Aquaculture in Chilean Enclosed Coastal Seas. Management and Prospects

A. L. ALVIAL
Fundacion Chile, Dept. of Marine Resources, P.O. Box 773, Santiago, Chile

In Chile the Canals Zone (41° 30'S – 56°S) has had a fundamental role in the recent extraordinary development of aquaculture. Its potential leads to the prediction that centers will increase and that they will extend farther south into the area.
Despite this growth in aquaculture, its management has relied on a scattered, non regionalized normative with scant contributions from research. The new fishery and aquaculture law gathers together the scattered regulations and gives this activity its own physiognomy, by emphasizing the balanced development of aquaculture within its natural surroundings. For this purpose the law proposes, among other things, mechanisms for the evaluation and prevention of environmental impact, plans and programs for research and regional participation in the administrative system.

Chilean Aquaculture and The Canals Zone

Aquaculture in Chile has undergone spectacular development in recent years. Only between 1986 and 1989, have harvests from the centers of cultivation increased from 9941 Tons to 51513 Tons which represents an increase of 518% (SERNAP, 1989), 94% of this production comes from marine species. Currently 10 species are being farmed commercially of which 4 have been introduced, after a consideration of the technical– market information (Table 1).

In this notable growth in aquaculture, the Canals Zone (hereafter CZ) located approximately between 41° 30' and 56° Latitude South, has played a fundamental role. In effect, because it contains numerous protected areas with good water quality, the CZ as of the end of 1989 has come to shelter some 1400 authorized centers of cultivation, equivalent to 83% of the national total.

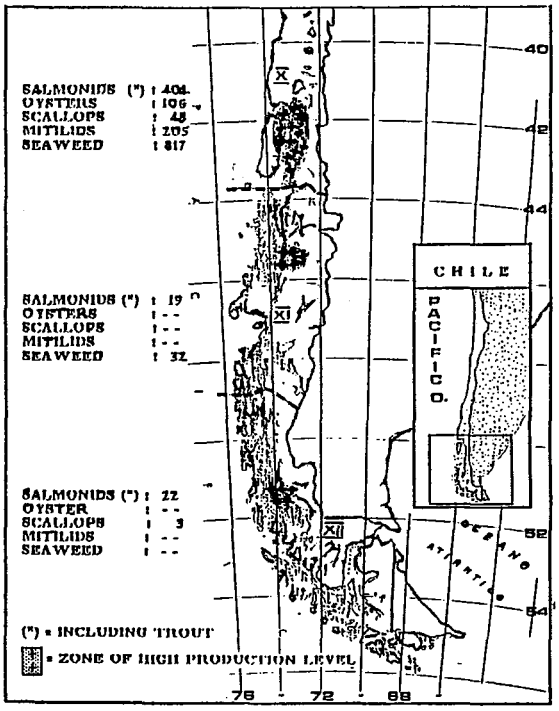


FIG 1.- DISTRIBUTION OF THE AQUACULTURE CENTERS IN THE CANALS ZONE (REGIONS X, XI AND XII). PRINCIPAL CULTURES ARE INDICATED TO THE LEFT INDICATING NUMBER OF CENTERS PER EACH ONE.

TABLE 1.- LIST OF MARINE SPECIES CURRENTLY CULTURED IN CHILE.

COMMON NAME	SC. NAME	NATIVE OR NOT	CULTURE SCALE
FISH			
SALMON DEL ATLANTICO	*Salmo salar*	NO	COMMERCIAL
SALMON DEL PACIFICO	*Oncorhynchus kisutch*	NO	COMMERCIAL
SALMON CHINOOK	*Oncorhynchus tshawytscha*	NO	COMMERCIAL
SALMON CEREZA	*Oncorhynchus masu*	NO	PRE-COMMERCIAL
SALMON KETA	*Oncorhynchus keta*	NO	PRE-COMMERCIAL
SALMON ROSADO	*Oncorhynchus gorbuscha*	NO	PRE-COMMERCIAL
SALMON SOCKEYE	*Oncorhynchus nerka*	NO	PRE-COMMERCIAL
TURBOT (FLATFISH)	*Scophthalmus maximus*	NO	PRE-COMMERCIAL
LENGUADO OJO CHICO	*Paralychthys microps*	YES	EXPERIMENTAL
LENGUADO OJO GRANDE	*Hippoglossina macrops*	YES	EXPERIMENTAL
MOLLUSCS			
CHORO	*Choromytilus chorus*	YES	COMMERCIAL
CHORITO	*Mytilus chilensis*	YES	COMMERCIAL
CHOLGA	*Aulacomya ater*	YES	COMMERCIAL
OSTION DEL NORTE	*Chlamys purpurata*	YES	COMMERCIAL
OSTION DEL SUR	*Chlamys patagonica*	YES	PRE-COMMERCIAL
OSTRA CHILENA	*Ostrea chilensis*	YES	COMMERCIAL
OSTRA DEL PACIFICO	*Crassostrea gigas*	NO	COMMERCIAL
ALMEJA	*Protothaca thaca*	YES	PRE-COMMERCIAL
ABALON ROJO	*Haliotis rufescens*	NO	PRE-COMMERCIAL
ABALON JAPONES	*Haliotis discus hannai*	NO	EXPERIMENTAL
CRUSTACEAN			
CAMARON ECUATORIANO	*Penneaus spp.*	NO	PRE-COMMERCIAL
EQUINODERMS			
ERIZO BLANCO	*Loxechinus albus*	YES	EXPERIMENTAL
SEAWEEDS			
PELILLO	*Gracilaria spp.*	YES	COMMERCIAL
LUGA-LUGA	*Iridaea spp.*	YES	EXPERIMENTAL
LUCHE	*Porphyra spp.*	YES	EXPERIMENTAL

Marine Pollution Bulletin, Vol. 23, pp. 789–792, 1991.
Printed in Great Britain
0025-326X/91 $3.00+0.00

Despite the fact that this zone has a total extension of some 1800 Kms with innumerable archipelagos, islands, islets, canals, fjords and bays, only some sectors, determined by the proximity of populated areas and communications networks, have until now taken advantage of this activity. In particular, the focus of greatest concentration for cultivation centers has been until now the areas of Reloncaví Cove, on the eastern side of the Great Chiloe Island and areas close to Chaiten, Aisen and Puerto Natales (Fig. 1).

From the geomorphological point of view, from Puerto Montt (42° S.) to the south, fjords and canals which are old glacial valleys now occupied by the sea, can be seen to dominate the landscape. The prevailing climate on the islands and on the continental coastal strip is influenced by activity from the polar front and is Mild Maritime Rainy type, with a median rainfall which fluctuates between 2000 and 4000 mm per year. (Romero, 1981).

Throughout the zone's entire length there is a general predominance of Subantarctic type waters with low salinity and temperature and high content of dissolved oxygen. Nevertheless, these characteristics undergo changes in the interior coastal zones from the effects of rainfall and from local temperature increases in enclosed places with low circulation. A frequent ecological event in the zone are red tides, which impact on some resources and on the population, and more recently have strongly affected the cultivation of salmon (Clement et al., 1988; Muñoz and Alvial, 1988; Alvial and Labbe, 1989).

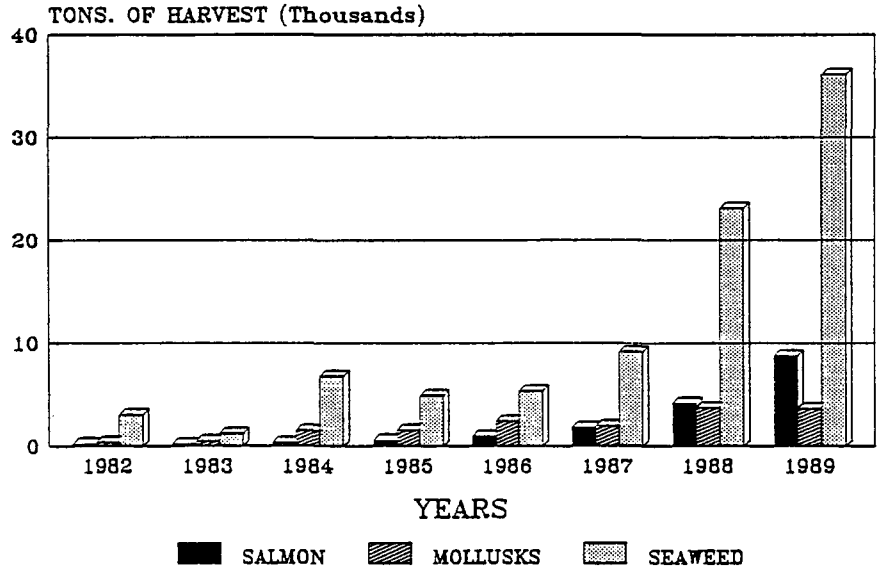
Demographically this zone is one of the country's most underpopulated, with a median density of 0.67 inhab./km^2 and an annual population growth rate of around 2% (INE, 1989). The greater part of the population is concentrated in a few coastal cities leaving extensive areas unpopulated. Consequently, contamination from urban wastes of industrial operations is low and is restricted only to the points of greatest population concentration.

Aquaculture has grown massively only up to the X Region, in relation to the greater development in infrastructure and services (Fig. 1). It is expected that the extension of highways and roads begun in the south will facilitate the installation of new centers of cultivation in more southern areas, far from those bays and fjords where there is greater human intervention.

Farming in the Canals Zone

The farming of salmonids, mollusks and algae takes place in the CZ. The first mentioned experienced an explosive development in Chile beginning in 1985, with practically all production located in the X Region (Fig. 2). The marine grow-out centers operate with the raft-cage system in relatively shallow, protected zones.

FIG.2.- CHILEAN AQUACULTURE PRODUCTION (HARVEST) SINCE 1982.



The cultivation of mollusks has not developed with the same magnitude as that of other crops (Fig. 2), mainly due to the variability which collecting seeds from the natural environment implies and to these species' low value in the internal market, which at the same time compete with products coming from natural banks. The grow-out techniques are based mainly on suspended systems and in the case of oysters, grow-out has been tested also with trays located in the intertidal zone. Only in 1990 did the cultivation of the red California abalone (*Haliotis rufescens*) begin in the precommercial or pilot phase. The commercial expansion of this crop in Chile will depend on the results of an environmental impact evaluation study (the first of its kind), which is about to be completed.

With reference to algae, farming is based on the species *Gracilaria* sp., and its harvesting evolution is shown in Fig.2. The technology applied is Chilean and is meant to repopulate devastated areas and to plant artificial prairies in appropriate zones (Ponce, 1989). The CZ represents about 88% of the national total of centers authorized for this cultivation

All this development of aquaculture in the CZ is due to the zone's natural benevolence, on the research and development work carried out for several years by national and foreign organizations who believed in its potential, and on the availability of Chilean professionals and technicians opportunely prepared by the centers of higher education in response to the foreseen demand. Certainly, industry's rapid response to the new demands arising from these crops in expansion also has been fundamental as well as the economic and institutional environment in which the activity has been developing.

At the present time, mainly state organizations cover the basic areas of research and formation of human resources. Fundación Chile, on its side, develops the transfer of technolgy, acting as a link between the basic technological knowledge and its application in commercially viable projects. As for the private sector, it is responsible for the productive work in conformity with the country's economic policy.

Administration of Aquaculture in Chile

Up to the present time, there has not been any specific legislation in Chile which refers to aquaculture, but instead a set of scattered regulations which have been applied and which have come from 4 Ministries, these are: Economy, Defense, Health and Foreign Relations (Conley, 1985). Aquaculture activities also have not been administered on the regional or zonal levels. The policies related to fishery activities, and consequently to aquaculture, until now have been based mainly on the role assigned to the private sector as the economy's engine, and to the State as regulator within the current legal framework. The State simultaneously oversees the exercise of economic activities and the preservation of the resources which constitute the foundation of this activity (Conley, 1985; Mendez, 1988).

The specific regulation which has been applied to aquaculture until now has rested on a Supreme Decree (S.D.) of the Ministry of Economy which regulates authorization for the initiation and expansion of fish culture activities and on a S.D. from the Ministry of Defense which regulates the awarding of marine concessions, among which are found those for marine farming.

The centers' operation is inspected by the National Fisheries Service (SERNAP) and information about their results and about the sanitary condition of their establishments must be sent regularly to the same service. Other important aspects which have been regulated until now are those referring to the import, release and propagation of hydrobiological resources (including eggs), particularly with reference to salmonids and to protections for certain zones where released salmon will return to the ranching system.

As regards protection of the environment, a 1990 S.D. from the Ministry of Economy modified and integrated a set of standards to conserve the natural characteristics of the aquatic environment, especially in zones where there are concentrations of salmonid farming activity where wastes and the proximity of the centers could alter the quality of the water and generate risks for the propagation of diseases which affect the farmed species themselves. In particular, this regulation establishes among others, minimum depth and velocity of the currents, as well as minimum distance between centers.

There are another two legal bodies which are indirectly related to the environmental aspects of cultivation. In the first place there is one which establishes a basic program for an evaluation of the environmental impact on the coastal marine ecosystem. This regulation instructs those who empty or plan to empty liquid or liquid mixed with solid wastes into the sea, to support environmental impact assessment studies according to the terms of reference determined in the same legal text.

The other normative is that referring to the certification program for waters where bivalve mollusks are grown or extracted and which are to be exported to the United States. This regulation also establishes a set of evaluations for the area where the product is obtained and requires the development of an ecological study in the zone, with special attention to some chemical and biological contaminants. This program and that of basic environmental impact have the positive effect of adding more and better essential information about cultivation zones in Chile and of evaluating and correcting the environmental effects which have evolved in those places where there is greater human activity.

New Regulation

In December 1989, the General Fishery and Aquaculture Law was announced but its enforcement was postponed by the present government in order that all the affected sectors may study it in depth and correct some technical aspects found therein. This legal system and its current modifications gives aquaculture its own physiognomy which is differentiated from the remaining fishery activities (Madariaga, 1990), by establishing a title expressly referring to it and which contains the basic standards which regulate this activity in Chile and the regulations which are derived from them. In this sense, the new law has gathered together those aspects which until today were scattered among standards of different origin and has integrated them into a more coherent and complete system.

According to the law, the concessions awarded for aquaculture activities in the appropriately designated areas for this purpose will be for an indefinite period, will be transferable and, in general, will be susceptible to legal negotiation. The Fisheries Subsecretary together with the other institutions in charge of alternative

uses for the lands or waters under analysis will be in charge of preparing the technical studies to determine which areas are qualified as appropriate for aquaculture.

Also, in addition to the sanitary requirements already established in the current regulations, the new law establishes that for the first import of hydrological species the preparation of sanitary and environmental impact evaluation studies of not more than one year's durations may be required. High risk diseases are qualified and defined and procedures are determined for their eventual detection in farming installations.

The law points out that, with the technical information from the case, the Ministry of Economy must control the measures of environmental protection so that the aquaculture establishments will operate at levels compatible with the capacities of the bodies of water. In this respect, the law establishes the development of annual research programs to determine the conditions under which the farming of hydrobiological species must be carried out, in equilibrium with the aquatic environment.

In relation to ranching, it is stipulated that the Ministry of Economy can establish temporary closed seasons or special prohibitions where required for the protection of anadromous or catadromous species.

Finally, it should be emphasized that in addition to the Central level, the zonal boards, within their respective orbits of activity, must pronounce upon the measures established in relation to regulation of the farmed species, protection of the environment, the National Fisheries Development Plan, the Annual Research Program and on the establishment of areas recommended as appropriate for farming.

Conclusions.

The physical characteristics of the Canals zone and the expansion of road infrastructure and communications services lead to the conclusion that the sustained expansion of Chilean aquaculture will continue to settle in this zone, gradually reaching the southern most regions and those far removed from actual urban centers.

Within the above context, if a regulation is established to protect investors, the development of salmonid ranching operations seems very probable. At the same time, the opening to the North American market and to other foreign markets probably will stimulate the expansion of shellfish farming in the CZ.

The opportune implementation of research programs in the CZ is indispensable in order to establish the areas appropriate for marine farming and their tolerance ranges, given the imminent expansion of farming operations in this zone.

Until now the administration of aquaculture in Chile has been sustained by scattered regulations which, despite its limitations, has led to this activity's spectacular development in recent years. Neverthless, this normative lacks organization and clear and stable procedures.

The new Aquaculture and Fisheries Law integrates the normative relative to aquaculture and incorporates new elements in the regulation which are indispensable for the balanced development of this activity in its natural surroundings, within the framework of the free exercise of the subsector's productive activities. Thus, the evaluation and prevention of environmental impacts, the est ablishment of research programs and plans and the tendency to regionalize administrative measures for farmed hydrobiological resources shows clear progress in the above sense.

REFERENCES

ALVIAL, A. and A. LABBE. 1989. Manual para el Acuicultor. Impactos del Fitoplancton sobre Centros de Cultivo. Fundación Chile, Depto. de Recursos Marinos, 1989. 147 pp.

CLEMENT, A., NESHYBA, S., FONSECA, T. and N. SILVA. 1988. Oceanographic and meteorological factors affecting the cage salmon industry in southern Chile. In: Proceedings of the International Seminar. Técnicas de cultivo y manejo del salmón. Desarrollos recientes. Tomo I, Fundación Chile, Santiago de Chile.

CONLEY, C. 1985. Aspectos legales y de control en la acuicultura en Chile. Documento del Servicio Nacional de Pesca, 78 pp., 1985.

I.N.E. 1989. Compendio Estadístico 1989. Instituto Nacional de Estadísticas, Santiago de Chile, 1989.

MADARIAGA, M. 1990. La nueva Ley de Pesca y la acuicultura. Aquanoticias Internacional, Fundación Chile, 4:31.

MENDEZ, R. 1988. El estado de la norma que regula el cultivo comercial del salmón en Chile. In: Proceedings of the International Seminar: Técnicas de cultivo y manejo del Salmón. Desarrollos recientes. Tomo II. Fundación Chile, Santiago de Chile.

MUÑOZ, P. and A. ALVIAL. 1988. Algae blooms. Origin dynamic and impacts on fish farms. In: proceedings of the International Seminar: Técnicas de cultivo y manejo del salmón. Desarrollos recientes. Tomo II. Fundación Chile, Santiago de Chile.

PONCE, F. 1989. El cultivo de Gracilaria en Chile. Aquanoticias Internacional, Fundación Chile, 3:30 -37.

ROMERO, H. 1981. Description, classification and evaluation of Chilean climatic patterns. Inform. geogr. Chile 28: 15-70.

SERNAP 1989. Nómina de Centros de Cultivo autorizados a diciembre de 1989. Documento del Servicio Nacional de Pesca, Depto. de Recursos Naturales, Valparaíso, Chile.