



**PLANNING
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Research & Planning

Economic Impact of Aquaculture in Maine

For: The Maine Aquaculture Innovation Center

October 14, 2003

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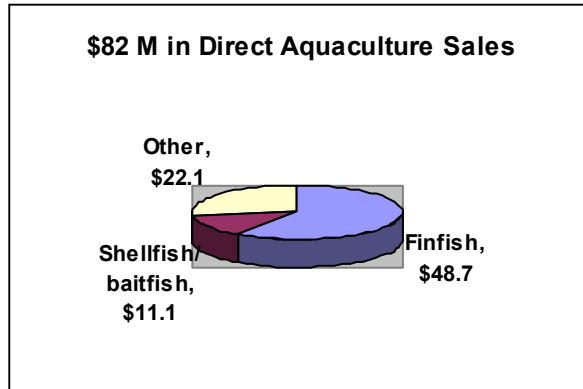
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Part I: Overall Economic Impact

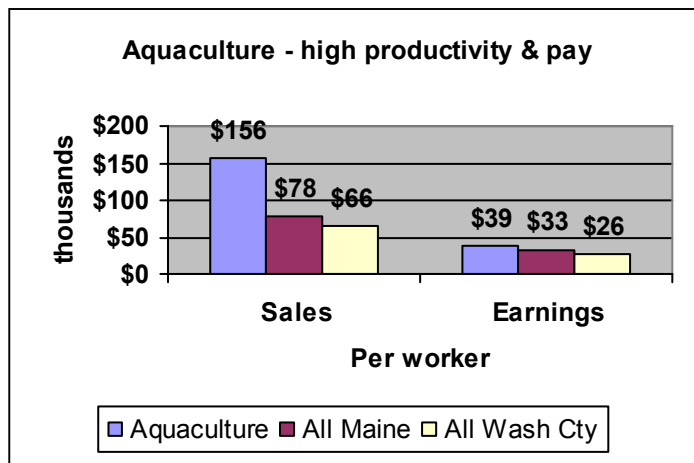
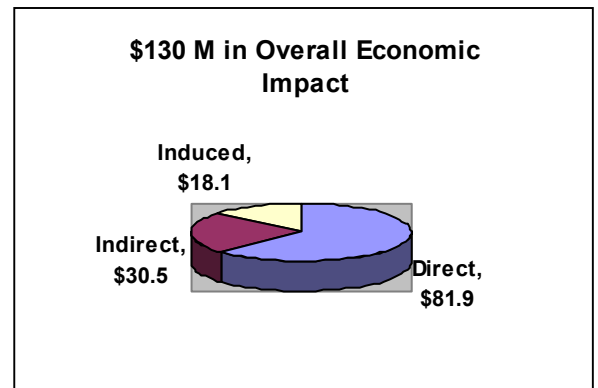
The Maine aquaculture industry consists of businesses involved in raising and selling salmon, trout, oysters, mussels, and baitfish. They include fish hatcheries, grow-out operations, fish health companies, and fish processing operations. Altogether their activities account for \$130 million in total economic activity in Maine on an annual basis (see Table 2).



The total figure begins with \$82 million in direct sales and revenue. Of this, almost two-thirds come from finfish farming¹ -- mostly salmon, but also trout. Another one-eighth comes from oyster, mussels, and baitfish operations. The remainder comes from fish smoking operations and fish health businesses.

Out of these revenues, the industry spends \$50 million on purchases, of which 30% (\$15.4 million) is spent on Maine businesses such as trucking firms, construction, insurance, feed, and the like (see Table 1). Many of these businesses serve Maine's traditional fishing industry – and are being sustained during hard times by aquaculture clients.

This spending circulates through the Maine economy, and contributes to an additional \$30.5 million in indirect (supply chain) spending on gas, electricity, supplies, and so forth. Finally, the jobholders in both the aquaculture businesses and their suppliers – about 1,400 in Maine, earning \$56 million – contribute another \$18 million in induced (consumer spending) impact through their personal spending on grocery stores, car dealerships, housing improvements, and other retail categories.



These are good jobs and productive businesses. Sales per employee in aquaculture is \$156,000, double the average of all Maine businesses. Compensation per worker (salary and benefits) is \$39,000, higher than the state average, and almost double the average for Washington County businesses. Finally, this industry contributes \$9.7 million annually in tax payments.

¹ Because of the unusual issues present this year in the salmon industry, the estimate in this study uses a three-year average figure to estimate annual salmon sales. For all other categories sales figures are for the current year.

These estimates are based upon a 4-month study of the industry involving dozens of interviews with individual business owners, analyses of many business financial statements (generously shared by private owners), and a careful review of state and federal agency data. The resulting data was entered into the IMPLAN input-output model for the State of Maine. IMPLAN is a proprietary model that estimates the inter-industry, supply chain relationships among businesses in Maine as well as the relationship of income to spending patterns.² It enables an economist to estimate the total impact of an industry based on industry-specific data.

This study has found that Maine's aquaculture industry is diverse, going far beyond salmon farming alone; it is entrepreneurial; it is productive and well-paying; and it has tremendous potential. It is composed of Maine people who have taken a traditional natural resource and transformed it into a modern and globally competitive industry. Today 1,400 people are engaged in work, many in Washington and Hancock Counties where good jobs are hard to find. They are accounting for nearly \$10 million in tax revenues annually. This is an industry with great current value, and even greater future economic potential, for Maine.

² IMPLAN Pro is a computerized model originally developed in the 1980's at the University of Minnesota for use in forestry research. In 1993, its developers entered into a technology transfer agreement with the University of Minnesota that allowed them to form the company, Minnesota IMPLAN Group, Inc. or MIG. At first, MIG, Inc. focused on database development and provided data that could be used in the Forest Service version of the software. In 1995 MIG, Inc. rewrote the IMPLAN software from scratch. The new version incorporated national input-output data prepared by the U.S. Bureau of Economic Analysis from millions of business tax returns and developed state and county files integrating input-output relationships with local employment and business sales data. There are over 1,500 active users of MIG databases and software in the United State as well as internationally, these include clients in federal and state government, universities, as well as private sector consultants.

Table 1
Aquaculture and Associated Industries – Direct Impact on Maine Economy, 2003

IMPLAN Sector	Category	Sales/Expenses	Per sales \$	Estimated Maine %	Estimated Maine Sales
	Total Sales (from VA + Purchases)	81,902,454	1.000000		
	Value Added	30,524,915	0.372698		
	1. Total Employee Related Costs	22,713,510	0.277324		
	2. Proprietor's Income	401,000	0.004896		
	3. Other Property Income	6,110,404	0.074606		
	<u>4. Indirect Taxes (2% sales minimum)</u>	<u>1,600,001</u>	<u>0.019535</u>		
	Purchases (excluding depreciation)	50,803,539	0.616662	30%	15,423,976
21	Aquaculture	9,570,241	0.116849	26%	2,510,634
78	Feed	15,024,500	0.183444	0%	0
456	Interest	3,655,995	0.044638	11%	419,125
459	Fish Insurance	2,231,674	0.027248	1%	11,840
435	Warehousing & Trucking	3,509,084	0.042845	49%	1,726,654
165	Packaging	2,836,100	0.034628	34%	951,635
482	Repairs and Maintenance Total	1,701,691	0.020777	66%	1,116,275
462	Rent Total	1,360,500	0.016611	89%	1,205,920
460	Other Insurance	1,083,341	0.013227	87%	939,581
443	Electricity	1,678,152	0.020490	98%	1,640,402
195	Fish Health \ Vaccination	615,565	0.007516	40%	247,765
210	Oil & Gas	592,975	0.007240	97%	574,075
204	Production Supplies	853,526	0.010421	66%	561,787
401	Lab Supplies	300,000	0.003663	10%	30,000
441	Telephone \ IT	593,157	0.007242	77%	455,927
445	Water/Sewer Services	62,100	0.000758	100%	62,100
494	Legal	601,060	0.007339	67%	401,060
209	Oxygen \ Other Gases	405,800	0.004955	100%	405,800
508	Professional Services - Consulting	756,700	0.009239	34%	259,310
469	Marketing Fees & PR	703,100	0.008585	62%	436,680
437	Travel Expenses, air	328,050	0.004005	27%	87,488
451	Travel Expenses, auto	328,050	0.004005	56%	184,838
463	Travel Expenses, lodging	328,050	0.004005	40%	131,738
503	MAA Dues	190,300	0.002323	100%	190,300
196	Cleaning Supplies	152,000	0.001856	75%	114,000
509	Laboratory Testing	141,900	0.001733	86%	122,110
445	Waste Disposal	253,300	0.003093	100%	253,300
449	Office Supplies and Expense	270,370	0.003301	56%	151,940
507	Accounting Services	378,843	0.004626	61%	231,693
49	Commercial/Industrial Buildings	75,641	0.000924	100%	75,641
122	Cordage & Twine	65,789	0.000803	75%	49,341
304	Fabricated Wire Products	65,789	0.000803	40%	26,315
330	Food Products Machinery	18,420	0.000225	20%	3,684
332	Pumps & Compressors	65,789	0.000803	20%	13,158
347	<u>Refrigeration Equipment</u>	<u>65,789</u>	<u>0.000803</u>	<u>20%</u>	<u>13,158</u>
	Depreciation	6,444,788			

Table 2
Aquaculture and Associated Industries
Secondary Impacts in Maine, 2003

Activity	Sales (\$1,000)	jobs	Earnings (\$1,000)	Indirect Taxes (\$1,000)	Direct Taxes (\$1,000)
Total Direct Impact	\$81,902	524	\$29,225	\$1,600	\$2,500
Indirect (supply chain) Impact	\$30,496	548	\$16,288	\$2,131	\$1,400
Induced (consumer spending) Impact	\$18,093	289	\$10,301	\$1,180	\$880
Total Impact (Sales of Maine Businesses)	\$130,491	1,361	\$55,814	\$4,911	\$4,780
earnings equal labor income, proprietor's income and corporate profit					
indirect taxes equal sales, property and other taxes paid by businesses					
direct taxes equal all taxes paid by individuals (calculated as the average per dollar of income)					

Part 2: Detailed Industry Description

The Maine aquaculture industry is very diverse and involves different kinds of economic activities. This section provides the details of different kinds of aquaculture operations in Maine, as background to the numbers in the prior section.

A. Salmon

The farmed Atlantic salmon industry in Maine began in 1970 and is comprised of three companies. The first, Atlantic Salmon of Maine (ASM), is owned and operated by its Norwegian parent company Fjord Seafood USA. ASM has hatcheries in Embden and Oquossoc, and offices in Belfast, Maine. The second, Heritage Salmon (formerly Connor's Aquaculture Inc.), is a Canadian company with hatcheries in Gardner Lake, Maine and Lake Utopia, New Brunswick, and offices in Blacks Harbor, New Brunswick. Heritage is a wholly-owned subsidiary of George Weston Limited, one of the largest food processing and distribution companies in North America. The third, Stolt Sea Farm Holdings, is a wholly-owned subsidiary of Stolt-Nielson S.A. They have a hatchery in Bingham, Maine and main offices in New Brunswick, Canada, and Oslo, Norway. Together the three companies employ over 240 fulltime workers in their freshwater and ocean farming operations, processing plants, and administrative and sales positions.



In 2002, these companies produced 15 million whole pounds of salmon while utilizing 10 lease sites and 4 hatcheries throughout Maine. The state of Maine leases about 40 sites to companies that grow salmon in Maine, and receives an annual rent of \$33,177.35 for the use of the 663.55 total acres. Currently the state of Maine supplies 18% of domestic consumption and 2% of world consumption of farmed Atlantic salmon.

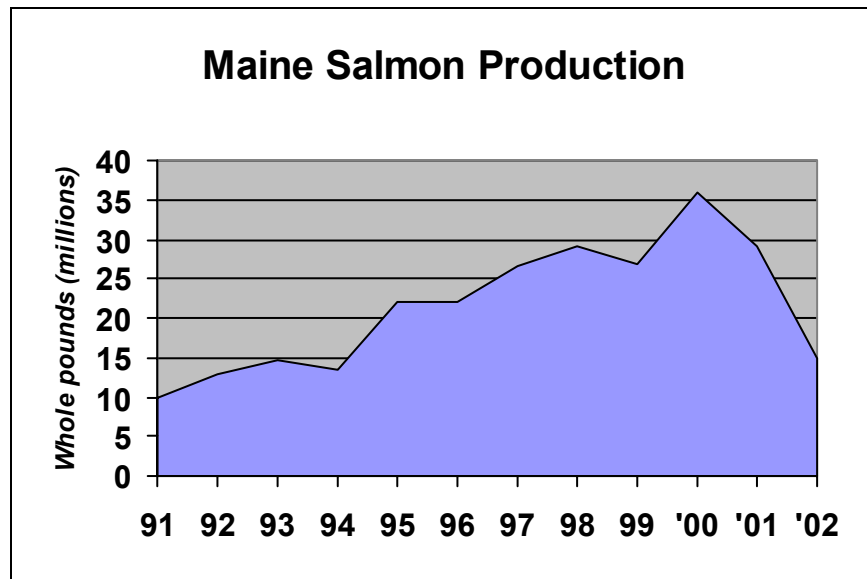
The process for the farming is as follows. During the fall each year, some of the best adult salmon at the farms are selected and reserved as brood stock. These fish yield thousands of fertilized eggs that are then incubated for 4 to 6 weeks at inland hatcheries before hatching into free-swimming fry. In the freshwater hatcheries the hatched eggs develop inside large hatchery tanks and grow from the fry stage to a parr size. In the freshwater tanks they are cared for, vaccinated, and fed a nutritional diet. While living in fresh water for up to 18 months, the fry will mature into smolts, and when they are ready to be moved to the saltwater farms they will experience a process called smoltification. During this process, the smolts will they undergo the necessary changes that allow them to eventually live in salt water much in the same way wild salmon do before leaving the inland rivers for the Atlantic. When the smolts reach about 5 inches long, they are transferred by boat to floating net-pens called polar circles at lease sites in the ocean.

The pens are covered with large nets to keep out predators. Each morning, boats take workers to the lease sites where the polar circles are filled with growing salmon of all ages. The fish are fed pellets purchased from one of three major Canadian feed companies. A large barge resembling a

tank is responsible for sending the feed through thick hoses to each of the pens where the feed-pellets are shot out of a spinning tube to the salmon. With the use of an underwater camera, one worker can watch a monitor from a small boat next to the pen, and can then control the output of feed on the barge when the fish stop eating. The salmon grow from 3-5 ounces to a market weight of 6-12 pounds during the time they live in the saltwater pens, and it takes about 30 months after hatching for the salmon to reach market.

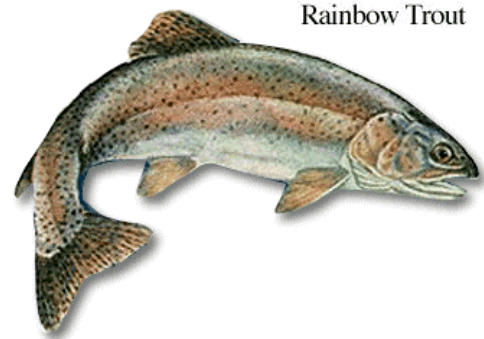
On harvesting days, an operator controls a crane-like machine that is mounted to a barge and dips a large bucket into a pen where its bottom can open and then close with salmon inside. The fish are scooped from the ocean, and after the water drains from the bucket the fish are placed onto the barge where other employees can pack the fish in flake ice inside large bins to keep them cold without freezing. After the desired amount of salmon is harvested, the barge takes the bins full of salmon directly back to shore. Processing plants are usually close to the pier on shore so that the workers can process the harvested fish the same day. Small local trucking companies are used to ship the salmon from the processing plants to wholesalers, distributors, restaurants, and fish markets, where price is negotiated with every order. To ensure quality and freshness, the farmed salmon can be harvested, packed, and shipped all within 24 hours.

Salmon production peaked in 2000, and has dropped off in the last two years due to health and environmental problems.



B. Trout

The farmed trout industry in Maine is comprised of seven companies who grow rainbow trout, brook trout, and brown trout. The businesses employ an average of 1.5 workers each, and sometimes hire seasonal part-time local help. In 2002 the inland trout farms raised an estimated 150,000 trout; there has been no saltwater production in the last two years.



Rainbow Trout

Trout farming dates back over 400 years in Europe, and over 100 years in Maine

Brook trout, brown trout, rainbow trout (the most commonly raised), all belong to the same family as the Atlantic salmon. The life cycles of the two fish are essentially the same, except that the farmed freshwater trout will not go through the smolting process and their optimal growing temperature range is slightly higher than for salmon. Because the trout farming industry is much smaller, there is more diversity in farming methods than is true for a larger enterprise like salmon.

In the early stages of production, trout eggs from brood stock are fertilized in hatcheries just as they are for salmon. Some of the Maine companies choose to use their own brood stock for producing and fertilizing eggs, while others have abandoned this technique and instead choose to purchase fertilized eggs.

Some trout farmers grow their fish in freshwater pools and tanks for the entire lifecycle (the pools and tanks are often handmade affairs, adapted from old swimming pools or equipment purchased at local stores). Other trout farmers move their fish at a certain age from the pools or tanks into ponds or long raceways that imitate rivers. Trout farmers have high electricity bills to pay for flowing water in the pools and raceways so that the trout can build muscle by swimming against the current. Feed (mostly purchased from Canadians) is usually just thrown into the water by hand. Some trout farmers keep at least some of their mature fish in indoor pools, while others may have most of their trout outdoors fulltime as soon as they are old enough for the bigger tanks. Farmed Maine trout can be bred to different sizes, but most reach market size in only 7-8 months. Most trout is sold to restaurants or for stocking recreational fisheries.

C. Shellfish Grow-Out

Mussels

There are 16 active mussel lease sites in the state. Mussel companies together employ over 55 fulltime workers as well as part-time help. IN addition, many fishermen up and down the Maine coast are hired to help care for and harvest the farmed mussels grown in state.



Most of the mussels come from a bottom culture technique developed in Europe, but there are also experimental sites using mussel raft aquaculture. Total harvest numbers for farmed mussels is leveling off, and growers are optimistic about the future potential of raft culture.

Mussel farming companies in Maine produce an all-natural product. They do not use any feed or additives, instead relying on plankton and organic matter in that occur naturally in the ocean.

Bottom Culture

Wild mussels spawn each spring in Maine along the coast, and by early July the seeds have set. The following spring, these same mussels are located in ocean beds and mussel farmers transplant those seeds into shallow saltwater aquaculture lease sites all though the summer. Maine mussel farmers are the only growers in North America who have commissioned a bottom culture vessel that is designed to transfer the one-year-old mussels to the lease sites. It usually takes 18-24 months for the mussels to reach a market size of 2.25-3 inches.

Similar to the farmed salmon industry, mussels are also only harvested based upon current demand. Local fisherman and company employees take the mussels from their beds at the lease sites, and bring them to the plant onshore. To ensure that there is no grit or sand in the mussels, they are “re-watered” in 20,000 gallon tanks for 24 hours. Mussels also have a beard that allows them to cling to the ocean floor, but during this purging process in the tanks the mussels also usually lose them. Then after a marine biologist inspects the mussels for quality, they are graded for size, packaged, and then shipped.

Raft Culture

Since 1998 at least twelve Maine fishermen have worked with mussel farmers on raft culture projects. Just like in the bottom culture method, the seed mussels are collected after the wild mussels have spawned. This technique however involves collecting those seeds onto 400 ropes. The ropes are tied to a 40 x 40 foot rafts in the ocean, and after 12-14 months of hanging from the raft’s ropes, the mussels reach a market size equal to that of bottom cultured mussels. A giant barge harvests the raft-cultured mussels by lifting up the ropes by crane and then piling them on deck. After this, the mussels are “declumped” from the ropes and each other, “debearded,” and graded before being packaged and shipped. These mussels are of superior quality and are sold for a higher price to stores and restaurants nationwide.

Oysters

There are about 15 oyster farming companies using 26 active oyster lease sites along the Maine coast (of 45 totally leased for the purpose). Together these companies directly employ 19 fulltime employees and over 55 seasonal and part-time workers.



Oyster farming began in Maine in the 1970s where companies first attempted to grow European oysters in nets and in floating or stacked trays. Today Maine producers grow American oysters. Oyster aquaculture remains very diverse. Different growers have very different views concerning which techniques and equipment work best and produce the highest quality product. Many use homemade equipment and make purchases from local stores, and quite often equipment and supplies are used that may not be designed for aquaculture purposes. Swimming pool toys and supplies from hardware stores are just a few products used in the oyster production process.

There are two basic approaches used by oyster farmers in Maine. *Suspension culture* involves growing oysters off the bottom of the sea floor using ropes and bags, cages, or floating trays. *Bottom culture* oysters simply grow on the sea floor. Both techniques depend upon natural food supplies in the ocean, natural currents, and protection from predators.

Oyster farmers start with hatchery-produced seed, which they either purchase, or produce in their own hatchery. Seed is usually acquired around early May and often lives in large tanks for the first few months. By mid to late July the seed is ready for the ocean.

The now ½ inch oysters are then either laid to rest on the sea floor if they are to be bottom cultured, or placed into a nursery bag or tray that is attached to bungee cords, swivels, and something to make them all float. The oysters continue to grow usually until sometime in October when they eventually stop all growth due to the cold Maine winter waters. Growers don't have much to do until the oysters start maturing again sometime in April, when they can again grow through October. Bottom culture is more labor-intensive than suspension culture because the sites, oysters, and equipment require tending and cleaning. By the time the oysters stop their second year growing in October, usually 30-40% have reached about 3 inches, and at the start of the third year in April those oysters are ready to sell.

Harvesting the oysters is another process that differs between growers. One technique is to use a harvesting boat with 3-4 foot drags to collect the oysters that have reached market size. The other is to use divers to hand-harvest their oysters. The oysters are then dropped off and washed, filtered, and purged before they are ready to ship out. The market size oysters are boxed by count on shore, and then shipped live in their shells. Oyster growers often use local shipping companies to truck their product to wholesalers and restaurants.

Shellfish Hatchery

There are five shellfish hatcheries in Maine. These small privately owned businesses usually employ one to three persons; a few employ workers year-round, but most only hire seasonally. The five hatcheries produce oyster and clam seed stock that is used in their own grow-out operations and/or is sold to other oyster growers.

Hatcheries are indoor, using tanks of varying sizes to provide a safe, temperature-controlled environment for young shellfish to develop before they are ready for the grow-out stage.

D. Baitfish

Baitfish are fish that are used for bait, such as fathead minnows, golden shiners, suckers, and smelt. Because it is illegal to import baitfish into the state, the demand in Maine must be met entirely by in-state supply. Limited wild stocks cannot be relied upon to meet this demand, and while aquaculture of small freshwater baitfish remains a huge industry in other states, demand continues to exceed supply here in Maine. Almost all growers in Maine supplement their grown crops with a wild harvest, as very few find it profitable to deal exclusively with their own product. Total bait sales for recreational fishers alone in Maine exceeds \$6 million annually (this includes wild bait as well as farm-raised baitfish).

There are three types of baitfish dealer licenses sold in Maine – one to be a bait retailer, one to be a baitfish wholesaler, and one to be a smelt wholesaler. Any resident or nonresident is eligible to obtain a license to deal in baitfish and/or live smelts upon payment of the appropriate fee. The baitfish wholesaler license allows for the wild harvest of legal baitfish species from legal harvesting waters, while the smelt wholesaler license allows for wild commercial smelt harvest. Currently there is only one smelt grower in Maine, and limited success has led to a smelt harvest that is almost 100 percent wild catch.

While there are hundreds of baitfish retailer and wholesaler licenses currently valid in Maine, very few grow a significant amount. A few serious growers have established legitimate businesses and supply most of the market, while others have short-term operations and work with baitfish for only a small portion of the year. The majority of baitfish sales occur during the three-month ice-fishing season, but some growers are able to store and distribute their product throughout other times of the year when they can enjoy a better market price. There is no limit on the number of baitfish that can be taken from the wild, but there is a restriction on wild smelt catch. Growers in Maine are still not required to report their harvest numbers, and are also not subject to any kind of annual production quota.

Estimates of the total value of baitfish sales range from \$100,000 to \$5 million. Based on interviews with participants in the baitfish industry, our estimate for this study is \$1.5 million.

E. Other Related businesses

As aquaculture in Maine has been around for several decades, there are now supporting businesses that grew up around the industry, and that can be considered part of the aquaculture “cluster.”

Four such businesses were interviewed for this study. Ducktrap River Fish Farm of Belfast, Maine, has a very successful smoked fish wholesale and retail business that grew out of Maine salmon aquaculture operations. MariCal and Micro Technologies Inc. are sophisticated providers of fish health services and products to the aquaculture industry in Maine and beyond. Several other individuals and businesses are exploring new products related to aquaculture, including products related to improving human health.

These high value-added businesses, most state-of-the-art in terms of science and technology, are here in Maine as a direct result of the existing aquaculture farms.