National Recovery Plan for the Barred Galaxias *Galaxias fuscus*

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Australian Government

State Government Victoria Department of Sustainability and Environment

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This Recovery Plan has been developed with the involvement and cooperation of a range of stakeholders, but individual stakeholders have not necessarily committed to undertaking specific actions. The attainment of objectives and the provision of funds may be subject to budgetary and other constraints affecting the parties involved. Proposed actions may be subject to modification over the life of the plan due to changes in knowledge.

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Cover photograph: Barred Galaxias *Galaxias fuscus* Falls Creek, Mt. Stirling, by Tarmo A. Raadik

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Summary

The Barred Galaxias (*Galaxias fuscus*) is a small, scaleless, non-migratory freshwater fish endemic to a small upland area in central Victoria, on the Murray-Darling Basin side of the Great Dividing Range. It has suffered an extensive decline in range and abundance, and now occurs only in small, isolated, remnant populations in short sections of small headwater streams. All remaining populations are at high continuing risk from predation by and competition from alien Brown Trout and Rainbow Trout, and from deleterious stochastic events such as bushfire and drought. This interplay between biotic threats and the increasing frequency and severity of physical threats from climate change, combined with the severely fragmented and isolated nature of remaining populations in fragile headwater catchments, create a very high extinction risk. The Barred Galaxias is listed as Endangered under the Commonwealth *Environment Protection and Biodiversity Conservation Act* 1999 (EPBC Act). This national Recovery Plan details the species' distribution, ecology, threats to survival and recovery objectives and actions necessary to ensure long-term survival of the Barred Galaxias.

Species Information

Description

The Barred Galaxias (*Galaxias fuscus*) Mack, 1936, belongs to the family Galaxiidae. It is a distinctive species that has an elongate, tubular and scale–less body with a relatively large, bulbous head, large mouth, thick tail and a single, soft–rayed dorsal fin situated well back on the body. Colour varies from dull brownish-orange to bright orange-yellow, with up to 10 distinct black vertical bars on the sides. Maximum size is about 150 mm total length. The species is non-migratory and completes its entire life cycle in freshwater. Diet consists mostly of aquatic and terrestrial insects, with fish foraging off the bottom and mid water in pools and at the end of riffle/glide sections (Raadik *et. al* 1998; Shirley & Raadik 1997). Spawning occurs from August to October. Fecundity is low (mean approx. 500 eggs); eggs are adhesive, about 2.2 mm diameter (Raadik *et al*. 1996; Shirley & Raadik 1997), and laid on the underside of large rocks in fast-flowing, shallow, cold (1–5^{0}C) water. Hatching occurs after about a month, and the newly hatched larvae are about 12 mm in length. Growth rates are slow, and adults live to about 15 years of age (T. Raadik unpubl.).

Taxonomy

Despite its distinctive appearance, the taxonomic status of the Barred Galaxias has remained uncertain. It was originally described as a distinct species (*Galaxias fuscus*) by Mack (1936) from two poorly preserved specimens deposited in the Museum of Victoria. In a taxonomic review of the family Galaxiidae, McDowall and Frankenberg (1981) placed *Galaxias fuscus* as a junior synonym of *Galaxias olidus* (Mountain Galaxias) without collecting or examining fresh specimens from the type locality (Rubicon River), although specimens were examined from a new, previously unknown site near Kinglake. An electrophoretic study by Rich (1986), again based on material from only one site, was inconclusive, although it did show that the Barred Galaxias was genetically distinct from southern forms of the Mountain Galaxias. Allen (1989) and Allen *et al*. (2002) reinstated Barred Galaxias as a distinct species separate from the Mountain Galaxias, although no formal taxonomic revision was undertaken or published. A review of the systematics of the *G. olidus* species complex (including *G. fuscus*) is currently underway, and genetic and morphometric/meristic results support the re-elevation of Barred Galaxias as a distinctive species (Raadik 2010). A full taxonomic revision and redescription of *G. fuscus* will be published as a result of this study.

Distribution

The Barred Galaxias is endemic to a small upland area in the south-eastern portion of the Goulburn River system in central Victoria, on the Murray-Darling Basin side of the Great Dividing Range (Figure 1) (Armstrong 1993; Kuiter 2003; Raadik *et al*. 1996; Raadik 2006b, c), in the South Eastern Highlands IBRA bioregion (*sensu* DEH 2000). The species is now confined to four general areas – near Mt. Buller/Mt. Stirling, Woods Point, Marysville and between Narbethong and Mt Disappointment. Remaining populations are now highly fragmented and isolated from each other by large distances. The Barred Galaxias is the only freshwater fish endemic to Victoria.

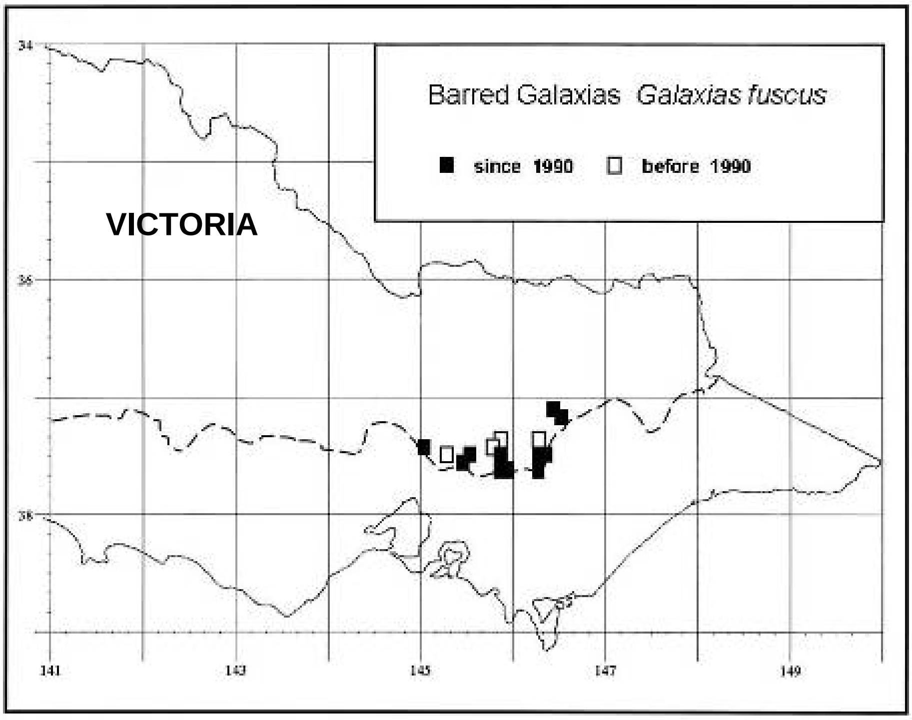

Figure 1. Distribution of Barred Galaxias (dashed line indicates Great Dividing Range).

Population Information

There are only 12 known extant populations of Barred Galaxias, including several that are fragmented into sub-populations in nearby headwater catchments. All populations represent the severe fragmentation of a previously larger range, and are considered important to the survival of the species. All sites are public land/water managed for a variety of purposes (lat. long. locations using GDA94):

- Delatite River (north of Mt. Buller): 1 population (37^0 05’ 146^0 21’)
- Howqua River (Mt. Stirling): 1 population, 3 sub-populations) (37^0 09’ 146^0 31’)
- Goulburn River tributaries (Gaffneys Creek) 1 population, 2 sub-populations (37^0 32’ 146^0 13’)
- Goulburn River tributaries (Woods Point) (1 population, 3 sub-populations) (37^0 32’ 146^0 13’)
- Big River (Lake Mountain): 1 population (37^0 28’ 145^0 56’)
- Rubicon River & tributary (Lake Mountain): 1 population, 2 sub-populations (37^0 25’ 145^0 51’)
- Taggerty River & tributaries (Lake Mountain): 1 population, 2 sub-populations (37^0 29’ 145^0 50’)
- Steavenson River tributary (Marysville): 1 population (37^0 31’ 145^0 44’)
- Acheron River (Narbethong): 1 population (37^0 31’ 145^0 46’)
- Murrundindi River (west of Buxton): 1 population (37^0 26’ 145^0 35’)
- Yea River (Toolangi): 1 population, 3 sub-populations (37^0 28’ 145^0 28’)
- Sunday Creek (Mt. Disappointment): 1 population (37^0 22’ 145^0 07’)

The majority of these populations/sub-populations are small, consisting of fish in low to moderate abundance in short headwater sections, usually 1–2 km in length. The total length of all occupied streams is <20 km. Quantitative assessments of abundance have been conducted at four sites. Fish densities ranged from 0.11 to 0.50 fish m^{-2} at sites with no predators (Raadik 1995; T. Raadik unpubl.) and from 0.003 to 0.027 fish m^{-2} at sites undergoing early predator (trout) incursion (Shirley & Raadik 1997). These abundance estimates suggest populations of approximately 280—1000 fish in a 'typical' headwater stream 2.0 km long and 1.0 m wide (estimates may not be accurate when applied to lower elevation, larger streams throughout the historical range of Barred Galaxias, such as at the type locality for the species in the lower Rubicon River). The historical population in the Rubicon River system in the 1930s may have numbered hundreds of thousands of fish, based on abundance estimates from the remaining population in the headwaters of the system (Raadik unpubl.).

Habitat

The Barred Galaxias is currently restricted to the upper reaches of headwater tributary streams in forested catchments above about 400 m in elevation, occurring in small to medium-sized, moderately to fast flowing, steep gradient, shallow upland streams, all typically cool, well shaded and well oxygenated. Previously the species occupied larger, deeper and more moderate gradient/flowing river systems at lower altitudes (down to about 300 m elevation), with a coarser substrate and larger accumulations of timber debris. The preferred instream habitat of adults includes slower, deep pools adjacent to areas of faster flow, whilst juveniles (<50 mm in length) are usually found in shallow water along the banks. Stream substrate consists of a heterogeneous combination of bedrock, boulder, cobble, with smaller amounts of pebble, gravel and sand, and streams are usually well shaded by dense overhanging riparian vegetation. Water salinity is very low (<0.01 g/L) and water temperature is usually less than 15^0C during summer, falling to 1–2^0C during winter/early spring. Instream habitat usually consists of accumulations of large and small timber debris, rocks and tree roots in undercut banks, with minimal aquatic vegetation usually consisting of submerged marginal terrestrial vegetation, or small patches of bryophytes (T. Raadik unpubl.). The Barred Galaxias is often the only native fish species found at these sites, or it may co-occur with just one other native fish, the Mountain Galaxias (*Galaxias olidus*).

Decline and Threats

The Barred Galaxias has suffered a catastrophic decline of over 95% of its likely historical distribution and abundance across its small upland range, and all remaining populations are now highly fragmented and isolated by large distances. Some populations have declined so rapidly that they have become extinct within 1–5 years of their discovery. Extinction of the species has been documented in four streams: Gaffneys Creek, Quartz Creek, Whitehouse Creek and Mountain Creek, and from the type locality for the species near the township of Rubicon on the Rubicon River (Frankenberg 1969, Raadik 2000). Even within small headwater stream systems populations have become further fragmented and isolated within the last 50 years. Consequently, many smaller sub-populations now exist in short sections in the very upper portion of small, discrete, low stream order tributaries about 1.0 m wide. Its current distribution represents the extreme fragmentation of a much wider and continuous distribution in the south-eastern portion of the Goulburn River system, possibly extending upstream from about 300 m in elevation.

Considering the rapid rate at which some populations have declined to extinction, it is highly likely that there has been a rapid, undocumented extinction of the majority of Barred Galaxias populations since European settlement. The relatively few extinctions (and near extinctions before rapid management intervention) documented in the past 50 years are not surprising, as most probably occurred earlier, well before surveys for the species commenced. Ongoing extinctions of small remnant Barred Galaxias populations could potentially be occurring in small remote catchments that have not yet been surveyed.

A decrease in population abundance at many sites has been noted recently during regular population demographic monitoring (T. Raadik unpubl.), possibly from impacts associated with on-going drought conditions. Due to their extremely fragmented range and geographic isolation of small remnant populations in small headwater streams, Barred Galaxias are now much more susceptible to population decline or complete loss due to impacts from stochastic events such as drought (short to long term loss of water), bushfire (short-term increased water temperatures killing individuals), post-bushfire related ash input and/or sediment slugs (extirpating entire populations), and increased stream sedimentation (smothering and killing eggs laid on the substrate and reducing food supply). Additional processes that degrade aquatic habitat and damage aquatic systems (e.g. input of chemicals from riparian weed spraying) also pose a threat to isolated populations.

Recent conservation management involving trout removal and increasing the availability of habitat immediately downstream of Barred Galaxias populations demonstrates that the species has a surprisingly poor ability to recolonise suitable habitat. At one site it took 10 years for Barred Galaxias to naturally recolonise downstream through a 1 m wide, 2 km stream reach, representing an extremely slow rate of about 200 m per year. Recolonisation rates at other sights are even slower (Raadik 2006a; T. Raadik unpubl.). This slow rate of natural recovery contrasts markedly with the Mountain Galaxias, which recolonised a 2 km predator-free stretch of stream within two years, 75% of the length within one year. Consequently, recovery of impacted populations has a relatively long time frame, including inherent high cost, and low to moderate rates of success. Therefore actions that address threats causing the decline or loss of populations will be the most effective.

The major threats to the Barred Galaxias are:

- Predation by and competition from the alien salmonid species Rainbow Trout *Oncorhynchus mykiss* and Brown Trout *Salmo trutta*
- Dewatering during drought
- Siltation/sedimentation
- Bushfire impacts
- Water regime changes
- Genetic isolation

Current and potential threats to Barred Galaxias are likely to vary between populations (Table 2), with alien fish impacts, siltation/sedimentation and threats from genetic isolation continuously operating. Threats from bushfire and drought can be seasonal (increased during wetter or drier months) and hence appear short term, being ameliorated to some degree during benign conditions in intervening months. More significantly, these threats and impacts are also long-term, linked to extended changes in weather patterns. Modelling indicates a high probability that the frequency and severity of droughts and subsequently bushfires will increase in Victoria (DPC 2009), and their threat to Barred Galaxias will become more constant due to climate change in the forested headwater catchments. The interplay of high impact constant threats (trout predation) with increasing frequency of medium to high threats, combined with the severely fragmented and isolated nature of all remaining Barred Galaxias populations in vulnerable and fragile headwater catchments, results in a significantly increased extinction risk.

Main threats to the Barred Galaxias are discussed in further detail as follows:

Trout Predation and Competition

The most serious threat faced by Barred Galaxias is from predation by, and to a lesser degree from competition with, the alien salmonid species Brown Trout (*Salmo trutta*) and Rainbow Trout (*Oncorhynchus mykiss*), which were introduced into Australia for recreational angling (Raadik 1995, 1999; Raadik *et al*. 1996, 2003, 2004). Wherever trout have colonised or been stocked upstream into Barred Galaxias populations they have completely displaced the species and further fragmented its range. Barred Galaxias are highly susceptible to predation by trout. Direct predation by trout on all juvenile (<65 mm length) and some adult Barred Galaxias, and competition for food and space with large juvenile and adult Barred Galaxias, can quickly lead to the local extinction of populations (Raadik 1995; Raadik *et al.* 1996). Small numbers of trout can completely eliminate Barred Galaxias in a short space of time from sections of the narrow streams they now occupy, first quickly (3–4 months) eliminating smaller individuals (first 4–5 age classes), then more slowly (0.5–1.5 years) eating larger individuals as the established trout grow in size (T. Raadik unpubl.). During this slower phase, the complete reproductive output (recruitment of successfully hatched larvae/juveniles) from surviving larger Barred Galaxias, that have been able to successfully breed, is eaten by trout. More than 50% of a population of Barred Galaxias in a narrow 2.0 km stretch of upland stream was eliminated by a small number of Rainbow Trout within a six-month period. At another site, 10 Rainbow Trout (all <240 mm in length) caused the local extinction of a healthy Barred Galaxias population in a 400 m reach of a shallow stream in a three-month period (T. Raadik unpubl.). Consequently trout predation is a primary cause of population decline and inhibits population recovery and range expansion. Trout also impact (predation/competition) on other galaxiid species in Australia (Mountain Galaxias) and in New Zealand, as well as on frog species in Australia (Cadwallader 1996; Crowl *et al*. 1992; Gillespie 2001; Gillespie & Hero 1999; Gillespie & Hines 1999; Glova 1989; Jackson *et al*. 2004; Lintermans 2000; McDowall 1990, 2003, 2006; Raadik 1995; Raadik *et al*. 1996; Raadik & Kuiter 2002; Simon & Townsend 2003; Tilzey 1976; Townsend 1996).

Barred Galaxias that may escape trout predation by being too large to eat are nonetheless highly susceptible to competition for food and space resources from trout. Diet, feeding positions and general instream habitat requirements overlap between trout and Barred Galaxias. In addition to predation, invading trout take over feeding positions, continually display aggressive behaviour towards remaining Barred Galaxias and keep them away from optimal feeding and resting areas. This leads to starvation, occupying suboptimal habitat, physical wounding and probably a subsequent decline in reproductive output. This loss of condition and overall health in Barred Galaxias results in increasing mortality and eventually eliminates remaining larger fish in 0.5–1.5 years after trout invasion. Trout are known to also impact other galaxiid species via competition (Cadwallader 1996; Crowl *et al*. 1992; Glova 1989; McDowall 2003, 2006; Simon & Townsend 2003; Townsend 1996).

The introduction or colonisation of trout into stream systems occupied by Barred Galaxias leads to rapid extinction of the species, often within 1–2 years. Many Barred Galaxias populations, especially at lower altitudes, most likely became extinct during the initial phase of trout introduction and colonisation in the late 1800s and early 1900s. This was probably followed by the extinction of populations at higher altitudes in the mid 1900s, due to widespread liberation of trout for recreational angling, and as upstream colonisation of trout continued. Accordingly extinctions would have occurred later in systems where upstream colonisation was less rapid. Natural in-stream barriers to upstream movement of trout would have protected some galaxias populations especially those in tiny headwater streams. These barriers include natural features such as waterfalls and debris dams from fallen trees, and artificial barriers such as weirs and culverts with a free fall of water at their lower end, However, these barriers may be overtopped by flooding, allowing passage of trout above the barrier. The low number of Barred Galaxias extinctions observed in recent years is due to the fact that the majority of extinctions have already occurred, the small number of populations remaining and the localised management of trout. However, all remaining populations of Barred Galaxias are considered under threat, due primarily to ongoing trout incursions or the constant and high risk of incursion from immediately downstream of populations that are above instream barriers, such as could occur through floods overtopping the barrier.

Remaining Barred Galaxias populations are now restricted to the very upper reaches of smaller, predator-free stream systems where trout have not been able to access due to natural instream barriers, or where natural barriers have been modified or artificial barriers installed to prevent their upstream colonisation. Brown Trout and/or Rainbow Trout are present in the streams immediately below each population, and the risk of trout incursion and the consequent loss of the upstream Barred Galaxias population is constant and high. What is now occurring is the infrequent elimination of the last fragments of previously larger populations in the very headwaters of catchments, when environmental and physical conditions (or deliberate malicious introduction) allow the incursion of trout into these relatively inaccessible habitats. The risk of barriers being breached by trout is exacerbated during higher rainfall periods, or during intense storm events. Elevated stream flows and localised flooding can alter the physical structure of barriers (e.g. causing erosion of, or timber debris realignment on, the barrier), altering flow patterns and velocities over the structure, or inundate bank areas on each side of a barrier, providing temporary colonisation pathways around the structure. Trout are able to take advantage of these changes to move upstream and bypass the barrier.

Deliberate malicious introduction of trout by humans into Barred Galaxias streams has also occurred at sites that are relatively easily accessible. This risk is significantly increased when new access tracks are made into previously inaccessible areas of catchments (e.g. during timber harvesting operations), or where previously existing, though overgrown, tracks are rehabilitated (e.g. for timber harvesting, general access, fire-fighting or back burning operations). Consequently, increased access to remote catchments/streams containing Barred Galaxias due to improved or new roads or tracks also pose a significant threat to this species.

Dewatering during drought

Remnant populations of Barred Galaxias are all geographically isolated in small headwater streams in the very upper portion of steep catchments. Water in these small systems is derived from surface run-off and groundwater inflow, with groundwater recharged from surface water infiltration. During prolonged drought, surface run-off is greatly reduced and the bulk of stream flow is derived from groundwater. This can also reduce as drought continues and groundwater recharge falls. Barred Galaxias populations are vulnerable to high mortality from the complete loss of surface water in these small streams (Raadik 2007), particularly in streams in which the usually heterogeneous substrate of rocks and cobbles is smothered and in filled with silt and coarse sand. Barred Galaxias are usually able to temporarily move down into rock/cobble substrates and so remain within the water table as it declines, but cannot burrow into coarse sand substrates (T. Raadik unpubl.). They are unable to perform aerial respiration and quickly suffocate when out of water. Consequently they are particularly susceptible to mortality from even short periods (1–2 hours) of surface water loss in sand-smothered streams, if deeper pools that intersect the water table are not present.

Siltation/sedimentation

Stream substrates at Barred Galaxias sites are usually composed of a heterogeneous mix of cobbles and pebbles, with some boulder, gravel and sand. The substrate complexity is important as habitat for aquatic macroinvertebrates that are the main food source, and also as resting habitat for fish and refuge habitat as water levels fall (T. Raadik unpubl.). With increased sedimentation, such as from catchment disturbance, the heterogeneous substrate is smothered and deeper holes filled with silt and sand. In particular, coarse sand input can be a long-term and persistent impact, particularly in highly erodible catchments, due to its on-going supply and slower rate of flushing downstream. Barred Galaxias cannot burrow into the coarse sand substrates as the water table declines (hence loss of refugia), aquatic invertebrate (hence food) diversity and abundance decreases, and resting habitat is reduced or eliminated. This increases behavioural interactions between fish, particularly young and old, and also exposes fish to possible increased predation from birds and other terrestrial fauna. Deteriorating water quality through increased siltation is a major threat to the health of Barred Galaxias populations, particularly as the populations are all small in size and severely isolated from each other. Siltation can cause increased water turbidity and changes in water chemistry such as temperature increases and lower dissolved oxygen levels, particularly after sediment pulses. Poor water quality can directly lead to fish mortality, primarily eggs, larvae and young juveniles.

Bushfire impacts

Remnant populations of Barred Galaxias are all geographically isolated, small, and restricted to headwater streams in the forested upland portion of the Goulburn River system. Because of this, and their inability to recolonise (sites are isolated, poor recolonisation ability, predators are present in intervening waters) the immediate and post impacts of bushfire can devastate populations. During a bushfire, the temperature of the water in the small headwater tributaries can become elevated, leading to mortality of fish. Post bushfire, sudden pulses of ash and sediment, carried into the stream with runoff from storm events, can drastically alter water quality conditions causing high or complete fish mortality (Raadik 2007). Severe storm runoff can also lead to localised bank slumping or catastrophic stripping of soil and rock from steep slopes, introducing larger quantities and particle sizes into streams. Ash input can quickly reduce dissolved oxygen levels, and fine and coarse sediment (silt, fine and coarse sand) and larger particle sizes (gravels, pebbles) can suffocate fish or physically smother them. High sediment loads can smother the substrate (or completely infill streams), reducing or eliminating aquatic food supplies and smothering spawning and resting habitat for fish. Longer term post bushfire, sedimentation into streams can also be exacerbated by timber salvage-harvesting operations in burnt catchments, as riparian buffer strips are usually ineffective or absent. Bushfires in December 2006 and February 2009 have burnt over all but three known Barred Galaxias sub-populations.

Water regime changes

Barred Galaxias currently occupy streams that are unregulated and essentially free from large amounts of water extraction. During summer, low to no-flow events can impact populations (see ‘Dewatering during drought’ above). During winter and spring, stream flows are elevated from rainfall and snow-melt at alpine sites. However water extraction for snow making may partially or significantly de-water small headwater tributaries above the snowline for short periods, possibly locally affecting key biological processes such as spawning or possibly de-watering demersal fish eggs.

Genetic Isolation

Currently, all known Barred Galaxias populations are severely fragmented and isolated, found in the headwaters of widely separate stream systems. Due to the distance between populations, and the presence of trout in intervening waters, it is very unlikely that contemporary gene flow exists between these populations. Gene flow is also considered unlikely or severely reduced between the relatively closer sub-populations, which are usually found closer together within upland catchments of a single stream system (e.g. upper Taggerty River). The implication of the loss of gene flow on maintenance of genetic diversity within the species is unknown, particularly regarding the long-term viability of populations that become suddenly and severely reduced in size (see Frankham et al. 2002).

Table 1: Populations and Threats

Threat	Populations Affected	Threat Ranking	
		Current/Potential	**High Medium Low**
Trout competition/predation	All	Current	High
De-watering during drought	All (except Rubicon R main site, Taggerty R main site)	Current/potential	High
Siltation/sedimentation	All	Current	High

Bushfire impacts	All	Potential	High
Water level/flow changes	All (incl. water abstraction at Taggerty R sites)	Current/potential	High/Medium
Genetic Isolation	All	Potential	Medium

Recovery Information

Existing Conservation Measures

The Barred Galaxias has been the focus of recovery efforts for about 15 years, and a considerable amount of effort has gone into recovery over this period, particularly addressing the major threat from trout predation. A number of specific and general initiatives for conservation of the Barred Galaxias are underway or have been completed, including:

- Preparation of a research recovery plan (Raadik 1995) and state Action Statements (Koehn & Raadik 1995; Anon 2008) that provide the basis for this Recovery Plan.
- Formation of a management team to co-ordinate research and management actions.
- Assessment of status at all recorded locations and surveys to locate additional sub-populations [12 additional sub-populations found].
- Construction of instream barriers (or modification to existing natural barriers) to prevent the upstream incursion of trout (Saddlier & Raadik 1995a, b) [barriers constructed or modified on four systems].
- Enlarging existing Barred Galaxias populations by removal of trout from above barriers to create predator-free habitat (Saddlier & Raadik 1995a, b; Lintermans & Raadik 2003) [total of 20 km of trout-free habitat reclaimed; sub-populations recovering].
- Annual predator detection and control in Barred Galaxias habitats [predators removed from within predator-free zone when detected and before they can spawn and become established].
- Annual population monitoring and threat assessment at all sites since 1995 [documented sub-population recovery and natural population fluctuations].
- Confirming the specific status of the species and examining genetic diversity between populations (Raadik 2010).
- Investigation of aspects of general ecology and breeding biology (Shirley & Raadik 1997).
- Information published on Barred Galaxias, including threats, protected status and management actions required for conservation (see References section).
- Temporary captive maintenance of fish from populations affected by post-bushfire impacts and drought, most recently fish salvaged from several streams burnt over by the December 2006 and January 2009 bushfires in Victoria [proportion of sub-populations held ex-situ while parent populations experienced disturbance following fires or loss of water due to drought; harvested fish replaced once catchment conditions recovered].

Strategy for Recovery

The strategy for recovery of the Barred Galaxias will be to focus on continuing protection and management of locations where the species occurs, particularly predator exclusion, removal or control, and monitoring/management of bushfire and drought impacts. Investigation of key biological and ecological attributes, such as reproduction, movement and dispersal, desiccation tolerance, habitat requirements and genetic issues induced by isolation is also required to facilitate recovery. Further, development of methods to increase the number of populations and individuals within its natural range is crucial to the survival of the Barred Galaxias.

Program Implementation and Evaluation

The Recovery Plan will be implemented and managed by the Department of Sustainability and Environment. A Recovery Team with key State agency and other stakeholder representation will be formed to coordinate recovery actions and exchange information on Barred Galaxias conservation. Implementation of individual actions will remain the responsibility of the relevant agencies and organisations identified in the Recovery Plan (subject to available resources), who will be responsible for preparing work plans and monitoring progress toward recovery within their own jurisdiction. The

Recovery Plan will run for a maximum of five years from the date of its adoption under the EPBC Act, and will be reviewed and revised within five years of the date of its adoption.

Recovery Objectives

The **Overall Objective** of recovery is to minimise the probability of extinction of the Barred Galaxias in the wild, to increase the probability of important degraded populations becoming self-sustaining in the long term and to significantly reduce the predation risk from alien predators (Brown Trout and Rainbow Trout) for all important populations in the long-term. Within the life span of this Recovery Plan (five years), the **Specific Objectives** of recovery of the Barred Galaxias are to:

1. Ensure all important populations and their habitat are protected and managed appropriately.
2. Investigate key aspects of biology and ecology to acquire targeted information to aid recovery.
3. Increase the number of populations and individuals.
4. Increase awareness of Barred Galaxias and support for its conservation with resource managers and the community.

Recovery Objectives, Actions and Performance Criteria – Summary

Note: Detailed implementation information is contained in Appendix 1.

Recovery Objectives	Recovery Actions
1. Ensure all important populations and their habitat are protected and managed appropriately. ***Performance Criterion**: Important populations are secured from controllable threats.*	1.1 Undertake data-gap surveys for new populations. 1.2 Acquire baseline data on newly discovered populations. 1.3 Assess threats and undertake frequent threat monitoring. 1.4 Construct or modify, and maintain, barriers to prevent the upstream access of alien predators. 1.5 Erect control structures to prevent or control access. 1.6 Remove/control predators. 1.7 Undertake detailed, long-term monitoring to determine population and species trends, and as early warning of predator incursion. 1.8 Liaise with government agencies and stakeholders to ensure information on Barred Galaxias populations and threat identification and management is conveyed to land/water managers and included in relevant management processes. 1.9 Provide/augment habitat features. 1.10 Undertake temporary salvage of individuals from at-risk populations.
2. Investigate key aspects of biology and ecology to acquire targeted information to aid recovery. ***Performance Criterion**: Biological information is successfully obtained for preparation of management strategies to maintain, enhance or restore processes fundamental to survival, reproduction and viability of populations.*	2.1 Investigate key aspects of reproduction. 2.2 Undertake assessment and monitoring of population structure (genetic diversity) throughout the range. 2.3 Investigate movement and dispersal patterns of adults and juveniles, including climbing ability. 2.4 Investigate desiccation and low dissolved oxygen tolerance of adults, juveniles, larvae and eggs. 2.5 Investigate specific instream habitat requirements.
3. Increase the number of populations and individuals. ***Performance Criterion**: Establish new, viable populations within the natural range of Barred Galaxias to decrease the risk of extinction of the species, and to enhance the rate of natural recovery of existing managed populations.*	3.1 Investigate techniques for captive breeding and on growing. 3.2 Identify and evaluate potential translocation sites. 3.3 Prepare translocation or stocking plan. 3.4 Maintain and monitor established translocated or stocked populations.
4. Increase awareness of Barred Galaxias and support for its conservation with resource managers and the community. ***Performance Criterion**: Knowledge of Barred Galaxias, and support for its conservation, increased with managers, recreational angling groups, and the community and conservation requirements included in NRM plans and projects.*	4.1 Promote community awareness of and identify opportunities for involvement in the conservation of the Barred Galaxias.

Cost of the Recovery Plan

The estimated cost of the recovery program is $2.582 million over five years (see Appendix 2 for details).

	Year 1	Year 2	Year 3	Year 4	Year 5	**Total**
Totals	$491,000	$588,000	$566,000	$511,000	$426,000	**$2,582,000**

Affected Interests

The Barred Galaxias occurs in areas with a variety of land management tenures and agencies, although virtually all of these are in some form of public authority ownership and management. Consequently, management is the responsibility of a range of agencies and organisations (Table 2). This Recovery Plan has the support of State government agencies and regional land/water managers including Catchment Management Authorities.

Table 2: Organisations with an interest in conservation of the Barred Galaxias

Organisation	Type
Department of Sustainability and Environment	State Government
Department of Primary Industries	State Government
Parks Victoria	State Government
Goulburn-Broken Catchment Management Authority	Regional Authority
Goulburn-Murray Water	Regional Authority
NFA (Native Fish Australia Inc.)	National Interest Group
Australia New Guinea Fishes Association (ANGFA) National	National Interest Group
Australia New Guinea Fishes Association (ANGFA) Victoria	State Interest Group

Role and Interests of Indigenous People

Indigenous communities on whose traditional lands and waters the Barred Galaxias occurs will be advised, through the relevant regional Indigenous Facilitator, of the preparation of this draft Recovery Plan and invited to provide comments if so desired. Opportunities to involve indigenous communities in the implementation of the Recovery Plan will be explored once it is finalised.

Biodiversity Benefits

The Recovery Plan includes a number of biodiversity benefits for other native species in the mid to headwater catchments of the southern and south-eastern Goulburn River basin, such as the nationally threatened Spotted Tree Frog *Litoria spenceri*, and aquatic ecological communities (e.g. macroinvertebrates). Principally, this will be through predator control, and also by the protection and management of aquatic and terrestrial riparian habitat. The adoption of broad-scale management techniques and collection of baseline data will also benefit other native aquatic species occurring in association with Barred Galaxias, particularly those species with similar habitat requirements, life histories and threats such as the Mountain Galaxias. Other Victoria listed threatened aquatic fauna species likely to benefit include the threatened alpine stoneflies *Thaumatoperla flaveola*, *Riekoperla intermedia* and *Riekoperla isosceles* and the alpine dragonfly *Austroaeschna flavomaculata* (Doeg 1999; Crowther *et al.* 2008). Populations of the Central Highlands Spiny Cray *Euastacus woiwuru* and upland populations of the state threatened Murray Spiny Cray *Euastacus armatus* will also benefit from predator control and improved catchment management. The Recovery Plan will also provide an important public education role as threatened fish have the potential to act as 'flagship' species for highlighting broader nature conservation issues in aquatic habitats, such as alien fish predation/competition, other invasive species, habitat degradation and positive benefits to instream barriers in upland systems.

Social and Economic Impacts

The implementation of this Recovery Plan is unlikely to cause significant adverse social and economic impacts, as the majority of populations are found on public land, are in remote catchments, and all occur upstream of significant dams and water extraction areas. Timber harvesting occurs in headwater catchments occupied by Barred Galaxias. Many actions to prevent or control sedimentation to streams and protect riparian habitat are already covered by the Code of Forest Practices for Timber Production in Victoria and additional actions to increase protection (e.g. increased buffer widths) are already prescribed under local forest management plans.

Recreational angling for alien trout species is an important social and economic activity undertaken in the Goulburn River catchment, mainly for Brown Trout and Rainbow Trout, though these are the main predators of Barred Galaxias. There is consequently a concern amongst some anglers that recreational fishing opportunities may be lost due to recovery actions for Barred Galaxias. However, Barred Galaxias are currently restricted to largely trout-free headwater streams, due to trout having extirpated them elsewhere. Therefore, recovery actions in currently-occupied Barred Galaxias streams are not expected to impact recreational fishing, which in the upper Goulburn River catchment is mainly confined to the medium to larger streams. These waterways total more than 2000 km of stream length. In contrast, Barred Galaxias are currently known to occupy less than 20 km in stream length, i.e. less than 1% of estimated trout streams (about 0.03% statewide). If additional Barred Galaxias populations are discovered, additional populations are established by translocation, or current populations are expanded, the total stream length occupied by Barred Galaxias is estimated not to exceed 100 km. Thus, the worst case scenario for recreational fishing under this plan is that trout would be actively removed and excluded from 5% of the estimated length of trout streams in the Goulburn River catchment (less than 0.16% of the estimated length of streams with trout in Victoria). Trout in these small headwater streams are small in size for their age, generally reaching a maximum of about 230 mm in length. This is a result of a combination of small restricted habitats, competition between a number of trout for limited resources leading to slow growth rates, and low predation pressure. Further, the contribution of trout in these small headwater streams to fisheries much further downstream in larger systems is negligible, due to the distance and large numbers of trout in intervening waters.

Management Practices

Recovery efforts for Barred Galaxias have been underway for approximately 15 years, and a number of management actions have been implemented to directly benefit the species' recovery (Lintermans & Raadik 2003; Raadik 2000, 2002; Saddlier & Raadik 1995a, b). The species is also a beneficiary of the recent strategy to rehabilitate native fish communities in the Murray-Darling Basin (Native Fish Strategy – MDBC 2004), in particular under the following driving actions:

- Controlling alien fish species.
- Protecting threatened native fish species.
- Protecting fish habitat.
- Managing fish translocation and stocking.

While a range of management practices planned or underway may be of benefit, it needs to be recognised that there are some management practices that may be detrimental to Barred Galaxias and jeopardise their recovery.

Management practices that will aid recovery

- Control and removal of alien fish.
- Protecting populations from alien fish incursion.
- Expanding existing populations and establishing new populations.
- Controlling road or trail access.
- Controlling water quality and sedimentation.
- Monitoring drought and bushfire impacts.

Management practices that will avoid significant adverse impacts

- Preventing the release of predators/competitors (trout or other alien fish species) into areas near or where Barred Galaxias populations occur.
- Restricting road or trail access improvements in Barred Galaxias catchments.
- Controlling and reducing siltation or sedimentation from entering waterways from works such as new or improved roading, riverbank rehabilitation, instream construction activities, weir desilting, and from normal or post-fire salvage timber harvesting operations.
- Controlling and reducing pesticide run-off and overspray, and pollution input into waterways to avoid localised fish kills.
- Avoiding the removal of riparian vegetation/habitat.
- Avoiding reduction in/alteration of flows, such as increased water extraction upstream of Barred Galaxias populations.

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Appendix 1. Recovery Objectives and Actions (details)

Objective 1. Ensure all important populations and their habitat are protected and managed appropriately.

Recovery Criterion:
Important populations are secured from controllable threats.

Action 1.1 Undertake data-gap surveys for new populations.

Barred Galaxias are now restricted to small headwater tributaries and much of this area is remote and difficult to access. Undertake targeted surveys in unsampled areas within the historical range of Barred Galaxias to locate potential additional extant populations. Surveys will also assist in locating potential predator-free and/or secure sites above significant instream barriers which may be used for translocation activities (see Objective 3 - Action 3.2, below). Surveys are difficult due to the steepness and remoteness of catchments, including extremely poor access. Previous aerial assessment of barriers failed due to dense riparian vegetation cover over most of the small streams.

Action 1.2 Acquire baseline data on newly discovered populations.

At newly discovered Barred Galaxias populations undertake detailed surveys to define the upstream and downstream extent of the population within the catchment, including assessment of population abundance and structure, and habitat quality.

Action 1.3 Assess threats and undertake frequent threat monitoring.

Following location of a new Barred Galaxias population undertake an initial assessment of threats. Threats should include presence of predators within or immediately downstream of the population, security of the site from predator incursion (e.g. presence/absence of instream barrier, type and nature of barrier, etc.), proximity of access tracks/roads, risk and sources of sediment input, proximity to timber harvesting coupes, approximate length of available stream habitat, water quality and flow and condition of substrate with respect to sedimentation.

Threat monitoring should be conducted at all extant important Barred Galaxias populations during annual population monitoring. Threats to be monitored include presence of predators (trout), new potential sources of sediment input, water quality, risks from any new disturbance to the catchment (e.g. timber harvesting, improved access via new/improved roading, etc.). During drought periods more frequent monitoring is required of stream baseflow levels at high-risk sites to ensure the population is not extirpated due to stream drying, and immediately following bushfire at all impacted sites to monitor for significant ash and/or sediment input. During wetter periods, greater monitoring of predator incursions is required, as incursions may be facilitated by increased stream flows, and by more favourable temperature regimes which will aid survival of predators.

Action 1.4 Construct or modify, and maintain, barriers to prevent the upstream access of alien predators.

Barred Galaxias are highly susceptible to predation from, and competition with, the much larger alien trout species Brown Trout and Rainbow Trout, which have been introduced into Australia and are widespread in the upper Goulburn River system. At all newly detected Barred Galaxias populations where the population needs to be protected from the upstream incursion of predators (trout), and where no sufficiently effective instream barrier exists, an artificial barrier(s) should be constructed if feasible, or modifications undertaken to an ineffective existing barrier. Where instream barriers (e.g. natural or artificial) preventing the incursion of predators into Barred Galaxias habitat exist, annual inspection of barrier integrity should be conducted, and maintenance undertaken when required, ensuring the effectiveness of the barrier.

Action 1.5 Erect control structures to prevent or control access.

Deliberate introduction of alien trout into streams managed for Barred Galaxias has occurred at sites which are relatively easily accessible, severely compromising recovery efforts. Access conditions at all existing Barred Galaxias catchments should be routinely reviewed, including any newly located populations. A risk assessment should be undertaken and structures put in place to restrict or control access if required (e.g. seasonally or permanently locked gates, track closure and rehabilitation, no new roading or upgrading, etc.). A regular review of the effectiveness of existing access control should also be conducted, control options modified if necessary, and maintenance undertaken when required.

Action 1.6 Remove/control predators.

Barred Galaxias juveniles and adults are highly susceptible to predation by the alien trout species Brown Trout (*Salmo trutta*) and Rainbow Trout (*Oncorhynchus mykiss*), and to a lesser degree to competition between trout and larger, remaining galaxias individuals for food and habitat resources. Whilst Barred Galaxias populations subjected to past management actions are currently free of predators (trout), predators are present immediately downstream. When circumstances allow (e.g. during stochastic events), predators can move upstream into the Barred Galaxias habitat, and even a few individuals can cause major mortality in a short time, severely compromising past management efforts. Therefore each population is constantly at high risk of predator incursion. Annual predator detection monitoring is therefore critical, and if predators are found, removal to downstream of the predator-free zone is required. If predators (trout) are present within newly found Barred Galaxias populations, then predator removal is also required to be undertaken.

Action 1.7 Undertake detailed, long-term monitoring to determine population and species trends, and as early warning of predator incursion.

Continue detailed population monitoring (total fish abundance and individual fish length and weight) within established monitoring reaches at known Barred Galaxias population sites, to monitor population health over time and to provide additional, early-predator detection warning (e.g. absence of first 4–5 age classes indicates one or more predators (trout) present).

Action 1.8 Liaise with government agencies and stakeholders to ensure information on Barred Galaxias populations, threat identification and management is conveyed to land/water managers and included in relevant management processes.

To increase protection for, and reduce threats to, Barred Galaxias populations, continued liaison is required with government agencies and stakeholder groups involved in management or other activities in Barred Galaxias catchments. Information dissemination needs to provide population and catchment details into existing relevant planning scheme overlays and schedules, or new overlays when needed, to increase protection of Barred Galaxias populations. Key outcomes should include the incorporation of the details of existing and any newly discovered Barred Galaxias populations into regional fire management and operational plans, implementing or updating forest plan prescriptions to protect catchments/populations in timber harvesting areas (including during post fire timber salvage operations), particularly with respect to sedimentation amelioration, riparian vegetation, and access issues, and widespread, current knowledge on important catchments for the species, potentially threatening processes and progress of recovery actions.

Action 1.9 Provide/augment habitat features.

As remnant populations of Barred Galaxias are geographically isolated in small headwater streams in the very upper portion of steep catchments, they are susceptible to high mortality from the complete loss of surface water during prolonged drought, particularly in streams where the usually heterogeneous substrate is smothered and in filled with silt and coarse sand. Options for the creation of effective, temporary artificial, deep ‘refuge’ pools in these systems should be trialled, particularly immediately below groundwater inflow areas. This will potentially provide temporary security from the complete loss of a population in the event of a sudden but short-term loss of surface water (dewatering), allowing for salvage of surviving individuals.

Action 1.10 Undertake temporary salvage of individuals from at-risk populations.

Where the risk of population loss is high due to stochastic events such as ash or sediment input post bushfire during storm events, or short and/or long term complete loss of surface water during drought, undertake removal of a proportion of individuals from the population and maintain in captivity in aquaculture facilities until threat(s) abate (temporary captive maintenance). Strict biosecurity, disease prevention and aquarium maintenance procedures are to be followed to allow the return of fish to the site following abatement of the risk.

Objective 2. Investigate key aspects of biology and ecology to acquire targeted information to aid recovery.

Recovery Criterion:
Biological information is successfully obtained for preparation of management strategies to maintain, enhance or restore processes fundamental to survival, reproduction and viability of populations.

Action 2.1 Investigate key aspects of reproduction.

Precise requirements for spawning of Barred Galaxias are not known. Determining the spawning requirements (e.g. spawning cues, spawning sites, egg hatching times) is necessary to ensure suitable conditions are available (or can be created), at population expansion sites and particularly at translocation sites, to maximise chances of successful population establishment and recruitment. This will also assist in the success of captive breeding.

Action 2.2 Undertake assessment and monitoring of population structure (genetic diversity) throughout the range.

Initial determination and continued monitoring of the genetic diversity of populations of Barred Galaxias are critical for guiding recovery efforts, particularly for understanding the current and long-term genetic implications of the relatively recent fragmentation and isolation of all populations. This information will be essential for our understanding of the genetic diversity across the range of Barred Galaxias, assist in planning programs to maintain and/or expand genetic diversity at the species or population level, and also guide translocation efforts and hatchery protocols for artificial breeding.

Action 2.3 Investigate movement and dispersal patterns of adults and juveniles, including climbing ability.

While it appears that Barred Galaxias do not undertake long distance upstream migration for breeding, precise details on shorter-range movements within streams is lacking. This information is critical to understand the process of natural recolonisation (direction, speed, life history stage) and for formulating procedures to assist or enhance natural downstream recolonisation in systems where additional predator-free habitat has been created.

Action 2.4 Investigate desiccation and low dissolved oxygen tolerance of adults, juveniles, larvae and eggs.

Barred Galaxias populations are susceptible to high mortality from the complete loss of surface water in small streams during prolonged drought, particularly in small streams in which the usually heterogeneous substrate of rocks and cobbles is smothered and in filled with silt and coarse sand. Barred Galaxias are usually able to temporarily move down into rock/cobble substrates and so remain within the water table as it declines, but cannot burrow into coarse sand substrates. They are also unable to perform aerial respiration and quickly suffocate when out of water. Consequently data are required on the desiccation and low dissolved oxygen tolerance of adults, larvae and eggs to determine tolerance levels and response times to refine recovery actions if possible.

Action 2.5 Investigate specific instream habitat requirements.

Specific habitat requirements of Barred Galaxias are not known. Determining habitat requirements (e.g. spawning cues, spawning sites, egg hatching times) is necessary to ensure suitable conditions are available (or can be created), at population expansion sites and particularly at translocation sites, to maximise chances of successful population establishment and recruitment.

Objective 3. Increase the number of populations and individuals.

Recovery Criterion:
Establish new, viable populations within the natural range of Barred Galaxias to decrease the risk of extinction of the species, and to enhance the rate of natural recovery of existing managed populations.

Action 3.1 Investigate techniques for captive breeding and on growing.

Establishing new Barred Galaxias populations can be achieved via the translocation of individuals from a source population to a new area, though this can have potential impacts on the viability and continued survival of the source population. Alternatively, individuals can be stocked from captive breeding populations. The feasibility of techniques for captive breeding and on growing of this cold-adapted freshwater fish in aquaculture facilities requires investigation, to potentially enable the captive rearing of fish from specific populations suitable for translocation or re-establishment. Techniques are required to induce the successful spawning and fertilization of eggs under artificial conditions, facilitate egg development and successful hatching, as well as assist in larval rearing and on growing of juvenile fish. Hatchery protocols will be developed to ensure the maintenance of genetic integrity of separate stocks, maintenance of genetic diversity in reared fish, and for hygiene and disease control.

Action 3.2 Identify and evaluate potential translocation sites.

Currently predators (Brown Trout and Rainbow Trout) are widely distributed in large and small streams in the upper part of the Goulburn River catchment and no suitable (predator-free) sections or streams with security from predator invasion (above significant instream barriers) have been identified during general data gap surveys. Targeted surveys are required to identify predator-free and/or headwater reaches of streams above instream barriers, which are, or can be modified to be suitable for the translocation of Barred Galaxias populations. Potential translocation sites need to be evaluated and prioritised, based on a number of criteria, including abundance (area) and suitability (quality) of instream habitat, potential impact on existing fauna, security from threats (predator invasion, permanency of surface water, remoteness from access) and location to existing Barred Galaxias populations.

Action 3.3 Prepare translocation or stocking plan.

A translocation plan needs to be prepared to guide translocation efforts. This should specify information such as a prioritisation of sites for translocation, source of fish (natural population or artificial breeding), number of fish to be translocated, when and how many releases there will be, monitoring protocol and defining evaluation criteria. Similarly, a stocking plan to enhance natural recovery of managed Barred Galaxias populations is also required if fish become available from artificial breeding. The plans needs to comply with the 'National Policy for the Translocation of Live Aquatic Organisms' (MCFFA 1999) and relevant State requirements (e.g. FFG Act, DPI 2003, 2005).

Action 3.4 Maintain and monitor established translocated or stocked populations.

Once the translocation occurs, there will be an on-going requirement to monitor the outcome. The monitoring protocol needs to be sufficient to detect survival and dispersal of released fish, as well as reproduction and recruitment success into the adult population. Once established, maintenance and monitoring of the population, including threats, is covered by actions under Objective 1 above, as is the monitoring of stocking efforts to enhance populations.

Objective 4. Increase awareness of Barred Galaxias and support for its conservation with resource managers and the community.

Recovery Criterion:
Knowledge of Barred Galaxias, and support for its conservation increased with managers, recreational angling groups, and the community and conservation requirements included in NRM plans and projects.

Action 4.1 Promote community awareness of and identify opportunities for involvement in the conservation of the Barred Galaxias.

Community support for Barred Galaxias conservation, especially from recreational angler and landowners, local communities and managers adjacent to waters where the species occurs is important in ensuring the successful outcome of conservation efforts. Opportunities for promoting conservation of the species include interpretive displays, information brochures and other publications, encouraging the reporting of potential new populations, and adoption of Barred Galaxias as a flagship species for conservation by nearby local communities including involvement in threat monitoring at nearby populations.

Appendix 2. Priority, Feasibility and Estimated Costs of Recovery Actions

Action	*Description*	*Priority*	*Responsibility*	*Feasibility*	*Cost estimate*					
					Year 1	Year 2	Year 3	Year 4	Year 5	Total
1	**Important populations**									
1.1	Data-gap surveys	1	DSE	100%	**$22,000**	**$22,000**	**$22,000**	**$22,000**	**$0**	**$88,000**
1.2	Baseline information	1	DSE	100%	**$0**	**$15,000**	**$15,000**	**$15,000**	**$15,000**	**$60,000**
1.3	Assess threats and monitor	1	DSE	100%	**$0**	**$10,000**	**$10,000**	**$10,000**	**$10,000**	**$40,000**
1.4	Predator exclusion barriers	1	DSE	100%	**$60,000**	**$60,000**	**$60,000**	**$60,000**	**$60,000**	**$300,000**
1.5	Control access	1	DSE	100%	**$10,000**	**$10,000**	**$10,000**	**$10,000**	**$10,000**	**$50,000**
1.6	Remove/control predators	1	DSE	75%	**$70,000**	**$70,000**	**$70,000**	**$70,000**	**$70,000**	**$350,000**
1.7	Monitoring	1	DSE	100%	**$60,000**	**$60,000**	**$65,000**	**$65,000**	**$70,000**	**$320,000**
1.8	Stakeholder liaison	2	DSE, GBCMA	100%	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**
1.9	Habitat features	1	DSE	75%	**$20,000**	**$20,000**	**$10,000**	**$10,000**	**$10,000**	**$70,000**
1.10	Temporary salvage/captive maintenance	1	DSE	100%	**$150,000**	**$150,000**	**$150,000**	**$150,000**	**$150,000**	**$750,000**
2	**Biology/ecology attributes**									
2.1	Reproduction	1	DSE	100%	**$15,000**	**$15,000**	**$10,000**	**$10,000**	**$0**	**$50,000**
2.2	Genetic diversity	1	DSE	100%	**$10,000**	**$20,000**	**$30,000**	**$0**	**$0**	**$60,000**
2.3	Movement and dispersal	1	DSE	100%	**$0**	**$20,000**	**$20,000**	**$10,000**	**$0**	**$50,000**
2.4	Desiccation/oxygen tolerance	1	DSE	100%	**$10,000**	**$40,000**	**$0**	**$0**	**$0**	**$50,000**
2.5	Instream habitat	2	DSE	100%	**$0**	**$0**	**$20,000**	**$10,000**	**$0**	**$30,000**
3	**Increase numbers/populations**									
3.1	Captive breeding techniques	1	DSE	100%	**$30,000**	**$30,000**	**$30,000**	**$15,000**	**$15,000**	**$120,000**
3.2	Translocation site selection	1	DSE	100%	**$30,000**	**$30,000**	**$30,000**	**$30,000**	**$0**	**$120,000**
3.3	Translocation plan	1	DSE	100%	**$0**	**$0**	**$0**	**$10,000**	**$0**	**$10,000**
3.4	Population maintenance	1	DSE	100%	**$0**	**$10,000**	**$10,000**	**$10,000**	**$10,000**	**$40,000**
4	**Information and awareness**									
4.1	Community involvement	3	DSE, GBCMA, PV	100%	**$4,000**	**$6,000**	**$4,000**	**$4,000**	**$6,000**	**$24,000**
	Totals				**$491,000**	**$588,000**	**$566,000**	**$511,000**	**$426,000**	**$2,582,000**

Abbreviations: DSE=Department of Sustainability and Environment; GBCMA=Goulburn Broken Catchment Management Authority; PV=Parks Victoria