
# Translocation risk assessment for the stocking of Murray cod *(Maccullochella peelii)* Golden perch *(Macquaria ambigua)* and Estuary perch *(Macquaria colonorum)* into Rocklands Reservoir for recreational fishing.

**Prepared for:** Victorian Fisheries Authority
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***About this report:***

*There are two documents that make up the Risk Assessment. The first is this report which provides the context, supporting information and the detailed Risk Assessment and possible treatments. The second is the TEP Risk Assessment Proforma, provided in Appendix A, which has been completed to the requirements of the TEP and associated guidelines and draws extensively on this supporting information. This report must be read in conjunction with the TEP Risk Assessment Proform.*

# Executive Summary

Rocklands Reservoir is large man made impoundment located on the Glenelg River in Victoria's south west. Since commissioning in 1953, up until the early 2000's, the reservoir has supported a productive recreational fishery based on the introduced species Redfin (*Perca fluviatus*), that has attracted anglers from across Victoria and South Australia. It was originally established to supply the Wimmera-Mallee Domestic and Stock channel system however, ongoing development of the storage and supply network over the last 50 years has resulted in Rocklands being in the unique situation of being able to supply all current entitlement holders from the reservoir (GWMW 2014).

The Victorian Stream Classification (VSC) classifies Rocklands Reservoir as a 'Mixed Fishery' meaning that it supports recreational fishing for both native and introduced species. (http://agriculture.vic.gov.au/fisheries/policy-and-planning/fisheries-management-plans/inland-waters-classification). Since 1987, Fisheries Victoria have stocked over 390,000 Brown trout (*Salmo trutta*) and Rainbow trout (*Oncorhynchus mykiss*) into the reservoir to improve recreational fishing with varied and often minimal success. This is important context because the ongoing presence of stocked trout and other non-endemic fish in Rocklands including Redfin and carp which include an existing high abundance of predatory fish and pose a threat to endemic native fish populations. Although these risks fall outside the scope of this study.

In March 2015 the Toolondo Reservoir Recreational Fishery Advisory Group (TRRFAG) was established to provide advice to the Victorian government on "strategies and actions to enhance the recreational fishing opportunities at Lake Toolondo and surrounding regional waterways". A key recommendation of the Advisory Group was to **"investigate the potential to create a high quality native fishery in Rocklands Reservoir by undertaking a fish stocking risk assessment in accordance with departmental translocation policy."**

This study considers stocking Rocklands Reservoir with three native species; Murray cod (*Maccullochella peelii),* Golden perch (*Macquaria ambigua)* and Estuary perch (*Macquaria colonorum)* and presents a comprehensive assessment of the environmental risk associated with the proposal. The risk evaluation process includes consideration of the environmental values of the site and the potential impacts of the translocated species and is based upon the approved proforma for submission to the Translocation Evaluation Panel (see Appendix A).

There are twenty-three (23) endemic fish species reported to occur in the Glenelg River, nine (9) of which are listed as significant under Victorian legislation. Six (6) of these are also recognized under the Commonwealth Environment Protection and Biodiversity Conservation Act (EPBC Act) (see Table E.1).

Three (3) other non-endemic native species; Murray cod (*Maccullochella peelii*), Eel tail catfish (*Tandanus tandanus*) and Macquarie perch (*Macquaria australasica*), have been recorded in the Glenelg River system and are also listed under Victorian and Commonwealth legislation. These legislations provide for the protection and conservation of threatened species and for the management of the threatening processes. The proposal to stock fish into Rocklands Reservoir must consider these legislation as they apply to the potential impacts of stocking on the listed threatened species in the Glenelg River.

Rocklands Reservoir is primarily managed to ensure the supply of water for domestic and commercial use and clear operating rules are in place to ensure that this objective is achieved. Rocklands also provides an important source of environmental water for the Glenelg River and the Wimmera Basin which is determined by seasonal watering plans developed by the Victorian Environmental Water Holder.

Subsequent to studies undertaken in 2006, Continuous Deflection Units (fish screens referred to as CDS units) were installed downstream of the outlet regulator of Rocklands Reservoir to prevent the escape of European carp and their eggs into the Glenelg River. Prior to the installation of the screens Rocklands had a nominal discharge capacity of 600 ML/Day, however, this is now restricted to the capacity of the fish screens which is nominally 400 ML/Day and since the installation of the CDS units in 2006 discharge flow rates have seldom exceeded 300ML/day. The CDS's would also be effective in preventing the movement of the proposed stocked species (and their eggs) into the Glenelg River.

**Table E.1: Significant endemic fish species in the Glenelg River system. Bold denotes listed under Commonwealth EPBC Act**

| Species | Victorian Conservation Status |
|---|---|
| **Australian grayling *Prototroctes mareana*** | Vulnerable, FFG Listed |
| River blackfish *Gadopsis marmoratus* | Critically endangered in upper Wannon River |
| **Variegated pygmy perch *Nannoperca variegata*** | Vulnerable, FFG Listed |
| **Yarra pygmy perch *Nannoperca obscura*** | Vulnerable, FFG Listed |
| **Little Galaxias *Galaxiella toourtkoourt*** | Vulnerable, FFG listed |
| Australian mudfish *Neochanna cleaveri* | Critically Endangered, FFG Listed |
| Western swamp crayfish *Gramastacus insolitus* | Critically Endangered, FFG Listed |
| **Glenelg spiny freshwater crayfish *Euastacus bispinosus*** | Endangered, FFG Listed |
| **Glenelg Freshwater Mussel *Hyridella glenelgensi*** | Critically Endangered, FFG Listed |

Two of the three species proposed to be stocked into Rocklands Reservoir; Murray cod and Golden perch are native to the Murray Darling Basin while Estuary perch are endemic to the Glenelg River Catchment and are common in the lower reaches of the Glenelg River below Casterton. Both Murray cod and Golden perch have been recorded in the Glenelg River below Rocklands Reservoir while Murray cod are also present in Rocklands Reservoir. In general, environmental conditions in Rocklands Reservoir appear suitable to support the growth and survival of all three species however, hydrological and water quality factors will inhibit the natural breeding of all species in the Reservoir. The ongoing maintenance of populations for recreational fishing will thus be substantially reliant on stocking. While each of the species will survive in the Glenelg River, it is unlikely that Murray cod and Golden perch will successfully breed. It is expected that Estuary perch that escape from Rocklands Reservoir will generally migrate downstream and

assimilate with natural populations. This present minimal risk to endemic fish populations as the Estuary perch stocked into Rocklands are derived from brood stock sourced from the Glenelg River.

The risks associated with stocking Murray cod, Golden perch and Estuary perch are assessed against the key environmental values relating to the endemic fish species in the Glenelg River catchment. Risks associated with the release of Estuary perch into Rocklands reservoir are considered low and manageable and therefore the risk assessment focuses primarily on the threats posed by the release of Murray cod and Golden perch. Values are described for the fish communities and in particular threatened species within Rocklands Reservoir and in the Glenelg River both upstream and downstream of Rocklands. The potential predatory, competition and disease threats of stocking relating to each of these values are also described.

The Preliminary Risk Assessment adopted a precautionary 'worst case scenario' approach to assessing the risks of stocking recreational fish species into Rocklands Reservoir. In particular, where a lack of information pertaining to a specific threat was identified, the initial risk rankings were appropriately increased to allow for this uncertainty.

The Preliminary Risk Assessment demonstrated that significant information gaps existed relating to the hydrology of the catchment and in particular its impact on the behaviour of Rocklands Reservoir as a water storage. This level of uncertainty prompted further investigation to better understand the hydrology of Rocklands Reservoir under a range of climate conditions. A range of important new data was released during the period of investigation which was assessed with respect to the risks associated with stocking target species in Rocklands Reservoir.

A Revised Risk Assessment incorporating new knowledge about the hydrology of Rockland Reservoir showed that the risks of stocking Murray cod, Golden perch and Estuary perch into the Reservoir are universally low, except for two risks which are ranked as medium. This suggests that should the stocking of these target species into Rocklands Reservoir proceed, there is little risk to the environmental values of the Glenelg River system.

A suite of possible management treatments was also identified that might further reduce risk and assist in the implementation and evaluation of the proposed stocking program.

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# 1 Introduction

## 1.1 Aim and Scope this Project

Developing Rocklands Reservoir as an important recreational fishery will require a commitment to stocking the waterway with suitable fish species that will form the basis of the fishery. This project considers stocking Rocklands Reservoir with three native species Murray cod, *Maccullochella peelii,* Golden perch, *Macquaria ambigua and* Estuary perch, *Macquaria colonorum* that are currently not officially stocked into the reservoir.

In order to stock these species into Rocklands Reservoir, it is necessary is to conduct a risk assessment for submission to the Translocation Evaluation Panel (TEP). The risk assessment must demonstrate that the translocation meets the requirements of the Guidelines for Assessing Translocations of Live Aquatic Organisms in Victoria. The established risk evaluation process includes consideration of the values of the site and the potential impacts of the translocated species.

The risk assessment is to be based on the approved proforma for submission to the TEP (see Appendix A) and the project has been undertaken in accordance with the methodology outlined in Figure 1.1 below.

## 1.2 Structure of the Risk Assessment

There are two documents making up this risk assessment. The first is this document that provides the context, supporting information and the detailed Risk Assessment and possible treatments. The second is the TEP Risk Assessment Proforma, which has been completed to the requirements of the TEP and draws on this supporting information, key stakeholder engagement and the risk assessment workshop held with key agency stakeholders.

The key components of the Risk Assessment are provided in the following sections:

- **Section 4** – Identified Values and Threats
- **Section 5** – The Risk Assessment Process and Findings
- **Section 6** – Recommended Risk Treatments

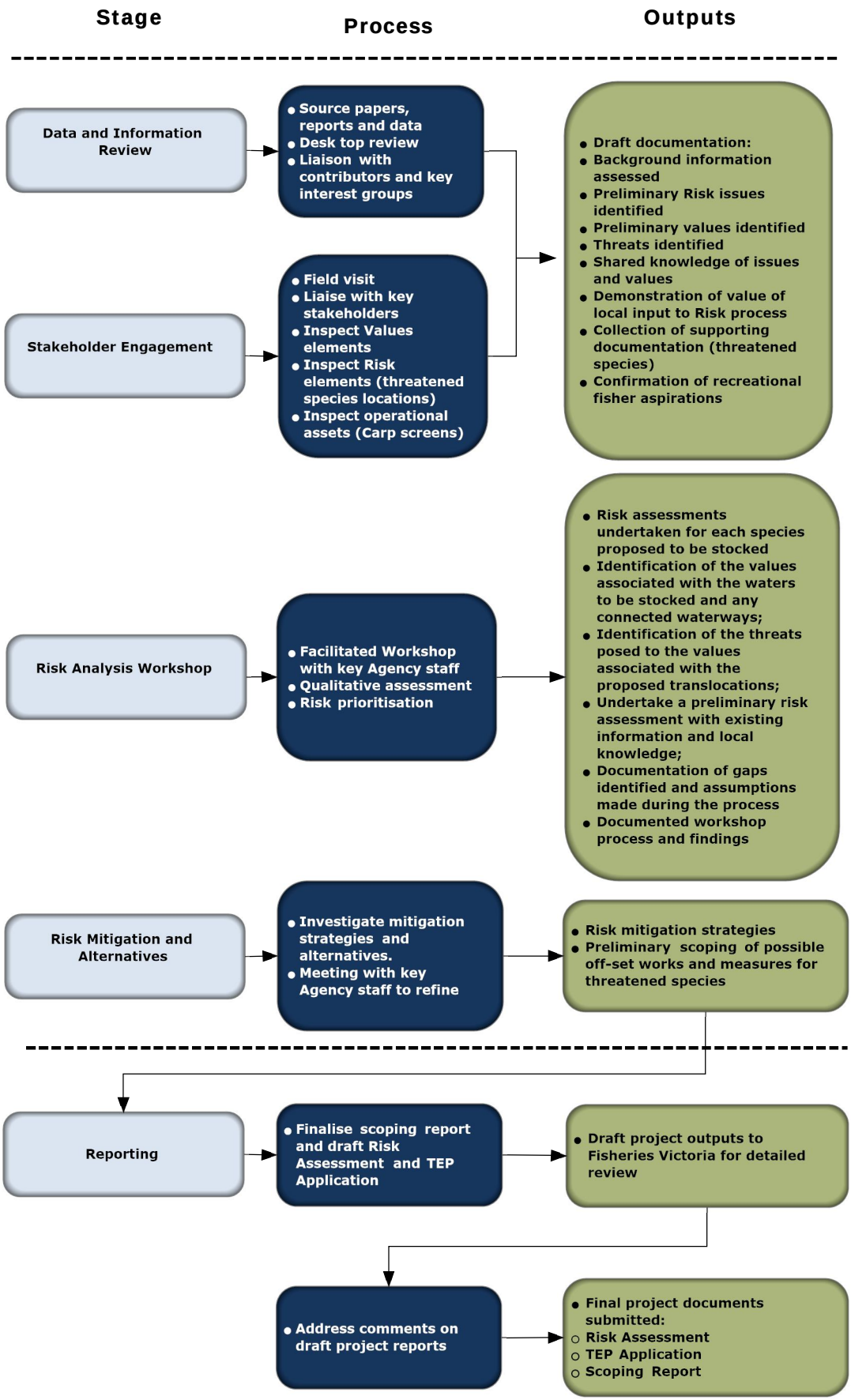



**Figure 1.1: Risk Assessment and Translocation Application Task Interface**

## 1.3 Background to this Risk Assessment

Rocklands Reservoir is large man made impoundment located on the Glenelg River in Victoria's south west. Since commissioning in 1953, up until the early 2000's, this vastly modified environment supported a productive recreational fishery based on the introduced species Redfin (*Perca fluviatus*), that attracted large numbers of anglers from across Victoria and South Australia. The impacts of drought in the early 2000's, and the changed operating regimes that ensued, led to a decline in the quality of the Redfin fishery along with visitors to the region which has impacted on the regions social and economic character.

Since 1987, Fisheries Victoria have stocked Rocklands Reservoir with over 390,000 yearling Brown trout (*Salmo trutta*) and Rainbow trout (*Oncorhynchus mykiss*) with minimal success. While Brown trout are sometimes caught, the general opinion amongst anglers is that that the trout fishery has never really taken off and that consideration should be given to stocking alternative native species.

In 2006, the Glenelg Hopkins Catchment Management Authority, in response to community support for the introduction of species that may assist in controlling carp numbers, submitted an application to Fisheries Victoria to translocate Australian bass *(Macquaria novemaculeata*), Estuary perch *(Macquaria colonorum)* and Murray cod *(Maccullochella peelii*) to Rocklands Reservoir to enhance recreational fishing opportunities and help manage carp populations. In accordance with the Department of Primary Industries (now DEDJTR) Translocation Policy, a risk assessment was conducted and submitted with the application to the Translocation Evaluation Panel (TEP). The TEP recommended that the Executive Director of Fisheries Victoria refuse the application primarily because of the potential risks associated with escape (upstream and downstream) of long-lived stocked native fish which may impact on biodiversity. Genetic impacts on downstream populations of Estuary perch were also raised as were potential impacts on existing recreational fishing resources. The Executive Director of Fisheries Victoria supported the TEP recommendation and the application was refused.

The risk assessment for Rocklands Reservoir identified a number of threatened species may exist within the reservoir, upstream or downstream of the Rocklands Reservoir including; Glenelg spiny crayfish, Western swamp cray, Glenelg freshwater mussel, dwarf galaxias, variegated pygmy perch and Yarra pygmy perch. There is uncertainty about where these species are found relative to Rocklands Reservoir. There is some evidence that some remnant populations of these species may exist outside of the reservoir (upstream or downstream) in shallow areas free from predatory pressure.

Subsequent to this assessment, Continuous Deflection Separation (CDS) units (screens) were installed at the outlet of Rocklands Reservoir as a means of containing the carp population and prevent a large scale introduction into the Glenelg River downstream. These units are specially designed to screen out carp and their eggs and larvae from the large volumes of water that are released from the Reservoir into the Glenelg River. They may also reduce the risk of stocked fish escaping downstream under normal operating conditions.

Since 2006, further information has come to hand suggesting that risks highlighted in the initial risk assessment may now be mitigated and the application worthy of reinvestigation. Firstly, the CDS units installed to prevent downstream escapement of carp may also prevent the escapement of species planned for stocking. Secondly, suitable Estuary perch fingerlings collected from broodstock collected in the Glenelg River are now readily available for stocking, mitigating potential genetic concerns downstream of Rocklands Reservoir. Thirdly, considerable research has been conducted on the movement patterns of

Murray cod, Estuary perch and Golden perch, potentially informing the argument that these species are unlikely to escape upstream and or impact on biodiversity.

In 2014, the State Government's Target One Million policy made a number of commitments to improve recreational fishing including a commitment to ensure "Lake Toolondo will remain Victoria's best trout fishing location, with a local advisory group established to take action on minimum water levels". The Toolondo Reservoir Recreational Fishery Advisory Group (TRRFAG) was established in March 2015 and was asked to provide advice on "strategies and actions to enhance the recreational fishing opportunities at Lake Toolondo and surrounding regional waterways". A key recommendation of the Advisory Group was to **"investigate the potential to create a high quality native fishery in Rocklands Reservoir by undertaking a fish stocking risk assessment in accordance with departmental translocation policy"**.

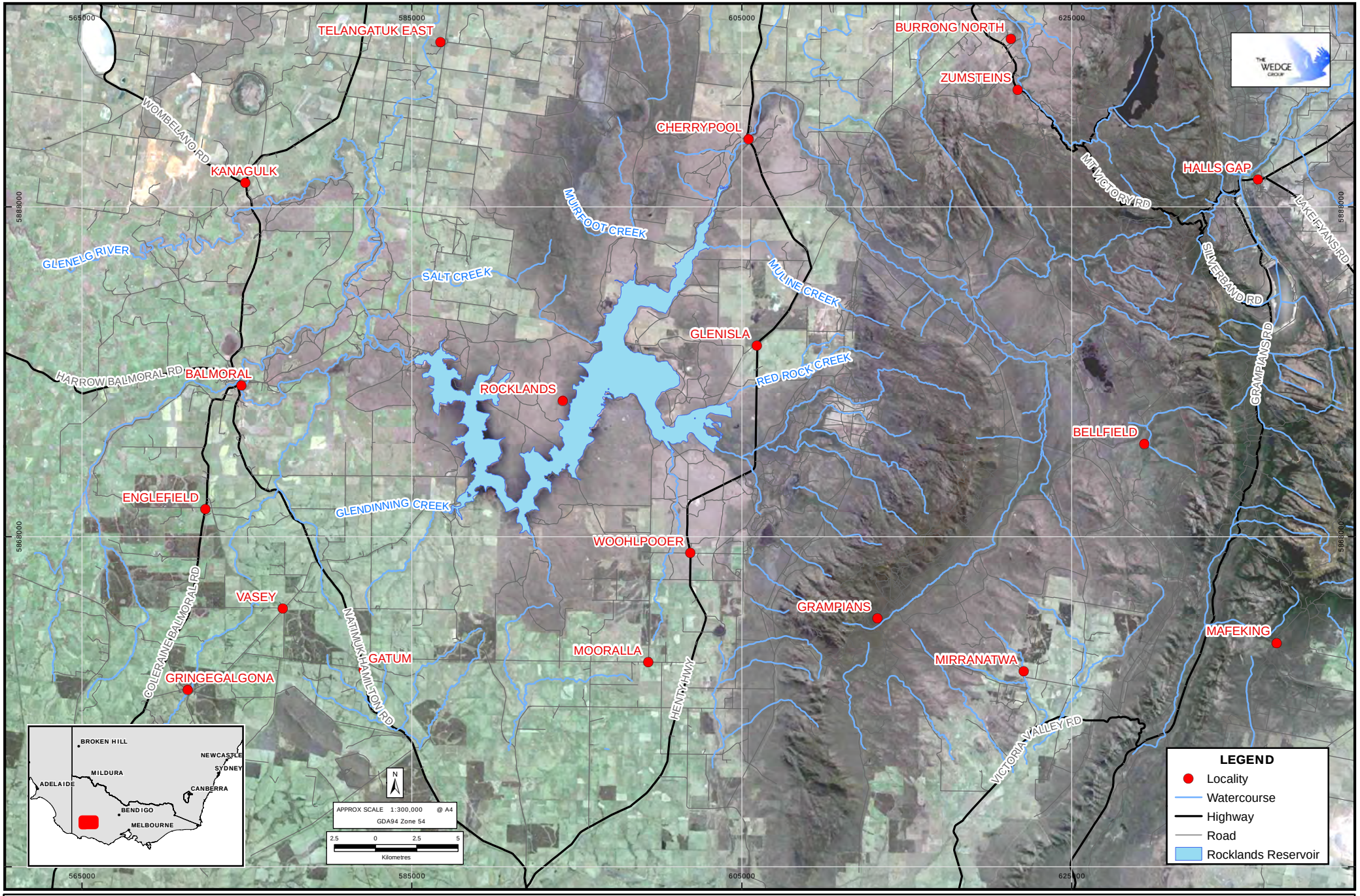



**Figure 1.2: Rocklands Reservoir Location and Key Features**

## 1.4 Policy and Context

### 1.4.1 Translocation policy

Under the Protocols for Translocation of fish in Victorian public waters, Rocklands Reservoir is an approved water for stocking salmonid fish (not native fish). Since 1987, more than 395,000 yearling trout (brown and rainbow trout) have been stocked in Rocklands Reservoir to improve recreational fishing.

In recognition of the need for nationally consistent, risk-based approach to managing translocation of aquatic organisms, the National Policy for the Translocation of Live Aquatic organism was developed in 1999. In response, the then Victorian Departments of Primary Industries and Sustainability and Environment jointly developed Guidelines for Assessing Translocations of Live Aquatic Organisms in Victoria (2003). This document was updated in 2009 and in 2014 (version 3). These guidelines provide for the establishment of an expert Translocation Evaluation Panel (TEP) that provides advice to the Executive Director of Fisheries Victoria on translocation proposal under a standardised risk assessment framework. The guidelines also enable the preparation of translocation protocols for regular translocation events that have similar characteristics including Protocols for the Translocation of Fish in Victorian Inland Public Waters (2005).

### 1.4.2 Water and Environmental Management Policies

There are a range of water and environmental management legislative frameworks that provide valuable context and direction to the development of translocation and stocking risk assessments. The key legislative frameworks are summarised as follows:

Water Act 1989

(Source: http://www.depi.vic.gov.au/water/governing-water-resources)

Under the Water Act 1989, the Government uses a water entitlement framework to balance the demands for water for consumption, the environment and other non-consumptive uses. The water entitlement framework is administered at three levels:

- the State Government retains overall right to the use, flow and control of all surface water and groundwater on behalf of all Victorians
- the Minister for Water is responsible for granting entitlements to water (including environmental entitlements) and setting limits and caps
- individual rights to water

**Victorian Environmental Water Holder**

The Victorian Environmental Water Holder (VEWH) was established in July 2011 and is the independent statutory body responsible for holding and managing Victoria's environmental water entitlements (the Water Holdings).

The VEWH works with catchment management authorities and waterway managers to ensure environmental water entitlements are used to achieve the best environmental outcome with the water that is available.

The main responsibilities of the VEWH include:

- making decisions on the most effective use of the Water Holdings, including use, trade and carryover

- authorising waterway managers to implement watering decisions
- liaising with other water holders to ensure coordinated use of all sources of environmental water
- publicly communicating environmental watering decisions and outcomes.
- commissioning targeted projects to demonstrate ecological outcomes of environmental watering at key sites.

**Catchment and Land Protection Act 1994**

The Act establishes the framework for the integrated management and protection of catchments in Victoria and encourages community participation in the management of land, water and biodiversity resources. The catchment management framework includes 10 catchment and land protection regions (including the Glenelg Hopkins Catchment Management Authority covering the Rocklands Reservoir catchment) responsible for the integrated planning and coordination of land, water and biodiversity management, in conjunction with local communities.

**Flora and Fauna Guarantee Act 1988**

(Source: http://www.depi.vic.gov.au/environment-and-wildlife/threatened-species-and-communities/flora-and-fauna-guarantee-act-1988)

The Flora and Fauna Guarantee Act 1988 is the key piece of legislation for the conservation of threatened species and communities and for the management of threatening processes.

The flora and fauna conservation and management objectives, as outlined under the Flora and Fauna Guarantee Act 1988, are:

- to guarantee that all taxa of Victoria's flora and fauna ….. can survive, flourish and retain their potential for evolutionary development in the wild
- to conserve Victoria's communities of flora and fauna
- to manage potentially threatening processes
- to ensure that any use of flora or fauna by humans is sustainable
- to ensure that the genetic diversity of flora and fauna is maintained
- to provide programs:
    - of community education in the conservation of flora and fauna
    - to encourage co-operative management of flora and fauna through, amongst other things, the entering into of land management co-operative agreements under the Conservation, Forests and Lands Act 1987
    - of assisting and giving incentives to people, including landholders, to enable flora and fauna to be conserved
- to encourage the conserving of flora and fauna through co-operative community endeavours.

**Environment Protection and Biodiversity Conservation Act 1999**

(Source: https://www.environment.gov.au/epbc/about)

The *Environment Protection and Biodiversity Conservation Act 1999* is the Australian Government's key piece of environmental legislation

The objectives of the EPBC Act are to:

- provide for the protection of the environment, especially matters of national environmental significance
- conserve Australian biodiversity
- provide a streamlined national environmental assessment and approvals process
- enhance the protection and management of important natural and cultural places
- control the international movement of plants and animals (wildlife), wildlife specimens and products made or derived from wildlife
- promote ecologically sustainable development through the conservation and ecologically sustainable use of natural resources
- recognise the role of Indigenous people in the conservation and ecologically sustainable use of Australia's biodiversity
- promote the use of Indigenous peoples' knowledge of biodiversity with the involvement of, and in cooperation with, the owners of the knowledge.

### 1.4.3 Rocklands Reservoir Recreation Management Plan

In 2011, the Victorian Government released the *Western Region Sustainable Water Strategy (WR SWS)* which is aimed at:

- Providing increased certainty for water users and environmental managers;
- Promoting sustainable water use;
- Protecting and improving the health of waterways, aquifers, wetlands and estuaries.

The management actions identified in the sustainable water strategy included specific actions around clarifying principles for providing water for recreational use and improving opportunities for recreational use in the supply area. In the case of the Western Headworks of GWMW the completion of the Wimmera Mallee Pipeline resulted in changes to the management of a number of reservoirs. These changes have resulted in significant impacts on public recreational use of these reservoirs and in response recreation management plans are being developed in consultation with key stakeholders.

The working group charged with developing the Rocklands Recreation Management Plan comprises a cross section of Agency (DEWLP, Parks Vic) and Authority (CMA and GWMW) personnel along with representatives from traditional owner groups and the recreational angling fraternity. The working group are in agreement that the management plan should support the further development of the recreational fishery, furthermore there was general agreement that the management plan should recommend that the reservoir be stocked with Estuary perch, Golden perch and Murray Cod. It was acknowledged by the working group that the previous TEP application was prior to the installation of the carp screens (RRMP Working Group Minutes 24 Nov 2014).

GWMW are well aware of the current translocation and stocking risk assessment and are largely awaiting the outcomes so that they can facilitate the completion of the draft Rocklands Recreation Management Plan, currently being developed (B. Dunn GWMWater pers. Comm.).

### 1.4.4 Target One Million

Through its Target One Million plan "to get more people fishing, more often", the State Government has committed a range of initiatives to improve recreational fishing outcomes. This includes a commitment to increase fish stocking from 3 million to 5 million fish each year, improve boat launching facilities and access to waterways and other actions.

Fisheries Victoria administers the *Fisheries Act 1995* and leads implementation of the State Government Target One Million policy to increase recreational fishing participation. Part of this initiative is to increase fish stocking from 3 to 5 million fish a year to rebuild native fish stocks and improve recreational fishing outcomes.

### 1.4.5 Fisheries Management

(Source: http://agriculture.vic.gov.au/fisheries/recreational-fishing/fishing-locations/inland-angling-guide/glenelg)

Fisheries Victoria, a business unit of the Victorian Department of Economic Development, Jobs, Transport, and Resources (DEDJTR) manages stocking, fisheries policy, compliance with fisheries regulations and contact with anglers. As part of this responsibility, Fisheries Management Plans (FMP) are developed for major fisheries across the state. FMP's provide recreational anglers, government agencies and other stakeholders with clear guidance on fisheries management issues with a regional area over a five year period). A FMP for waters within the Glenelg Hopkins Basin declared in October 2006 (ref: Fisheries Victoria Management Report Series. Glenelg Hopkins Fishery Management Plan. No. 42. October 2006).

Up-to-date information on numbers and size of each species stocked into various waterways within the Basin can be found under Fish Stocking in the Fisheries and section of the Fisheries Victoria website or in the annual Vic Fish Stock Report published by the department.

The **Victorian Stream Classification (VSC)** classifies each water as a native, salmonid or mixed fishery. The VSC classifies **Rocklands Reservoir as a Mixed Fishery**.

The **Glenelg Hopkins Catchment Management Authority** is responsible for catchment management and the River Health Program aimed at achieving healthy rivers, streams and floodplains.

**Heritage River Areas**

The section of the Glenelg River from Dartmoor to the sea (excluding the section in South Australia) has been listed.

# 2 Background

## 2.1 Rocklands Reservoir

Rocklands Reservoir is the largest reservoir within Grampians Wimmera-Mallee Water's (GWMW) storage network. It was completed in 1953 and is located on the mid-upper reaches of the Glenelg River above Balmoral in Victoria's western districts.

The range of users is as follows:

- Coliban Water can be supplied from Rocklands, via Taylors Lake, through the Wimmera Mallee Pipeline.
- Wannon Water uses its entitlement to supply the towns of Balmoral and Hamilton directly from Rocklands.
- GWM Water supplies customers both directly from Rocklands (e.g. Supply by Agreement customers) and via transfers to Taylors Lake for delivery through the Wimmera Mallee Pipeline and to the Commonwealth Environmental Water Holder.
- Some water held within Rocklands is also available as 'growth water'. This is available both as a supply direct from Rocklands or for supply via the Wimmera Mallee Pipeline after transfer to Taylors Lake.
- GWM Water supplies compensation flows and a share of the environment's regulated entitlement to the Glenelg River from Rocklands.
- Environmental passing flows are released from the reservoir.

This range of users means there are many diverse and sometimes competing needs in managing water quality and access to water, particularly at low volumes.

Figure 2.1 presents a schematic of the Wimmera - Mallee system headworks. The system is complex, very interconnected, and with many possible combinations for supply and movement of water. Note that Pine Lake and Dock Lake are shown as empty in this figure denoting their status as being off-line (GWMW 2014).

At the current maximum operating level it holds around 296,000 megalitres and is one of the larger man made reservoirs in Victoria with a surface area of some 6,250 hectares and a catchment area of approximately 1,355 km2, much of which is located in the Grampians National Park.

As with many of the Victorian storages Rocklands Reservoir is susceptible to the impacts of climate variability. However, its critical storage role in the GWMW network and its relatively significant 'dead storage' below the minimum gravity discharge level, makes it a relatively attractive proposition for large scale stocking. The minimum operating level for Rocklands is nominally 189.1m/AHD which provides some 70,000 ML covering 2000 hectares. Table 2.1: Water storage capacity of Rocklands Reservoir below provides the basic storage details for Rocklands with further detail provided in Section 2.1.3.

**Table 2.1: Water storage capacity of Rocklands Reservoir**

| Rocklands Reservoir Water Levels | m/AHD | Volume(ML) | Area (Ha) |
|---|---|---|---|
| Land acquired for reservoir land, below this level | 197.29 | | |
| Previous high water level | 195.47 | 348 310 | 6900 |
| Maximum Operating Level | 194.67 | 296 000 | 6250 |
| Minimum Operating Level | 189.1 | 70 330 | 2000 |


**Figure 2.1: Schematic of the Wimmera-Mallee System Headworks (GWMW 2014), (not to scale, but shows relative elevation, depth, surface areas and connectedness of reservoirs)**

## 2.2 Description of the Fishery

The Victorian Inland Waters Classification formally classifies Rocklands Reservoir as a 'Mixed Fishery' meaning that it supports both native and introduced species that provide recreational fishing opportunities (http://agriculture.vic.gov.au/fisheries/policy-and-planning/fisheries-management-plans/inland-waters-classification). The Fisheries Victoria angling guide further describes Rocklands Reservoir as;

***"a mixed recreational fishery that provides variable quality fishing, predominately for redfin and stocked trout. Fisheries Victoria's Inland Angling Guide (2010) describes Rocklands Reservoir as holding abundant redfin up to 2 kg, with most fish 450-770 g, brown trout to 1.6 kg, av. about 1 kg, tench to 1.5 kg, goldfish to 800 g and some river blackfish. Redfin is the predominant target species and fishing is best around submerged timber when the lake is near full. Brown and rainbow trout are stocked occasionally when conditions are favourable. European carp were detected in the Reservoir in 2000. Anglers occasionally report catches of illegally stocked Australian bass, Murray cod and catfish."***

***http://agriculture.vic.gov.au/fisheries/recreational-fishing/fishing-locations/inland-angling-guide/glenelg/glenelg-angling-waters#rocklands***


**Figure 2.2: Two large Redfin caught from Rocklands Reservoir in May 2016. Redfin have been the mainstay of the recreational fishery for many years. (photo courtesy of Darcy Trotman, Balmoral Angling Club)**

In recent years, the quality of the Redfin angling is thought to have declined with regular fishers suggesting lower water levels and changed operating regimes as the reason for this decline. In contrast, there are increasing reports on angling websites of Rocklands providing improved fishing for introduced Australian bass and Murray cod, neither of which have been officially stocked into the reservoir. Murray cod in particular have been observed in the Continuous Deflection Separation (CDS) units located on the dam spillway (K. Mayers, GWMW) suggesting that illegal stocking may have been occurring for several years.

**Figure 2.3: Murray cod caught at Rocklands Reservoir in early 2016 (photo courtesy of Chris Spence, Horsham Angling Club)**

### 2.2.1 Fish species

The Glenelg River below Rocklands Reservoir has been the subject of a number of detailed fish surveys and assessments that provide a comprehensive fish species list for the river. In contrast, surveys of fish species in the Glenelg River upstream Rocklands Reservoir are more difficult to source. The most recent available accounts of the status of general fish populations in the Glenelg River are presented in the following studies.

1. Austral Research and Consulting (2014) VEFMAP Adult Fish Monitoring of the Glenelg River 2014,
2. Lieschke, J.A., et al (2013), The status of fish populations in Victorian rivers 2004–2011 — Part B: Individual basin assessments. Arthur Rylah Institute for Environmental Research Technical Report Series No. 247. Department of Environment and Primary Industries, Heidelberg, Victoria and
3. Howson, T. J, (2013) Fish assemblage response to experimental rehabilitation in the Glenelg River, Victoria, Australia, Deakin University, July, 2013.

Austral (2014) was a continuation of the annual fish monitoring program undertaken since 2009 as part of the Victorian Environmental Flow Monitoring and Assessment Program (VEFMAP) and is limited to the Glenelg River below Rocklands Reservoir.

Lieschke et al (2013) is broader in geographical range and presents findings of monitoring effort undertaken in the Glenelg River catchment including the reach of the Glenelg River upstream of Rocklands Reservoir (one monitoring site) and the main tributaries of the Wannon, Chetwynd, Crawford, Stokes and Wando rivers, and Grange Burn Creek. In this survey, five species of endemic fish were recorded above Rocklands Reservoir including two significant species Obscure galaxias and Little galaxias, plus Southern pygmy perch, Flat-headed gudgeon and Common galaxias. Additionally, the introduced native Carp gudgeon and exotic Eastern gambusia were captured during the survey. Howson (2013) cites (Jackson and Davies 1983, Department of Water Resources 1989, Koehn and O' Connor 1990a, Mitchell et al. 1996, Close et al. 2003) in presenting that 19 native freshwater fish species, and 7 exotic species have been recorded in the Glenelg River catchment.

**Table 2.2: Glenelg River freshwater fish species list compiled from Austral (2014), Lieschke (2013) & Howson (2013). Conservation Status recognizes the listing of that species under the Victorian Flora and Fauna Guarantee Act and the Conservation Status in Victoria. Bold denotes Commonwealth EPBC listing.**

| Species | Victorian Conservation Status |
|---|---|
| **Riverine*** | |
| Shortfin eel *Anguilla australis* | |
| **Australian grayling *Prototroctes mareana*** | Vulnerable, FFG Listed |
| Australian smelt *Retropinna semoni* | |
| Tupong *Psuedaphritis urvillii* | |
| Flathead gudgeon *Phylipnodon grandiceps* | |
| River blackfish *Gadopsis marmoratus* | Critically endangered in upper Wannon |
| Southern pygmy perch *Nannoperca australis* | |
| **Variegated pygmy perch *Nannoperca variegata*** | Vulnerable, FFG Listed |
| **Yarra pygmy perch *Nannoperca obscura*** | Vulnerable, FFG Listed |
| Short headed lamprey *Mordacia mordax* | |
| Pouched lamprey *Geotria australis* | |
| Common galaxias *Galaxias maculatus* | |
| Obscure galaxias *Galaxias oliros.* Formerly part of Mountain Galaxias *Galaxias olidus.*^ | |
| ***Little Galaxias Galaxiella toourtkoourt.* Formerly described as Dwarf galaxias *Galaxiella pusilla or Western Plains galaxiella*^^** | Vulnerable, FFG listed |
| Spotted galaxias *Galaxias truttaceus* | |
| Australian mudfish *Neochanna cleaveri* | Critically Endangered, FFG Listed |
| Broad-finned galaxias *Galaxias brevipinnis* | |
| **Invertebrates** | |
| Western swamp crayfish *Gramastacus insolitus* | Critically Endangered, FFG Listed |
| Western Cray *Geocharax falcata* | |
| **Glenelg spiny freshwater crayfish *Euastacus bispinosus*** | Endangered, FFG Listed |
| Burrowing crayfish *Engaeus lyelli* | |
| Eastern long neck turtle *Chelodina longicollis* | |
| **Glenelg Freshwater Mussel *Hyridella glenelgensi*** | Critically Endangered, FFG Listed |
| **Exotic** | |
| Common carp *Cyprinus carpio* | |
| Eastern gambusia *Gambusia holbrookii* | |
| Goldfish *Carasius auratus* | |
| Redfin perch *Perca fluviatus* | |
| Tench *Tinca tinca* | |
| Brown trout *Salmo trutta* | |
| Rainbow trout *Oncorhynchus mykiss* | |
| **Non-endemic native** | |
| Carp gudgeon *Hypseleotris spp.* | |
| Golden perch *Macquaria ambigua* | |
| Australian bass *Macquaria novemaeculata* | |
| **Murray cod *Maccullochella peeli*** | Vulnerable, FFG listed |
| Freshwater catfish *Tandanus tandanus* | FFG Listed |
| **Macquarie perch *Macquaria australasica*** | Endangered, FFG Listed |
| **Other** | |
| Yabby *Cherax destructor* | |

*Life stages of some species may occur in both marine and freshwater environments;** Occurring predominantly in the Glenelg River estuary below Dartmoor;^ Raadik, T. A. (2014);^^ Coleman, R.A., Hoffmann, A. A. & Raadik, T. A. (2015).

The Glenelg Hopkins Catchment Management Authority maintains data on the presence of native and introduced fish species above Rocklands Reservoir. This list summarises the results of surveys and observations undertaken between 1969 and 2002 and provides an historical perspective on the fish

species of the upper Glenelg River period through this period (see Appendix B). Significant fish species identified through this exercise include Obscure galaxias and Little galaxias. Additionally, DEWLP (http://delwp.vic.gov.au/fishing-and-hunting/recreational-fishing/fishing-locations/inland-angling-guide/glenelg/glenelg-angling-waters#grampians) refers to surveys undertaken by the Victorian Department of Primary Industries, of Tea Tree Creek and Scott Creek which drain the western side of the Victoria Ranges and flow into Rocklands Reservoir. These surveys recorded significant species including Obscure galaxias (which were particularly abundant) and Little galaxias and the crustaceans; Northern burrowing cray, Western cray, Swamp cray. River blackfish, Australian smelt, Common galaxias, Flathead gudgeon and the introduced species Western carp gudgeon, Eastern gambusia, and Redfin were also recorded. The results of these surveys correspond with Lieschke (2013) which recorded Obscure galaxias and Little galaxias as the only significant fish species above Rocklands Reservoir.

The Victorian Environmental Water Holder Seasonal Watering Plan 2015-16 (Sec.4.2 Glenelg system p68), reports that native fish are responding positively to environmental flows delivered to the Glenelg River from Rocklands Reservoir. While actual data is not available, fish surveys show that Estuary perch have increased their upstream range in the Glenelg River by 160 km and that Variegated pygmy perch (a significant species) *"showed a strong spawning response and were the most abundant species caught in 2015 Glenelg River fish surveys."* (VEWH, 2015).

## 2.3 Developing Rocklands Reservoir as a Recreational Fishery

Rocklands Reservoir is a man-made and highly modified waterway that harbors a high abundance of introduced large bodied fish such as redfin, carp and stocked trout. It is believed to have considerable potential to support a high quality native species recreational fishery.

Large scale stocking of impoundments has been a successful strategy in building native fish populations, developing recreational fisheries and growing strong regional economic activity as demonstrated for example at Lake Eildon and Lake Nagambie. The development of a native fishery in Rocklands Reservoir reflects the growing aspirations of recreational fishers to fish for large freshwater native species and in some cases to transition from traditional fisheries based on introduced species (Trout and Redfin) to native fisheries.

The altered water management regimes of Rocklands Reservoir also mean that the hydrological conditions that supported such a strong Redfin fishery in the past may not be replicated in the future. Future management will see vastly altered hydrology that appears more suitable to native species such as Murray cod and Golden perch which are better adapted to variable water levels.

Ernst & Young (2010) reported that the economic impact of Murray Cod recreational fishing in Victoria for 2009-10 to be:

- $166.7 million in direct expenditure;
- $59.0 million in contribution to GSP; and
- 374 jobs

Gregg and Rolfe (2013), estimated that the total economic value of impoundment fishing alone was worth $95.3 million/annum to the Queensland economy, much of which is spent into regional economies. Consultation with communities in the region of Rocklands Reservoir reveal that many community members believe that the demise of the Redfin fishery in Rocklands has had a significant impact on

economic activity in the region. Discussions with members of the Balmoral Angling Club and local business owners provided valuable insight into the regional value of a vibrant fishery with accounts of 7,000-10,000 day visitors and campers skiing and fishing during the peak Easter and post-Christmas periods. Further accounts of the volume of fuel and ice sales over these periods at the now closed service station along with the publicans account of an additional 3-4 full time staff 'when the reservoir was firing' support the well held position that rejuvenation of Rocklands Reservoir as a recreational fishery would greatly assist in supporting economic growth in the region.

### 2.3.1 Water Management and Risk of Spill

Grampians Wimmera-Mallee Water was appointed Storage Manager in 2010 in respect of the Bulk Entitlements and Environmental Entitlements granted for the Wimmera-Mallee system.

As detailed in the GWMW 2014 Storage Management Rules, Rocklands Reservoir can store up to 348,300 ML at the spillway crest level of 195.47 m AHD and is termed the Full Supply Level (FSL). The reservoir is operated at a Maximum Operating Level (MOL) of 194.67 m AHD or 296,000 ML whenever possible.

This MOL has been increased following the completion of the 2013 – 2014 Bulk and Environmental Entitlements Operations Review to improve the operational flexibility of the system with no material impact on the reliability of supply to entitlement holders whilst reducing uncontrolled spills, evaporation losses and the opportunity of carp entering the Glenelg River downstream of the reservoir.

The fundamental operating rule for Rocklands Reservoir is to operate the reservoir up to its MOL throughout the year when practicable. It is also attempted to maintain Rocklands Reservoir above a minimum operating level of 189.06 m AHD or 69,600 ML. This level is a desirable minimum and Rocklands may be drawn down to lower levels under extreme dry conditions. The minimum level is aimed at providing storage for entitlement holders that can only be supplied from Rocklands, buffer poor quality inflows during low inflow years and facilitate suitable recreation levels.

Rocklands Reservoir has a nominal outlet capacity of 600 ML/d, although this is limited by the operation of installed carp screens. Currently the capacity of the outlet via the carp screens is 400 ML/d. If water is released via the 5 Mile or 12 Mile Escapes, release capacity is limited to the channel capacity of 280 ML/d. Inflows to Rocklands can far exceed the capacity to release water (e.g. the January 2011 floods saw daily inflows of approximately 7,000 ML/d). As levels approach the MOL, water surplus to that required to meet entitlement holder demands is actively transferred to downstream reservoirs where space exists (i.e. Taylors Lake or Toolondo Reservoir) or directed to the Glenelg River. In the event that levels rise above the MOL plans to quickly and safely draw levels down to the MOL are developed.

Entitlement holder demand for water from Rocklands Reservoir can exceed delivery capacity and when this occurs deliveries to entitlement holders will take precedence over transfers to other reservoirs.

Rocklands Reservoir provides an important source of environmental water for the Glenelg River via regulated and passing flows. Passing flows occur between June to November inclusive and are able to be accumulated following agreement between the Storage Manager and the Victorian Environmental Water Holder in order to achieve a range of outcomes such as improve environmental effects, allow for maintenance or protect water quality in the Wimmera – Mallee headworks

Environmental flows are able to be delivered direct to the Glenelg River immediately downstream of the dam wall and from the 5 mile and 12 mile escapes on the Rocklands outlet channel. This may be done to

spread larger flow rates across multiple delivery points, to improve the efficiency of water delivery during dry years or to reduce the potential for flooding downstream of the wall during wet years.

Rocklands can also supply environmental water to the Wimmera basin for the Wimmera River, lower MacKenzie River, Burnt Creek and Bungalally Creek. Environmental deliveries are determined through seasonal watering plans developed by the Victorian Environmental Water Holder.

Compensation flows are required to be delivered to the Glenelg River between November and May of each year which are complementary to regulated environmental water releases. Glenelg-Hopkins CMA develop flow plans for this entitlement on behalf of and in consultation with GWM Water.

If Rocklands is required to transfer water to downstream reservoirs, it is desirable for this to happen during the inflow season (May to November inclusive) to minimise transmission losses. However, transfers during warmer summer months may also be required for example, to support Taylors Lake in delivering entitlement holders' water.

In balancing water resources across the water supply system, an objective will be for transfers to occur from Rocklands so that levels are not drawn down below its minimum operating level. However, if available water for the Wimmera – Mallee system is low and Rocklands is at risk of dropping below its minimum operating level, the balance of the resource will be utilised to ensure that basic needs can be delivered to respective entitlement holders. Basic needs will always be prioritised above other possible uses for water including, for example, transfers to downstream reservoirs (GWMW 2014).

### Rocklands Reservoir Demands

Rocklands Reservoir demands include environmental supply to the Glenelg River, urban supply to Hamilton and Balmoral and transfers to the Wimmera for consumptive, environmental and recreational purposes. All entitlement holders are able to be supplied with water from Rocklands. The Rocklands Reservoir demands over the past five seasons are provided in Table 2.3: Rocklands reservoir water demands in the last five years below.

Transfers to the Taylors Lake occur frequently each year. Transfers are also made to Lake Toolondo for recreational purposes. The Wimmera Mallee System Headworks Storage Management Rules state that transfers to Lake Toolondo can occur when Rocklands is holding 116,000ML or more. In supplying Toolondo, Rocklands shall not fall below 116,000ML.

There are six Guiding Principles also used for making decisions on transfers to Toolondo from Rocklands. These are:

1. No reliability impact to entitlement holders.
2. Cost to transfer in and take out.
3. Evaporation and seepage characteristics of each storage.
4. Timing.
5. Maintain a balance between water supply and quality in both reservoirs.
6. No overall increase to the volume that would have been transferred prior to May 2014 (when the MOL at Rocklands Reservoir was increased).

**Table 2.3: Rocklands reservoir water demands in the last five years**

| Rocklands Reservoir Demands (ML) | 2010/11 | 2011/12 | 2012/13 | 2013/14 | 2014/15 to end March | 2014/15 forecast total |
|---|---|---|---|---|---|---|
| Urban | 51 | 115 | 91 | 99 | 41 | 60 |
| Supply by Agreement | 226 | 1,581 | 85 | - | 5,000 | 5,000 |
| Transfer (Taylors) | - | - | 3,500 | 6,500 | 13,030 | 13,030 |
| Transfer (Toolondo) | - | 33,525 | 1,770 | - | - | - |
| Environment (Entitlement) | 965 | 4,219 | 19,806 | 10,207 | 13,856 | 15,800 |
| Environment (Passing Flow) | 11,128 | 17,261 | 12,128 | 10,645 | 4,856 | 5,110 |
| Compensation Flow | - | 3,300 | 1,602 | 2,145 | 38 | 50 |
| **Total demand** | **12,370** | **60,001** | **38,982** | **29,596** | **36,821** | **39,050** |

## Inflow Variability

Ongoing climate variability, including severe drought, will continue to have significant impacts on the water volumes available year on year to meet the demands of entailment holders and the desires of recreational users of the reservoir. Figure 2.4 provides clear evidence of the step change in rainfall patterns and storage yield observed across Southern Australia over the past two decades. As can be seen, average inflows to Rocklands over the past twenty years are approximately half that of the long term average. While a concern for all entitlement holders and the likes of the Catchment Management Authority, it is also a significant concern for recreational fishers across the region and further emphasises the need to concentrate development effort on those storages like Rocklands with significant security even in the driest of periods.

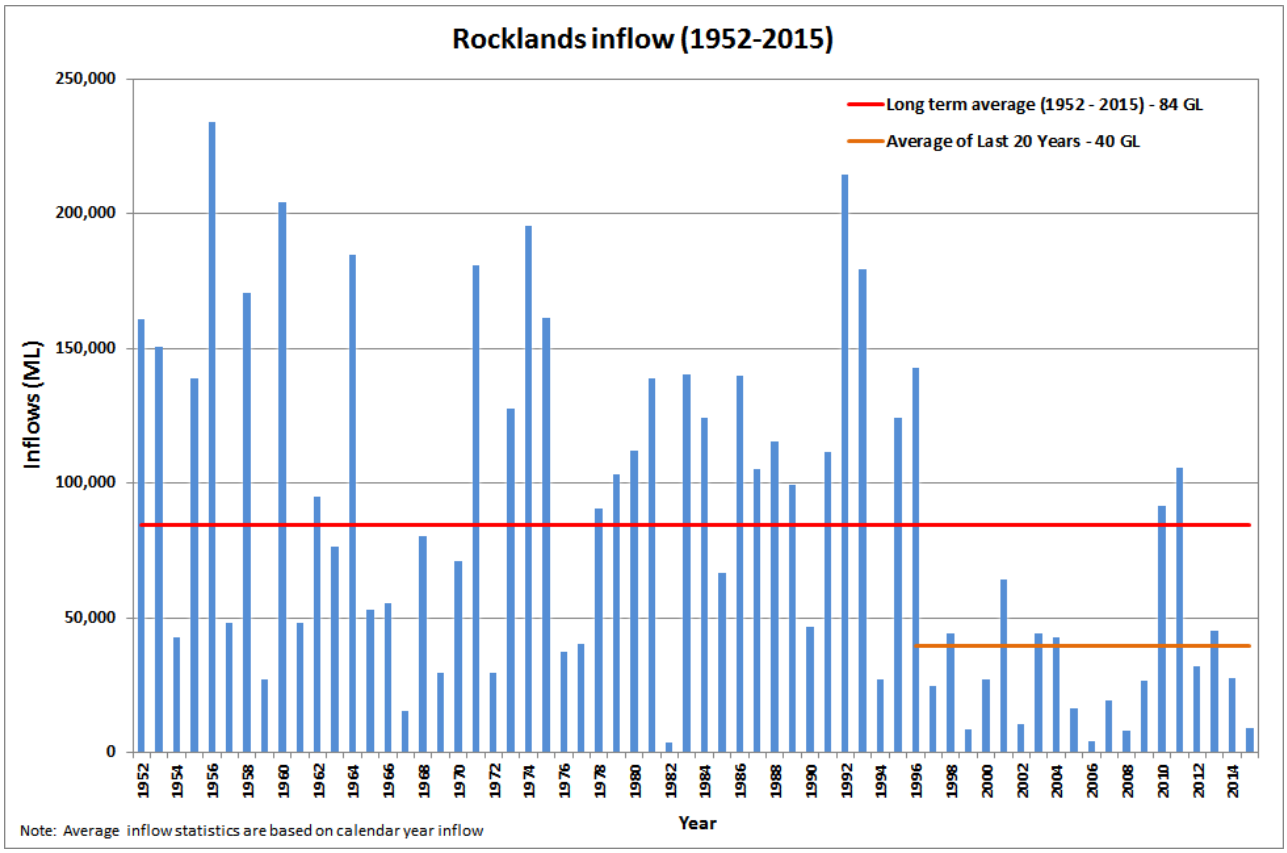


**Figure 2.4: Rocklands Inflows from 1952 to 2015 (Source: GWMW – Bernie Dunn)**

## 2.4 The Glenelg River Catchment

The Glenelg River system both upstream and downstream of Rocklands Reservoir are the potential receiving waters for fish stockings undertaken in the reservoir. Overflows and environmental flows from Rocklands Reservoir will enter the Glenelg River downstream of the reservoir. While during high water periods, there will be greater hydraulic connectivity between the reservoir and the Glenelg River upstream.

### 2.4.1 Glenelg River upstream of Rocklands Reservoir

The Glenelg River rises in the Grampians National Park and travels for a distance of approximately 50 kms before entering Rocklands Reservoir upstream of the township of Balmoral. Through this area the river flows intermittently from the highland slopes of the Victoria Range into a complex arrangement of wetland and swamp environments before becoming more channelised near Cherrypool. Much of the river in this section flows through the Grampians National Park. Flows in this section of the Glenelg River are heavily regulated through a system of diversion weirs that are used for urban water supply and agriculture (Lieschke, et al, 2013). Red Rocks Creek, Tea Tree Creek and Scott Creek also enter Rocklands Reservoir on its eastern side near the Henty highway.

### 2.4.2 Glenelg River downstream of Rocklands Reservoir

The Glenelg River below Rocklands Reservoir flows for a distance of approximately 330 kilometres before entering the sea at Nelson, in far western Victoria. Through this reach, the Glenelg River is joined by several major tributaries including the Wannon River which joins near the town of Casterton and the Crawford, Stokes, Wando, Henty and Chetwynd River's. While intermittent in flow, these rivers contain large permanent pools over much of the year thus providing habitat for a number of fish species. (Howson 2014).

Howson (2014) presents a detailed technical account of the channel morphology of the Glenelg River below Rocklands Reservoir which is summarised below.

**Channel characteristics between Balmoral and Harrow were similar, with deeper pools interdispersed by areas of shallow runs, and the river bed consisting of largely sand or fine silt substrates (Lind et al. 2006, Turner and Erskine 2005). Woody debris was present in an assortment of sizes and forms (e.g. single logs, log and debris jams) while dominant macrophyte species including *Phragmites australis*… and *Typha domingensis*…, *Triglochin procerum*… and *Potamogeton ochreatus* … cover the pool edges and runs (Lind et al.2006). Downstream of Harrow, the river characteristically changes as the channel widens and becomes increasingly shallow (Rutherfurd and Budhazy, 1996). In the lower reaches, the river cuts through softer sandstones and limestone yielding a deeply incised channel and forms a gorge in the estuary (Rutherfurd and Budahazy 1996)**."

Throughout the stretch between Rocklands and Casterton, a number larger well known pools including Yat Nat Hole, 5 Mile Pool, 12 Mile Pool, Gorge Hole, Fulham Hole and Harrow Hole remain which provide a venue for recreational activity including fishing and refuge for both native and introduced aquatic fauna.

## 2.5 Fish Species Proposed to be Translocated

Three species are proposed for translocation:

- Murray cod, *Maccullochella peelii*
- Golden perch, *Macquaria ambigua*

- Estuary perch, *Macquaria colonorum*

### 2.5.1 Murray cod

Murray cod are a large native species that are endemic to the Murray Darling Basin. Within this range they are the apex predator that will prey on a wide range of food items including fish, crayfish, frogs as well as birds and reptiles. Murray cod are an "ambush" predator that will occupy preferred feeding locations and wait for food items to present themselves. This hunting strategy and the large gape size of the mouth means that large Murray cod are likely to select for larger prey items that enter their feeding zone.

Murray cod mature at approximately 500-600mm and spawn on a solid substrate such as logs or rock bars when water temperatures exceed 15°C. They may migrate up to 120kms during this period to find preferred spawning locations before returning to their former home (Lintermans, 2007). It is believed that Murray cod will spawn in impoundments such as Lake Charlegark in western Victoria however, there is no confirmed evidence of them spawning in man-made lakes or in rivers outside of their natural range.

They are a long lived species with an oldest known age of 48 years (Lintermans, 2007). In keeping with their broad distribution across the Murray Darling Basin, Murray cod are tolerant of large seasonal variations in water temperature.

**Figure 2.5: Murray cod (photo courtesy of Queensland government www.daf.qld.gov.au)**

### 2.5.2 Golden perch

Golden perch are native to the Murray Darling Basin and are amongst the most common species encountered by recreational anglers across this range. They are a medium to large predator that opportunistically feeds on a variety of prey organisms from insect larvae to fish and larger crustaceans (Lintermans, 2007).

Golden perch are thought to spawn during spring and summer when water temperatures exceed 20°C however, recent work by Sharpe C.P. (2011) showed evidence that Golden perch were able to spawn at any time of the year but only in response to acute flow pulses. Similar to Murray cod, Golden perch are tolerant to a large range of seasonal water temperatures.

**Figure 2.6: Golden perch (photo courtesy of Queensland government www.daf.qld.gov.au)**

### 2.5.3 Estuary perch

Estuary perch are native to south east Australia including the Glenelg River system and are commonly encountered in the estuary and lower reaches downstream of Dartmoor and are sometimes encountered upstream of during low flow conditions. They feed on a range of food items including insect larvae, small crustaceans and small fish. Estuary perch breed in the brackish water of estuaries and eggs will not survive in freshwater.

In the past 5 years, Fisheries Victoria have embarked on a program to breed Estuary perch in captivity which has resulted in moderate numbers of fingerlings being made available for stocking. The bulk of the brood fish for this program are collected from the Glenelg River.

Estuary perch are a highly prized angling species that are becoming increasingly recognized for their sportfishing value and are increasingly being stocked into freshwater bodies where they have shown an ability to adapt his environment and form valuable fisheries.


**Figure 2.7: Estuary perch**

# 3 Stakeholder Engagement

A range of stakeholders were identified early in the project as being critical to the provision of background information and the identification of the vales and threats to be carried forward to the formal risk assessment process.

Key stakeholder groups identified included:

- Agencies - Fisheries Victoria, Parks Victoria and DEWLP
- Authorities – Glenelg Hopkins CMA and Grampians Wimmera Mallee Water
- Research Institutions – Deakin University
- Angling Clubs – Balmoral and Horsham

The aim of the stakeholder engagement was primarily to:

- Source published and unpublished reports and data pertaining to the distribution of threatened species in or connected to waters of Rocklands Reservoir;
- Source data and reports relating to the water management regime and the operation of key infrastructure including the carp screens;
- Engage with a selection of key stakeholders in order to identify the range of values and threats associated with the reservoir; and
- Seek feedback and opinion on the proposal to stock the reservoir.

The stakeholder engagement undertaken has primarily been in the form of face to face meetings and/or telephone conversations that have in most cases been followed up with email exchanges providing data and further feedback on perceived values and threats.

Appendix D provides an overview of the various individual stakeholders engaged and the key points raised during the development of the Translocation Risk Assessment and the TEP Application.

# 4 Values and Threats

## 4.1 Values

Through the series of consultations presented in Section 3, a list of values for the Rocklands Reservoir and Glenelg River were identified. The list relates to those values associated with the Rocklands Reservoir fishery and the aquatic biota present within the reservoir and the Glenelg River that may be impacted by the introduction of Murray cod, Golden perch and Estuary perch.

The values for the Rocklands Reservoir and Glenelg River are:

1 Significant species in Rocklands Reservoir including Little galaxias, Obscure galaxias and Western swamp cray (the primary value being the protection of those species).

2 The existing fish community in the Glenelg River system (the primary value being the natural ecosystem).

3 Significant fish species in the lower Glenelg River system including Australian grayling, River blackfish (upper Wannon River only), Variegated pygmy perch, Yarra pygmy perch, Little galaxias, Australian mudfish, Glenelg spiny freshwater crayfish, and Glenelg Freshwater mussel (the primary value being the protection of these species).

4 The fish community in Rocklands Reservoir (the primary value being angling).

The key threats posed to each value through stocking with Murray cod, Golden perch and Estuary perch are listed in Table 4.1: Values and Threats for Rocklands Reservoir fish stocking.

### 4.1.1 Ecosystem Level Impacts

The large bodied fish population in Rocklands Reservoir is dominated Redfin and European carp; both exotic species. Each of these species have exploited a specific ecological niche within the waterbody which is generally absent of competitors for resources or aquatic predators (other than cannibalism). The presence of these species has influenced the aquatic ecosystem of Rocklands Reservoir.

Lloyd and Newall (2009) cite (Lloyd et al 1998 & 2000; Berg et al 1997; Benndorf 1990) in demonstrating that the stocking of Australian Bass and two trout species into Devilbend and Bittern Reservoirs in Victoria is unlikely to result in complex ecosystem level impacts such as restructuring food webs and changing nutrient cycling. The presence of a large Redfin population in these waterbodies also suggests the likelihood that “further predator introductions would not lead to an increased predatory impact on native fish or other ecosystem components,” (Lloyd & Newall, 2009). This may be applicable to Rocklands Reservoir as it to contains a large Redfin population that has occupied the waterbody for many years.

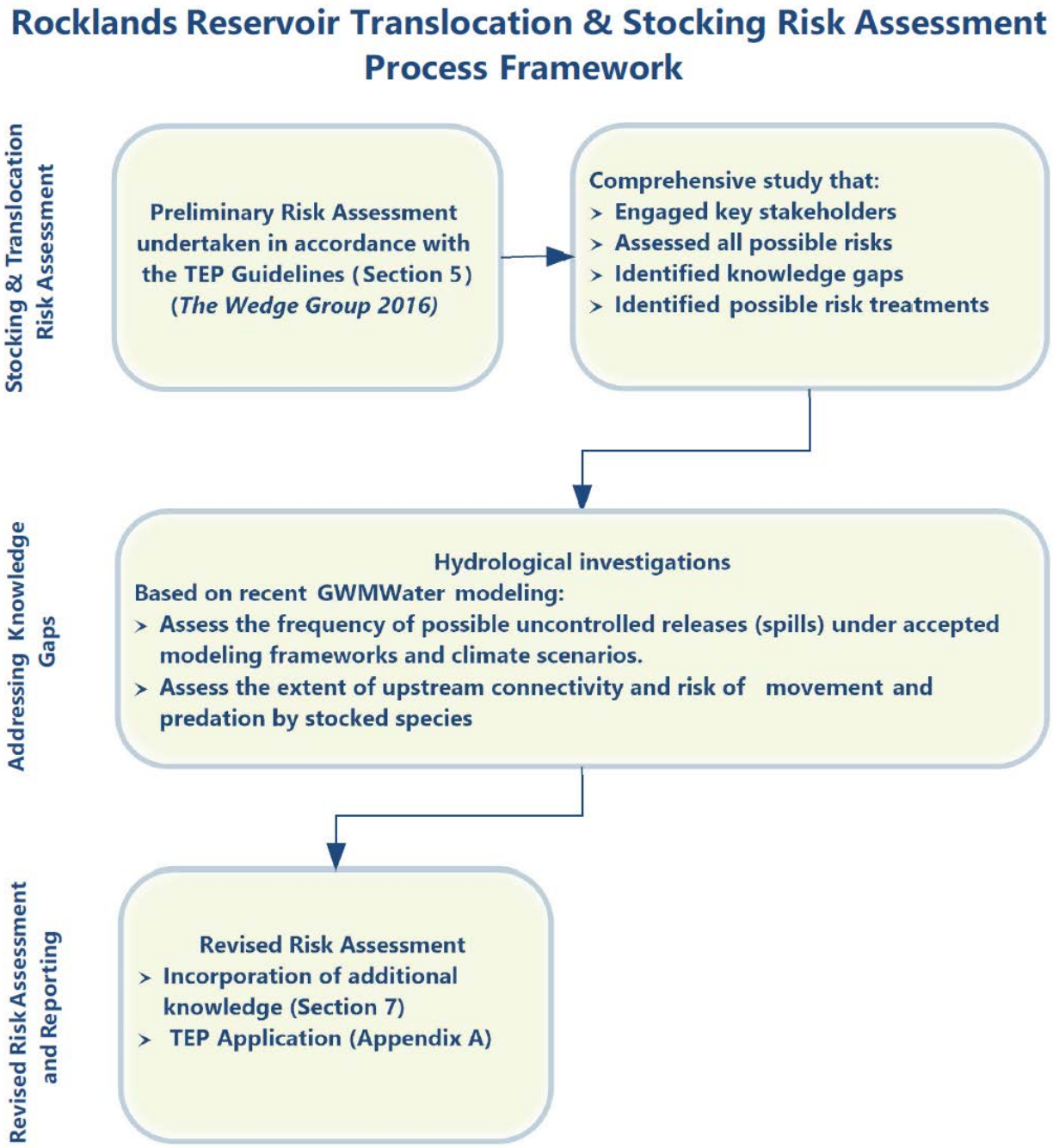
In a recent studies Sierp (2008) found that the presence of a large piscivore, Murray cod, had a positive influence on water quality in two lakes. In controlled experiments Sierp showed that Murray cod readily preyed on Eastern gambusia and Goldfish which often exert substantial grazing pressure on large zooplankton. Sierp (2008) concludes that Murray cod may prove a keystone species for the eco-technique called biomanipulation which can improve water quality by predation on benthivorous and planktivorous fish and shifting ecosystems from a phytoplankton dominated state to a macrophyte dominated state.

**Table 4.1: Values and Threats for Rocklands Reservoir fish stocking**

| Value | Threat |
|---|---|
| **Significant fish species in Rocklands Reservoir including Little Galaxias, Obscure galaxias and the Western Swamp cray. (the primary value being the protection of these species)** | • Stocked species may prey upon significant fish species in Rocklands Reservoir including significant species Little Galaxias, Obscure galaxias and the Western Swamp cray..<br>• Juvenile stocked species may compete with significant species in Rocklands Reservoir including Little Galaxias, Obscure galaxias and the Western Swamp cray.<br>• Stocked species may introduce disease and/or parasites to Rocklands Reservoir, threatening Little Galaxias, Obscure galaxias and the Western Swamp cray. |
| **The existing fish community in the Glenelg River (the primary value being the natural ecosystem)** | • In the event that they escape, stocked species may prey upon existing fish species in the upper Glenelg river system threatening Little Galaxias, Obscure galaxias and the Western Swamp cray.<br>• In the event that they escape, juvenile stocked species may compete with existing fish species in the upper Glenelg River system threatening Little Galaxias, Obscure galaxias and the Western Swamp cray.<br>• Stocked species may introduce disease and/or parasites to the upper Glenelg River, threatening Little Galaxias, Obscure galaxias and the Western Swamp cray.<br>• In the event that they escape, mature stocked species may prey upon existing fish species in the lower Glenelg river system<br>• In the event that they escape, stocked species may compete with existing fish species in the lower Glenelg River system<br>• Stocked species may introduce disease and/or parasites to the waterbodies, threatening existing fish species in the lower Glenelg River system |
| **Significant fish species in the lower Glenelg River including Australian grayling, River blackfish (upper Wannon River only), Variegated pygmy perch, Yarra pygmy perch, Little galaxias, Australian mudfish, Glenelg spiny freshwater crayfish, and Glenelg Freshwater mussel (the primary value being the protection of these species)** | • In the event that they escape, adult Murray cod may prey upon Glenelg Spiny Freshwater crayfish in the Glenelg River system.<br>• In the event that they escape, mature stocked species may prey upon significant species in the lower Glenelg River including Australian grayling, River blackfish (upper Wannon River only), Variegated pygmy perch, Yarra pygmy perch, Little galaxias, Australian mudfish, Glenelg spiny freshwater crayfish, and Glenelg Freshwater mussel (the primary value being the protection of these species).<br>• In the event that they escape, stocked species may compete with significant species in the lower Glenelg River including Australian grayling, River blackfish (upper Wannon River only), Variegated pygmy perch, Yarra pygmy perch, Little galaxias, Australian mudfish, Glenelg spiny freshwater crayfish, and Glenelg Freshwater mussel (the primary value being the protection of these species).<br>• Stocked species may introduce disease and/or parasites to the waterbodies, threatening existing significant fish species in the lower Glenelg River system. |
| **The fish community in Rocklands Reservoir (the primary value being angling)** | • Mature stocked species may prey upon Redfin in Rocklands Reservoir which may impact on the quality of Redfin fishing.<br>• Stocked species may compete with Redfin in Rocklands Reservoir, leading to the reduction of this species.<br>• Stocked species may introduce disease and/or parasites to the waterbodies, threatening the existing recreational fishery. |

# 5 Risk Assessment

## 5.1 Two Stage Risk Assessment process




## 5.2 Risk Assessment Matrix

Assessing the level of a particular risk involves determining the consequence and likelihood of that risk occurring, and using this to determine the level of risk (Table 5.1 Risk Analysis Matrix). The assessment of

risk level also takes into consideration any controls that are currently in place to minimise negative risk or enhance positive opportunities.

**Table 5.1 Risk Analysis Matrix**

| LIKELIHOOD | CONSEQUENCE | | | | |
|---|---|---|---|---|---|
| | Insignificant | Minor | Moderate | Major | Critical |
| Near certain | Low | Medium | High | Severe | Severe |
| Highly likely | Low | Medium | Medium | High | Severe |
| Likely | Low | Low | Medium | High | Severe |
| Unlikely | Low | Low | Low | Medium | High |
| Highly unlikely | Low | Low | Low | Medium | High |

**Table 5.2: Consequence levels of impacts on the values of the study area (derived from Lloyd and Newall, 2009). Lloyd and Newall's version has been modified by the addition of an extra consequence category and the renaming of the Descriptors to match the Risk Analysis Matrix presented in Table 5.1**

| Consequence Severity Level | Descriptor | Consequence to the current aquatic fauna assemblages |
|---|---|---|
| 5 | Critical | Loss of species |
| 4 | Major | General long-term reduction of existing community or population |
| 3 | Moderate | Long term reduction in local community or population in some areas |
| 2 | Minor | Long-term maintenance of existing community or population, but with short term reductions |
| 1 | Insignificant | No short or long term impact on existing community or population at current numbers |

**Table 5.3: Likelihood ratings for threats to the values of the study area.**

| Likelihood Rating | Descriptor | Definition |
|---|---|---|
| 5 | Near certain | Confident that the threat will occur |
| 4 | Highly likely | The threat is expected to occur |
| 3 | Likely | The threat is likely to occur |
| 2 | Unlikely | The threat is unlikely to occur |
| 1 | Highly unlikely | Confident that threat will not occur |

## 5.3 Approach to Assessing Individual Species

The risks were collectively assessed for the three proposed translocated species on the assumption that they are long-lived, medium to large bodied predators that will survive environmental conditions in Rocklands Reservoir and the Glenelg River. However, where particular threats were identified that related to the specific physiology of a species, they were assessed separately. This occurred on two occasions;

1. The threat of Murray cod preying on adult Glenelg spiny crayfish in the lower Glenelg River, and
2. The threat of adult Golden perch and Estuary perch displacing adult Redfin in Rocklands Reservoir.

Overall, the risks posed by introducing Estuary perch to Rocklands Reservoir were considered insignificant for all threats given that Estuary perch are endemic to the Glenelg River and the fish to be stocked will be the progeny of adult brood fish collected from this environment.

## 5.4 Risk Management

The purpose of risk assessments is to inform decisions based on the outcomes of the risk analysis. Once the level of risk has been determined, a decision can be made on whether the risks are acceptable, or whether they require further treatment to lower the level of risk prior to the action going ahead. An approach to risk management is presented in Table 5.4: Risk Management.

**Table 5.4: Risk Management**

| | |
|---|---|
| Severe | Do not go ahead with action unless significant treatments result in mitigation of risk to acceptable level |
| High | Do not go ahead with action unless treatments result in mitigation of risk to acceptable level |
| Medium | Risks rated at this level should be considered for further treatment, but action may still go ahead under defined conditions |
| Low | Risks considered to be adequately managed and not requiring further treatment |

# 6 Preliminary Risk Assessment

The results of the Preliminary Risk Assessment are presented in Table 6.1.

## 6.1 Risk Assessment Tables

**Table 6.1: Preliminary Risk Assessment for the Translocation of Murray cod, Golden perch and Estuary perch into Rocklands Reservoir**

| Value | Threat | Description of Threat | Unmitigated Risk | | |
|---|---|---|---|---|---|
| | | | L | C | Risk |
| **1. Significant fish species in Rocklands Reservoir including Little Galaxias, Obscure galaxias and the Western Swamp cray. (the primary value being the protection of these species)** | **1. Stocked species may <u>prey</u> upon significant fish species in Rocklands Reservoir including significant species Little Galaxias, Obscure galaxias and the Western Swamp cray.** | • None of the significant species have been recorded from Rocklands Reservoir but do occur upstream and may exist in small numbers in the reservoir.<br>• Murray cod, Golden perch and Estuary perch are predatory species with diets that will vary through the different age classes ranging from zooplankton in the very early life stages, through to insects, large crustaceans and fish. The introduction of these species to Rocklands Reservoir creates a predation threat to the populations of significant native species in the reservoir. | **4** | **3** | **Medium** |
| | **2. Juvenile stocked species may <u>compete</u> with significant species in Rocklands Reservoir including Little Galaxias, Obscure galaxias and the Western Swamp cray.** | • None of the significant species have been recorded from Rocklands Reservoir but do occur upstream and may exist in small numbers.<br>• The juveniles of all three species may compete with significant native fish species which have overlapping resource requirements and displace them from preferred habitat. | **4** | **3** | **Medium** |
| | **3. Stocked species may introduce disease and/or parasites to Rocklands Reservoir threatening Little Galaxias, Obscure galaxias and the Western Swamp cray.** | • All fish legally stocked to Rocklands Reservoir will be sourced from health accredited facilities that are certified “Disease Free”.<br>• Stocking will be undertaken by Fisheries Victoria using well established protocols and procedures that minimize disease risk (see Protocols for the Translocation of Fish in Victorian Inland Public Waters (Department of Primary Industries 2005). | **1** | **1** | **Low** |
| **2. The existing fish community in the Glenelg River (the primary value being the natural ecosystem)** | **4. In the event that they escape, stocked species may <u>prey</u> upon existing fish species in the upper Glenelg river system threatening Little Galaxias, Obscure galaxias and the Western Swamp cray.** | • Escape of stocked species from Rocklands Reservoir is the key process for the threats to aquatic organisms in the Glenelg River upstream of Rocklands Reservoir.<br>• The primary means by which fish may escape the reservoir is migration during high flow events that increase hydraulic connectivity with the river upstream of Rocklands.<br>• Murray cod, Golden perch and Estuary perch are predatory species with diets that will vary through the different age classes ranging from zooplankton in the very early life stages, through to insects, large crustaceans and fish, including the juveniles of exotic species. Murray cod will also prey on large fish. The escapement of these species to the Glenelg River creates a predation threat to the populations of existing species in the river. | **5** | **3** | **High** |
| | **5. In the event that they escape, juvenile stocked species may <u>compete</u> with existing fish species in the upper Glenelg River system threatening Little Galaxias, Obscure galaxias and the Western Swamp cray.** | • Escape of stocked species from Rocklands Reservoir is the key process for the threats to aquatic organisms in the Glenelg River upstream of Rocklands Reservoir.<br>• The primary means by which fish may escape the reservoir is migration during high flow events that increase hydraulic connectivity with the river upstream of Rocklands.<br>• Juveniles of all three species may compete with native fish species for habitat and food resources and may displace them. | **5** | **2** | **Medium** |
| | **6. Stocked species may <u>introduce disease and/or parasites</u> to the upper Glenelg River threatening Little Galaxias, Obscure galaxias and the Western Swamp cray.** | • All fish legally stocked to Rocklands Reservoir will be sourced from health accredited facilities that are certified “Disease Free”.<br>• Stocking will be undertaken by Fisheries Victoria using well established protocols and procedures that minimize disease risk (see Protocols for the Translocation of Fish in Victorian Inland Public Waters (Department of Primary Industries 2005). | **1** | **1** | **Low** |
| | **7. In the event that they escape, mature stocked species may <u>prey</u> upon existing fish species in the lower Glenelg river system** | • Escape of stocked species from Rocklands Reservoir is the key process for the threats to aquatic organisms in the Glenelg River both upstream and downstream of Rocklands Reservoir.<br>• The primary means by which fish may escape the reservoir is migration during high flow events that either cause spilling of the reservoir into the Glenelg River or increase hydraulic connectivity with the river upstream of Rocklands.<br>• Murray cod, Golden perch and Estuary perch are predatory species with diets that will vary through the different age classes ranging from zooplankton in the very early life stages, through to insects, large crustaceans and fish, including the juveniles of exotic species. Murray cod will also prey on large fish. The escapement of these species to the Glenelg River creates a predation threat to the populations of existing species in the river.<br>• The Continuous Deflection Separation (CDS) screens placed on the spillway of Rocklands Reservoir are likely to provide an effective means of preventing large scale of escapement of introduced species. The screens are designed to prevent the passage of carp and carp eggs through to the Glenelg River. All species proposed for stocking have a larger egg size than carp and newly hatched fry are larger. | **5** | **3** | **High** |
| | **8. In the event that they escape, stocked species may <u>compete</u> with existing fish species in the lower Glenelg River system** | • Juveniles of all three species may compete with native fish species for habitat and food resources and may displace them.<br>• Estuary perch and Golden perch are both medium to large bodied predators that may compete directly with some of the larger native species i.e.: Australian grayling, River blackfish | **4** | **2** | **Medium** |

| Value | Threat | Description of Threat | Unmitigated Risk L | C | Risk |
|---|---|---|---|---|---|
| | **9. Stocked species may <u>introduce disease and/or parasites</u> to the waterbodies, threatening existing fish species in the lower Glenelg River system** | • All fish legally stocked to Rocklands Reservoir will be sourced from health accredited facilities that are certified "Disease Free".<br>• Stocking will be undertaken by Fisheries Victoria using well established protocols and procedures that minimize disease risk (see Protocols for the Translocation of Fish in Victorian Inland Public Waters (Department of Primary Industries 2005). | **1** | **1** | **Low** |
| **3. Significant fish species in the lower Glenelg River including Australian grayling, River blackfish (upper Wannon River only), Variegated pygmy perch, Yarra pygmy perch, Little galaxias, Australian mudfish, Glenelg spiny freshwater crayfish, and Glenelg Freshwater mussel (the primary value being the protection of these species)** | **10. In the event that they escape, adult Murray cod may <u>prey</u> upon Glenelg Spiny Freshwater crayfish in the Glenelg River system** | • The Glenelg Spiny Freshwater Crayfish only inhabits a short section of the lower Glenelg River and has few known predators in its adult stage (possibly Water rats, *Hydromys chrysogaster*) though juvenile crayfish are likely to be preyed upon by numerous fish and birds. The introduction of Murray cod into the environment of the Glenelg spiny crayfish may see predation upon adults by large Murray cod. | **5** | **3** | **High** |
| | **11. In the event that they escape, mature stocked species may <u>prey</u> upon significant species in the lower Glenelg River including Australian grayling, River blackfish (upper Wannon River only), Variegated pygmy perch, Yarra pygmy perch, Little galaxias, Australian mudfish, Glenelg spiny freshwater crayfish, and Glenelg Freshwater mussel (the primary value being the protection of these species**| • Escapement of stocked species from Rocklands Reservoir is the key process for the threats to fish and aquatic communities in the Glenelg River both upstream and downstream of Rocklands Reservoir.<br>• Murray cod, Golden perch and Estuary perch are predatory species with diets that will vary through the different age classes ranging from zooplankton in the very early life stages, through to insects, large crustaceans and fish, including the juveniles of exotic species. Murray cod will also prey on large fish. The escapement of these species to the Glenelg River creates a predation threat to the populations of existing species in the river.<br>• Escaped fish are likely to prey on native fish in the Glenelg River and may impact on local fish communities (i.e. individual pools)<br>• The primary means by which fish may escape the reservoir is migration during high flow events that either cause spilling of the reservoir into the Glenelg River or increase hydraulic connectivity with the river upstream of Rocklands.<br>• The Continuous Deflection Separation (CDS) screens placed on the spillway of Rocklands Reservoir are likely to provide an effective means of preventing large scale of escapement of introduced species. The screens are designed to prevent the passage of carp and carp eggs through to the Glenelg River. All species proposed for stocking have a larger egg size than carp and newly hatched fry are larger. | **5** | **3** | **High** |
| | **12. In the event that they escape, stocked species may <u>compete</u> with significant species in the lower Glenelg River including Australian grayling, River blackfish (upper Wannon River only), Variegated pygmy perch, Yarra pygmy perch, Little galaxias, Australian mudfish, Glenelg spiny freshwater crayfish, and Glenelg Freshwater mussel (the primary value being the protection of these species)** | • Escapement of stocked species from Rocklands Reservoir is the key process for the threats to fish and aquatic communities in the Glenelg River both upstream and downstream of Rocklands Reservoir.<br>• The primary means by which fish may escape the reservoir is migration during high flow events that either cause spilling of the reservoir into the Glenelg River or increase hydraulic connectivity with the river upstream of Rocklands.<br>• Prescribed environmental flow events that are designed to flow through Rocklands during defined inflow events may also contribute to escapement.<br>• Stocked species may escape upstream or downstream of Rocklands Reservoir during regulated and unregulated flow events.<br>• The Continuous Deflection Separation (CDS) screens placed on the spillway of Rocklands Reservoir are likely to provide an effective means of preventing large scale of escapement of introduced species. The screens are designed to prevent the passage of carp and carp eggs through to the Glenelg River. All species proposed for stocking have a larger egg size than carp and newly hatched fry are larger. | **4** | **2** | **Medium** |
| | **13. Stocked species may <u>introduce disease and/or parasites</u> to the waterbodies, threatening existing significant fish species in the lower Glenelg River system** | • All fish legally stocked to Rocklands Reservoir will be sourced from health accredited facilities that are certified "Disease Free".<br>• Stocking will be undertaken by Fisheries Victoria using well established protocols and procedures that minimize disease risk (see Protocols for the Translocation of Fish in Victorian Inland Public Waters (Department of Primary Industries 2005). | **1** | **1** | **Low** |
| **4. The fish community in Rocklands Reservoir (the primary value being angling)** | **14. Mature stocked species may <u>prey</u> upon Redfin in Rocklands Reservoir which may impact on the quality of Redfin fishing.** | • Murray cod, Estuary perch and Golden perch may prey on juvenile Redfin which may impact upon the Redfin population.<br>• Murray cod would become the apex predator in Rocklands Reservoir and would prey on adult Redfin which may impact upon the Redfin population. | **5** | **1** | **Low** |
| | **15. Stocked species may <u>compete</u> with Redfin in Rocklands Reservoir, leading to the reduction of this species** | • The proposed species for introduction have the potential to compete with existing species in the reservoirs for food and habitat. In particular, the existing population of introduced Redfin may have overlapping resource requirements with one or all of the three proposed introductions during various life stages.<br>• Estuary perch and Golden perch are both medium to large bodied predators that may compete directly with Redfin for habitat and prey resources which may impact on Redfin numbers. | **5** | **1** | **Low** |
| | **16. Stocked species may <u>introduce disease and/or parasites</u> to the waterbodies, threatening the existing recreational fishery.** | • All fish legally stocked to Rocklands Reservoir will be sourced from health accredited facilities that are certified "Disease Free".<br>• Stocking will be undertaken by Fisheries Victoria using well established protocols and procedures that minimize disease risk (see Protocols for the Translocation of Fish in Victorian Inland Public Waters (Department of Primary Industries 2005). | **1** | **1** | **Low** |

## 6.2 Risk Analysis Results and Rationale

### 6.2.1 Value 1: Significant fish species in Rocklands Reservoir including Little Galaxias, Obscure galaxias and the Western Swamp cray. (The primary value being the protection of these species)

None of the fish surveys reviewed provide evidence that any of the significant species present in the upper Glenelg River catchment occur in Rocklands Reservoir however, a conservative approach to their presence has been adopted for this Risk Assessment. The principle for this approach is that while the significant species have not been recorded in Rocklands Reservoir, their presence in the inflowing waterways could imply that they may be present in small and/or isolated populations in the reservoir that cannot be accessed by large bodied fish such as Redfin or any of the proposed stocked species. The value of protecting these species in Rocklands Reservoir may also be debated in the context that Rocklands may provide some refuge for these species but the main driver for management is to protect these species in their natural habitats in the upper Glenelg River.

Rocklands Reservoir currently contains a large population of the exotic predatory fish Redfin perch and European carp, which appear to successfully breed in the reservoir and associated waterways. Redfin are thought to have occupied the reservoir since it was constructed in 1953 and populations were believed to be much greater prior to an extended period of low water levels from year 2000 and the growth in the European carp population from that date. Other introduced predatory species including Brown and Rainbow trout, Tench, Murray cod and Australian bass have been recorded in the reservoir. In the case Murray Cod and Australian Bass that have not been formally stocked, it is assumed that their existence is a result of illegal stocking activities.

Because each of the species proposed to be stocked are piscivorous, it is highly likely that they will prey on native fish species in Rocklands Reservoir; the extent to which they may prey on significant species is unknown. Because native fish populations have persisted in the presence of Redfin for 60 years, there is unlikely to be any further impact on these species in the long term, as a result of the proposed stocking. This is because the total biomass of predatory species is limited by available food and habitat resources and for stocked species to establish “fishable” populations, they will need to displace existing predatory species such as Redfin, meaning that total predator pressure on species in Rocklands Reservoir would not increase.

The threat posed by overall competition for food and habitat resources may impact native fish communities during the early life stages of the introduced species. The “crash” stocking with tens or hundreds of thousands of juveniles may lead to short term competition with significant native species which are likely to occupy similar habitat zones and prey on similar food items. Once the introduced species grow through this early life stage they will likely occupy different habitat zones and switch feeding preferences.

The risk of introducing disease and or parasites to Rocklands Reservoir through stocking with hatchery reared fish is low. Fisheries Victoria adhere stringently to the procedures set out in the Protocols for the Translocation of Fish in Victorian Inland Public Waters (Department of Primary Industries 2005) for eliminating introductions of pathogens.

### 6.2.2 Value: The existing fish community in the Glenelg River (the primary value being the natural ecosystem)

The geographic scope of this value was the natural riverine ecosystem of the Glenelg River upstream and downstream of Rocklands Reservoir (in contrast to the "modified" environment of the reservoir).

Stocked fish in all life stages may enter the Glenelg River during particular flows which may result in the establishment of introduced species populations in the short to long term.

### Upper Glenelg River (applies also to Red Rocks Creek, Tea Tree Creek and Scott Creek).

Escapes of introduced species into the upper Glenelg River (upstream of Rocklands Reservoir) are highly unlikely during managed flows as there is insignificant hydraulic connectivity between the reservoir and the inflowing waterways to allow fish passage. Escapes can only occur during high inflows when hydraulic connectivity between Rocklands Reservoir and the upper Glenelg River allows the passage of fish through the river system, this will only occur during high inflow/flood events.

The behavioral characteristics of the stocked species suggest that they are unlikely to migrate to the upper Glenelg River during high flows. Murray cod have been shown to be quite sedentary in large impoundments across a range of flow regimes and show no preference for upstream migration (Douglas, 2009), while Estuary perch are likely to migrate downstream to estuarine environments during winter in search of suitable breeding habitat. While the migratory behavior of Golden perch is more variable, there is still a strong tendency for this species to remain in the area of the impoundments to which they are stocked particularly, in larger deeper lakes such as Lake Eildon in Victoria and Somerset Lake and Boondooma in Queensland (Douglas 2009, Sawynok & Platten, 2009). Ryan and Mahony (2005), observed that upstream movements of Golden perch only occurred when water temperatures exceeded 20°C and coincided with increased flow into the Lakes.

In any event, the movement of large bodied fish into the upper Glenelg River is likely to be short term for the period that sufficient water is available. The species proposed for introduction require sufficient space to survive and hunt; conditions which do not prevail in the small stream and marshy environments of the upper Glenelg River during normal flows. Thus, it is unlikely and of minor consequence that native fish species will be impacted by the introduction of Murray cod, Golden perch and Estuary perch.

**Figure 6.1: Typical habitat in the upper Glenelg catchment. (Cultivation Creek, a tributary of the upper Glenelg River, courtesy of Ty Matthews)**

The threat posed by overall competition for food and habitat resources may impact native fish communities in the upper Glenelg River during the early life stages of the introduced species and only if these species are able to migrate to the upper river. The "crash" stocking with tens or hundreds of thousands of juveniles during periods of hydraulic connectivity with the upper Glenelg River may lead to short term competition with native species which are likely to occupy similar habitat zones and prey on similar food items. However, flow velocities during floods will have a significant influence on the ability for large numbers of introduced juveniles to access upstream habitats.

Once the introduced species grow through their early life stage they will likely occupy different habitat zones (e.g. return to the reservoir) and switch feeding preferences or are likely to experience total population mortality as water levels drop and suitable habitat is lost.

**Figure 6.2: Dead European carp, after become stranded in Red Rocks Creek (photo courtesy of Ty Matthews)**

The risk of introducing disease and or parasites to Rocklands Reservoir through stocking with hatchery reared fish is low. Fisheries Victoria adhere stringently to the procedures set out in the Protocols for the Translocation of Fish in Victorian Inland Public Waters (Department of Primary Industries 2005) for eliminating introductions of pathogens.

### Lower Glenelg River (below Rocklands Reservoir including all tributaries)

The ability of the stocked species to move downstream into the Glenelg River from Rocklands Reservoir is significantly limited by the presence of the CDS units on the outlet of the reservoir. The screens were designed to prevent the transportation of European carp and their eggs from Rocklands Reservoir to the lower Glenelg River during managed flows and have a mesh size to achieve this. All discharge flows up to a maximum capacity of 480 ML/day are diverted through the screens however, the reported discharge capacity is nominally 400 ML/day (K. Mayers, GWMW). Since the installation of the CDS units in 2006 discharge flow rates seldom exceed 300ML/day and only occur when GWMW are moving water to Taylors Lake at approximately 160 ML /day or the Glenelg Hopkins CMA call on environmental flows at the same time (which are generally in the order of 140 ML/day and up to 170 ML/day but only for limited periods of 3-4 weeks).

The CDS units will be an effective mechanism in preventing downstream transportation of Golden perch eggs (in the unlikely event that spawning occurs) during regulated flows, as they are a larger size than carp eggs. Murray cod eggs (which are also larger than carp eggs) are adhesive to the substrate they are laid on and therefore will not be transported while Estuary perch will not spawn in freshwater (and if they do, their eggs are larger than carp eggs and will not survive in freshwater).

Based on historical observations flows from Rocklands Reservoir have not exceeded the capacity of the CDS in the past 30 years thus limiting any opportunity for all three stocked species (as well as other species) to escape downstream into the lower Glenelg River. The extent to which this may occur is dependent upon the behavioral characteristics of the stocked species and the magnitude, duration and seasonality of the flows. Coordinated management of environmental flow releases and transfers to Taylors Lake is a possible treatment to reduce the chance of downstream escapes.

As previously discussed Douglas (2009 & 2011), found that Murray cod and Golden perch in Lake Eildon showed a strong affinity for the section of the lake to which they were released and while there was a high degree of movement within this section, the few fish that moved outside of this area showed strong "homing" characteristics and will constantly remain in the same section of the lake to which they are stocked. Sawynok and Platten (2009) undertook a review of tagging studies on Golden perch (and other species) conducted in Queensland between 1987 and 2008. From a relatively large sample size (1022 fish recaptured) only 1.2% were recaptured outside of the impoundment to which they were stocked. The fish that had moved from the impoundment had moved both upstream and downstream in equal proportions. Movement upstream tended to associate with increasing flows to the impoundment while movement downstream was associated with spilling of the dam. Ryan and Mahony (2005), in a study of wild adult Golden perch captured in the Goulburn River and Nagambie Lakes and then released back into the Nagambie Lakes, showed the fish to be highly mobile and often moved into the vicinity of the downstream outlets. Fish passed downstream through the East Goulburn Main and Stuart Murray Canal gates but despite visiting often, did not pass through the Cattanach outlet. Of the fish that did not pass through the gates most visited the area on numerous occasions suggesting that there was some willingness to pass downstream.

Juvenile Estuary perch proposed to be stocked to Rocklands Reservoir are the progeny of adult fish sourced from the estuarine reach of the Glenelg River and therefore attend concerns regarding the maintenance of genetic integrity in wild fish stocks.

Each of the three species proposed for stocking are long-lived and while Estuary perch are endemic to the Glenelg River and will breed in the estuarine reach, Murray cod and Golden perch are highly unlikely to establish breeding populations.

As is the case with the predation risk presented by stocked fish in the Rocklands Reservoir, the total biomass of predatory species in the lower Glenelg River will be limited by available food and habitat resources. For escaped species to establish viable populations in the lower Glenelg River, they will need to displace existing introduced predatory species such as Redfin and Australian bass, meaning that total predator pressure in the river would not increase. Therefore, the introduction of additional fish species to the Glenelg River (via escape from Rocklands Reservoir) is unlikely to lead to any increased predatory impact on overall native fish populations.

The threat of juvenile stages of the stocked species competing with native fish in the lower Glenelg River is likely to occur on an infrequent basis and depends entirely upon the frequency of flows from Rocklands Reservoir exceeding the capacity of the CDS units and the number of escaped fish.

In the event that large numbers of juvenile stocked fish escape to the lower Glenelg River, it is likely that there will be some short term impact on native fish communities before the escapee's grow out and occupy alternative habitat and change prey preferences. The consequences of this competition are again dependent upon the density of escaped juveniles and will be concentrated in habitats suitable to escapees. Little is understood about the comparative habitat and prey preferences of the juveniles of the proposed stocked species and the native species in the Glenelg River.

The risk of introducing disease and or parasites to the Glenelg River via the stocking with hatchery reared fish to Rocklands Reservoir is low. Fisheries Victoria adhere stringently to the procedures set out in the Protocols for the Translocation of Fish in Victorian Inland Public Waters (Department of Primary Industries 2005) for eliminating introductions of pathogens.

### 6.2.3 Value: Significant fish species in the lower Glenelg River including Australian grayling, River blackfish (upper Wannon River only), Variegated pygmy perch, Yarra pygmy perch, Little galaxias, Australian mudfish, Glenelg spiny freshwater crayfish, and Glenelg Freshwater mussel (the primary value being the protection of these species)

The introduction and survival of new predators to the lower Glenelg River may have consequences for the existing populations of threatened species including Australian grayling, River blackfish (upper Wannon River), Variegated pygmy perch, Yarra pygmy perch, Little galaxias, Australian mudfish, Glenelg spiny freshwater crayfish and Glenelg Freshwater mussel.

The results of the VEFMAP survey undertaken by Austral (2014) divides the Glenelg River into three reaches based upon geomorphological form and presents species abundance and distribution data for each reach. These data are presented in Appendix C and show that the threatened species of concern to this element of the Risk Assessment are poorly represented; only Variegated pygmy perch and Glenelg Spiny crayfish were captured during the survey. A greater diversity and abundance of introduced species (non-endemic native and exotic) occur in Reach 1, declining through reaches 2 & 3. In contrast native species, while more prevalent in Reach 3, are reasonably represented through all reaches except in the case of Variegated pygmy perch which appears to show a preference for downstream environments. Glenelg spiny crayfish were only recorded in Reach 3.

Lieschke et. al. (2013), divides the catchment between 'Lowland' and 'Slopes' altitudinal zones (Figure C.2). Only six (6) of eighteen (18) survey sites were located in the Glenelg River with others distributed across the Chetwynd, Wannon, Stokes and Crawford rivers (and their tributaries).

These data show that Yarra pygmy perch were only observed in the area Glenelg River that corresponds to Reach 3 (Casterton to Dartmoor) of the VEFMAP survey, while Variegated pygmy perch were observed in all reaches. No other significant species were recorded in the Glenelg River but two others, Little galaxias and River blackfish were recorded in tributaries which enter the Glenelg below Rocklands Reservoir. These species were only recorded in the mid to upper reaches of the tributaries (Appendix C).

This paucity of data meant that a conservative approach was adopted in assessing the possible impacts of escaped fish on significant species. Each species other than the Glenelg Freshwater Mussel which only exists in the lower Crawford River (Playford & Walker 2008), were assumed to exist in all parts of the Glenelg River and its tributaries between Rocklands Reservoir and Dartmoor, while noting that certain species appear to be more abundant in different reaches/zones. The Crawford River which enters the Glenelg River at Dartmoor is also reported to carry abundant populations of Glenelg spiny crayfish (http://agriculture.vic.gov.au/fisheries/recreational-fishing/fishing-locations/inland-angling-guide/glenelg/glenelg-angling-waters#crawford ).

The physical constraints to escaped fish migrating through the catchment system were also considered. The reach of the Glenelg River between Harrow and Casterton is described by Howson (2014) as a widening channel that becomes increasingly shallow therefore, it is likely that the ability for large body fish to occupy the waterway is restricted during base flows, while increasing flows through this reach will obviously facilitate movement. The data presented by Austral (2014) and Lieschke (2013) somewhat supports the assumption that large bodied fish are unlikely to reside in significant populations in this reach of the river.

Known barriers to the passage of large bodied fish also occur at a number of locations throughout the catchment. On the Wannon River, Wannon Falls and Nigretta Falls effectively prevent the upstream movement of fish including the endemic introduced species Golden perch and Macquarie perch, which are reported to occur immediately below Wannon Falls, but not upstream. Trout and redfin do occur above Nigretta Falls and were thought to be stocked there many years ago. These barriers will also prevent the passage of Murray cod in the event that they escape from Rocklands Reservoir and are able to migrate to the Wannon River.

Below Casterton, introduced species are uncommon, with only Eastern gambusia and Tench occurring in low numbers (Austral, 2014, Lieschke et al, 2013). These data may indicate that environmental conditions (i.e. salinity, habitat, hydrology) below Casterton are unsuitable for introduced species and therefore large scale colonization does not occur.

The consequences of Estuary perch escaping to the Glenelg River are considered insignificant because they are endemic to the system and the stocked fish will be derived from a captive breeding program that utilises adult Estuary perch from the Glenelg River. It is believed that escapee's will quickly assimilate with native populations within their natural range.

In general, the longevity of Murray cod and Golden perch means that the consequences of any impact could be long-term for significant species. It is recognized however, that adult Murray cod may present a particular threat to adult Glenelg spiny crayfish.

Glenelg spiny crayfish are a long lived species with few natural predators in their adult stages (possibly with the exception of water rats, *Hydromys chrysogaster*. Historically, they were thought to have occurred in the Glenelg River in its upper reaches above Balmoral however, it is believed that the construction of Rocklands Reservoir in 1953 lead to the localized extinction of the species. The current distribution of Glenelg spiny crayfish populations in the Glenelg River system is well understood and they are estimated to occur in only 19.7 km2 of the Glenelg River catchment (Beeton, 2011) although, the Crawford River is reported to contain an abundance of this species (http://agriculture.vic.gov.au/fisheries/recreational-fishing/fishing-locations/inland-angling-guide/glenelg/glenelg-angling-waters#crawford.

The predation threat that Murray cod pose to Glenelg spiny crayfish is dependent upon the likelihood of Murray cod being able to access crayfish populations e.g. populations in the Crawford River may be sufficiently remote from Murray cod escaping Rocklands Reservoir to avoid predation. The relatively large size of adult crayfish means that they are an unsuitable prey for small to medium predatory species such as Redfin but may be susceptible to the larger Murray cod. In waters that Murray cod are able to access and survive, predation may have significant consequences for the Glenelg spiny crayfish population.

Golden perch are likely to prey upon juvenile Glenelg spiny crayfish but the consequences are likely to be minor as overall predatory pressure from medium bodied fish is not likely to increase due to displacement of extant predatory species e.g. Redfin.

The threat of juvenile stages of the escaped species competing with threatened species in the Glenelg River are considered likely to have some short term impact when large numbers escape. Juvenile escapee's will quickly grow out and occupy alternative habitat and change prey preferences (if available). The consequences of this competition are dependent upon the density of both native fish and escaped juveniles and will be concentrated in habitats suitable to escapees. Little is understood about the comparative habitat and prey preferences of the juveniles of the proposed stocked species and the native species in the Glenelg River.

Similar to the rationale presented for the threat of diseases impacting the fish community in the Glenelg Reservoir, the possible risk to significant species populations in the Glenelg River is low.

### 6.2.4 The fish community in Rocklands Reservoir (the primary value being angling)

The large scale stocking of Rocklands Reservoir with Murray cod, Golden perch and Estuary perch is likely to result in the development of a diverse and abundant mixed species recreational fishery. Prior to 2000, the abundant Redfin fishery in Rocklands Reservoir attracted significant visitation and evidence from other large impoundments in Victoria and Australia confirm that such high quality fisheries attract significant local and interstate angler visitation. Australian anglers are become increasingly more interested in the development of freshwater fisheries based on native species in appropriate impoundments rather than fisheries based on introduced trout and Redfin.

The addition of these Murray cod, Golden perch and Estuary perch is unlikely to lead to an increase in the total biomass of predatory species in Rocklands Reservoir with large scale stocking more likely to result in reduction in the Redfin population which will be partially displaced by through predation and competition. While this may result in a decline in the Redfin population, it may improve the quality of the fishery by reducing the potential for this species to overpopulate which leads to stunting. The introduction of an apex predator (Murray cod) may also contribute to ecosystem improvement in an environment where invasive species are prevalent (Sierp, 2008).

Stocking will be undertaken by Fisheries Victoria using well established protocols and procedures that minimize disease risk (see Protocols for the Translocation of Fish in Victorian Inland Public Waters (Department of Primary Industries 2005).

## 6.3 Assumptions

The Preliminary Risk Assessment was able to identify a number of threats that needed to be assessed in order to rank the critical risks related to stocking the target species in Rocklands Reservoir. Most threats

were able to be confidently assessed by using existing information as explained in Section 5.5 Risk Analysis Results and Rationale. However, significant knowledge gaps relating to the hydrology and water management operations of Rocklands Reservoir were identified that had a profound bearing on the outcome of the Preliminary Risk Assessment. These knowledge gaps required that the Preliminary Risk Assessment adopted a precautionary principle of assuming the "worst case scenario" for any prospective risk relating to the escapement of target species into the Glenelg River, as highlighted in the example below.

***In the event that they escape*, stocked species may prey upon existing fish species in the upper Glenelg River system threatening Little Galaxias, Obscure galaxias and the Western Swamp cray.**

This statement assumes that large numbers of stocked fish will escape the reservoir during high inflows that increase upstream hydrological connectivity and also result in spilling of the reservoir over the top of the CDU's into the lower Glenelg River. However, there are uncertainties relating to this assumption due to the lack of knowledge of the detailed hydrology of Rocklands Reservoir and its catchment.

The worst case scenario assumption "***In the event that they escape***" applied to seven (7) of the sixteen (16) threats assessed during the Preliminary Risk Assessment and significantly influences the likelihood ranking applied to each of these threats. For each of the threats listed in Table 6.1, the likelihood of the threats occurring are ranked as either 5 – near certain or 4 – highly likely.

**Table 6.2 Threats showing worst case scenario assumptions**

| Value | Threat | Unmitigated Risk | | |
|---|---|---|---|---|
| | | L | C | Risk |
| **2. The existing fish community in the Glenelg River (the primary value being the natural ecosystem)** | **4. In the event that they escape,** stocked species may prey upon existing fish species in the upper Glenelg river system threatening Little Galaxias, Obscure galaxias and the Western Swamp cray. | **5** | **3** | **High** |
| | 5. **In the event that they escape,** juvenile stocked species may compete with existing fish species in the upper Glenelg River system threatening Little Galaxias, Obscure galaxias and the Western Swamp cray. | **5** | **2** | **Medium** |
| | 7. **In the event that they escape,** mature stocked species may prey upon existing fish species in the lower Glenelg river system | **5** | **3** | **High** |
| | **8. In the event that they escape,** stocked species may compete with existing fish species in the lower Glenelg River system | **4** | **2** | **Medium** |

| Value | Threat | Unmitigated Risk L | C | Risk |
|---|---|---|---|---|
| **3. Significant fish species in the lower Glenelg River including Australian grayling, River blackfish (upper Wannon River only), Variegated pygmy perch, Yarra pygmy perch, Little galaxias, Australian mudfish, Glenelg spiny freshwater crayfish, and Glenelg Freshwater mussel (the primary value being the protection of these species)** | **10. In the event that they escape**, adult Murray cod may prey upon Glenelg Spiny Freshwater crayfish in the Glenelg River system | **5** | **3** | **High** |
| | **11. In the event that they escape,** mature stocked species may prey upon significant species in the lower Glenelg River including Australian grayling, River blackfish (upper Wannon River only), Variegated pygmy perch, Yarra pygmy perch, Little galaxias, Australian mudfish, Glenelg spiny freshwater crayfish, and Glenelg Freshwater mussel (the primary value being the protection of these species | **5** | **3** | **High** |
| | **12. In the event that they escape,** stocked species may compete with significant species in the lower Glenelg River including Australian grayling, River blackfish (upper Wannon River only), Variegated pygmy perch, Yarra pygmy perch, Little galaxias, Australian mudfish, Glenelg spiny freshwater crayfish, and Glenelg Freshwater mussel (the primary value being the protection of these species) | **4** | **2** | **Medium** |

To fill the primary knowledge gap, a further more detailed assessment of the hydrology and water operations strategy of Rocklands Reservoir was undertaken. The primary objective of the assessment was to determine critical flow characteristics and future water management plans that will better inform the Risk Assessment for stocking target species into Rocklands reservoir.

# 7 Hydrological assessment

The assessment focused on identifying the likelihood of flood flows exceeding the capacity of the CDU's installed on the Rocklands Reservoir outlet which would facilitate the escape of target species into this reach of the river. It also aimed to gain a better understanding of the hydrodynamics of the Glenelg River which would enable an assessment of the capacity for stocked species to move throughout the upper and lower catchment during different flow conditions. This will be particularly relevant to determining the potential for these species to impact upon native species in the upper Glenelg River.

The hydrological assessment was significantly aided by the release of new data that provides greater certainty about hydrological conditions in the catchment and the possible future inflow scenarios that may occur and which have significant implications for the Risk Assessment for the proposal to stock Rocklands Reservoir with native fish.

## 7.1 Rocklands Capacity and Current Operation

The following storage operations overview has been sourced from the GWMW discussion paper "Rocklands Reservoir Operating Rules" (GWMW 2011) and provides context to the hydro-climatic modelling and the revised risk assessment.

Rocklands Reservoir can store up to 348,300 ML at the spillway crest level of 195.47 m AHD and is termed the Full Supply Level (FSL). Following the completion of the Wimmera Mallee Pipeline, Rocklands Reservoir is now operated to a Maximum Operating Level (MOL) of 194.10 m AHD or 261,500 ML. The MOL is possible because the Wimmera Mallee Pipeline reduced the need to harvest and store as much water for consumptive use, and ensures the environment receives its share of the Wimmera- Mallee pipeline savings contracted by the State and Commonwealth Governments. This MOL also reduces the chance of uncontrolled spills and evaporation losses from the reservoir.

The fundamental operating rule for Rocklands Reservoir is to operate the reservoir up to its MOL throughout the year. Rocklands Reservoir is also to be operated to a target minimum operating level of 189.06 m AHD or 69,600 ML. This lower target is aimed at facilitating suitable levels for recreation, with the additional benefit of assisting to manage water quality, particularly salinity levels, by buffering poor quality inflows during low inflow years.

Rocklands Reservoir has a nominal outlet capacity of 600 ML/day, however, this is limited to 400 ML/day, being the operating discharge capacity of installed carp screens. Inflows to Rocklands can far exceed the capacity to release water (e.g. the January 2011 floods saw daily inflows of approximately 7,000 ML/day). As levels approach the MOL, water surplus to that required to meet entitlement holder demands is actively transferred to downstream reservoirs where space exists (i.e. Taylors Lake, Toolondo Reservoir and possibly Green Lake – pending finalisation of management rules). It is still possible for levels to rise above the MOL and when this happens plans will be developed to draw levels down to the MOL.

It is possible that downstream demands could be greater than the ability to deliver from Rocklands and there may be competing needs for channel capacity. When this occurs, deliveries to entitlement holders will take precedence over transfers to downstream reservoirs. Passing flows may also be altered in consultation with the environmental entitlement holder to free up channel capacity in the short term.

Environmental flows will primarily be delivered direct to the Glenelg River directly downstream of the dam wall. It is also possible, however, to deliver environmental flows from the 5 mile and 12 mile escapes on the Rocklands outlet channel. This may be done to spread larger flow rates across multiple delivery points to improve the efficiency of water delivery during dry years or to reduce the potential for flooding downstream of the wall during wet years.

Compensation flows are required to be delivered to the Glenelg River typically between November and May of each year. These flows will be planned to be complementary to environmental water releases. Glenelg-Hopkins CMA is required to develop flow plans for this entitlement on behalf of and in consultation with GWMWater.

If Rocklands is required to transfer water to downstream reservoirs, it is desirable for this to happen during the inflow season (May to November inclusive) to minimise transmission losses. However, transfers during warmer summer months may also be required, for example, to support Taylors Lake in delivering irrigation water. In balancing water resources across the water supply system, an objective will be for transfers to occur from Rocklands so that levels are not drawn down below its target minimum operating level.

**Table 7.1 Rocklands Reservoir - Storage Overview**

| | | Comment |
|---|---|---|
| Full Supply Level (FSL) | 195.47 m AHD | |
| Full Supply Volume (ML) | 348,300 ML | |
| Maximum operating level (MOL) | 194.10 m AHD | 1.37m below spillway crest |
| Maximum operating volume (ML) | 261,500 ML | 86,800 ML less than the Full Supply Volume |
| Minimum operating level | 189.06 m AHD | |
| Minimum operating volume (ML) | 69,600 ML | |
| Dead Storage | 3,000 ML | |
| Inlet Channel Capacity | none | Peak inflows in 2011 floods ~ 7,000 ML/day |
| Maximum Discharge | 600 ML/d | Limited by CDU's (Carp Screens) to 400ML/d |
| Catchment Area | 1,355 km2 | |
| Surface Area when Full | 6,750 ha | |
| Average Annual Inflow | 83,000 ML | |

## 7.2 Inflow Variability

Ongoing climate variability, including severe drought, will continue to have significant impacts on inflows to Rocklands Reservoir. The likelihood of stocked species escaping from Rocklands Reservoir into the Glenelg River is critically linked to the frequency and duration of high inflows that create hydraulic connectivity upstream and which cause the reservoir to either spill or require managed releases, in excess of the 400ML/day capacity of the CDS units, into the Glenelg River downstream.

Figure 7.1 shows that water storage yields in Rocklands Reservoir have declined significantly over the past 20 years. In the period since Rocklands reservoir was constructed, average annual inflow was 84 GL/year whereas between 1996 and 2016 average annual inflow was only 40 GL/year or 48% of the long-term average and in only two years (2010 & 2011) inflows exceeded the long-term average.

In the context of inflow variability it is worth considering the impacts of the 2011 floods across parts of the Glenelg catchment. Rocklands Reservoir commenced the January 2011 flood event holding 84,200 ML. Within one week the volume held increased to over 110,000 ML with total inflows as a direct result of the January rain resulting in over 40,000 ML of inflows being received over the following days. Peak inflows reached about 7,000 ML/d. Rocklands Reservoir did not spill.

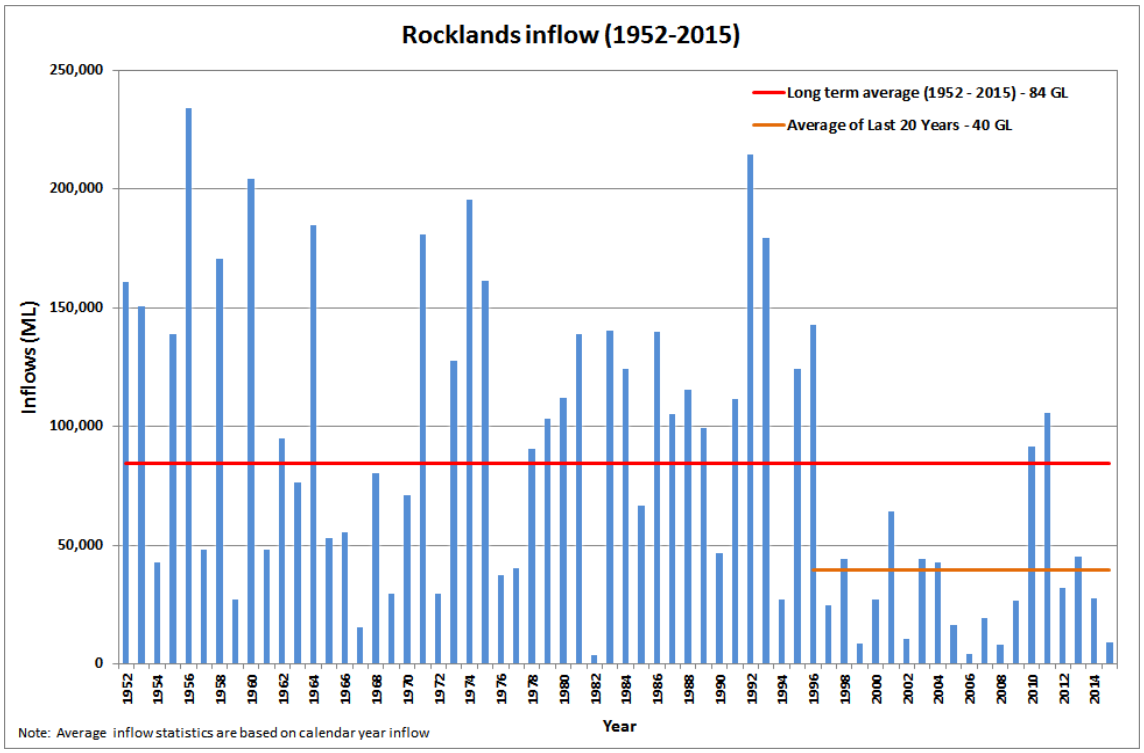
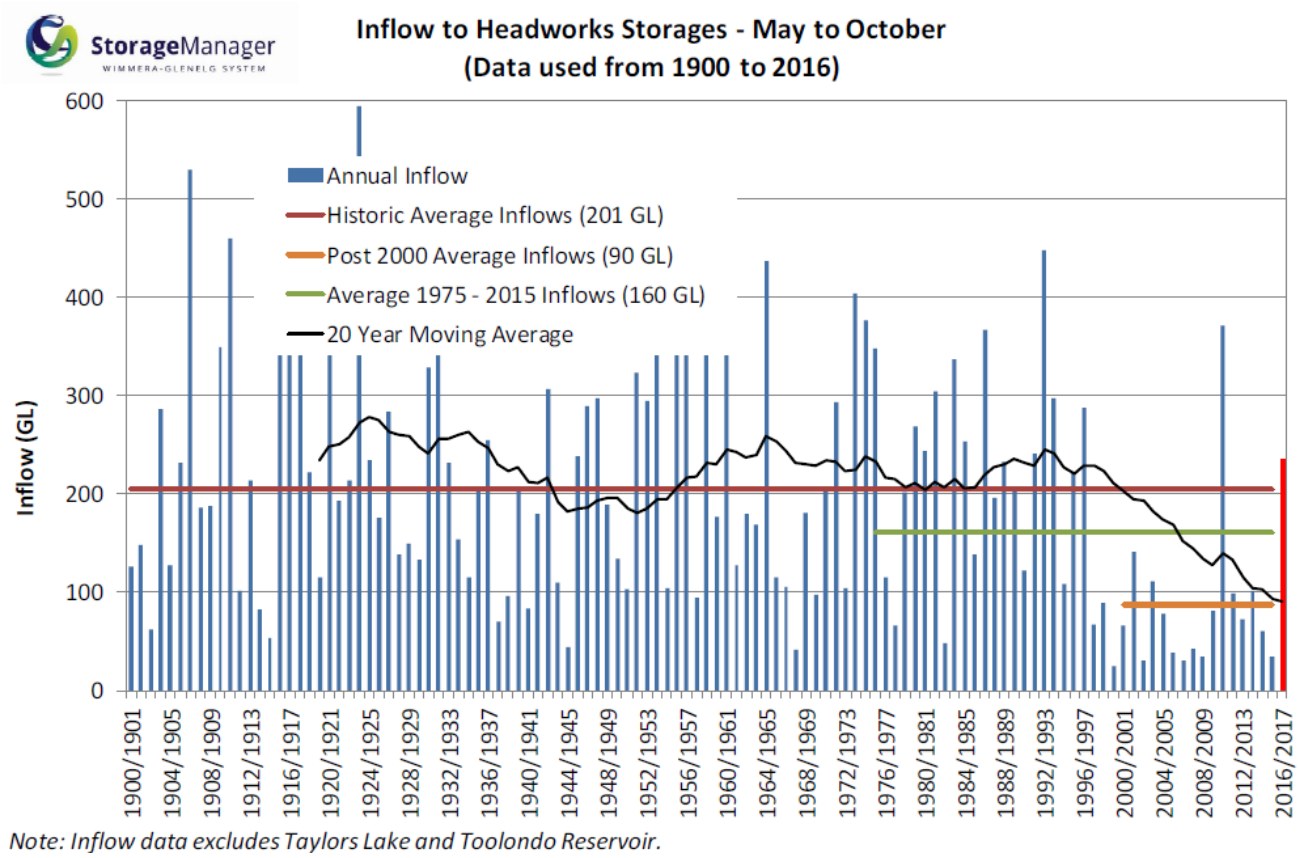



**Figure 7.1 Rocklands Inflows from 1952 to 2015 (Source: GWMW – Bernie Dunn)**

The data presented in Figure 7.1 is further corroborated by Figure 7.2 which presents the total volume of inflows for all storages in the Grampians -Wimmera system from 1900 – 2016. These data show that average inflows have declined by 55% since 2000 (GWMWater, 2016)

The decline in average inflows in the past twenty years with the addition of the revised operating rules that saw the introduction of the Maximum Operating Level, mean that water levels in Rocklands Reservoir are much lower and hydraulic connectivity between the Reservoir and inflowing streams is greatly reduced. This results in greatly diminished opportunities for stocked species to migrate from the Reservoir to the upper Glenelg River and associated tributaries. This greatly reduces the likelihood of stocked species preying upon small native fish in the upper Glenelg River.




*Note: Inflow data excludes Taylors Lake and Toolondo Reservoir.*

**Figure 7.2 Average inflows for the Grampians -Wimmera water supply system 1900-2016 (source: GWMWater, 2016-17 Annual Water Security Outlook Report, 2016)**

## 7.3 Risk of Spill investigations

As stated previously, the fundamental gap in the knowledge for each of the residual high risks relates to the likelihood of stocked species escaping from Rocklands Reservoir into the upstream and downstream reaches of the Glenelg River. In seeking to further evaluate the risk of uncontrolled releases from Rocklands Reservoir GWMWater were consulted in order to access available inflow data and to understand the scope and outputs of any previous modelling work, in particular if any catchment yield modelling had been undertaken consistent with the DELWP Guidelines for Assessing the Impact of Climate Change on Water Supplies in Victoria (DELWP, 2016). Fortuitously, GWMWater had recently completed their Urban and Rural Water Strategy (July 2017) which was based on a range of REsource ALocation Model (REALM) outputs, inclusive of the DELWP hydro-climatic model inputs, undertaken by Jacobs (March 2017) and further analysed and reported by GWMWater (March 2017).

The following sections provide a summary of the Grampians supply system modelling as reported in GWM Water's Modelling Output Report (March 2017).

*DELWP Surface Water Assessment and Modelling unit undertook initial work in September-October 2016 to generate the hydrologic/climatic data inputs for each of the model scenarios for the Wimmera-Glenelg system. The following methods were used to scale historic inflows for the various climate scenarios:*

- *Transformation by flow duration curve decile method to convert historic inflow and climate data to current (post 1975) climate conditions for base case;*
- *Scaling the base case inputs for low, medium and high climate change scenarios using climate change factors from Guidelines for Assessing the Impact of Climate Change on Water Supplies in Victoria (DELWP 2016b); and*
- *Transformation by flow duration curve decile method for post-1997 step climate change scenario.*

*Jacobs Consulting were engaged by GWMWater in December 2016 - January 2017 to undertake a suite of REALM model runs using the DELWP climate inputs and demands scenarios provided by GWMWater. Jacobs generated 21 model outputs which were used to assess supply across the nine climatic scenarios described in Guidelines for Assessing the Impact of Climate Change on Water Supplies in Victoria (DELWP 2016b) and other scenarios determined by GWMWater. These modelling runs have assessed the potential impacts to water availability across a range of possible future climates and demand scenarios for GWMWater's Urban and Rural Water Strategy.*

*Model outputs produced by Jacobs were analysed by GWMWater Water Resources staff to determine the implications of the various climate and demand scenarios for the Urban & Rural Water Strategy*

Whilst the focus of the modelling work and output analysis was on better informing future water availability under a range of plausible climate change scenarios the outputs provided an opportunity to develop a range of reservoir volume exceedance plots in order to better understand the percentage of years in which Rocklands Reservoir could possibly fill and spill. This work thus provides the necessary insight into the likelihood that stocked fish could escape the reservoir.

Figure 7.3 Historic Climate, present the outcomes of hydrological modelling undertaken to better understand the likely inflows to Rocklands Reservoir under 3 climate scenarios. The climate scenario 'post 1975' is recommended as the new baseline for Water Corporation future water resource planning (DELWP, 2016). This scenario involved scaling of historic data between 1891 and 1974 to reflect the climate observed between 1975 and present. These data provide an important input to the Risk Assessment as they inform the previous uncertainties relating to the likelihood of fish escaping from Rocklands Reservoir to both the upstream and downstream reaches of the Glenelg River.

Figure 7.4 predicts that if the hydrological conditions experienced in the catchment since 1975 were to prevail for the foreseeable future then maximum storage volumes will only been achieved 10% of the time, as compared to 22% for historic conditions (Figure 7.3). The prevailing climate conditions since 1997 provide an even more dramatic prediction of declining inflows to Rocklands Reservoir (Figure 7.5). Under these conditions, it is predicted that full supply level cannot be achieved and that the volumes held in storage in Rocklands reservoir will always be less than half of the full supply volume.

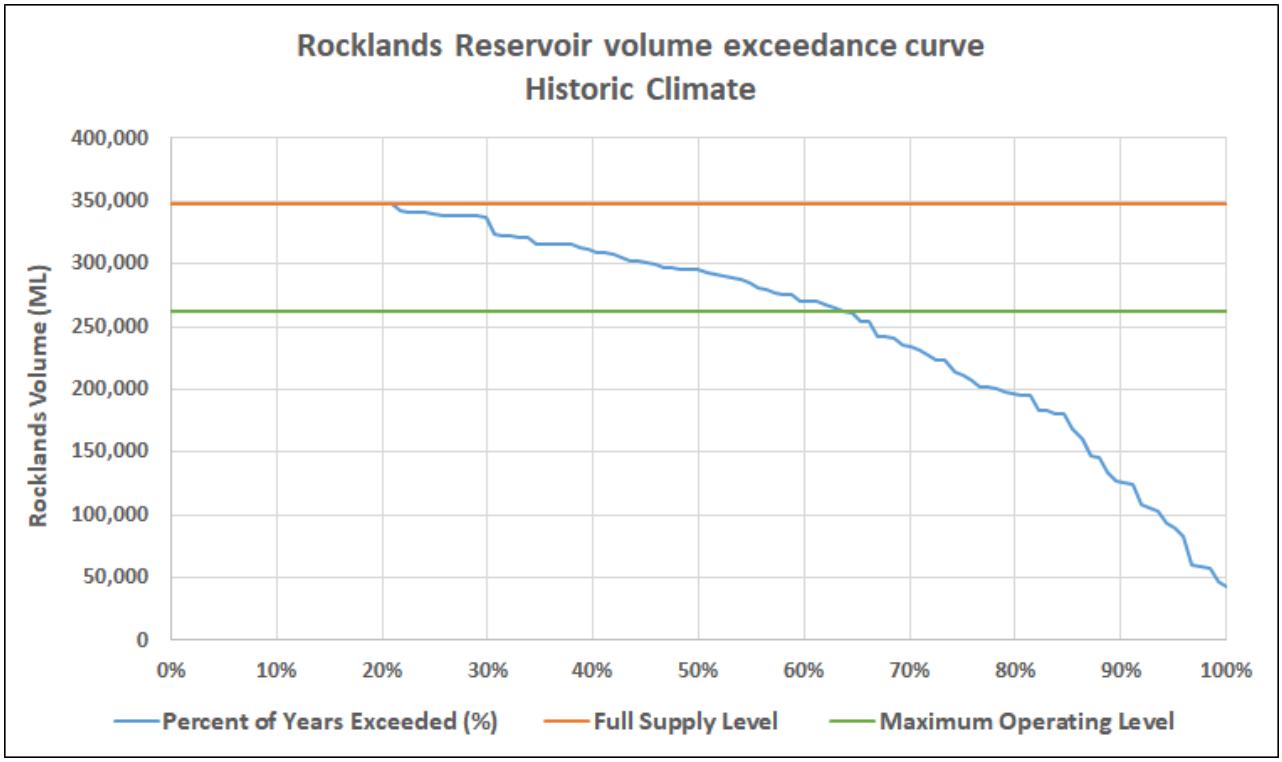



**Figure 7.3 Historic Climate**

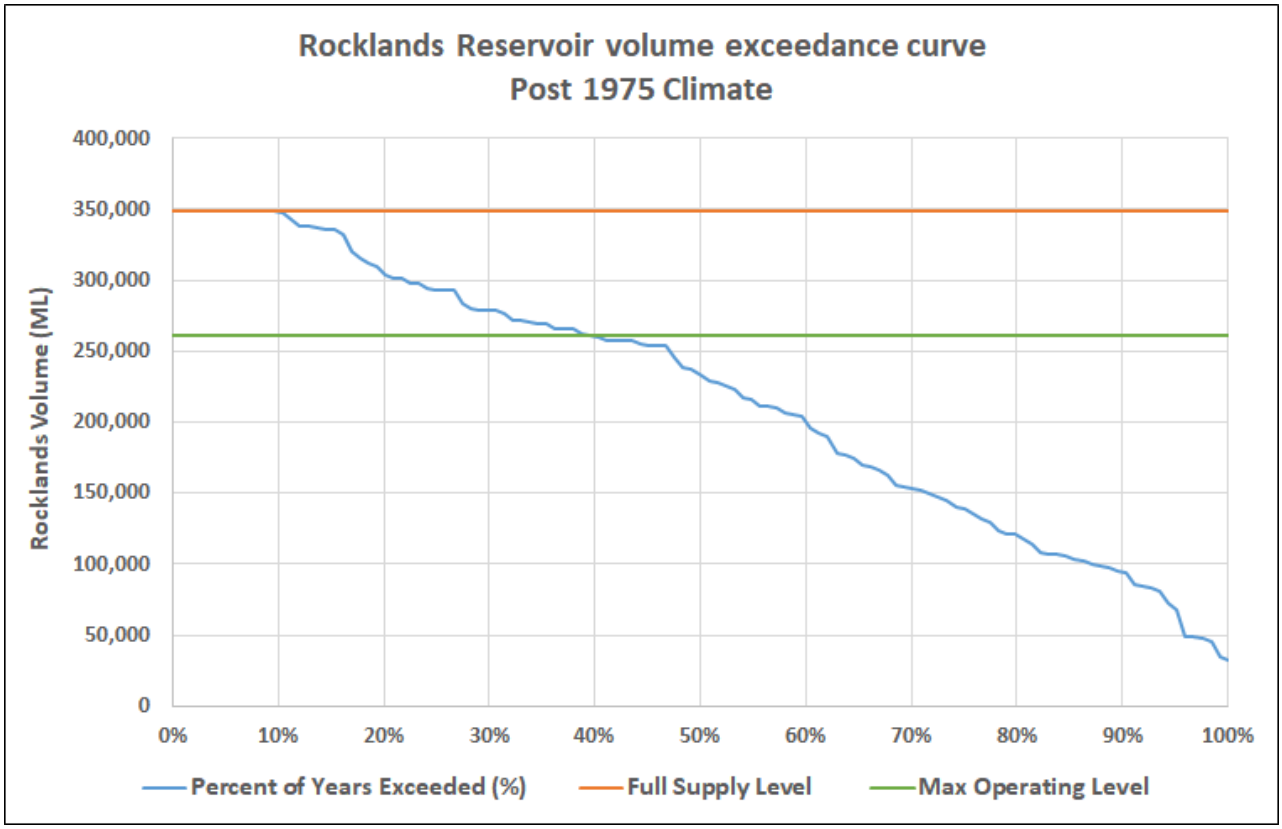



**Figure 7.4 Post 1975 Climate (the new baseline)**

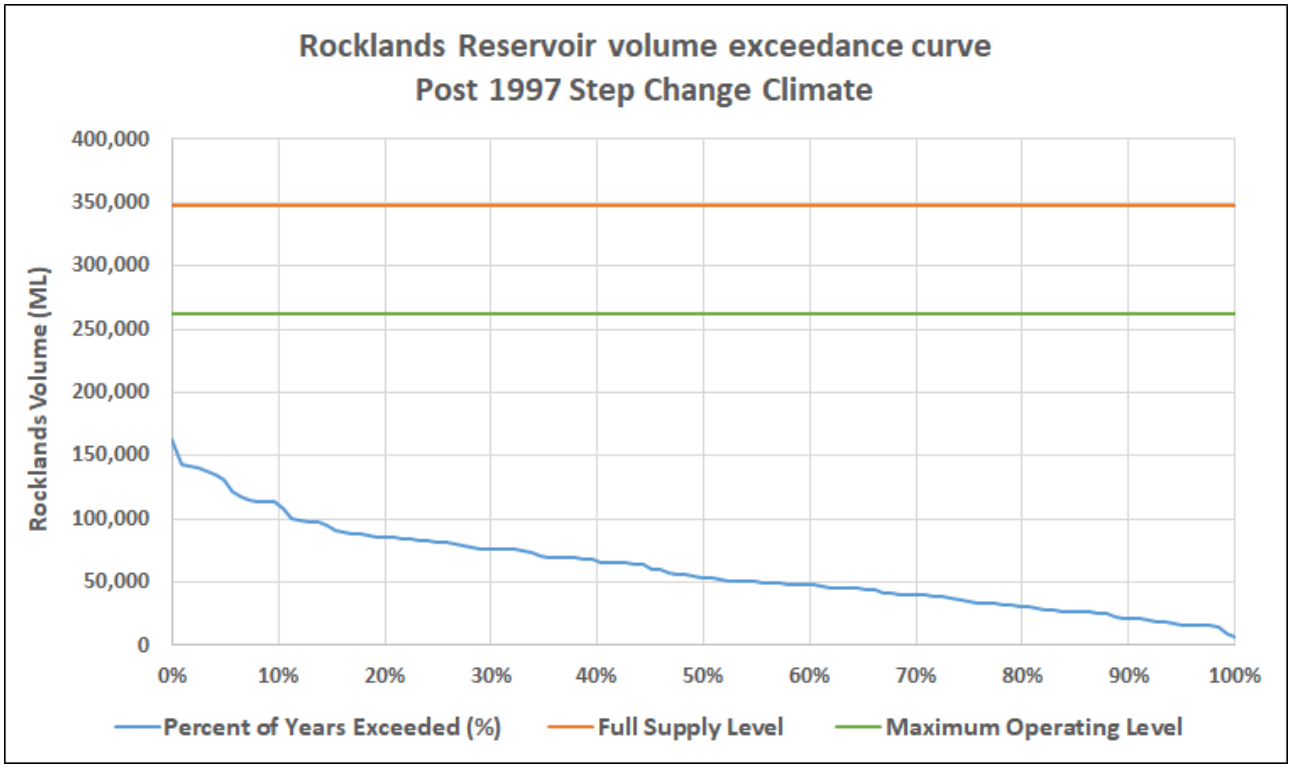



**Figure 7.5 Post 1997 Step Change Climate**

It should be emphasised that the modelling undertaken does not take account of the current Rocklands operation whereby the storage is managed to a Maximum Operating Level (MOL) of 194.10 m AHD or 261,500 ML (as described above). This would have the effect of further significantly reducing the possibility of spills, for example, under the Post 1975 climate scenario the MOL would only be reached 40% of the time with managed releases up to the CDS capacity of 400 ML/day implemented to maintain the reservoir capacity at or below the MOL.

The MOL has the effect of providing a significant buffer of some 1.37m or 86,800 ML (in the context of a long term annual inflow of only 83,000 ML) which in itself has a demonstrable effect on the likelihood of any future spill occurring.

# 8 Revised Risk Assessment

This additional hydrological and operational information presented in Section 8, enables the description of the threats to be revised to reflect the greater certainty relating to the likelihood that stocked species will escape from Rocklands Reservoir. The revised description of these threats where his assumption applied is shown below in Table 8.1. The Revised Risk Assessment for these threats is presented in Table 8.2.

**Table 8.1 Revised threat descriptions for 7 (seven) identified in the Preliminary Risk Assessment.**

| Value | Threat | |
|---|---|---|
| **2. The existing fish community in the Glenelg River (the primary value being the natural ecosystem)** | 4. | Stocked species may prey upon existing fish species in the upper Glenelg river system threatening Little Galaxias, Obscure galaxias and the Western Swamp cray. |
| | 5. | Juvenile stocked species may compete with existing fish species in the upper Glenelg River system threatening Little Galaxias, Obscure galaxias and the Western Swamp cray. |
| | 7. | Mature stocked species may prey upon existing fish species in the lower Glenelg river system |
| | 8. | Stocked species may compete with existing fish species in the lower Glenelg River system |
| **3. Significant fish species in the lower Glenelg River including Australian grayling, River blackfish (upper Wannon River only), Variegated pygmy perch, Yarra pygmy perch, Little galaxias, Australian mudfish, Glenelg spiny freshwater crayfish, and Glenelg Freshwater mussel (the primary value being the protection of these species)** | 10. | Adult Murray cod may prey upon Glenelg Spiny Freshwater crayfish in the Glenelg River system |
| | 11. | Mature stocked species may prey upon significant species in the lower Glenelg River including Australian grayling, River blackfish (upper Wannon River only), Variegated pygmy perch, Yarra pygmy perch, Little galaxias, Australian mudfish, Glenelg spiny freshwater crayfish, and Glenelg Freshwater mussel (the primary value being the protection of these species |
| | 12. | Stocked species may compete with significant species in the lower Glenelg River including Australian grayling, River blackfish (upper Wannon River only), Variegated pygmy perch, Yarra pygmy perch, Little galaxias, Australian mudfish, Glenelg spiny freshwater crayfish, and Glenelg Freshwater mussel (the primary value being the protection of these species). |

**Table 8.2 Revised Risk Assessment for 4 revised threats**

| Value | Threat | Preliminary Risk Assessment | | | Revised Risk Assessment | | |
|---|---|---|---|---|---|---|---|
| | | L | C | Risk | L | C | Risk |
| **The existing fish community in the Glenelg River (the primary value being the natural ecosystem)** | 4. Stocked species may prey upon existing fish species in the upper Glenelg river system threatening Little Galaxias, Obscure galaxias and the Western Swamp cray. | **5** | **3** | **High** | **1** | **3** | **Low** |
| | 5. Juvenile stocked species may compete with existing fish species in the upper Glenelg River system threatening Little Galaxias, Obscure galaxias and the Western Swamp cray. | **5** | **2** | **Medium** | **1** | **3** | **Low** |
| | 7. Mature stocked species may prey upon existing fish species in the lower Glenelg river system | **5** | **3** | **High** | **1** | **3** | **Low** |
| | 8. Stocked species may compete with existing fish species in the lower Glenelg River system | **4** | **2** | **Medium** | **1** | **3** | **Low** |
| **Significant fish species in the lower Glenelg River including Australian grayling, River blackfish (upper Wannon River only), Variegated pygmy perch, Yarra pygmy perch, Little galaxias, Australian mudfish, Glenelg spiny freshwater crayfish, and Glenelg Freshwater mussel (the primary value being the protection of these species)** | 10. Adult Murray cod may prey upon Glenelg Spiny Freshwater crayfish in the Glenelg River system | **5** | **3** | **High** | **1** | **3** | **Low** |
| | 11. Mature stocked species may prey upon significant species in the lower Glenelg River including Australian grayling, River blackfish (upper Wannon River only), Variegated pygmy perch, Yarra pygmy perch, Little galaxias, Australian mudfish, Glenelg spiny freshwater crayfish, and Glenelg Freshwater mussel (the primary value being the protection of these species | **5** | **3** | **High** | **1** | **3** | **Low** |
| | 12. Stocked species may compete with significant species in the lower Glenelg River including Australian grayling, River blackfish (upper Wannon River only), Variegated pygmy perch, Yarra pygmy perch, Little galaxias, Australian mudfish, Glenelg spiny freshwater crayfish, and Glenelg Freshwater mussel (the primary value being the protection of these species) | **4** | **2** | **Medium** | **1** | **3** | **Low** |

## 8.1 Rationale

### 8.1.1 Risk 4 & 5:

4. **Stocked species may prey upon existing fish species in the upper Glenelg river system threatening Little Galaxias, Obscure galaxias and the Western Swamp cray.**
5. **Juvenile stocked species may compete with existing fish species in the upper Glenelg River system threatening Little Galaxias, Obscure galaxias and the Western Swamp cray.**

Hydraulic connectivity between Rocklands Reservoir and the upper Glenelg River is largely determined by water levels in the Reservoir and inflows from the Glenelg River. High water levels in Rocklands Reservoir (e.g. in excess of the MOL) coupled with high inflows may facilitate the migration of large bodied fish species upstream if flows are of a sufficient depth and suitable velocity. During periods when Rocklands Reservoir is at MOL and high inflows persist, connectivity between the two waterbodies may be prolonged. If water levels in the reservoir are low and high inflows do not occur, hydraulic connectivity is unlikely between the waterbodies thus, preventing fish migration.

Connectivity can also occur when flow in the catchment increases in response to rainfall events even when the level of Rocklands Reservoir is low. In these circumstances, high inflows can promote connectivity for the length of time that the inflows occur. Inflow events associated with episodic rainfall are often characterised by short term pulses in flow which increase hydraulic connectivity for short periods, before rapidly receding to low flow conditions. In these circumstances, the movement of large bodied fish into the upper Glenelg may only infrequently occur for short periods of time when sufficient flow is available. The velocity of inflows under any of these circumstances described above will have a profound effect on the ability of large bodied species to move upstream.

Overall declining inflows mean that suitable conditions for large bodied native fish (e.g. large deep permanent pools) will be less common in the Glenelg River upstream of Rocklands Reservoir. Large bodied species such as Murray cod, Golden perch and Estuary perch require sufficient space to survive, as evidenced by their natural preference for occupying predominantly large stream environments, and the small stream, marshy environments of the upper Glenelg River are unlikely to be suitable for the persistence of these species for extended periods of time.

Under each of these scenarios, it is unlikely that large bodied fish will be able to distribute broadly throughout the catchment due to the intermittent nature of the flows and the paucity of suitable habitat to sustain these species for prolonged periods.

The information presented to support the further assessment of Risk 1 can be summarised as follows;

1. Significantly reduced future inflows from the Glenelg River and low water levels in Rocklands Reservoir mean that hydraulic connectivity will be infrequent and of a shorter duration than that historically measured.
2. Hydraulic connectivity is the only means by which fish can migrate from Rocklands Reservoir to the upper Glenelg River.
3. The prevailing small marshy stream environment of the upper Glenelg River is unsuitable for the persistence of large bodied fish including Murray cod, Golden perch and Estuary perch.

This hydrological information presented above has a significant influence on the impact that predation and competition by stocked species may have on native fish populations in the upper Glenelg River. While it is likely that Murray cod, Golden perch and Estuary perch will prey upon small native fish species when and where they are able, the consequences of predation on small native species populations are low as they will be limited to isolated areas of the River where sufficient habitat exists (e.g. deep permanent pools, large woody debris). This habitat occurs predominantly in the area of the Cherrypool Reserve approximately 10 kilometres upstream of Rocklands Reservoir, above which it is virtually non-existent.

The impact of stocked species predation and competition on small native fish species in the area of the Glenelg River near Cherrypool is limited to the extent that the stocked species will contribute to overall predatory and competitive activity. It is unlikely that there will be any increase in predatory pressure on small native fish species as a result of stocking due to the abundance of predatory Redfin (*Perca fluviatilis*) in the waterway. The stocked species are likely to displace Redfin by competing with them and preying upon them but overall predatory biomass will not increase.

### 8.1.2 Risks 7, 8, 10, 11 & 12

7. **Mature stocked species may prey upon existing fish species in the lower Glenelg river system**
8. **Stocked species may compete with existing fish species in the lower Glenelg River system**
10. **Adult Murray cod may prey upon Glenelg Spiny Freshwater crayfish in the Glenelg River system**
11. **Mature stocked species may prey upon significant species in the lower Glenelg River including Australian grayling, River blackfish (upper Wannon River only), Variegated pygmy perch, Yarra pygmy perch, Little galaxias, Australian mudfish, Glenelg spiny freshwater crayfish, and Glenelg Freshwater mussel (the primary value being the protection of these species**
12. **Stocked species may compete with significant species in the lower Glenelg River including Australian grayling, River blackfish (upper Wannon River only), Variegated pygmy perch, Yarra pygmy perch, Little galaxias, Australian mudfish, Glenelg spiny freshwater crayfish, and Glenelg Freshwater mussel (the primary value being the protection of these species)**

The information presented in Section 3 on Inflow Variability, provides compelling evidence that there is little likelihood of stocked species escaping from Rocklands Reservoir to the lower Glenelg River via flow from Rocklands Reservoir. Inflows into Rocklands Reservoir from the Glenelg River have declined significantly in recent decades to the extent that if current conditions prevail, combined with the new operating rules and MOL, the reservoir will no longer achieve Full Supply Level and will not spill.

Under the 1975 inflow scenario (Figure 7.4), stocked species will rarely have any opportunity to escape from Rocklands Reservoir through the outfall to the lower Glenelg River and under the 1997 modelled scenario shown in Figure 7.5, cannot escape from Rocklands Reservoir through the outfall to the lower Glenelg River.

# 9 Risk Mitigation

## 9.1 Risk Summary

The risks associated with stocking Murray cod, Golden perch and Estuary perch can be divided into three geographical categories Rocklands Reservoir, the Upper Glenelg River and its tributaries and the Lower Glenelg River and its tributaries, as presented in Table 9.1: Summary of Risk Assessment process categorised by locationTable 9.1.

The risks of impacting significant species in Rocklands Reservoir are medium and are based on the assumption that these species actually occur in Rocklands Reservoir, despite the available data suggesting that they don't. All other risks in Rocklands Reservoir are low.

In the Glenelg River, both upstream and downstream of Rocklands Reservoir, the risks are consistently ranked as low due to the predicted hydrology of the system which will prevent the escapement of target species from Rocklands Reservoir into the Glenelg River

**Table 9.1: Summary of Risk Assessment process categorised by location**

| Threat | Risk Ranking |
|---|---|
| **Rocklands Reservoir** | |
| 1. Stocked species may prey upon significant fish species in Rocklands Reservoir including significant species; Little Galaxias, Obscure galaxias and the Western Swamp cray.. | Medium |
| 2. Juvenile stocked species may compete with significant species in Rocklands Reservoir including Little Galaxias, Obscure galaxias and the Western Swamp cray. | Medium |
| 3. Stocked species may introduce disease and/or parasites to Rocklands Reservoir , threatening Little Galaxias, Obscure galaxias and the Western Swamp cray. | Low |
| 4. Mature stocked species may prey upon Redfin in Rocklands Reservoir which may impact on the quality of Redfin fishing. | Low |
| 5. Stocked species may compete with Redfin in Rocklands Reservoir, leading to the reduction of this species | Low |
| 6. Stocked species may introduce disease and/or parasites to the waterbodies, threatening the existing recreational fishery. | Low |
| **Upper Glenelg River and tributaries** | |
| 7. Stocked species may prey upon existing fish species in the upper Glenelg river system threatening Little Galaxias, Obscure galaxias and the Western Swamp cray. | Low |
| 8. Juvenile stocked species may compete with existing fish species in the upper Glenelg River system threatening Little Galaxias, Obscure galaxias and the Western Swamp cray. | Low |
| 9. Stocked species may introduce disease and/or parasites to the upper Glenelg River, threatening Little Galaxias, Obscure galaxias and the Western Swamp cray. | Low |

| | |
|---|---|
| **Lower Glenelg River and tributaries** | |
| 10. Mature stocked species may prey upon existing fish species in the lower Glenelg river system | **Low** |
| 11. Stocked species may compete with existing fish species in the lower Glenelg River system | **Low** |
| 12. Stocked species may introduce disease and/or parasites to the waterbodies, threatening existing fish species in the lower Glenelg River system | **Low** |
| 13. Adult Murray cod may prey upon Glenelg Spiny Freshwater crayfish in the Glenelg River system | **Low** |
| 14. Mature stocked species may prey upon significant species in the lower Glenelg River including Australian grayling, River blackfish (upper Wannon River only), Variegated pygmy perch, Yarra pygmy perch, Little galaxias, Australian mudfish, Glenelg spiny freshwater crayfish, and Glenelg Freshwater mussel (the primary value being the protection of these species). | **Low** |
| 15. Stocked species may compete with significant species in the lower Glenelg River including Australian grayling, River blackfish (upper Wannon River only), Variegated pygmy perch, Yarra pygmy perch, Little galaxias, Australian mudfish, Glenelg spiny freshwater crayfish, and Glenelg Freshwater mussel (the primary value being the protection of these species) | **Low** |
| 16. Stocked species may introduce disease and/or parasites to the waterbodies, threatening existing significant fish species in the lower Glenelg River system | **Low** |

## 9.2 Risk Treatments

While the environmental risks associated with the stocking of target species to Rocklands Reservoir are generally low, there may be opportunities to implement management initiatives that further mitigate the possible negative impacts of the proposed activity. Management initiatives may comprise both on-ground actions to offset possible impacts (i.e. installation of CDU's) or building better knowledge and a greater understanding of the factors applying to the perceived threat (i.e. monitoring fish populations). Both responses are critical elements in the adaptive management approaches that are commonly applied to contemporary natural resource management projects. Possible risk treatments are shown in Table 9.2.

**Table 9.2: Possible treatments**

| Threat | Risk Ranking | Possible Treatments |
|---|---|---|
| **Rocklands Reservoir** | | |
| Stocked species may prey upon significant fish species in Rocklands Reservoir including significant species; Little Galaxias, Obscure galaxias and the Western Swamp cray.. | Medium | • Confirm the status of significant species in Rocklands Reservoir. Absence of significant species will alleviate the threat.<br>• Identify mechanisms to protect significant species strongholds in Rocklands Reservoir |
| Juvenile stocked species may compete with significant species in Rocklands Reservoir including Little Galaxias, Obscure galaxias and the Western Swamp cray. | Medium | |
| Stocked species may introduce disease and/or parasites to Rocklands Reservoir , threatening Little Galaxias, Obscure galaxias and the Western Swamp cray. | Low | • Monitor the health of significant species to determine signs of infection emanating from stocked species |
| Mature stocked species may prey upon Redfin in Rocklands Reservoir which may impact on the quality of Redfin fishing. | Low | • Monitor and evaluate the stocking program |
| Stocked species may compete with Redfin in Rocklands Reservoir, leading to the reduction of this species | Low | |
| Stocked species may introduce disease and/or parasites to the waterbodies, threatening the existing recreational fishery. | Low | |
| **Upper Glenelg River and tributaries** | | |
| Stocked species may prey upon existing fish species in the upper Glenelg river system threatening Little Galaxias, Obscure galaxias and the Western Swamp cray. | Low | • Survey the upper Glenelg River to determine strongholds for significant species and identify solutions to protect these.<br>• Do not stock juvenile fish immediately prior to or during increases in inflow that cause hydraulic connectivity between Rocklands Reservoir and the upper Glenelg River and other tributaries.<br>• Identify the possible migratory range of stocked species during various inflow scenarios.<br>• Survey the distribution and abundance of stocked species in the upper Glenelg River and other tributaries of Rocklands Reservoir immediately after high inflows.<br>• Investigate the possibility of installing appropriate fish screens on the Glenelg River and other tributaries of Rocklands Reservoir to prevent the upstream migration of stocked |
| Juvenile stocked species may compete with existing fish species in the upper Glenelg River system threatening Little Galaxias, Obscure galaxias and the Western Swamp cray. | Low | |

| | | |
|---|---|---|
| | | species during periods of hydraulic connectivity |
| Stocked species may introduce disease and/or parasites to the upper Glenelg River, threatening Little Galaxias, Obscure galaxias and the Western Swamp cray. | Low | • Monitor the health of significant species to determine signs of infection emanating from stocked species |
| **Lower Glenelg River and tributaries** | | |
| Mature stocked species may prey upon existing fish species in the lower Glenelg river system | Low | • Survey the abundance and distribution of significant species in the lower Glenelg River prior to stocking Rocklands Reservoir so as to identify strongholds and protection solutions.<br>• Coordinate managed flow events including Environmental Flows and transfers to Taylors Lake to ensure that they do not exceed the capacity of the CDS units.<br>• Do not stock juvenile fish immediately prior to or during flows that exceed the capacity of the CDS units.<br>• Implement regulations that will allow anglers to substantially remove stocked fish from the Glenelg River (e.g. larger bag limits, lower size limits, no return). This should be accompanied by an appropriate education program.<br>• Implement a long-term (10yr) annual monitoring to measure the distribution and abundance of fish species in the lower Glenelg River. Further monitoring may involve targeted promotion of the angler 'my-catch' initiatives. |
| Stocked species may compete with existing fish species in the lower Glenelg River system | Low | |
| Adult Murray cod may prey upon Glenelg Spiny Freshwater crayfish in the Glenelg River system | Low | • Survey the abundance and distribution of Glenelg spiny cray in the Glenelg River to identify strongholds and protection solutions.<br>• Coordinate managed flow events including Environmental Flows and transfers to Taylors Lake to ensure that they do not exceed the capacity of the CDS units.<br>• Do not stock juvenile fish immediately prior to or during flows that exceed the capacity of the CDS units.<br>• Implement regulations that will allow anglers to substantially remove stocked fish from the Glenelg River (e.g. larger bag limits, lower size limits, no return). This should be accompanied by an appropriate education program.<br>• Implement a long-term (10yr) annual monitoring to measure the distribution and abundance of fish species in the lower Glenelg River. Further monitoring may involve targeted promotion of the angler 'my-catch' initiatives. |
| Mature stocked species may prey upon significant species in the lower Glenelg River including Australian grayling, River blackfish (upper Wannon River only), Variegated pygmy perch, Yarra pygmy perch, Little galaxias, Australian mudfish, Glenelg spiny freshwater crayfish, and Glenelg Freshwater mussel (the primary value being the protection of these species). | Low | |
| Stocked species may compete with significant species in the lower Glenelg River including Australian grayling, River blackfish (upper Wannon River only), Variegated pygmy perch, Yarra pygmy perch, Little galaxias, Australian mudfish, Glenelg spiny freshwater crayfish, and Glenelg Freshwater mussel (the primary value being the protection of these species) | Low | |
| Stocked species may introduce disease and/or parasites to the waterbodies, threatening existing significant fish species in the lower Glenelg River system | Low | • Monitor the health of significant species to determine signs of infection emanating from stocked species |


THE
WEDGE
GROUP

# 10 Conclusions

The Risk Assessment process undertaken for this project followed a rigorous and comprehensive two stage format that provides greater certainty for the outcomes of the assessment. By undertaking a Preliminary Risk Assessment, key knowledge gaps are able to be identified thus enabling further investigations to be conducted to address these gaps. In the case of this project, key gaps in the knowledge of the hydrology of the Glenelg River and Rocklands Reservoir were identified during the Preliminary Risk Assessment that resulted in a high level of uncertainty relating the possibility of the stocked target species Murray cod, Golden perch and Estuary perch escaping the reservoir and preying upon or competing with native fish species in the Glenelg River. This knowledge gap undermined the value of the Preliminary Risk Assessment as a tool for determining the potential negative impacts of proceeding with the project.

Further investigation into the hydrology of the Glenelg river and Rocklands reservoir systems was greatly aided by the publication of new data and modelling outputs which provided greater certainty about the extent to which flooding would occur in the catchment and cause spilling of the reservoir into the Glenelg River. These data demonstrated that flooding and spilling of the reservoir are highly unlikely events in the future and in some scenarios, Rocklands Reservoir is predicted to never again reach its full supply level. This means that the possibility of stocked species escaping into the Glenelg River as a result of flooding is negligible which has a large bearing on the risk profile for this project.

The incorporation of additional hydrological knowledge into the Revised Risk Assessment revealed that the 13 of the 15 risks of undertaking this project are ranked as **low** while the remaining two are ranked as **medium** therefore suggesting that this project may proceed with little or no further treatment to mitigate risks (see Table 5.4).

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# Appendix A – TEP Pro-forma

## Explanatory Notes: Risk Assessment (Form B) for Translocating Live Aquatic Organisms

### Introduction

When proposed translocations don't comply with a translocation protocol or the low risk criteria for translocation, they must undergo a full risk assessment.

DEPI will inform you if you need to conduct a risk assessment and complete this form after you have submitted an Initial Screening Application (Form A).

### Completing the Risk Assessment Form.

The form is divided into 8 sections. Section 1 requires relevant contact details. Sections 2 -7 deal with key issues likely to arise when assessing risks associated with translocation to closed, semi-closed and open systems. Section 8 requires the applicant to identify the social and economic benefits and implications of the translocation.

The questions are designed to gather information that will enable the Translocation Evaluation Panel (TEP) to determine the likelihood and consequences of escape, survival and establishment of the organism, diseases and other unwanted pests associated with the translocation. By providing current and accurate information on the likelihood (probability) and consequences (impact) of an event occurring, the applicant's responses to the questions provide the main basis on which to assess the risks of the translocation.

Each question is prefaced by explanatory notes designed to provide the applicant with guidance for their answer. Base all answers on factual evidence or analysis and where possible you are encouraged to provide case studies. If a question is not relevant to your proposal, please enter NA (not applicable) and provide reason as to why this is the case.

The questions deal with a range of scientific, technical and operational matters that are best addressed through the provision of validated, referenced and current information. Some of this information may be sourced from published material, research institutions, Government agencies and the aquaculture industry. A suitable person to complete this form should possess the following skills and experience:

- A tertiary qualification in Aquatic Biology, Marine and or Freshwater Ecology, Natural Resource Management or similar; or
- Demonstrated experience in the aquaculture industry; or
- Demonstrated experience in fisheries management; or
- Experience in conducting a risk assessment.

Sufficient detail should be provided in response to each question to enable adequate consideration by the TEP.

### Yes/no answers will require adequate justification.

A risk assessment does not have to be completed using the attached template however if you decide to complete it in another format you will still need to address the risks identified below and detailed in Appendix B of the Guidelines for Assessing Translocations of Live Aquatic Organisms in Victoria.

These guidelines and other translocation information can be found at www.DEPI.vic.gov.au/translocation.

### Assessing your proposal.

The TEP is responsible for assessing translocation applications. The TEP does not authorise translocations or stocking, rather it is an advisory panel providing advice to the Secretary, DEPI on the risks of a particular proposal.

The quality of the information provided on the Risk Assessment will determine the outcome of the assessment process. Poor quality risk assessments that do not provide the appropriate level of detail, that provide no defensible argument or fail to validate their responses, are unlikely to be successful.

## Glossary of terms

**Closed systems:** relate specifically to systems that have effective control over both the movements of organisms and water. Systems that may be considered closed include recirculating aquaculture systems **or aquarium displays.**

**Open systems:** are defined as systems where there is inadequate or no control over the movement of organisms and water flow. Systems that may be considered open include lakes and rivers.

**Semi-closed systems:** are defined as systems where there is control over the movement of organisms and some control over water flow. Systems that may be considered as semi-closed include farm dams, purpose built aquaculture ponds or small purpose built lakes with some control over water movement.

**Destination**: The system (recirculating aquaculture system, farm dam, waterbody) where the target species is intended to be stocked.

**Target Species:** The aquatic organism that is intended to be translocated for the purpose of stocking.

Transport medium: Transport medium, refers generally to the water in which the organism/s are transported. For molluscs and crustaceans this may include damp sponges, ice, ropes etc.

**Potential Receiving Waters:** Any waterbody (natural or man-made) that the target species, diseases, parasites, and associated organisms may escape to as a result of any adverse event.

# 1 Risk Assessor Details

### 1.1 Risk Assessor

| | |
|---|---|
| Name: | Anthony Forster, Inland Fisheries Manager, Victorian Fisheries Authority |
| Postal address: | 1 Spring Street, Melbourne, 3000 |
| State: | VIC |
| Telephone: | 0419 871 096 |
| E-mail; | anthony.forster@vfa.vic.gov.au |
| Any relevant qualifications: | Diploma of Applied Science, Aquaculture |

# 2 Likelihood of Escape or Release

### 2.1 Will the transport medium and equipment be treated before and after translocation? Please indicate what treatment will be used.

*The transport medium (usually water) and equipment used to transport the proposed species for translocation, can harbour infectious organisms and unwanted pests. Appropriate disinfection procedures and appropriately designed transport vessels may reduce the load of infectious organisms or reduce the likelihood of spillage en-route. International standards of procedures can be located on the Office International des Epizooties (OIE) website www.oie.int in the Manual of Diagnostic Tests for Aquatic Animals 2006.*

Yes, Fisheries Victoria conducts the transport of fish under established protocols that effectively manage the risk of disease transfer. Protocols include the thorough washing of transport tanks and sun drying between fish liberations. Where fish are sourced from private hatcheries, transport vehicles are cleaned and washed with a formalin solution before rinsing and drying

## Important note for questions 2.2 - 2.7

Questions 2.2 -2.7 apply to closed and semi-closed systems only (see glossary of terms). If your translocation event is the stocking of organisms into a system that is defined as an open system please disregard questions 2.2 -2.7 and proceed to question 2.8. A definition of each system is provided in the Explanatory Notes.

### 2.2 How close and accessible are potential receiving waters?

*The risk of escape from closed or semi-closed systems can be heightened where the facility is in close proximity to a waterway. In addition, infectious organisms found in untreated effluent water may be transported via a watercourse to larger waterways that contain susceptible species. Please estimate the distance to potential receiving waters and identify their potential to transport organisms, including fish, pathogens or other pests.*

Rocklands Reservoir is the largest reservoir within Grampians Wimmera-Mallee Water's (GWMW) storage network. It was completed in 1953 and is located on the mid-upper reaches of the Glenelg River above Balmoral in Victoria's western districts.

The range of users is as follows:

- Coliban Water can be supplied from Rocklands, via Taylors Lake, through the Wimmera Mallee

Pipeline.

- Wannon Water uses its entitlement to supply the towns of Balmoral and Hamilton directly from Rocklands.
- GWM Water supplies customers both directly from Rocklands (e.g. Supply by Agreement customers) and via transfers to Taylors Lake for delivery through the Wimmera Mallee Pipeline and to the Commonwealth Environmental Water Holder.
- Some water held within Rocklands is also available as 'growth water'. This is available both as a supply direct from Rocklands or for supply via the Wimmera Mallee Pipeline after transfer to Taylors Lake.
- GWM Water supplies compensation flows and a share of the environment's regulated entitlement to the Glenelg River from Rocklands.
- Environmental passing flows are released from the reservoir.

This range of users means there are many diverse and sometimes competing needs in managing water quality and access to water, particularly at low volumes.

Figure 2.1 presents a schematic of the Wimmera - Mallee system headworks. The system is complex, very interconnected, and with many possible combinations for supply and movement of water. Note that Pine Lake and Dock Lake are shown as empty in this figure denoting their status as being off-line (GWMW 2014).

At the current maximum operating level it holds around 296,000 megalitres and is one of the larger man made reservoirs in Victoria with a surface area of some 6,250 hectares and a catchment area of approximately 1,355 km2, much of which is located in the Grampians National Park.

As with many of the Victorian storages Rocklands Reservoir is susceptible to the impacts of climate variability. However, its critical storage role in the GWMW network and its relatively significant 'dead storage' below the minimum gravity discharge level, makes it a relatively attractive proposition for large scale stocking. The minimum operating level for Rocklands is nominally 189.1m/AHD which provides some 70,000 ML covering 2000 hectares. Table 2.1: Water storage capacity of Rocklands Reservoir below provides the basic storage details for Rocklands with further detail provided in Section 2.1.3.

**Table 2.1: Water storage capacity of Rocklands Reservoir**

| Rocklands Reservoir Water Levels | m/AHD | Volume(ML) | Area (Ha) |
|---|---|---|---|
| Land acquired for reservoir land, below this level | 197.29 | | |
| Previous high water level | 195.47 | 348 310 | 6900 |
| Maximum Operating Level | 194.67 | 296 000 | 6250 |
| Minimum Operating Level | 189.1 | 70 330 | 2000 |


**Figure 2.1: Schematic of the Wimmera-Mallee System Headworks (GWMW 2014), (not to scale, but shows relative elevation, depth, surface areas and connectedness of reservoirs)**

## 2.3 Is the receiving facility fully enclosed and secure from unauthorised access?

*Fully enclosed and secure systems can effectively reduce the risk of escape of aquatic organisms. The level of physical security is also important as it prevents unauthorised access to the property. Provide details of the security measures in place or proposed to be in place at the site.*

N/A

**2.4 Based on knowledge of the facility's waste water treatment and disposal, and the capability to contain all life stages of the target species, are any life stages likely to be released from the facility during normal operations?**

*Effective screening of waste water outflow is an important mechanism to prevent escape of the target species. However, such screening needs to take into account all life stages of the target species including eggs, larvae, fingerling, sub-adult and adult forms. For both closed and semi closed systems describe the mechanisms in place to control organism and water movement throughout the system*

Continuous Deflection Units (fish screens referred to as CDS units) were installed downstream of the outlet regulator of Rocklands Reservoir to prevent the escape of European carp and their eggs into the Glenelg River. Prior to the installation of the screens Rocklands had a nominal discharge capacity of 600 ML/Day, however, this is now restricted to the capacity of the fish screens which is nominally 400 ML/Day and since the installation of the CDS units in 2006 discharge flow rates have seldom exceeded 300ML/day. The CDS's would also be effective in preventing the movement of the proposed stocked species (and their eggs) into the Glenelg River.

**2.5 Based on knowledge of the facility's waste water treatment and disposal, are any diseases present in the facility that are likely to escape?**

*It is imperative to consider the diversity of unwanted organisms that may be in wastewater and, recognise that some life stages of infectious organisms are well adapted to withstand unfavourable conditions. It is therefore appropriate that wastewater treatment methods are well designed to eradicate all infectious organisms. Provide details of any treatment systems with reference to OIE disinfection standards where possible.*

N/A

**2.6 Does the facility have adequate contingency plans in the event of a technical failure?**

*Technical failures of fish farms may result in unplanned release of water and or stock from the facility. Please provide details of the contingencies and design elements that will be used to contain any stock and water in the case of technical failure.*

N/A

**2.7 Have local environmental issues (e.g. 1 in 100 year flood levels, land subject to flooding) been considered in containment planning?**

*In the first instance, local environmental issues may be discovered and responded to when applying for a planning permit. Consult with your local council or Department of Sustainability and Environment office for further information about important environmental sites and environmental issues in your area.*

The following storage operations overview has been sourced from the GWMW discussion paper "Rocklands Reservoir Operating Rules" (GWMW 2011) and provides context to the hydro-climatic modelling and the revised risk assessment.

Rocklands Reservoir can store up to 348,300 ML at the spillway crest level of 195.47 m AHD and is termed the Full Supply Level (FSL). Following the completion of the Wimmera Mallee Pipeline, Rocklands Reservoir is now operated to a Maximum Operating Level (MOL) of 194.10 m AHD or 261,500 ML. The MOL is possible because the Wimmera Mallee Pipeline reduced the need to harvest and store as much water for consumptive use, and ensures the environment receives its share of the Wimmera- Mallee pipeline savings contracted by the State and Commonwealth Governments. This MOL also reduces the chance of uncontrolled spills and evaporation losses from the reservoir.

The fundamental operating rule for Rocklands Reservoir is to operate the reservoir up to its MOL throughout the year. Rocklands Reservoir is also to be operated to a target minimum operating level of 189.06 m AHD or 69,600 ML. This lower target is aimed at facilitating suitable levels for recreation, with the additional benefit of assisting to manage water quality, particularly salinity levels, by buffering poor quality inflows during low inflow years.

Rocklands Reservoir has a nominal outlet capacity of 600 ML/day, however, this is limited to 400 ML/day, being the operating discharge capacity of installed carp screens. Inflows to Rocklands can far exceed the capacity to release water (e.g. the January 2011 floods saw daily inflows of approximately 7,000 ML/day). As levels approach the MOL, water surplus to that required to meet entitlement holder demands is actively transferred to downstream reservoirs where space exists (i.e. Taylors Lake, Toolondo Reservoir and possibly Green Lake – pending finalisation of management rules). It is still possible for levels to rise above the MOL and when this happens plans will be developed to draw levels down to the MOL.

It is possible that downstream demands could be greater than the ability to deliver from Rocklands and there may be competing needs for channel capacity. When this occurs, deliveries to entitlement holders will take precedence over transfers to downstream reservoirs. Passing flows may also be altered in consultation with the environmental entitlement holder to free up channel capacity in the short term.

Environmental flows will primarily be delivered direct to the Glenelg River directly downstream of the dam wall. It is also possible, however, to deliver environmental flows from the 5 mile and 12 mile escapes on the Rocklands outlet channel. This may be done to spread larger flow rates across multiple delivery points to improve the efficiency of water delivery during dry years or to reduce the potential for flooding downstream of the wall during wet years.

Compensation flows are required to be delivered to the Glenelg River typically between November and May of each year. These flows will be planned to be complementary to environmental water releases. Glenelg-Hopkins CMA is required to develop flow plans for this entitlement on behalf of and in consultation with GWMWater.

If Rocklands is required to transfer water to downstream reservoirs, it is desirable for this to happen during the inflow season (May to November inclusive) to minimise transmission losses. However, transfers during warmer summer months may also be required, for example, to support Taylors Lake in delivering irrigation water. In balancing water resources across the water supply system, an objective will be for transfers to occur from Rocklands so that levels are not drawn down below its target minimum operating level.

**Table 7.2 Rocklands Reservoir - Storage Overview**

| | | Comment |
|---|---|---|
| Full Supply Level (FSL) | 195.47 m AHD | |
| Full Supply Volume (ML) | 348,300 ML | |
| Maximum operating level (MOL) | 194.10 m AHD | 1.37m below spillway crest |
| Maximum operating volume (ML) | 261,500 ML | 86,800 ML less than the Full Supply Volume |
| Minimum operating level | 189.06 m AHD | |

| | | |
|---|---|---|
| Minimum operating volume (ML) | 69,600 ML | |
| Dead Storage | 3,000 ML | |
| Inlet Channel Capacity | none | Peak inflows in 2011 floods ~ 7,000 ML/day |
| Maximum Discharge | 600 ML/d | Limited by CDU's (Carp Screens) to 400ML/d |
| Catchment Area | 1,355 km2 | |
| Surface Area when Full | 6,750 ha | |
| Average Annual Inflow | 83,000 ML | |

**Inflow Variability**

Ongoing climate variability, including severe drought, will continue to have significant impacts on inflows to Rocklands Reservoir. The likelihood of stocked species escaping from Rocklands Reservoir into the Glenelg River is critically linked to the frequency and duration of high inflows that create hydraulic connectivity upstream and which cause the reservoir to either spill or require managed releases, in excess of the 400ML/day capacity of the CDS units, into the Glenelg River downstream.

Figure 7.1 shows that water storage yields in Rocklands Reservoir have declined significantly over the past 20 years. In the period since Rocklands reservoir was constructed, average annual inflow was 84 GL/year whereas between 1996 and 2016 average annual inflow was only 40 GL/year or 48% of the long-term average and in only two years (2010 & 2011) inflows exceeded the long-term average.

In the context of inflow variability it is worth considering the impacts of the 2011 floods across parts of the Glenelg catchment. Rocklands Reservoir commenced the January 2011 flood event holding 84,200 ML. Within one week the volume held increased to over 110,000 ML with total inflows as a direct result of the January rain resulting in over 40,000 ML of inflows being received over the following days. Peak inflows reached about 7,000 ML/d. Rocklands Reservoir did not spill.

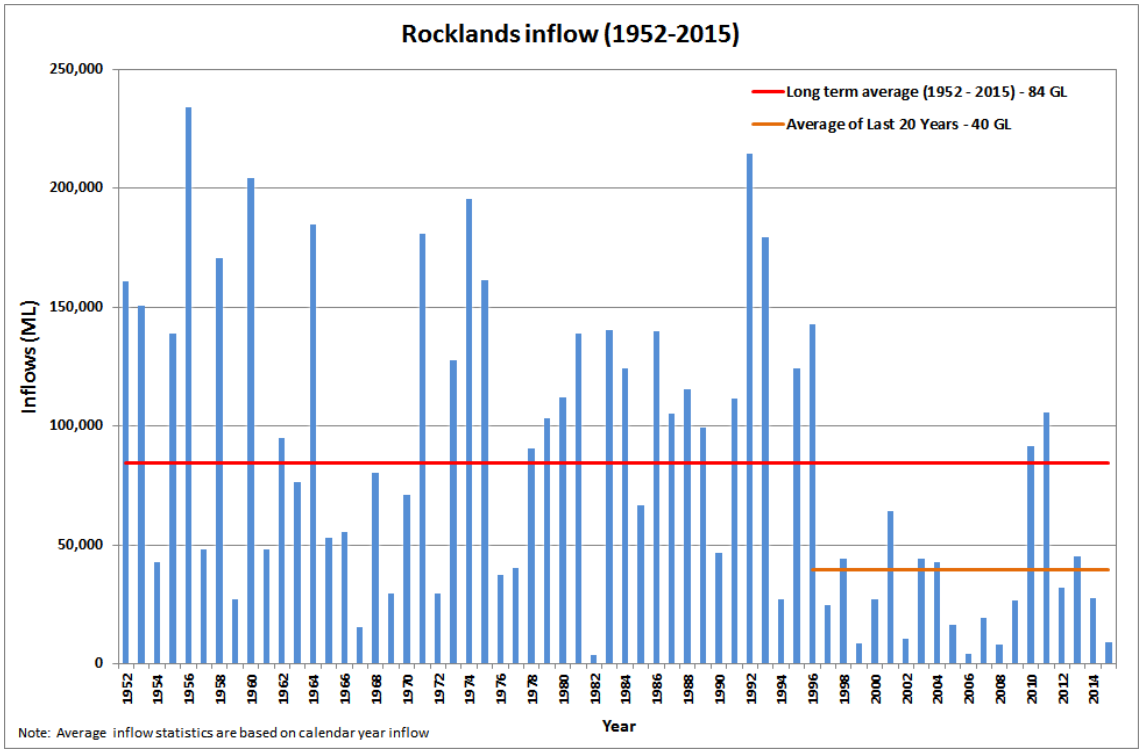
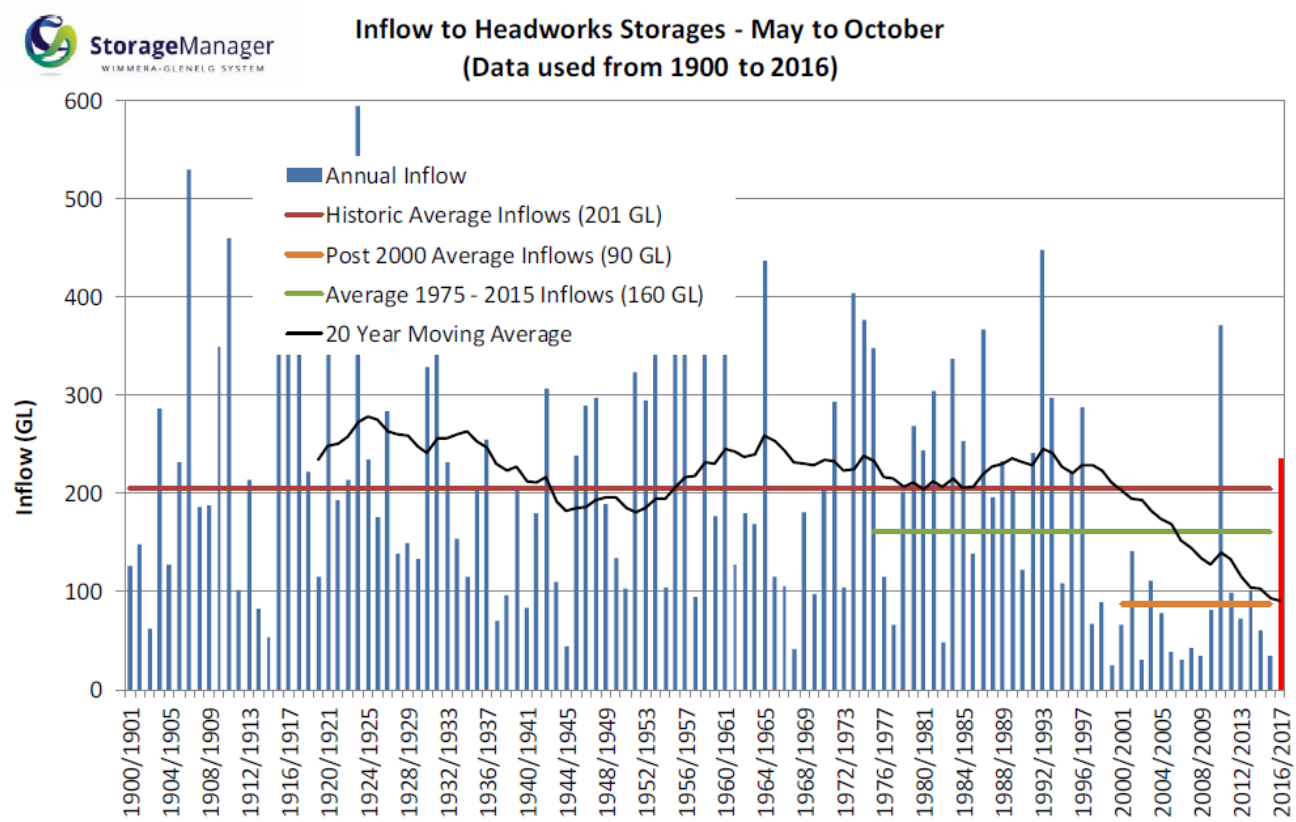



**Figure 7.2 Rocklands Inflows from 1952 to 2015 (Source: GWMW – Bernie Dunn)**

The data presented in Figure 7.1 is further corroborated by Figure 7.2 which presents the total volume of inflows for all storages in the Grampians -Wimmera system from 1900 – 2016. These data show that average inflows have declined by 55% since 2000 (GWMWater, 2016)

The decline in average inflows in the past twenty years with the addition of the revised operating rules that saw the introduction of the Maximum Operating Level, mean that water levels in Rocklands Reservoir are much lower and hydraulic connectivity between the Reservoir and inflowing streams is greatly reduced. This results in greatly diminished opportunities for stocked species to migrate from the Reservoir to the upper Glenelg River and associated tributaries. This greatly reduces the likelihood of stocked species preying upon small native fish in the upper Glenelg River.




*Note: Inflow data excludes Taylors Lake and Toolondo Reservoir.*

**Figure 7.3 Average inflows for the Grampians -Wimmera water supply system 1900-2016 (source: GWMWater, 2016-17 Annual Water Security Outlook Report, 2016)**

### Risk of Spill investigations

As stated previously, the fundamental gap in the knowledge for each of the residual high risks relates to the likelihood of stocked species escaping from Rocklands Reservoir into the upstream and downstream reaches of the Glenelg River. In seeking to further evaluate the risk of uncontrolled releases from Rocklands Reservoir GWMWater were consulted in order to access available inflow data and to understand the scope and outputs of any previous modelling work, in particular if any catchment yield modelling had been undertaken consistent with the DELWP Guidelines for Assessing the Impact of Climate Change on Water Supplies in Victoria (DELWP, 2016). Fortuitously, GWMWater had recently completed their Urban and Rural Water Strategy (July 2017) which was based on a range of REsource ALocation Model (REALM) outputs, inclusive of the DELWP hydro-climatic model inputs, undertaken by Jacobs (March 2017) and further analysed and reported by GWMWater (March 2017).

The following sections provide a summary of the Grampians supply system modelling as reported in GWM Water's Modelling Output Report (March 2017).

*DELWP Surface Water Assessment and Modelling unit undertook initial work in September-October 2016 to generate the hydrologic/climatic data inputs for each of the model scenarios for the Wimmera-Glenelg system. The following methods were used to scale historic inflows for the various climate scenarios:*

- *Transformation by flow duration curve decile method to convert historic inflow and climate data to current (post 1975) climate conditions for base case;*
- *Scaling the base case inputs for low, medium and high climate change scenarios using climate change factors from Guidelines for Assessing the Impact of Climate Change on Water Supplies in Victoria (DELWP 2016b); and*
- *Transformation by flow duration curve decile method for post-1997 step climate change scenario.*

*Jacobs Consulting were engaged by GWMWater in December 2016 - January 2017 to undertake a suite of REALM model runs using the DELWP climate inputs and demands scenarios provided by GWMWater. Jacobs generated 21 model outputs which were used to assess supply across the nine climatic scenarios described in Guidelines for Assessing the Impact of Climate Change on Water Supplies in Victoria (DELWP 2016b) and other scenarios determined by GWMWater. These modelling runs have assessed the potential impacts to water availability across a range of possible future climates and demand scenarios for GWMWater's Urban and Rural Water Strategy.*

*Model outputs produced by Jacobs were analysed by GWMWater Water Resources staff to determine the implications of the various climate and demand scenarios for the Urban & Rural Water Strategy*

Whilst the focus of the modelling work and output analysis was on better informing future water availability under a range of plausible climate change scenarios the outputs provided an opportunity to develop a range of reservoir volume exceedance plots in order to better understand the percentage of years in which Rocklands Reservoir could possibly fill and spill. This work thus provides the necessary insight into the likelihood that stocked fish could escape the reservoir.

Figure 7.3 Historic Climate, present the outcomes of hydrological modelling undertaken to better understand the likely inflows to Rocklands Reservoir under 3 climate scenarios. The climate scenario 'post 1975' is recommended as the new baseline for Water Corporation future water resource planning (DELWP, 2016). This scenario involved scaling of historic data between 1891 and 1974 to reflect the climate observed between 1975 and present. These data provide an important input to the Risk Assessment as they inform the previous uncertainties relating to the likelihood of fish escaping from Rocklands Reservoir to both the upstream and downstream reaches of the Glenelg River.

Figure 7.4 predicts that if the hydrological conditions experienced in the catchment since 1975 were to prevail for the foreseeable future then maximum storage volumes will only been achieved 10% of the time, as compared to 22% for historic conditions (Figure 7.3). The prevailing climate conditions since 1997 provide an even more dramatic prediction of declining inflows to Rocklands Reservoir (Figure 7.5). Under these conditions, it is predicted that full supply level cannot be achieved and that the volumes held in storage in Rocklands reservoir will always be less than half of the full supply volume.

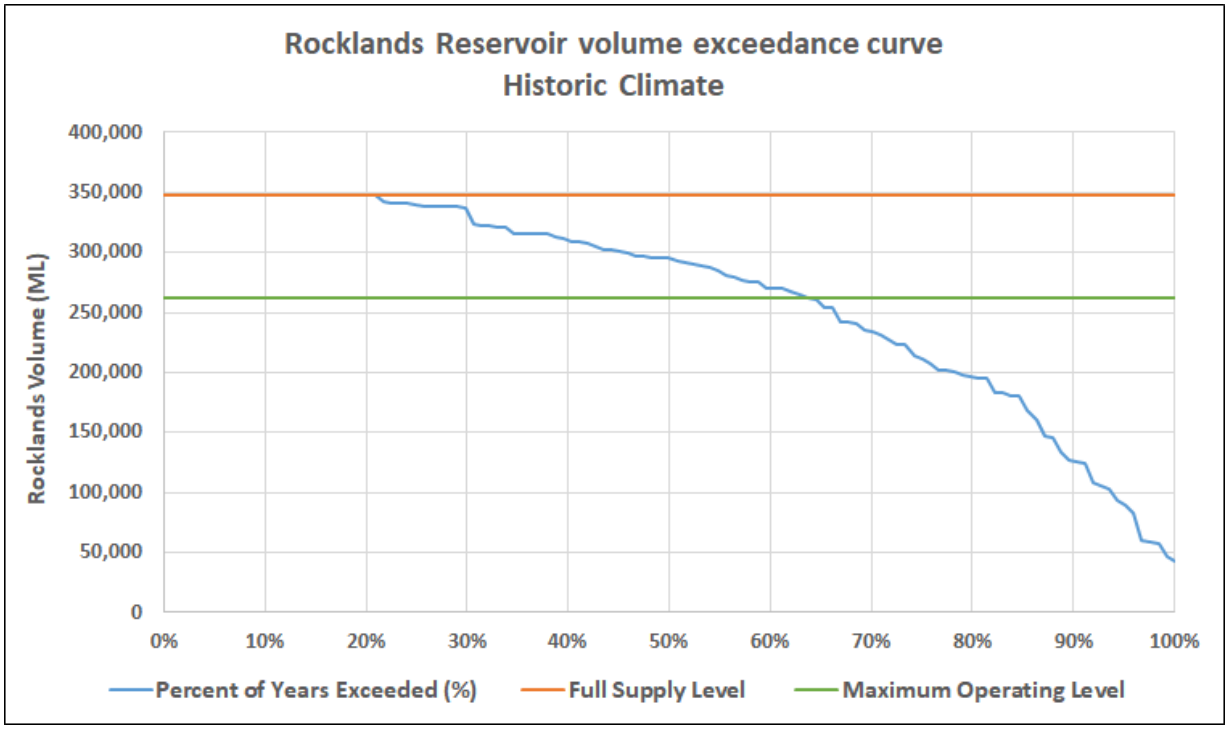



**Figure 7.4 Historic Climate**

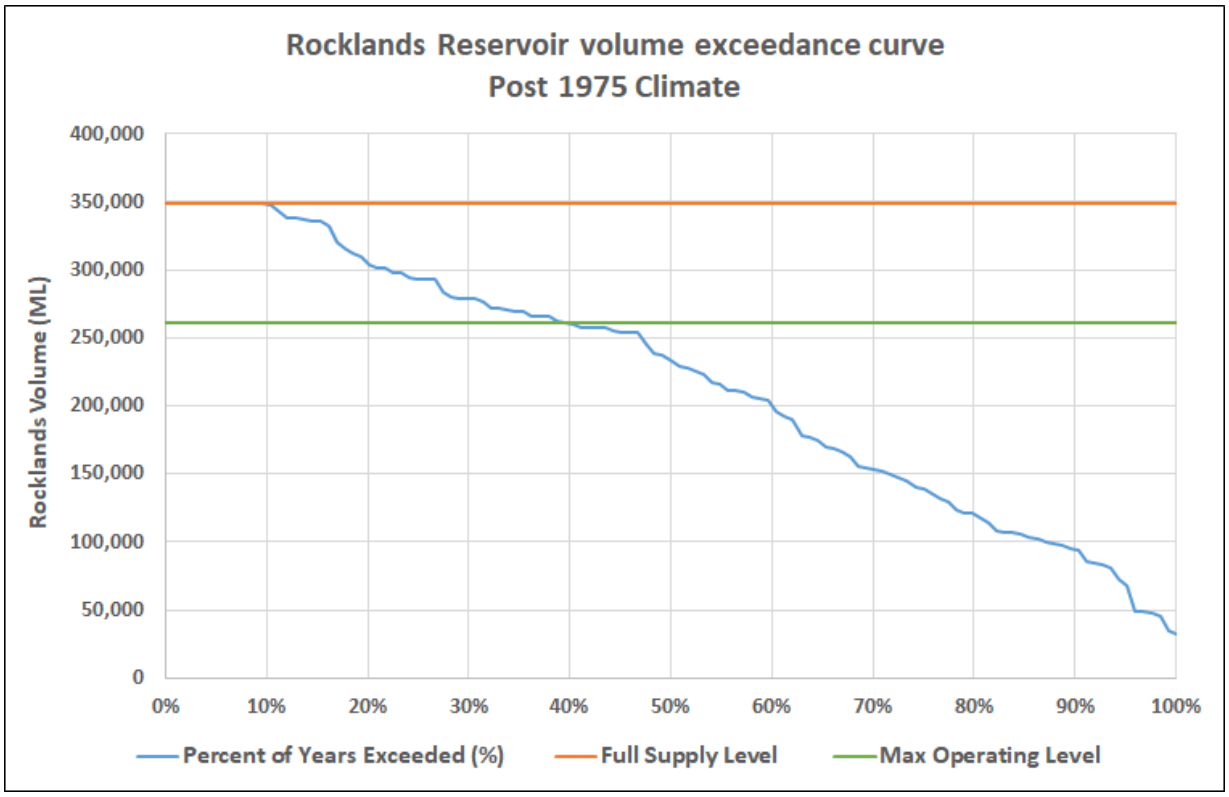



**Figure 7.5 Post 1975 Climate (the new baseline)**

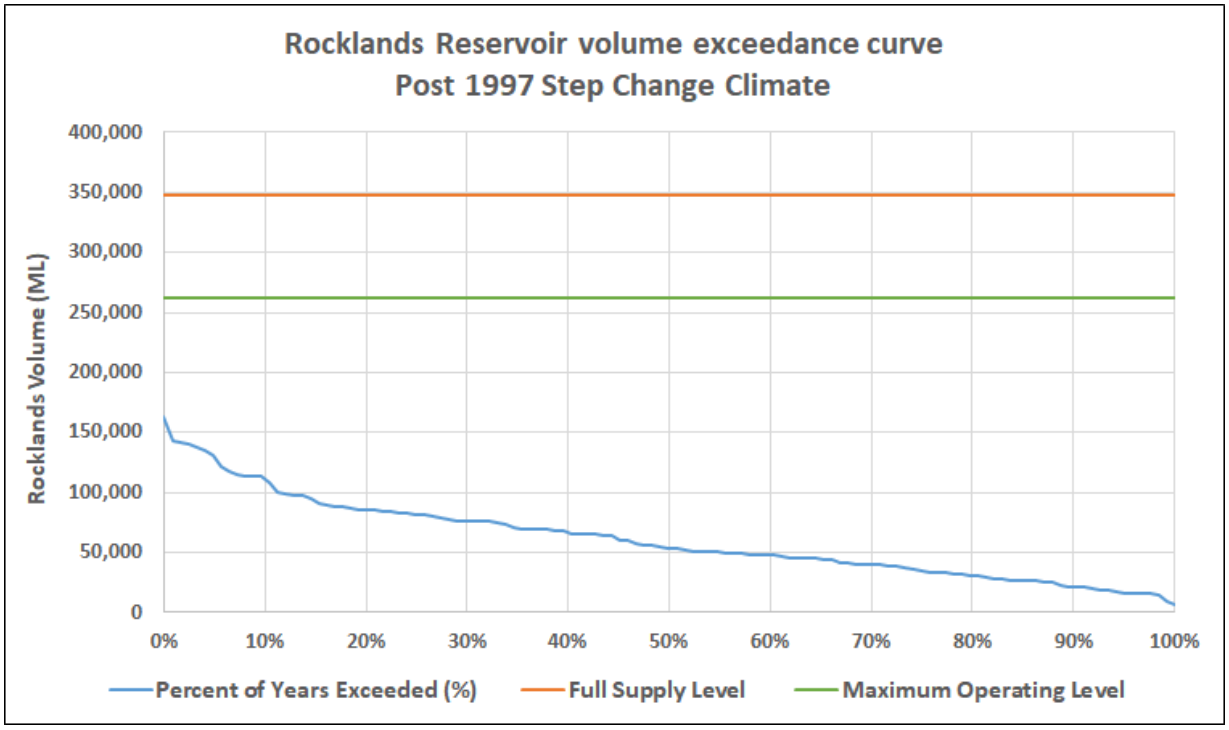



**Figure 7.6 Post 1997 Step Change Climate**

It should be emphasised that the modelling undertaken does not take account of the current Rocklands operation whereby the storage is managed to a Maximum Operating Level (MOL) of 194.10 m AHD or 261,500 ML (as described above). This would have the effect of further significantly reducing the possibility of spills, for example, under the Post 1975 climate scenario the MOL would only be reached 40% of the time with managed releases up to the CDS capacity of 400 ML/day implemented to maintain the reservoir capacity at or below the MOL.

The MOL has the effect of providing a significant buffer of some 1.37m or 86,800 ML (in the context of a long term annual inflow of only 83,000 ML) which in itself has a demonstrable effect on the likelihood of any future spill occurring.

### 2.8 Are there any disease, parasite or unexplained mortality issues in the source area or source facility? For imports of live aquatic organisms, what is the OIE disease zoning status of the source area?

*Provide details as to whether there have been any disease, parasite or unexplained mortalities in the source area or facility. For imports: According to OIE guidelines, there are three classes of disease zoning: free, surveillance and infected. Information on these zones can be obtained from the relevant countries export approval authority or through the OIE.*

No. Murray cod, golden perch and estuary perch will be sourced from private hatcheries that are accredited under the NSW Hatchery Quality Assurance Scheme. These hatchery suppliers are routinely audited by NSW Fisheries staff. In regard to estuary perch, only fish that are free of nodavirus as a result of independent pathology testing are accepted for fish stocking.

### 2.9 What is the nature of any disease surveillance programs in the source area or source facility?

*Understanding the health status of organisms in an aquaculture facility is an important economic and environmental consideration. Programs to monitor fish mortalities and disease can include the regular screening of fish and or wastewater. Monitoring of fish and wastewater can also allow an aquaculture venture to measure the effectiveness of their treatment system. Provide details of any monitoring programs that are undertaken in the source area or facility.*

All native fish hatcheries are routinely audited by NSW Fisheries staff in accordance with the NSW Hatchery Quality Assurance Scheme. As part of this scheme, prior to shipment, samples of native fish are routinely microscopically examined and screened for the presence of external parasites. In the event of unexpected mortality events at the hatchery, fish are subject to independent veterinary examination and supervised treatment as required. In regard to estuary perch, only fish that are free of nodavirus as a result of independent pathology testing are accepted for fish stocking

### 2.10 What quarantine processes and/or treatments will the consignment be subject to?

*Quarantining of new stock is an established best practice approach for many aquaculture facilities. Quarantine provisions are best developed to manage the risks associated with particular species and source areas. Quarantine procedures can be obtained from AQIS at www.aqis.gov.au. Alternatively, quarantine procedures may be customised for the species.*

All native fish hatcheries are routinely audited by NSW Fisheries staff in accordance with the NSW Hatchery Quality Assurance Scheme. Pond harvested native fish are subjected to multiple salt baths with a concentration of 10 ppt for at least 1 hour each. All native fish are transported in a salt concentration of 3 to 5ppt. This reduces external parasite loading and reduces fish stress during transportation. Fish harvested from plankton ponds are held in quarantine for at 24 hours where they are intensively monitored.

### 2.11 Are undesirable species (e.g. parasites, blue green algae, other species) likely to be translocated with the consignment that are not currently found at the destination or potential receiving waters?

*Translocating the target species may cause parasites or diseases present in the source area to also be translocated. List parasites and diseases species present in the source area and provide details as to whether any of these species are likely to be transported with the consignment. Various publications on fish diseases and parasites may assist the applicant in answering this question.*

Common and ubiquitous opportunist parasites associated with fish aquaculture, such as white spot, are present at the facility and the receiving waters. Prior to stocking, fish are treated with salt baths to minimise parasite load. Careful screening of fish in the hatchery ensures other undesirable species are separated from target native fish. Fish are also transported using long-established vessel disinfection methods and established protocols that effectively manage the risk of disease and transfer of parasites. Protocols include health checks on the fish, and the thorough washing of transport tanks and sun drying between fish liberations. Where fish are sourced from private hatcheries, transport vehicles are cleaned and washed with a formalin solution before rinsing and drying.

### 2.12 Based on the answers to Questions 2.1 to 2.11, what is the likelihood of escape?

*This question asks the applicant to consolidate responses to all questions in this section and provide a summary argument on the likelihood of escape with particular reference to the effectiveness of proposed control measures at managing the risk of escape or release, including the threat of disease and parasite transfer*

The risk of introducing disease and or parasites to the Rocklands Reservoir and the Glenelg River via the stocking of hatchery reared fish is low because screening, disinfection, routine fish health monitoring and

veterinary advice are established practice at quality assured native fish hatcheries. These hatcheries are subject to strict New South Wales Hatchery Quality Assurance Scheme protocols and independent audit provisions.

# 3 Consequences of Escape or Release

### 3.1 What species (including diseases and parasites) and life stages (e.g. gametes, fertilised eggs, juveniles, adults, etc) are likely to escape?

*This question requires the applicant to provide details of species that are likely to escape from the destination. Adverse events may make it possible for the target species, disease and parasites to escape from the destination e.g. system failure, flood, transport via waterfowl and vermin Provide details of the life stages that may be released or escape during an adverse event.*

The Risk Assessment undertaken for this project which is presented in the attached supporting documentation show that for Estuary perch, Golden perch and Murray cod, there is a very low to negligible likelihood that the stocked species will escape from Rocklands Reservoir. This assessment is based largely on the hydrological features of the catchment under a series of climate scenarios.

### 3.2 In the event of an escape how many individuals are likely to escape?

*The consequence of a handful of species being released during an adverse event may be less than that of an event where thousands of the one species are released, however both escapes may constitute a risk. Please provide details of the number of organisms likely to escape.*

The numbers of fish that could escape will be influenced by the extent of the flood and the size of the fish at the time of flooding

### 3.3 Based on the answers to Questions 3.1 to 3.2, what are the consequences of escape?

*The proponent must provide a consolidated response to all questions in this section and provide a summary argument on the consequence of escape with particular reference to the effectiveness of proposed control measures for managing these risks.*

The addition of the Murray cod, Golden perch and Estuary perch is unlikely to lead to an increase in the total biomass of predatory species in Rocklands Reservoir with large scale stocking more likely to result in reduction in the Redfin population which will be partially displaced by predation and competition. While this may result in a decline in the Redfin population, it may improve the quality of the fishery by reducing the potential for this species to overpopulate which leads to stunting. The introduction of an apex predator (Murray cod) may also contribute to ecosystem improvement in an environment where invasive species are prevalent (Sierp, 2008).

Because each of the species proposed to be stocked are piscivorous, it is highly likely that they will prey on native fish species in Rocklands Reservoir; the extent to which they may prey on significant species is unknown. Because native fish populations have persisted in the presence of Redfin for 60 years, there is unlikely to be any further impact on these species in the long term as a result of the proposed stocking. This is because the total biomass of predatory species is limited by available food and habitat resources and for stocked species to establish “fishable” populations, they will need to displace existing predatory species such as Redfin, meaning that total predator pressure on species in Rocklands Reservoir would not increase.

The threat posed by overall competition for food and habitat resources may impact native fish communities during the early life stages of the introduced species. The “crash” stocking with tens or hundreds of

thousands of juveniles may lead to short term competition with significant native species which are likely to occupy similar habitat zones and prey on similar food items. Once the introduced species grow through this early life stage they will likely occupy different habitat zones and switch feeding preferences.

The behavioral characteristics of the stocked species suggest that they are unlikely to migrate to the upper Glenelg River during high flows. Murray cod have been shown to be quite sedentary in large impoundments across a range of flow regimes and show no preference for upstream migration (Douglas, 2009), while Estuary perch are likely to migrate downstream to estuarine environments during winter in search of suitable breeding habitat. While the migratory behavior of Golden perch is more variable, there is still a strong tendency for this species to remain in the area of the impoundments to which they are stocked particularly, in larger deeper lakes such as Lake Eildon in Victoria and Somerset Lake and Boondooma in Queensland (Douglas 2009, Sawynok & Platten, 2009). Ryan and Mahony (2005), observed that upstream movements of Golden perch only occurred when water temperatures exceeded 20°C and coincided with increased flow into the Lakes.

In any event, the movement of large bodied fish into the upper Glenelg River is likely to be short term for the period that sufficient water is available. The species proposed for introduction require sufficient space to survive and hunt; conditions which do not prevail in the small stream and marshy environments of the upper Glenelg River during normal flows.

Figure 6.1: Typical habitat in the upper Glenelg catchment. (Cultivation Creek, a tributary of the upper Glenelg River, courtesy of Ty Matthews)

Once the introduced species grow through their early life stage they will likely occupy different habitat zones (e.g. return to the reservoir) and switch feeding preferences or are likely to experience total population mortality as water levels drop and suitable habitat is lost.

Figure 6.2: Dead European carp, after become stranded in Red Rocks Creek (photo courtesy of Ty Matthews)

Juvenile Estuary perch proposed to be stocked to Rocklands Reservoir are the progeny of adult fish sourced from the estuarine reach of the Glenelg River and therefore attend concerns regarding the maintenance of genetic integrity in wild fish stocks.

Each of the three species proposed for stocking are long-lived and while Estuary perch are endemic to the Glenelg River and will breed in the estuarine reach, Murray cod and Golden perch are highly unlikely to establish breeding populations.

The consequences of Estuary perch escaping to the Glenelg River are considered insignificant because they are endemic to the system and the stocked fish will be derived from a captive breeding program that utilises adult Estuary perch from the Glenelg River. It is believed that escapee's will quickly assimilate with native populations within their natural range.

In general, the longevity of Murray cod and Golden perch means that the consequences of any impact could be long-term for significant species

The consequences of this competition are dependent upon the density of both native fish and escaped juveniles and will be concentrated in habitats suitable to escapees. Little is understood about the comparative habitat and prey preferences of the juveniles of the proposed stocked species and the native species in the Glenelg River.

Summary argument: In the unlikely event that stocked fish escape and survive downstream from Rocklands Reservoir, relatively small numbers may occupy the Glenelg River for short to long term depending upon the availability of suitable habitat. Escaped stocked fish may prey upon or compete with existing fish and spiny crayfish populations. The extent of these impacts will be influenced by the number of stocked fish that escape. Should escape occur, stocked fish may also prey on other predatory fish such as Redfin which are abundant. By displacing already present Redfin, additional predatory pressure from escaped stocked fish is considered low. Estuary perch are native to the freshwater reaches of the Glenelg River and local native fish populations have evolved in their presence.

Stocked fish that enter the shallower reaches of the upper Glenelg catchment will only persist for short periods until flows subside and fish become stranded and eventually die. In these circumstances, stocked fish are likely to prey on small native fish but predation will be confined to localised pools and wider overall

populations will be unaffected.

# 4 Likelihood of Survival

### 4.1 Is the natural and/or current range of the species/genetic stock known?

*A species' natural range is an area where that species is found prior to any translocation events occurring. The current range of a species may differ to its natural range through a number of reasons including habitat degradation or over- fishing. Genetic homogeneity of a species may also differ between areas due to separation of a species through physical barriers.*

Three species are proposed for translocation:

- Murray cod, Maccullochella peelii
- Golden perch, Macquaria ambigua
- Estuary perch, Macquaria colonorum

Murray cod and Golden perch are endemic to the Murray Darling Basin and do not naturally occur in the Glenelg River catchment. Estuary perch are endemic to coastal rivers and streams of south east Australia including the Glenelg River where healthy populations exist in the estuarine and freshwater reaches. The juvenile Estuary perch proposed for stocking will be sourced from adult brood stock collected from the Glenelg River by the Victorian Fisheries Authority and hold the same genetic make-up as native populations.

### 4.2 Are the water quality, habitat and food requirements known for the species and are they available at the destination or potential receiving waters?

*If the environmental and biological requirements of the species to be translocated exist at the destination or potential receiving waters, the likelihood of survival is increased. The applicant should provide information demonstrating temperature, water quality, habitat and food requirements of the target species and those that are found at the destination and potential receiving waters. Some of the parameters that may be provided include temperature, dissolved oxygen, pH and salinity.*

The environmental and biological requirements for all stocked species are well known. All species will readily survive in Rocklands Reservoir and the Glenelg River as evidenced by the presence of adult specimens currently occurring in these waters. The likelihood of these species surviving in the upper Glenelg River ephemeral streams is critically limited to the absence of adequate water (habitat) for much of the year. The environmental conditions in Rocklands Reservoir are expected to favour the performance of native fish compared with trout which are annually stocked.

## Murray cod

Murray cod are a large native species that are endemic to the Murray Darling Basin. Within this range they are the apex predator that will prey on a wide range of food items including fish, crayfish, frogs as well as birds and reptiles. Murray cod are an “ambush” predator that will occupy preferred feeding locations and wait for food items to present themselves. This hunting strategy and the large gape size of the mouth means that large Murray cod are likely to select for larger prey items that enter their feeding zone.

Murray cod mature at approximately 500-600mm and spawn on a solid substrate such as logs or rock bars when water temperatures exceed 15°C. They may migrate up to 120kms during this period to find preferred spawning locations before returning to their former home (Lintermans, 2007). It is believed that Murray cod will spawn in impoundments such as Lake Charlegark in western Victoria however, there is no confirmed evidence of them spawning in man-made lakes or in rivers outside of their natural range.

They are a long lived species with an oldest known age of 48 years (Lintermans, 2007). In keeping with their broad distribution across the Murray Darling Basin, Murray cod are tolerant of large seasonal variations in water temperature.

## Golden perch

Golden perch are native to the Murray Darling Basin and are amongst the most common species encountered by recreational anglers across this range. They are a medium to large predator that opportunistically feeds on a variety of prey organisms from insect larvae to fish and larger crustaceans (Lintermans, 2007).

Golden perch are thought to spawn during spring and summer when water temperatures exceed 20°C however, recent work by Sharpe C.P. (2011) showed evidence that Golden perch were able to spawn at any time of the year but only in response to acute flow pulses. Similar to Murray cod, Golden perch are tolerant to a large range of seasonal water temperatures.

## Estuary perch

Estuary perch are native to south east Australia including the Glenelg River system and are commonly encountered in the estuary and lower reaches downstream of Dartmoor and are sometimes encountered upstream of during low flow conditions. They feed on a range of food items including insect larvae, small crustaceans and small fish. Estuary perch breed in the brackish water of estuaries and eggs will not survive in freshwater.

In the past 5 years, Fisheries Victoria have embarked on a program to breed Estuary perch in captivity which has resulted in moderate numbers of fingerlings being made available for stocking. The bulk of the brood fish for this program are collected from the Glenelg River.

Estuary perch are a highly prized angling species that are becoming increasingly recognized for their sportfishing value and are increasingly being stocked into freshwater bodies where they have shown an ability to adapt his environment and form valuable fisheries.

### 4.3 For diseases and parasites, are suitable hosts likely to be available at the destination or potential receiving waters and are the hosts required for the completion of all the lifecycle stages?

*Many diseases and parasites are opportunistic and can infect a range of hosts at the destination or potential receiving waters. Others are species specific and can only affect a particular host during a particular lifecycle stage.*

Rocklands Reservoir and the Glenelg River holds are large fish population which would carry thethe normal range of diseases and parasites which are wide spread in Australian waters. The array of opportunist parasites found occasionally on stocked fish are typically ubiquitous to native fish populations in the Rocklands Reservoir and Glenelg River.

### 4.4 Based on the answers to Questions 4.1 to 4.3, what is the likelihood of survival?

*In consideration of the responses made to questions 4.1-4.3 provide a detailed summary describing the likelihood of survival of the target species, parasites and pathogens at the destination and the potential receiving waters.*

The survival of stocked species is highly likely given that one of the species - Estuary perch is endemic to the Glenelg River system and the two species Golden perch and Murray cod currently exist in Rocklands Reservoir. Habitat conditions in the Rocklands Reservoir are expected to favour stocked fish.

# 5 Consequences of Survival

### 5.1 Is the species endemic to, or currently present, at the destination and the potential receiving waters?

*A species endemic to the destination and potential receiving waters poses a lower risk to the environment than non- endemic species. The presence of the target species at the destination and potential receiving waters indicates that survival of the species in those waters is likely.*

Estuary perch are endemic to the Glenelg River. The juveniles proposed for stocking are sourced from adult brood fish collected from the Glenelg River. Murray cod and Golden perch are endemic to the Murray Darling Basin. Murray cod are currently present in Rocklands Reservoir and are occasionally taken by recreational fishers. A population of Golden perch is evident in the lower Wannon River.

### 5.2 Is the species likely to alter the physical environment and/or destabalise local plant communities?

*Some species habits may have an effect on the physical habitat in which they live, eg yabbies are known for burrowing, potentially causing seepage of ponds. Please also provide details of the species behavioural characteristics and evidence as to whether the target species is or is not likely to cause an effect on local plant communities at the destination and potential receiving waters.*

Stocked species are not known to cause negative changes to the physical environment and/or destabilise plant communities as they are all piscivorous species that also rely on structural habitat i.e. macrophytes beds, woody debris

### 5.3 Based on the answers to Questions 5.1 to 5.2, what are the consequences of survival?

*In consideration of the responses made to questions 5.1-5.2 provide a detailed summary describing the likelihood of survival of the target species, parasites and pathogens at the destination and potential receiving waters.*

All stocked species are expected survive and grow well in Rocklands Reservoir and will not destabilise the physical environment.

# 6 Likelihood of Establishment

### 6.1 Are the environmental requirements for the completion of all stages of the life cycle known and are they available at the destination and potential receiving waters?

*Many species require certain environmental conditions to successfully complete all stages of their life cycle. For example many warm water natives require a temperature increase to spawn. The applicant should demonstrate the environmental conditions required for the completion of all life stages of the target species and identified parasites or diseases and whether or not they are present at the destination and potential receiving waters.*

Knowledge about the all stages for the life cycle of Murray cod, Golden perch and Estuary perch are well understood through field work and hatchery production experience. All species can be breed in captivity but is very unlikely that Estuary perch, and Golden perch will breed in Rocklands Reservoir. Murray cod may breed in Rocklands Reservoir but breeding effectiveness in large static water bodies for this species is generally low e.g. Lake Eildon less than 2 % of the population were derived from naturally breeding fish.

### 6.2 Is the ability of the species to hybridise with local species known?

*Hybridisation of species may occur where two separate species interbreed and produce offspring. Viable offspring, such as in some abalone species, or unviable offspring may be produced from this cross breeding. If a species can interbreed with another species at the destination or potential receiving water, then the likelihood of a hybrid population in that waterway increases. Please provided details as to whether or not the target species will be able to interbreed with species at the destination and potential receiving waters and in the case that this may occur, will the offspring be viable or unviable.*

Neither Murray cod nor Golden perch will hybridise with any native species in the Glenelg River. The Estuary perch proposed for stocking are bred from broodstock which are collected to from the Glenelg River and carry the same genetic make-up.

### 6.3 Based on the answers to Questions 6.1 to 6.2, what is the likelihood of establishment?

*In consideration of the responses made to questions 6.1 -6.2 provide a detailed summary describing the likelihood of establishment of the target species at the destination and the potential receiving waters.*

It is highly unlikely that Golden perch and Estuary perch will establish self-sustaining populations in Rocklands reservoir as they will not breed in this environment. Estuary perch will not be self-sustaining in Rocklands Reservoir as they require estuarine conditions to breed and their eggs will not survive in fresh water. Murray cod may establish breeding populations in Rocklands Reservoir but the effectiveness of Murray cod breeding in larger scale impoundments is generally considered low.

# 7 Consequences of Establishment

### 7.1 How `natural` is the destination and potential receiving waters and is the level of disturbance suitable to the target species?

*The consequences of a non-endemic species establishing itself within a pristine area may be considered a greater risk than in an area where the waterway is degraded or has a number on non-endemic species already within it. Please indicate in your response the level of disturbance the waterway has been subject to and what these disturbances are, eg snag removal, bank erosion etc. Depending on the species being translocated, some require a pristine habitat to survive while others may thrive in a disturbed environment. Please indicate if the level of disturbance is suitable to the target species.*

Rocklands Reservoir is a highly modified and artificial environment created by the damming of the Glenelg River in 1953 and does not resemble the natural environment of the Glenelg River. As such it supports high abundances of exotic species such as Redfin and European carp which will provide a source of prey for the stocked species. Murray cod already exist in Rocklands Reservoir thus it is expected that stocked fish will be viable. Golden perch require similar conditions as Murray cod for survival thus, it is expected that will survive in Rocklands

### 7.2 Are there any endangered or rare species at the destination or potential receiving waters?

*A list of threatened species can be obtained from the Department of Sustainability and Environment web page. The applicant must consider whether the species proposed to be stocked will pose a risk to other aquatic fauna/flora, which may include invertebrates, amphibians and reptiles. In the case where threatened species are located at the destination and/or potential receiving waters demonstrate whether the target species will have an effect on them.*

The Glenelg River below Rocklands Reservoir has been the subject of a number of detailed fish surveys and assessments that provide a comprehensive fish species list for the river. In contrast, surveys of fish species in the Glenelg River upstream Rocklands Reservoir are more difficult to source. The most recent available accounts of the status of general fish populations in the Glenelg River are presented in the following studies.

- Austral Research and Consulting (2014) VEFMAP Adult Fish Monitoring of the Glenelg River 2014,
- Lieschke, J.A., et al (2013), The status of fish populations in Victorian rivers 2004–2011 — Part B: Individual basin assessments. Arthur Rylah Institute for Environmental Research Technical Report Series No. 247. Department of Environment and Primary Industries, Heidelberg, Victoria and
- Howson, T. J, (2013) Fish assemblage response to experimental rehabilitation in the Glenelg River, Victoria, Australia, Deakin University, July, 2013.
- Austral (2014) was a continuation of the annual fish monitoring program undertaken since 2009 as part of the Victorian Environmental Flow Monitoring and Assessment Program (VEFMAP) and is limited to the Glenelg River below Rocklands Reservoir.
- Lieschke et al (2013) is broader in geographical range and presents findings of monitoring effort undertaken in the Glenelg River catchment including the reach of the Glenelg River upstream of Rocklands Reservoir (one monitoring site) and the main tributaries of the Wannon, Chetwynd, Crawford, Stokes and Wando rivers, and Grange Burn Creek. In this survey, five species of endemic fish were recorded above Rocklands Reservoir including two significant species Obscure galaxias and Little galaxias, plus Southern pygmy perch, Flat-headed gudgeon and Common galaxias. Additionally, the introduced native Carp gudgeon and exotic Eastern gambusia were captured during the survey.
- Howson (2013) cites (Jackson and Davies 1983, Department of Water Resources 1989, Koehn and O' Connor 1990a, Mitchell et al. 1996, Close et al. 2003) in presenting that 19 native freshwater fish species, and 7 exotic species have been recorded in the Glenelg River catchment.

**Table 2.1: Glenelg River freshwater fish species list compiled from Austral (2014), Lieschke (2013) & Howson (2013). Conservation Status recognizes the listing of that species under the Victorian Flora and Fauna Guarantee Act and the Conservation Status in Victoria. Bold denotes Commonwealth EPBC listing.**

| Species | Victorian Conservation Status |
|---|---|
| **Riverine*** | |
| Shortfin eel *Anguilla australis* | |
| **Australian grayling *Prototroctes mareana*** | Vulnerable, FFG Listed |
| Australian smelt *Retropinna semoni* | |
| Tupong *Psuedaphritis urvillii* | |
| Flathead gudgeon *Phylipnodon grandiceps* | |
| River blackfish *Gadopsis marmoratus* | Critically endangered in upper Wannon River |
| Southern pygmy perch *Nannoperca australis* | |
| **Variegated pygmy perch *Nannoperca variegata*** | Vulnerable, FFG Listed |
| **Yarra pygmy perch *Nannoperca obscura*** | Vulnerable, FFG Listed |
| Short headed lamprey *Mordacia mordax* | |
| Pouched lamprey *Geotria australis* | |
| Common galaxias *Galaxias maculatus* | |
| Obscure galaxias *Galaxias oliros.* Formerly part of Mountain Galaxias *Galaxias olidus.*^ | |
| ***Little Galaxias Galaxiella toourtkoourt.* Formerly described as Dwarf galaxias *Galaxiella pusilla or Western Plains galaxiella*^^** | Vulnerable, FFG listed |
| Spotted galaxias *Galaxias truttaceus* | |
| Australian mudfish *Neochanna cleaveri* | Critically Endangered, FFG Listed |
| Broad-finned galaxias *Galaxias brevipinnis* | |
| **Invertebrates** | |
| Western swamp crayfish *Gramastacus insolitus* | Critically Endangered, |
| **Western Cray *Geocharax falcata*** | |
| Glenelg spiny freshwater crayfish *Euastacus bispinosus* | Endangered, FFG Listed |
| **Burrowing crayfish *Engaeus lyelli*** | |
| **Eastern long neck turtle *Chelodina longicollis*** | |
| **Glenelg Freshwater Mussel *Hyridella glenelgensi*** | Critically Endangered, |
| **Exotic** | |
| **Common carp *Cyprinus carpio*** | |
| **Eastern gambusia *Gambusia holbrookii*** | |
| **Goldfish *Carasius auratus*** | |
| **Redfin perch *Perca fluviatus*** | |
| **Tench *Tinca tinca*** | |
| **Brown trout *Salmo trutta*** | |
| **Rainbow trout *Oncorhynchus mykiss*** | |
| **Non-endemic native** | |
| **Carp gudgeon *Hypseleotris spp.*** | |
| **Golden perch *Macquaria ambigua*** | |
| **Australian bass *Macquaria novemaeculata*** | |
| Murray cod *Maccullochella peeli* | **Vulnerable, FFG listed** |
| **Freshwater catfish *Tandanus tandanus*** | **FFG Listed** |
| **Macquarie perch *Macquaria australasica*** | **Endangered, FFG Listed** |
| **Other** | |
| Yabby *Cherax destructor* | |

*Life stages of some species may occur in both marine and freshwater environments;** Occurring predominantly in the Glenelg River estuary below Dartmoor;^ Raadik, T. A. (2014);^^ Coleman, R.A., Hoffmann, A. A. & Raadik, T. A. (2015).

The Glenelg Hopkins Catchment Management Authority maintains data on the presence of native and introduced fish species above Rocklands Reservoir. This list summarises the results of surveys and observations undertaken between 1969 and 2002 and provides an historical perspective on the fish species of the upper Glenelg River period through this period (see Appendix B). Significant fish species identified through this exercise include Obscure galaxias and Little galaxias. Additionally, DEWLP (http://delwp.vic.gov.au/fishing-and-hunting/recreational-fishing/fishing-locations/inland-angling-guide/glenelg/glenelg-angling-waters#grampians) refers to surveys undertaken by the Victorian Department of Primary Industries, of Tea Tree Creek and Scott Creek which drain the western side of the Victoria Ranges and flow into Rocklands Reservoir. These surveys recorded significant species including Obscure galaxias (which were particularly abundant) and Little galaxias and the crustaceans; Northern burrowing cray, Western cray, Swamp cray. River blackfish, Australian smelt, Common galaxias, Flathead gudgeon and the introduced species Western carp gudgeon, Eastern gambusia, and Redfin were also recorded. The results of these surveys correspond with Lieschke (2013) which recorded Obscure galaxias and Little galaxias as the only significant fish species above Rocklands Reservoir.

The Victorian Environmental Water Holder Seasonal Watering Plan 2015-16 (Sec.4.2 Glenelg system p68), reports that native fish are responding positively to environmental flows delivered to the Glenelg River from Rocklands Reservoir. While actual data is not available, fish surveys show that Estuary perch have increased their upstream range in the Glenelg River by 160 km and that Variegated pygmy perch (a significant species) "showed a strong spawning response and were the most abundant species caught in 2015 Glenelg River fish surveys." (VEWH, 2015)

### 7.3 Is the target species subject to an eradication or minimisation program at the destination or potential receiving waters?

*It is important to ensure that where a species is subject to an eradication program in a particular area that the translocation will not re-introduce the species into the area. Information as to whether the species in subject to such a program can be obtained through your local DEPI office.*

No

### 7.4 Is the target species genetically modified?

*Species that have been genetically modified may be more suited to an environment than species endemic to that area and may therefore displace these species through competition for food and habitat. Please provide details as to whether the target species has been genetically modified and what are the implications of the modifications.*

No

### 7.5 Should the target species establish at the destination or potential receiving waters, is it likely that it can be eradicated?

*There are many examples of animal translocations that have resulted in the establishment of feral populations. In most of these cases attempts to prevent their spread or eradicate the species has not been successful. Please provide details as to whether it is likely that the species to be translocated could be eradicated from the potential receiving waters.*

Because it is very unlikely that the target species Golden perch and Estuary perch will breed in the environments of Rocklands Reservoir and the Glenelg River their population abundance will be determined through stocking. By ceasing stocking, population abundance will diminish over time. As stocked species are long-lived, allowing the population to die out would take at least several decades. Population abundance of stocked fish could be further reduced through recreational fishing pressure or targeted harvest using

commercial fishing equipment. This is likely to be more effective in the concentrated river habitat than vast and complex habitat of the Rocklands Reservoir. In the event large bodied stocked fish are detected in the Glenelg River, a concerted electrofishing could be used to target and remove native fish.

**7.6 Based on knowledge of the species' growth, reproductive characteristics and behaviour, is the target species likely to displace local species in similar ecological niches?**

*The displacement of species through competition for similar ecological niches can be as damaging to biodiversity as predation or habitat destruction. Provide details as to whether any life stages of the species proposed to be translocated may displace species found at the destination and the potential receiving waters.*

Yes. Target species will displace the existing exotic predatory Redfin in Rocklands Reservoir.

**7.7 Based on knowledge of the species' behaviour and physical characteristics, is it likely to be a significant predator at the destination or potential receiving waters?**

*The possibility of predation by the target species on species found in the potential receiving waters must also be considered. Noting that most recreational species in Victoria are predatory by nature, provide details as to whether any life stages of the target species may predate on species found at the destination or potential receiving waters.*

All species proposed for stocking are opportunistic predators and will prey upon fish species in Rocklands Reservoir and the Glenelg River (in the event that they escape)

**7.8 Is the consignment of the same genetic stock as local populations?**

*The mixing of genetic stocks can reduce the genetic integrity of species and in turn may reduce its resistance to disease or certain environmental conditions. It is therefore important that genetic stocks are not mixed in order to maintain genetic integrity within natural populations. Provide details describing the source of the stock/broodstock.*

The Estuary perch proposed for stocking are the progeny of adult brood fish collected from the Glenelg River. Murray cod and Golden perch are non-endemic.

**7.9 What effects are any released diseases or parasites likely to have at the destination or potential receiving waters?**

*Some diseases and parasites are host specific. Therefore the effect of these on other species in the potential receiving waters will alter depending on the inhabitants of those waters. Provide details of the potential effects that any diseases or parasites could have on species found at the destination or potential receiving waters.*

All fish are sourced from accredited hatcheries and are fish health accredited

**7.10 Based on the answers to Questions 7.1 to 7.9, what are the consequences of establishment?**

*Based on questions 7.1-7.11 what are the consequences of establishment of the target species or diseases and parasites at the destination or potential receiving waters.*

The fish surveys undertaken in the catchment show that Rocklands Reservoir does not contain any significant species though they do support a number of other native fish species which are likely to be subject to predation by stocked species. However, the risks for this impact is rated low as Rocklands Reservoir contains a large population of Redfin which has exhibited predatory pressure in the reservoir since its construction in 1953. European carp also inhabit the reservoir in significant numbers and will readily prey on the eggs of all fish species.

As it is unlikely that any of the proposed species will breed in Rocklands Reservoir, eradication could be achieved by ceasing stocking however, it may take several decades for the stocked fish to die out as they are all long-lived species.

The addition of the target species is unlikely to lead to increased predatory pressure in Rocklands reservoir as these species are likely to displace part of the Redfin population rather than add to total predatory biomass.

Because it is highly unlikely that Rocklands reservoir will achieve FSL and spill in the foreseeable future, there is little likelihood that stocked species will escape the reservoir into the Glenelg River via flood flows.

The negative consequences including predation on threated species from stocking native fish in Rocklands Reservoir are considered to be low. Where negative impacts do occur they are likely to be short term or only effect localised populations due to expectation that target species will displace extant introduced predators and the limitations to the species distributing throughout the Glenelg system.

# 8 Socio-Economic

### 8.1 What are the social or community impacts associated with your proposal to translocate?

*Describe the social benefits that may be gained from the proposal to translocate an organism e.g fish for tourism. Detail whether these social benefits will "outweigh" any of the social aspects of other activities in the proposed receiving waters e.g damage to other recreational fisheries.*

The stocking of estuary perch, golden perch and Murray cod in Rocklands Reservoir is aimed at creating a high quality recreational fishery that will attract significant visitation from anglers. Currently the fishery is based on the exotic Redfin and the possibility of establishing a native fishery is greatly supported by the fishing community. The Victorian Fisheries Authority estimate the successful stocking of native fish in Rocklands Reservoir will attract an additional 10,000 recreational fishers each year and create significant positive social outcomes for local and visiting tourists.

### 8.2 What are the estimated economic impacts associated with your proposal to translocate?

*Provide details of the economic impacts of the proposal. These may be positive effects such as regional employment and tourism or negative effects such as the cost of eradication and or recovery programs.*

Large scale stocking of impoundments has been a successful strategy in building native fish populations, developing recreational fisheries and growing strong regional economic activity as demonstrated for example at Lake Eildon and Lake Nagambie. The development of a native fishery in Rocklands Reservoir reflects the growing aspirations of recreational fishers to fish for large freshwater native species and in some cases to transition from traditional fisheries based on introduced species (trout and Redfin) to native fisheries.

Ernst & Young (2010) reported that the economic impact of Murray Cod recreational fishing in Victoria for 2009-10 to be:

- $166.7 million in direct expenditure;
- $59.0 million in contribution to GSP; and
- 374 jobs

Gregg and Rolfe (2013), estimated that the total economic value of impoundment fishing alone was worth $95.3 million/annum to the Queensland economy, much of which is spent into regional economies. Consultation with communities in the region of Rocklands Reservoir reveal that many community members

believe that the demise of the Redfin fishery in Rocklands has had a significant impact on economic activity in the region.

The local community of Balmoral is reported to have been impacted by the decline of the Redfin fishery and trout fishery in Rocklands Reservoir and consultations have revealed that the economic impacts have been significant, although hard to quantify. Discussions with members of the Balmoral Angling Club and local business owners provided valuable insight into the regional value of a vibrant fishery with accounts of 7,000-10,000 day visitors and campers skiing and fishing during the peak Easter and post-Christmas periods. Further accounts of the volume of fuel and ice sales over these periods at the now closed service station along with the publicans account of an additional 3-4 full time staff 'when the reservoir was firing' support the well held position that rejuvenation of Rocklands Reservoir as a recreational fishery would greatly assist in supporting economic growth in the region.

The Victorian Fisheries Authority estimate the successful stocking of native fish in Rocklands Reservoir will attract an additional 10,000 recreational fishers each year and generate more than $6 million in economic expenditure in the region (from year 5) and create exciting recreational and social outcomes form both locals and travelling tourists.

# Appendix B – GHCMA fish data (2016)

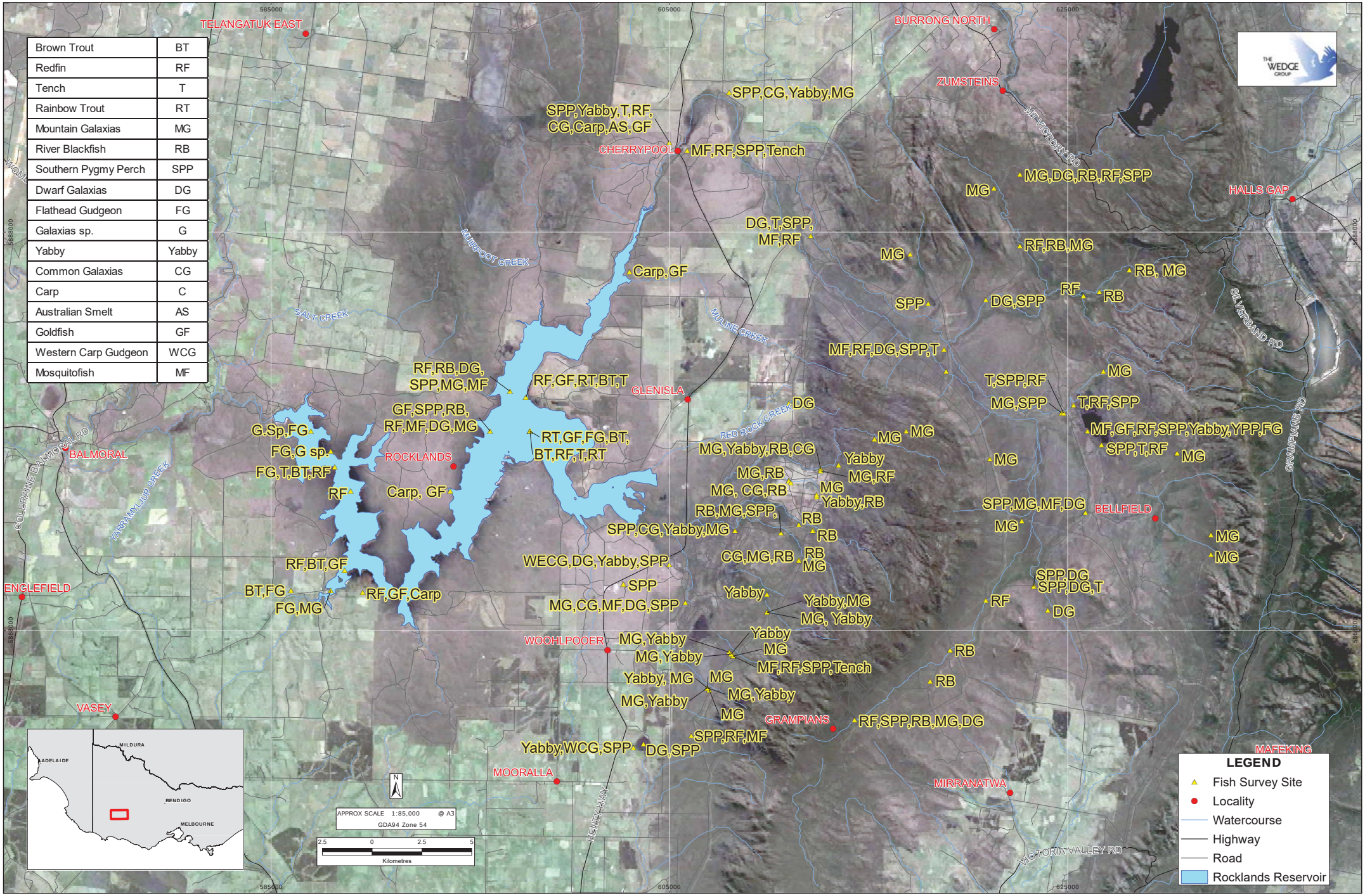



**Figure B1: Distribution of fish species in upper Glenelg River and Rocklands Reservoir (GHCMA compilation of fish capture data between 1969 and 2002)**

**Table B1: Fish recorded in the upper Glenelg catchment (above Rocklands reservoir) and Rocklands reservoir 1969 -2002 (GHCMA,2016)**

| WATER | LOCATION | COLLECT DATE | Site ID | COMMNAM | Text 22 | AGENCY |
|---|---|---|---|---|---|---|
| G6 | | 01-Sep-02 | 701 | Mosquitofish | 3 | Arthur Rylah Institute |
| | | 01-Sep-02 | 701 | Goldfish | 3 | Arthur Rylah Institute |
| | | 01-Sep-02 | 701 | Redfin | 3 | Arthur Rylah Institute |
| | | 01-Sep-02 | 701 | Southern Pygmy Perch | 3 | Arthur Rylah Institute |
| | | 01-Sep-02 | 701 | Yabby | 3 | Arthur Rylah Institute |
| | | 01-Sep-02 | 701 | Yarra Pygmy Perch | 3 | Arthur Rylah Institute |
| | | 01-Sep-02 | 701 | Flathead Gudgeon | 3 | Arthur Rylah Institute |
| G6 | a creek crossing Victoria Valley Road, south-west side of Moora Moora Reservoir | 09-Aug-74 | 610 | Southern Pygmy Perch | -999 | DSE (Aquatic fauna database) |
| | | 09-Aug-74 | 610 | Tench | -999 | DSE (Aquatic fauna database) |
| | | 09-Aug-74 | 610 | Redfin | -999 | DSE (Aquatic fauna database) |
| G6 | a tributary of on east side | 18-Oct-79 | 505 | Mountain Galaxias | -999 | DSE (Aquatic fauna database) |
| G6 | a tributary of, at Atterby Road | 18-Oct-79 | 574 | Southern Pygmy Perch | -999 | DSE (Aquatic fauna database) |
| | | 18-Oct-79 | 574 | Redfin | -999 | DSE (Aquatic fauna database) |
| | | 18-Oct-79 | 574 | Mosquitofish | -999 | DSE (Aquatic fauna database) |
| G6 | a tributary of, downstream of Moora Moora Reservoir | 18-Oct-79 | 392 | Mountain Galaxias | -999 | DSE (Aquatic fauna database) |
| | | 18-Oct-79 | 392 | Dwarf Galaxias | -999 | DSE (Aquatic fauna database) |
| | | 18-Oct-79 | 392 | River Blackfish | -999 | DSE (Aquatic fauna database) |
| | | 18-Oct-79 | 392 | Redfin | -999 | DSE (Aquatic fauna database) |
| | | 18-Oct-79 | 392 | Southern Pygmy Perch | -999 | DSE (Aquatic fauna database) |
| G6 | a tributary of, upstream of Glenisla Crossing | 18-Oct-79 | 506 | Mountain Galaxias | -999 | DSE (Aquatic fauna database) |
| G6 | Arm | 01-Feb-03 | 703 | Galaxias sp. | 4 | Peter Lind |
| | | 01-Feb-03 | 703 | Flathead Gudgeon | 210 | Peter Lind |
| G6 | at bridge on Harrop Track, Grampians National Park | 16-Aug-88 | 408 | River Blackfish | 10 | DSE (Aquatic fauna database) |
| G6 | at bridge on Harrop Track, Grampians National Park | 26-Nov-79 | 397 | River Blackfish | -999 | DSE (Aquatic fauna database) |
| | | 26-Nov-79 | 397 | Mountain Galaxias | -999 | DSE (Aquatic fauna database) |
| | | 26-Nov-79 | 397 | Southern Pygmy Perch | -999 | DSE (Aquatic fauna database) |
| | | 28-Nov-79 | 398 | Mountain Galaxias | -999 | DSE (Aquatic fauna database) |

| | | | | | | |
|---|---|---|---|---|---|---|
| | | 28-Nov-79 | 398 | River Blackfish | -999 | DSE (Aquatic fauna database) |
| | | 30-Mar-86 | 518 | Mountain Galaxias | -999 | DSE (Aquatic fauna database) |
| | | 16-Aug-88 | 522 | Mountain Galaxias | 2 | DSE (Aquatic fauna database) |
| | | 16-Aug-88 | 578 | Yabby | 2 | DSE (Aquatic fauna database) |
| | | 16-Aug-88 | 397 | Mountain Galaxias | 1 | DSE (Aquatic fauna database) |
| | | 16-Aug-88 | 397 | River Blackfish | 7 | DSE (Aquatic fauna database) |
| | | 16-Aug-88 | 522 | Yabby | 2 | DSE (Aquatic fauna database) |
| | | 16-Aug-88 | 397 | Yabby | 3 | DSE (Aquatic fauna database) |
| | | 16-Aug-88 | 409 | River Blackfish | 10 | DSE (Aquatic fauna database) |
| G6 | at bridge on Victoria Valley Highway | 06-Nov-79 | 396 | River Blackfish | -999 | DSE (Aquatic fauna database) |
| | | 06-Nov-79 | 396 | Mountain Galaxias | -999 | DSE (Aquatic fauna database) |
| G6 | at crossing on Goat Track | 15-Nov-94 | 536 | Mountain Galaxias | 2 | DSE (Aquatic fauna database) |
| G6 | at crossing on Goat Track, Grampians National Park | 18-Oct-79 | 507 | Mountain Galaxias | -999 | DSE (Aquatic fauna database) |
| | | 03-Nov-91 | 507 | Mountain Galaxias | -999 | DSE (Aquatic fauna database) |
| G6 | at crossing on Henham Track, Grampians National Park | 15-Nov-94 | 537 | Mountain Galaxias | 1 | DSE (Aquatic fauna database) |
| G6 | at crossing on Lodge Road, Grampians National Park | 17-Nov-94 | 570 | Dwarf Galaxias | 1 | DSE (Aquatic fauna database) |
| | | 17-Nov-94 | 570 | Southern Pygmy Perch | 1 | DSE (Aquatic fauna database) |
| G6 | at culvert on Harrop Track, Grampians National Park | 16-Aug-88 | 523 | Yabby | 2 | DSE (Aquatic fauna database) |
| | | 16-Aug-88 | 523 | Mountain Galaxias | 3 | DSE (Aquatic fauna database) |
| G6 | at ford on Harrop Track, Grampians National Park | 18-Oct-79 | 500 | Mountain Galaxias | -999 | DSE (Aquatic fauna database) |
| | | 16-Aug-88 | 500 | Mountain Galaxias | 6 | DSE (Aquatic fauna database) |
| | | 16-Aug-88 | 500 | Yabby | 3 | DSE (Aquatic fauna database) |
| G6 | at Hynes Road | 07-Dec-93 | 631 | Brown Trout | 1 | DSE (Aquatic fauna database) |
| | | 07-Dec-93 | 631 | Redfin | 75 | DSE (Aquatic fauna database) |
| | | 07-Dec-93 | 631 | Tench | 3 | DSE (Aquatic fauna database) |
| | | 22-Jun-94 | 631 | Brown Trout | 8 | DSE (Aquatic fauna database) |
| | | 22-Jun-94 | 631 | Rainbow Trout | 2 | DSE (Aquatic fauna database) |
| | | 22-Jun-94 | 631 | Redfin | 28 | DSE (Aquatic fauna database) |
| G6 | at Moora Track | 18-Oct-79 | 508 | Mountain Galaxias | -999 | DSE (Aquatic fauna database) |
| G6 | at Rose Creek Falls near Rose Creek Track | 07-Aug-74 | 492 | Mountain Galaxias | -999 | DSE (Aquatic fauna database) |
| | | 24-Sep-75 | 492 | Mountain Galaxias | -999 | DSE (Aquatic fauna database) |

| | | | | | | |
|---|---|---|---|---|---|---|
| *G6* | *at the wall* | *08-Dec-93* | *630* | *Brown Trout* | *1* | *DSE (Aquatic fauna database)* |
| | | *08-Dec-93* | *630* | *Redfin* | *22* | *DSE (Aquatic fauna database)* |
| | | *08-Dec-93* | *630* | *Tench* | *6* | *DSE (Aquatic fauna database)* |
| | | *21-Jun-94* | *630* | *Rainbow Trout* | *3* | *DSE (Aquatic fauna database)* |
| | | *21-Jun-94* | *630* | *Redfin* | *9* | *DSE (Aquatic fauna database)* |
| | | *21-Jun-94* | *630* | *Tench* | *1* | *DSE (Aquatic fauna database)* |
| | | *21-Jun-94* | *630* | *Brown Trout* | *39* | *DSE (Aquatic fauna database)* |
| *G6* | *at track crossing* | *18-Oct-79* | *501* | *Mountain Galaxias* | *-999* | *DSE (Aquatic fauna database)* |
| | | *18-Oct-79* | *501* | *Redfin* | *-999* | *DSE (Aquatic fauna database)* |
| | | *17-Dec-79* | *399* | *Redfin* | *-999* | *DSE (Aquatic fauna database)* |
| | | *17-Dec-79* | *399* | *River Blackfish* | *-999* | *DSE (Aquatic fauna database)* |
| | | *17-Dec-79* | *399* | *Mountain Galaxias* | *-999* | *DSE (Aquatic fauna database)* |
| *G6* | *at track crossing, upstream of Harrop Track* | *29-Jun-05* | *551* | *Mountain Galaxias* | *-999* | *DSE (Aquatic fauna database)* |
| *G6* | *at Victoria Valley Highway, Grampians* | *08-Aug-74* | *560* | *Southern Pygmy Perch* | *-999* | *DSE (Aquatic fauna database)* |
| | | *08-Aug-74* | *560* | *Dwarf Galaxias* | *-999* | *DSE (Aquatic fauna database)* |
| *G6* | *at Victoria Valley Road* | *09-Dec-81* | *515* | *Mountain Galaxias* | *-999* | *DSE (Aquatic fauna database)* |
| | | *09-Dec-81* | *515* | *Southern Pygmy Perch* | *-999* | *DSE (Aquatic fauna database)* |
| *G6* | *at Victoria Valley Road, Grampians* | *09-Aug-74* | *562* | *Southern Pygmy Perch* | *-999* | *DSE (Aquatic fauna database)* |
| | | *14-Apr-76* | *562* | *Dwarf Galaxias* | *-999* | *DSE (Aquatic fauna database)* |
| | | *18-Oct-79* | *562* | *Tench* | *-999* | *DSE (Aquatic fauna database)* |
| *G6* | *Big Cord, upstream of junction Green Creek* | *24-Apr-83* | *653* | *Redfin* | *-999* | *DSE (Aquatic fauna database)* |
| *G6* | *Broadies* | *01-Feb-03* | *704* | *Flathead Gudgeon* | *193* | *Peter Lind* |
| | | *01-Feb-03* | *704* | *Galaxias sp.* | *101* | *Peter Lind* |
| *G6* | *Cherrypool* | *01-Sep-02* | *684* | *Southern Pygmy Perch* | *3* | *Arthur Rylah Institute* |
| | | *01-Sep-02* | *684* | *Yabby* | *3* | *Arthur Rylah Institute* |
| | | *01-Sep-02* | *684* | *Tench* | *3* | *Arthur Rylah Institute* |
| | | *01-Sep-02* | *684* | *Redfin* | *3* | *Arthur Rylah Institute* |
| | | *01-Sep-02* | *684* | *Common Galaxias* | *3* | *Arthur Rylah Institute* |
| | | *01-Sep-02* | *684* | *Carp* | *3* | *Arthur Rylah Institute* |
| | | *01-Sep-02* | *684* | *Australian Smelt* | *3* | *Arthur Rylah Institute* |
| | | *01-Sep-02* | *684* | *Goldfish* | *3* | *Arthur Rylah Institute* |
| *G6* | *downstream of culvert on Harrop Track, Grampians National Park* | *04-Oct-79* | *498* | *Mountain Galaxias* | *18* | *DSE (Aquatic fauna database)* |
| *G6* | *downstream of Glenisla Crossing, Victoria Gap* | *18-Oct-79* | *565* | *Dwarf Galaxias* | *-999* | *DSE (Aquatic fauna database)* |

| | | | | | | |
|---|---|---|---|---|---|---|
| | | *18-Oct-79* | *565* | *Tench* | *-999* | *DSE (Aquatic fauna database)* |
| | | *18-Oct-79* | *565* | *Southern Pygmy Perch* | *-999* | *DSE (Aquatic fauna database)* |
| | | *18-Oct-79* | *565* | *Mosquitofish* | *-999* | *DSE (Aquatic fauna database)* |
| | | *18-Oct-79* | *565* | *Redfin* | *-999* | *DSE (Aquatic fauna database)* |
| *G6* | *drain into south end of Moora Moora Reservoir, at Victoria Valley Road* | *18-Oct-79* | *509* | *Southern Pygmy Perch* | *-999* | *DSE (Aquatic fauna database)* |
| | | *18-Oct-79* | *509* | *Mountain Galaxias* | *-999* | *DSE (Aquatic fauna database)* |
| | | *18-Oct-79* | *509* | *Mosquitofish* | *-999* | *DSE (Aquatic fauna database)* |
| | | *18-Oct-79* | *509* | *Dwarf Galaxias* | *-999* | *DSE (Aquatic fauna database)* |
| *G6* | *Fergusons* | *26-Feb-01* | *691* | *Carp* | *86* | *Fisheries Victoria* |
| | | *26-Feb-01* | *691* | *Goldfish* | *6* | *Fisheries Victoria* |
| *G6* | *from 20 m downstream to 80 m upstream of ford on Harrop Track, Grampians National Park* | *15-Aug-95* | *539* | *Mountain Galaxias* | *16* | *DSE (Aquatic fauna database)* |
| | | *15-Aug-95* | *539* | *Yabby* | *3* | *DSE (Aquatic fauna database)* |
| *G6* | *from 40 m downstream to 40 m upstream of ford on Harrop Track, Grampians National Park* | *15-Aug-95* | *584* | *Yabby* | *4* | *DSE (Aquatic fauna database)* |
| *G6* | *from 48 m downstream to 32 m upstream of bridge on Harrop Track, Grampians National Park* | *15-Aug-95* | *439* | *River Blackfish* | *25* | *DSE (Aquatic fauna database)* |
| *G6* | *from 50 m downstream to 50 m upstream of bridge on Harrop Track, Grampians National Park* | *02-May-96* | *443* | *Yabby* | *2* | *DSE (Aquatic fauna database)* |
| | | *02-May-96* | *443* | *River Blackfish* | *38* | *DSE (Aquatic fauna database)* |
| *G6* | *from 65 m downstream to 35 m upstream of culvert on B1 Track, Billywing State Forest* | *02-May-96* | *444* | *Mountain Galaxias* | *3* | *DSE (Aquatic fauna database)* |
| | | *02-May-96* | *444* | *Freshwater Shrimp* | *10* | *DSE (Aquatic fauna database)* |
| | | *02-May-96* | *444* | *Common Galaxias* | *6* | *DSE (Aquatic fauna database)* |
| | | *02-May-96* | *444* | *River Blackfish* | *13* | *DSE (Aquatic fauna database)* |
| *G6* | *from 65 m downstream to 35 m upstream of ford on Harrop Track, Grampians National Park* | *01-May-96* | *544* | *Yabby* | *3* | *DSE (Aquatic fauna database)* |
| | | *01-May-96* | *544* | *Mountain Galaxias* | *14* | *DSE (Aquatic fauna database)* |
| *G6* | *from 65 m downstream to 45 m upstream of bridge on Harrop Track, Grampians National Park* | *02-May-96* | *445* | *River Blackfish* | *26* | *DSE (Aquatic fauna database)* |
| *G6* | *from 70 m downstream to 15 m upstream of bridge on Harrop Track, Grampians National Park* | *15-Aug-95* | *440* | *River Blackfish* | *17* | *DSE (Aquatic fauna database)* |

| | | | | | | |
|---|---|---|---|---|---|---|
| *G6* | *from 70 m downstream to 30 m upstream of bridge on Harrop Track, Grampians National Park* | *01-May-96* | *545* | *Yabby* | *9* | *DSE (Aquatic fauna database)* |
| | | *01-May-96* | *545* | *Mountain Galaxias* | *124* | *DSE (Aquatic fauna database)* |
| | | *01-May-96* | *442* | *Common Galaxias* | *1* | *DSE (Aquatic fauna database)* |
| | | *01-May-96* | *442* | *Mountain Galaxias* | *5* | *DSE (Aquatic fauna database)* |
| | | *01-May-96* | *442* | *River Blackfish* | *50* | *DSE (Aquatic fauna database)* |
| *G6* | *from 80 m downstream to 15 m upstream of bridge on Harrop Track, Grampians National Park* | *02-May-96* | *446* | *Mountain Galaxias* | *6* | *DSE (Aquatic fauna database)* |
| | | *02-May-96* | *446* | *Yabby* | *3* | *DSE (Aquatic fauna database)* |
| | | *02-May-96* | *446* | *River Blackfish* | *21* | *DSE (Aquatic fauna database)* |
| | | *02-May-96* | *446* | *Common Galaxias* | *96* | *DSE (Aquatic fauna database)* |
| *G6* | *from culvert on Harrop Track to 100 m downstream, Grampians National Park* | *01-May-96* | *546* | *Mountain Galaxias* | *14* | *DSE (Aquatic fauna database)* |
| | | *01-May-96* | *546* | *Yabby* | *-999* | *DSE (Aquatic fauna database)* |
| *G6* | *from ford on Harrop Track to 50 m downstream, Grampians National Park* | *15-Aug-95* | *585* | *Yabby* | *5* | *DSE (Aquatic fauna database)* |
| *G6* | *from ford on Shillcock Track to 30 m upstream, Grampians National Park* | *01-May-96* | *488* | *Southern Pygmy Perch* | *3* | *DSE (Aquatic fauna database)* |
| | | *01-May-96* | *488* | *Common Galaxias* | *5* | *DSE (Aquatic fauna database)* |
| | | *01-May-96* | *488* | *Yabby* | *9* | *DSE (Aquatic fauna database)* |
| | | *01-May-96* | *488* | *Mountain Galaxias* | *1* | *DSE (Aquatic fauna database)* |
| *G6* | *Glendinning* | *13-Mar-01* | *689* | *Brown Trout* | *1* | *Fisheries Victoria* |
| | | *01-Feb-03* | *689* | *Flathead Gudgeon* | *174* | *Peter Lind* |
| *G6* | *Glendinning Arm* | *15-Jul-98* | *201* | *Redfin* | *10* | *PIRViC* |
| | | *15-Jul-98* | *201* | *Brown Trout* | *6* | *PIRViC* |
| | | *15-Jul-98* | *201* | *Goldfish* | *3* | *PIRViC* |
| *G6* | *headwaters* | *18-Oct-79* | *395* | *Redfin* | *-999* | *DSE (Aquatic fauna database)* |
| | | *18-Oct-79* | *395* | *Southern Pygmy Perch* | *-999* | *DSE (Aquatic fauna database)* |
| | | *18-Oct-79* | *395* | *River Blackfish* | *-999* | *DSE (Aquatic fauna database)* |
| | | *18-Oct-79* | *395* | *Mountain Galaxias* | *-999* | *DSE (Aquatic fauna database)* |
| | | *18-Oct-79* | *395* | *Dwarf Galaxias* | *-999* | *DSE (Aquatic fauna database)* |
| *G6* | *Hynes* | *14-Mar-01* | *721* | *Redfin* | *28* | *Fisheries Victoria* |
| *G6* | *Hynes Road* | *19-Jul-89* | *198* | *Redfin* | *16* | *PIRViC* |
| | | *30-Apr-91* | *198* | *Goldfish* | *2* | *PIRViC* |
| | | *30-Apr-91* | *198* | *Rainbow Trout* | *9* | *PIRViC* |
| | | *30-Apr-91* | *198* | *Redfin* | *28* | *PIRViC* |

| | | | | | | |
|---|---|---|---|---|---|---|
| | | 30-Apr-91 | 198 | Brown Trout | 59 | PIRViC |
| | | 30-Apr-91 | 198 | Tench | 3 | PIRViC |
| | | 01-May-91 | 198 | Redfin | 26 | PIRViC |
| | | 01-May-91 | 198 | Brown Trout | 30 | PIRViC |
| | | 01-May-91 | 198 | Rainbow Trout | 4 | PIRViC |
| | | 01-May-91 | 198 | Tench | 1 | PIRViC |
| | | 02-Jun-93 | 198 | Brown Trout | 1 | PIRViC |
| | | 22-Jun-93 | 198 | Redfin | 33 | PIRViC |
| | | 22-Jun-93 | 198 | Brown Trout | 20 | PIRViC |
| | | 07-Dec-93 | 198 | Tench | 3 | PIRViC |
| | | 07-Dec-93 | 198 | Redfin | 75 | PIRViC |
| | | 07-Dec-93 | 198 | Brown Trout | 1 | PIRViC |
| | | 23-Jun-94 | 198 | Redfin | 28 | PIRViC |
| | | 23-Jun-94 | 198 | Rainbow Trout | 2 | PIRViC |
| | | 23-Jun-94 | 198 | Brown Trout | 8 | PIRViC |
| | | 15-Sep-95 | 198 | Brown Trout | 16 | PIRViC |
| | | 15-Sep-95 | 198 | Rainbow Trout | 1 | PIRViC |
| | | 15-Sep-95 | 198 | Redfin | 15 | PIRViC |
| | | 13-Feb-97 | 198 | Redfin | 20 | PIRViC |
| | | 13-Feb-97 | 198 | Tench | 2 | PIRViC |
| | | 13-Feb-97 | 198 | Goldfish | 3 | PIRViC |
| | | 09-Jul-97 | 198 | Rainbow Trout | 10 | PIRViC |
| | | 09-Jul-97 | 198 | Brown Trout | 2 | PIRViC |
| | | 09-Jul-97 | 198 | Redfin | 11 | PIRViC |
| G6 | in fire dam at south-west edge, near stand pipe | 30-Apr-96 | 365 | Yabby | 8 | DSE (Aquatic fauna database) |
| | | 30-Apr-96 | 365 | Western Carp Gudgeon | 15 | DSE (Aquatic fauna database) |
| | | 30-Apr-96 | 365 | Southern Pygmy Perch | 6 | DSE (Aquatic fauna database) |
| G6 | in pool immediately downstream of ford on Old Billywing track, just downstream of outlet from Ming Ming Swamp, Grampians National Park | 30-Apr-96 | 487 | Mountain Galaxias | 10 | DSE (Aquatic fauna database) |
| | | 30-Apr-96 | 487 | Common Galaxias | 70 | DSE (Aquatic fauna database) |
| | | 30-Apr-96 | 487 | Mosquitofish | 10 | DSE (Aquatic fauna database) |
| | | 30-Apr-96 | 487 | Dwarf Galaxias | 70 | DSE (Aquatic fauna database) |
| | | 30-Apr-96 | 487 | Southern Pygmy Perch | 650 | DSE (Aquatic fauna database) |
| G6 | just upstream of Harrop Track | 22-Apr-64 | 491 | Mountain Galaxias | -999 | DSE (Aquatic fauna database) |

| | | | | | | |
|---|---|---|---|---|---|---|
| *G6* | *just upstream of Harrop Track, Grampians National Park* | *18-Oct-79* | *510* | *Mountain Galaxias* | *-999* | *DSE (Aquatic fauna database)* |
| *G6* | *near Cherrypool, top of Rocklands Reservoir* | *18-Oct-79* | *575* | *Mosquitofish* | *-999* | *DSE (Aquatic fauna database)* |
| | | *18-Oct-79* | *575* | *Redfin* | *-999* | *DSE (Aquatic fauna database)* |
| | | *18-Oct-79* | *575* | *Southern Pygmy Perch* | *-999* | *DSE (Aquatic fauna database)* |
| | | *18-Oct-79* | *575* | *Tench* | *-999* | *DSE (Aquatic fauna database)* |
| *G6* | *near Harrop Track, east of Woohlpooer* | *12-Aug-74* | *494* | *Mountain Galaxias* | *-999* | *DSE (Aquatic fauna database)* |
| *G6* | *near intersection of Moora Moora Track and Lodge Road, Grampians* | | | | | |
| | | *08-Aug-74* | *642* | *Redfin* | *-999* | *DSE (Aquatic fauna database)* |
| *G6* | *near outlet into Moora Moora Channel* | *18-Oct-79* | *613* | *Tench* | *-999* | *DSE (Aquatic fauna database)* |
| | | *18-Oct-79* | *613* | *Redfin* | *-999* | *DSE (Aquatic fauna database)* |
| | | *18-Oct-79* | *613* | *Southern Pygmy Perch* | *-999* | *DSE (Aquatic fauna database)* |
| *G6* | *near Victoria Valley Highway* | *08-Aug-74* | *379* | *River Blackfish* | *-999* | *DSE (Aquatic fauna database)* |
| *G6* | *north of Brooks Road* | *22-Mar-01* | *695* | *Carp* | *31* | *Fisheries Victoria* |
| | | *22-Mar-01* | *695* | *Goldfish* | *25* | *Fisheries Victoria* |
| *G6* | *north-east side of Moora Moora Reservoir* | *08-Aug-74* | *493* | *Mountain Galaxias* | *-999* | *DSE (Aquatic fauna database)* |
| *G6* | *north-north-east of Mt. Thackery* | *29-Mar-86* | *517* | *Mountain Galaxias* | *-999* | *DSE (Aquatic fauna database)* |
| *G6* | *Not Supplied* | *14-Sep-69* | *341* | *Rainbow Trout* | *-999* | *DSE (Aquatic fauna database)* |
| | | *14-Sep-69* | *341* | *Goldfish* | *-999* | *DSE (Aquatic fauna database)* |
| | | *14-Sep-69* | *341* | *Flathead Gudgeon* | *-999* | *DSE (Aquatic fauna database)* |
| | | *14-Sep-69* | *341* | *Brown Trout* | *-999* | *DSE (Aquatic fauna database)* |
| | | *14-Sep-69* | *341* | *Tench* | *-999* | *DSE (Aquatic fauna database)* |
| | | *22-May-74* | *341* | *Redfin* | *-999* | *DSE (Aquatic fauna database)* |
| | | *18-Oct-79* | *564* | *Dwarf Galaxias* | *-999* | *DSE (Aquatic fauna database)* |
| | | *18-Oct-79* | *564* | *Southern Pygmy Perch* | *-999* | *DSE (Aquatic fauna database)* |
| | | *01-Jan-81* | *341* | *River Blackfish* | *-999* | *DSE (Aquatic fauna database)* |
| | | *28-Apr-87* | *341* | *Redfin* | *1* | *DSE (Aquatic fauna database)* |
| | | *28-Apr-87* | *341* | *Brown Trout* | *2* | *DSE (Aquatic fauna database)* |
| | | *18-Jul-89* | *341* | *Redfin* | *25* | *DSE (Aquatic fauna database)* |
| | | *22-Jun-93* | *341* | *Tench* | *3* | *DSE (Aquatic fauna database)* |
| | | *22-Jun-93* | *341* | *Brown Trout* | *56* | *DSE (Aquatic fauna database)* |
| | | *22-Jun-93* | *341* | *Redfin* | *47* | *DSE (Aquatic fauna database)* |
| | | *22-Jun-93* | *341* | *Rainbow Trout* | *1* | *DSE (Aquatic fauna database)* |
| | | *30-Jan-00* | *639* | *Flathead Gudgeon* | *11* | *DSE (Aquatic fauna database)* |

| | | | | | | |
|---|---|---|---|---|---|---|
| | | 30-Jan-00 | 639 | Tench | 6 | DSE (Aquatic fauna database) |
| | | 30-Jan-00 | 639 | Brown Trout | 4 | DSE (Aquatic fauna database) |
| | | 31-Jan-00 | 639 | Flathead Gudgeon | 10 | DSE (Aquatic fauna database) |
| | | 31-Jan-00 | 639 | Freshwater Shrimp | 0 | DSE (Aquatic fauna database) |
| | | 31-Jan-00 | 639 | Tench | 2 | DSE (Aquatic fauna database) |
| | | 31-Jan-00 | 639 | Brown Trout | 7 | DSE (Aquatic fauna database) |
| | | 31-Jan-00 | 639 | Redfin | 1 | DSE (Aquatic fauna database) |
| G6 | off old Adelaide Road | 01-Sep-02 | 698 | Southern Pygmy Perch | 3 | Arthur Rylah Institute |
| | | 01-Sep-02 | 698 | Common Galaxias | 3 | Arthur Rylah Institute |
| G6 | off unnamed track off Henty Highway | 02-May-96 | 571 | Western Carp Gudgeon | 3 | DSE (Aquatic fauna database) |
| | | 02-May-96 | 571 | Dwarf Galaxias | 7 | DSE (Aquatic fauna database) |
| | | 02-May-96 | 571 | Yabby | 37 | DSE (Aquatic fauna database) |
| | | 02-May-96 | 571 | Southern Pygmy Perch | 40 | DSE (Aquatic fauna database) |
| G6 | Red Rock picnic area | 10-Mar-77 | 563 | Dwarf Galaxias | -999 | DSE (Aquatic fauna database) |
| G6 | Rocklands Dissipation pool | 07-Mar-01 | 692 | Redfin | 50 | Fisheries Victoria |
| | | 07-Mar-01 | 692 | Goldfish | 45 | Fisheries Victoria |
| | | 07-Mar-01 | 692 | Carp | 5 | Fisheries Victoria |
| G6 | Rocklands Wall (within dam) | 01-Feb-03 | 702 | Galaxias sp. | 6 | Peter Lind |
| | | 01-Feb-03 | 702 | Flathead Gudgeon | 36 | Peter Lind |
| G6 | swamp near Rocklands Reservoir, south of Henty Highway | 18-Oct-79 | 614 | Southern Pygmy Perch | -999 | DSE (Aquatic fauna database) |
| G6 | swamp off Glenelg River, near Moora Moora channel | 18-Oct-79 | 615 | Southern Pygmy Perch | -999 | DSE (Aquatic fauna database) |
| G6 | upper reaches, Grampians National Park | 18-Oct-79 | 511 | Mountain Galaxias | -999 | DSE (Aquatic fauna database) |
| G6 | upstream of Big Cord, at junction with Boundary Road | 09-Aug-74 | 380 | River Blackfish | -999 | DSE (Aquatic fauna database) |
| G6 | upstream of Moora Moora Reservoir, Grampians | 26-Aug-75 | 561 | Dwarf Galaxias | -999 | DSE (Aquatic fauna database) |
| G6 | upstream of Victoria Gap | 18-Oct-79 | 568 | Mosquitofish | -999 | DSE (Aquatic fauna database) |
| | | 18-Oct-79 | 568 | Redfin | -999 | DSE (Aquatic fauna database) |
| | | 18-Oct-79 | 568 | Dwarf Galaxias | -999 | DSE (Aquatic fauna database) |
| | | 18-Oct-79 | 568 | Southern Pygmy Perch | -999 | DSE (Aquatic fauna database) |
| | | 18-Oct-79 | 568 | Tench | -999 | DSE (Aquatic fauna database) |
| G6 | upstream of Victoria Valley Road, downstream of Moora Moora Reservoir | 18-Oct-79 | 616 | Tench | -999 | DSE (Aquatic fauna database) |
| | | 18-Oct-79 | 616 | Southern Pygmy Perch | -999 | DSE (Aquatic fauna database) |

| | | | | | | |
|---|---|---|---|---|---|---|
| | | *18-Oct-79* | *616* | *Redfin* | *-999* | *DSE (Aquatic fauna database)* |
| *G6* | *various sites* | *18-Oct-79* | *344* | *Goldfish* | *-999* | *DSE (Aquatic fauna database)* |
| | | *18-Oct-79* | *344* | *Southern Pygmy Perch* | *-999* | *DSE (Aquatic fauna database)* |
| | | *18-Oct-79* | *344* | *River Blackfish* | *-999* | *DSE (Aquatic fauna database)* |
| | | *18-Oct-79* | *344* | *Redfin* | *-999* | *DSE (Aquatic fauna database)* |
| | | *18-Oct-79* | *344* | *Mosquitofish* | *-999* | *DSE (Aquatic fauna database)* |
| | | *18-Oct-79* | *344* | *Dwarf Galaxias* | *-999* | *DSE (Aquatic fauna database)* |
| | | *18-Oct-79* | *344* | *Mountain Galaxias* | *-999* | *DSE (Aquatic fauna database)* |
| *G6* | *various tributaries* | *18-Oct-79* | *345* | *Redfin* | *-999* | *DSE (Aquatic fauna database)* |
| | | *18-Oct-79* | *345* | *River Blackfish* | *-999* | *DSE (Aquatic fauna database)* |
| | | *18-Oct-79* | *345* | *Dwarf Galaxias* | *-999* | *DSE (Aquatic fauna database)* |
| | | *18-Oct-79* | *345* | *Goldfish* | *-999* | *DSE (Aquatic fauna database)* |
| | | *18-Oct-79* | *345* | *Southern Pygmy Perch* | *-999* | *DSE (Aquatic fauna database)* |
| | | *18-Oct-79* | *345* | *Mountain Galaxias* | *-999* | *DSE (Aquatic fauna database)* |
| | | *18-Oct-79* | *345* | *Mosquitofish* | *-999* | *DSE (Aquatic fauna database)* |
| *G6* | *Victoria Valley Road, The Grampian Ranges* | *28-May-82* | *404* | *River Blackfish* | *-999* | *DSE (Aquatic fauna database)* |
| *G6* | *west-south-west of Moora Moora Reservoir* | *18-Oct-79* | *512* | *Mountain Galaxias* | *-999* | *DSE (Aquatic fauna database)* |

# Appendix C –Austral (2014) and Lieschke et. al. (2013) fish survey results

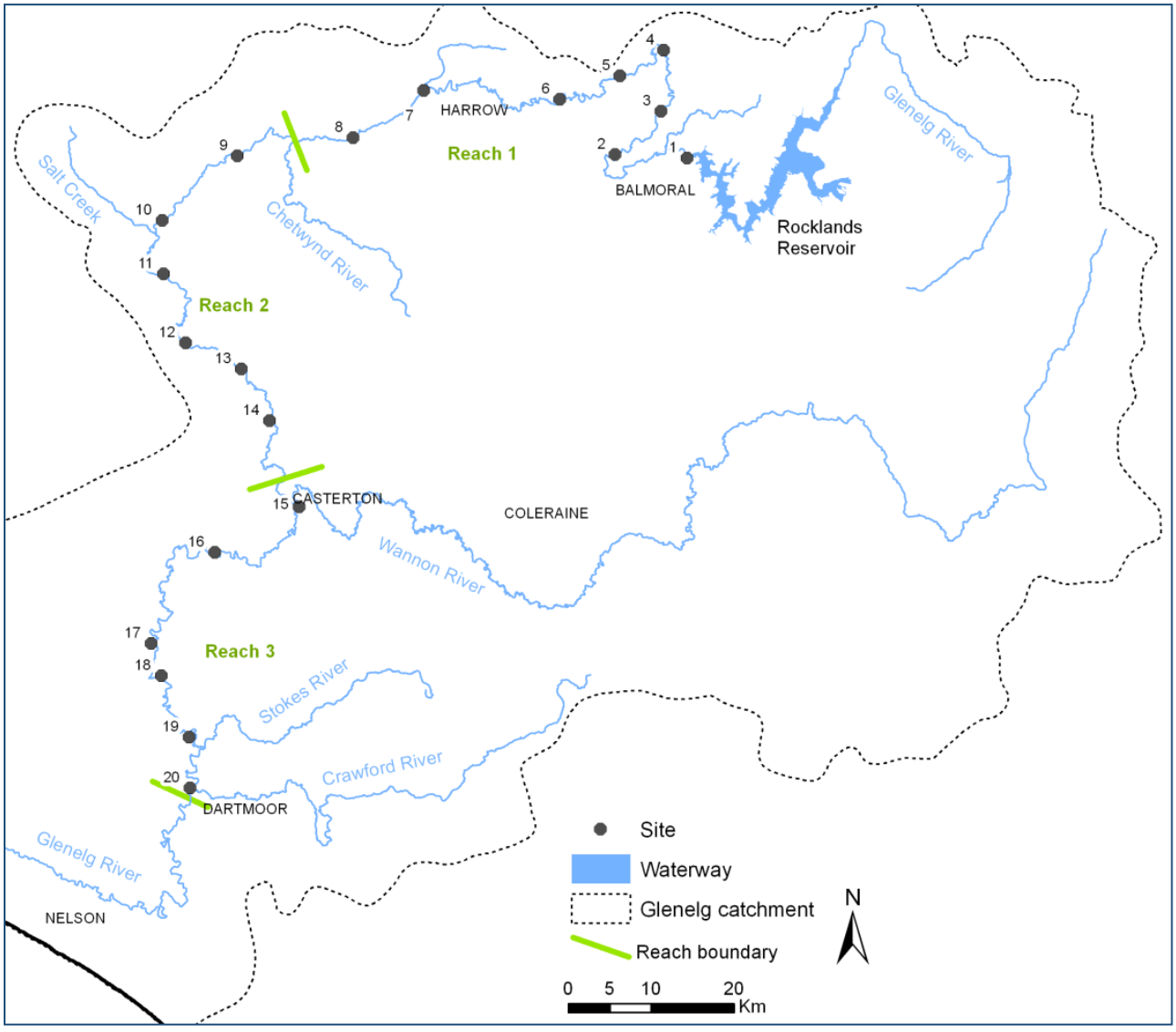



**Figure C.1: VEFMAP Survey sites and reach locations in the lower Glenelg River (Austral,2014)**

**Table C.1: Summary of total fish captures by reach in the lower Glenelg River (Austral 2014)**

| Category | Common name | Reach 1 | Reach 2 | Reach 3 | Total |
|---|---|---|---|---|---|
| **Marine Vagrant** | Southern black bream | | | 39 | 39 |
| | Yellow-eye mullet | | | 2 | 2 |
| **Migratory** | Australian smelt | 2 | 45 | 18 | 65 |
| | Common galaxias | | | 17 | 17 |
| | Estuary perch | | 3 | 38 | 41 |
| | Short-finned eel | | | 3 | 3 |
| | Tupong | 5 | 16 | 25 | 46 |
| **Non-endemic native** | Australian bass | 5 | | | 5 |
| | Carp gudgeon | 39 | 2 | | 41 |
| **Non-migratory** | Flathead gudgeon | 53 | 192 | 114 | 359 |
| | River blackfish | 32 | 38 | 158 | 228 |
| | Southern pygmy perch | 66 | | 30 | 96 |
| | Variegated pygmy perch | 2 | 33 | 93 | 128 |
| **Exotic** | Common carp | 51 | 35 | | 86 |
| | Eastern gambusia | 41 | 101 | 8 | 150 |
| | Goldfish | 44 | 1 | | 45 |
| | Redfin perch | 64 | | | 64 |
| | Tench | 7 | 7 | 4 | 18 |
| **Fish abundance** | | 411 | 473 | 549 | 1433 |
| **No. of native species** | | 8 | 7 | 11 | 13 |
| **No. of exotic species** | | 5 | 4 | 2 | 5 |
| **Other aquatic biota** | | | | | |
| *Invertebrates* | Glenelg spiny freshwater crayfish | | | 1 | 1 |
| | Yabby | 12 | 10 | 14 | 36 |
| *Vertebrates* | Eastern long neck turtle | | 6 | 13 | 19 |

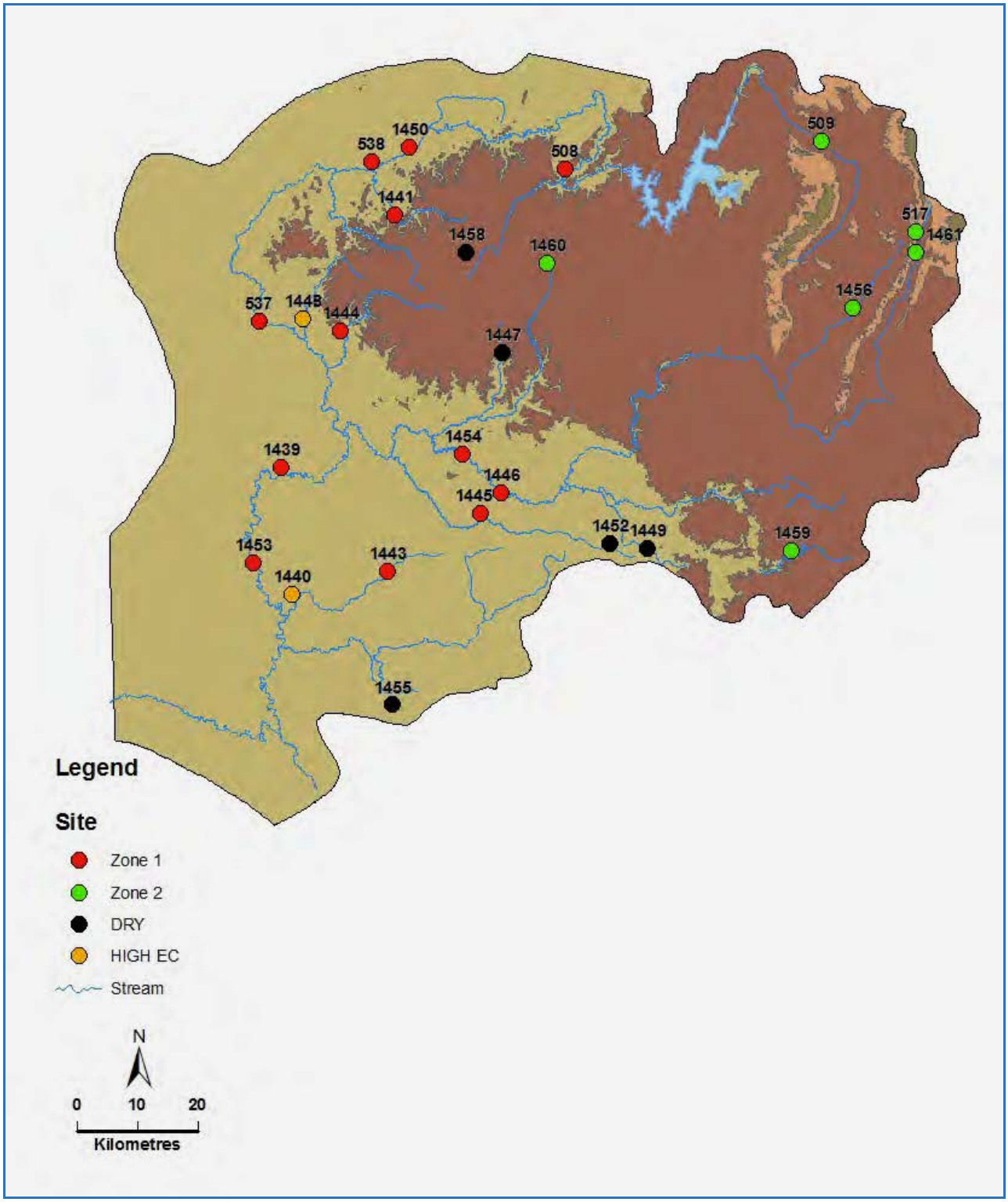



Figure C.2: Fish sampling locations (Lieschke 2013)

Table C.2: Summary of fish species captured at each location (Lieschke et al 2013)

| Reference Condition Species List | Site Number | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 508 | 537 | 538 | 1439 | 1441 | 1443 | 1444 | 1445 | 1446 | 1450 | 1453 | 1454 | 509 | 517 | 1456 | 1459 | 1460 | 1461 |
| River Blackfish (T) | ✓ | ✓ | | ✓ | | ✓ | | | | | ✓ | ✓ | | ✓ | | | | ✓ |
| Obscure Galaxias | | | | | | | | ✓ | | | | | ✓ | | | | | ✓ |
| Western Plains Galaxiella (T) | | | | | | | | ✓ | | | | | ✓ | | | | | |
| Estuary Perch | | ✓ | | | | | | | | | | | | | | | | |
| Southern Pygmy Perch | | ✓ | ✓ | | | ✓ | | ✓ | | ✓ | | | ✓ | | | ✓ | | ✓ |
| Yarra Pygmy Perch (T) | | | | | | ✓ | | | | | ✓ | ✓ | | | | | | |
| Variegated Pygmy Perch (T) | ✓ | ✓ | ✓ | ✓ | | | | | ✓ | | ✓ | ✓ | | | | | | |
| Flat-headed Gudgeon | ✓ | ✓ | ✓ | ✓ | | | ✓ | | ✓ | ✓ | | ✓ | ✓ | | | | | |
| Short-finned Eel | | | | | | | | | | | | | | | | | | |
| Broad-finned Galaxias | | | | | | | | | | | | | | | | | | |
| Common Galaxias | | | | | ✓ | ✓ | ✓ | | | | ✓ | | ✓ | ✓ | | | | |
| Spotted Galaxias | | | | | | | | | | | | | | | | | | |
| Pouched Lamprey | | | | | | | | | | | | | | | | | | |
| Short-headed Lamprey | | | | | | | | | | | | | | | | | | |
| Australian Mudfish (T) | | | | | | | | | | | | | | | | | | |
| Australian Grayling (T) | | | | | | | | | | | | | | | | | | |
| Tupong | | | | | | | | | | | | | | | | | | |
| Australian Smelt | ✓ | | ✓ | ✓ | | | | | ✓ | | | | | | | | | |
| Carp Gudgeon complex | ✓ | | | | | ✓ | ✓ | | | | | | ✓ | | ✓ | ✓ | | |
| Australian Bass | ✓ | | | | | | | | | | | | | | | | | |
| Goldfish | ✓ | | ✓ | | | | | | | ✓ | | | | | | | | |
| Carp | | | | | | | | | | ✓ | | | | | | | | |
| Eastern Gambusia | ✓ | | ✓ | ✓ | | | | | | ✓ | ✓ | | ✓ | | | | | |
| Redfin | ✓ | ✓ | ✓ | | | | | | ✓ | | | | | | | ✓ | ✓ | |
| Tench | ✓ | ✓ | | | | | ✓ | | | ✓ | | | | | | | | |

T – threatened species (as listed in Table 4 in Part A).

Lowland | Slopes | Upland | Montane

Non-migratory | Migratory | Introduced Native | Alien Species

**Table C.3: Zone distribution of fish captured (Lieschke et al 2013)**

| Common Name | Scientific Name | Lowland | Slopes | Total |
|---|---|---|---|---|
| **Native** | | | | |
| Obscure Galaxias | *Galaxias* sp.1 | 45 | 567 | 612 |
| Southern Pygmy Perch | *Nannoperca australis* | 50 | 334 | 384 |
| Australian Smelt | *Retropinna semoni* | 294 | 0 | 294 |
| Western Plains Galaxiella | *Galaxiella* sp. | 1 | 158 | 159 |
| Yarra Pygmy Perch | *Nannoperca obscura* | 155 | 0 | 155 |
| Flat-headed Gudgeon | *Philypnodon grandiceps* | 100 | 4 | 104 |
| River Blackfish | *Gadopsis marmoratus* | 15 | 57 | 72 |
| Variegated Pygmy Perch | *Nannoperca variegata* | 59 | | 59 |
| Common Galaxias | *Galaxias maculatus* | 22 | 33 | 55 |
| Estuary Perch | *Macquaria colonorum* | 1 | | 1 |
| Australian Grayling | *Prototroctes maraena* | 0 | | 0 |
| Australian Mudfish | *Neochanna cleaveri* | 0 | | 0 |
| Broad-finned Galaxias | *Galaxias brevipinnis* | 0 | 0 | 0 |
| Pouched Lamprey | *Geotria australis* | 0 | | 0 |
| Short-finned Eel | *Anguilla australis* | 0 | 0 | 0 |
| Short-headed Lamprey | *Mordacia mordax* | 0 | 0 | 0 |
| Spotted Galaxias | *Galaxias truttaceus* | 0 | | 0 |
| Tupong | *Pseudaphritis urvillii* | 0 | 0 | 0 |
| Native Total | | **742** | **1153** | **1895** |
| **Alien** | | | | |
| Redfin | *Perca fluviatilis* | 9 | 257 | 266 |
| Eastern Gambusia | *Gambusia holbrooki* | 84 | 8 | 92 |
| Carp Gudgeon complex* | *Hypseleotris* spp. | 27 | 26 | 53 |
| Goldfish | *Carassius auratus* | 11 | | 11 |
| Tench | *Tinca tinca* | 11 | | 11 |
| Carp | *Cyprinus carpio* | 4 | | 4 |
| Australian Bass* | *Macquaria novemaculeata* | 3 | | 3 |
| Alien Total | | **149** | **291** | **440** |
| Total Fish | | **891** | **1444** | **2335** |

Zero scores represent zones where a species was not collected, but predicted to be collected under the Reference Condition. Blank cells indicate a species was not predicted to be collected under Reference Condition.

* – introduced native species.

# Appendix D – Stakeholder Engagement Summary

| Stakeholders | Key Points |
|---|---|
| **Murray Burns** (DEDJTR, Fisheries Victoria-Horsham)<br>**Engagement Method:** Rocklands site inspection and discussion | ▪ Carp first recorded around 1992<br>▪ Traditionally a bait fishery (small fin fish) for RF and Trout, this has transitioned over recent years toward more lure fishers.<br>▪ Systemic illegal stocking (MC, GP, RF) over may years<br>▪ Reasonably sterile water body with the more ecologically productive areas U/S of Ferguson's and this area is not likely to see water in the majority of years going forward.<br>▪ Significant investment by Parks et al in infrastructure upgrades (new toilet blocks etc.); almost full perimeter access with good camping and boat access.<br>▪ Historically a great RF fishery, less productive for Trout<br>▪ Sterile with relatively low stocking capacity (at odds with some rec fisher and agency opinion)<br>▪ Current water management regime will have significant impact on the fishery going forward, irrespective of species (carrying capacity etc.)<br>▪ Generally supports current stocking policy, but also of the opinion that RF (if they recover to pre millennium drought conditions) would satisfy rec fishers and be largely sustainable. |
| Balmoral Angling Club<br>**Engagement Method:** Forum style meeting with ~28 members at the Western Hotel, Balmoral | ▪ Very informed group with sound knowledge of their fishery<br>▪ Critical of the current water management regime that seems to favour down steam environs over the within storage environment.<br>▪ Wanted to know what studies have been done in in the res and upper Glenelg to identify the location and abundance of the threatened species (small bodied natives and spiny cray)<br>▪ Carp screens – concerns raised by a number of people as to their effectiveness. All species trapped are killed (anecdotal).<br>▪ Members reiterated that the fishery is classified as a mixed fishery and that the introduction of carp has been detrimental.<br>▪ Have seen significant decline in the RF fishery over the past 20 years<br>▪ Positive discussion on the possible benefits of the Carp virus<br>▪ Discussion around the new Max and Min operating levels with people questioning the viability of the minimum operating level being only a guide and GWMW can draw down below this point |

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| | ▪ Min operating level is well below the prime feeding grounds (Glendenning Arm and above Hynes')<br>▪ IF level are to be kept low then species stocked need to return the best value for money – i.e. which species will perform better in the lower levels<br>▪ From a socio-economic perspective ~20% full was the old trigger for visitation<br>▪ Upward of 10,000 people have been recoded camping around the lake at peak times (Christmas and Easter holidays)<br>▪ Observations of the Service Station needing three ice deliveries a day and 10K lt of fuel a day and pub needing 3-5FTE/day, now shop closed and the pub operates with 1-2 staff<br>▪ Trevor Holmes – comments on healthy RF population below Rocklands; view screens must work because Carp not seen in numbers in Toolondo<br>▪ Pre millennium drought and more so pre carp the clubs Easter fishing comp would regularly involve 600-700ppl and up to $10K in prizes<br>Values<br>▪ Community place a huge value on the social and amenity aspects of having such a great storage and surrounding environment (access, free camping etc) in the region.<br>▪ Significant value placed on a productive fishery and are fully supportive of a large stocking program. Preference was for Cod (given icon status) and EP's<br>▪ Those that fish for Bass in the res can see benefits of a large EP fishery, although some were concerned as to the effectiveness (being a low light feeder)<br>▪ Some would love to see carp gone and a return of the RF in numbers<br>▪ Equitable water management was critical. |
| Glenelg Hopkins CMA; (Stephen Ryan, Bryce Morden and Helen Arundel)<br>**Engagement Method:** Face to Face meeting – GH CMA Hamilton (Helen Arundel on teleconference) | ▪ SR raised the current discussions around Rec Fishing being a threatening process under EPBC. Recreational fishing is not currently listed as a threatening process under the EPBC Act or the FFG Act (Vic);<br>▪ CMA have or are developing action plans for the Threatened Species; Spiny Crayfish are the highest priority threatened species<br>▪ SR – concerned around the 'cod predating on carp argument' and a management tool previously put forward from community. Agreed it's not the focus this time.<br>▪ CMA particularly concerned about possible impacts stocking would have on the D/S environment<br>▪ Some numbers of Catfish below wall – limited data available<br>▪ Judas carp project - most fish caught are from the 10/11 breeding event (weir didn't spill, 1996 was last spill)<br>▪ No CMA monitoring data on carp screens (GWMW responsibility)<br>o Some large bodied fish removed (RF/Cod) - at odds with subsequent operator discussion – 3 Cod removed from separator, large RF removed to eat !<br>o Turtles removed<br>▪ CMA very keen to hear what rec fishers had to say about the proposal to stock Rocklands and noted the CMA's impending community monitoring events<br>▪ Emerging new literature around reclassification of some species that may change their conservation status, for example the little galaxid - potentially higher status; possible splitting of the blackfish into a new species….<br>▪ SR questioned how these would be considered in the RA (new species of Mountain Galaxia etc.); General response was 'the same as other threatened species' |

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| | ▪ Discussion on offsets and or possible mitigating strategies should stocking be approved<br>o CMA preference to not entertain the topic initially (but have been talking with ARI on compiling information on a number of possible offset initiatives)<br>o HA was keen to ensure that if offsets were introduced that they have security into the future (not just a one off)<br>▪ CMA offered no real insights into the development of the current water sharing arrangements, indicating that is was all basically down to GWMW and that they had some issues with the distribution, particularly the 2006 shared environmental entitlement with the Wimmera River.<br>▪ SR provided a comprehensive download of additional data and reports |
| GWM Water; Bernie Dunn<br>**Engagement Method:** Site meeting at Rocklands Reservoir (CDS inspection) | ▪ Bernie is coordinating the development of the draft rec management plan for Rocklands; they are waiting to see outcome of Stocking assessment before finalising<br>▪ Discussed history of the storage, the current managementregime (provided subsequently in an email)<br>▪ Discussed sharing arrangements and impacts of Max and Min op levels – agreed in consultation with CMA's and licence holders etc.<br>▪ Inherited the carp screens from the CMA, expressed some disappointment that there was no ongoing monitoring by the CMA<br>▪ GWMW are well aware of the stocking proposal (arising out of the Toolondo working group meetings and have no major objections.<br>▪ Min operating level is a guide and will be drawn down blow to meet critical needs in future droughts. Still a reasonable dead storage volume / fish refuge available if this were to occur.<br>▪ Frequency of spills will be less (assuming a return to better seasons) given new operating rules.<br>▪ Suggested that we speak with Ken Mayer (operator) regarding the CDS operation |
| Horsham Angling Club<br>**Engagement Method:** Meeting with 8 members of the Horsham Angling Club | ▪ In favour of stocking and can see a wide range of social and economic benefits flowing from targeted stocking of Rocklands<br>▪ Some diehard RF fishers would prefer to see an enhanced RF fishery<br>▪ Preference for EP and Cod rather than GP's – logic is to stock a species people would be keen to travel to catch. GP's are an easy target in Wimmera River and regional lakes<br>▪ Would like to see a crash stocking of EP's but understand the breeding limitations and cost<br>▪ Question the extent of threatened species (especially Spiny Cray) within the Reservoir<br>▪ Water management again seen as critical – Obviously with their lodge at Hynes not having seen water for many years they would like to see more water retained for longer |
| John Douglas (DEDJTR, Fisheries Victoria) | ▪ Numerous emails and phone calls to collate historical trout stocking data for Rockland Reservoir<br>▪ Specific discussions regarding Murray Cod breeding research relating to the likelihood of Cod breeding outside their natural range<br>▪ Information provided has informed the Risk Assessment |

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| **Engagement Method:** Email and Phone | |
| Tarmo Raadik (DEWLP)<br><br>**Engagement Method:** Phone conversations regarding threatened species distribution and research findings | ▪ Phone conversations to discuss the overall project and risk assessment and to more specifically seek further information regarding the distribution of threatened species throughout the system<br>▪ Tarmo provided additional information relating to ongoing threatened species investigations and direction to potential additional sources of species distribution data<br>▪ Tarmo provided additional support to the CMA position relating to the need for the Risk Assessment to clearly assess all possible risks stocked species may pose to the range of threatened species within the system |
| Travis Howson (Aust Private Fisheries Resources)<br><br>**Engagement Method:** Face to face discussion – Adelaide | ▪ General discussion around PHD research and findings with a particular emphasis on threatened species habitat below Rocklands Reservoir<br>▪ Input incorporated in background report and informed the Risk Assessment |
| Ty Matthews (Deakin University)<br><br>**Engagement Method:** Phone conversation (in | ▪ Discussion to follow-up on some of the information provided through the CMA with particular emphasis on any additional information or studies relating to the habitats of the upper Glenelg and its tributaries<br>▪ Ty provided a number of key references and additional observations through Stephen Ryan from the GH CMA.<br>▪ Ty gave approval for Parks Victoria to provide the project team with a report commissioned by Parks Victoria looking at the effects of wildfire and flooding on stream conditions and the distribution of freshwater animals in the Grampians National Park. This report provided valuable information relating to habitat type and extend which was used in undertaking the risk assessment |

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| addition to a significant amount of data and information provided through the GH CMA) | |
| Ryan Duffy (Parks Victoria, Halls Gap)<br><br>**Engagement Method:** Phone conversation to discuss the project | ▪ Discussion with Ryan to introduce the project, understand the key issues and values from Parks Victoria perspective and to specifically seek additional information regarding habitat assessments (and photographs) of the upper tributaries of the Glenelg River.<br>▪ Parks Victoria are aware of the stocking proposal and as with a number of key stakeholders are keen to see the risk assessment |
| Ken Mayers (GWMWater, Reservoir Operator)<br><br>**Engagement Method:** Phone conversations | ▪ A number of conversations were had with Ken relating to the operation of the CDS and the range of discharge flow rates from Rocklands<br>▪ It was confirmed that there has been no formal monitoring of the CDS<br>▪ Carp and Redfin are regularly observed trapped in the CDS along with a range of other species including Cod, Turtles and |

# Appendix E – About the Authors

**KARL MATHERS, Director and Principal Consultant, The Wedge Group, Moama, NSW**

Bachelor of Business, Charles Sturt University, Albury, NSW, 1994

Following ten years of Water and Natural Resource Management consulting, Karl launched 'The Wedge Group' in June 2014, an independent Water and NRM consultancy. Previous senior private and public sector positions held by Karl have enabled the development of proven abilities in the design, implementation, and management of significant technical investigations, NRM engineering projects, and major change programs across the Murray-Daring Basin. Karl's broad range of skills combined with his knowledge of the water sector, and broader NRM management frameworks have been successfully applied to the consulting arena, delivering a range of program, project, and policy outcomes for a wide range of public and private sector clients.

A keen recreational fisherman with strong interests in the promotion, recognition and sustainability of the recreational fishing sector and the policy platforms that shape its future direction.

A strong focus on collaborating with clients to deliver practical solutions has seen Karl excel in the coordination and delivery of multi-disciplinary and multi-jurisdictional Water and NRM initiatives such as his recent role delivering a Kow Swamp Recreational Boating Master Plan for Fisheries Victoria and Project Management of a number of aspects of the Swan Hill Irrigation Modernisation Project. Other examples include the coordination of the Koondrook-Perricoota Forest Living Murray Investment Proposal, development of future management options for the Euston Lakes and the development of a prospectus of Environmental Works and Measures for the Queensland Government.

In addition to project direction and NRM sector coordination, Karl's key skills include;

- Recreational Fishing related project and program delivery
- Stock sustainability - The support for appropriately designed and monitored fishing programs.
- Resource Management - Karl's working career has been dominated by NRM project and policy initiatives aimed at the long-term sustainability of our Natural Environment, particularly across the Murray Darling Basin.
- Education and Compliance - Fisher and wider community engagement is critical to achieving key sustainability and sector policy and economic objectives.

**DANNY SIMPSON, Associate Principal Consultant, The Wedge Group, Moama, NSW**

Bachelor of Applied Science in Natural Resources Management (Hons), University of Adelaide, 1988
Graduate Diploma of Applied Science in Aquaculture, University of Tasmania, 1989
Diploma of Applied Science in Natural Resources Management, Roseworthy Agricultural College, 1983.

Danny's 25 years of experience in environmental management in the fisheries, infrastructure, mining and natural resource sectors and his broad range of skills and experiences enable him to manage a multidisciplinary team approach to meeting the needs of clients where it is necessary to coordinate numerous tasks of differing technical nature. Danny's approach to managing recreational fishing sector projects is characterised by his ability to collate and analyse complex scientific data and present it in practical terms that is "useable" by resource managers. The foundation of this ability is a strong and extensive technical knowledge of aquatic ecology and experience in managing Australia's natural resources.

His working knowledge of government processes and his extensive professional contacts means that he is able to proficiently identify and source important natural resource management information in an effective and efficient manner. Danny offers:

- high level skills in Fisheries, Natural Resources and Environmental Management
- Leadership and staff management capabilities
- Exceptional written and verbal communication
- High level collaboration
- Business management
- Financial management
- Project management

Danny's key skills and areas of expertise include: Recreational Fisheries policy and project delivery; Stocking assessments and coordination, Wetland and Riverine ecology; Biological survey; Environmental water planning and management; Environmental approvals for mining and infrastructure development; Knowledge management and capacity for natural resource management; Fisheries management; Complex Environmental Project/Program Management; Legislative, regulatory and administrative arrangements for NRM and environmental water management; and Community consultation and engagement.

He has successful delivered numerous large environmental projects including the SA River Murray Wetlands Baseline Survey in 2004 and 2005; a comprehensive survey of over 60 wetlands in the SA River Murray basin. He is the author of over 30 wetland management plans for sites throughout Australia and has participated in the development of integrated flow management strategies for numerous major wetland complexes in the Murray Darling Basin

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