PROSPECTS AND PROBLEMS FOR THE RESTORATION OF THE PEDDER GALAXIAS.

Andrew C. Sanger[1]

SANGER, A.C., 2001: Prospects and problems for the restoration of the Pedder galaxias; in: Sharples, C., (ed.), *Lake Pedder: Values and Restoration*, Occasional Paper No. 27, Centre for Environmental Studies, University of Tasmania, p. 125 - 130.

The Pedder galaxias is one of the endemic species which has suffered a population decline subsequent to flooding of Lake Pedder. This decline apparently started in the 1980's following an earlier population explosion, but was not recognised until the late 1980's, by which time the species had become very rare. Research into its distribution, life history and artificial propagation was conducted between 1988 and 1992 by the Inland Fisheries Commission.

Following this research a recovery plan for the Pedder galaxias was prepared and recovery actions funded and instigated. The primary recovery action is establishing refuge populations of the species through translocation and captive breeding. Monitoring of the populations in Lake Pedder is also ongoing. The scarcity of stock for both direct translocation and for captive breeding has limited the effectiveness of the recovery plan. Monitoring of the populations in the lake suggests further decline.

The long-term prospects for survival of this species are bleak, and the prospects for reintroduction to the new Lake Pedder are remote. The lake and many of its tributaries contain large populations of predatory fish. Even if stock were available, the presence of predators in Lake Pedder would severely compromise the chances of successful reintroduction.

Key Words: Australia, Tasmania, Lake Pedder, fish, galaxias pedderensis, flooding, endangered, restoration, recovery.

INTRODUCTION

The galaxiid group of fishes is the most diverse freshwater fish group in Tasmania with 15 species in 3 genera: 10 species of *Galaxias*, 4 species of *Paragalaxias* and one species of *Galaxiella*. (Fulton 1990). Ten of these 15 species are endemic, i.e., found only in Tasmania. All of the endemics share a common trait - a restricted distribution within the State.

A common feature of these endemic species with restricted distributions is that decline in a single population can have a significant effect in terms of the overall conservation status of the species. In recognition of this feature, and as a result of the collection of evidence on the distribution and abundance of native fish in the State, we have the unfortunate situation where four of the six galaxiids which are classified as either endangered or vulnerable species by the Australian Nature Conservation Agency are endemic Tasmanian species (Wager & Jackson 1993). The Pedder galaxias, *Galaxias pedderensis* (Figure 1), is one of those endangered species, and the one most perilously close to extinction.

EARLY RECORDS

The Pedder galaxias was described from specimens collected in the mid to late 1960's (Frankenberg 1968). At the time, the species was considered to be abundant in the lake and in a stream connecting the Maria Lakes to Lake Pedder[2].

In an early review of the Tasmanian galaxiids, the species was recorded as being abundant in the lake and its immediate tributaries in the period between about 1970 and 1972 (Andrews 1976).

Nothing much more was noted about the Pedder galaxias in the scientific literature until another major review of the Australian galaxiids by McDowall & Frankenberg (1981) recorded the species as remaining abundant after flooding of the lake.

Anglers noted that trout were eating galaxiids in the new lake throughout the mid to late 1970's and very

[1] Inland Fisheries Commission, Hobart, Tasmania (currently: NSW Fisheries, Albury).

[2] *Editors note:* In this paper, the term "Lake Pedder" is used for both the original lake, and the Huon-Serpentine Impoundment which was formed by flooding the original lake.

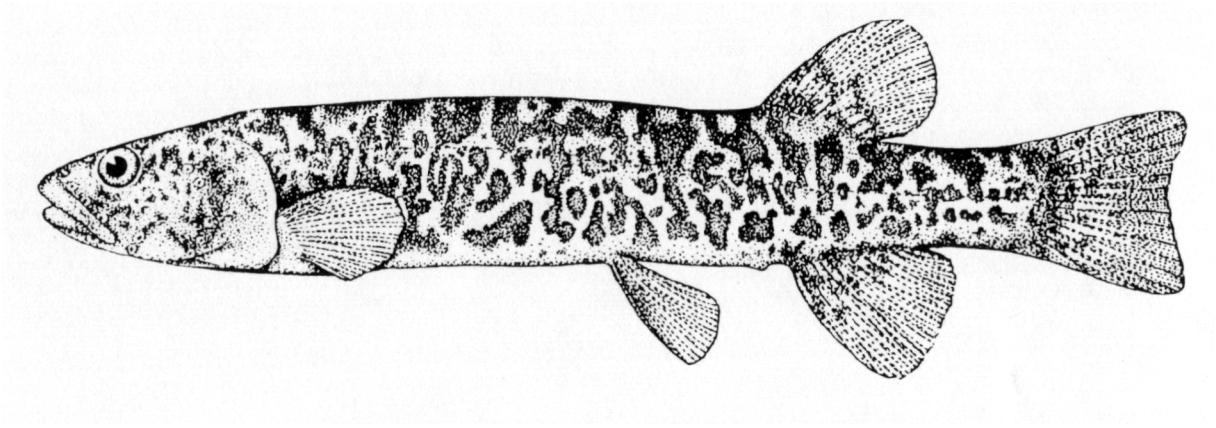

Figure 1: *Galaxias pedderensis*. Figure reproduced from Fulton (1990). Scale: adult specimens grow to 75 - 120 mm length.

early 1980's. This feeding habit was thought to have been a major factor leading to the rapid growth of trout in the lake. Unfortunately there was little scientific work carried out on the trout fishery or the native fauna of Lake Pedder during the 1970's and 1980's and so there is not much solid information on the level of predation by trout on galaxiids at that time.

RECENT SURVEYS

In 1988 the Inland Fisheries Commission (IFC) surveyed various aspects of the fauna of the World Heritage Area, including the Lake Pedder region. At that time there was some anecdotal evidence that the Pedder galaxias was less abundant in the lake, but it was thought by IFC staff that there would still be significant numbers of the fish both in the lake and, more particularly, in its many tributary streams.

Electrofishing surveys of a number of creeks in the vicinity of the original lake were conducted. Surprisingly, the species most commonly found in these streams was not the Pedder galaxias, but the climbing galaxias, *G. brevipinnis*, a species with a widespread distribution but which had not previously been definitely recorded from Lake Pedder (Sanger 1988).

Only one specimen of Pedder galaxias was collected in the 1988 survey, along with a few specimens of the swamp galaxias, *G. parvus*, the other galaxiid species endemic to the Pedder region (Sanger 1988).

The survey was extended in 1989 to include more streams with similarly alarming results. Only a few Pedder galaxias were found in two small streams; no more specimens were found in the stream where they had been recorded in the previous year; and, once again, the climbing galaxias was found to be widely distributed in the tributary streams of the lake (Sanger & Fulton 1989).

CONSERVATION RESEARCH

Because of the serious decline in abundance of the Pedder galaxias detected by these two preliminary surveys, the IFC embarked on a full-time study of various aspects of the biology and conservation of Pedder galaxias. This study was funded by the Endangered Species Unit of the Australian National Parks and Wildlife Service and the IFC. Two people, a project officer and a technical officer, were employed full-time in the first 12 months of the study, with the project officer employed for a further 12 months full-time and 6 months part time.

The study had several aims:

- To survey the Gordon and Pedder catchments as completely as possible for the presence of Pedder galaxias and other native fish.
- To examine the life histories of native and introduced fishes in the Lake Pedder area.
- To verify the taxonomic identity of the galaxiid populations in the Lake Pedder region.
- To investigate artificial breeding techniques.
- To examine translocation as an option for conservation of the Pedder galaxias.

The results of this study confirmed most of what was already known about the Pedder galaxias, but provided some cause for optimism about the prospects for the future of the species (Hamr 1992).

Firstly, despite a very intensive field program lasting many months and involving an exceptional amount of uncomfortable and often dangerous

work, no locality was found where the Pedder galaxias was abundant, and only one new site was found. Two sites where the Pedder galaxias had been found in the preliminary surveys no longer contained any of the fish. In summary, between 1988 and 1991 a total of 117 sites were surveyed, and Pedder galaxias was found at only 5 of these (Hamr 1992).

Two small streams, Bonnet Bay Creeks 1 and 2, were found to contain reasonable numbers of Pedder galaxias, although even there, the species was relatively uncommon with only 68 specimens captured in a total of 43 separate trips between February 1990 and September 1991 (Hamr 1992).

The life history of the species was studied by examining the behaviour of captive specimens held in aquaria and in an artificial Lake Pedder ecosystem, and by dissection of museum specimens or specimens which died in captivity (Hamr 1992).

The species was found to have an unremarkable life-history, typical of lake dwelling galaxiids with:

- spawning in spring.
- large eggs.
- a relatively long development period before hatching.
- fairly rapid larval development.
- a diet of aquatic and terrestrial insects and aquatic crustaceans.

There is nothing remarkable in what was found out about the life history of the species which would indicate that it should be any more vulnerable to extinction than other galaxiids.

The presence of large numbers of climbing galaxias in the lake raised the possibility that there may have been some taxonomic confusion included in statements about the abundance of the various galaxiids in the lake. There was even some debate about the taxonomic validity of the Pedder galaxias as a species, given its superficial similarity to the climbing galaxias. To the untrained eye, the two species are, in fact, quite difficult to tell apart. Hamr (1992) examined a large number of specimens of both species and found that the most significant character which distinguishes the two species in Lake Pedder is the number of vertebrae, with Pedder galaxias having between 49 and 55 vertebrae and climbing galaxias having between 58 and 62 vertebrae. This was very useful information, as it allowed the museum collections of galaxiids from Lake Pedder to be screened for the timing of the influx of climbing galaxias. Although based on few samples, this study confirmed that up until about 1980 the dominant galaxiid in samples from the lake was the Pedder galaxias, but from about 1983 onwards the climbing galaxias became more abundant. This has progressed to the stage where it is now the most common galaxiid in both tributary and lake habitats.

While conducting the life-history studies on Pedder galaxias, valuable information was gained on techniques for artificial propagation of the species. Two approaches were investigated (Hamr 1992).

The first approach was to establish a small population of the fish in an artificial lake and stream habitat. The pond and stream were furnished with gravel and rocks, fallen timber and aquatic vegetation from the Lake Pedder area and filled with water from Lake Pedder. Aquatic insects and crustaceans were added to the pond to provide a natural food supply, and the whole system was kept shaded to minimise stress to the fish through disturbance and warming of the water.

Pedder galaxias adapted quite well to life in this system, and many individuals lived for several months in the pond. It was hoped that by allowing the fish to reproduce in a semi-natural environment, large numbers of larval or juvenile fish could be produced for restocking. However, although some of the females apparently attempted to spawn in the "Passion Pond", none of the eggs which were laid developed. Whether this was due to the eggs themselves being infertile, whether the males did not fertilise the eggs, or whether there was some developmental problem after fertilisation is uncertain.

The second approach attempted was to manually strip the eggs and milt from reproductively mature fish and rear these eggs in the laboratory. Limited success with this technique resulted in the production of 11 juvenile Pedder galaxias. However, this small success gave some hope that mass production of the fish was possible given enough mature broodstock.

WHAT CAUSED THE DECLINE?

The fundamental question which all of this work was designed to help us answer was "Why was the Pedder galaxias in decline?"

Clearly, there had been predation by brown trout on Pedder galaxiids in the years since flooding. The evidence from studies of other Tasmanian galaxiids showed that in some cases (e.g., *G. johnstoni* and *G. fontanus*) predation by brown trout can be the cause of serious population declines (Sanger & Fulton 1991), whereas in other cases (e.g., *Paragalaxias* species, *G. auratus*, *G. brevipinnis*

and *G. truttaceus*), co-existence of brown trout and galaxiids is sustainable in the long term, as evidenced by over 100 years of co-existence in many lakes on the central plateau (Fulton 1990). However, predation by brown trout is a possible contributing factor in the decline of Pedder galaxias.

Colonisation of the new lake and, more particularly, of the tributary streams by the climbing galaxias is also a potential cause of the decline. Climbing galaxias is a particularly good coloniser, with juveniles being able to negotiate steep barriers such as waterfalls. There appear to be at least two forms of climbing galaxias in the State - a riverine migratory form which has a marine larval stage, and a landlocked lacustrine form which has a lake dwelling larval stage. Experience following the construction of hydro-electric schemes has shown that the riverine form can readily adapt to life behind a barrier and establish landlocked populations. This is probably what happened after construction of the dams in the Lake Pedder area. Climbing galaxias can grow to in excess of 250 mm, which is large for a galaxiid. In the Lake Pedder area they spawn in the autumn, and larval development occurs over the winter. Adult climbing galaxias have been observed to eat large food items such as other galaxiids, frogs and cicadas. The species is closely related to Pedder galaxias and the two probably have similar ecological requirements. However climbing galaxias seems to be a superior competitor in terms of its reproductive strategy, feeding habits, growth rates and ability to colonise new areas. So it seems highly likely that its colonisation of Lake Pedder may have placed further pressure on the endemic species.

The limited samples and observations which are available suggest that the Pedder galaxias was already in decline, at least in the lake, before the climbing galaxias became abundant. So we might speculate that climbing galaxias hastened, rather than initiated the decline in Pedder galaxias populations.

The changes that have occurred in the littoral (shore-line) fauna of the lake since flooding have been documented (Lake 2001). These changes, while significant, suggest that the invertebrate community has become less diverse, with several common species continuing to occur in reasonable numbers. Most galaxiids have fairly generalised feeding requirements, and the limited data available on the Pedder galaxias suggest that they will eat a wide range of aquatic and terrestrial invertebrates. So it seems unlikely that collapse in the food supply of the galaxiid could have contributed significantly to its decline. Similarly, the water quality of the lake appears to be quite suitable for other fish life, and presumably remains suitable for *Galaxias pedderensis*.

In summary, to the best of our knowledge, the most likely factors which could have caused the decline of Pedder galaxias are predation and competition with both brown trout and climbing galaxias.

RECOVERY PLAN

In 1992 it was agreed that a recovery plan should be prepared for the species to try to overcome what was seen as the strong likelihood of extinction of the species in the very near future. This plan was subsequently prepared by the IFC and the Parks and Wildlife Service, and was presented in the format adopted nationwide by the Endangered Species Unit of the Australian Nature Conservation Agency (Gaffney *et al.* 1993).

The recovery plan process identifies actions which should be taken to meet the recovery objectives of the plan, which in the case of *Galaxias pedderensis* was to achieve a downlisting of the species from endangered to vulnerable or better. In recognition of the difficulties of controlling the threatening processes in Lake Pedder, the principal recovery action adopted in the plan was to establish one or more refuge populations of the species by translocation of wild and captive bred fish. The plan also calls for continued monitoring of the population in the lake and other minor actions.

An attempt to establish a translocated population of Pedder galaxias required the identification of a suitable site which had similar physico-chemical characteristics to the original lake, contained a range of suitable microhabitats, and did not contain or was secure from invasion by brown trout and/or *Galaxias brevipinnis*. Following a survey of potential lake sites, Lake Oberon in the Arthur Range was chosen as a translocation site.

A total of 42 Pedder galaxias were released there between November 1991 and November 1992. The recovery plan requires an assessment of the success of this stocking, and an assessment of the impact of the stocking on the Lake Oberon ecosystem.

Lake Oberon is a remote lake, creating some difficulties in assessing the effects of the translocation as helicopters are required to ferry in all of the gear and personnel required for the work there and at Lake Cygnus, which is being used as a control. The lake has been revisited several times by IFC staff as required by the Recovery Plan.

There has been no sign of the Pedder galaxias at Lake Oberon since their release *(as at 1995, but see editors postscript - ed.)*. The recovery plan calls for the release of more captive bred stock.

Attempts to collect adult fish in reproductive condition at Lake Pedder have failed over the last couple of years. The IFC is reluctant to hold fish in captivity for long periods, because experience with this species is that it is much more sensitive to stress than other galaxiids, and will die if kept in aquaria for long. The recovery objectives have therefore not been met to date.

PROSPECTS FOR LAKE PEDDER

With regard to the re-establishment of Pedder galaxias in Lake Pedder if the lake is drained and restored to its original state, the following observations are relevant:

- The decline in the Pedder galaxias occurred after an initial boom following flooding, and so it is not a physical or chemical change which has affected the galaxiid, but rather a biological interaction.

- The current decline seems to be heading towards the extinction of the Lake Pedder population of Pedder galaxias.

- The two fish species thought to be responsible for the decline are present in large numbers in the lake as it currently stands, and will still be there should the lake be drained.

- These two fish species are also widely distributed in the tributary streams of the current lake. If the current recovery plan does start to succeed, and large numbers of Pedder galaxias become available, it would seem foolish to restock them into a lake where the principal threatening process is still very much in operation.

It seems unwise therefore to suggest that restocking of a restored Lake Pedder with Pedder galaxias should proceed without some preliminary assessment of the likely impact of trout and climbing galaxias.

The Inland Fisheries Commission is currently grappling with the problems associated with eradication of a pest species from Lakes Crescent and Sorell. While there is broad community support for the view that eradication of carp is in the best interests of the State, there are a range of views on what are acceptable means of achieving that goal. For a species like carp the only known method of eradication is by poisoning. Some members of the public, and at least one politician, have expressed the view that poisoning is unacceptable. If that is the case, then eradication of carp is unachievable, at least in the short to medium term.

In the case of a restored Lake Pedder, it is debatable whether the community would accept that the use of poisons would be necessary to eliminate a threat to an endemic species. This also ignores the fact that Lake Pedder is fed by many tributary streams which would be a potential source of recolonisation by these threatening species. Many of these tributaries could not be managed to reduce or eliminate the populations of trout and climbing galaxias. So, given that scenario, Lake Pedder is, and will probably remain, a hostile environment for Pedder galaxias, and should not be the focus of future work on this species.

To summarise, the available information does not indicate that the restoration of the Lake Pedder population of Pedder galaxias is feasible, or a reasonable goal which should be linked to the restoration of the lake. If the species survives at all, it won't be in Lake Pedder as it is today, or in a re-creation of its former state.

ACKNOWLEDGMENTS

Much of the work reported in this paper was conducted by Staff of the Inland Fisheries Commission under very trying conditions. The contributions of Premek Hamr are acknowledged in the text. Many other present and former staff have contributed willingly to the field work including; Phil Boxall, Vic Causby, Stuart Chilcott, Peter Davies, Wayne Fulton, Jean Jackson, Mike Jaegerman, Brett Mawbey and Mark Nelson. The Pedder galaxias recovery team continue to oversee recent and ongoing work with this species. Funding has been provided by the Australian Nature Conservation Agency and the Department of Environment and Land Management.

REFERENCES

ANDREWS, A.P., 1976: A revision of the family Galaxiidae (Pisces) in Tasmania; *Australian Journal of Marine and Freshwater Research*, Vol. 27, p. 297 - 349.

FRANKENBERG, R., 1968: Two new species from the Lake Pedder region of southern Tasmania; *Australian Zoologist*, Vol. 14, p. 268 - 274.

FULTON, W., 1990: *Tasmanian Freshwater Fishes*; Fauna of Tasmania Handbook No. 7, University of Tasmania, Hobart.

HAMR, P., 1992: *Conservation of* Galaxias pedderensis; Occasional Report 92-01, Inland Fisheries Commission, Hobart.

GAFFNEY, R.F., HAMR, P. & DAVIES, P.E., 1993: *The Pedder Galaxias Recovery Plan: Management Phase*; Department of Parks Wildlife and Heritage, Tasmania.

LAKE, P.S., 2001: The fauna of Lake Pedder - changes after the flooding and thoughts on restoration; in: Sharples, C., (ed.), *Lake Pedder: Values and Restoration*, Occasional Paper No. 27, Centre for Environmental Studies, University of Tasmania, p. 87 - 98.

McDOWALL, R.M. & FRANKENBERG, R.S., 1981: *The galaxiid fishes of Australia (Pisces: Galaxiidae)*; Record of the Australian Museum, No. 33, p. 443 - 605.

SANGER, A., 1988: The distribution, abundance and status of *Galaxias parvus* and *G. pedderensis* in the Lake Pedder region of the World Heritage Area; in: Fulton, W., (ed.), *Further Collections of Freshwater Fauna from the World Heritage Area, Tasmania*, Occasional Report 88-03, Inland Fisheries Commission, Hobart.

SANGER, A. & FULTON, W., 1989: *Investigation of the Lake Pedder Galaxias,* Galaxias pedderensis; Unpublished Report to the Department of Parks, Wildlife and Heritage, Tasmania.

SANGER, A., & FULTON, W., 1991: *Conservation of Endangered Species of Tasmanian Freshwater Fish*; Occasional Report 91-01, Inland Fisheries Commission, Hobart.

WAGER, R., & JACKSON, P., 1993: *The Action Plan for Australian Freshwater Fishes*; Australian Nature Conservation Agency, Canberra.

EDITORS POSTSCRIPT

Since this paper was presented, surveys of the Lake Oberon translocation site have found that a small Pedder galaxias population has established and is successfully breeding (Bryant, S.L., & Jackson, J., 1999: *Tasmania's Threatened Fauna Handbook: what, where and how to protect Tasmania's threatened animals*; Threatened Species Unit, Parks & Wildlife Service, Hobart).

Chris Sharples (ed.), April 2001