POND REARING OF T[illegible]

Basic Considerations

1. Before there can be any consideration of fish-stocking practices there must be an actual need for stocking. A need can only arise where there is no existing game species of a sufficiently satisfactory kind or where the stocks being produced naturally are inadequate to convert available food resources into fish for the use of anglers.

2. Under such conditions fish can be transferred and it becomes a matter for consideration whether they can be collected:-

   (a) As young wild fish from where there is a natural excess, particularly where conditions are such that they would die (e.g., drought-affected streams such as Selwyn River in North Canterbury, Lindis, and others elsewhere).

   (b) As eggs, purchased or obtained from where there is an excess, and hatched for release.

3. If eggs are obtained the questions arise as to:

   (a) What stage the resultant fish should be released at.

   (b) What fishing any particular quantity could be expected to provide.

Overseas Practices

It is erroneous to simply follow overseas practices without knowledge of local conditions. The facts are that following investigations mainly in Canada and New Zealand, which showed that losses in nature were likely to be heavier after the egg stage than before it, there was a great shift in emphasis of the United States hatchery policy. Realising that fry releases were much less an improvement on nature than formerly thought, the U.S. authorities increased production of fingerlings and larger fish. By 1949 annual trout liberations in the United States were of the order of 38 million fry, 48 million fingerlings and 20 million fish of six inches or more. A big proportion of these fish went into waters where legal size limits were 6,7 or 8 inches and where partly in consequence there was greatly less chance of natural spawning providing the help it does in New Zealand. Many of these fish go into small streams handy to great cities where few liberated fish survive more than a few weeks.

There is no sound scientific basis for this United States policy of preferring large fish. The position is that having tried fry liberations without worthwhile results they then tried fingerling liberations and because these also proved substantially ineffective they have more recently tried "legal sized" fish with just as disappointing results. The evidence covering this is set out in pages 95-109 in Fisheries Bulletin No.9.

New Zealand Evidence

Fisheries Bulletin No.10A shows that in a typical small New Zealand trout stream 500,000 natural fry dwindle down to 4,000 yearlings of which about 1400 survive to reach two years. In this fairly heavily fished stream, which has extremely little cover and sanctuary water, the 4,000 natural yearlings which are well-developed fish of six inches, finally yield to the angler only about 290 fish of about one pound weight, plus a balance which survives to spawn.

The review of past New Zealand pond-rearing experiences given at page 67 of Fisheries Bulletin No.9 shows that in the case of brown trout a loss of about 90% can usually be expected if fish are reared from fry to the yearling stage. Thus 500,000 fry might yield 50,000 yearlings, but it will be seen later that these would be greatly inferior in quality to wild fish.

Costs

Careful costing in Canada has shown that it costs about fourteen times as much to produce brown trout fingerlings of three inches as to produced unfed fry. (See Fish.Bull. No.9,p.103). In other words, you can turn out for the same sum of money about 500,000 fry or 30,000 fingerlings of three inches. To produce full yearlings would be greatly more expensive and thus far less than 30,000 could be produced.

Inferiority of Pond-reared fish

While 4,000 well-grown wild yearlings (naturally produced) might be expected in a stream to yield about 290 fish of a pound each to anglers, pond-reared fish could not be expected to do this. In practice, artificially reared fish do not survive so well (see Bull.9 p.79). Still more recent evidence on this comes from Canada (Canadian Fish Culturist, July 1952). Investigations have shown that when pond-reared fish of six inches or so are liberated in streams, one third have actually died within two weeks and the balance, from inability to adjust themselves to natural stream conditions, has steadily lost weight and proved incapable of competing successfully with wild fish. Still smaller trout were found to suffer even more severely, and about half died of exhaustion in the first two weeks. (Note: it is possible that transfers from ponds to still lake waters might not result in such heavy losses). Tests were then made by capturing wild fish and transferring them to the same streams that the pond fish had been put in. They quickly adjusted themselves to the new environments and did well.

Pond rearing

The basic requirements for a pond-rearing system are a copious dependable and controllable supply of water of good quality and low temperature. With this there is need for accommodation on the spot as fish need to be fed several times daily, seven days a week. Availability of a satisfactory water supply must always determine the choice of site. It is not satisfactory to establish ponds and depend on an inferior water supply simply because there are other facilities there.

It is noted that the only existing rearing ponds in New Zealand which have good water supplies are those of the Auckland Society (near Arapuni); Internal Affairs (Ngongotaha) and Wellington (Masterton). In each of these cases copious springs are tapped close to the source. The Auckland establishment, which is by far the largest in output, has a huge spring comparable in size with the Brightwater or the large spring creek which enters the Oreti opposite Lumsden. The Taranaki Society's hatchery draws water by a short race from a natural stream and there is frequent trouble both from silt and from farmyard contamination of the water supply.

There is an extensive literature on this question and the notes which follow cover the main points emphasized.

The rearing of trout to a larger size than hatchery fry can be done by two principal methods:-

(a) Rearing in ponds under natural conditions and utilizing natural foods present in the ponds.

(b) Rearing in ponds under artificial conditions and feeding artificial foods.

With both systems ponds are used and these, for efficiency, should conform to the following conditions:- (P.F.C. Vol.10,No.4)

1. To provide for a compact rearing pond layout.

2. To provide at the intake and outlet, water conducting facilities to meet normal operating demands and additionally for pond cleaning, treatment of fish, and the collection and handling of fish.

3. To provide sufficient slope on the pond bottom for complete drainage, and incorporate a type of bottom surface which will not shift, entrap or injure fish, and which will not be unduly slippery under normal conditions.

4. To design the rearing pond so that the movement of water will provide for both adequate current and resting areas.

5. To provide a practical means of collecting fish for removal, sorting or treatment.

6. To provide an adequate pond screening area with types of pond outlet and intake regulators which are positive in action and placed in such a manner that they will be reasonably free from frost, damage, or movement by visitors.

7. To incorporate the above features in a rearing pond as economically as possible and with due consideration for operating and maintenance costs.

Artificial feeding and rearing are almost universally used in U.S.A. This system, however, requires a large outlay in construction works (water supplies and ponds), food costs, operating and maintenance costs, which in some stations amounts to hundreds of thousands of dollars and even in the smaller stations the capital costs are great compared with the output. ~~But this is justified by the need.~~

Types of Pond

The three main types of pond construction are:

raceways
circular ponds
circulating raceways.

The raceway type is the oldest in current use. Circular ponds are a development of recent years and are said to have some distinct advantages over the other types. Circulating raceways are the main type of pond in standard use.

Dimensions of the common types are given in the descriptions ~~above~~; some points are common to each. Concrete is the preferred construction material because of its strength, durability, ease of maintenance and cleanliness. A flow of water which provides a current in all parts of the pond is needed. However, to a limited extent, particularly with circular ponds, velocity can substitute volume if the water supply is limited.

Raceways

For fingerling trout raceways should generally be from 3-5 feet wide, 50-100 feet in length and a water depth of 20-25 inches in the lowest part. The waterflow should provide for a current in all parts of the pond. Unless the soil is firm and non-porous, wooden or concrete sides should be built.

There are two schools of thought as to whether dirt or gravel bottoms or concrete bottoms are to be preferred. For fish of 4-5 inches, dirt or gravel bottoms are likely to provide a certain amount of natural food and support algal growths which help keep the water clean, but particularly more natural conditions are obtained before the fish are liberated. However, dirt or gravel bottoms can harbour disease and parasites, are hard to keep clean and difficult to sterilize in the event of a disease outbreak. Concrete bottoms are easy to clean, don't scour, allow execrement and dirt to float away. Experiments have shown that there is little appreciable difference in the growth rate between fish reared in dirt-bottomed and concrete-bottomed ponds under artificial feeding conditions.

When the water temperature is higher there should be a greater flow of water for the same depth and poundage of fish. A shallower raceway requires less water to produce a good flow.

When the trout have reached a length of 4-5 inches they can be safely transferred to a pool type of pond where the water velocity need not be so vigorous.

Circular ponds

This type of pond is generally used overseas for small or fingerling fish and has largely supplanted the raceway and larger type of pool. The design is a simple one and only differs from pond to pond in size, type of inlet and outlet.

A circular hole is dug, anything from 15-50 feet in diameter. Concrete is used for sides and bottom because it is necessary to keep a slope from the outside to the middle. A depth of 8-10 inches at the outside deepening to 18-20 inches at the centre. Water is introduced from a pipe at the edge so that a circular flow of water in the pond is maintained (see diagram). A recent Australian modification suggests that if the water is forced under pressure to spray into the pond, water temperatures can be lowered at the inlet (Affleck). Flows of from 12.5 g.p.m. for a 15 feet diameter pool 18 inches deep to 100 g.p.m. for a 50 feet diameter pool, 20 inches deep are quoted.

These ponds can be made virtually self cleaning, using a special type of outlet described. (See T.A.F.S. Vol 63 p139). The advantages claimed for this type of pond are:-

(a) Fish space themselves evenly around the pool.

(b) All wastes are collected in the centre where they can be easily removed by siphon.

(c) Generally more fish can be carried than in other types of pool or raceway.

(d) The water circulates several times before it is drained off.

(e) They are easier to maintain.

(f) Efficient circulation forestalls any rise in water temperature after the water enters the pond.

Circulating Raceways

A rearing pond of this type is fully described in the accompanying photostats. These seem to be suitable only for large hatching stations where sufficient funds are available to build the elaborate design.

Production and Stocking

Raceway. Length 37 ft., width 4 ft., depth 10 ins - 12 ins, flow 20-30 g.p.m., 6000 fingerlings held for 7 months with almost no mortality. (H.S. Davis).

Naturalistic: with small pools created by small weirs. Length 380 ft., width 4 ft., depth in pools 7 ins. 40,000 brown held during February (U.S.A. (Fortney)).

Drop Centre. (Rodgers). Length 22 ft., width 5 ft 6 ins, flow 60 g.p.m. approx. 175 lbs 5" fish stocked 1.6 lbs per cubic foot of water. Held for 23 days until the pond was cleaned. 175 lbs 5" fish = 3150 fish approx. (1.6 lbs cubic feet 5" fish).

Circular Ponds. Pool diameter 15 ft., depth 18 ins, flow 12.4 g.p.m. Stocked 20,000 rainbow fingerlings 2.3 gms wt = 2¼ ins approx. Held June 11th to September 6th; low mortality; average wt. 8.8 gms. Length 3½ ins approx. Weight of fish 387 lbs approx. (Davis). (1.8 lb cubic ft at start, 2¼" fish; final weight 2.1 lbs cubic ft.)

Pool diameter 15 ft., depth 18 ins, flow 12.4 g.p.m. (Davis). Stocked 15,000 rainbow fingerlings 1.9 gms, average weight .2". Held June 2nd until September 2nd. Average weight 11.5 gms, length 3¾" approx. (Initial stocking 1.1 lb cubic ft.)

Pool diameter 46 ft., depth 22 ins, flow 100 g.p.m. Dirt-bottomed; grassed sides. Fish held from September 1st to April following year. 3853 trout harvested weighing 1706 lbs (2.3 fish to 1lb, about 9 ins approx. (Cobb)).

Circulating raceways. See description photostat. Length 70 ft. twin 140 ft., width 5 ft. Water supply 150 gallons per minute. Stocked with 150,000 fingerlings No.1, graded down to 25,000 to be retained on yearling basis.

Temperature. The water temperature which promotes growth best is between 55°F and 60°F. Higher temperature should be avoided and providing the water supply temperature is low enough, high temperatures in the ponds can be avoided by good water circulation.

Foods and Feeding (artificial)

A large number of experiments have been conducted on the artificial feeding of fry and fingerling trout. Artificial feeding is the only possible method to use to obtain maximum growth from large numbers of fish reared in ponds. The natural feed present in a pond is not sufficient to support more than a small fraction of the pond capacity with artificial feeding.

Tests have shown the most suitable food combination is one which combines beef liver with animal meals such as dried milk, meat meal, etc.

Beef liver, all things considered, where costs and availability permit gives better growth results for small fish than any other liver or meat. Sheep or pig livers or melts (spleen) can be used for larger fingerlings and older fish.

A diet of meat alone while it promotes the best growth can later on be the cause of disease; therefore the addition of dried milk will make for a better balanced diet.

The liver and dried milk should be mixed together for small fingerlings or advanced dry. 80% liver, 20% milk, progressing as the fish grow to about 60% to 40%.

As soon as fry begin to feed they should be fed about 5 or 6 times a day. 2 meals a day are sufficient for larger fingerlings. To ensure good growth a fish requires 5% of its body weight in wet food per day (i.e., 1 lb of food for every 20 lbs of fish - see table for sized.

Natural feeding in Ponds & Races

If fry are liberated to grow on natural foods in ponds or races for removal at 6 ins. in length, a production of possibly as much as 20 lbs per acre may result. Great variation can be expected according, largely, to natural factors not easy to control, for instance; chemical composition of water, nature of sub-soil, amount of sunlight, and the temperature - all of which might affect amount of food and some of the use which is made of it.

In practice, variation in lbs per acre might be below 10 lbs up to - under most favourable circumstances - 40 lbs. On the basis of 20 lbs per acre a yield of about 250 6" fish would be obtained.

In practice there would be a considerable wastage of food when fry were released until they built up to a sufficient size to make good use of the food resources. Thus, if conditions permitted it being easily done, the ideal would be to put in more fry than would be required to produce 250 six-inch fish and grade them progressively. It is difficult to set any reliable figure for number of fry to liberate per acre to produce 250 six-inch fish because losses would vary through unknown causes additionally to the presence or absence of eels, bullies, shags, kingfishers, etc. Under optimum conditions, because dispersion would lessen the risk of infection by protozoan parasites, a survival of 90% might be obtained. Under the worst conditions survival might be as poor as it is usually in hatchery ponds in New Zealand - rainbow 50%, brown 10%.

As a basis for converting figures for size and weight of fish to number of fish per lb., the following table is of use:-

SIZE & WEIGHT OF TROUT and No. per LB.

Size in inches	Size in cms	Weight in ozs ~~unfed~~	Weight in gms ~~unfed~~	No. per lb ~~Unfed fry~~
		Unfed fry	.1	4,000
1	2.5	.0064	.180	Approx. 2,340
2	5.0	.053	1.500	302
3	7.6	.186	5.268	86
4	10.1	.436	12.36	37
5	12.7	.866	24.57	18
6	15.2	1.48	42.14	10.8
7	17.7	2.35	66.6	6.8
8	20.3	3.54	100.4	4.5

Some improvement in these yield-per-acre figures might be possible with artificial fertilization of the water. This, however, is n just a simple process of throwing in so much superphosphate or other nutrient matter, and often technical problems which have to be solved for each different location, arise. The only time it has been attempted on a large scale in New Zealand (see Annual Report Wellington Society) an almost total failure resulted. (See also discussion in Bulletin 9, p. 116

Screens

The type of screen necessary for a pond is dependent upon the design of pond chosen. For each design of pond there are one or more variations of screening. Basically, screens should be simple to operate, easy to clean, not readily tampered with by casual visitors; the maximum flow of water possible through the pond should be allowed and there should be meshes small enough to stop the smallest size of fish.

Vegetation

A certain amount of vegetation is permissible and desirable in a pond or raceway. Algal growths can have a purifying effect on the water.

Too much growth can have harmful effects. Growth should be kept to a point where it will not interfere with the complete cleaning of the pond or raceway and the removal of accumulations of decaying food, vegetation and excrement.

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