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MARICULTURE DEVELOPMENT IN NORTHEASTERN UNITED STATES

by

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ABSTRACT

In marine aquaculture the recent success of the Northeast United States culture of Atlantic salmon (*Salmo salar*) has produced a multi-million dollar industry which will soon exceed in value that of wild-harvested State of Maine lobsters. From 1988-92 salmon farms increased in number from 10 to 21, and raised over 12 million pounds of round weight fish worth some 37 million dollars. This economic benefit has provided new jobs in areas depressed because of a lack of income, resulting from previous dependence on wild fisheries (e.g. herring) which were over fished and depleted. While federal regulations are strict concerning adverse changes to coastal waters resulting from salmon waste, federal regulators have worked actively with states to streamline the permitting process, enabling permittees to satisfy the codes of one entity rather than a group of agencies, often with conflicting permitting requirements.

In 1990, aquaculture production throughout the U.S. exceeded 860.8 million pounds with a value of $761 million dollars, a four-fold increase from 1980. Of these amounts, U.S. marine aquaculture accounts for 119.5 million pounds and 114.5 million dollars.

INTRODUCTION

According to the U.S. National Fisheries Institute, consumers eat 22% more seafood now than ten years ago. The current seafood consumption estimate of 15.5 pounds per person per year is expected to reach 20 pounds by the 2000. Another organization, The U.S. National Research Council, has estimated a worldwide demand for seafood of 138 million tons with a wild harvest of only 100 million tons. Thus, aquaculture must produce 38 million tons to meet that demand by the year 2000 or shortages will exist. United States aquaculture output has been growing at 20% per year, but as more farms produce more product, competition and the rules of supply and demand will control output (Chamberlain, 1993).

The reasons for increased seafood utilization are related to health--seafood is a low-fat, low-sodium source of animal protein which has an appetizing taste. In addition, consumers have demanded high quality and more variety in fishery products, the science and technology have improved, and permitting agencies have expanded the use of coastal areas available to aquaculture. This increasing demand for edible seafood products combined with diminishing supply has created an economic incentive for farmed or cultured products produced in the U.S. Northeastern region.

Two types of culture will be discussed: Intensive, with artificial feeding (e.g. finfish); and extensive/intensive--a combination of hatcheries where feeding occurs, but with a wild grow out of juveniles to adult animals (e.g. shellfish).

This paper reviews U.S. Northeastern output and impediments involved in some of the commercially cultured products including Atlantic salmon (*Salmo salar*), trout (*Salmo sp.*), oysters (*Crassostrea virginica* and *Ostrea edulis*), and hard clams (*Mercenaria mercenaria*). Although it is an important export crop, culture of seaweed will not be addressed by this communication.

SHELLFISH PRODUCTION

Primary species cultured included the Northeastern American oyster, *C. virginica*, blue mussel, *Mytilus edulis*, European oyster, *Ostrea edulis*, and hard clam, *Mercenaria mercenaria*.

In the state of Maine the following data for 1991 aquaculture production of shellfish (Fig. 1) show an evolving industry, typical of that found in other Northeastern U.S. states:

Figure 1.* Shellfish Industry in Maine (Blue Mussels, American and European Oysters)

Hatcheries:	2 private, 1 public	Hatchery Production:	100 million spat
Growers:	10 commercial scale	Acreage:	250 acres

Harvest, 91-92 (estimated): 1 million pounds mussels
1.25 million count oysters

Gross Value, 91-92 (estimated): $1.75 million (grow-out and hatchery)
Economic benefits to Maine: $5 million
Jobs (full time/part time): 25/50

*Taken from Rivara, 1992.

The economics of large scale aquaculture have allowed only one blue mussel hatchery and grow-out farm in Maine to continue profitable operations, largely by combining wild harvest with hatchery seed. In oyster culture, production of seed or spat was the primary business for ten years while grow-out of both American and European oysters emerged only recently as a result of increasing demand and price. Decline of wild oyster harvests in the Delaware and Chesapeake Bays, resulting from disease in wild stocks, created this shortage which Maine is attempting to rectify with aquaculture grow-out.

Figure 2. Shellfish Aquaculture in New York (American oysters and Hard Clams)

Hatcheries:	2 private, 1 public	Hatchery Production:	60 million oyster spat 46 million clam spat
Growers:	2 of commercial scale	Acreage:	15,000

Gross Value, '92 (estimated): $6.1 million
Jobs (full time/part time): 20/75

New York Aquaculture Harvest 1989-1992*

Year	No. of Bushels (250 oysters/bu)	No. of Bushels (500 necks/bu)
1989	43,000	--
1990	98,497	13,700
1991	70,000	14,000
1992	74,000	15,600

*Oyster data from David Relyea, Bayville NY; clam data from Craig Strong, Saville NY as Pers. Comm. to the authors.

In New York (Fig. 2) molluscan farming continues as a primary form of aquaculture. Hatcheries produce shellfish seed under controlled conditions of using elevated temperatures for water containing algal food to supplement phytoplankton derived from natural waters. When the seed reach about 25 mm, they are planted on bay bottoms leased from the state or owned outright as colonial grants from the King of England in the early 1700's. In the case of oysters, a half shell product is marketed 2½ years later while clams require three to five years or longer to reach market size of 1⅛" (termed little necks). New York shellfish hatcheries and grow-out facilities are combined in integrated operations. Shellfish seed produced by hatcheries is used for local grow-out and not sold outside of NY state.

In the state of Rhode Island interest in aquaculture declined with economic recession, high costs of coastal land, and hatchery disease; an oyster hatchery ceased operations when disease devastated juvenile oysters from the 1991-1992 growing season. In addition, a Rhode Island mussel farm closed in 1988 when product price did not support that fledgling industry.

In Connecticut the only commercial hard clam hatchery and grow-out facility closed in 1991. However, about 46,576 acres of state and town shellfish beds in Connecticut are leased to 22 companies which plant wild-captured American oyster seed. In 1992, this grow-out provided Connecticut a shellfish-related income of over 45 million dollars. There were 425 individuals employed part or full time in shellfish work.

In Massachusetts there are 3 commercial seed hatcheries and 4 grow-out facilities which lease about 700 acres of shellfish beds. In addition, there are about 70 individually owned shellfish grow-out facilities, which usually lease one acre or less from coastal towns. The estimated value of this fishery is placed at 1.5 million dollars. There is one hybrid striped bass grow-out farm in Massachusetts, the only commercial-size fish culture operation in that state.

FINFISH PRODUCTION

In the Western U.S., the Federal Government openly assisted in the development of salmonid aquaculture, not as a private enterprise but for mitigation of habitat lost through dams placed by Federal agencies.

In the U.S. East, salmon aquaculture is primarily private enterprise, with benefits to local economies. Knowledge gained from the U.S. West coast experience plus the Norway salmonid efforts provided the impetus for a replacement to the herring industry in Maine. Federal research dollars in the Western U.S. have provided an important industry in the East. In addition, there was no Atlantic salmon industry prior to the commercialization of that species in Eastport, Maine and New Brunswick, Canada. Vocal opposition, including claims that accidental release of hatchery stock would dilute the genetic character of wild fish, was non-existent.

In 1992, Maine farms grew Atlantic salmon from smolt size, supplied by hatcheries in Maine (Fig. 3), to 12 million pounds of marketable table fish (6-8 lbs. each). The value

Figure 3. Finfish Industry in Maine (Salmon and Trout)

Hatcheries: 9 private
Growers: 22 sea-based

Hatchery Production: 87 million smolt
Acreage: 600 acres leased
25 acres occupied

Economic benefits to Maine: $100 million
Jobs (full time/part time): 250/200

(Whole weight in pounds)

1992	Salmon*	Trout*	Total
Jan	1,084,650	122,115	1,206,765
Feb	1,234,737	137,804	1,372,541
Mar	1,582,222.47	8,622	1,590,844.47
Apr	1,373,079.4	2,696	1,375,775.4
May	1,087,757.9	4,005.75	1,091,763.65
Jun	1,182,456.97	6,888.8	1,189,345.77
Jul	810,469	11,981	822,450
Aug	711,903	18,678	730,581
Sep	781,870.8	26,868.7	808,739.5
Oct	502,289.2	28,576	530,865.2
Nov	1,032,187	112,252	1,144,439
Dec	1,486,050.1	139,218.2	1,625,268.3
Total	12,869,672.84	619,705.45	13,489,378.29
Estimated value in U.S. $			$37,000,000.00

Subject: Finfish Harvest through 1991*

Year	# of Sites	Pounds Salmon & Trout Combined
1988	10 (growers)	900,000-1,000,000
1989	10	1,990,548
1990	17	4,589,809
1991	19	10,370,378

* Salmon and trout data from Robert Morrill and Laurie Churchill as a Pers. Comm. 1992. NMFS and State of Maine, DMR, Portland and Boothbay Harbor ME.

of this farmed salmon was 37 million dollars, placing it second only to that of the wild-capture lobster industry in Maine. It is interesting to note that in spite of cold water temperatures averaging 5°C, salmon reached market size in 18 months.

Across the Bay of Fundy from U.S. salmon operations, private enterprise in Canada had also grown Atlantic salmon on a larger scale than their United States neighbors. Much of the pelletized feed used in the U.S. is manufactured in Canada, as well as are the nets and pen-culture systems. Fish farmers in Canada formed the New Brunswick Salmon Growers Association, a non-profit fishing cooperative venture, to test new methods of culture, feed, medications, and cages for the industry. This venture is not supported by the Canadian government. In 1992 the Canadian salmon industry marketed similar amounts of salmon as the U.S. growers but earned less for that product--34 million dollars.

AQUACULTURE POLICY

In the Northeastern U.S., many states have developed workable aquaculture plans, but due to fiscal problems usually lack sufficient personnel to implement their plans. The National Marine Fisheries Service, Environmental Assessment Division, in consort with state offices is responsible for determining whether proposed aquaculture plans will adversely impact ecosystems or habitat. Historically, NMFS developed through NOAA an aquaculture plan in 1977. This was followed by the passage in the U.S. Congress of the National Aquaculture Act of 1988 (re-authorized through 1993). This Act empowers the U.S. Secretary of Agriculture to coordinate activities with the Secretarys of Commerce and Interior to develop joint activities and recommendations on Federal policies related to aquaculture. Public aquaculture for restocking purposes is not directly addressed by this Act, which focuses on private or commercial aquaculture to contribute to domestic fisheries production.

In addition to the harvested value of product, aquaculture supports an infrastructure of feed mills, processing plants, suppliers of fuel, ice, and specialty products, as well as equipment manufacturers. These industries support jobs and their value is believed to exceed the value of the landed product by a multiplier of 2 to 3 times.

Aquaculture depends on clean seawater, free of organic contaminants, heavy metals, and microorganisms which might adversely affect survival of the cultured product or the health of the consumer. Existing aquaculture plans prepared by state and federal agencies require careful soil and water conservation practices, as well as permits for using coastal areas for the commercial culture of fish or shellfish. In the past, the permitting agencies had conflicting requirements with each other, often forcing private enterprise to spend considerable time and money before understanding and/or fulfilling the applications required by the agencies responsible.

In the Northeast this process was recently streamlined by the National Marine Fisheries Service, Environmental Assessment Division (Ludwig *et al.*, 1990). Faced with a series of new permit applications for siting Atlantic salmon farms, representatives of the State of Maine, the U.S. Fish and Wildlife Service, the U.S. Environmental Protection

Agency, U.S. Army Corps of Engineers, and NMFS developed a single permit application process which describes siting of an aquaculture proposal. This relieved the applicants of the necessity of submitting four separate permit applications; the resulting single process was shorter than each of the individual permits.

CONCLUSION

Aquaculture continues to grow as an industry in the U.S. Northeast where consumers are becoming educated to the numerous benefits of consuming farmed products. The prime benefit is higher quality--products are processed close to their point of origin, saving days of delivery time from "at sea" catching, holding, and sailing to port typical of wild caught seafood. Another is wholesomeness--the life history of the product is controlled by feeds with known quantities of protein, carbohydrates, and vitamins while exposure to and accumulation of pollutants is greatly minimized. The U.S. Food and Drug Administration regulates the use of drugs such as antibiotics or other chemicals which may not be used during the culture of seafood. Wild product has an ambiguous background and in certain cases such as Striped Bass from the Hudson River, New York, has been shown to contain polychlorinated biphenyls (PCB's) which may compromise the health of those who consume wild caught bass.

About 60% of U.S. seafood is now imported, making a trade deficit of 2-3 billion U.S. dollars, second only to that of manufactured goods. The demand for cheap, wholesome seafood has risen over the last decade while the price of wild caught seafood has doubled and tripled in cost (Chew, 1993).

With economies and market as incentives, the U.S. aquaculture industry will continue to develop new products and likely continue to expand at the rate of 20% per year until markets are saturated. Probably, with demand exceeding supply, the year 2000 should see at least another four-fold increase in production (Blogoslawski, 1993) as had the decade from 1980 and 1990 as shown in Table 1.

For the next century aquaculture will have to incorporate agricultural concepts such as crop rotation, fertilization, disease control, hybridization, and genetic engineering. Government scientists and cooperative extension agents will be required to channel research from traditional farming practices as well as unconventional approaches such as bioengineering.

Intensive aquaculture will expand initially because it is cheaper, although it will be constrained by environmental concerns and limited resources. Extensive aquaculture may become limited by the cost and availability of feed derived from fishery sources. It will become necessary to adapt plant proteins to serve as the basis for animal feeds because the next century consumers will determine newer ways to use nearly all of seafood resources. Today, gurry and fish meal are waste problems--tomorrow, these items will be too valuable to waste. Finally, energy constraints in regard to transportation, holding, and processing will encourage growing areas be located close to urban markets. Concerns for high quality, uncontaminated cultured product(s) will result in habitat restoration to accommodate such

activities. Coastal development will be managed to the end that sustainable development is a reality. All suitable coastal areas can become sites for marine aquaculture with proper planning and coordination. This will be essential if we are to meet the needs, and demands, for seafoods nationally and internationally.

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Table 1.* U.S. Private Marine Aquaculture Production for 1980, 1985, 1989, and 1990.

	1980	1985	1989	1990
		(1,000 lbs.)		
Clams	561	1,588	4,000	4,000
Mussels	NA	928	2,500	2,500
Oysters	23,755	22,473	25,000	25,000
Pacific Salmon	76,616	84,305	85,000	85,000
Shrimp	NA	440	2,500	3,000
Trout	48,141	50,600	67,000	67,000
Other Species	NA	14,000	80,000	85,000
Total	149,073	174,334	266,000	271,500

*Taken from the Joint Subcommittee on Aquaculture, 1992.