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# CONTINUING EXPERIMENTS IN SALMON OCEAN RANCHING IN SOUTHERN CHILE

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## Abstract

Salmon ocean ranching offers an efficient method of making available for human use significant underutilized biological resources in temperate and subarctic seas. Domsea Pesquera Chile, renamed Salmones Antartica, began releasing salmon in Chiloe province, Chile in 1977. Returns of adult salmon through July 1981 were good with chinook and poor with coho. From July 1981 through July 1982, adult spring chinook and coho continued to return to the Chiloe site and the first fall chinook adults returned. Fall chinook and pink salmon migrants were released from the Rio Santa Maria in Magallanes province.

## Résumé

Ranchant océanique de saumon offre une méthode efficace pour mettre à la disposition du genre humaine considérable ressources biologiques, sous-exploiter, en mers tempérés et sub-arctiques. Domsea Pesquera Chile, rebaptisé Salmones Antartica, commencait à relever le saumon en la provence de Chiloe, Chile en 1977. Les retours de saumon adulte par juillet 1981 étaient bons avec chinook mais pauvres avec coho. De juillet 1981 par juillet 1982, les adults de printemps de chinook et coho continuent retourner à la situation de Chiloe et les premiers adults de l'automne de chinook ont retournés. Les migrants de chinook de l'automne et de saumon rose étaient relevés de Rio Santa Maria en la provence de Magallanes.

## Introduction

Annual world landings of fisheries produce reached about 70 million metric tons in 1970. Subsequently, production has not continued to increase inspite of intense effort and sophisticated techniques. Large under-utilized food resources still exist, but mostly in forms expensive to extract and difficult to utilize, such as Krill, pelagic crabs, and small low value fishes.

With a few exceptions, people have not developed a taste for the smaller pelagic organisms low in the food chain. Some fish, on the other hand, have an avid taste for these organisms. Edible fish can concentrate this protein source in a form acceptable for human consumption, provided the fish can be economically harvested. The ideal fish are salmon who, by their nature, migrate from the land to forage at sea and return at maturity to the precise location from whence they originally migrated. The technique of culturing and harvesting such fish is called salmon ocean ranching.

## Salmon Ocean Ranching

In a salmon ocean ranching program, young salmon are reared in hatcheries, where they are protected from most natural hazards. Once they reach a size where predation and juvenile mortality is much reduced, the fish are released to forage and fatten at sea. Adults still return home by the homing instinct characteristic of anadromous fish, but they do not have to fare the risks inherent in ascending rivers. Instead, they swim back to a fish trap placed close to a selected river mouth. Brood stock are isolated from the population and the rest, still in prime condition, are marketed.

## Salmones Antarctica's Results Through July, 1981

Salmones Antarctica, S.A. was previously named Domsea Pesquera Chile, and is now affiliated with Fundacion Chile, a non-profit corporation located in Santiago, Chile. The company established a salmon ocean ranching program at Curaco de Velez in Chiloe province, Chile and began to release migratory salmon in 1977. Coho salmon (Onchorhynchus kisutch) were released in 1977, 1978 and 1979. Spring chinook salmon (O. tshawytscha) were released in 1978 and 1979.[1] Fall chinook (O. tshawytscha) were released in 1980.

Coho adults returned from the 1977 and 1978 releases[1]. While these coho were the first confirmed returns of Pacific salmon in Chile, the percentages were not encouraging. Spring chinook adults from the 1978 release returned at a rate approaching one percent. This rate was in excess of projections and considered very encouraging. One million one hundred thousand spring chinook eggs were taken in 1981. Survival through transfer to rearing ponds was 712,000.

## Spring Chinook Returns to Curaco de Velez

Approximately 130 spring chinook adults returned to Curaco de Velez

from August through December 1981. These fish are 3½ and 4½ year olds from 1977 and 1978 brood year releases. (The half year is accounted fro by the season shift from the northern hemisphere to the southern hemisphere). The largest fish was about 22 kg. in weight. Most of the spring chinook were held for brood stock and approximately 300,000 eggs were taken (Table 1).

Spring chinook returns during this period were considerably less than anticipated. Two factors appear to account for the shortfall. First, the number of 4½ year olds from the 1977 brood year release was projected to equal the number of 3½ year olds, which was about 700. The estimate was derived from chinook records from the stock's parent stream, the Cowlitz River in Washington State. In reality, the percentage of 4½ year olds was much less. The extra half year of growth and more abundant feed may have allowed the chinook to grow larger, and return earlier. In the only other successful transplant of chinook to the southern hemisphere, to New Zealand, the fish predominantly return as 3 year olds.[2]

A second factor in the shortfall is that the 3½ year olds from the 1978 brood year release did not return as strongly as the 1977 brood year 3½ year olds. Several possible reasons for this were evaluated to account for the variance of performance between the two groups. These include diet, different culture techniques, different densities, different times of release, disease, different ocean survivals, and increased straying by the 1978 brood year.

It was concluded that diet deficiencies in the 1978 brood year fish were the primary factors in this group's poor return performance. While both the 1977 and 1978 brood year groups were released at approximately the same weight at the same time of year, the 1978 group had considerably more pinheads (emaciated fingerlings) and had a wider size variation. The feed used for the 1978 group was a dry pellet imported from North America. Much of this feed had been stored for as long as a year before use. Serious degradation of nutrient value can occur during extended storage.

A contributing factor may lie in higher density culture used with the 1978 brood year fish. The 190,000 1978 brood year chinook smolts released were reared in the same enclosure as the 120,000 1977 brood year smolts. Recent experience in British Columbia[3] indicates that coho salmon reared at relatively low densities return at much higher rates than those reared at higher densities. Evaluation of other factors considered does not show evidence that they have had a major effect on return results.

Fall Chinook Returns to Curaco de Velez

Approximately 160 fall chinook adults from the 1979 brood year release returned to Curaco de Velez between January and April, 1982. This return indicates that fall chinook, as well as spring chinook, can adapt successfully to conditions in the Chiloe region of Chile. Most of this group were retained as brood stock and 175,000 eggs were taken and placed in incubation (Table 1).

Coho Returns to Curaco de Velez

Forty eight coho from the 1979 brood year release returned to Curaco de Velez in March and April 1982. These coho were from the Alsea River, Oregon and have returned in relatively larger numbers than coho from Skagit and Skykomish stocks. Never the less, 48 fish from a release of 81,000 are not particularly impressive. Forty two thousand eggs were taken and placed into incubation (Table 1).

Salmon Released from Curaco de Velez

The first generation of spring chinook smolts from adults returning to Curaco de Velez are being released at several different times during 1982. Each group is being marked and a tabulation of returns will help determine optimum sizes and times for release of this stock. Research at the University of Washington[4] indicates that returns of subsequent generations of a transplanted stock do better than the transplant generation. It is anticipated that spring chinook of Cowlitz origin, with a return percentage approaching one percent in the transplant generation, will do well in the Chiloe region.

Salmones Antarctica is presently rearing spring chinook, fall chinook, Atlantic salmon (Salmo salar), and coho for future releases.

New Salmon Ranching Activities in Magallanes Province

Salmones Antarctica established a new salmon ocean ranching site at Rio Santa Maria, Magallanes province in 1981. Pink salmon (O. gorbuscha) and fall chinook salmon eggs were shipped to the site (Table 2).

Pink Salmon Releases in Magallanes

Six hundred thousand pink salmon eggs from Sheldon Jackson College, Sitka, Alaska were placed in incubation in Rio Santa Maria on November 6, 1981[5]. A rapid drop in water flow in the river caused extensive mortality and less than 100,000 eggs survived through ponding. Fry were ponded in the first week of December and subsequently were fed on Biodiet$^{R}$ (Bioproducts, Warrenton, OR). Mortality after ponding was minimal. On January 26, 1982 approximately 70,000 pink fry at one gram weight each were released from the rearing pond into Rio Santa Maria. On January 27, schools of fry were observed 1.5 kilometers down stream at the mouth of the river where it empties into the Straits of Magellan. On the following day no pink fry could be found either in the river or at the rivermouth. Pink salmon adults are not anticipated until autumn of 1983.

Fall Chinook Releases in Magallanes

Two hundred fifty thousand chinook salmon eggs from the University of Washington, Seattle, Washington were placed in incubation in Rio Santa Maria on December 11, 1981. The chinook fry were ponded in the rearing pond on January 26, 1982, just subsequent to the pink fry release. Mortality during incubation was low. Ponded fry were fed Biodiet$^{R}$ and

feeding activity was considered good.

It was necessary to release the chinook fry into the Rio Santa Maria at a relatively small size to avoid crowding and winter flooding. Release data is given below.

| Date | $\bar{W}$ (g) | $\bar{L}$ (cm) |
|---|---|---|
| Feb. 2, '82 | 0.6 | 4.2 |
| Mar. 3, '82 | 1.0 | 4.3 |
| Apr. 2, '82 | 1.7 | 6.0 |
| Apr. 10, '82 | 1.8 | 6.3 |

A total of approximately 200,000 chinook fry were released. Most of the fish appeared to migrate out of the river in less than 24 hours. The small size of the migrants gives concern regarding future return percentages of this group.

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TABLE 1 CURACO DE VELEZ, CHILOE, CHILE

| Brood Year | Species | Stock | No. Eggs | Date Imported or Taken | No. Fish Released | Date Released | No. Returned To Date (Jacks & Adults) | Year Returned |
|---|---|---|---|---|---|---|---|---|
| 1976 | Coho (O. kisutch) | Skagit | 715,000<br>180,000 | Mar. 1977<br>Apr. 1977 | 90,000 | Late 1977<br>Early 1978 | 30 | 1978,79 |
| 1977 | Chinook-spring (O. tshawytscha) | Cow-litz | 500,000<br>300,000 | Nov. 1977<br>Feb. 1978 | 120,000 | Late 1978 | 1050 | 1979,80,81,82 |
| 1977 | Coho | Skagit | 10,000<br>45,000 | Apr. 1978<br>Jun. 1978 | 30,000 | Late 1978 | 6 | 1979,80 |
| 1977 | Steelhead (S. gairdneri) | Alsea | 60,000 | Apr. 1978 | 10,000 | 1979 | Less than 10 | 1980,81 |
| 1978 | Chinook-spring | Cow-litz | 350,000 | Nov. 1978 | 190,000 | Late 1979 | 228 | 1980,81,82 |
| 1978 | Coho | Skyko-mish | 400,000 | Jan, 1979 | 210,000 | Late 1979 | 20 | 1980,81 |
| 1979 | Chinook-fall | Bonne-ville | 250,000<br>200,00 | Nov. 1979<br>Jan. 1980 | 90,000 | Late 1980<br>Early 1981 | 260 | 1981,82 |
| 1979 | Coho | Alsea | 200,000 (Est.) | Dec. 1979 | 81,000 | Late 1980<br>Early 1981 | 98 | 1981,82 |
| 1980 | Chinook-fall | U Of W | 12,000 | Dec. 1980 | 3,000 | Early 1982 | --- | --- |
| 1981 | Chinook-spring | Curaco de Velez (F2) | 1,100,000 | Mar. 1981 (Taken) | --- | --- | -- | --- |
| 1981 | Chinook-fall | Bonne-ville | 200,000 | Nov. 1981 | --- | --- | -- | --- |
| 1981 | Chinook-fall | U Of W | 360,000 | Dec. 1981 | --- | --- | -- | --- |
| 1981 | Atlantic (S. salar) | Sterling University | 10,000 | Feb. 1982 | 100% Mortality | --- | -- | --- |
| 1981 | Atlantic | Norway | 80,000 | Mar. 1982 | --- | --- | -- | --- |

| Brood Year | Species | Stock | No. Eggs | Date Imported or Taken | No. Fish Released | Date Released | No. Returned To Date (Jacks & Adults) | Year Returned |
|---|---|---|---|---|---|---|---|---|
| 1982 | Chinook-spring | Curaco de Velez (F2) | 300,000 (Est.) | Mar. 1982 (Taken) | --- | --- | -- | --- |
| 1982 | Chinook-fall | Curaco de Velez (F2) | 175,000 | Apr. 1982 (Taken) | --- | --- | -- | --- |
| 1982 | Coho | Curaco de Velez (F2) | 42,000 | Apr. 1982 (Taken) | --- | --- | -- | --- |

TABLE 2 RIO SANTA MARIA, MAGALLANES, CHILE

| Brood Year | Species | Stock | No. Eggs | Date Imported or Taken | No. Fish Released | Date Released | No. Returned To Date (Jacks & Adults) | Year Returned |
|---|---|---|---|---|---|---|---|---|
| 1981 | Pink (*O. gorbuscha*) | Sheldon Jackson | 600,000 | Nov. 1981 | 70,000 (Est.) | Jan. 1982 | --- | --- |
| 1982 | Chinook-fall | U of W | 280,000 | Dec. 1981 | 200,000 (Fry release) | Apr. 1982 | --- | --- |