TROUT FARMING IN FRESHWATER

by

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Fisheries Leaflet 119

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Trout farming, the business of producing and selling high quality rainbow trout, has been expanding rapidly in the last 5 years. There are now some 20 freshwater farms in operation producing over 500 tonnes per annum. Initially some farms were operated as part of an integrated agricultural farm activity but more recently units have been established exclusively to produce fish and it has become a highly specialised business.

BASIC REQUIREMENTS

Essential requirements are as follows:-

1. Water Supply

An unfailing supply of water free from any element injurious to fish such as drainage from nearby dwelling houses, creameries, silage pits or dumps, piggeries, garages or any other source of pollution.

The minimum water requirement is 60 gallons per minute (4.5 litres per second) for every tonne of fish produced. This is needed at all times especially at the driest period of the year. Operating costs in 1982 suggest that the minimum economic size for an owner-operated unit employing one full-time assistant is 30 tonnes per annum. Thus a minimum water requirement of 1800 gallons per minute (135 litres/sec) is required for a farm of this size.

See Appendix for instructions on having a water sample analysed.

2. Site

A suitable site, preferably convenient to a dwelling house, for ease of supervision. The area required will be about 1 to 3 hectares for a

30 tonne unit depending on the type of rearing system chosen. The site should be free from flooding and it should be possible to arrange for a fall of not less than 1.5 metres between water levels at the intake and at the outfall. Ideally it should be on sloping ground with the general ground level at the inlet and outfall about 1 metre above normal water level at these points.

Raceways or rearing ponds can be excavated (Fig 1) or built of concrete or blocks (Fig 2). Other materials such as corrugated iron or steel circular tanks with a concrete base or fibre glass tanks are also used extensively (Fig 3). The soils for excavated earthen ponds should hold water. If the soil is porous and seepage excessive the site is not suitable. Where concrete ponds, raceways and other facilities are considered the site must be safe for such construction. The cost of excavating rock would normally rule out sites where rock is present. In all cases trial pits should be opened and examined to establish site characteristics prior to any major construction being undertaken.

Because of high energy costs and the need to have expensive standby generating equipment if there is a mains electrical supply failure, the use of pumped water supplies is regarded as uneconomic and most farms use a gravity fed water supply.

3. Food

Convenient sources of food are essential. Rainbow trout use a compound pelleted feed which gives a conversion rate (weight of food required to give one kilogramme weight gain) which lies between 1.5 and 2.0 to 1.

Suitable pellets are currently being manufactured in Ireland or can be imported. Pigmented feeds are also available and can be used for some weeks prior to sale of fish to give a pink colour to the fish flesh.

The average cost per tonne of feed in 1982 was approximately £350 to £400 per tonne.

The practice of using minced waste fish is not now encouraged because of its low nutritive value, poor conversion rate (figures of 10 : 1 having been demonstrated experimentally) and the unpredictable nature of supplies. Cold storage facilities would be required to retain sufficient supplies which also makes it expensive. Finally but importantly the nature of the wet feeds is such as to reduce the water quality within the farm and reduce overall production.

4. Access to Markets

Marketing of rainbow trout is a highly competitive business. Presently some 410 tonnes are being consumed on the domestic market per annum - mainly sold to wholesale fish merchants and to the catering trade. Ex-farm gate sales are limited to high population areas - and most producers have to deliver or freight fish to Dublin or some other large city. Prices per 1lb of fish were between 58 and 70p in 1982. Premium prices are paid for pink fleshed rainbows.

Present indications are that existing producers are meeting domestic demand and all potential new farmers are likely to need an export market. Traditionally the main export market for Irish producers has been to the United Kingdom. Unfortunately very little information is available in this country on the potential for markets abroad and basically each new producer is expected to do his own market research. Production increases in the U.K. itself as well as in other E.E.C. trout producing countries such as Denmark, Italy and France make the marketing of rainbow trout even more difficult. In 1982 prices in UK dropped to 54p /1b and this depressed the price on the home market as well.

The minimum production to be aimed at with a view to export would lie between 35 and 50 tonnes per annum. Any prospective fish farmer should investigate possible outlets thoroughly and consider associating with other trout farmers in a co-operative marketing and exporting venture, having as an objective a combined production of at least 50 tonnes.

5. Training

Persons intending to take up fish farming should visit units at present in production and view and discuss the nature of the enterprise with those already experienced in this type of work. A list of producers can be obtained from the Department of Fisheries and Forestry.

Newcomers to fish farming should undergo a period of training at a production unit before commencing operations on their own. A practical training course is available at the Galway Regional Technical College and details should be obtained from that institution.

6. Licencing Requirements

A Fish Culture Licence issuable under Section 15 of the Fisheries (Consolidation) Act, 1959 must be obtained by any person who intends to

engage in fish culture. Before granting a licence the Department will require evidence of competency in fish farming operations either on the part of the sponsor or the person employed by him.

Planning permission must also be obtained from the Local Authority in the area under the Local Government (Planning and Development) Acts 1963 and 1976

~~7. Grants~~

This Section is NO longer applicable

~~For Fisheries Fish Farming grants are available under the Farm Modernisation Scheme and in the first instance application should be made to the C.A.O. of A.C.O.T. to advise on the criteria which must be met in order to quality for grant assistance.~~

~~Maximum grant is 30% of capital costs (excluding land purchased).~~

8. Costs

It is difficult to say very precisely what the capital costs of developing a site will be, since much will depend on the physical features of each specific site. For example, if the soil were rocky or sandy then costs might increase beyond the point of economic viability. Alternatively if soil were sandy then it might be necessary to consider putting in concrete ponds or using some form of liner such as butyl rubber. This would also be a cost increasing factor. The rough guidelines for cost on the basis of our experience to date are between £1,500 and £2,000 per tonne per annum production. For example the capital requirements for a 30 tonne production unit would be between £45,000 and £60,000 for site development and the provision of hatchery and storage buildings.

Working capital is required for:-

1. Fixed Charges:-
   - (i) Interest
   - (ii) Administration
   - (iii) Rent, rates, insurance
   - (iv) Depreciation
   - (v) Maintanance

2. Variable Charges:-
   - (i) Food
   - (ii) Labour
   - (iii) Selling and Transport
   - (iv) Power
   - (v) Restocking

Of the variable charges food is the most expensive item and is roughly 60% of variable costs with labour approximately 30% and other items 10%.

Food in 1982 cost £350 - £425 per tonne and between 1½ and 2 tonnes of food are required to produce 1 tonne of finished fish. About 3 people are required to run a 50 tonne unit, one of whom might be the owner/manager. He would be occupied largely on the marketing side but would be involved also in some of the labour-intensive aspects - catching, sorting and packing for sale.

9. General

Persons interested in commencing fish farming should submit to the Department of Fisheries and Forestry full details of the site which they are considering and of the quantity and quality of the water supply. An inspection of the site will be arranged. If the indications are that fish farming is feasible, advice and information on the layout and size of units, pond designs, water control systems and stocking rates will be made available.

Engineering plans of the fish farm should, however, be prepared and be submitted to this Department for approval before construction work actually commences. The proposal should likewise be brought to the notice of the local Regional Fisheries Board as the body responsible for protection and conservation of fisheries.

TROUT FARM PRODUCTION CYCLE

The following notes are issued for the information and guidance of those interested in pond culture of trout. They are based on material compiled originally by the Central Fisheries Board, in operating a fish farm at Fanure near Roscrea, and on research work carried out by the Department of Fisheries and Forestry on the development and operation of commercial fish farms over a number of years.

Rainbow Trout

The rainbow trout is native to the Pacific coast of North America, but has been widely introduced into other countries. There are several different strains of rainbow and some forms are migratory (the steelhead has the same habits as the Irish sea trout or white trout). Rainbow trout used in commercial production are late autumn and winter spawners.

In nature, rainbows deposit their eggs in excavations made in the gravel of a river bed. The eggs hatch in about two months. The fry, which are about 20mm long, remain in the gravel for about six weeks, while they are absorbing the contents of the yolk sac. They then emerge from the gravel and begin to feed on tiny crustaceans, insect larvae and other invertebrates. The rainbow, as it grows larger, is an active forager and its natural diet consists entirely or almost entirely of small animals of various kinds - winged insects and their larvae, crustaceans such as water fleas, shrimps, water lice and crayfish; aquatic snails; and small fish. Maturity is attained, in the case of the females, usually at 3 years old (sometimes at 2 years), by which time the fish weigh anything from 0.5 kg - 3 kg or more. The males mature at a lesser age and size.

It has been found that under favourable conditions in Ireland rainbow trout can be grown to 200 grams in from nine to twelve months from commencement of feeding. The growth rate, however, is affected by climatic factors so that for Ireland it is well to allow for a full year's growth to bring the main stock to the 200-250 gram This is the most popular size for the market.

Hatching

A female rainbow trout yields about 2,000 eggs per kg of her body weight. For fish farm purposes, gravid females are stripped of their eggs, which are pressed into a basin, and covered with milt taken from a male fish. The eggs are then placed in perforated trays in troughs through which a flow of water is maintained. For some weeks, they are delicate and easily injured by shock or disturbance. They are also sensitive to light so they are covered. As the embryos develop, and their eyes become visible through the translucent capsules of the eggs as two dark specks (the "eyed-egg" stage), the eggs become more hardy. Troughs have to be inspected daily, to ensure that the water flows through the incubation tanks and to remove dead eggs.

The fry - or alevins, as they are termed - at first are very puny, little more than appendages to their own yolk sacs. They avoid light and stay at the bottom of the trays or troughs. During this stage, as during the egg stage, the troughs are kept covered to exclude the light.

By the time the yolk sac is almost gone, the alevins have become much stronger. Soon they no longer try to avoid light, and begin to swim up from the bottom. They are now ready to feed.

Feeding the Fry

The fish in captivity must be trained to feed. Care and patience are needed in this operation. Feeding is usually begun in the hatching troughs, from which the trays and lids are removed. The natural instinct of the little fish, whose natural food is living animals, is to snap at moving particles. Their first meals in a fish farm consist of very fine pellets given frequently and in small amounts, and in such a way that the particles are moved by the current or by swirling the water around, so as to induce the fish to snap at them. Feeding must be carried out at intervals of 1 hour throughout the day, with the utmost care, until the fish have come to recognise food, and will accept it as soon as it is thrown to them. This may take a week or more.

Rearing in Ponds

When the fish have been trained to feed they are put out in small, shallow ponds, tanks, or raceways. Concrete, fibre glass, or other materials have been used successfully for this purpose. There they can be kept under close scrutiny while being fed, so as to ensure that each gets its share of food, and that no small predators which may get in can escape notice. As the fish grow, the number of feeds per day is gradually cut down, until only two or three feeds a day are given. Automatic feeders can be used at this stage to cut down on labour requirements. A number of different models are available from specialised equipment manufacturers. Details can be found in any trade magazine.

About three months after hatching the amount of close attention can be safely reduced. The fish are transferred to larger ponds, which may be of various types. The following designs are used:-

(a) Rectangular ponds with a screened inflow pipe at one end and a screened sluice at the other. These are usually excavated in the earth but they can also be made of concrete. This is normally referred to as Danish system (Figure 1).

(b) A raceway with a continuous controlled flow of water, divided up into successive sections by screens with 15 to 20 cm fall at each section to re-aerate water (Figure 2).

(c) Circular concrete ponds with a central outflow and inflows directed at an angle so as to cause a circulating current all through the ponds. Recently the circular ponds have been constructed using specially moulded corrugated iron sheets on a concrete base (Figure 3).

Ideally, each pond should have an independent water supply and outlet and be capable of being completely drained. There should be spare pond capacity to permit cleaning, grading and routine maintenance.

It is desirable to cover the ponds with small mesh wire netting to protect the small fish from rats and birds. Nylon thread strung across the larger ponds is effective in excluding gulls and herons which are serious predators.

Food - Kinds and Quantities

Food usually consists of branded compound dry diets of sizes ranging from fine crumb for fry to progressively larger diameter pellets for growing fish.

The amount fed per day depends on the size of the fish and also on the temperature. Usually 1 to 3 per cent of the weight of fish in a pond is fed per day - this weight being calculated from the average weight of the fish in the pond (periodically determined) multiplied by the number (determined from original stocking less casualties and checked at each grading). The appetite of the fish however increase with a rise in temperature and decreases with a fall in temperature, and this involves varying the amount fed so as to ensure the fish get all they can eat, without leaving an uneaten surplus to decay and foul the water.

Manufacturers generally provide feeding tables to guide farmers on the amounts to be fed, taking into account the temperature, the size of the fish and the pellet type to be used. These are guide tables only but local conditions such as quantity and quality of the water have an effect on feeding regime. Usually fish are not fed at temperatures below 4°C or above 18°C. It is also necessary to stop feeding during flood conditions, when due to high concentrations of suspended solids fish may not see the pellets and thus waste the feed.

Fish feed generally has a shelf life of 3 to 6 months from the date of manufacture and should be stored in a cool dry place to avoid loss of the vitamins' potency. The manufacturers instructions should be adhered to in this regard.

The conversion factor from dry diets, that is the amount of food required to produce one kg of trout is usually in the range between 1.5 and 2 to 1. Routine checks on the conversion rates being obtained on the farm are an important feature of economic management. As fish feed is probably the single most expensive item in the running costs of a fish farm, it is important to ensure that maximum feed conversion efficiencies are obtained.

Grading

Routine management of a fish farm involves not merely feeding, removal of dead fish, and so on, but also periodic grading and counting. Fish even from the same lot of eggs grow at different rates. As soon as some fish become appreciably bigger than their fellows, they begin to monopolise the food supplies. Careful distribution of the food helps, but does not entirely eliminate the ris of the faster growing fish growing still faster at the expense of the smaller ones. Grading of the fish, and separation of the big from the small ones, is therefore essential to ensure as uniform a growth as is possible, and also to avoid cannibalism.

Grading involves netting out the fish,and placing them in grading boxes. These have screens each having a uniform series of slots of the required size which enables the small fish to swim through, but retains the larger one. Grading should ideally be carried out at least twice in the period May/Sept and as often as a marked variation in the size of the fish is observed. When the bigger fish are removed there is a remarkable spurt of growth by the smaller fish left behind.

Protection from Predators

Apart from maintenance of the ponds, measures to protect the fish from predators must be taken. Small fish, or fish of any size in shallow ponds, must be protected by netting of some kind, from herons and gulls. A nylon thread stretched across above the surface of the pond is beneficial. Otters and feral mink are also serious predators, but under the Wildlife Act 1976 most species of wild mammals and birds are protected and a permit to shoot or trap predators must be obtained from the Department of Fisheries and Forestry. Mink are however, exempted and no permit is needed to trap them. The gen trap is illegal at all times.

Risks

Fish farming is a high risk capital-intensive form of farming. At the outset it requires very careful research into the site potential, careful planning at all stages and very strict management procedures and surveillance to minimise the risks. This includes maintenance of daily water temperature and mortality records, noting appetite and behaviour of stocks and keeping a watchful eye on water levels in each pond to avoid blockage of pipes or screens under adverse weather conditions.

As in most intensive systems it is likely that there may be outbreaks of disease from time to time.

Diseases of farmed-fish fall broadly into three main categories:-

- dietary diseases
- environmental diseases
- infectious diseases

Dietary diseases can be avoided by using a good quality food. The Fisheries Research Centre provides an analytical and advisory service to ensure that the quality of feed is maintained and keeps in touch with the fish feed manufacturers if problems arise.

Environmental diseases arise mainly due to insufficient or unsuitable water, dirty water, or overcrowding. The water supply should be sufficient to give at least two complete changes of water per day in independently supplied ponds; it should be free from all possibility of pollution and adequately aerated.

Fish excreta and/or uneaten food, dead fish or organic debris should not be allowed to accumulate in the ponds. A stocking density of 1.5 - 2kg per cubic metre is normally recommended, although higher densities can be maintained without loss for short periods.

Fish thrive best under farm conditions when fairly densely stocked in clean water. When overcrowding does incur risks these can be minimised by strict hygiene independent and varied rate of water supply, reduced feeding and stress.

If conditions deteriorate to the point where an outbreak of disease occurs then it may be necessary to isolate or destroy excessive stocks.

Some forms of disease can be treated or prevented by chemotherapeutic methods, but this is a complex question which may require the expert diagnostic facilities and advice of the Fish Pathology Unit of the Fisheries Research Centre. Advice is available on request. All outbreaks of disease or suspected disease should be notified immediately to the Department of Fisheries and Forestry who operate a Fish Pathology service at Abbotstown, Castleknock(Tel No. 01-210111). It will help in speedy diagnosis if detailed farm records are available.

Finally Insurance cover for most known risks can be obtained. The premium is essentially based on the Insurance Company's assessment of the site risks and the operators competence and skills.

Transport and Marketing

Traditionally fish were sold to wholesalers or caterers fresh, ungutted on ice, packed in polystyrene or cardboard boxes - and delivered either by road or rail within a few hours of being cropped. Nowadays high costs of transport are making bulk deliveries more attractive economically. There has also been an increase in the delivery of smoked trout for the catering trade and in vacuum-packed ready-to-cook-trout for the housewife who seeks a convenience food from the supermarket - and a number of processors are engaged in selling trout in these ways.

Whatever method of selling is chosen it is essential to maintain a high quality product.

Fish must be starved for at least 4 days before being sold to avoid spoilage. They should be size or weight graded and any with net marks or abrasions should be withdrawn..

The present freshwater production of over 500 tonnes is now consumed almost entirely on the home market, in sharp contrast to the mid 1970's when the bulk of our production was exported to the U.K. Domestic production in that country has increased dramatically to nearly 7,000 tonnes in 1981 - and export markets for our producers are retracting. Before getting started in fish production it is essential that a potential farmer establishes new or untapped outlets for his product. Otherwise he will find himself competing with already established producers for a limited market and perhaps a reducing price!

END

Fig I. DANISH SYSTEM

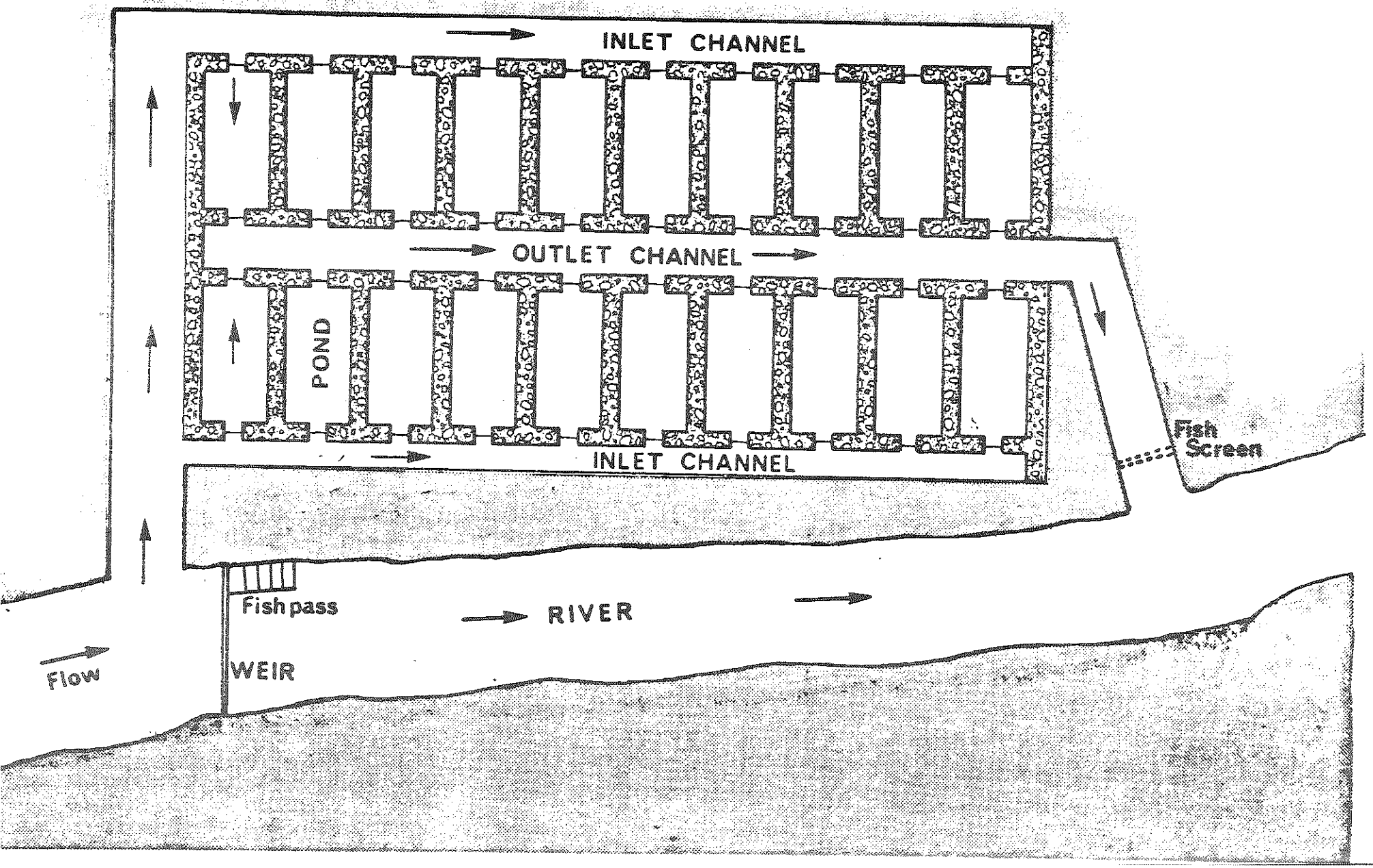
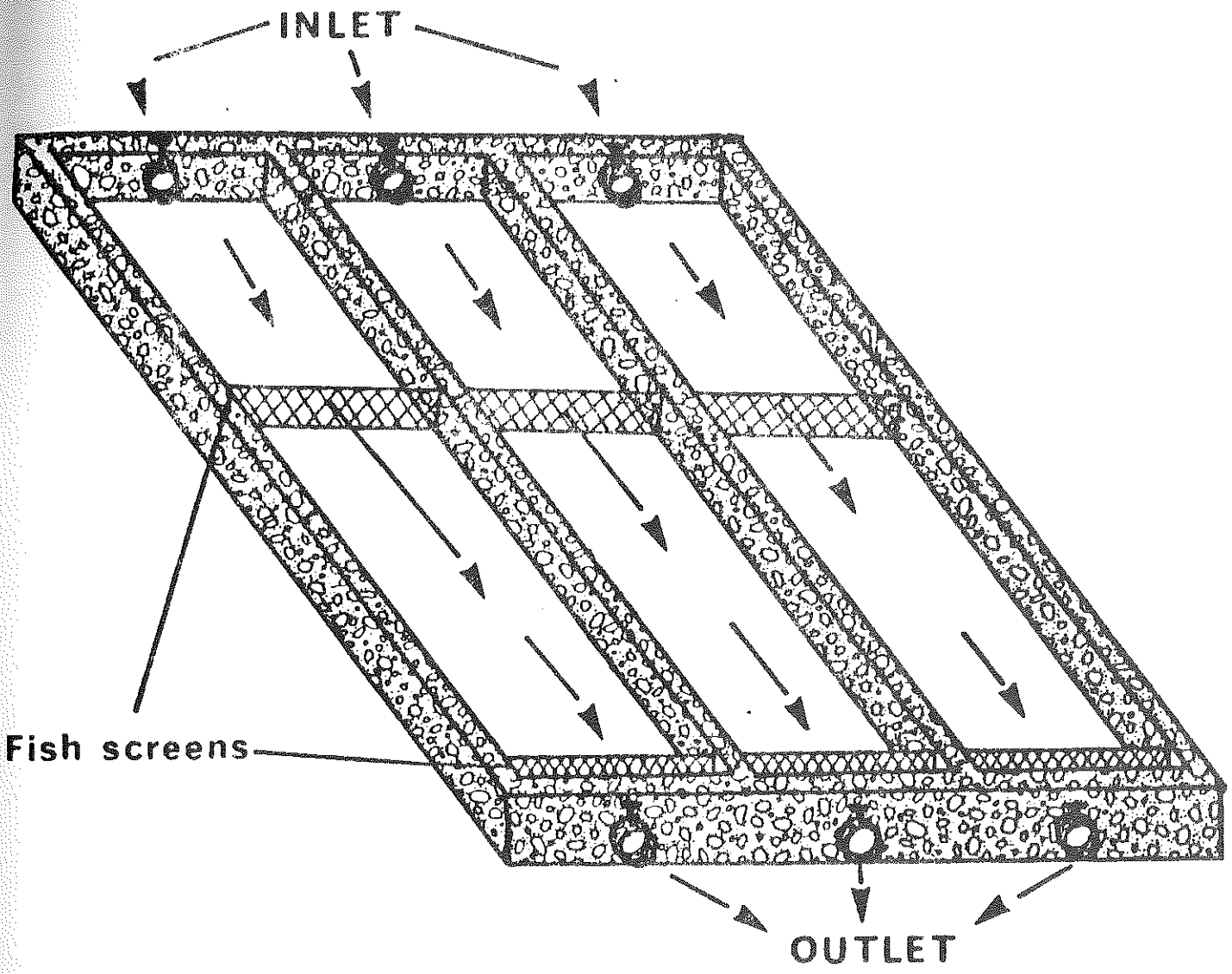
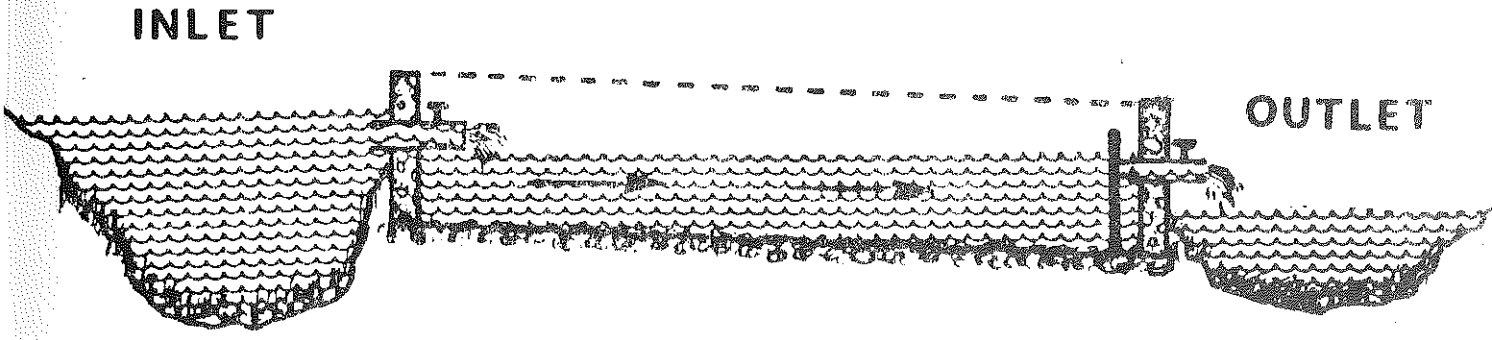


Fig2 RACEWAY SYSTEM (American)





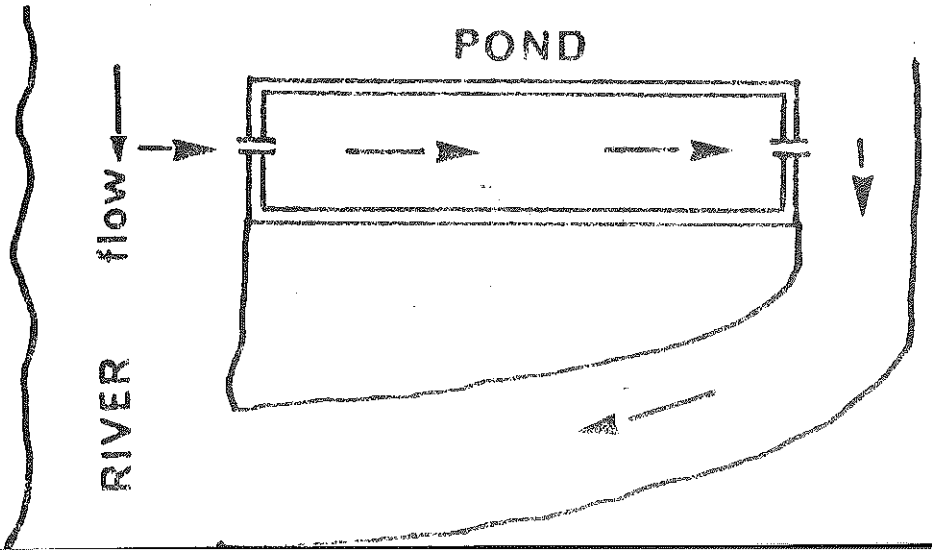
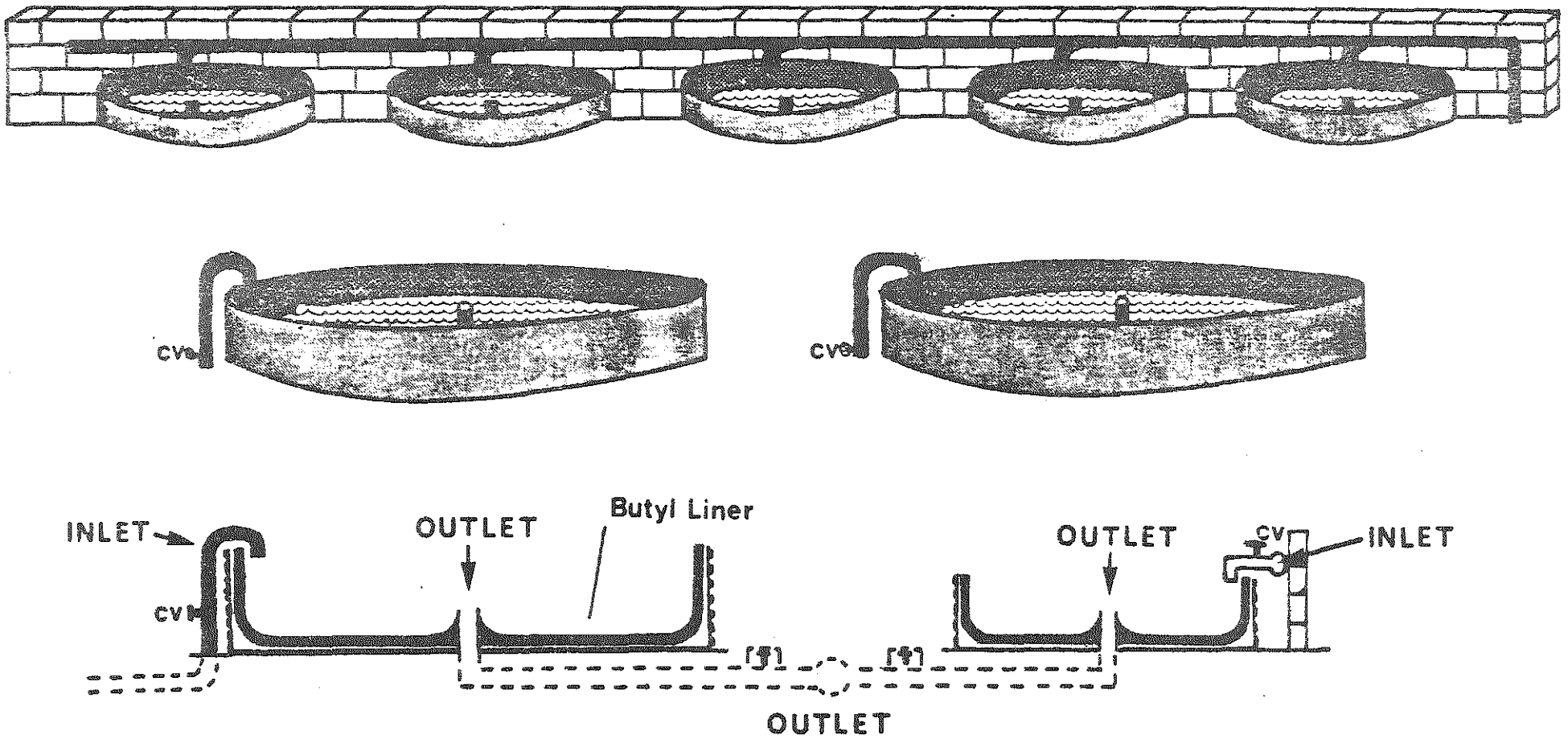


Fig3 CIRCULAR TANK SYSTEM



Suggested Books and Journals on Fish Farming

1. Handbook of Trout and Salmon Diseases
   by R J SRoberts and C J Sheperd

2. Fish and Shellfish Farming in Coastal Waters
   by P H Milne

3. Farming the edge of the Sea
   by E S Iverseen

4. Salmon and Trout Farms in Norway
   by David H Edwards

5. Trout Farming Manual
   by Dr John P Stevenson

All published by Fishing News (Books) Ltd
1 Long Garden, Farnham
Surrey
ENGLAND

6. Trout and Salmon Culture (Hatchery Methods)
   California Fish Bulletin Number 164
   by Earl Leitritz and Robert C Lewis
   Agricultural Sciences Publications
   University of California
   Berkeley, California 94720
   U.S.A.

7. Trout Farming - Hand book by S Drummond Sedgewick
   Published by Seeky Service & Co. 196,
   Shaftesbury Avenue, London WC2H 8JL

Journals of interest are:

1. Fish Farming International
   Arthur J Heighway Publications Ltd.
   110 Fleet Street, London EC2A 2JL

2. Fish Farmer
   Subscriptions Manager
   IPC Buisness Press (Sales and Distribution) Ltd
   Oakfield House, Perry Mount Road, Haywards Heath
   Sussex RH16 3DH

Fisheries Research Centre
Abbotstown
CO DUBLIN

DIRECTIONS FOR SAMPLING WATER FOR ANALYSES

Analysis of sample

Samples should be submitted to an Analyst for examination if possible within four hours of taking the sample but not later than twenty four hours. It is essential that some parameters be measured on site and it is necessary therefore to contact the analyst in advance to obtain suitable containers and chemicals.
In most cases it would be preferable if the analyst could visit the site and take such samples as the range of tests to be done require, but where this is not possible then the instructions of the analyst of choice should be obtained as to any additional measures to be observed in sampling. A List of Analysts can be suppl

Parameters

The following information will be required from the analyst:-

- Dissolved Oxygen content
- Biochemical Oxygen Demand (B.O.D.)
- Total and Free Ammonia (NH_3)
- Free Carbon Dioxide (CO_2)
- Total alkalinity
- Total hardness
- pH value
- Nitrates
- Phosphates

Where local geological characteristics or a previous history of mining in the area indicate that there may be traces of heavy metal deposits, then lead, zinc,copper and iron levels should also be determined as very minute quantities can be lethal to young fish.

Minimum requirements for fish farming are:-

- Dissolved oxygen: fully saturated at ambient temperature
- B.O.D.: less than 2mg/l
- Free CO_2 : less than 12mg/l
- Free NH_3 : less than 0.025mg/l
- pH : 6-8

Size of Sample

One litre of water should be sent for analysis and a separate sample taken for dissolved oxygen measurement 250cc's pre treated with fixing agents (Winkler Reagents).

Container

In the past "Winchester quart" bottles obtained from a Chemist have been recommended and they are suitable provided they are fitted with a ground glass stopper.

A screw cap stopper must not be used. Plastic or other glass containers can be used but in all cases the sample bottle must be thoroughly cleaned and sterilised. Soaking in 20% Sulphuric Acid overnight and triple rinsing with de-ionised water is standard procedure to avoid contaminants in the sample and distortion of the results.

Since the purpose of taking a water sample is to establish the purity or otherwise of the potential supply to the fish farm, it is advisable to take the sample during periods of LOW FLOW when minimum dilution of any pollutant would occur. Ideally a number of samples should be taken over a period of one year in case there are seasonal activities in the area giving rise to localised pollution which may not be evident on casual observation but which could pose a threat to an intenisvely stocked fish farm.

Taking the Sample

Rinse the container three times with the water to be sampled, having the container about one-third full each time. Then immerse the container well below the surface of the water and allow it to fill to overflowing. Avoid collecting water from the surface and disturbing the mud or other sediment at the bottom of the river or lake.

Labelling of Sample

The sample should be labelled to show the following particulars:-

(1) Name and Address of Sender.
(2) River or Lake concerned.
(3) Locality from which Sample was taken.
(4) Date and hour when Sample was taken.
(5) Condition of flow of river or stream on days immediately before and at the time of taking of sample.
(6) Temperature of water at time of sampling.