

FISHERIES ENVIRONMENTAL REPORT NO. 10

COMMERCIAL PRODUCTION  
OF QUINNAT SALMON  
IN NEW ZEALAND WATERS—  
BACKGROUND PAPERS



FISHERIES RESEARCH DIVISION  
MINISTRY OF AGRICULTURE AND FISHERIES  
CHRISTCHURCH

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OF QUINNAT SALMON  
IN NEW ZEALAND WATERS -  
BACKGROUND PAPERS

BY  
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N.Z. MINISTRY OF AGRICULTURE AND FISHERIES  
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## FISHERIES ENVIRONMENTAL REPORTS

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## CONTENTS

	<u>Page</u>
1. Introduction	1
2. Establishment of Salmon in New Zealand	3
3. Salmon Enhancement - Ocean Ranching	5
(i) Selection of release localities - geographical	8
(ii) Selection of rearing localities - site requirements	14
4. Salmon Farming Establishment procedures	17
5. Allocation of Salmon Stock	21
6. Staff Training	25
7. Operational Procedures	26
8. Disease	28
9. Policy with Regard to salmon Farming	29
Appendix I - Legislation and regulations	31
Appendix II - Contacts and addresses	32
Appendix III - Application for a fish farm licence under the Freshwater Fish Farming Regulations 1972	34
Appendix IV - Allocation of salmon stock to salmon farmers for ocean ranching. Policy adopted by Salmon Committee of Council of South Island Acclimatisation Societies, February 1981	36
Appendix V - Introductory literature	41
Appendix VI - Recommendations for the quinnat salmon tagging and recovery programme, by D.H. Lucas	42
Appendix VII - Ocean-ranching of quinnat salmon. Policy approved by the Ministry of Agriculture and Fisheries, December 1980	49

## 1. INTRODUCTION

Salmon enhancement, by which man artificially increases the run of salmon in a river system by raising and then releasing large numbers of young salmon, is a rapidly developing technology in many areas, particularly in western North America, the eastern seaboard of Russia, and Japan, but also in western Europe, Scandinavia and Chile. Considerable success has followed in some areas, and recent reports of returns to Chilean rivers suggest that New Zealand is no longer unique in its possession of a sea-run of Pacific salmon in the Southern Hemisphere (New Zealand apparently remains unique in that our runs are self-sustaining).

There is currently intense interest in enhancing salmon runs in New Zealand, this interest coming from groups as diverse as large multi-national or New Zealand-owned companies (involved in a wide range of interests - from oil to food processing and textiles), small companies formed specifically for salmon farming by a few individuals with minimal capital, and pastoral farmers with suitable water supplies.

Some of those involved have had a long interest in either the salmon fishery or salmon research while others know little or nothing of salmon biology and behaviour.

Interest is growing rapidly. It is evident that enthusiasm is beginning to outstrip experience, and that commitment of companies and persons interested, of the capital available, and of New Zealand's wild salmon resource, may move ahead of the technological knowledge available to manage the whole problem and to enhance the likelihood of success.

Many of those pursuing an interest in salmon farming admit to having little or no knowledge of what salmon enhancement programmes entail, nor of salmon handling and management techniques. Literature available to enlighten and educate them, although quite extensive, is almost exclusively of North

American origin and is not easily accessible to those who do not have the use of specialist fishery libraries.

In addition some of those expressing an interest in establishing commercial salmon ventures appear to have little knowledge of the administrative procedures involved or appreciation of the character and variety of organisations that need to be consulted. Nor does there seem much appreciation of either the historical background to salmon introduction or the policies and attitudes of various organisations towards salmon development.

Finally, with rapid growth of salmon enhancement by recreational interests (Acclimatisation Societies), Government (Fisheries Research Division) and commercial interests, it has become imperative that consistent monitoring of the success of these programmes, and their effects on the wild populations, be carried out. To do this, extensive tagging of fish for release down-river to the sea has been initiated. There are procedures related to this tagging programme that need to be understood and adhered to.

This report thus covers various aspects of salmon enhancement policies, principles, and practice, to clarify, for those already or wishing to become involved, some of the facts that need consideration as follows:

- (1) A brief introductory statement on the establishment of salmon in New Zealand and historical facts related to recent development of salmon enhancement programmes;
- (2) A consideration of factors related to selection of sites for salmon enhancement in New Zealand;
- (3) A detailed discussion of procedures for establishment and liaison of salmon ranching ventures;
- (4) A statement of procedures to be adopted by salmon farmers in obtaining the services of Fisheries Research Division's salmon tagging team.

## 2. ESTABLISHMENT OF SALMON IN NEW ZEALAND

Quinnat salmon (*Oncorhynchus tshawytscha*) - known more commonly in North America as chinook or spring salmon - were first introduced into New Zealand from California by Acclimatisation Societies in 1875. These early introductions left no clear evidence of success and quinnat were again introduced in the early 1900's by the New Zealand Government with the objective of establishing a commercial salmon fishery. Releases of quinnat were made in widespread and various localities in both islands but the major effort was made by Government agencies in the early 1900's in the Hakataramea River, a tributary of the Waitaki.

Very large numbers of young salmon were released into the Waitaki, extensive releases into the Wairau (Marlborough) and Clutha, and small numbers into the Selwyn, other small Canterbury-Otago rivers, and the Hokitika River on the West Coast. It is largely on the basis of these early 1900's releases, and the spread from initial release locations, that the present salmon fishery has developed. It seems that salmon very quickly spread along the Canterbury-Otago coast but what happened to the West Coast stocks is not really known, apart from the continued presence of a few fish in Lakes Mapourika, Paringa, and Moeraki and associated river systems, about 100-150 km south of the Hokitika. These populations are, at least in part, landlocked. Occasional salmon and some reports of spawning are known from other rivers, e.g. Grey, Taramakau and Arawata. Very occasional salmon have been reported from some North Island rivers, e.g. the Mohaka and Rangitikei in 1980.

Quinnat salmon numbers now vary from several to tens of thousands in rivers of the east coast of the South Island, from about the Waimakariri south to the Waitaki. North of the Waimakariri numbers decline, with a moderate run known in the Hurunui River and some as far north as the Wairau. The Clutha River further to the south once carried a substantial run but this has been

reduced by truncation of the river by an impoundment (Roxburgh Dam) which prevents upstream migration into most of the spawning tributaries of that river. Over a period of about 70 years quinnat salmon seem to have established a "natural" range in New Zealand waters within which populations are self-sustaining.

The quinnat salmon fishery, in addition to recreational angling, was commercially harvested in some South Island east coast rivers until the early 1960's when allegations of over-exploitation resulting in the decline of populations led to its prohibition. Population decline can probably be attributed to heavy commercial exploitation initially, but river modifications - truncation of upstream runs in rivers like the Waitaki and Clutha, and excessive water abstraction in rivers like the Opihi and Ashburton - have also been major contributors to reduced salmon numbers.

In the 1970's, salmon anglers recognised that salmon numbers in South Island rivers had declined, and the N.Z. Salmon Anglers Association was formed to promote increases in salmon numbers. The Acclimatisation Society movement also recognised this and took action to set up a hatchery at Silverstream (Waimakariri River system), to produce salmon smolts for enhancement purposes. The Salmon Anglers Association in 1973, produced proposals for the establishment of a Salmon Fisheries Development Commission to take over the management of the salmon fisheries and to promote commercial ocean ranching of salmon - involving the release of large numbers of hatchery reared smolts to sea. This proposal was discussed by the Salmon Committee of the South Island Council of Acclimatisation Societies and subsequently at a special meeting of the Freshwater Fisheries Advisory Council in 1975. It did not gain general support and eventually lapsed.

In 1975 the Ministry of Agriculture and Fisheries (MAF) acquired the Silverstream Hatchery from the North Canterbury Acclimatisation Society and began experiments on the establishment of an induced run of salmon in the Waimakariri River system. Returns to date have been only moderate reaching

335 in 1979 and 448 in 1980 from releases in 1976 and 1977 exceeding three quarters of a million smolts. Subsequently, private individuals and companies have become interested in salmon ranching with two groups establishing pilot ventures in the late 1970's; ICI/Watties Salmon Consortium on the Waitaki and Clutha Rivers, and Bubbling Springs Company on the Takaka River. In 1979-1980 there was rapid expansion of interest culminating in early 1980 with establishment of the New Zealand Salmon Farmers Association.

Early development of the commercial salmon industry has not always been as well thought out as it should have been. Some enterprises have focused undue attention on the freshwater supply for egg and smolt rearing and have possibly given insufficient attention to obtaining adult returns from the sea. As a result some salmon farms have been established well outside the existing range of sea-run salmon in New Zealand. The industry has developed more rapidly than the capacity to supply salmon stock from either wild stocks or man-developed runs, and faster than the necessary technological backup that is needed. Progress towards establishment of new ventures, and relationships between ventures already operating have not always been smooth and orderly. In part this is because those involved have been insufficiently aware of the range and diversity of interested parties that need to be involved in early discussions. Nor have prospective salmon farmers always been sensitive to the political climate within which expansion of the salmon fishery into a commercial enterprise has been taking place. These matters need to be clarified so that the industry can develop in as rapidly and orderly a manner as is possible.

### 3. SALMON ENHANCEMENT - OCEAN RANCHING

In the past 5-10 years, increased and renewed attention has been paid in North America, Russia and Japan to augmenting runs of salmon into rivers within the natural range of the species. Salmon are raised to smolt size (at which stage they normally go to sea) and are released with the expectation

that in 3-5 years a proportion of the fish released will return to the water of origin where they can be caught by anglers or harvested commercially.

It has seemed logical to some that the same process could be applied in New Zealand. Fisheries Research Division, M.A.F. has, for a number of years, been experimenting with the enhancement of quinnat salmon populations in the Rakaia and Waimakariri Rivers. The objectives of these programmes are neither specifically nor exclusively related to recreational or commercial fisheries, but rather to developing a technology to make both possible. Results of this research suggest that enhancement schemes could be beneficial in New Zealand river systems and both angling interests and commercial operators have investigated possible hatching and release sites on a variety of rivers. By mid-1980 there was an installation on the Takaka River (Nelson district) and one on each of the Hurunui, Rakaia, Waitaki, Clutha and Hokitika, all of these being commercially motivated and primarily ocean-ranching ventures. Potential for growth and development of the New Zealand salmon fishery seems to be immense and because of this apparent potential, commercial interests continue to investigate additional possible locations for installation of ocean ranching facilities. Further sites are proposed, or under investigation, on the Ashley, Waimakariri, Ashburton, Orari, Rangitata and Owaka Rivers. Interest has been also expressed in raising quinnat to marketable size in sea pens.

Establishment and maintenance of salmon enhancement/ocean ranching facilities is expensive and it will be a minimum of three years before any significant returns of salmon can be expected. It will take substantially longer for a cash flow to develop. It is therefore imperative that careful planning and analysis should precede involvement in salmon ranching if the likelihood of success is to be maximised.

There is at present little literature specific to the New Zealand fishery and environment to guide in the selection of localities either for

rearing sites or release localities, and it is one of the purposes of this discussion to form a basis for such a guide. In what follows I have sought to establish what governs salmon distribution and abundance in New Zealand waters. A series of assumptions has been made which are both explicit and where appropriate can be shown to be false. If the assumptions are shown to be false, then the conclusions derived from them must be modified accordingly. But in making assumptions I have sought to establish restrictive criteria which will indicate the rivers where the greatest likelihood of success is to be found.

There are several semi-discrete phases in the life cycle of salmon that need to be examined in any analysis. These are -

- (1) Spawning, development, and life in the river gravels after hatching.
- (2) Early growth in fresh water.
- (3) Migration downstream into the sea.
- (4) Distribution, feeding, and growth in the sea.
- (5) Homing, return to fresh water, and migration upstream.

Attention must be paid to fulfilling necessary conditions for the completion of each of these phases if salmon ranching is to be successful. In the recent past and present there has, I believe, been a tendency amongst those seeking salmon release locations to seek situations where there is abundant high quality fresh water in which phases 1 and 2 can be carried out successfully, i.e. development (spawning is replaced by stripping and artificial fertilisation) and early growth in fresh water. The presence in quantity of a stable supply of high quality water not subject to discoloration and flooding is, of course, important. Thus we see the establishment of a rearing facility in water derived from Waikoropupu Springs (Takaka River) in the Nelson District, requests to release fish into Spring Creek, a tributary of the Wairau River (Marlborough) and into upwelling

spring waters near Kaikoura, and interest in an old trout hatchery site at Kaniere on the Hokitika River. All these locations are regarded by proponents as having suitable high quality water and are at the fringes of the natural range of salmon in New Zealand. The placement of salmon research installations at Silverstream and Glenariffe is based, in part, on having stable supplies of good quality water of largely spring origin, but these by contrast lie within the centre of distribution of salmon.

(i) Selection of Release Localities - Geographical

ASSUMPTION 1. QUINNAT SALMON HAVE IN THE PAST 70 YEARS SPREAD TO THE APPROXIMATE LIMITS OF THEIR NATURAL RANGE IN NEW ZEALAND.

There are no salmon in the Mataura, Wairau or other rivers in Southland. There are few in the Wairau in Marlborough (although there are suggestions of greater numbers in the past) and none in rivers of the Nelson province, nor in rivers of the Wellington province (Ruamahanga, Waikanae, Hutt, Otaki, Manawatu, Rangitikei, Wanganui Rivers). There are none, or at best, very few (possibly only stragglers) in rivers of the Buller-Grey district - the Heaphy, Karamea, Mokihinui, Buller, Grey, Hokitika (to the north of the Paringa River where a few salmon occur) - nor in the rivers of South Westland - the Haast, Waiatoto, Okuru, Turnbull, Arawata Rivers to the south (some spawning is reported from Ellery Creek in the Arawata River system). This distribution of salmon is in large measure a product of natural dispersal from release areas. It is likely that in 70 years, salmon would have spread into all accessible, suitable rivers.

ASSUMPTION 2. SALMON COULD SPREAD NATURALLY TO ADDITIONAL RIVERS IF CONDITIONS WERE SUITABLE.

Although salmon tend naturally to home to the river of their birth a certain percentage stray (possibly several per cent). This, combined with early releases in a considerable number of rivers, has led to the population of all suitable rivers of the east coast of the South Island from about the

Clarence south to the Clutha. Recent results of salmon tagging have shown the spread of fish of Rakaia origin to rivers as far apart as the Wairau (Marlborough) and Rangitata, including the Hurunui and Waimakariri. Occasional salmon have been reported from rivers in and north of Cook Strait (Hutt, Rangitikei) but populations have never been established. It is possible that ocean current systems through Cook Strait are restricting movements and thus limiting spread and establishment. Thus occasional salmon are spreading beyond their core distribution but the core distribution is not expanding. It seems safe to assume that some factor(s) in the natural environment is(are) limiting the natural spread and wider establishment of salmon in New Zealand waters.

ASSUMPTION 3. ALTHOUGH THEY HAVE NO SALMON, ALL OR MOST OF THE RIVERS LISTED ABOVE ARE "MORE OR LESS" SUITABLE FOR THE SPAWNING, DEVELOPMENT AND EARLY GROWTH OF SALMON.

This is a highly arguable assumption. The fact that salmon do not occur in certain rivers could be taken to indicate that it is, in fact, false. However, most of the rivers mentioned above carry populations of brown trout which shows that conditions suitable for spawning and early growth of another salmonid with not too dissimilar requirements are found in these rivers. Although gravel size requirements of salmon and trout are different it nevertheless remains likely that rivers with gravels suitable for trout will also have gravels suitable for salmon spawning. The requirements of quinnat salmon are not fundamentally different from those of brown trout. Requirements for the two species overlap broadly as evidenced by both fish spawning in the same waters in various river systems in Canterbury. Differences apply primarily to details such as flow velocities and depths, gravel size, and temperature levels - they are quantitative rather than qualitative. Possibly to the north of the existing range of salmon, river temperatures are too high for long term survival of salmon populations - they may be suitable in some years but marginal or worse in others, preventing the long term establishment of populations there. It is arguable that river instability, in West Coast

rivers particularly, is preventing the long term establishment of salmon populations.

There is a small sea-run of salmon in a few West Coast rivers centred on the Paringa River. Factors limiting these populations are unstudied, but some success in enhancing the run in the Paringa has resulted from releases made by the Southern Lakes Conservancy of the Wildlife Service. On the basis of this success it could therefore be argued that the suitability of West Coast rivers for spawning, hatching and early life in the gravels and in fresh water is limiting populations there; in particular, that frequent violent flooding in West Coast rivers destroys salmon redds, where present, and also results in coarse-gravelled or bouldery river beds unsuitable for salmon spawning. The presence of landlocked salmon populations in some West Coast lakes - Mapourika, Moeraki, Paringa - shows that a spawning environment for salmon is present in some West Coast rivers which has enabled the long term survival of salmon stocks even though these may be of limited abundance. If lake stocks can persist why can sea-run stocks not develop? The critical question seems to be "Are the stocks limited by flooding in the spawning river, or by conditions at sea?" The answer is not known.

Some of the east coast rivers where there are good salmon populations have spring fed tributary systems that are cold and very stable, and which are therefore highly suitable for salmon spawning. Such streams are largely lacking in West Coast rivers. However, quite a few West Coast rivers are lake fed and should provide stable river conditions facilitating salmon spawning success. A further fact that may affect the success and viability of salmonid populations in many West Coast rivers is water acidity. Many rivers have a high content of organic materials from the forest, are stained dark brown, and have low pH, sometimes as low as 4.

If Assumptions 1, 2 and 3 are correct (and there is some doubt as regards West Coast rivers at least), it can be concluded that the distribution

of salmon is not limited by the absence of waters suitable for spawning, development, and early growth in fresh water.

There can be little doubt that this is true as regards failure of salmon to spread to the rivers of Southland - there seems little reason why there should not be salmon, for instance, in the Maitai. Possibly distribution and abundance of salmon in the rivers of North Canterbury - north of the Hurunui - and in Marlborough is limited by the instability of the rivers there.

At this point, it is appropriate to examine the northwards decline in abundance of salmon along the North Canterbury coast. Salmon are abundant in the Rakaia and Waimakariri Rivers, occur in significant but much smaller numbers in the Ashley, Hurunui, and Waiau Rivers further to the north, and apparently occur in small numbers in rivers such as the Clarence and Wairau.

It could be argued that the Clarence and Wairau are suitable for spawning development and early growth of salmon since both carry significant trout populations and the Clarence, at least, has a long stable reach below Lake Tennyson which would seem to be suitable water for salmon rearing. Further study is needed to clarify this point. Possibly, populations in the smaller rivers do not increase because these rivers are subject to more extreme flow fluctuations and because the salmon are unsuccessful in drought years.

ASSUMPTION 4. ALL THESE RIVERS ARE EQUALLY SUITABLE FOR MIGRATION TO SEA. One of the factors thought by some to limit the abundance of salmon in New Zealand is that the rivers are short and have very small estuaries, so that salmon going to sea have little time to make the transition from fresh to sea water. In this regard rivers with salmon are no better than those without them. This assumption seems to be broadly true.

If Assumptions 1 to 4 are (more or less) true, it could be argued that environmental factors in New Zealand's rivers are not a prime cause

for limiting the distribution of salmon. It would follow, then, that distribution is limited more seriously by factors related to their life at sea and their return into fresh water.

ASSUMPTION 5. SALMON HAVE NOT INCREASED THEIR RANGE BECAUSE OF LIMITATIONS IN THE MARINE ENVIRONMENT AND/OR INABILITY TO RETURN FROM THE SEA TO THE RIVERS OUTSIDE OF THEIR PRESENT RANGE.

This Assumption is a logical consequence of the preceding Assumptions 1-4.

If Assumption 5 is correct, previous attention paid by those interested in salmon ranching to the fresh water environment for development and early growth of salmon seems inappropriate and therefore a likely contributor to failure of salmon enhancement ventures. One of the critical weak points in the life cycle of salmon in New Zealand seems likely to be "return from the sea" and accordingly it is at this point that attention should be concentrated when selecting release sites.

Unfortunately, at present, very little is known about the life of salmon at sea and virtually nothing is known about environmental factors that influence either their oceanic distribution or their return to New Zealand fresh waters.

A cool ocean current (the Southland current) passes eastwards through Foveaux Strait and sweeps up the east coast of the South Island. Salmon have not spread south and west from the Otago area (by moving upstream in this current system) into the rivers of Southland. Possibly the southern range of salmon is limited by the presence and character of this ocean current. A warm current sweeps down the east coast of New Zealand and meets cooler waters derived from the south, somewhere and at varying positions, along this coast. Sometimes it is as far north as Castlepoint, at other times as far south as Kaikoura. This southern occurrence of the meeting of the cold and warm waters (the sub-tropical convergence) more or less coincides with the northern limits of the distribution of salmon. In

simple terms, salmon seem to occur off the east coast of the South Island in the area formed by -

- (a) the Canterbury coast to the west
- (b) the sub-tropical convergence to the north
- (c) the cool Southland current to the south-east.

Salmon do not seem to have been able to spread beyond this area and establish self-sustaining, sea-run populations.

The factors that influence the range and abundance of salmon in West Coast rivers are quite unknown.

The logical conclusion reached from the above assumptions and discussion is that the likelihood of success in salmon ocean ranching ventures is very much higher in areas where good populations of salmon already occur. This might seem self-evident but the location of existing installations, and plans under development to establish salmon release sites outside the existing range of salmon, indicate either that it is not self-evident to salmon development companies or that they are prepared to take substantial risks in obtaining successful returns from their releases.

It is important to re-iterate that the position reached here is dependent on a series of assumptions, any of which may be shown to be false. In the meantime it would seem that risk of failure will be minimised if further salmon release locations are sited within the existing range of salmon populations in New Zealand.

The fact that there has been a return (even though numbers are very small) of adult salmon to the installation in Waikoropupu Springs (five 2-year-olds in 1980) suggests that there may be errors in the assumptions, and priority should be given to determining which of the assumptions needs to be modified. It remains possible that the venture might succeed. It is also possible that the site is in a position providing only marginal

conditions for the survival and growth of salmon and that the returning salmon are the remnant survivors of the releases. If this is so, the future for the Waikoropupu Springs location is at best erratic, and probably poor. However, the meagre returns to Waikoropupu Springs do not indicate that the approach adopted in this discussion is wrong. What is now needed is attention to, and refinement of the assumptions made here to improve the reliability in assessing the likely success of various and specific salmon enhancement proposals.

Companies that plan to become involved in establishing sea-run stocks of salmon need to understand clearly the odds for and against success. Although there is obviously nothing sacrosanct about the assumptions that have been made, it should be understood that attempts to establish sea-run stocks beyond the existing range of the New Zealand salmon populations are, in effect, attempts to falsify one or more of these assumptions. What is of ultimate importance is that the best possible use be made of New Zealand's potentially very valuable salmon resource and of the limited capital and manpower that can be assigned to its commercial enhancement. It is important that attempts to enhance this resource should succeed, as rapidly as possible, and at the smallest possible financial outlay.

Consultation with staff of Fisheries Research Division, M.A.F., Christchurch, will allow much more detailed evaluation of proposed sites for the establishment of ocean-ranching salmon rearing and production facilities.

(ii) Selection of Rearing Localities - Site Requirements

The placement of a rearing and release location on a stream with suitable site and water attributes is of fundamental importance.

The following points do not constitute a comprehensive list of criteria for site choice and they are not all necessarily imperative, as

alternatives (i.e. less than ideal sites) can often be managed. However, if a site meets all the specifications discussed below, the programme is more likely to succeed.

Choice of site locations involves both marine and freshwater habitats. Thus before itemising freshwater requirements, the marine habitat must be touched on if proposals for ocean-ranching (or marine pen rearing) are to be considered. Data from North America suggest that if at any time during the year the sea surface (15 metres) temperature exceeds about 15<sup>0</sup>C, quinnat salmon growth is likely to be impaired and survival is likely to become marginal. As a result it seems probable that localities in the north of the South Island (from about the Clarence (east coast) north and west to the Grey) and the whole North Island are unsuitable for ocean ranching of salmon. Oceanic water temperatures in this area exceed those found, by North American experience, to be most suitable for quinnat. However, initial results of rearing salmon in sea cages in Golden Bay suggest that the fish will survive and show good growth in warmer waters.

Little is known about the effects of ocean currents on salmon distribution and migrations, especially in New Zealand, but possibly if there are major offshore currents or confused patterns, success of releases may be jeopardised.

The release site should preferably be close to the sea, so that the returning adults do not need to travel far upstream to the recapture site. The condition of returning adults declines in proportion to time in freshwater, and thus, to some extent, the distance they must travel. The presence of a large brackish lagoon at the mouth of the release river favours survival of the young fish during the transition from fresh to sea water.

Certain basic site criteria need to be met. Water quality for the freshwater rearing site is of importance. The water should not exceed

15°C, with a preferred temperature of 12.5°C. Ideally it should be saturated with oxygen, but should not contain less than 6 ppm dissolved oxygen. Highly acid waters (low pH) such as typically drain low elevation forests in New Zealand may contribute to problems of hatching, survival and growth of salmon. Ground water is sometimes initially unsuitable owing to high dissolved nitrogen levels and needs to be aerated before use. Sometimes, too, it is very low in oxygen and needs aeration for that reason.

It is preferable that the water supply to the hatchery, especially for the hatching of ova, is derived from a source which is silt-free and does not suffer flooding. Silt-laden water is very damaging both to developing ova and to young fry, smothering ova, interfering with fry feeding, damaging the gills of young fish, and contributing to susceptibility to disease.

The best source of silt-free water is a spring or spring-fed stream; in the absence of a spring source the next best is a lake. Least satisfactory, but still practical is diversion of water from a river. Gravity feed of water is preferable to pumping since pumping has high plant, maintenance and energy costs, and pumps - or power supplies - may fail at critical times. If pumping is called for an auxiliary power supply and duplicate pumping system is almost mandatory. The site should ideally have sufficient space for expansion while allowing for complete gravity feed of water supply. An adequate fall on the site to maintain sufficient flow volumes and depths is important, and future expansions and developments should be forecast with the water resource and likely flow patterns planned. Adequate year-round flow must be assured in sufficient quantity to meet the needs of the planned number of fish. The quantity of water needed varies in relation to both numbers and sizes of fish to be reared.

Where water volume is limiting, water can be treated and recycled. Recycling can also be used to increase fish raising capacity, but necessitates treatment of the water (both plant and running costs may be considerable).

Re-use of water is not ideal but does render the operation less vulnerable to changes in the volume and characteristics of the water supply and also helps to isolate the fish from external disease sources. Recycling is both successful and economic in some North American hatcheries.

Water used should be from an unpolluted source. Thus investigation of the catchment of the water source for farming, forestry, mining, and other resource-exploitation activities should be carried out. In addition, it is important that the downstream migrating fish (after release) and the returning upstream migrating adults, should not have to pass through polluted waters. Industrial pollution may cause mortalities amongst the downstream migrants, and possibly confusion amongst the returning adults by affecting their ability to home on the release stream.

For these reasons there is considerable value in obtaining some sort of control over the catchment of the supply water to be used in the hatchery. This measure enables the development of a catchment management strategy most suited to the maintenance of suitable quantities of high quality water and also guards against the discharge of pollutant effluents into the water supply.

Salmonids in New Zealand are known to be very healthy. Nevertheless wild populations of fish may harbour disease, although usually at very low levels of infection. These diseases can be the source for outbreaks of disease in fish under high density hatchery conditions and thus create disease problems in the hatchery stocks. For this reason there is an advantage in having the water supply upstream of the hatchery site devoid of all fish life, a further reason why there is some advantage in having control over the catchment of the supply water.

#### 4. SALMON FARMING ESTABLISHMENT PROCEDURES

Control of all fish and fishing activities in New Zealand, including salmon ranching ventures, lies with the Ministry of Agriculture and Fisheries

under the Fisheries Act (1908), and regulations pursuant to that Act. For salmon ranchers, there are the Freshwater Fisheries Regulations 1951 and the Freshwater Fish Farming Regulations 1972, each with various amendments. These are listed in Appendix I. Within the Ministry, legislative control over fisheries is exercised primarily by Fisheries Management Division (FMD) based in Wellington (see list of addresses in Appendix II).

Under the various regulations, FMD has the right and obligation to ensure that any proposal is properly founded, that plant design is appropriate, that effluent from the farm is properly treated so as not to detrimentally affect water quality of the receiving water, and that suitably trained and qualified personnel are involved in the operation. Control of effluent standards is under the jurisdiction of the local catchment authority, and is based on the construction and operation of settling ponds which hold effluent for a period before discharge. Details of the requirements of these ponds are obtained from FMD. At present no training courses are available for potential operators but arrangements can possibly be made for them to obtain practical experience at MAF salmon research facilities.

In the establishment of a salmon ranching venture a primary requirement is the obtaining of a fish farming licence.

In the initial stages it is proposed that this be a "preliminary licence" which gives notice of the applicant's intention to proceed and enables an evaluation of his credentials and suitability as specified by these regulations. Application for a licence is made to the Director-General, Ministry of Agriculture and Fisheries, on a form (see Appendix III) provided for the purpose.

In the original regulations (1972) it was required that the granting of a water right (under the Water and Soil Conservation Act 1967) should precede the granting of fish farming licence. Under the terms of a proposed amendment, allowance would be made for the issuing of the provisional licence prior to

the receipt of a water right. Apart from problems related to land tenure, then, the first legal step in obtaining a fish farming licence will be application to the MAF for a provisional licence. A full licence is issued at a later date when conditions stipulated by the regulations have been met. The issue of licences and their administration is under the control of FMD.

The Fisheries Research Division of MAF has no statutory responsibility with regard to the establishment of a salmon farm, but it does have an important role in advising FMD on the suitability of proposed sites and water supplies. It also has an important role with regard to allocations of salmon stock to farmers from the wild (either ripe adults, freshly water-hardened ova, eyed ova, wild fry, or smolts). Fisheries Research Division (FRD) also supplies the salmon (see below, "Allocation of salmon stock"). For these reasons discussions at an early stage with FRD officers at the Christchurch laboratory of the Division are important.

Release of fish into rivers and lakes is regulated. The Freshwater Fisheries Regulations (1951) stipulate that before a fish species is released into a water not already containing that species, the prior approval of the Director General of the MAF be obtained. This approval is likely only following discussions between the Ministry and the appropriate Acclimatisation Society.

In addition the Freshwater Fisheries Regulations (1951) require that the locally administering Acclimatisation Society gives prior approval in writing for the release of any acclimatised fish (whether already present or not) into its waters. It is the responsibility of the salmon farmer to obtain that approval.

Although primary control of the developing salmon industry does lie with the MAF, consultation with other organisations is essential throughout the early planning and development of any venture. Control of recreational

fisheries in New Zealand has been delegated by the Ministry under the Fisheries Act to the Acclimatisation Societies. They are responsible for the management and conservation of recreational fisheries resources within their defined boundaries. As many Society districts are defined by rivers, there are rivers that are under the jurisdiction of two Societies, e.g. the Rakaia is managed by North Canterbury (north side) and Ashburton (south side); the Maitai by Otago (east) and Southland (west). At times, rivers flow from one Society to another, e.g. the Rangitata, which lies entirely within the Ashburton Society district in its upper reaches but is controlled by both Ashburton and South Canterbury in its lower reaches.

Although the Societies have no legal administrative control over salmon ranching within their districts, they do have certain rights and it is important that all Acclimatisation Societies involved or affected by any proposal be consulted at the earliest possible stage of planning of a salmon ranching proposal. Approval in principle by affected Societies is likely to be a pre-condition of Ministry approval. In general, history shows that agreement over conditions applying to salmon ranching ventures between the company and Society involved has preceded the obtaining of support by the company from the Society. Therefore, regardless of the legal situation, extensive consultation between proposed salmon farmers and Acclimatisation Societies is of basic importance. The experience of Acclimatisation Society personnel and their familiarity with river systems and conditions can be of considerable assistance to prospective salmon farmers seeking sites and setting up commercial operations.

Establishment of salmon farms requires the use of large quantities of fresh water. The removal of water from a stream system (or the ground) and the discharge of water into a river system requires a water right from the appropriate Catchment Board or Regional Water Board. This right must be applied for by the water user. The granting of water rights for any purpose is open to objection by other water users who might be detrimentally affected

by the granting of such a right. Without a water right, no fish farm can operate. The local Catchment Board also has the responsibility to maintain water quality in its rivers, and thus has the right to demand certain standards in any effluent discharges from salmon farms.

Land tenure is a problem for negotiation with the landowner. This sometimes involves negotiations with the Department of Lands and Survey as the administering authority of Crown leases to high country run holders. Ownership or formal lease of the land is necessary before the granting of a fish farming licence, and an informal agreement to use land does not suffice.

In some instances, ventures have been set up in association with the discharges from hydro dams and this has required negotiations with either Electricity Division of the Ministry of Energy, or the locally administering Electric Power Board.

Other national or local government bodies may also become involved, e.g. in regard to obtaining planning approval in relation to a district planning scheme. It is conceivable that the N.Z. Forest Service may become involved as a landowner. In South Westland, the administering authority for recreational fisheries is the Wildlife Service of the Department of Internal Affairs (in lieu of an Acclimatisation Society), and consultation with this Department is then necessary.

It is obvious that a complex series of negotiations and approvals is required, with a potential for the creation of a situation where approval for any specific action or development is dependent on approvals in other areas - what has become known as a "Catch 22" situation. Accordingly it is important that discussions and negotiations be orderly and thorough.

## 5. ALLOCATION OF SALMON STOCK

To date, and at least until good returns of adult spawning salmon to commercial recapture facilities are assured, salmon stock (either spawning

adults, ova, fry or smolts) will be derived from wild salmon stocks. The management of these wild fish, which form the basis for the recreational salmon fishery has been delegated to Acclimatisation Societies by MAF under the Fisheries Act 1908. This is an additional reason why early consultation with Acclimatisation Societies is desirable.

A policy for the allocation of salmon stock to salmon farmers was approved by the Salmon Committee of the South Island Council of Acclimatisation Societies at its February 1981 meeting (see Appendix IV). This committee comprises representatives of all Societies with an active interest in the salmon fishery, plus MAF representatives. Allocations are usually discussed at the February meeting of the Committee and provision of salmon stock to new ventures is unlikely without extensive prior discussion between companies and both Ministry officials and the relevant Acclimatisation Society. Salmon farmers should lodge requests for salmon stock allocations with the Secretary of the Salmon Committee by the middle of January each year, with copies sent to Fisheries Research Division, Christchurch. Prior discussion with FRD about the source and size of the proposed allocation would undoubtedly be beneficial.

In the past all allocations of salmon stock (ova, smolts or wild fry) have been provided by FRD, from either the Silverstream Hatchery or the Glenariffe salmon trap. Ova for hatchery rearing at Silverstream have been obtained by stripping adults from a variety of sources - Winding Creek (Waimakariri River), Double Hill Flats and Highbank Power Station (Rakaia River), Deep Creek (Rangitata River) - or from returns to the Silverstream Hatchery. Some ova, and captured early outmigrant wild fry have been obtained from the Glenariffe Stream (Rakaia River). In the past, stocks from Silverstream have been supplied primarily as smolts, with smaller numbers of eyed ova. However, as a result of the February 1980 whirling disease outbreak, the Silverstream facility will rear smolts only for release into the Waimakariri River system. As a result salmon farmers must be willing to accept freshly

fertilised or eyed ova, or wild fry, and must construct facilities capable of handling such stock. Substantial costs are incurred by both FRD and Acclimatisation Societies in collecting ova or fry for salmon farmers, who can expect to be charged for their salmon stock at a rate that makes their collection economic.

Allocations of salmon to Acclimatisation Societies for salmon enhancement programmes are made by the Salmon Committee on a similar basis to allocations to commercial operations, although provisions for charging for stock may be different owing to past support of the commercial development of salmon by these Societies. These Society enhancement programmes are subject to detailed scrutiny and require backup observations that can demonstrate the success or otherwise of the release programmes.

Various of the wild salmon stocks form the foundation both for the recreational fishery and for salmon farmers. This will continue until either MAF produces sufficient salmon to provide stock beyond its own maintenance needs, and/or one or more of the commercial salmon operators does the same. There will always be limitations and uncertainties of supply. Both the Ministry and the Acclimatisation Societies see that protection of the wild stocks from over-exploitation is a primary concern since they constitute the basic stock resource for both the recreational fishery and any future commercial salmon industry, and both adopt the position that nothing should be done to jeopardise the viability of these wild stocks. Therefore the supply of salmon from wild stocks will always be limited, and in years of poor wild salmon runs, may be severely restricted. This situation occurred during 1980 when stock allocated by the Salmon Committee could not be supplied owing to a below average wild adult salmon run and requests for high allocations. The Salmon Committee cannot, therefore, guarantee to supply stock requested nor can FRD assure provision of stock tentatively allocated by the Salmon Committee.

Some steps have been taken by commercial operators to obtain salmon stock, either ripe adults or as fry, direct from wild populations. Sometimes this

has been due to a desire to obtain fish from the river on which the commercial operation is sited, sometimes to obtain increased numbers of fish in years when supplies have been limited. In all instances approval from the administering Acclimatisation Society to take and hold fish is mandatory. The Salmon Committee may require that FRD supervises these captures.

Therefore the following facts should be clearly understood:

1. The capture and retention alive of salmon from the wild by any person (other than those with special authorisation) is illegal unless the fish are captured under the conditions of an angling licence. Fish captured subject to such a licence may not be retained alive in captivity.
2. Capture of salmon in the wild for transfer to commercial salmon farms, can be done only with the approval of the appropriate Acclimatisation Society. A condition of this approval will usually be that the capture operation is under the supervision of staff of Fisheries Research Division, Ministry of Agriculture and Fisheries. It is therefore important to ensure that appropriate Divisional staff are available to carry out this supervision. This cannot be guaranteed.

Commercial operators must therefore consult with or obtain approvals from the following:

1. Fisheries Management Division - obtaining a provisional licence, approvals for site, approval of operators, design of plant including effluent treatment and disposal, and granting of a full licence.
2. Fisheries Research Division - consultation over suitability of site, design of plant, allocation of salmon stock, etc.
3. Landowner - regarding the tenure of proposed site.
4. Acclimatisation Society - regarding proposed release and (if different)

recapture sites, for general discussions regarding plans, policy and procedure and any proposals to capture wild salmon, whether adults, fry or ova.

5. Catchment Board - regarding obtaining a water right and concerning effluent standards in discharge water.
6. Salmon Committee - for allocation of salmon stock (ova, fry, smolts, etc.).

Because of the range of organisations involved it is advisable in many instances that information copies of correspondence be distributed widely amongst other appropriate organisations, in particular that FRD and the relevant Acclimatisation Society be kept well informed of formal negotiations with Fisheries Management Division.

Thus, applications for licences are submitted to the Ministry of Agriculture and Fisheries in Wellington but copies should be sent to Fisheries Research Division, Christchurch. Applications for salmon allocations should be sent to the Secretary of the Salmon Committee but copies should also go to the relevant Acclimatisation Society, Fisheries Research Division and Fisheries Management Division.

Inasmuch as salmon allocations are processed by the Salmon Committee it is advisable that copies of all relevant correspondence should be sent to the Secretary of that committee.

## 6. STAFF TRAINING

Before a licence is granted the Ministry must take into account the qualifications, previous training and experience of the applicant, to ensure that suitably qualified people have oversight of the operations. At present there are no training courses available to prospective salmon farmers and the only way appropriate experience can be obtained is by spending time

at the MAF salmon installations (at Silverstream on the Waimakariri River, and Glenariffe on the Rakaia River) or with suitably experienced personnel involved in other commercial salmon ventures. Currently there is a serious shortage of workers experienced in salmon culture and husbandry and there seems no simple rapid solution. Lists of appropriate literature can be obtained from Fisheries Research Division, Ministry of Agriculture and Fisheries, Christchurch (see Appendix V for some relevant introductory literature).

Large allocations of salmon stock to developing ventures lacking full-time experienced salmon workers are unlikely. Such ventures may possibly expect to receive token allocations with which to gain practical experience.

## 7. OPERATIONAL PROCEDURES

Since ocean ranching ventures are operating under MAF legislation but within areas under the jurisdiction of Acclimatisation Societies, collaboration with both on a continuing basis is highly desirable, if not mandatory, in all instances.

Salmon ranching involves the transport of very large numbers of salmon between Acclimatisation Society districts, with the inherent danger that, for instance, disease can be transferred. It is therefore important that relevant Acclimatisation Societies be notified of movements of fish between river systems. Release of fish into any public water requires the approval of the administering Acclimatisation Society.

The Salmon Committee of the South Island Council meets twice yearly, in February and August, just prior to the South Island Council meetings. This Committee requests from each salmon farmer a report on receipt of the salmon allocated by the Committee, growth and survival rates, numbers, dates and sizes of releases, returns of adult salmon and on general matters

related to the management and development of the salmon farm. Salmon farmers will be held accountable for the allocations of salmon stock made to them from wild populations. These reports should be sent to the host society with copies to the Secretary of the Salmon Committee and to the Scientist-in-Charge, Fisheries Research Division, Ministry of Agriculture and Fisheries, Christchurch.

At the beginning of each rearing season, salmon farmers will need to make decisions about and plan for the forthcoming season's rearing and release schedules. It would seem appropriate that Acclimatisation Societies and FRD be advised of these schedules.

It is important to be able to assess the results of salmon ranching releases. This can be done, in part, by simple monitoring of marked adults returning to the recapture site. Tagging and other marking of released fish requires permission from MAF, to avoid duplication of marking procedures and the generation of confusion. With the advent of coded wire nasal tagging it is possible and desirable to tag a proportion of the fish released.

The salmon tagging programme is extensive and requires careful planning. The technical officer in charge of the tagging team, (Co-ordinator, Salmon Tagging Committee, Fisheries Research Division, Christchurch) in collaboration with a small committee, establishes the tagging schedule and programme about May each year, and this requires detailed planning input from the salmon farmers. There is an optimal size at which to tag the fish. Accordingly it is essential that there be continuing and close liaison between salmon farmers and FRD's tagging team.

A coded wire tagging machine was purchased for FRD by the South Island Council of Acclimatisation Societies in 1977. This machine inserts a tiny metal tag about  $1\frac{1}{4}$  mm long, into the nose of small salmon, the ideal size for tagging being about 8 gm (a length of about 80 mm).

Tagging of a proportion of each salmon farm's release is important to enable evaluation of the success of the release and the degree to which

the release contributes to the run in the river of release.

The tagging machine has been in use for three years, with 143,000, 335,000 and 346,000 salmon being tagged in 1977-78, 1978-79 and 1979-80. There is only a single tagging machine and one tagging team to operate it. This imposes limits on the number of salmon that can be tagged each season. A further limitation is that the fish must be at least 2.5 gm before tagging, and can be no greater than 25 gm for the quality control device to reliably sort tagged fish from untagged fish. This means that tagging generally takes place between September and March.

It is evident from past years' experience that no more than about 350,000 salmon can be tagged in any one season, with available tagging staff. Operational and planning procedures for salmon tagging are discussed in Appendix VI.

There will at time, be releases of large numbers of salmon from the hatcheries into river systems under the jurisdiction of Acclimatisation Societies. These releases will have some impact on the ecology of the rivers' systems and again, it is appropriate that prior advice of the releases, in writing, be given to the appropriate Acclimatisation Society.

In general, and insofar as it is compatible with the salmon rancher's rights to confidentiality, full information on the plans, activities and results of salmon ranching ventures should be made available to individual Acclimatisation Societies, the Salmon Committee, Fisheries Research Division and Fisheries Management Division.

## 8. DISEASE

The Fish Farming Regulations (1972) require a licensed fish farmer to notify the presence of diseases specified in the regulations, the information to be supplied to the Director General, Ministry of Agriculture and Fisheries, Wellington.

As a result of the whirling disease outbreak at the Ministry's Silverstream Hatchery in February 1980, certain fish diseases have been gazetted as notifiable diseases under the Animals Act (1967). Ministry of Agriculture and Fisheries Livestock Officers now have right of entry to any fish hatchery or salmon farm at any time. Should they suspect disease they are required to check with appropriately qualified fish pathologists and to supply specimens for examination. If disease is confirmed, the relevant Acclimatisation Society is notified and the hatchery may be quarantined or closed and the stock destroyed.

#### 9. POLICY WITH REGARD TO SALMON FARMING

Policy with regard to the ocean ranching of salmon has been developed in consultation with Acclimatisation Societies and other interested parties, and was outlined by the Minister of Fisheries when opening the FRD Salmon Symposium in Christchurch, August 1980 (see Appendix VII).

One matter of particular relevance to the development of ocean ranching is the number of commercial salmon farms on any river. A Ministerial paper discussed this question in 1975 and specified that there should be only one farm per river, at least until the ecological effects of such an installation are understood. This decision pre-dated the acquisition of the nose tagging machine and thus the ability to adequately monitor the effects of large salmon releases. In spite of this acquisition there remains some feeling that in the meantime a limitation on the number of farms per river is desirable, and the Freshwater Fisheries Advisory Council continues to support this position. This effectively limits the expansion of salmon farming in the immediate future.

The 38th meeting of the Freshwater Fisheries Advisory Council (Rotorua 1980) supported the establishment of a moratorium on growth of the salmon ranching industry owing to shortages in the supply of salmon ova to salmon

farms, and until this problem has a long term solution.

Acclimatisation Societies have in the past made it clear that their support for commercial farming is based on the prospect that large releases of salmon from farm to sea will result in the return from the sea of increased numbers of adult salmon that are accessible to capture by anglers. The Societies have made it quite clear that they are opposed to the raising for sale of salmon derived from wild populations, either in freshwater hatchery raceways or sea pens. They expect fish derived from wild stocks to be released to sea, offering anglers an opportunity to catch them when they return as adults. They have also indicated a distinct preference for commercial recapture sites that are well upstream. This creates a conflict for the commercial operator inasmuch as the closer the recapture site is to the sea, the better is the quality of the fish caught after returning from the sea.

These questions of Acclimatisation Society policy need to be understood clearly by prospective salmon farmers and explored during early discussions with the Societies.

APPENDIX I. LEGISLATION AND REGULATIONS

Fisheries Act 1908. (Consolidated with amendments 1977.)

Freshwater Fisheries Regulations 1951. (Consolidated with amendments to 1976.) Amendments 14 (1976), 15 (1977) and 16 (1980).

Freshwater Fish Farming Regulations 1972.  
Amendments 1 (1973) and 2 (1980).

Quinnat Salmon Regulations 1963.  
Amendment 1 (1975).

Water and Soil Conservation Act 1967.

Animals Act 1967.

APPENDIX II. CONTACTS AND ADDRESS

Director General Ministry of Agriculture and Fisheries Private Bag WELLINGTON	Telephone WN. 720-367
Director Fisheries Management Division Ministry of Agriculture and Fisheries Private Bag WELLINGTON	Telephone WN. 720-367
Director Fisheries Research Division Ministry of Agriculture and Fisheries P.O. Box 297 WELLINGTON	Telephone WN. 861-029
Scientist-in-Charge Fisheries Research Division Ministry of Agriculture and Fisheries P.O. Box 8324, Riccarton CHRISTCHURCH	Telephone CH. 488-902
Officer-in-Charge Silverstream Hatchery Fisheries Research Division Ministry of Agriculture and Fisheries R.D.2 KAIAPOI	Telephone KI. 7960
Officer-in-Charge Salmon Trap Fisheries Research Division Ministry of Agriculture and Fisheries Post Office METHVEN	Telephone LCR. 815
Secretary Salmon Committee South Island Council of Acclimatisation Societies P.O. Box 113 ASHBURTON	Telephone AR. 6424
Secretary Ashburton Acclimatisation Society P.O. Box 113 ASHBURTON	Telephone AR. 4113
Secretary Marlborough Acclimatisation Society P.O. Box 105 BLENHEIM	Telephone BW. 4478
Secretary Nelson Acclimatisation Society P.O. Box 190 NELSON	Telephone NN. 84-894

Chief Executive Officer  
North Canterbury Acclimatisation Society  
61 Bealey Avenue  
CHRISTCHURCH

Telephone CH. 69-191

Secretary Manager  
Otago Acclimatisation Society  
P.O. Box 76  
DUNEDIN

Telephone DN. 779-076

Secretary  
South Canterbury Acclimatisation Society  
P.O. Box 40  
TIMARU

Telephone TU. 4938

Secretary  
Southland Acclimatisation Society  
P.O. Box 844  
INVERCARGILL

Telephone IN. 86-179

Secretary  
Waitaki Valley Acclimatisation Society  
P.O. Box 167  
OAMARU

Telephone OU. 37-991

Secretary  
West Coast Acclimatisation Society  
P.O. Box 105  
GREYMOUTH

Telephone GM. 5403

Secretary  
Westland Acclimatisation Society  
P.O. Box 179  
HOKITIKA

Telephone HK. 9075

Conservator of Wildlife  
Wildlife Service  
Department of Internal Affairs  
P.O. Box 11  
QUEENSTOWN

Telephone Q. 125

Secretary  
N.Z. Salmon Farmers Association  
10b Grange Street  
CHRISTCHURCH

Telephone CH. 325-759

Co-ordinator  
Salmon Tagging Programme  
Fisheries Research Division  
Ministry of Agriculture and Fisheries  
P.O. Box 8324,  
Riccarton  
CHRISTCHURCH

Telephone CH. 488-902

APPENDIX III - APPLICATION FOR A FISH FARM LICENCE UNDER THE FRESHWATER  
FISH FARMING REGULATIONS 1972

To: Director-General  
Ministry of Agriculture and Fisheries  
Fisheries Management Division  
Private Bag  
WELLINGTON

Full name address, and occupation of applicant I, .....

Maximum term is 14 years apply for a fish-farm licence for a term of ..... years

Name fish To farm .....

Describe area so it can be readily identified The farm will be located at .....

Address where notices, correspondence, etc., are to be sent My address for service is: .....

Dated this ..... day of ..... 19.....

Signature of Applicant.....

Date received: .....  
(office use only)

Accompanying this application are the following:

Evidence giving the applicant right to occupy the area of the proposed fish farm.

Evidence that all rights, licences, and other authorities authorising the applicant to draw and return water into any lake, river, stream, or the sea and to occupy the foreshore have been granted and are in force. \*

Plans in duplicate showing:

- (i) The location of farm and associated premises
- (ii) The layout of ponds and buildings
- (iii) Intake and outlet structures
- (iv) Source of water to be used, the flow pattern of water through the fish farm and the location of outflows.

Description of the means any fish offal is to be disposed of by the licensee.

The qualifications, previous training and experience of the applicant and, if the farm is to be managed, the qualifications, previous training and experience of the manager.

\* Not required for a provisional licence.

APPENDIX IV - ALLOCATION OF SALMON STOCK TO SALMON FARMERS FOR OCEAN RANCHING. POLICY ADOPTED BY SALMON COMMITTEE OF COUNCIL OF SOUTH ISLAND ACCLIMATISATION SOCIETIES, FEBRUARY 1981.

Government policy is that ocean ranching of salmon should be fostered provided that recreational interests are protected. At present (March 1981) five salmon farming companies receive allocations from the Salmon Committee.

The thrust of expansion of commercial salmon farming is in the field of ocean ranching. Despite this, Bubbling Springs Salmon Company has approval to raise 60,000 salmon to pan-size, in freshwater, for sale, to enable a cash flow to support efforts to establish a sea-run of salmon. This is a practice to which the South Island Council takes exception, as the stock reared to pan-size for sale are derived directly from wild salmon populations. The agreement to condone the raising of such fish to pan-size for sale derives from a meeting between the Minister of Fisheries, Fisheries Research Division and the Executive of the Council of South Island Acclimatisation Societies. At this meeting the Minister agreed that before any further raising of salmon to pan-size is approved, the question would again be discussed with the Executive of the South Island Council.

The Salmon Committee of the South Island Council agreed to condone experiments conducted by Bubbling Springs Salmon Farm at rearing salmon to adulthood in sea pens, to provide a brood stock, and to thereby free the salmon farmer from dependence on wild stocks. An allocation of salmon to Bubbling Springs Salmon Company in 1979 for raising in sea pens was approved by the Salmon Committee but rejected in 1980 and 1981. The results of the experiments at rearing salmon to adult size are still awaited. This programme is not seen by the Salmon Committee as designed to produce salmon for sale, although this may be an eventual outcome of salmon farming developments when the ocean ranching of salmon is successful and salmon farmers are able to generate more ova supplies than they require for ocean

ranching purposes. At present, rearing of salmon in sea cages is not covered by legislation and amendments to the Marine Farming Act (1971) are required. The Bubbling Springs Salmon Company activities are seen as experimental.

Ocean ranching of salmon proceeds within several constraints, as outlined in a policy for salmon farming approved by MAF in December 1980 (see Appendix VII).

A major constraint limiting the development of commercial salmon farming is the scarcity of salmon stock to supply farms. In June 1980 the Freshwater Fisheries Advisory Council recommended that there be no further expansion of salmon farming while the shortage of salmon stock persisted. This recommendation was endorsed by MAF officers and has been forwarded to the Minister of Fisheries for his consideration.

The following five companies currently receive salmon allocations from the Salmon Committee:

- (1) Bubbling Springs Salmon Company, Takaka River.
- (2) Hurunui Salmon Company, Hurunui River.
- (3) Tasman Salmon Company, Hokitika River.
- (4) South Pacific Salmon Company, Rakaia River.
- (5) ICI/Watties Salmon Development Project, Waitaki and Clutha Rivers.

At this point, allocations of salmon will be limited to the above organisations and are likely to remain limited to them until some success is achieved and some, at least, of the above become self-supporting.

Reasonable efforts should be made to see that these farms are adequately stocked with salmon.

To facilitate the orderly approval and supply of salmon stock to salmon farmers some changes in approach are needed. The present system of variable ova allocations made each year by the Salmon Committee has caused difficulties

for all concerned - MAF, the Salmon Committee and salmon farmers. The system needs to be modified.

It is suggested that a ceiling target of 500,000 stock units should be allocated to each farmer. MAF will take responsibility for organising and managing the procurement of these stock and will work towards the target in co-operation with the Acclimatisation Societies and the Salmon Farmers Association.

On the basis of 500,000 per farm, and with five companies to be supplied, about 3 million stock units are required. This figure allows for infertility, and losses in handling, transit, and eyeing (at Silverstream). If the supply is to be as eggs about 630 female salmon will be required and the same number of males. These are in addition to MAF requirements for research purposes.

It is not suggested that this number of stock units will be obtainable every year, nor even in most years. But it provides a target figure to aim at and a sound basis for planning.

Salmon ranchers prefer to receive salmon stock as ova. Nevertheless, MAF believes that a major part of the early fry outmigration does not contribute to adult returns and should be utilised, particularly if insufficient eggs were obtained earlier in the season. Ideally stock should be obtained from the river on which the farm is sited. In some instances this is impossible (Takaka, Hokitika) and in others may be difficult (e.g. Clutha), but this should be borne in mind in planning. Where the stock cannot be thus obtained, the sources of ova will be primarily Winding Creek (Waimakariri), Glenariffe Stream, Highbank tailrace (Rakaia) and Deep Stream (Mesopotamia-Rangitata).

MAF will endeavour to supply ova to salmon farmers, either freshly fertilised or eyed (after consultation with recipient farmer). Shortfalls in ova supply will be made up, insofar as is possible, by supply of early outmigrant fry. Sources of fry will be primarily Double Hill Flats Stream

and Hydra Waters (Rakaia). The capture of all salmon stock, whether adults for ova, or fry for rearing will be either carried out by MAF or under MAF supervision and oversight with due regard for Acclimatisation Society statutory functions and responsibilities. This oversight does not mean that MAF staff will be on location at the capture site at all times.

With an "average" run into the three main river systems, the following numbers of females could be obtained, if necessary:

Waimakariri River Winding Creek	150
Rakaia River Glenariffe Stream	250
Rangitata River Highbank	100
Rangitata River Deep Stream	150
Hurunui River South Branch and Sisters Stream	120
	<hr/>
TOTAL	770
	<hr/>

This would yield more than the requisite numbers of ova to supply 500,000 per farm.

Usually there is an excess of males over females. Certainly it is rare to have a shortage of males. Therefore, if the numbers of females listed above are taken, no damage to the runs should result by taking the same number of males.

Procedure for obtaining ova will be as follows:

- (1) MAF will trap Winding Creek, Glenariffe, Highbank and (with the assistance of Ashburton Acclimatisation Society) Deep Stream, for adult salmon for ova supply. If numbers entering warrant, some adults could be obtained also from Double Hills Flats.
- (2) South Pacific Salmon are constructing a trap in the Coleridge Power Station tail race to trap salmon returning from their releases. Wild salmon also enter this tail race and are likely to be trapped. These

form a source of supply to this company, with approval of North Canterbury Acclimatisation Society. Shortfall will be met from other sources.

- (3) With approval from North Canterbury Acclimatisation Society and with FRD oversight, Hurunui Salmon Company will trap migrating adult salmon in the South Branch of the Hurunui River, where there may be a substantial run, but where river instability leads to heavy losses and very poor survival. Salmon entering the Sisters Stream will also be trapped. Shortfall will be met from other rivers.
- (4) ICI/Watties will continue to endeavour to capture salmon from the Waitaki and Clutha Rivers, subject to approval from Waitaki Valley and Otago Acclimatisation Societies.
- (5) If there are insufficient ova to meet allocation, an endeavour will be made to meet the shortfall by capture of early outmigrant fry from the Hydra Waters, Double Hill Flats (Rakaia River) and other suitable streams.

The fry capture programmes will be planned, carried out and financed by the salmon farmers, but under the direction and oversight of MAF.

APPENDIX V.    INTRODUCTORY LITERATURE

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APPENDIX VI.      RECOMMENDATIONS FOR THE QUINNAT SALMON TAGGING AND  
RECOVERY PROGRAMME

by

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It is necessary to take stock of the salmon tag/recovery programme and, in particular, the total number of smolts that can be tagged in one season by one team using one tagging machine.

From the 1978 brood year 335,000 smolts were tagged during the period 15 September 1978 to 14 March 1979. This six-month limit is dictated by the time the fish take to reach a taggable size (at least 2.5 g and for best efficiency 8 g average weight) and the size limit of the machine (the Quality Control Device does not separate tagged from untagged fish efficiently at an average weight exceeding 25 g.) .

Tagging the fish is a relatively costly process, the cost being met by FRD.

A conservative estimate of cost for the six-month's tagging (1979-80) including wages, overtime, camping and travelling allowances, vehicle mileage, and the cost of tags amounted to \$23,500. This does not take into account backup, such as head depots, equipment, pamphlets and posters, salmon carcass recovery trips into spawning streams, personnel to man traps and replacement parts for the tagging unit.

Therefore any decision to begin a protracted tagging project should not be taken lightly. It is with the above costs in mind that the co-ordinator considers the following should be followed before a tagging project is implemented.

A project supervisor must be appointed at the outset and he will provide:

1. A detailed objective containing the following points:
  - (a) The reason for marked salmon releases, e.g. enhancement, induced run, restoration of salmon run after flooding, abstraction or obstruction at mouth, etc.
  - (b) The duration of the tagging - whether short term (one or two years) for such projects as recovery of stocks after flooding, or long term (three years or more) as in the case of developing an induced run.
  - (c) The estimated capacity of the stream at the release location with regard to holding smolts and for spawning of returning adults.
2. A project description which includes:
  - (a) The anticipated origin of the smolts - Silverstream, Glenariffe, etc.
  - (b) The total number of smolts to be released.
  - (c) The suggested locality and timing of tagging.
  - (d) The proposed size and number of each size class requiring tagging.
  - (e) A description of the release location.
  - (f) The manpower available to collect returning, marked fish in the spawning streams for the subsequent three years.
  - (g) The agency who will pay for the cost of raising the fish to smolt size, the tags and transportation.

At this stage the project supervisor and FRD will evaluate the project. Once agreement is reached the project will be considered, together with others, by the Tagging Co-ordinating Committee where a timetable will be made up for the season. Requests for tagging should be submitted to the Co-ordinator of the tagging programme.

3. Data on Fish Released:

- (a) The mortality of tagged and untagged fish up to release, including transfer.
- (b) The size of tagged fish at release, plus scale samples taken just before release and covering the size range of the smolts (a sample of 50 smolts). The scales should be scraped from a small area on the side of the fish and inserted in a scale envelope that will be supplied by FRD.
- (c) The actual date and place of release.
- (d) The river conditions - colour, height above or below normal, temperature and water chemistry (pH, turbidity).
- (e) Any other information which may be helpful for future projects (e.g. smolt behaviour after release).

The detailed project description (for example, see below) should be forwarded to the Co-ordinator by the end of February each year so that an evaluation can be made and a timetable can be prepared.

Orders for tags require at least three months' notice and all coded wire tags will be held by the Co-ordinator.

Although estimates of tag returns under New Zealand conditions are not yet available, results to date and from the Canadian literature indicate that returns tend to be between 0.1% and 1%. This suggests that a minimum of 10,000 smolts should be tagged with one code in order to obtain a return of 10-100 adults. Projects which involve tagging less than 10,000 smolts will be considered by the Committee where special circumstances apply.

Examples of project proposals and a completed tagging record sheet follow:

SAMPLE PROGRAMME.Example (a)

Programme Fisheries Research Division, Ministry of Agriculture and

Originator: Fisheries, Christchurch.

Objective: To compare the returns of smolts released in the upper and lower Rakaia River. By releasing smolts in the Rakaia lagoon and at Glenariffe simultaneously the effects of predation in the main river can be evaluated.

This investigation will be short term and will be carried out over two consecutive years.

The estimated capacity to hold smolts would be far in excess of the intended release of 25,000 in March.

Origin: Fry caught in the Glenariffe trap and raised in the Glenariffe raceways.

Description: 50,000 fry will be fed in the raceways until they reach an average weight of 8 g. These smolts will be divided into two groups of 25,000 and each batch tagged with a separate code. After tagging the smolts will be held at Glenariffe until February 1980 when one batch will be released. The remaining 25,000 will be taken by transporter to the mouth of the Rakaia River and released at the boat ramp on the north side of the lagoon.

Timetable: Tagging can be carried out as soon as possible after the average weight of 8 g has been attained (early January). The exact release date will depend on river conditions but should not be later than the end of February.

Tag Recovery: Tagged adults will be recovered by the Head Depots, the Glenariffe Trap and carcass recovery teams in the spawning streams

of the Rakaia River. Carcass recovery will occupy a four-man team for eighteen days over a period of three years.

Example (b)

Programme Bubbling Springs Salmon Company.

Originator:

Objective: To evaluate the returns from tagged smolts released from the Bubbling Springs Salmon Farm, Takaka, and to determine if a significant number stray into other South Island rivers.

It is the objective of the programme to induce a run of salmon back to the Takaka River to provide brood stock to obviate the necessity of flying ova or fry from Glenariffe and also to begin ocean ranching on a commercial scale.

This is a long term project and a minimum of three years' tagging is required. The capability of the Takaka River and Golden Bay to maintain smolts in a seemingly adverse temperature range has yet to be determined.

Origin: 250,000 outmigrant fry will be caught by FRD staff in the Glenariffe trap and flown to Takaka where they will be raised in raceways at the Bubbling Springs salmon farm.

Description: The fry will be raised to an average weight of 20 g and released from the farm into the Takaka River. Returning adults will be used as brood fish or sold.

Timetable: Tagging will be carried out as soon as possible after the average weight of 8 g has been attained (mid-December). 25,000 smolts will be tagged and released together with the unmarked fish in March when they have reached 20 g and when the river conditions and weather are most suitable.

Tag Recovery: Adults will be recovered at the farm, at Head Depots and by carcass recovery in spawning streams in Golden Bay by staff of the Bubbling Springs Salmon Farm. Marked fish will be recovered in other rivers by staff from FRD and Acclimatisation Societies or Salmon Anglers Association.

Costs: All costs of transfer of fish, tags and the actual tagging will be paid by Bubbling Springs Salmon Farm.

QUINNAT SMOLT TAGGING FORM

CODE 163/43/2 EXPERIMENT Rocky Creek Salmon Co. BROOD YEAR 1980  
 PROJECT SUPERVISOR John Smith MARKING SITE Rocky Creek Salmon Farm  
 NO. OF TAGS REQUIRED 25,000 PROVISIONAL MARKING DATES 7-11.12.80

Date Marked	Total Tags Used	Mortality		Total Marked Fish	Tag Retention Test			Estimated tag loss (AR only)	Total tagged fish	No. fish released unmarked
		No.	%		No Tested	Lost Tag	%			
7.12.80	5,966	28	0.47	5,938						
8.12.80	5,556	41	0.74	5,515	128	Nil	0	Nil	180,000	
9.12.80	6,251	1	0.02	6,250						
10.12.80	6,621	23	0.35	6,598						
11.12.80	2,304	10	0.43	2,294						
Totals	26,698	93	0.35	26,595				Nil	26,595	
Transfer Mortality		3	0.36	26,592				Nil	26,592	
Final Release Numbers								Nil	26,592	180,000

RELEASE DATA

DATE 20.2.81 LOCATION Rocky Creek, Milton RIVER CONDITIONS Clear  
 WATER TEMP. River 12°C WATER CHEMISTRY ETC. \_\_\_\_\_  
 AVERAGE WEIGHT AT RELEASE 20 gm

APPENDIX VII

Ministry of Agriculture and Fisheries

P O L I C Y   S T A T E M E N T

Date: 12.12.80   Review at: 25.7.82

OCEAN-RANCHING OF QUINNAT SALMONSalmon Ranching:Major Goals

- \* The primary goal is to support the enhancement of salmon stocks in the South Island river systems and thereby improve the recreational fishery.
- \* The primary means of achieving salmon enhancement are:
  - (a) To avoid wastage of salmon fry and to release artificially-raised juvenile salmon, in co-operation with acclimatisation societies;
  - (b) To help maintain an aquatic environment suitable for fish populations; and
  - (c) To promote ocean ranching of quinnat salmon, within the guidelines of stated policy (Potential profitability is essential if private enterprise is to accept this role).
- \* Anticipated consequential goals associated with profitable salmon ranching are:
  - (a) Substantial export earnings; and
  - (b) Reduced dependence on imported salmon products.
- \* Protection of recreational interests : In encouraging the rational commercial development of the ocean-ranching

quinnat salmon fishery, every endeavour will be made to:

- (a) Attempt to prevent or minimise effects of activities that may damage the existing freshwater recreational fisheries resource.
- (b) Ensure the existing resources' availability to the angler is maintained and enhanced.
- (c) Ensure that no management strategies are undertaken that will endanger the long term viability of the trout and salmon fisheries.

Ocean Ranching:

- \* Ocean ranching of salmon means the hatching and release of smolts from a fish farm into rivers to grow and mature at sea and return to the fish farm for harvesting or to another authorised place for food and ova production. There shall be no restriction on the taking by anglers of the returning salmon except in the immediate vicinity of the fish farm in accord with the provisions of fisheries legislation.

Consultations:

- \* Consultation between the Ministry of Agriculture and Fisheries, Department of Internal Affairs, New Zealand Fishing Industry Board and Acclimatisation Societies movement will be established and maintained.

This policy was determined at a meeting of the Freshwater Fisheries Advisory Council at Rotorua on 13 June 1980 with the Salmon Farmers' Association, the Salmon Anglers' Association and the Fishing Industry Board attending as observers. The policy proposals, with minor alterations were submitted to the Minister of Fisheries and adopted on 25 July 1980.

Development  
Proposals:

- \* In considering development proposals, decisions should take into account:
  - (a) The need for the ocean ranching applicant to obtain all the initial legal authorities to commence the planning and experimental phase.
  - (b) Before the issue of an ocean ranching licence the applicant must be able to demonstrate he has the ability and financial resources to support the biological and economic viability of the commercial development for a minimum licence period of 6 years.
  - (c) That for approved proposals where ova must be supplied from natural runs, approvals will generally be for the shortest period necessary to establish the viability of the farm for ocean ranching purposes, normally for a maximum of 6 years.
  - (d) That the pond raising of salmon for sale or use on the farm will not be authorised under any circumstances except for the initial cycle of operations at Bubbling Springs Salmon Farm, Takaka, concluding no later than 1985.
  - (e) That where there is a conflict of interests between commercial operators in the development of a salmon fishery, support will be given to proposals which show the greatest benefit to the sports' fishery.
  - (f) That to foster the more widespread distribution of salmon, developments will be encouraged for rivers so long as other sport fisheries are not endangered.

(g) That in the initial stages it is considered necessary to limit the number of salmon ranching developments in any one catchment.

(Without such restrictions, monitoring of the effect of any new installation would be difficult and furthermore it would be undesirable to encourage too many developments until adequate supplies of ova are assured.)

(h) All applications and proposals to establish ocean ranching salmon farms received by the Ministry of Agriculture and Fisheries shall be notified, in confidence, to the appropriate Acclimatisation Societies for their comments before a provisional licence is issued. Any comments made to the Ministry will not prejudice any formal legal objection proceedings as the applicant proceeds with the licensing formalities.

(i) Within the above constraints, developments will be encouraged.

Specific

Provisions:

Supply of Ova:

- \* The obtaining and supply of ova from districts where natural runs of salmon exist shall remain under the overall control of the Ministry of Agriculture and Fisheries in consultation with the Acclimatisation Societies movement or the Department of Internal Affairs and in particular the South Island Salmon Committee.

The Director-General of the Ministry of Agriculture and Fisheries will not approve the transfer of salmon (including ova) between salmon farms without consultation with and having regard to the functions and responsibilities of

the Acclimatisation Societies movement.

Ova surplus to the needs of a salmon farm shall not be destroyed by that farmer except with the approval or under the control of the Director-General but must be offered for sale or disposed of to other farmers or the Acclimatisation Societies movement.

Release of  
Fish:

- \* Commercial hatcheries shall have the right to release live fish from the water specified in their licence into the receiving waters specified in their licence.

Commercial hatcheries shall mark fish prior to release into waters in accordance with the method and in quantities approved by the Ministry.

Capture of  
Fish:

- \* Provision will be made within fisheries legislation to afford sufficient protection from angling to returning salmon in the proximity of the hatchery authorised in the licence. This protected area to be decided in consultation with the local Acclimatisation Societies or Department of Internal Affairs as appropriate.

There shall be no commercial harvesting of salmon other than the hatchery or the specified release point or at other points specified after consultation with the Acclimatisation Societies concerned.

The Ministry will exercise its powers under the Fisheries Act 1908 to impose restrictions on non-angling fishing methods from January to April to safeguard the return of salmon to authorised capture sites after consultation with the Acclimatisation Societies.

The Ministry will pursue methods to protect salmon at sea from deliberate capture utilising the best management methods available.

Marketing:

- \* Salmon must not be sold in any form unless the source of the salmon can be verified as originating from authorised farmers. The onus of providing such proof shall be on both the seller and the purchaser.

In the marketing of salmon due regard will be given to the necessity for controlling disease and preventing its spread through the New Zealand fishery.

Procedures:

- \* To facilitate the granting of an operating licence provision will be made for the issue of a provisional licence, without authority to sell. This should assist the applicant in purchasing a hatchery site and obtaining water rights and will enable the Ministry to rationalise development.

After consultation with the Acclimatisation Societies, the issue of such a licence will enable the applicant to proceed with the requirements laid down by the Freshwater Fish Farming Regulations for obtaining a permanent licence.

The sequence of events to gain a salmon ranching licence will be made available in summarised form.

The Ministry will continue to ensure that provision is made for sporting and commercial interests to have a direct involvement in the formulation of policy to control the commercial salmon fishery. This will include Acclimatisation Societies and the Department of Internal Affairs as local management organisations, representation from

the ocean ranching operators and other appropriate commercial fishing organisations.