THE FAUNA OF LAKE PEDDER - CHANGES AFTER THE FLOODING AND THOUGHTS ON RESTORATION.

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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.

Lake Pedder was remarkable for its setting, its unique quartzitic sand beach and its fauna. Its high biological value was not realised until the scheme for flooding became entrenched. From 1975 to 1989 twelve sites around the Huon - Serpentine Impoundment ("Lake Pedder") were regularly sampled. Four species of endemic animals have disappeared and five species peculiar to the lakes (Lake Pedder and Lake Edgar) have also disappeared. During the survey 73 faunal species were collected. Faunal abundance, dominated by the trichopteran Notalina parkeri*, peaked in 1977 and then steadily declined to low levels. If restoration is to be carried out, problems to deal with include erosion and plant colonisation of the exposed shores and the control of trout. The original beach appears to be intact. With careful planning, Lake Pedder is restorable.*

Key Words: Australia, Tasmania, Lake Pedder, freshwater invertebrates, species loss, fauna, flooding, restoration

INTRODUCTION

As many have expressed eloquently in print and in images, the original Lake Pedder with the confluent Lake Maria was a very beautiful lake in a dramatically inspiring setting. There were many moods of the lake from the balmy stillness of autumn to the swirling cold storms of any time of the year. To many the lake was the natural centrepiece, the symbol of sanctity, of the south-west wilderness:- destroy it and the wilderness shrinks. The beach of Lake Pedder was famous for its great size, its beautiful symmetry, its stark pinkish white sand and its very marked seasonal changes in water level - being inundated in winter and spring and uncovered in summer. Behind the beach were tea tree-covered dunes and behind the dunes were the swamps, pools, lagoon and slow flowing channels and creek of the Lake Maria-Maria Creek system. Away to the south-east by about 12 km on the eastern margins of the Huon Plains was the shallow and small Lake Edgar (surface area = 0.8 km^2); a sheltered lake with extensive beds of reeds and sedges (Knott & Lake 1974). All of these lakes contained acidic waters low in conductivity and darkly coloured with dissolved humic materials (Buckney & Tyler 1973).

These lakes, the Huon and Serpentine river valleys and the extensive areas of buttongrass plains and heath of the Huon Plains were all inundated in 1973-74 by the impounded waters of the Middle Gordon Hydro-Electric Power Scheme. Almost it seems as a gesture of repentant propaganda, the new impoundment, "the enlargement of Lake Pedder", was called Lake Pedder, even though it bore little resemblance to the original lake and flooded two other lake systems as well; an unofficial name for the new Lake Pedder is the Huon-Serpentine Impoundment. In discussing the fauna of the original Lake Pedder I will also be dealing with the fauna of Lake Maria, Lake Edgar and fleetingly the Huon Plains and buttongrass plains around Lake Pedder.

THE BIOLOGICAL VALUES OF THE LAKE PEDDER AND LAKE EDGAR AREAS

As related in the Final Report of the Lake Pedder Committee of Enquiry (1974), the scientific and ecological values of Lake Pedder were not recognised in the official surveys of the lake (Hydro-Electric Commission 1967); even though two fish species, one being the endemic *Galaxias pedderensis*, had been collected and described (Frankenberg 1968). Then steadily, through the unofficial and frugally funded efforts of scientists (mostly biologists) such as Ian Bayly, Bill Williams, Roy Swain, Bill Wilson, John Hickman, Arturs Neboiss, Peter Tyler, Brenton Knott, and Jim Peterson, by 1970-71 it became obvious that the Lake Pedder/Lake Maria system was an ecologically valuable if not unique ecosystem. Further it became clear that this ecosystem, with its acidic, darkly coloured and humic waters of low conductivity (Buckney & Tyler 1973), harboured a set of distinctive faunal communities - zooplankton, nekton, benthos and psammon - the integrity of all

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of which was threatened by flooding (Bayly 1965, 1973, Bayly *et al.* 1966, 1972, Swain 1972, Lake Pedder Committee of Enquiry 1974). The unique psammon community of the Lake Pedder beach was dominated by an abundant phreatoicid isopod, *Uramphisopus* sp. 1 (see Knott 1975), which formed characteristic trails in the fine pale pink sand (Bayly *et al.* 1972, Bayly 1973). The endemic fish *G. pedderensis*, and the water bug *Diaprepocoris pedderensis* were part of the nekton. By 1974, it was suggested that Lake Pedder/Lake Maria harboured 13 endemic species of animals along with 3 species of rare animals for which "the Lake Pedder area provided the most important, or one of the most important, habitats" (Lake Pedder Committee of Enquiry 1974).

In a separate survey the shallow dystrophic Lake Edgar with its macrophyte beds was found to harbour an abundant invertebrate fauna (47 taxa). An unpigmented phreatoicid isopod found only in Lake Maria and Lake Edgar was moderately common (Knott & Lake 1974, Knott 1975). In crayfish burrows and bogholes of the buttongrass plains of the Huon Plains and McPartlan Pass, two species of syncarid crustaceans, *Allanaspides helonomus* (Swain *et al.* 1970) and *Allanaspides hickmani* (Swain *et al.* 1971) were found. The peculiar community of animals dwelling in the water of the crayfish burrows was subsequently termed <u>pholeteros</u> (Lake 1977).

THE ENDEMIC AND DISTINCTIVE FAUNA

Over the years through taxonomic studies (eg., Pinder & Brinkhurst 1989, StClair 1994) and through extensive collecting in south-west Tasmania (e.g., Chilcott 1988 a & b, Neboiss *et al*. 1989), the lists of endemic animals and of fauna peculiar to Lake Pedder have steadily changed. Currently five species of invertebrates and 1 species of fish are regarded as endemic to the Lake Pedder area (Table 1), whereas 8 species of invertebrates and 1 species of fish are identified as taxa for which the Lake Pedder area was an important habitat (Table 2).

THE FLOODING OF THE LAKE PEDDER AREA.

In late 1972 the inundation of Lake Pedder began amid much outcry and protest. In early 1973 the new Federal Minister for Environment, Moss Cass, visited the lake seeing the last of the lakeside protesters camped on the top of the dunes. During its filling I remember on several trips, including one with P.Tyler, being worried by the extent of wave erosion along the new shores and by the undercutting of steep slopes. By 1974 following the rejection of the findings of the Lake Pedder Committee of Enquiry the fate of the lake and its

Platyhelminthes	Tricladida		*Romankenkius pedderensis*
Crustacea	Isopoda	Phreatoicidae	*Uramphisopus* sp. 1 *Uramphisopus* sp. 2
Insecta	Trichoptera	Kokiriidae	*Taskiria mccubbini* *Taskiropsyche lacustris*
Pisces		Galaxiidae	*Galaxias pedderensis*

Table 1: Animal species endemic to the original Lake Pedder system.

Annelida	Oligochaeta	Tubificidae	*Telmatodrilus pectinatus*
Crustacea	Copepoda Syncarida	Centropagidae Anaspididae	*Calamoecia australis* *Allanaspides helonomus* *Allanaspides hickmani*
Insecta	Hemiptera Trichoptera	Corixidae Limnephilidae Leptoceridae	*Diaprepocoris pedderensis* *Archeophylax vernalis* *Westriplectes pedderensis*
Mollusca	Gastropoda	Hydrobiidae	*Glacidorbis pedderi*
Pisces		Galaxiidae	*Galaxias parvus*

Table 2: Species for which the Lake Pedder basin provided an important habitat.

surrounds was sealed. One recommendation never acted upon was that:

> "funds be set aside for an urgent and intensive program of investigations to determine the possibilities of natural or artificial re-establishment of the species in the new environment of the enlarged impoundment and to suggest management strategies by which this might best be encouraged; to undertake a comprehensive long-term monitoring program to ascertain the extent to which the re-establishment is taking place".

Throughout the campaign to save the lake the protesting biologists had been told that our concerns for the fauna were misplaced and that the fauna of the lake would simply migrate up to the new shores. Indeed in places around the new shores, beaches were cut by the HEC through the peat to the underlying gravel .

The biologists' claims were also regarded as exaggerated. Judging the paper by Bayly *et al.* (1972) as an Environmental Impact Statement, an environmental consultant (Spry 1976) wrote:

> "examples of exaggerated impacts by conservationists are probably just as common as obscured or diminished impacts by developers. Assessment of impacts as being exaggerated is a subjective matter and unequivocal examples are not easy to find. I would offer the alleged detrimental impacts of the flooding of Lake Pedder on the flora and fauna (Bayly *et al.* 1972) as an example".

THE INITIATION OF THE MONITORING PROGRAM

Thus the biota and ecosystem of the area to be flooded were regarded by many aquatic biologists as being of very high scientific value in spite of the suggestions that such claims were seen by some as being exaggerated. In Australia over the years many large impoundments have been built, yet in no case after filling has the benthos been monitored regularly. Spurred on by these two considerations I decided to monitor the littoral benthos of the new impoundment. In this endeavour I was greatly assisted by many colleagues to whom I am very grateful; in particular from the University of Tasmania great help was given by Ron Mawbey, Roy Swain, Alastair Richardson, Dave Coleman, Richard Norris and Piers Allbrook, and from the Inland Fisheries Commission by Robert Sloane; at Monash University Dave Morton and Alena Glaister sorted the samples and identified many of the taxa and Leeanne Matheson helped in the analysis and in production of the figures. The Tasmanian National Parks and Wildlife Service and the Inland Fisheries Commission kindly gave us permission to take faunal samples.

Our first trip in November 1975, in which only 3 sites were sampled with two small aluminium runabouts, was a very hazardous pilot study; we needed a bigger and safer boat that must be ready for any kind of weather. So we then used Ron Mawbey's father's runabout that provided us with cold and wet but fast trips between sites. Finally we graduated to the University of Tasmania's comfortable Sharkcat. Twelve sites from near the Edgar and Scotts Peak Dams (Edgar Bay) to the Lake Pedder basin (Pedder Reach) were selected (Figure 1), ranging from sheltered swampy sites (sites E & J , Figure 2) to very exposed rocky sites (sites D & G). At each site along the shore we took four 3-minute sweep samples using standard F.B.A. long-handled pond nets. The samples were preliminarily sorted in the field, then preserved and returned to Monash for sorting, identification and counting. From 1975 to 1989, we sampled all of the sites on ten occasions - each time in December.

OBSERVATIONS AND RESULTS OF THE MONITORING PROGRAM

As stated before, shortly after the lake filled myself and Peter Tyler went on a trip on the new impoundment and we saw that wave erosion was having severe effects on the exposed shores and in places the erosion had quickly cut through to bedrock. This potential for erosion was borne in mind in the overall selection of sites for the monitoring program. There were four sheltered swampy sites where the soil/peat was not progressively eroded and where initially after flooding there was copious amounts of drowned vegetation including trees, such as at Site J (Sites E, F, I and J, Figure 1). This vegetation has steadily declined with wave action and decomposition though some of the dead trees have remained. Four sites were moderately sheltered (Sites B, C, H and L, Figure 1) with some erosion through the soil to expose gravel and rocks, and steady and substantial losses of drowned vegetation. There were four exposed sites (Sites A, D, G, and K, Figure 1) with almost complete loss of vegetation with time and great losses of soil and peat such that rocks, bedrock outcrops and gravel became the dominant substrata.

Over the course of the monitoring program, 73 species of littoral macrofauna were collected. Insects dominated this total with 60 species, followed by 5 species of water mites, 3 species of molluscs, 2 species of fish and one each of crustacean, oligochaete worm and triclad flatworm. Of the total number of animals collected, the case-

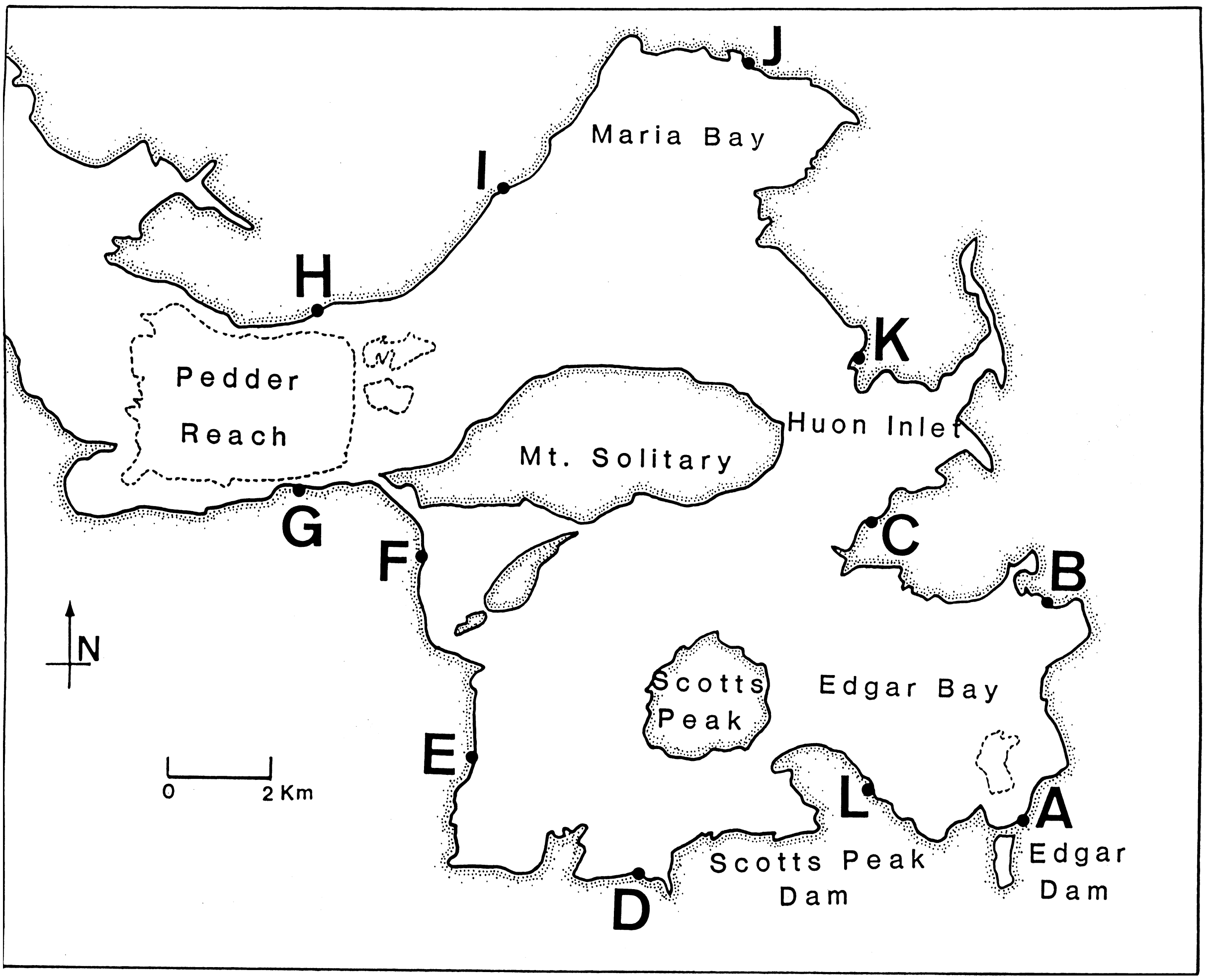

Figure 1: The distribution of sites where sampling was carried out around the Huon - Serpentine Impoundment.

Figure 2: A swampy site, Site J, in December, 1975.

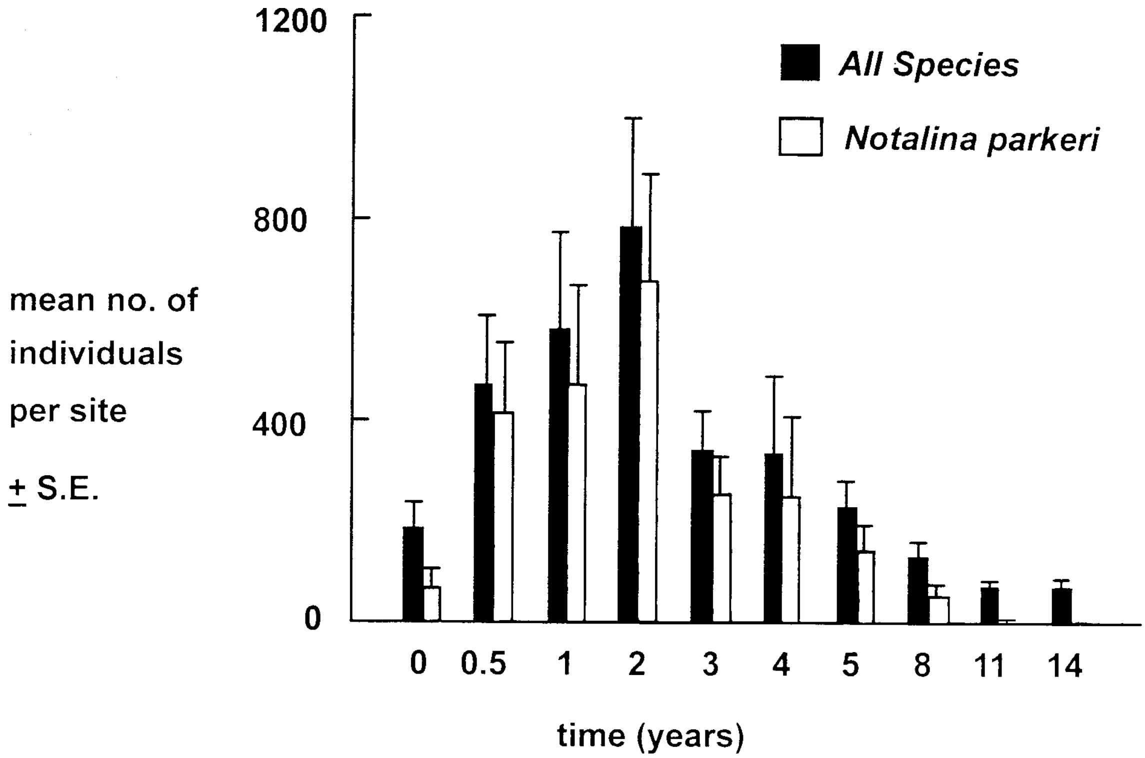

Figure 3: Mean numbers of animals and of the trichopteran *Notalina parkeri* (± standard deviation) caught per site per trip between 1975-1989.

building leptocerid trichopteran *Notalina parkeri* dominated, comprising 75%, followed by the amphipod crustacean *Austrochiltonia australis* at 13%. In the collections made shortly after flooding, *N. parkeri* was widespread and very common (Figure 3), whilst *A. australis* only occurred at sites around Edgar Bay and was uncommon. By 1986 *A. australis* was the dominant animal and occurred at all sites (Figure 4). In the final collection of 1989, 51% of the total abundance was *A. australis*, followed by 6.5% for *N. parkeri* and 4.8% of another leptocerid trichopteran *Atriplectides dubius*. The phenomenon of a slow and steady change from insect to non-insect domination of the fauna of lakes with time is an interesting and unsolved puzzle for limnologists (Hutchinson 1993).

In two years from 1975 to 1977, the littoral fauna underwent a massive increase in abundance, to peak at a mean total number of 816 animals per collection per site in 1977 (Figure 3). Steadily from 1977, there was a decline in abundance to reach the low average of 73 animals per site in 1989. This phenomenon of a boom in abundance and production after the filling of dams is well known (e.g., Zhadin & Gerd 1963, McLachlan 1974, Armitage 1977) and may be due to increased production stimulated by an increased input of nutrients from drowned soil and vegetation (Zhadin & Gerd 1963, Armitage 1977) and/or to the provision of an abundant and rich supply of detritus from the drowned vegetation (McLachlan 1977, Armitage 1977). In the Huon-Serpentine Impoundment the influence of increased detritus may have been particularly important. Nutrients may have also been released from drowned soil and decomposing vegetation: in the "boom" filamentous algae were present on stems of the drowned vegetation. It was in this period of the boom in invertebrates that "Lake Pedder" acquired its reputation as a fishery for large trout. It was also at this time that our sampling trips coincided with large hatches of dragonfly nymphs. Nymphs of the species *Hemicordulia tau* and *Procordulia jacksonensis* would migrate inshore to hatch in their thousands on the Edgar Dam wall in spring and early summer and were feasted upon by trout.

Notalina parkeri was always present at most sites of the impoundment. The amphipod *Austrochiltonia* was originally only present at sites around Edgar Bay; it was collected from Lake Edgar in 1972 (Knott & Lake 1974). As its abundance grew so did its distribution until it was present at all sites by 1989 (Figure 4).

Coincidental with the trend of a boom and decline in total animal abundance was the abundance patterns of many species. The unusual, streamlined water bug, *Diaprepocoris pedderensis*, was originally present in low numbers at two swampy sites. From 1975 to 1979 it increased in range and abundance (Figure 5) but by 1983 it had disappeared from the collections. Presumably populations of this species persist in isolated

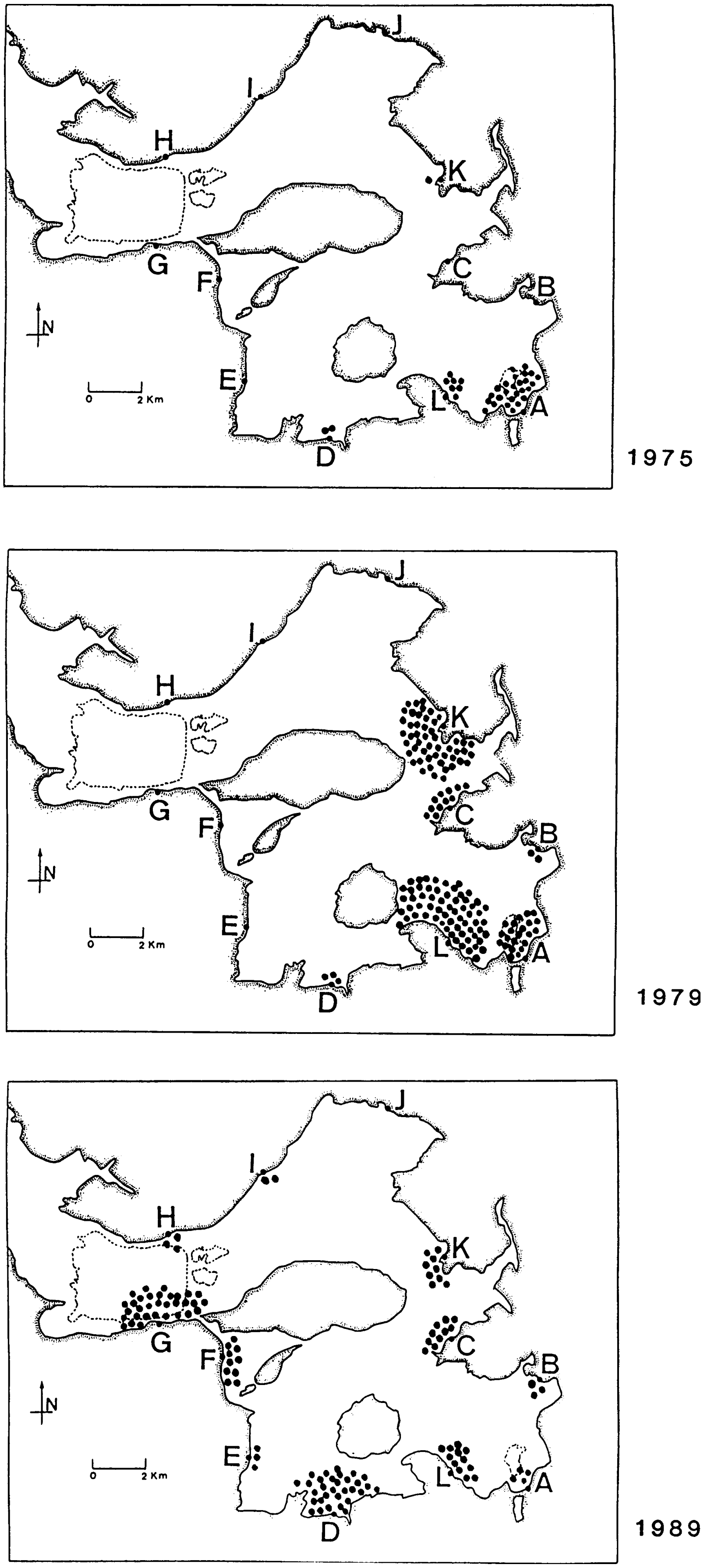

Figure 4: The changing distribution of the amphipod *Austrochiltonia australis* between 1975-1989.

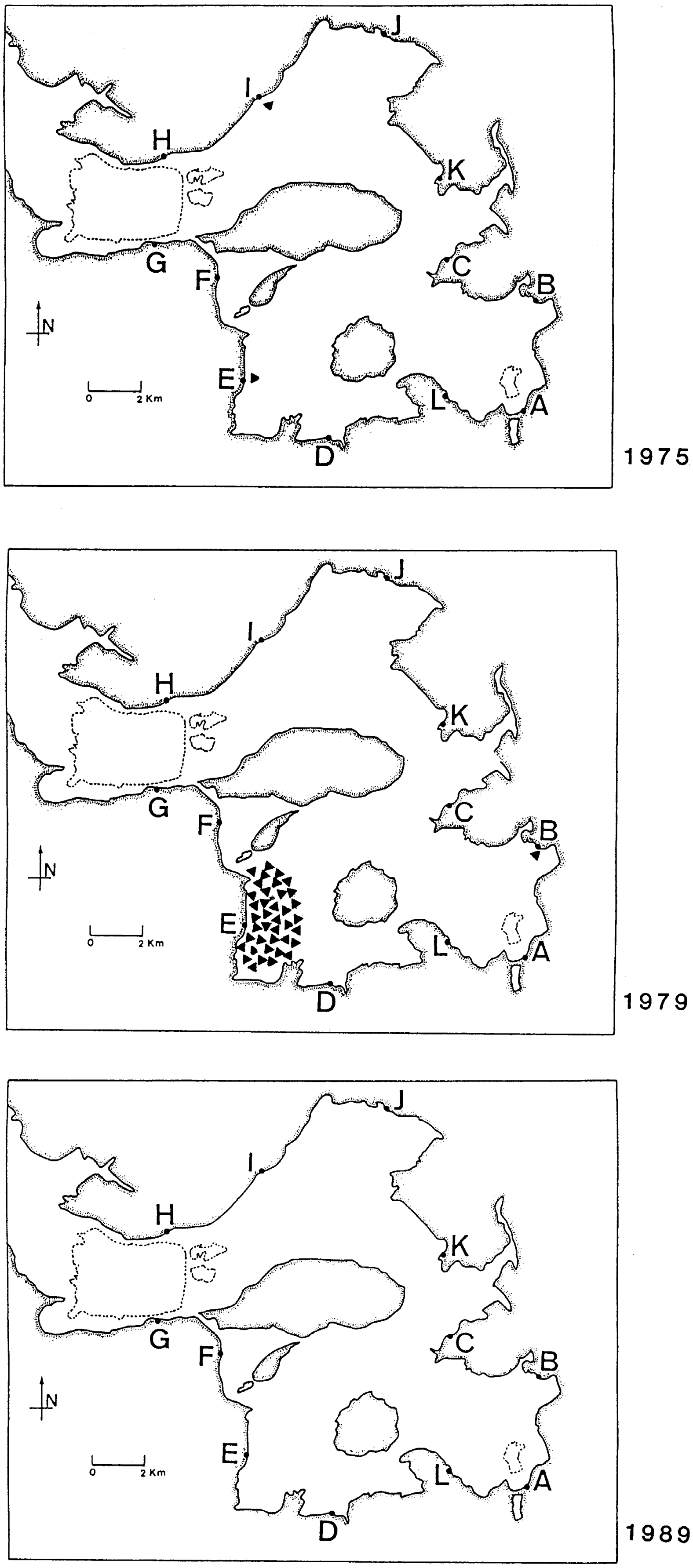

Figure 5: The changing distribution of the water bug *Diaprepocoris pedderensis* between 1975-1989.

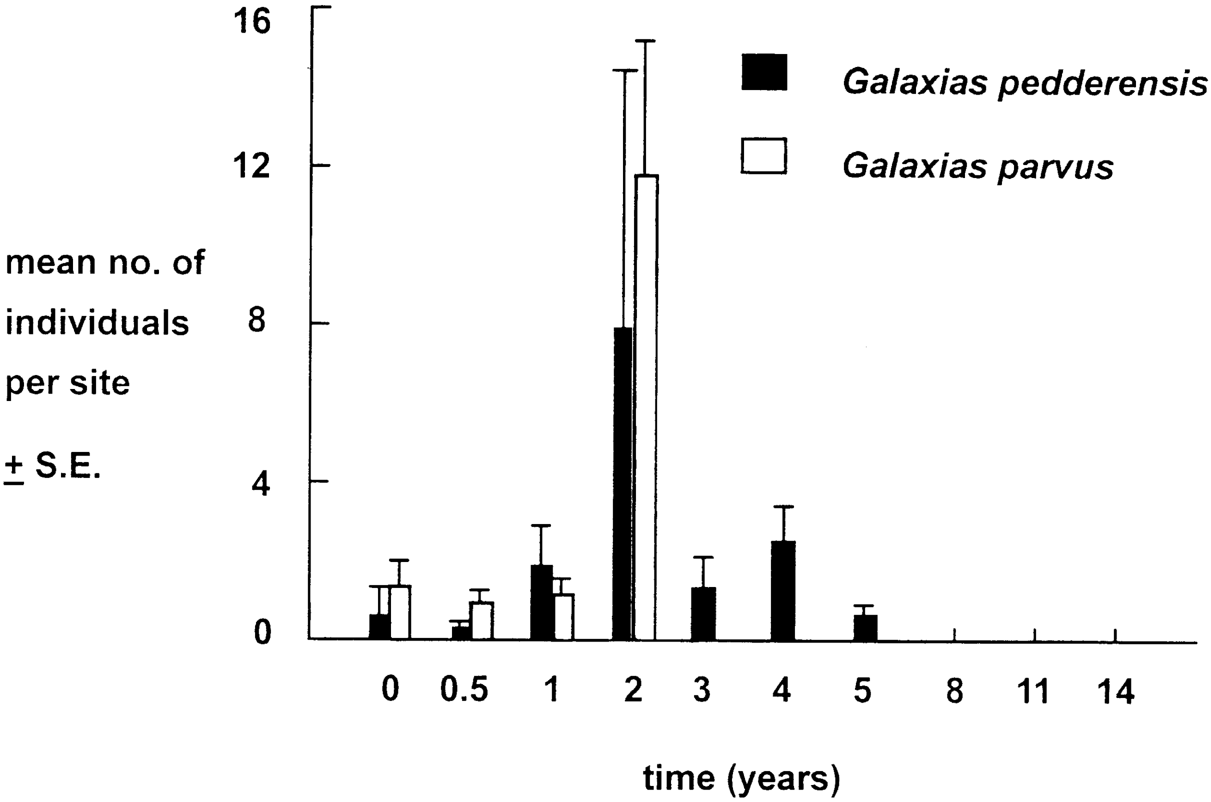

Figure 6: Mean number of individuals caught per site per trip (± standard deviation) of the fish *Galaxias pedderensis* and *Galaxias parvus.*

localities in south-west Tasmania. The stonefly *Leptoperla beroe* was first collected in low numbers in the Huon Inlet in 1975; by 1979 it was fairly common at sites around Huon Inlet, Mount Solitary and the original Lake Pedder but by 1989 it was rare and confined to 4 sites.

Both the endemic Pedder Galaxias, *Galaxias pedderensis*, and the Swamp Galaxias, *Galaxias parvus*, underwent dramatic changes in abundance and distribution. *G. parvus* was present in relatively high numbers in 1977 (Figure 6) but in 1978 none of this fish were collected and this remained the situation. *G. pedderensis* also peaked in numbers in 1977 and was subsequently collected in low numbers until 1980 when it disappeared from the collections. The causes for the declines in these two fish appear to be twofold: competition from, and predation by the introduced Brown Trout, and competition from the invading Climbing Galaxias, *Galaxias brevipinnis* (Hamr 1992 a & b, Smith & Gilfedder 1993). *G. pedderensis* is now an endangered species with no more than 200 individuals believed to exist and is now the subject of a rescue plan (Hamr 1992 a & b).

The physical changes at the various sites appear to be reflected in the successional patterns shown by the littoral fauna. The swamp sites began with a high abundance of detritivores, principally *N. parkeri*, and steadily changed to end with a low abundance of chironomids by 1989. The very exposed sites started with low numbers of animals, mainly *N. parkeri*, and ended with a relatively high abundance of amphipods. The moderately sheltered sites harboured at first a diverse fauna that subsequently declined in diversity and abundance to end with assemblages of low abundance dominated by the amphipods. Needless to say all of these 1989 endpoints are quite different from the original fauna of Lake Pedder (Bayly *et al.* 1966, 1972) and of Lake Edgar (Knott & Lake 1974).

Of the endemic fauna of Lake Pedder only one, the fish *G. pedderensis*, was collected in the monitoring survey, and it has now declined so much as to be endangered. Given our method of sampling it is not surprising that the endemic flatworm was not collected. However it is salutary to note that not one individual of the two species of endemic phreatoicid isopods or of the two species of beach-dwelling kokiriid trichopterans were collected. Of the animals for which the unflooded Lake Pedder basin was an important habitat, two species, the fish *G. parvus* and the water bug *D. pedderensis*, were collected but subsequently disappeared. However it does appear from recent sampling (1994) that the original beach of Lake Pedder is still intact and from this beach, individuals of the isopod *Uramphisopus* sp. 1 were collected (Tyler *et al.* 1994). Perhaps remnants of the psammon community (Bayly 1973) remain.

RESTORATION OF LAKE PEDDER AND ITS BIOTA.

Whilst Lake Pedder is the centre of attention for possible restoration, it should be noted that both the adjoining Lake Maria and the more distant Lake Edgar should also be considered. In the case of the latter, lake restoration depends on the way that water is released from the impoundment; if impounded waters remain behind the Edgar and Scotts Peak Dams then this lake will not be restored.

There is no doubt that attempting to restore Lake Pedder will be a complex and challenging project. Part of the difficulty stems from the fact that in Australia and in the world for that matter, there is an almost total lack of information and expertise on the successful restoration of large aquatic environments. The restoration project if carried out could be a world first.

If restoration is to be undertaken it will be necessary as a first step to carry out an extensive physical and biological survey. The state of the shoreline, the state of the Lake Pedder beach and the composition and relative abundance of the biota in the various communities - benthos (littoral and offshore), psammon, plankton and nekton - will need to be accurately assessed. Furthermore such a survey should be rigorously designed such that it can serve as a baseline for subsequent monitoring that should accompany restoration.

From observations of the current impoundment there are areas, especially in exposed positions with steep slopes, where wave erosion has been very substantial. The soil and subsoil have been removed and quartzitic gravels and rocks have been exposed. These areas are extensive and need to be mapped. If restoration of the lake is undertaken these areas if unattended may be long lasting scars and will require active physical intervention to heal them.

From our experience during our monitoring trips and as is evident in the maps of Peterson & Missen (1979), in the current impoundment there are extensive amounts of shallow, very gently sloping, areas extending out from the shorelines (e.g., off Site E, Figure 1). A small drop in water level will uncover many hectares of such shallow areas that may be visually unattractive and subject to damaging wind and water erosion. A limiting step to improving the stability and visual impression of these areas will be the rate of plant colonisation and succession. If this is very slow then active intervention to speed up plant colonisation may be required.

From the observations of Tyler *et al.* (1994) it does appear that the original beach of Lake Pedder is still intact, even though it may now be covered by a layer of organic matter. I am sure that this layer will dissipate as the lake is allowed to return to its original summer level.

A key matter for successful restoration is the rate at which the water level is to be dropped. If it was to be dropped rapidly, a very large, bare and unattractive area would be exposed. This area would also be physically unstable and could be subject to water and wind erosion. Thus to reduce the creation of a bad visual impact, to reduce erosion, to allow progressive repair of scarred areas and to allow successful development of plant cover in exposed areas, I am strongly of the view that the level of the impoundment should be dropped slowly and decrementally.

In terms of restoration of the biotic components of the original Lake Pedder it is difficult to make predictions. Clearly the rate and extent of plant colonisation is a key concern. The original beach of the lake is intact and the phreatoicids of the original psammon community are present, and thus some components of this community may return. The kokiriid caddis flies of the beach appear to have been lost.

Of the invertebrates originally present in the Lake Pedder/Lake Maria system, one of the two phreatoicid crustaceans is present and may return to its former abundance (cf. Bayly 1973) with restoration. For the second species (*Uramphisopus* sp. 2) there is the need to survey the bottoms of Lake Edgar and Lake Maria. Some insect species such as *Diaprepocoris pedderensis* and *Archeophylax vernalis* are known to have populations in the area and thus these species may return. For a species like *Westriplectes pedderensis* recolonisation may be difficult as the only known extant population is on Wilsons Promontory, Victoria (StClair 1994).

Conversely it is difficult to predict what restoration may do to those common invertebrates that invaded the impoundment (e.g., *Notalina parkeri*) or were previously only found in particular localities (e.g., *Austrochiltonia* previously only found in Lake Edgar). I suspect that many, such as the above two, are quite adaptable and will persist as dominant animals.

The restoration of populations of the two fish species (*G. pedderensis* and *G. parvus*) originally found in Lake Pedder may be difficult. Firstly, the current status of the fish populations in the impoundment is uncertain and both species may be locally extinct - thus there may not be populations for recovery, and fish as opposed to insects are poor colonisers from one isolated water body to another. Second, the restored lake would contain high populations of the two invading fish, *Salmo trutta* and *Galaxias brevipinnis*, implicated in the decline of the two native fish species (Hamr 1992 a & b). To allow the re-establishment and recovery of the populations of the original animals that dwelt in Lake Pedder, it may be necessary to have a specific program to greatly reduce the numbers of these fish. As the water level of the impoundment drops trout populations will become more and more concentrated and will no doubt have an increasing impact on their prey populations.

Thus in summary, it may be quite feasible to restore Lake Pedder and its surrounds. Such restoration will require careful planning, will need to be accompanied by regular rigorous monitoring and will necessitate active rehabilitation efforts. To restore Lake Pedder will serve as a great symbol to show that if we put our effort to it, we can bring back to their former value some parts of the natural world that we have needlessly destroyed.

ACKNOWLEDGEMENTS.

As indicated in above text, this study would not have been possible without the generous help of colleagues in the Department of Zoology, University of Tasmania and the Department of Ecology and Evolutionary Biology, Monash University. I am grateful to both the Tasmanian Department of Parks, Wildlife and Heritage (now part of the Department of Primary Industries, Water & Environment) and the Inland Fisheries Commission for permission to sample the lake. This study was supported by funds from the University of Tasmania, Co-operative Research Centre for Freshwater Ecology, and Monash University.

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