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Salmon farming in New Zealand

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ABSTRACT

Salmon farming began in New Zealand in 1976 with the introduction of ocean ranching. With this method of aquaculture, juvenile salmon are reared in freshwater and then released to the sea where they grow and subsequently return as adults at 2, 3 or 4 years of age to the freshwater release point. Two other methods of culture are also being practised, sea cage rearing and freshwater pond culture. With these 2 methods the salmon are reared to market size while fed an artificial diet. The increased rearing costs of these 2 methods of culture is offset by the higher survival of juvenile salmon to market size compared with ocean ranching. With ocean ranching 1-2% survival is considered the minimum necessary for a successful operation while returns of over 3% have been received at some hatcheries.

Salmon production has increased from about 200 t in 1984-85 season (October to March) to 712 t in 1986-87. Exports in 1986-87 were approximately 353 t valued at \$NZ4 million.

Keywords Salmon farming; ocean ranching; sea cage rearing; freshwater pond rearing.

INTRODUCTION

Commercial salmon farming in New Zealand started in 1976 with the introduction of ocean ranching. There are now 34 operating farms practising 3 methods of culture: ocean ranching, sea cage culture and freshwater pond rearing. The development of salmon farming in New Zealand has created considerable public interest, particularly with the listing on the stock exchange of 4 companies engaged in salmon farming. The purpose of this paper is to describe the development of salmon farming in New Zealand, and the present status and potential of the industry.

HISTORY

There are 3 species of salmon present in New Zealand, all introduced from the Northern Hemisphere. There are 2 species of Pacific salmon, the quinnat (chinook) salmon (*Oncorhynchus tshawytscha*) and the sockeye salmon (*O. nerka*), and the Atlantic salmon (*Salmo salar*).

Quinnat and sockeye salmon were introduced in 1901 from North America by the then Marine Department. Fish were raised and released from a hatchery on the Hakataramea River, a tributary to the Waitaki River. The quinnat salmon were able to establish self-sustaining sea-run populations in rivers along the east coast of the South Island. Its natural range now extends from the Waiau River in the north, to the Clutha River in the South and has become an important recreational species. There are also small sea-run populations in West Coast South Island rivers.

Sockeye salmon failed to establish a sea-run and became voluntarily lake limited, completing their

entire life cycle in fresh water. Likewise Atlantic salmon, which were introduced from a number of locations in North America and Europe, also failed to establish a sea-run and similarly became voluntarily lake limited. Atlantic salmon are now reduced to relic population in Lake Te Anau.

Originally brought to New Zealand to provide for a commercial fishery, quinnat salmon for many years remained the preserve of the angler. Commercial netting of salmon was permitted in some east coast rivers from 1924, but only small quantities were taken and netting was discontinued in 1952. At the time netting was allowed, anglers holding a trout licence were also allowed to sell any salmon caught, but this too was discontinued in 1951. From 1952 fish were salvaged from the Highbank Power Station (Rakaia River) for sale by the acclimatisation societies, but this ceased in 1960 when a change in the station's operating procedures prevented capture.

Until recently, therefore, the commercial exploitation of salmon in New Zealand has been limited. In 1976 a new phase of development began with the introduction of ocean ranching.

FARMING METHODS

Ocean Ranching

Ocean ranching entails the rearing in freshwater of juvenile salmon in raceways or ponds and their subsequent release into a river or the sea after approximately 6 to 12 months. At sea the fish feed and grow to adult size before returning to freshwater at 2, 3 or 4 years of age. Size ranges from less than 1kg for a small 2 year old, to approximately 40kg for a large 4 year old. The average weight varies from

year to year depending on rearing conditions in the ocean. The number, age and size at which fish return also depends on the time and size at which the juveniles were released.

During the period of rearing at the farm, the juvenile fish become imprinted with the odour of the rearing water and the majority of returning adults are able to home on the water outfall.

Ocean ranching has developed into 2 types of operation; upstream broodstock hatcheries and coastal release and recapture facilities. Ocean ranching was permitted on the basis that it would enhance the recreational fishery and anglers would be able to catch returning salmon as they made their way upriver. However hatcheries were located well upriver near the spawning grounds and the returning salmon were only suitable for broodstock purposes. The flesh quality of these fish is such that the majority are not of marketable quality.

Coastal release and recapture sites have been developed recently to harvest returning salmon in prime market condition. Eggs or juveniles are transferred from upstream broodstock hatcheries and reared at freshwater sites adjacent to the sea or an estuary. The fish are released directly into the sea or estuary, and return directly to these sites in prime market condition similar to salmon entering rivers from the ocean.

There are currently 10 ocean ranching farms, 2 of which are coastal sites. A further 5 coastal release and recapture operations are at various stages of planning and development. The first returns of marketable fish to coastal recapture sites were received in 1986 when approximately 10,000 2-year-old fish returned from a release of 1.6 million juveniles. Approximately 12,000 fish returned in 1987.

Hatchery releases of salmon have increased substantially over the past 3 years, from 0.9 million in 1983 to 6.0 million in 1986. Returns of hatchery salmon to freshwater have increased from less than 100 in 1979 to approximately 23,000 in 1986. These returns have resulted in considerable enhancement of the recreational fishery.

The percentage return of fish released is the critical factor in determining the success of ocean ranching. It is generally accepted that returns of 1-2% are required to be economically successful. To date some returns of over 3% have been received to some hatcheries. This has been achieved by releasing large fish, over 45g, and 6 to 12 months of age. Generally fish are released between March and August, depending on the site. The development of a release technology for New Zealand conditions has been undertaken at the Glenariffe Salmon Research Station on the upper Rakaia River, operated by the Ministry of Agriculture and Fisheries.

Although ocean ranching has produced good returns of fish to freshwater the production of

market quality fish to date has been small. It is not possible to make accurate predictions about future production because returns to different sites cannot be guaranteed. Nevertheless ocean ranching has the potential to produce large numbers of fish.

Sea Cage Culture

Sea cage culture involves the transfer of juvenile salmon from freshwater to sea cages where they are fed an artificial diet and grown to market size. The feed is a dry pellet containing fish meal as the protein source, a vitamin mix, trace elements and a binder. Food conversion is about 1.5:1 (dry food weight:wet fish weight). Optimum market size is about 3 kg, which is obtained after approximately 24 months in seawater.

Fish are transferred to the sea cages between November and May, depending on the location of the farm and the water temperature. To impart the red colour to the flesh, which is characteristic of ocean ranching and wild salmon, the fish in the sea cages are fed a colouring agent, carophyll red (astaxanthin) or carophyll pink (cantaxanthin). The pigment is added to the food about 3 months before harvest at a rate of 600-1000 g/t food for carophyll pink and 500 g/t food for carophyll red.

There are currently 10 sea cage complexes, located in the Marlborough Sounds, Akaroa Harbour and Stewart Island. Each farm consists of a net or a series of nets suspended from a floating platform. The cubic capacity of the nets ranges from 250 to 8000 m³.

Another method of culture using seawater, is to pump water into a land based site. There is currently 1 pumped seawater site in Marlborough, and at least 1 other is under consideration.

Freshwater Pond Rearing

As with sea cage culture, fish are grown to market size in captivity but using freshwater. The fish are grown in a raceway or pond system using a through flow of freshwater that is discharged into a settling pond to remove waste material. The water can be recycled, at least for early hatchery rearing, but generally the water is discharged into a river or stream directly from the settling ponds.

As with sea cage culture, a dry pellet food is used, and the red flesh colour is imparted using colouring agents added to the diet some time before harvest.

Most freshwater pond rearing farms are located in Canterbury, and have attracted a lot of attention from agricultural farmers who have a suitable supply of freshwater. As such several small scale operations have been developed, producing about 5 to 10 t/yr. Pond rearing farmers have mainly produced what is commonly called pan or plate sized fish of up to 600g which have been used to supply the domestic restaurant and hotel trade.

PRODUCTION

Salmon farming in New Zealand is recognised as an export orientated industry with the main markets in the USA and Japan. New Zealand has the market advantage of being able to supply both these markets with fresh chilled salmon during the northern hemisphere off season when fresh salmon are not available.

To date most of the salmon for export has been produced from sea cage farming. The fish are harvested between October and March. Exports have risen from approximately 25 t for the 1983-84 season, to 352.6 t for the 1986-87 season with an export value of about \$NZ4 million. Total farm production for the 1986-87 season was approximately 712 t, with a projected increase to about 1300 in 1987-88. Production beyond the 1987-88 season is difficult to predict but could be about 4000 t by the early 1990s. While the production from sea cages can be established, it is not possible to predict the number of salmon likely to be produced from ocean ranching.

New Zealand's present production from salmon farming can be contrasted with that of our other principal areas of aquaculture production, namely oysters (the Pacific oyster, *Crassostrea gigas* and the rock oyster, *Saccostrea glomerata*) and mussels (the green lipped mussel, *Perna canaliculus*) with exports of 828 t and 2530 t valued at \$NZ4.68 million and \$NZ10.7 million respectively during 1986-87.

Most of the salmon produced for sale in the world is caught at sea by commercial fishing vessels. The annual catch of Pacific salmon is 600,000 to 700,000 t, and Atlantic salmon 10,800 t. The contribution of farmed salmon to total salmon production is increasing rapidly. Farmed production

of Atlantic salmon was 52,000 t in 1985, and the market potential should be 120,000 t in 1990 (Dale *et al.*, 1986). Atlantic salmon production will be concentrated in Norway where the projected production for 1990 is 80,000 t, with the other major producers being Scotland, Iceland, the Faroe Islands, Ireland, Canada and the USA. Australia is also developing a salmon farming industry in Tasmania based on Atlantic salmon and the industry is expected to be in full production in the early 1990s (Hortle, 1986).

The farmed production of Pacific salmon in the USA in 1983 was estimated to be 1,600 t from sea cages and 9,500 t from ocean ranching. Ocean ranching production could be 30,000 to 500,000 t/yr within the next 15 to 20 years (Dale *et al.*, 1986). Production from Japan was 2,900 t in 1983 and is expected to rise to 8,000 t by 1990. Chile, considered to be a competitor with New Zealand because of its similar ability to provide fresh chilled salmon to northern hemisphere markets during their off season, is expected to be producing 8,000 to 10,000 t/yr by the early 1990s. Excluding ocean ranching fish, the farm production of Pacific salmon could be about 38,000 t by the early 1990s.

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