod recovery plans.

If necessary, limiting the catch and release fishery to a small proportion of the Ovens River population will minimise any negative impact upon that population. The actual impact may be negligible as anglers are regularly capturing trout cod at the present time. Any potential negative impact could be reduced or avoided by requiring those targeting trout cod to use artificial flies and lures to eliminate gut hooking. This would not affect general angling regulations in the Ovens River where bait fishing would still be legal for those anglers targeting other species. Rather, this regulation would act to minimise fish mortality from any extra angler effort that may occur directed at the trout cod. By applying an 'artificial fly or lure only' regulation to a catch and release fishery for trout cod in the Ovens River, NFA believes that this will satisfy our stated criteria that the angling activity should not significantly impact upon the recovery effort taking place in the Ovens River.

By opening at least the sections of the Ovens River between the Everton road bridge and Oxley flats road and from Boorhaman to the Peechelba road bridge to catch and release fishing, local angling guides as well as state and national fishing identities could promote the potential of the trout cod to the community. They in effect can become ambassadors for the species. This action would still leave the majority of the trout cod population in the Ovens system protected under the angling ban. However, all things considered, legalising catch and release angling of trout cod through the use of flies and lures within the Ovens River generally is probably preferable and would make any impacts diffuse rather than localised.

An advantage of the Ovens River option is that if activated its effects will be immediate. The Lake Kerford proposal will take a number of years for the fish to reach a size suitable for angling. Such a pragmatic approach with the Ovens River appears to satisfy all criteria of existing trout cod recovery plans without compromising conservation objectives. It would reflect well on the State and Federal governments and develop the type of community ownership of recovery efforts directed towards the Mary River cod and advocated for trout cod in the Murray cod workshop (Lintermans et al 2005).

NFA fully supports DPI Victoria's proposal to establish a recreational fishery for trout cod in either Lake Kerford or Lake Sambell with the proviso that the intention must be ultimately to develop the fishery for controlled harvest with a bag limit of one fish. If this intention is made clear from the outset then such a

proposal, incorporating an initial period of catch and release of say 3-4 years while the fish grow to a suitable size, is likely to be well received by local anglers and the wider angling community.

Marking stocked fish internally allows determination of the source of trout cod in the possession of anglers and would act as a deterrent to those considering removal of fish from the protected populations in nearby waters. This tool would ensure that our criteria of recreational fisheries for trout cod not having significant adverse effects on conservation efforts would be met as well as satisfy the guidelines outlined in state and national recovery plans. Establishment of a purely catch and release fishery in either impoundment is not supported as it is only likely to reinforce the image of the trout cod with local anglers as being a fish of limited potential. Such an adverse reaction will only hinder conservation efforts within the Ovens River system.

The alternative to opening a stretch of the Ovens River to catch and release fishing is to create one in a stream well away from the Ovens River. While NFA supports the establishment of an impoundment fishery in Lake Kerford, we believe that a small impoundment does not lend itself well to some sportfishing techniques such as dry fly and some popular forms of lure fishing, particularly when the water is relatively deep as in the case of Lake Kerford. A stream fishery, or a modest river as in the Ovens River proposal, allows all forms of sportfishing including polaroiding for individual fish. Angling guides could utilise such a water to develop their skills for future trout cod fisheries.

It is understood that a stream fishery could not sustain heavy fishing pressure without ongoing stockings and may require catch and release in the short term and very limited harvest in the long term to maintain quality angling. Ultimately, fish stocked for intended harvest from a stream could be internally marked for identification as discussed for Lake Kerford. If the intention is to improve angler perceptions of the trout cod then the Lake Kerford proposal, while a useful first step, may not be enough. A stream/river fishery is considered a priority as NFA believes that such an environment can quickly showcase the angling attributes of the trout cod.

The best available short-term candidate for a stream fishery appears to be Koetong Creek. It has a reliable flow, is thought to have a suitable temperature regime and its catchment and instream habitat bares a strong resemblance to the trout cod habitat in the Seven Creeks. Previous stockings have demonstrated excellent trout cod survival and there are angler's reports suggesting their continued presence. Stocked fish that disperse have the potential to recruit into the upper Murray River trout cod population, which we consider to be a major advantage.

Koetong Creek's isolation makes it a rare example where a dedicated trout cod fishery could be established without impacting many anglers. An annual stocking of 2000 fingerlings per annum is a small proportion of the trout cod production of the Snobs Creek facility. NFA's preferred option is catch and release fishing in part or all of the Ovens River with the establishment of an impoundment fishery in Lake Kerford. However, if the Ovens option proves unacceptable, we recommend that Koetong Creek be stocked with trout cod in addition to Lake Kerford.

In the short term another situation that needs reviewing is that of the trout cod in Lake Dartmouth. Stocked trout cod have survived in Dartmouth and the size of some fish suggests that limited reproduction and recruitment may have occurred. It would appear that, based on the experience gained with the Goulburn and Ovens River stockings, the numbers released in the Mitta Mitta River/Lake Dartmouth may have been insufficient to create a population of the critical mass to become self supporting. It would seem that, from the conservation perspective, follow up stockings should take place to support the existing population. Similarly follow up stockings are warranted in the Goulburn River near Murchison to help that population recover from the fish kill.

Given that some success has been achieved in stocking Lake Dartmouth, with this track record, NFA believes it should be earmarked for development as a mixed fishery containing trout cod. If the water is managed with a focus on the trout fishery with trout cod in the medium-long term becoming a trophy fish it is likely that such action will receive angler acceptance. Additional stockings within the next five years, followed by a period of catch and release angling, and ultimately controlled harvest within a decade appear to be feasible goals.

One of the criteria stated for the development of recreational fisheries for the trout cod was that the development of these fisheries would not have significant adverse impacts on two other native fish species of conservation significance namely Murray cod and Macquarie perch. Neither species is present in Lakes Kerford and Sambell or in Koetong Creek and so in these waters there is no issue. Trout Cod are currently being stocked in the Ovens River and so presumably the potential impacts on the Murray cod population in that water have previously been considered and determined to be acceptable. Similarly Lake Dartmouth contains Macquarie perch and has been previously stocked with trout cod and presumably undergone a similar process. In this water, strict controls are applied to the taking of Macquarie perch by anglers. None of the short-term options appear to pose significant risks to Murray cod or Macquarie perch.

In conclusion, NFA strongly recommends that in the short term (within 5 years) a controlled harvest fishery be established in Lake Kerford, a catch and release trial be undertaken in part or all of the Ovens River and that follow up stockings take place in Lake Dartmouth and the Goulburn River below the Goulburn Weir. The proposal is to progressively establish catch and release fisheries in these waters and ultimately controlled harvest as recovery objectives are satisfied and sustainability demonstrated.

In the medium to long term (5-10+ years) we believe that a number of other waters stand out with potential for the inclusion of trout cod in their recreational fisheries as well as contributing to the conservation of the species. The Murray River from its confluence with Lake Hume upstream to Towong represents the longest continuous stretch of foothill/upland riverine habitat capable of supporting a trout cod fishery available to Victoria anglers, albeit in NSW. While suffering limited thermal impact from coldwater releases it appears to be a very good habitat. Of the major rivers, this may be the best candidate for the development of a significant riverine sportfishery for the trout cod and other native species such as Murray cod and eventually Macquarie perch if hatchery technology can be developed for the latter.

Ray Clifford with a trout cod from the Murray River in the Barmah area. Anglers are heavily fishing this area while at the same time the trout cod population is expanding and moving downstream. This strongly suggests that, at the very least, catch and release angling is compatible with conservation.

(photo: Ray Clifford)

The main disadvantage of the upper Murray River is its distance from Melbourne though this would be offset by support from Canberra based anglers as well as regional anglers. However, acceptance by anglers of trout cod within this fishery is likely to depend upon the implementation of controlled harvest of trout cod. If this intention is stated from the outset then initial stockings for conservation, followed by catch and release angling, ultimately leading to controlled harvest will receive angler acceptance. The river contains a significant Murray cod fishery, which has not been adversely affected by past trout cod liberations and its conservation is of importance. Overall, from the Victorian perspective, this is an outstanding candidate for a foothill/upland trout cod fishery and should be given long term priority for the future.

Such a proposal would not impact upon some of the blue ribbon trout fisheries in the upper Murray region. Many feeder streams and rivers are outstanding trout waters and there is no reason why they should not remain so. The Murray River below Towong, like the Ovens River below Myrtleford, is a mixed fishery with significant numbers of native fish and it is our suggestion that both should be managed as such but primarily for native fish. Serious consideration should be given to the reintroduction of Macquarie perch to the upper Murray region through stocking of juveniles or translocation. This reintroduction could take place via a feeder stream such as the Koetong or Cudgewa Creek. NFA urges that Victorian authorities and peak angling groups

liaise with their NSW counterparts on behalf of Victoria anglers to bring these proposals in the upper Murray to fruition.

Native Fish Australia believes that if self supporting trout cod populations ultimately become established in the lower Goulburn River, the lower-mid Ovens River, Lake Dartmouth, and the upper Murray River, then combined with the natural population in the Murray River below Yarrawonga and the Seven Creeks population this should provide a baseline buffer to extinction for the species in the Victorian context. The consequence is likely to be the down-listing of the trout cod from endangered to vulnerable status as outlined in state and national recovery plans. Any additional self-supporting populations in New South Wales and the A.C.T. and those created with an emphasis on recreational angling in Victoria, can be viewed as further consolidating the future survival of the trout cod. This can assist ultimately in it's de-listing as a threatened species, if the criteria outlined in existing recovery plans are met. If in the medium to long term the conservation status of the trout cod further improves, a general relaxation of angling regulations can occur.

A number of other waters have merit for inclusion of trout cod in their mixed fisheries in the medium to long term. A strategy of stocking followed by initial catch and release angling, leading to controlled harvest of trout cod should prove acceptable to anglers in these waters. If required, fish stocked in these waters could be marked to allow identification of these fish from those in protected populations. Identifying candidate rivers for trout cod fisheries, other than those already stocked for conservation purposes, is problematic. Rivers in foothill and upland regions, which were the former strongholds of the species, have in many cases been drastically modified by dams and land use practices.

The Yea River appears to offer reasonably good habitat and its proximity to Melbourne makes it attractive. The Buffalo River between Buffalo Dam and Abbeyard, which previously has received small stockings of trout cod for conservation purposes, may offer better habitat than the Yea River and consequently the potential to have a higher population density. In addition stocked fish have the possibility of recruiting into the Ovens River population (though the dam is an obstacle) whereas the Yea River is isolated from other trout cod populations.

Both the Buffalo and Yea Rivers contain populations of Macquarie perch of conservation significance produced by previous stockings of fingerlings. A full investigation of their distribution and status is needed to consider the impact of trout cod liberations upon them. Small numbers of trout cod have been previously liberated into the Buffalo River and may still be present. This action by the relevant authorities in this water suggests that the potential for impact of stocked trout cod and other native species upon the Macquarie perch in this water has been previously assessed as acceptable. The recent liberations of both Murray cod and golden perch into Lake Buffalo support this contention.

Establishing sustainable recreational fisheries in creeks for trout cod may be difficult, as the small populations in such waters are unlikely to withstand significant angling pressure. An exception may be where creeks flow into rivers or dams containing trout cod populations with the ability to supply recruits to the creek population. Cudgewa Creek is considered to be a good medium-long term candidate with Hughes Creek being a secondary candidate due to its poorer habitat and isolation from existing trout cod populations.

The Cudgewa Creek in particular is attractive as stocking it would support the upper Murray population and effectively extend it. Hughes Creek still remains a candidate and may be useful for the establishment of a second population of the Seven Creeks genotypes as has been touted from time to time. However, conservation of its significant Macquarie perch population downstream from the area considered for trout cod stocking is a priority. The likely increased angler effort generated by a recreational fishery for trout cod in this water could be detrimental to the Macquarie perch population and this may rule the Hughes Creek out. Ryan's Creek is not considered a good candidate as even though suitable habitat exists in the impoundments along its course they are closed to anglers and the stream itself is probably too small a habitat to support a trout cod population with the ability to sustain even modest angling pressure.

Of the smaller impoundments, other than Lakes Kerford and Sambell, Lake Buffalo appears to be the best candidate with even modest stockings of perhaps 5 000-10 000 fingerlings per annum having the potential to establish a fishery. An introductory period of catch and release followed by controlled harvest is likely to be accepted by anglers. Lake Buffalo is also an excellent candidate and should be considered a priority in the medium to long term but only if earmarked initially as a put and take fishery introducing eventual controlled harvest.

The large impoundments would require massive stockings of trout cod to establish fisheries which may not be feasible in the short-medium term. All those considered show potential with Lake Eildon, due to its proximity to Melbourne, being attractive. However, the standout candidates are Lake Hume with an extensive stretch of river upstream capable of supporting trout cod and Lake Dartmouth with an existing stocked population. Lake Hume is particularly attractive with its potential to support the upper Murray trout cod population. If it were not for the limited success already achieved in Lake Dartmouth, Lake Hume would have been recommended as the favoured large impoundment for long term stocking.

Apart from the Ovens and upper Murray Rivers, at the present time thermal pollution from dams renders many candidate rivers unsuitable for the development of trout cod fisheries in the foreseeable future. The lower Mitta Mitta, mid Campaspe and mid Goulburn Rivers exhibit substantially modified thermal regimes, particularly the last two. Conditions in the lower Mitta Mitta River appear to be suitable for trout cod survival, and even spawning and recruitment in some years. The middle Goulburn River between Trawool and Nagambie is severely affected by cold water releases from Eildon Dam.

The current temperature regime in the middle Goulburn River supports the state's premier trout fishery between Eildon and Homewood/Trawool. That trout cod can survive in this temperature regime has been demonstrated by the capture of the fish at Molesworth this year. However, even if stocked in the reaches towards Nagambie the species is unlikely to reproduce in most seasons and the low temperatures may impact angling quality. Further investigation of the temperature requirements of trout cod are required to clarify the matter before stocking of trout cod in these waters can be recommended in their existing thermal regimes.

NFA acknowledges that both the lower Mitta Mitta and the mid-Goulburn Rivers are considered to be two of the best trout fisheries within the state of Victoria. Modelling of amelioration of the thermal pollution in the lower Mitta Mitta suggests that it may be possible to improve conditions in this river for trout cod while largely maintaining the quality of the trout fishery. The possibility that amelioration of the thermal regime of the Goulburn River could be carried out with minimal impact on the quality of the upstream trout fishery needs to be demonstrated. If this is feasible then, and only then, is such action likely to be broadly supported by the Melbourne angling community.

Given that recent modelling in the lower Mitta Mitta River suggests the potential for this concept in principle there is hope of improving native fisheries in the lower reaches of these sections of rivers without impacting significantly on upstream quality trout fisheries. In the case of the Goulburn River this action may be justified to support the efforts of anglers in the Nagambie region in establishing their desired native fisheries in their local waters. If this takes place at some point in the future, the mid Goulburn River could support a recreational trout cod fishery in such a scenario but it is only a possible long term view. However, if ultimately trout cod fisheries are established in the other waters outlined in this report then it may well be better to target resources into those waters and totally manage rivers such as the mid Goulburn River as cold water trout/redfin fisheries.

In preparing this report NFA has avoided where possible many popular trout streams and rivers focussing on those with the greatest potential for trout cod with the least impact on trout fisheries. Specifically, waters such as the upper Goulburn, Jamieson, Big, Delatite, Acheron, upper Broken, Upper King and Kiewa Rivers and many other streams showing potential could be candidates but are not advocated in order to try to reach a consensus with peak groups representing trout anglers. NFA's desire is to reach common agreement with these groups to end the controversy and acrimony surrounding the debate on how our mid and high altitude freshwater fisheries should be managed. If such agreement can be reached then angling groups can work together co-operatively for the common good of all anglers within the state without fear of hidden agendas between rival groups.

It is our proposal that in the long term the lower-mid Ovens/lower-mid Buffalo Rivers and the upper Murray region incorporating the Murray River upstream of Lake Hume to Towong and the lower reaches of the Cudgewa Creek be the focus for establishment of recreational fisheries for upland native species. Specifically, these species are trout cod, Murray cod, Macquarie perch and the northern blackfish. Such proposals do not exclude having trout or other introduced or native species such as golden perch in these fisheries, just that a concerted effort be made to establish and maintain native fisheries for the species listed in these waters.

It is our preference that trout should not be directly stocked into these waters but we acknowledge that trout can and will contribute to these fisheries by movement downstream from tributaries and headwater regions or upstream out of Lake Hume in the case of the upper Murray River. Adjacent and in-flowing waters can be maintained and managed as mixed fisheries and upstream as trout fisheries and if appropriate be stocked with trout. Similarly, trout stockings could continue in Lake Hume. This largely is the current management situation in the Ovens River as demonstrated by the Buckland River trout stocking.

Mixed fisheries in candidate waters such as Lakes Kerford, Sambell, Dartmouth, Hume and Eildon, and possibly Hughes Creek and the mid Yea River are also proposed and to varying degrees these waters are already mixed fisheries. There is a range of other waters in Victoria which may be considered candidates for including trout cod in their mixed fisheries in the distant future. However, those identified and discussed in this report are considered the best candidates in the near future.

In such mixed fisheries, we do not object to the stocking of trout if needed to maintain or enhance them, if the trout population is not adequately supported by natural recruitment. If required, the number stocked should preserve the balance to keep the fishery 'mixed'. In smaller waters like creeks or small rivers, a moratorium on stocking trout may be needed while trout cod are being stocked to establish a population, given that there is some evidence that trout can prey upon juvenile trout cod. However, in such mixed fisheries containing trout

cod we do not have an objection to stocking trout or other native angling species in these waters if necessary to maintain the overall quality of the fishery. Also, for dedicated trout fisheries we support them being managed to produce angling of the highest possible quality for anglers.

If the proposals in this report are adopted, aside from any specific conservation needs (eg for Galaxiids, Macquarie perch, Blackfish, etc), most streams containing trout within the Murray-Darling catchment in Victoria will retain their current status as mixed fisheries or dedicated trout fisheries. Specifically NFA views the remnant natural Macquarie perch populations in the King Parrot, Hughes and Seven Creeks and Lake Dartmouth and the stocked populations in the Yea, Broken, Yarra and Buffalo catchments as critical for the species survival. Until such time as this species can be reliably produced in hatcheries and larger, more extensive populations are created, priority has to be given in all management decisions to their well being.

NFA accepts the concept of classification of waters as suggested by some angling groups provided that the basic conservation objectives outlined in this proposal are satisfied, that Government legislative requirements are met, and that native fish anglers are provided with some quality foothill/upland fisheries. If the basic tenets of this proposal are generally adopted then the aspirations of both trout and native fish anglers can be satisfied and conservation objectives fulfilled without denying anglers access to waters as feared by some. Our belief is enhancing recreational angling can be used as a tool to support conservation efforts.

NFA hopes that in openly canvassing these proposals and demonstrating its pragmatism that this will be reciprocated by other angling bodies, particularly those representing trout anglers. It is our fervent hope that past differences be put aside so that angling groups can work towards common goals in an atmosphere of trust and mutual respect. The intention of this report from the outset has been to generate dialogue between all relevant parties and NFA invites discussion about the contents of this proposal with all interested groups and government authorities.

Summary of Recommendations

In conclusion, it is recommended that the following actions be taken to initiate the development of recreational trout cod fisheries within Victoria:

Short Term (within 5 years)

Impoundment Fishery

- 3000-5000 fish p.a. stocked into Lake Kerford or Lake Sambell, catch and release initially for 3-4 years, then a bag limit of one fish.
- Additional stockings of trout cod to take place in Lake Dartmouth for conservation purposes, with a view in the medium term to provide recreational angling, initially catch and release then controlled harvest.

River Fishery

- Catch and release angling to be legalised for trout cod in the Ovens River generally or at least between the Everton Road bridge and Oxley Flats Road and between Boorhaman and the Peechelba Road bridge for a trial period of 3 years. It is proposed that regulations be provided that those anglers targeting trout cod for catch and release be required to do so using artificial flies and lures.
- Additional stockings of trout cod to take place in the Goulburn River downstream from the Goulburn Weir for conservation purposes, with a view in the medium to long term to provide recreational angling, initially catch and release then controlled harvest.

Stream Fishery

- If the catch and release proposal is not adopted in the Ovens River, then 2000 fish p.a. to be stocked into Koetong Creek, catch and release initially, possibly progressing to a bag limit of one fish, depending upon sustainability.

Medium Term (within 10 years)

River Fishery

- If significant, sustained natural recruitment occurs in the Ovens River trout cod population, it is recommended that a bag limit of one fish to be introduced, with supplementary stockings if needed, to maintain the population against angling pressure; Consideration of closure of the river to angling downstream of Wangaratta during the spawning season for both cod species, September 1 to November 30, once a bag limit is introduced for trout cod.
- Priority to be given to establishment of a fishery in the upper Murray River, if agreed to by NSW DPI and peak angling groups, supported by stocking of around 10 000+ fingerlings p.a., catch and release initially followed by controlled harvest.
- 5000 – 10000 fish p.a. stocked into the upper Buffalo River or possibly the Yea River (subject to investigation and consideration of the resident Macquarie perch populations), bag limit of one fish.

Impoundment Fishery

- 10 000 – 20 000 fish p.a. stocked into either Lake Dartmouth or Lake Hume, increasing as fingerling production increases, bag limit of one fish.
- 5000 – 10 000 fish p.a. stocked into Lake Buffalo.

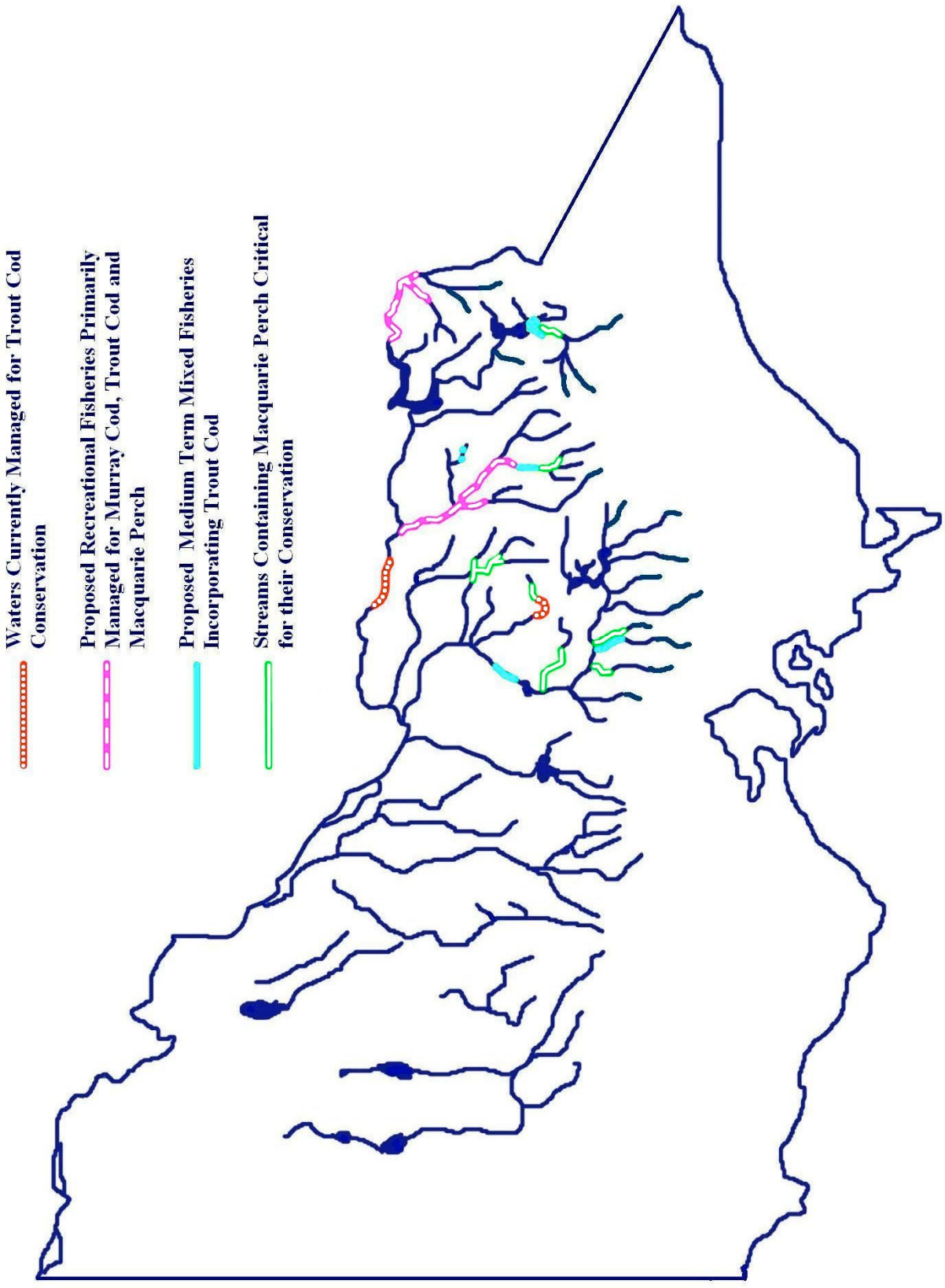
Stream Fishery

- 2000 -5000 fish p.a. stocked into Cudgewa Creek, bag limit of one fish.

Very Long Term (10+ years)

- General legalisation of trout cod angling with similar regulations to the Murray cod fishery, dependant upon improved conservation status of the species
- Stocking of lower Mitta Mitta, lower Campaspe and mid Goulburn Rivers if research determines their existing thermal regimes to be suitable or if their thermal regimes are improved in the future.
- Stocking of Lake Eildon

If these proposals are implemented then combined with recent/current conservation stockings it appears in the medium to long term that two regions can be developed to containing significant foothill/upland trout cod fisheries. The first is centred near Wangaratta, encompassing the lower and mid Ovens River, the lower King River and the Buffalo River upstream to Abbeyard. The second is centred at Lake Hume encompassing the lake itself, the upper Murray River, lower Cudgewa Creek, and Lake Dartmouth.


Waters Currently Managed for Trout Cod Conservation
Proposed Recreational Fisheries Primarily Managed for Murray Cod, Trout Cod and Macquarie Perch
Proposed Medium Term Mixed Fisheries Incorporating Trout Cod
Streams Containing Macquarie Perch Critical for their Conservation

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