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SPECIAL EDITION

THE GREAT LAKE TROUT FISHERY

This special edition of the Newsletter is entirely devoted to various aspects of the Great Lake trout fishery and has been prepared by Inland Fisheries Commission Scientific Officers, Peter Davies and Wayne Fulton.

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HISTORY OF THE GREAT LAKE AREA

Apparently Great Lake was discovered in 1815 by a kangaroo hunter named Toombs. A little later in 1817 a party led by a naval officer, John Beamont, and a settler from the Jordan River, Robert Jones, travelled from the Jordan River to Great Lake and from there proceeded further west across the plateau. The valleys of the Clyde, Shannon and Ouse Rivers were explored for most of their length by this time and graziers were beginning to run stock in the Bothwell district. By 1830 there were large numbers of cattle, many of them wild, grazing in the plateau area.

Stock grazing was the principal use of the central plateau area until about 1900 when trout were introduced into the area. The grazing continued but the region also became a popular recreational fishery. The waters of Great Lake, and to a lesser extent Arthurs Lake (then consisting of two separate lakes), received considerable attention after this time and successful stockings were made with brown trout, and later with rainbow trout. Atlantic salmon were also released into both lakes but they did not establish naturally reproducing populations. Further details of the acclimatisation of trout and salmon in these lakes are given by Gilmour (1973) along with interesting notes on the early days of fishing in these waters.

Drainage alterations

The first permanent dam on Great Lake was built across the Shannon River by the Hydro Electric Power and Metallurgical Company - the forerunner of the present Hydro-Electric Commission of Tasmania. This was a gravity dam built for the purpose of maintaining a constant flow in the Shannon River and was completed in 1916. It increased the depth of Great Lake by about 3 m to a supply level of 1022 m. Prior to this anglers had placed a loose rock barrier across the Shannon River in order to keep the water level up in Swan Bay. The Miena dam, completed in 1922, was built downstream from this. It was a multiple arch concrete structure built to supply the Waddamana power station. It increased the level of the lake to 1030 m.

A third dam was completed in 1967 further downstream from the multiple arch dam. It was about 550 m long and of rockfill construction. It increased the depth of Great Lake by a further 3.4 m to a full supply level of 1033.5 m. In July 1982 the height of this dam was increased by another 6 m.

There have been several other changes to the catchment of Great Lake since the first dam construction. Liawenee Canal was built in 1921 to divert waters from the Ouse River drainage into Great Lake. This was originally a 12.6 cumec capacity canal but it was enlarged in 1940 to carry 18.2 cumecs. The canal was concreted over a period of years with the majority of the work being done in 1950-51. The mean flow rate of the canal is about 9.7 cumecs.

Small diversions were constructed on the upper Liffey River and on Westons Rivulet - Brumbys Creek. These commenced operation in 1963-64 and 1966 respectively. The two diversions convey an average of about 0.7 cumecs to Great Lake over the year.

Pumping of water from Arthurs Lake into Tods Corner, Great Lake, commenced in May 1966. Water is pumped uphill from Arthurs Lake, then via approximately 6 km of fluming to Great Lake. The fall into Great Lake is used to power a small turbine which is in turn used to operate the pump at Arthurs Lake. The average yearly input to Great Lake from this source is about 3.7 cumecs.

Since 1968 Shannon Lagoon has also supplied water to Great Lake via a pump at Miena. Water is pumped from the lagoon in winter when there is an excess. It supplies an approximate yearly average of 0.3 cumecs.

Originally the major outlet from Great Lake was via the Shannon River. However, since the commencement of operation of the Poatina Power Station in 1964 and the closure of Shannon and Waddamana stations this outlet has only been used to supply riparian water rights in summer. Poatina is now the major user of Great Lake (and Arthurs Lake) water drawing a mean flow of about 18.7 cumecs. This water discharges via Brumbys Creek into the South Esk system.

Some water may be discharged from Arthurs Lake via the Lake River, again for riparian usage, but the majority is diverted into Great Lake via the pump on the western shore of Arthurs Lake.

The lake has been subject to considerable water level fluctuations since the first dam was constructed (Fig. 1).

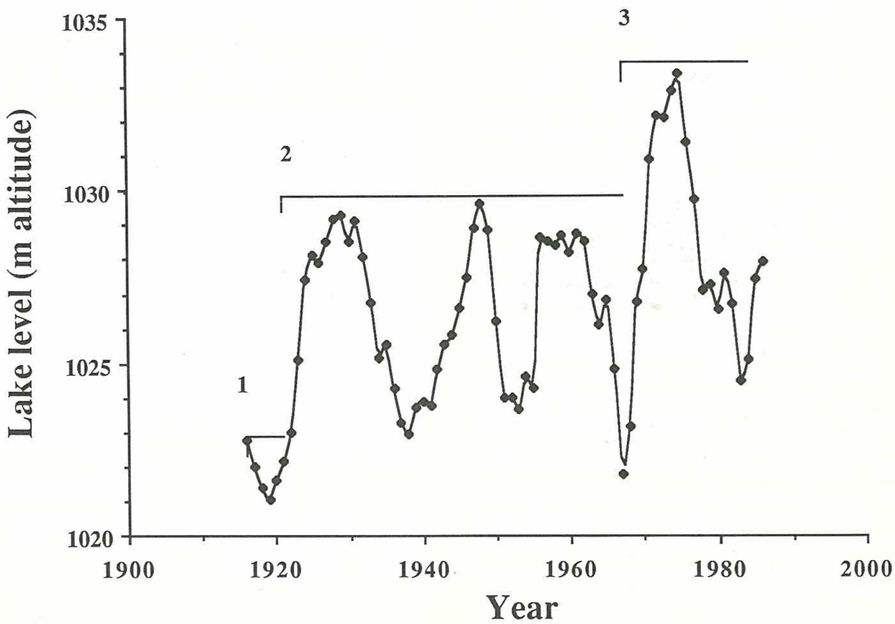


Fig. 1. Great Lake water level fluctuations 1910-1987.

Geology

The surface layer of rocks around Great Lake and Arthurs Lake is now predominantly dolerite (bluestone). This rock is of volcanic origin and was originally injected beneath and into a layer of sedimentary rocks, the uppermost layer of which has since eroded away.

The dolerite layer is generally between 60 and 300 m thick and appears to have intruded about 165 million years ago about the time of the beginning of the separation of the southern land masses. The overlying sedimentary rocks were gradually removed by erosion leaving a surface layer predominantly of dolerite.

Great Lake and Arthurs Lake both lie on the middle of the three main erosion surfaces forming the Central Plateau area. This surface lies between 900 and 1050 m above sea level. Sometime within the last 25,000 years most of the upper plateau surface was covered by ice. Glacial remnants are evident in the region of Lake Augusta but the ice sheet did not reach as far east as Great Lake.

The origin of the larger central plateau lakes has given rise to some conjecture. Early opinion was that the Great Lake at least was formed by glacial activity during the Pleistocene age but the lake is not of the characteristic form normally associated with such lakes. More recent opinion is that the lake probably has not been glaciated and it appears that Great Lake is quite old and predates the Pleistocene glaciation, although not necessarily in its present form. The lakes to the east may be of more recent origin.

Biological history

The Great Lake area was the centre of interest for many early collectors. Its vast area of cool shallow water contained many species formerly unknown to science. The crustacean fauna in particular was found to be rich in species variety and abundance. This fauna was studied to varying levels by numerous visitors. Many of these studies concentrate on the unique syncarid *Paranaspides lacustris* known locally as the Great Lake shrimp.

The abundance of fauna, particularly crustacea, in the littoral zone of Great Lake was remarked upon at the turn of the century, however by 1933 the shore fauna of the lake had been drastically reduced as a result of wide fluctuations in the water level. R.J. Tillyard considered that the Great Lake shrimp was in danger of extinction and that the may-fly, caddis-fly, stone-fly and dragon-fly populations were low in diversity and generally few in number. Tillyard found two species of phreatoicids (isopod crustacea) to be common both marginally and in deeper water. Only two years later, however, Cramp (1935) reported that the shrimps were apparently quite easily collected in Great Lake.

The invertebrate fauna of Great Lake received further attention during the "fish food investigations" of J.W. Evans from 1936 to 1941. The results of these investigations were published in the reports of the Salmon and Freshwater Fisheries Commissioners. In one of these reports brief details of the contents of dredge samples from Great Lake are given. The Great Lake shrimp was found to be common at all sites along with small galaxias, phreatoicids and caddis larvae. The large freshwater limpet *Ancylastrum cumingianus*, the snail *Ameria* sp., small bivalves (clams) and amphipods were also recorded from some sites. No mention was made of any midge larvae in the collections and they are only occasionally listed in the trout gut details from Great Lake. In summary of his findings from trout gut analyses, Evans concluded that the benthic (lake bed) fauna appeared to be in no immediate danger. The major benthic invertebrates eaten by trout were phreatoicids, caddis larvae and 'limpets'. Evans also found that the Great Lake shrimp was far more abundant in the lake than trout gut contents suggested.

A further study of gut contents of Great Lake trout was carried out by J. H. Wilson during the years 1961-1963. Variations were shown from the findings of Evans. There was a considerable increase in the percentage occurrence of plankton from 5% to 29% (Wilson 1966), shrimps 2-20%, trichopteran larvae 48-69% and midge larvae 1-33%. However, of these the midge larvae and shrimps did not constitute a significant proportion of the total food volume but were merely more widespread in their occurrence.

No thorough investigation of the benthic fauna of Great Lake or Arthurs Lake had been undertaken until the survey conducted by W. Fulton in the mid 1970's, and most of the early interest centred on the Great Lake shrimp. However many other workers made collections of specific groups from Great Lake. For example many caddis fly types were collected from the Miena area and large collections of phreatoicids were made by Nicholls.

The Shannon Rise

The Shannon Rise phenomenon has both biological and historical significance in relation to any discussion of the Great Lake area. It occurred in the Shannon River at its outlet from Great Lake. The continuous high flow rate of water from the Miena dam (completed in 1922) created favourable conditions for the larvae of the snow-flake caddis *Asmicridea grisea* and vast numbers were present.The larvae of this species construct webs on the rocks on the bottom of streams to filter out food items such as algae from the flowing water. When the larvae hatched in about December of each year large numbers of trout congregated to feed on them. The rise became extremely popular with anglers and its occurrence was known world wide.

In the initial stages of the hydro-electric power schemes in Tasmania, the Great Lake development provided all of the State's power. This meant that there was virtually a continuous flow of water down the Shannon River providing ideal conditions for the web-spinning caddis larvae. Progressively from about 1940, when other power stations came into operation, until 1965, when all Great Lake waters were diverted northwards, the flow in the Shannon River was interupted more and more often. As the interuptions became more and more frequent there was a parallel decline in the quality of the rise until it ceased with the introduction of the Poatina Power Station. Hence a phenomenon that had been originally enhanced by hydro-electric developments was also curtailed by the same.

INVERTEBRATE FAUNA OF GREAT LAKE

The history of biological interest in the Great Lake area has been briefly outlined in an earlier section. This interest, with the exception of the fish food studies, was generally of a scientific nature. However in the early 1970's there was considerable interest in the available fish food in the lake and it was considered desirable to investigate the status of the bottom fauna as well as the native fish to determine whether any introductions were necessary. Such studies were commenced in the mid 1970's and this section reports on the invertebrate or "fish food" section of that work.

The fish food study had two main objectives :

1. To examine the type of animals present and determine their distribution.
2. To determine the quantity of animals present at various localities throughout the lake.

The study also produced data on seasonal variations in the fauna and collections were used to further investigate the life history of particular species.

Due to the demands upon Great Lake for hydro-electric power generation there are often considerable fluctuations in water level (Fig. 1). Such fluctuations are at times unseasonal and cannot be tolerated by shallow water vegetation and its associated fauna. For this reason there is very little permanent aquatic life in the first few metres of the lake, so the study concentrated on the established fauna below about 7 m depth.

Methods of study

Samples of the bottom mud were taken using a grab with spring loaded jaws which are released when a weight is dropped down the holding cable. Twenty replicate samples were taken at each of six sites in Great Lake. The sample sites were chosen so as to represent the old lake as well as the newly flooded areas. Each of the sites was sampled every two months throughout a one year period.

The invertebrates were removed from the bottom debris, identified, counted and each species group was weighed. Obviously trout would not be all that particular about which species of mayfly or worm they were eating, but the exact identification and distribution of each species is of particular interest to scientists working in various fields. Also, to have any value for management purposes, the type of fauna and its quantity needs to be accurately known.

Material was sent to various overseas institutions for their use and several new species have been described.

Results and Discussion

The number of species in each group were as follows:

	Great Lake
Midge Larvae (chironomids)	15
Worms (oligochaetes)	13
Shrimps (crustaceans)	9
Snails, bivalves (molluscs)	5
Mites	4
Caddis larvae (trichopterans)	3
Flat-worms (turbellarians)	2
Stonefly larvae (plecopterans)	1
Nemerteans (proboscis worms)	1
Sponges	1
Totals	54

The total number of species found in Great Lake is among the highest yet recorded from any Australian lake. This may be due to a combination of factors. The bottom living fauna of only a few Australian lakes has been studied in such detail as this work. The lakes studied have generally not been as large as Great Lake, consequently there would have been fewer sites available for species variation. Great Lake appears to have been present longer than many lakes in warmer parts of Australia and does not have a harsh physical or chemical environment which may tend to restrict species diversity.

The fauna of Great Lake is generally quite similar to that of Arthurs Lake with the exception of the Crustacea. Within this group, four species of phreatoicids (a common and valuable trout food commonly known as shrimps) were locally abundant to varying degrees in Great Lake. Three of these species have not been found elsewhere. Another common freshwater crustacean group, the amphipods (scud), were only occasionally found in Great Lake. These are common inhabitants of weedy areas and were apparently more abundant in Great Lake in its earlier days. The

Great Lake shrimp, *Paranaspides lacustris*, was not collected in large numbers during this survey but the grab method was not suitable to collect this species as it is quite mobile.

In terms of numbers of species and overall abundance the fauna was dominated by the oligochaete (worms) and chironomid (midge) groups with the former more common in the original lake areas whilst the midge larvae were more abundant in the shallow areas. However, as indicated by the diet of the fish (see below) these species are generally below the surface of the bottom mud and are not frequently taken by trout.

Three species of caddis were found with one species in particular being common and quite widespread. The mayfly and stonefly groups were scarce, with the mayflies not recorded in the routine survey. This is not unusual as these species are generally more at home in much shallower water than was covered by the survey.

The mollusc group, particularly the snails, was never abundant, probably preferring more weedy areas. The remaining groups, although of considerable scientific interest, did not constitute a large part of the fauna in terms of numbers or weight.

The total weight of animals at each site was greatest in the original lake areas but this was due to the dominance of the oligochaete group and to one large species of worm in particular. Without the inclusion of this worm the weight of animals present per unit area (or biomass) would be approximately the same at all sites sampled, although the composition of the fauna varied considerably between levels within the lake.

The total weight of invertebrates at each site (biomass) was above average for Australian lakes. A high biomass level indicates that the bottom fauna is in a healthy state at the time of sampling at least, and consistent levels were evident throughout the year of study. It does not necessarily mean that the lake is highly productive.

Species presence and abundance data at each site were further analysed in order to relate the various sites to each other and therefore give some predictive value to the study. Because of the volume of data present a computer was used to group the sites in terms of the common elements of their fauna. Two methods were used and both gave essentially similar results. The fauna of each site was compared to the fauna of every other site by the computer which then grouped sites in order of their similarity to each other.

The analyses, as expected, resulted in groupings of sites according to depth and a characteristic fauna for various areas was recognised. The deep sites of the lake were characterised by the presence of large oligochaete species as well as certain species of chironomids. The shallow sites were characterised by a varied and abundant chironomid fauna, substantial numbers of caddis and certain smaller oligochaete species. Phreatoicids and one caddis species were quite widespread throughout the lake. Great Lake also showed evidence of some division of the shallow water fauna into "windward" and "leeward" elements although these differences were not on the same scale as the major old lake area/ new lake area differences.

Conclusions

The major conclusion from this study was that there is no cause for concern over the amount of food available in Great Lake. The quantity and type of food available for trout is adequate to support present stocks.

It is not anticipated that the shallow areas of Great Lake which are affected by large water level fluctuations will ever establish good invertebrate populations. However, the weedy areas which exist just beyond the affected areas would appear to offer the best and most accessible food for trout. These weedy areas do not persist throughout the lake as increasing depth reduces the light penetration thus preventing weed growth.

In Great Lake, particular areas of weed ("shrimp beds") are known to many anglers. These areas are generally located in the deeper parts of the newly flooded lake area on the western shore or areas sheltered from direct wind/wave action. Similar depth areas on the exposed side of the lake tend to have a different fauna probably due to this exposure to wind and wave action.

More detailed information resulting from these bottom fauna studies is contained in a number of scientific papers published by the Commission.

NATIVE FISHES OF GREAT LAKE

To the angler the trout is the best known inhabitant of freshwater in Tasmania. But whereas the trout is widespread around the world there are several species of related, but much smaller native fishes known generally as 'galaxias' that are restricted to the Southern Hemisphere. Some of these species are further restricted in that they only occur in Tasmania.

In the early 1960's there were a number of requests to introduce a small fish species to Great Lake as a forage fish for trout. A species of smelt, *Retropinna semoni*, very similar to a native Tasmanian species was collected from Victoria and introduced into ponds at Plenty. However this project was never proceeded with.

In the early 1970's, coincident with the study of the bottom fauna of Great Lake, the native fish of the area were also investigated. In Great Lake in particular there were found to be four separate species of native fish, one of which was previously undescribed. Further investigations in nearby lakes revealed a further three new species of native fishes, two in the Arthurs Lake/Woods Lake system and one in the Western Lakes.

The four species found in Great Lake are as follows;

Climbing galaxias	*Galaxias brevipinnis* Gunther
Spotted galaxias	*Galaxias truttaceus* (Valenciennes)
Shannon paragalaxias	*Paragalaxias dissimilis* (Regan)
Great Lake paragalaxias	*Paragalaxias eleotroides* McDowall & Fulton

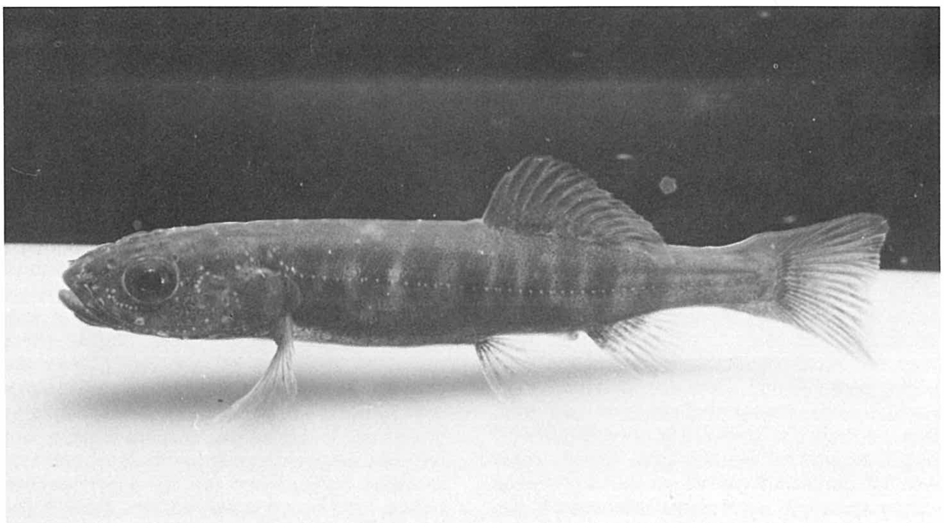
The first two of these fishes are widespread and common elsewhere in Tasmania but the two paragalaxias are only found in Great Lake and Shannon and Penstock lagoons.

Climbing galaxias

This species has a wide distribution around Tasmania having both landlocked populations in lakes as well as riverine forms. The riverine populations are generally confined to the upper reaches of streams with the juvenile fish having a marine phase and forming part of the spring whitebait migrations in coastal streams.

The species was first described in 1866 from fishes collected in New Zealand. At least five different names have been used for this fish in Tasmania because it varies somewhat in appearance from one population to another.

In Great Lake (and other highland lakes) this fish breeds in spring although it is not known where. The juvenile fish maintain some of the habits of the riverine populations as they still form schools which may be seen around the edges of the lake during summer. At this stage they are frequently taken as food by trout.



Paragalaxias dissimilis, the Shannon paragalaxias

Spotted galaxias

The spotted galaxias also has a wide distribution around Tasmania although it does not have the same climbing ability as the previous species and can therefore not get to some of the areas reached by the climbing galaxias. It was first described in 1846 from material collected in Tasmania and it is also found in south-eastern and south western mainland Australia. It also has both lake and river populations but normally inhabits the lower to middle reaches of coastal streams.The breeding biology of this species was described in an earlier IFC newsletter (December 1986).

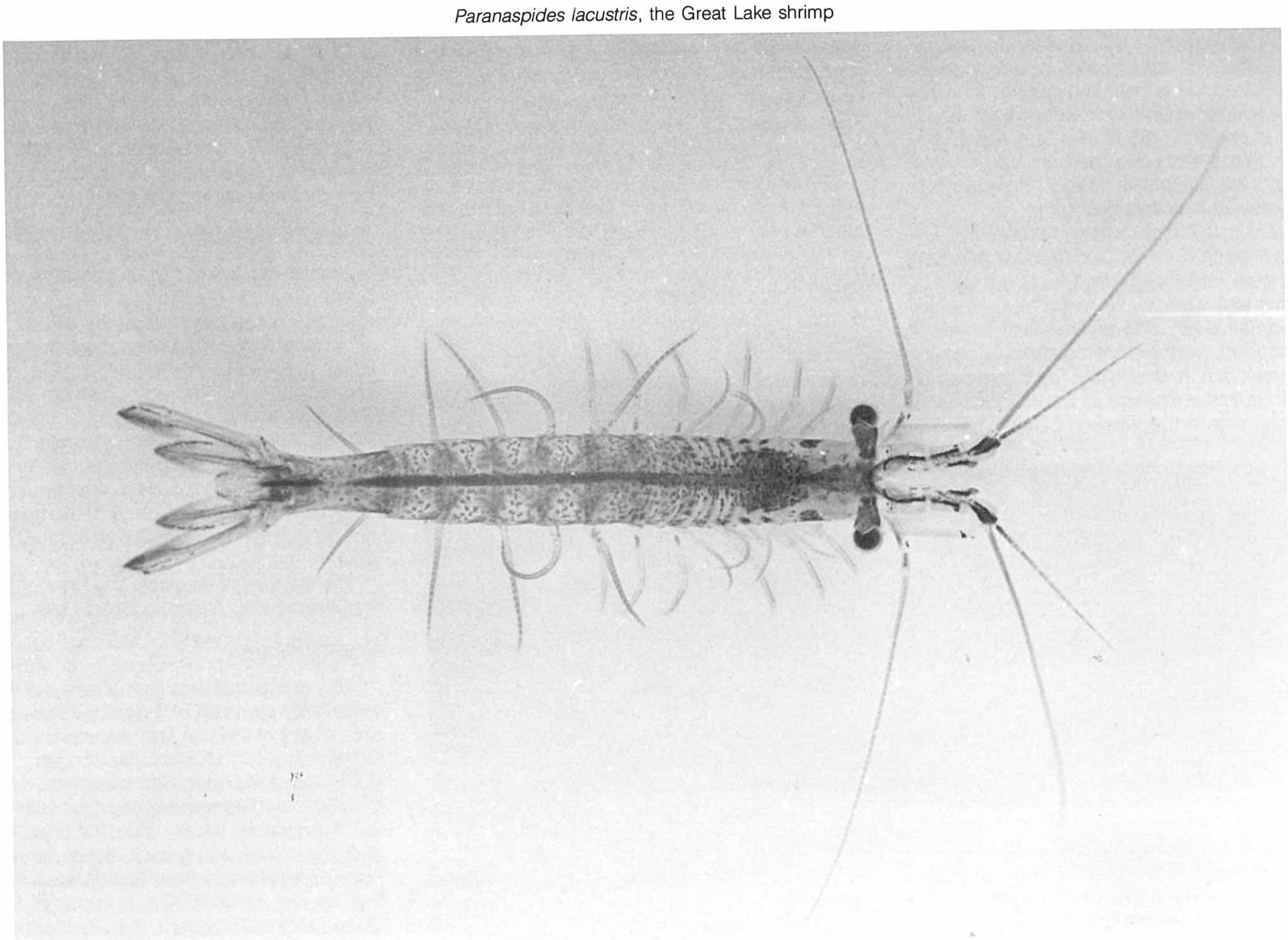
The species is probably the least common of the four species found in Great Lake.

Paragalaxias

This group contains four species of fish all of which are found only in Tasmania. The first specimen of any of the four species was probably collected about 1905 by the English scientist C.T. Regan. He published a description of the fish based on one specimen only, giving the locality as "New South Wales'. this has puzzled biologists ever since, as no such similar fish has ever been collected from New South Wales. Following this, in the early 1930's a biologist from the Queen Victoria Museum, Eric Scott, collected a series of these fishes from the Shannon River, just below the Great Lake. He considered this fish to be quite distinct from other species of *Galaxias* and described the species as *Paragalaxias shan-*

Galaxias truttaceus, the spotted galaxias

Paranaspides lacustris, the Great Lake shrimp



nonensis. After considerable debate over these two fishes, it was concluded that both species were one and the same. The New South Wales locality was probably recorded in error as in the early days collections were often made from various places and the material taken back to Europe for further work. According to the rules governing the scientific names of species the first name used takes precedence and the fish therefore became known as *Paragalaxias dissimilis*.

Since Scott's work on this species other scientists had attempted to collect this fish using traps and small nets without success. From their efforts they concluded that the species was in danger of extinction. However, in 1972 when the Commission began its study of the native fishes of Great Lake using electric fishing equipment it was found that the Shannon paragalaxias was in fact very abundant around the shoreline, particularly amongst rocks. On closer examination it was found that there were two quite different fishes in the collections and that they reacted differently to the electric fishing machine. One species floated in mid-water when shocked whilst the other sank to the bottom. This second species, which is not as common as the Shannon paragalaxias around the shore, was subsequently described as *Paragalaxias eleotroides* and given the common name of Great Lake paragalaxias.

The diving survey work recently undertaken in the lake (March 1987) showed that the second species is also very common but that it occurs further out on the bottom of the lake particularly amongst the weed beds. In the survey of the gut contents of trout in the lake both the paragalaxias species were found to be common elements of the diet of brown trout and the introduction of a further small species of fish would neither be required nor would it be desirable.

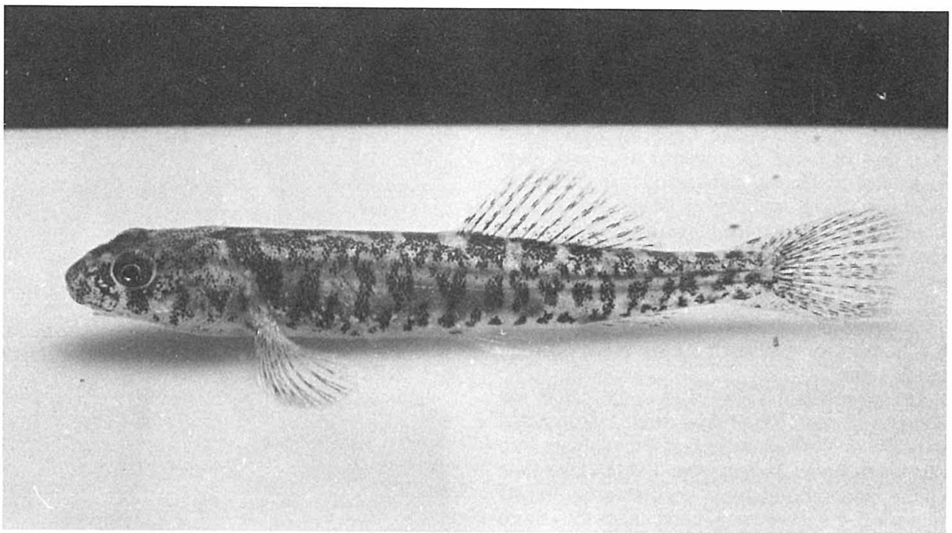
The life history of these species has been studied in some detail particularly that of the Shannon paragalaxias. Unlike the landlocked galaxias which generally breed in spring, this species breeds in about February. Its eggs are adhesive, about 150 in number per fish and are deposited on rocks around the shoreline. They are placed amongst rock piles probably to avoid predation. The young hatch in about 2-3 weeks and are about 8 mm long at this stage. The juvenile fish do not join the adult population for several months after hatching and are probably pelagic in the lake. They first breed at one year of age and probably do not live longer than 3-4 years.

The paragalaxias are all small fishes, the largest species only growing to about 10 cm in length. Because of this small size and the fact that they seldom move from cover in the daytime, they are only rarely seen by the casual observer.

It appears that at least one species has been present in the Great Lake area, probably since before the last glaciation of the Central Plateau about 25000 years ago. It is likely that the other paragalaxias species have evolved from a common ancestor in this region. The two Great Lake species sharing the same habitat, show the greatest dissimilarity whilst the two related species in nearby, but separate habitats are intermediate in many characters between the two Great Lake species. The pressures of natural selection have operated to ensure that the two cohabiting species make greatest use of the resources available to them with one species becoming a bottom-dwelling, sedentary species, whereas the other is a more active shoreline species.

The knowledge that there are four species of native fish present in Great Lake certainly removes the need for any forage fish introductions to the system. In fact the study of the food of trout in the lake has shown that these species, particularly the paragalaxias, are quite widely taken by trout. However, from a conservation point of view the populations are in a very healthy state and there is no concern that these endemic species are in any way at risk from trout predation.

Further information on the galaxias of Great Lake and the surrounding area may be found in Fulton (1978,1982) and McDowall and Fulton (1978a,b).



Paragalaxias eleotroides, the Great Lake paragalaxias

HISTORY OF THE GREAT LAKE TROUT FISHERY

The Establishment of the Brown Trout

Great Lake was first stocked with brown trout in 1870 by James Wilson when 120 fingerlings were carried in billy cans on horseback and released at Beckett's Bay. These fish grew remarkably well and formed the basis of the brown trout fishery present in the lake today. Between 1890 and 1910, the average size of brown trout caught was between 3.5 and 4 kg, and some reached 11 kg. A popular lure in those days was the eelskin spinner.

From 1910, the average weight of brown trout caught in the lake started to decline and by 1916 had reached 2 kg. It seems that the brown trout boom in Great Lake had already passed. In 1916, the first dam was built on the Shannon river, raising the level by 2 m. This flooded the marshes and gave the trout access to a large amount of new food. As a consequence, the weight improved and by 1918, anglers were again catching fish in the 3 to 4 kg range. The late 1910's were a comparatively dry period and the lake level dropped back toward its old level. As it did, the average weight of the brown trout dropped too, back to 2 kg by 1922.

The second dam – the multiple arch dam – was built in 1922 and the level of the lake rose quickly to a peak of 5 m above the original dam by 1925. The food provided by the flooding of the new ground boosted the weight of the brown trout back to its former glory, averaging 3 to 4 kg and reaching 9 kg. This boom period lasted for only 6 years and the size of brown trout started to decrease again. The input of food from the flooding of new ground had finished and the shore had degenerated to become the bare rocky strip still visible today, sometimes flooded during winter then exposed again during summer.

By 1940 the average weight of brown trout had dropped to 1.5-2 kg and it continued to drop to 1-1.5 kg by 1950. The average weight has stayed at that level ever since. Typical weights of brown trout caught from Great Lake in the 1980's are around the 1-1.2 kg mark.

The Brown Trout Today

The brown trout spawn in autumn between March and May. The main spawning run is at Liawenee Canal, 5 minutes drive north of Miena. Here, each year some 16,000 brown trout move up into the running water, pair up and dig egg nests or redds in the gravel. After spawning the adults drop back into the Lake where they gradually recover condition through the early part of the season. Most trout in Great Lake make most of their growth during mid summer especially January to March when water temperatures are at their highest.

The brown trout spawners provide most of the eggs for the stocking of other waters such as lakes and farm dams around the State. The eggs are stripped at Liawenee, usually on a public open day. They are then transferred to Salmon Ponds hatchery where they are hatched and reared to the sizes suitable for release. Some spawning adults are directly transferred into several of the smaller waters in the Highlands, particularly the near Western Lakes.

There are spawning runs in all of the creeks running into Great Lake, particularly Brandums, Sandbanks and Halfmoon creeks, and it is not unusual to see several hundred fish milling around in these waters during late autumn.

At Great Lake it takes up to 5 months for the eggs to hatch over winter, and for the young fry to emerge from the gravel and start feeding. After several weeks of feeding and rapid early growth, the young fish drop downstream and into the lake. For their first year or two they will live mainly in the shore area. During or after this time, they move onto the deeper weed beds to start feeding on the rich food supply there. They mature sexually in their third or fourth years and spawn for the first time. They will then spawn for a number of years, usually 3 to 4, before starting to lose condition. At that stage they are ousted from their feeding patch on the weed beds and are then forced to feed in the shore zone or in the open water. In these places the amount of food available for the effort taken to get it is much less and the fish gradually lose condition, giving rise to the ''slab' brown trout known to many anglers.

Despite there being about 10 times the number of brown trout in Great Lake as there are rainbow trout, on average anglers catch equal numbers of browns and rainbows. The methods of fishing for trout in Great Lake that have been traditionally used, shore fishing and shallow trolling, are far more selective for rainbow trout than for the brown trout. The brown trout living on the deeper weed beds are hardly being exploited. The average size of brown trout in the catch decreases as the lake level rises away from the weed beds as fewer of the better conditioned fish are caught. If the lake level rises into new ground, the shore fishing will improve and the average size of fish may increase if the level is high for a prolonged period.

The Establishment of the Rainbow Trout

In 1910 5,500 fingerling rainbow trout derived from a Californian stock were released into Great Lake. A number of other salmonid species were introduced into the lake after the brown trout had become established but it was only the rainbow that was successful. Within two years after release, rainbow trout started to be caught, and averaged 2.5-3.5 kg in the first few years. They soon declined in weight until the 1916 dam was built and then, like the brown trout, increased in weight for a short period reaching an average weight of 2.7 kg and a maximum of 5.7 kg in 1919, and then dropped back to 2 kg average weight by 1921.

After the multiple arch dam was built in 1922, the rainbow trout came into their own. They increased dramatically in size, as did the brown trout, reaching average weights between 3 and 3.5 kg and attaining maximum weights of 7.5 kg, as the new food supplies became available. At the same time Liawenee Canal had just been built and provided the rainbow trout with ideal spawning conditions: fast flowing cold water with extensive gravel and cobble beds. The rainbow trout population quickly built up until anglers at Great Lake were catching mainly rainbow trout; in fact 95-99% of the catch between 1925 and 1932 was rainbow trout. In the early 1930's it is estimated that there was approximately 10 times the number of rainbow trout as brown trout in Great Lake.

Coupled with the spawning in the canal, the flooding of new areas had exposed large areas of gravel on the lake shore and the rainbows also spawned here. During the 1940's Liawenee Canal was progressively concreted, gradually removing the spawning beds, and the shore gravel was dispersed more and more by wave action. The advantage to the rainbow trout disappeared and the proportion of rainbows in the spawning runs dropped until the browns outnumbered the rainbows by 10 to 1 in the early 1950's. The proportion of rainbows in the catch decreased until by 1950 it was 50%. This situation has remained until today.

The average size of rainbows declined in the mid1920's and by 1950 had reached 1-1.5 kg. It is now around 1kg. Despite the decline in size, the overall condition of rainbow trout in the catch has generally been maintained.

Several attempts were made to reverse the trend of declining rainbow trout numbers and weight. Between 1960 and 1980 108,000 adult brown trout were removed from the Liawenee Canal spawning run and distributed to other waters around the State. This was an attempt to reduce the brown trout numbers and to increase the weight and numbers of rainbow trout, but it did not produce any long-lasting result. Similarly, intensive stocking of the lake with over 5 million rainbow trout over a period of 20 years (1930-1950), did not reverse the trend.

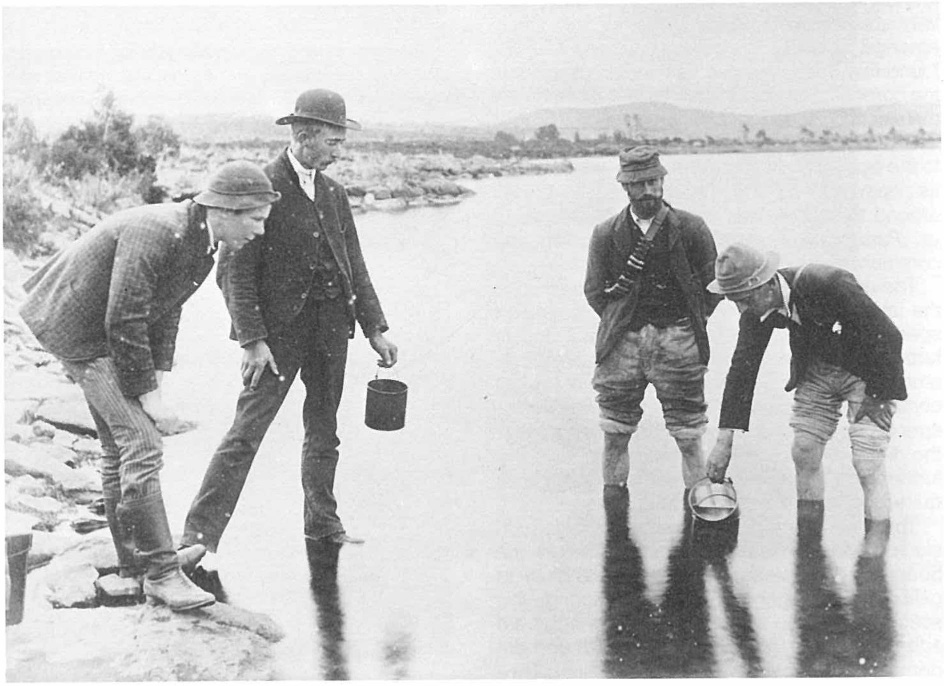
It appears that the proportion of rainbow trout in the catch may have increased for 3-4 years after the last major stocking programme (5 million fry released between 1972 and 1982). However, it seems that the natural dominance of the brown trout has essentially been unchallenged since the 1940's, and it is unlikely that the Great Lake will become a predominantly rainbow trout water again in the foreseeable future.

How has the Fishery Changed?

The Great Lake trout fishery has changed dramatically over the past 40 years. The greatest change has been in the number of anglers fishing the water, which has increased by 7 times to 8300 in the 1985/86 season. Coupled with this, increased leisure time has meant that the average number of days that anglers fish the water in a season has increased by a factor of 2, to 8 days on average. This means that the total amount of fishing effort expended on Great Lake has increased by nearly 12 times to about 70,000 angler days a year.

This has in turn led to an increase in the total number of trout caught in a season by 4 times to 45,500 in 1985/86. This means that 37 tonnes of trout are caught from Great Lake in a year. Great Lake ranks third in the total catch of fish behind Arthurs Lake (145,000) and Lake Sorell (80,000). It is the second most visited lake after Arthurs Lake (9000 anglers), ahead of Lake Sorell (7500).

	Number of anglers fishing each season	Number of days fished per angler per season	Total fishing effort in angler days	Total catch or harvest	Average catch per day of trout
1945-1958	1200	4.9	5900	12,000	2.0
1985/1986	8300	8.3	68900	45,500	0.7



Early stocking of Tasmania's inland waters

Can the Lake Take the Pressure?

The answer is not simple. The average number of fish caught per day in the 1945-1958 period was 2.0, whereas now it is 0.7 fish per day. This indicates either that the lake is affected by the increased pressure, or that the number of inexperienced anglers has increased. The tag study of rainbow trout (see below) indicates that the number of rainbow trout caught almost equals the number of fish entering the fishery each year. This means that the population of rainbow trout is being cropped at a rate equal to its production – a different situation to that occurring in the 1945-57 period. Tag studies from that period indicate that the average mortality caused by angling was 10% for rainbows, whereas it is now 25%. The rainbow trout are therefore under much greater angling pressure than they were. This has led in part to the decreased catch per day.

Anglers in Great Lake catch a greater proportion of the older, poorer conditioned brown trout than occur on the weed beds or in the spawning runs. Any method of fishing that does not involve catching trout from the weed beds will be biased towards the older, poorer fish, leaving the younger, better conditioned fish relatively unexploited. The population of these older fish has also decreased as the fishing pressure has increased. This also has led to a decrease in catch per day. However, the actual population of brown trout has not decreased significantly, as indicated by the tag studies. Nor has angling mortality of the brown trout that live on the weed beds. In 1950 it was 1.1% and now it is 2%.

What Now?

The Commission's policy is to keep Great Lake among the top of the State's trout fisheries by extending the spawning areas available for rainbow trout and by maintaining a rainbow trout stocking program. As regards the brown trout, the population is very well supported and underfished. The Commission is therefore attempting to increase the harvest of the main brown trout population by stimulating interest in fishing the weed beds by deep trolling or bait fishing techniques. To do this it is essential to have detailed information on the location of the major weed beds.

The Commission expects there to be temporary improvements in the fishery in the future due to rising levels as the water moves onto new ground for prolonged periods. These will be only temporary, as happened in the 1920's and 1930's. The key to good fishing in Great Lake is good information. This publication is the first step in this approach.

The Population of Trout in Great Lake in the 1980's

The tag studies of trout at Great Lake have enabled the Commission to estimate the population of brown and rainbow trout, as well as to estimate the chance of a fish being caught during a season. The studies also allow an estimate of the number of fish reaching takeable size, i.e. the recruitment, or the number of fish entering the fishery each year from spawning.

As the table shows, the population of takeable brown trout in Great Lake at the start of a season is very large. The first thing that becomes apparent when you look at the area covered by the major weed beds in the lake and the number of fish present, is that there is obviously very strong competition for food and feeding space. This is

	Population of takeable fish at start of the season	Recruitment into the fishery during the season	Total fish catch during the season
Brown trout	600,000	340,000	24,000
Rainbow trout	55,000	30,000	22,000

the reason for the slow growth rate of the trout after their third year of life, when they reach around 1 kg in size. Most trout do not grow much over that weight.

The mortality of trout is roughly 45-50% per year. That due to angling – the chance of a fish being caught by an angler – is only 2% for brown trout, but is around 25% for rainbow trout.

The estimated total number of brown trout growing into takeable size during a season is 340,000. The estimated total number of brown trout caught from the lake is 24,000. As you can see, the number of fish caught is a lot less than the number available. Why doesn't the population increase? Because the brown trout population is limited by suitable spawning areas and the food resources available. The brown trout are not limited by fishing pressure and probably never will be. There is room for a lot more fishing pressure on the brown trout in Great Lake.

The total number of rainbow trout reaching takeable size during a season is approximately 30,000. The estimated total number of rainbow trout caught from the lake is 22,000. The numbers are quite close. This means that the population of rainbow trout is probably limited by fishing pressure, which is about 10 times higher than for brown trout.

Have the Populations Changed?

In 1950 the estimated population of catchable brown trout was around 700,000, not much different from present estimates. Mortality due to angling was around 1%, again not much different. Fishing pressure on the brown trout has hardly changed.

In 1950 the population of rainbow trout was around 60,000, and the mortality due to angling was 10%. The fishing pressure on the rainbows has now increased by two and a half times to 25% and the rainbow trout fishery is approaching its limit.

NETTING SURVEYS OF GREAT LAKE

Recent surveys of trout anglers in Tasmania have shown that three lakes stand out as the most popular. These are Arthurs Lake, Lake Sorell and Great Lake. But despite considerable effort the catch return from Great Lake is much lower than from the other two lakes. This table clearly illustrates this;

Table 1:Catch data from angler surveys

	No. Anglers	Total Angler Days Fished	Total Fish Harvest	Days fished per angler per season	Average Catch per angler per season	Catch per day
Arthurs Lake	8900	67640	145500	7.6	16	2.2
Lake Sorell	7400	57700	79600	7.8	11	1.3
Great Lake	8300	68900	45500	8.3	6	0.7

For similar angler patronage and effort the catch rates differ markedly. Great Lake catch is half that of Lake Sorell and only one third that of Arthurs Lake.One could simply say that there are more fish in the other lakes and this may at least in part be true judging from the number of fish observed in the respective spawning migrations. However, there are some conflicting data that suggest that the situation is not that simple. It is also known that catch return to the angler has declined since the 1950's whilst records of spawning migrations from 1945 to the present do not show a corresponding decline. In addition there has been a long standing complaint by anglers regarding the quality of the catch from this lake. This was referred to by Nicholls in his work in the 1950's. Both shore and boat anglers frequently report a high proportion of poorly conditioned or slabby fish in their catch. This latter problem is not apparent in the fish present in the spawning migrations and is not simply a temporary post spawning or seasonal problem. It therefore appears that the fish the anglers are catching are not truly representative of the population present in the system.

The question is therefore asked by the anglers: Why are they catching so many poor conditioned fish if there are so many good fish in the spawning runs?

Great Lake is situated on the Central Plateau at an altitude of 1040 m. It was formerly Tasmania's largest natural lake with a surface area in the order of 80 square kilometres. It was originally a shallow lake with a maximum depth of about 6 metres and large areas only about 1-2 m deep. It has since undergone considerable change for hydro electric power generation purposes (as outlined in another section of this newsletter) since the first of four dams (or alterations thereof) was constructed in 1916. In total, these changes have increased the water level by a further 20 m.

As shown in Fig. 1, considerable water level fluctuations have accompanied the developments with changes of 5 m or more occurring in some years and fluctuations of 10 m in the space of three years or so not uncommon. Natural water level fluctuations would rarely exceed 1-2 m in this area. The fluctuations have resulted in extensive areas of barren shoreline as much of the area around the lake is reasonably flat.

Below the surface, there are no aquatic macrophytes (water weeds) in the shore zone of the lake and benthic (lake bed) fauna in this area is generally restricted to aquatic insects.

Beyond the area directly or regularly effected by water level changes there is a zone which may contain extensive algal beds consisting of *Chara* and *Nitella*. Their presence has long been known to many anglers who refer to the "shrimp beds' – a reference to the crustacean fauna found in them. These algal beds are occasionally exposed at very low water levels.

In contrast to the flooded areas, the original lake bottom is quite flat and devoid of vegetative cover. It consists of fine blue clay with a thick and very fine soft sediment coat.

The objective of the netting surveys was to see if any differences in abundance and/or condition of fish could be detected in these various areas of the lake thus providing answers to some of the anglers questions.

The area selected was Swan Bay where the various levels could be accessed easily. Gill nets of 50 and 100 mm mesh and up to 300 m long were set. These were of sufficient length to extend from the shore zone through the algal beds onto the original lake bottom. The location of the net sites is shown on the contour map (Fig. 2). Nets were set through the day and again at night at two sites in the Swan Bay area. The night catch included the dawn and dusk periods. As well as netting the bottom, floating nets of the same mesh size were also set at night over the top of the algal beds for comparison. Netting was undertaken on two occasions; October 1986 and March 1987.

The distance from shore of each of the trout caught was recorded on capture by position in relation to numbered net floats. Length, weight, age and diet were later examined. A depth and algal cover profile of the lake at the netting sites was drawn (Fig. 3) from soundings and diving transects done in March 1987.

Each of the fish could therefore be allocated to a zone of the lake according to its area of capture. The zones used were; shore, weed, open, surface. The weed zone was given a wide interpretation to include areas with quite sparse algal cover. This had the effect of reducing the catch values for this zone.

Combining all information on brown trout for all nets at each site for the two visits, more fish were caught in the weed zone than in any other area. Insufficient rainbow trout were caught to enable a detailed analysis for this species.

In terms of weight of fish this was still true. There was actually a slight increase in the weight proportion of fish in the weed zone compared to the shore zone indicating that there were not only more fish there, but that they were on average also larger.

Calculation of condition factors for the mature fish showed that those captured in the weed zone were generally in better condition than those captured inshore although not by enough to suggest that we were looking at two very different populations. The fish caught on the surface were in poorest condition. Population age structure and regressions of length versus weight for the fish caught in the weed area were similar to those calculated from fish examined during the spawning migrations.

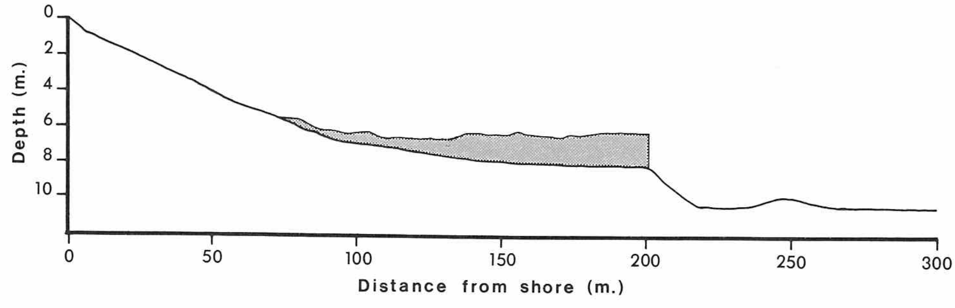
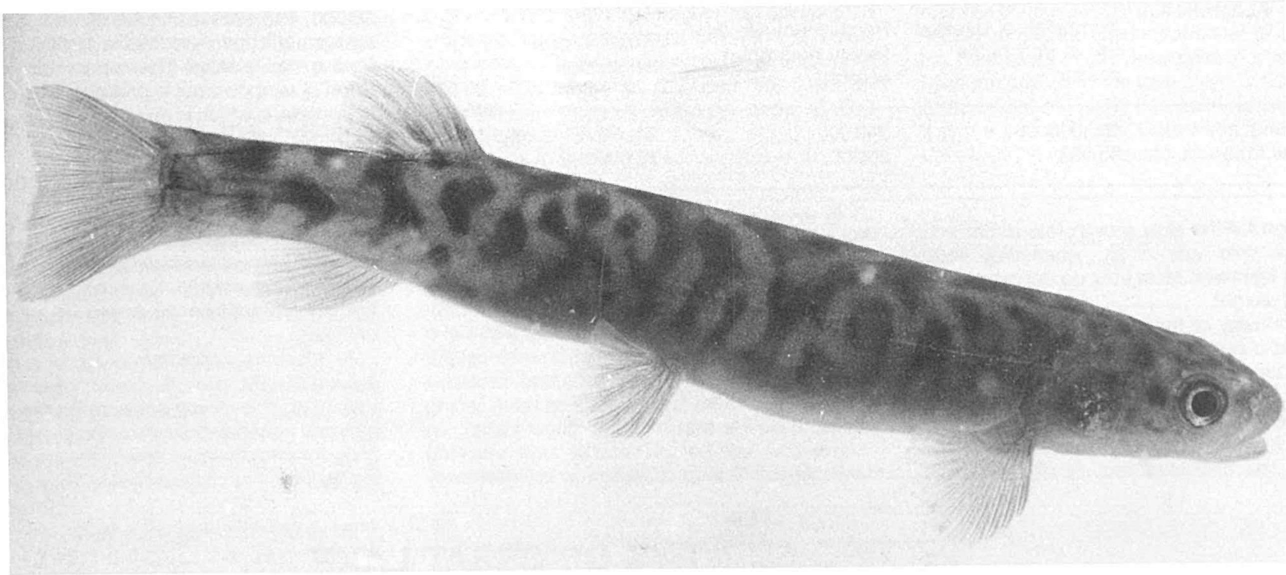


Fig. 3. Typical shore profile of Great Lake bottom along netting transects in Swan Bay and Dud Bay. The extent of weed (Chara) cover along the transects is indicated.



Galaxias brevipinnis, the climbing galaxias

Typical Great Lake brown trout

Examination of the day catch compared to the night catch clearly showed a change in activity pattern of the fish.

There is a slight tendency for avoidance of the shallower areas in the daytime but a definite movement onto the weed beds and inshore overnight.

The catch data can subsequently be further broken down.The March catch was almost twice as high as the October catch indicating greater fish activity at that time of year. Water temperatures in October were around 5°C but had risen to about 12°C in March. The surface net catches were also much higher in March than in October in response to an abundance of floating terrestrial food present at that time.

Gill net set across a weed bed in Swan Bay

The analysis of the diet of the fish was assisted by previous work on the benthic invertebrate fauna of the lake which enabled identification of the important species and provided information on their distribution. Further observations of the invertebrate fauna were made during the diving work.

The dietary study supported the netting results and further highlighted the importance of the weed zone.As expected from the activity differences, gut contents of the night catch were, by volume, almost twice that of the day catch, whilst the fish caught in March contained about 2.5 times as much food as those caught in October.

The smaller one and two year old fish complicated the results. They were caught throughout the bottom zones but their gut contents indicated that they were feeding predominantly in the shore zone rather than on the weed zone. The diet of the 3, 4 and older year class fish, i.e. the target of the anglers, was predominantly Crustacea and caddis. The majority of this diet would almost certainly have been taken from the weed bed areas as some of the species concerned have limited distributions elsewhere, especially in the case of the Great Lake shrimp, *Paranaspides*. Thus most of the fish caught in the open water area had certainly been feeding in the weed zone and so had many of those caught inshore.

Food of terrestrial origin was rare in fish caught in October. It was more common in fish caught in March when large numbers of beetles were present on the surface. Seventy-five percent of fish caught in the surface nets not surprisingly contained food of terrestrial origin whilst 50% of those caught in the shore zone and only 20% of those from the weed zone contained terrestrial items.

When the catch sites were related to the diet it was evident that there was considerable movement of the fish but that the weed zone was the major area as far as feeding was concerned.

Once the relevance of this zone was established its extent around the lake was examined. This was done in brief by diving along a number of transects. This information was then used to produce a preliminary location map of the major weed areas. The transect locations and main weed zones are shown in Fig. 2.

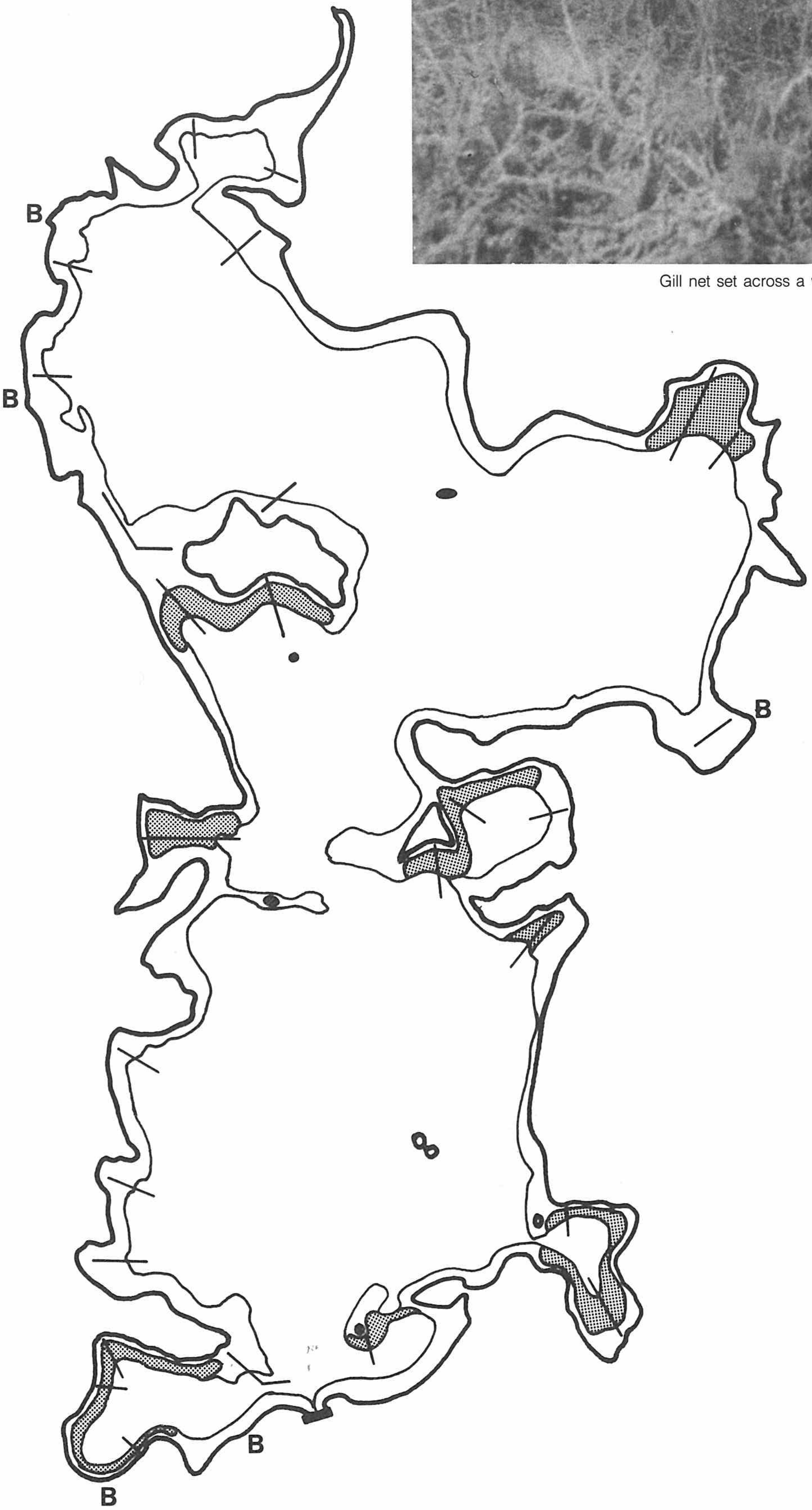
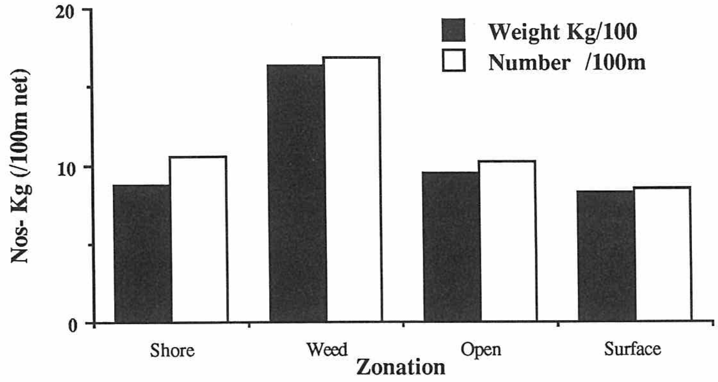


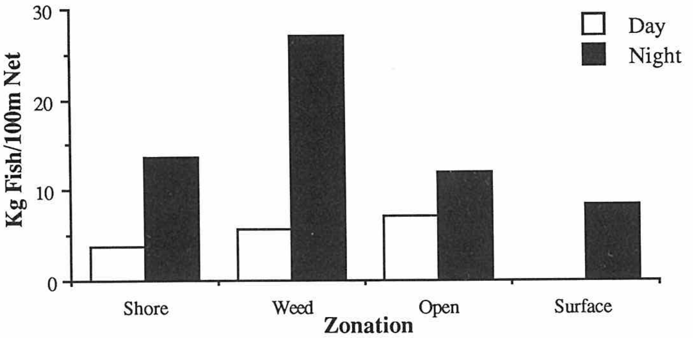
Fig. 2. Map of Great Lake showing new full supply and original lake level contours, major weed beds (marked in grey) and the diving transects (lines). Boat ramps are marked with a B.

The algal beds are not present in all areas of suitable depth but appear to be best represented in those areas least exposed to the prevailing north westerly winds. The algae are not com-

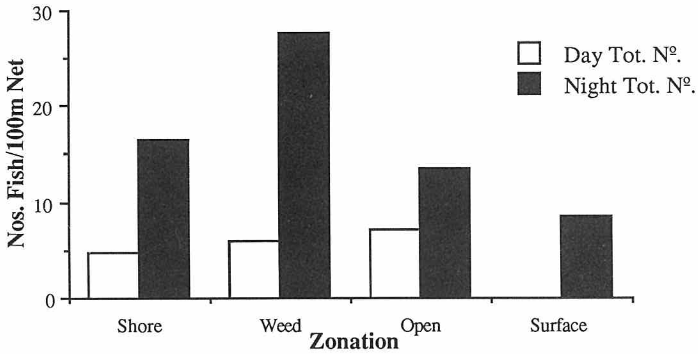
Overall Catch



Overall Catch : Day vs. Night (weight of fish)

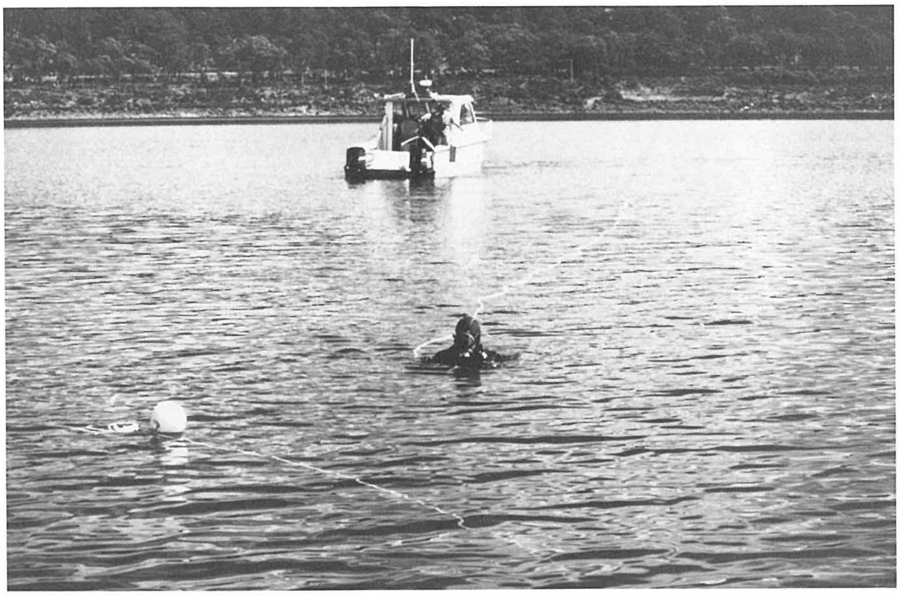


Overall Catch : Day vs. Night (Nos. of fish)



pletely absent from the other areas but growth is generally not thick enough elsewhere to provide significant shelter to the invertebrates, or the beds were not sufficiently extensive to warrant inclusion on the map. As can be seen the areas providing the major food resources for this large lake are quite limited; something of the order of 5% or less.

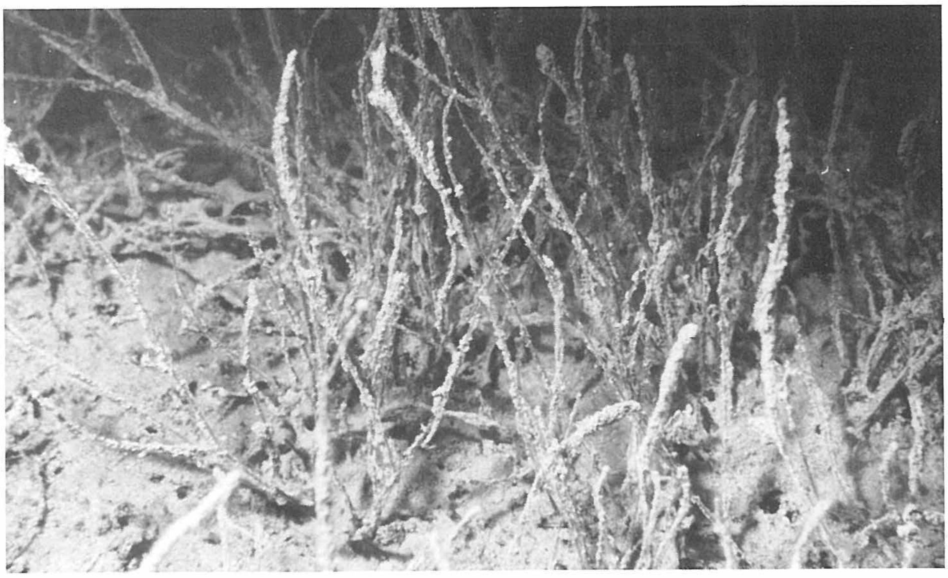
Having some idea of the brown trout population numbers for this water it is likely that there is some competitive interaction for space in these areas that could explain the higher proportion of poorer quality fish caught by the anglers. It appears that the mature and fitter 3-5 year old fish are dominating the weed bed areas thus forcing the other year class fish to feed elsewhere. In so doing this group, which would include the older poorer conditioned fish, are feeding nearer the surface and inshore thus increasing their chances of being caught by anglers who are fishing predominantly in these areas.



Diving on weed beds in Swan Bay

In the meantime, you could say, "So what? You've found that the trout are where the food is and how does this information benefit the angler?"

In Great Lake these weed areas are not specifically fished. There are two main methods of fishing practised in Great Lake; bait fishing from the shore or trolling artificial lures from a boat. The weed beds are not accessible from the shore under normal water level conditions thus only the shore feeding fish are available to those anglers. On the other hand the boat angler is frequently trolling over a lot of barren water, especially in the middle of the lake and even when fishing over the weed beds, is in most cases fishing about 1-2 m from the surface, whereas the beds are located at 6-10 m depth and visibility to the surface is unlikely from there. Therefore they are probably not getting their lures near as many fish as they



could. These anglers may perhaps improve their catch if they concentrate their efforts over the weed beds and troll their lures much deeper to increase the chances of them being seen and taken by the feeding fish.

The differences in activity of the fish, firstly between day and night, with the latter including dawn and dusk, and also between the different times of year should also be of use in choosing when to fish.

Dense *Chara corallina* weed bed at 8 metres depth

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One general word of warning – the weather at Great Lake is very unpredictable and can often create dangerous conditions, especially for boat fishing. If you are in any doubt please seek information from the Crown Land Warden, Inland Fisheries Commission officers or the hotels.

HOW TO CATCH MORE TROUT IN GREAT LAKE

The depth of the weed beds is generally between 6 and 10 metres with the lake at current levels. This means you need a lure and line rig that gets down there. Most normal trolling lures run at surprisingly shallow depths – most between 1 and 4 metres, even on 20 metres or more of line. This includes Flatfish, Rebels and Rapalas. Only a few lures will get you below 6 metres. These include the Whopper Stopper or Angler brand large Hellbenders and the aeroplane spinner (No. 1) and Spoonplug 900 series – all trolled on lines of 20 or more metres length. The older spoon designs run at slow speeds (rowing or drifting) will also get down to the right depths.

Paying out more line on most other lures will not substantially increase the running depth. As a general rule keep the breaking strain of a line as low as you can in order to reduce drag. The heavier the line the greater the drag and consequently the higher the lure will swim in the water.

We recommend that you experiment. A few good alternative methods are:

1. Use a handline attached to a heavy bomb sinker; about 1-2 metres above the sinker tie a clothes peg into the line. Run a normal trolling line from a rod through the clothes peg with a lure on the end about 10 or so metres back from the peg. When the fish strikes, the line pops free of the peg and the fish is played normally with the rod. A vane on the sinker prevents spinning of the handline and ravelling of both lines.
2. Use a lead-core line on a wide bakelite type reel on a rod, pay out the line until you hit weed, noting the depth position on the line. Most lead-core lines are colour coded at different line lengths.
3. Try a paravane on a standard rod. The extra line strain may require a heavier gauge line.
4. Try ''jigging' from a drifting or stationary boat. Commercially available jig lures for sea fishing are ideal in small sizes.

The Commission has experimented with these rigs and found them all to reach the required depth. An important factor is to troll slowly, allowing the lures to reach their depth.

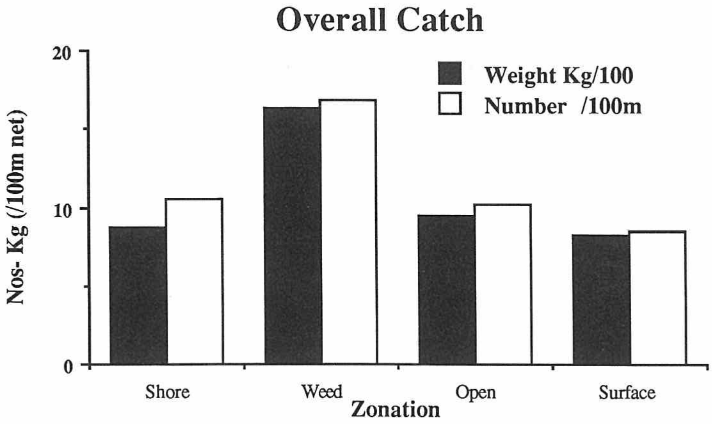
What of lure colour? During our diving survey we found the light on the beds to be blue-green. Red and orange objects look dark, even black. We would recommend flashy silver lures – spinners and Flatfish or bright blue or green colours. The main thing is to experiment. Matukas imitating native fish or shrimps may also be successful.

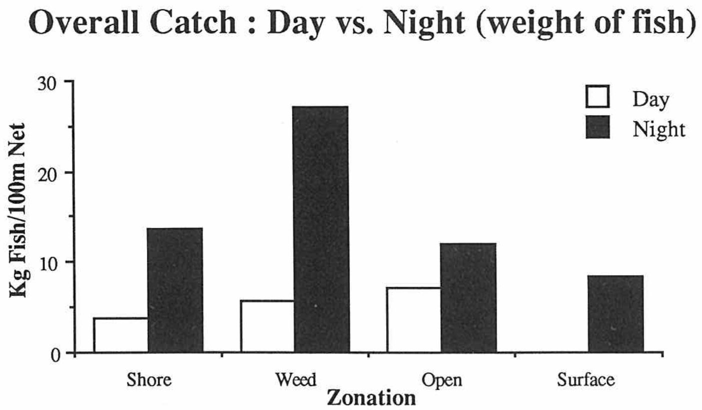
Bait fishing from a boat is a worthwhile method. Either stationary with the bait on or just above the bottom, jigging, or drifting slowly to cover more ground.

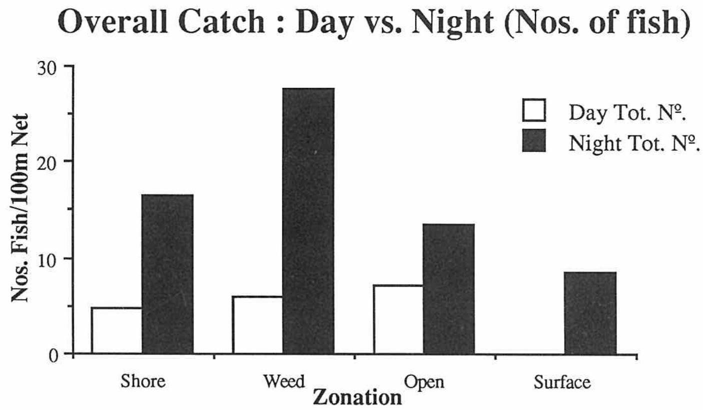
The most important thing is to be fishing directly over the weed beds. The map shows the main beds in the lake. Your boat should generally be between 100 and 200 metres from the shore to be in the weed bed zone. An echo sounder is of great help in picking the right area of the lake bottom. You won't detect the weed as it is low and on a silty bottom, but you will clearly see the correct area of the bottom – the almost flat gently sloping shelf just inshore from the distinct old lake edge.

Finally, since the level of Great Lake varies from season to season, the depth of the weed beds below the surface will also vary. For successful fishing, it is important to know how deep the weed beds are below the surface. The upper edge of the weed is at 1024 metres altitude (15 metres below full supply level) and the lower edge is at 1020 metres (19 metres below full supply level). In order to accurately gauge the depth of the beds, find the current Great Lake level and subtract the above numbers from the gauged level. Great Lake levels may be obtained from newspaper angling columns or the Hydro Electric Commission.

Tight lines!







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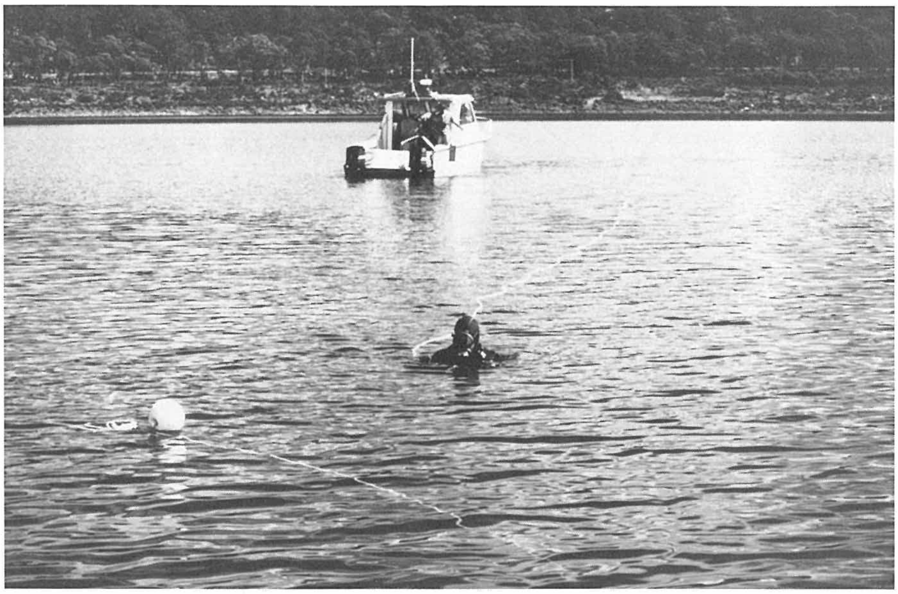

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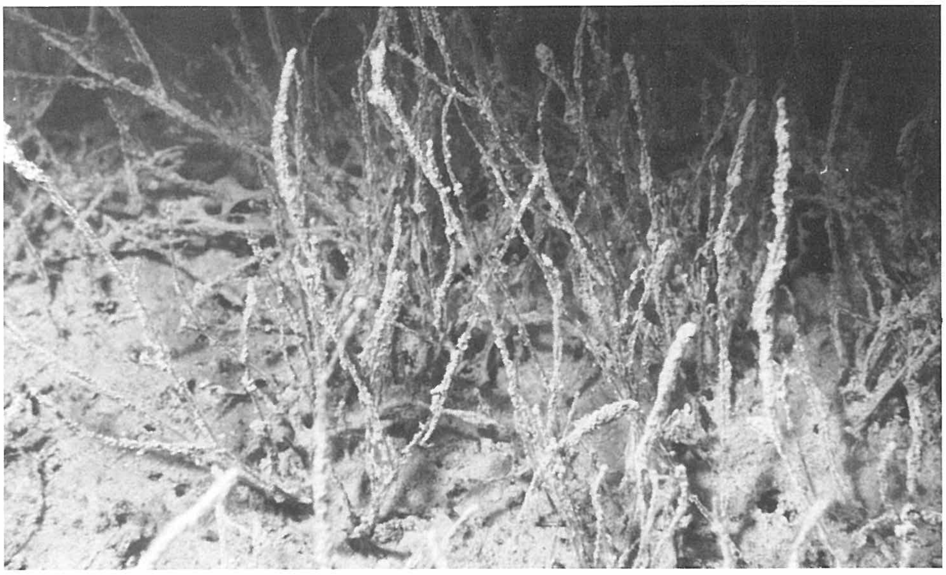

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One general word of warning – the weather at Great Lake is very unpredictable and can often create dangerous conditions, especially for boat fishing. If you are in any doubt please seek information from the Crown Land Warden, Inland Fisheries Commission officers or the hotels.

HOW TO CATCH MORE TROUT IN GREAT LAKE

The depth of the weed beds is generally between 6 and 10 metres with the lake at current levels. This means you need a lure and line rig that gets down there. Most normal trolling lures run at surprisingly shallow depths – most between 1 and 4 metres, even on 20 metres or more of line. This includes Flatfish, Rebels and Rapalas. Only a few lures will get you below 6 metres. These include the Whopper Stopper or Angler brand large Hellbenders and the aeroplane spinner (No. 1) and Spoonplug 900 series – all trolled on lines of 20 or more metres length. The older spoon designs run at slow speeds (rowing or drifting) will also get down to the right depths.

Paying out more line on most other lures will not substantially increase the running depth. As a general rule keep the breaking strain of a line as low as you can in order to reduce drag. The heavier the line the greater the drag and consequently the higher the lure will swim in the water.

We recommend that you experiment. A few good alternative methods are:

1. Use a handline attached to a heavy bomb sinker; about 1-2 metres above the sinker tie a clothes peg into the line. Run a normal trolling line from a rod through the clothes peg with a lure on the end about 10 or so metres back from the peg. When the fish strikes, the line pops free of the peg and the fish is played normally with the rod. A vane on the sinker prevents spinning of the handline and ravelling of both lines.
2. Use a lead-core line on a wide bakelite type reel on a rod, pay out the line until you hit weed, noting the depth position on the line. Most lead-core lines are colour coded at different line lengths.
3. Try a paravane on a standard rod. The extra line strain may require a heavier gauge line.
4. Try "jigging' from a drifting or stationary boat. Commercially available jig lures for sea fishing are ideal in small sizes.

The Commission has experimented with these rigs and found them all to reach the required depth. An important factor is to troll slowly, allowing the lures to reach their depth.

What of lure colour? During our diving survey we found the light on the beds to be blue-green. Red and orange objects look dark, even black. We would recommend flashy silver lures – spinners and Flatfish or bright blue or green colours. The main thing is to experiment. Matukas imitating native fish or shrimps may also be successful.

Bait fishing from a boat is a worthwhile method. Either stationary with the bait on or just above the bottom, jigging, or drifting slowly to cover more ground.

The most important thing is to be fishing directly over the weed beds. The map shows the main beds in the lake. Your boat should generally be between 100 and 200 metres from the shore to be in the weed bed zone. An echo sounder is of great help in picking the right area of the lake bottom. You won't detect the weed as it is low and on a silty bottom, but you will clearly see the correct area of the bottom – the almost flat gently sloping shelf just inshore from the distinct old lake edge.

Finally, since the level of Great Lake varies from season to season, the depth of the weed beds below the surface will also vary. For successful fishing, it is important to know how deep the weed beds are below the surface. The upper edge of the weed is at 1024 metres altitude (15 metres below full supply level) and the lower edge is at 1020 metres (19 metres below full supply level). In order to accurately gauge the depth of the beds, find the current Great Lake level and subtract the above numbers from the gauged level. Great Lake levels may be obtained from newspaper angling columns or the Hydro Electric Commission.

Tight lines!

A typical Great Lake rainbow trout

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