FRESHWATER FISHERIES ADVISORY SERVICE
DEPARTMENT OF AGRICULTURE AND FISHERIES

INVESTIGATION REPORT

North Island Job No.: 10 ?

Acclimatisation Society District: Auckland

Title of Job: A preliminary survey of Lake Pupuke.

Objective: An assessment of the trout population.

Introduction: The Auckland Acclimatisation Society requested the Fisheries Division to examine the trout stocks of Lake Pupuke in relation to the food supply as there has apparently been a severe reduction in numbers, and in individual trout condition, compared to previous years.

Lake Pupuke is situated amidst private homes in the Auckland Suburb of Milford ~~suburb xx~~ on the North Shore of the Waitemata Harbour and comprises an area of 213.8 acres, maximum depth 55 metres.

Methods:

Gill netting for trout was carried out and samples of other fish and xx eels were collected from fyke nets or scoop netting by torchlight at night. All fish were weighed and measured and stomach contents examined. Society reports were examined and discussions held with lakeside residents.

Findings:

General features:

(a) Geologically, Lake Pupuke is a flooded basin originally formed by volcanic explosions at some depth below the surface (Barker 1970). It is roughly circular in shape and the length of shoreline is calculated at approximately 2.5 miles and the bottom starts to fall away sharply to its maximum depth (55m.) about thirty feet from the lake edge in most places (Bell, 1971). The nigger-head sedge, Arundo conspicua is common on the south side of the lake and Vallisneria spiralis dominates the littoral zone. Th

lake supports plankton in abundance, carp (Carassius spp) catfish, eels, and perch as well as rainbow trout (Barker 1970). The trout population has to be artificially maintained as there are no tributaries suitable for spawning. The lake is noted for its resident colony of white throated shags which are strictly protected.

(b) Water Quality: Studies made by Barker (1970) from November 1966 to November 1967 revealed a range of temperatures 12.0 - 24.2°C at the surface and 11.3 - 14.5°C at 40 metres. A thermocline formed between early October and early January, when it became strongly developed at about 17m and persisted until late April. Between early May and late June the stratification was breaking down and between mid July and mid September the lake was isothermal.

The values for light transmitted per metre through the water were high from mid August to mid December (53-76% per metre), very low from mid December until mid February (23-49% per metre), high in March (75% per metre) and relatively constant over the winter months (53-64% per metre). The amount of light transmitted depended closely on the density of phytoplankton. Changes in the depth at which a Secchi disc disappeared paralleled the light transmission values, and the mean Secchi depth was 2.2m, range 1.0-5.2m.

Oxygen concentrations down to 30m were highest at all depths from mid November to early January (112-134% saturation). From early January to late April oxygen was strongly stratified (epilimnion 55-100% saturation, hypolimnion 24-77% saturation). During winter oxygen

values gradually increased at all depths.

The range of pH was 7.8-9.5 units at the surface and 7.8-8.6 units at 30m. From early January to late April pH values were strongly stratified but from mid July to mid August they were nearly uniform. The range of alkalinity (mainly HCO_3^- ions) was 76.0-80.8 ppm $CaCO_3$ and values showed stratification in summer. Carbonate ion was present from early October to mid June, but free carbon dioxide was only found in trace amounts. (Barker, 1970).

(c) Bottom Fauna: The bottom fauna was not able to be sampled or nor were any species (ex. snail) found in fish stomach contents to give a lead to the type available for fish food. However, studies by Barker (1966) show that the bloodworm or midge larvae, Chironomus Zealandicus is widely distributed as is a variety of Tubificid worm. The freshwater snail Potamopyrgus corolla is also known to occur as is a variety of the freshwater mussel, Hyridella spp. The freshwater crab, Hymensoma lacustris, once present, is believed to be severly reduced or even extinct.

(d) Fishing History: The first liberation of trout by the Auckland Society was in 1960 although before that time fish were raised at the water works from Rotorua and liberated. The first liberation was of 125,000 fingerlings. Since then about 10,000 fingerlings have been liberated annually and in 1967 the first of a continuing 200 tagged trout annually were liberated, these being 6" plus fish.

The first netting was undertaken by the Waitemata Sub-Society in 1964 and again in 1967. In 1967 many trout 5lb-6lb were netted, and altogether of the 34 fish caught both years no Shag Worm was observed.

1969 saw a very good years fishing but it has steadily deteriorated since then. At the last fishing contest which about 100 fishermen attended only 12 fish were caught, nine were tagged. - In August 1971. The weight of the fish caught lately is small 1¼ - ~~13/4~~ 1¾ lb). ~~I~~ (D. Bell, 1971).

(e) Results of gill netting: Only three trout were taken, all tagged through the dorsal fin:-

No.	Length ins.	cms	Weight ozs.	gms	Condition Factor		Sex	Tag
1	12½	31.8	12	340	38	(105)	M	Blue 'B'
2	12½	31.8	12	340	38	(105)	M	Red 'B'
3	11	28	8¼	228	38	(105)	F	Red 'B'

The trout were in poor condition with a below average condition factor, but there was no evidence of disease or parasitic infection. Examination of the stomach contents suggested a lack of suitable food available to the trout:

TROUT	STOMACH CONTENTS
1	Two small fish (prob. bullies), one snail, one moth, variety of weed and feathers
2	A mass of weed, no identifiable animals.
3	Plastic piece, pumice, weed, flying beetle.

The dorsal fins of the trout caught were badly deformed probably partly caused ~~because~~ by ~~of~~ the tag location and partly by hatchery rearing.

(f) Carp, perch and catfish: Carp and perch were examined from fyke net (and some gill net) catches.

The perch (Perca fluviatilis L.) examined from the lake were in poor condition, the majority with empty stomachs. These fish, of course, compete with the trout as do the eels in a lake of this nature. Results are detailed below:-

PERCH

Length	Weight	Sex	Stomach Contents
10¾"	11½ozs	Female (Ripe)	5 bullies, insect wings
9¾"	8½ozs	" "	remains of small fish.
9½"	7½ozs	" "	Fragments weed & fish.
9¼"	7ozs	" "	-
9¼"	7ozs	" "	nil
9¼"	7ozs	" "	Remains of small fish.
8½"	5½ozs	" "	nil

The carp that were examined, unlike the perch and trout, were excellent condition with stomachs full of weed which they feed upon. No catfish were seen or taken.

(g) Native fish: The common bully (Gobiomorphous spp) was observed at night by torchlight around the edges and samples were taken. They were extremely few in number. No other native fish were observed except for eels. Unfortunately no eels were able to be taken for analysis, bu one catcher spoken to said that a number of them were very "flabby" indicating poor condition. They are of both the long and short finned variety in a wide range of sizes. It is believed that they are able to migrate to and from the lake via underground seepage to the sea although this has not definitely been proven.

(h) Mosquito Fish: Mosquito fish (Gambusia affinis) were found to be present in the lake ~~as evidenced by~~ although only two specimens were caught in the bully catches. Whether these are the results of a deliberate or an accidental release is not known. They do not appear to be widespread at the moment but as they are known to be ~~xxxxxxxx~~ extremely hardy and prolific they could increase in numbers dramatically and cause further competition for food in the lake.

(i) Water race: Investigation of this matter has been deferred until further information is to hand and the effects that the Mosquito fish may have on the lake are known. Mosquito fish may compete intensely with trout fry in a situation like this to the latter's disadvantage.

Discussion:

Consideration of the water quality of Lake Pupuke shows that it is eutrophic and slightly alkaline and as such represents a below average environment for trout when compared to most other New Zealand lakes.

Further factors that makes it less favourable for trout are the limited areas of shallow littoral regions and also the competition posed by species already in the lake (e.g. perch, catfish, eels) for the available food supply. The shags also compete (and predate) to a certain extent. Bearing these factors in mind when computing a stocking rate indicates that the lake is possibly better than Lake Waingata which is a marginal water but probably not quite as good as Lake Ngapouri and Okaro in the Rotorua district which are also considered to provide inferior environment for trout (Fish 1963). In terms of a total trout population then, with the above in mind, this could mean an optimum population for Lake Pupuke of 2500 fish or 1000 fish/miles of shore or 11.7 fish/acre

which, assuming one third mortality per annum, could be achieved

by annual iberations of about 1800 fingerlings.

The stocking that has taken place however, has greatly exceeded this estimate. Expressed another way, again assuming 1/3 mortality per annum, stocking with 125,000 fish in the first year followed by annual liberations of 10,000 fish aims for an initial population in the third year of 50,000 fish or 234 fish/acre or 20,000 fish/mile of shoreline. Maintaining annual liberations of 10,000 fish is to aim for a total population of about 14,000 fish or 65 fish/acre or 5,600 fish/mile of shoreline, far in excess of the estimated carrying capacity of the water. The result of stocking now is excessive mortality due to the lack of food in the lake. In fact the selectiveness of the gill nets in taking only tagged fish (of the 200p.a. 6" + fish) indicates that hardly any of the fingerlings are now surviving. The problem, however, is not merely confined to the stocking rate now because of the abundance of self-propogating fish species already in the lake competing for the available food supplies. For instance it is not thought that by decreasing the stocking rate from 10,000 fingerlings to 6,000 fingerlings there would be a difference in the situation. Two courses of action do appear to be open however, One, a common feature of fish management in the United States in certain circumstances, would be to eliminate the entire fish population ~~the~~ in the lake by application of Rotenone (for instance.) This would eliminate all undesirable fish species leaving the way clear for the eventual re-establishment of only selected native and acclimatised species. The other method, thought to be more desirable as it does not eliminate the native fish or the perch which does provide some angling enjoyment although inferior to trout, is to concentrate purely on a "put and take" fishery. Therefore instead of 200 6" + fish and 10,000 fingerlings released yearly, 2,000 6" + trout only be released annually, but this figure subject to review depending upon ~~a~~ anglers results and the results of brief fish stock surveyes carried out in a regular pattern. For management

purposes, the fish of each liberation should be marked by fin clipping or tagging in a different manner. The population of mosquito fish and ~~oth~~ other fish species (e.g. bullies) should also be carefully monitored so that the overall effect of the mosquito fish in the lake can be guaged.

Conclusions:

The stocking of Lake Pupuke has been greatly in excess of the carrying capacity of the water. This, together with the effect of fish species already in the lake, has led to a drastic reduction in the amount of fauna available for food with the result that there is extremely poor survival of liberated fish now. The enriched waters of the lake are also not conducive to optimum trout condition and growth or a high carrying capcity. It appears that the best method of managing the fishery now is on a "put and take basis" for a trial period. Mosquito fish are present in the lake; their effect on the ecology of the lake will have to be observed.

Recommendations:

It is recommended that:-

(a) Stocking with trout fingerlings cease.

(b) Stocking with only 6" = fish be carried out; 2,000 in the first year and 2,000 in the second, the stocking rate to be reviewed if necessary after this period. Each liberation to be fin-clipped in a different manner.

(c) Population survey to be carried out by Fisheries Management personnel annually. The mosquito fish population also to be observed.

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