MAINE AQUACULTURE

ECONOMIC **IMPACT** REPORT

January 2017

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AQUACULTURE RESEARCH INSTITUTE


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Report prepared by:

Avery Cole, University of Maine Aquaculture Research Institute

Anne Langston, University of Maine Aquaculture Research Institute

Chris Davis, Maine Aquaculture Innovation Center

Study conducted in collaboration with:

Sebastian Belle, Maine Aquaculture Association

Jim McConnon, University of Maine School of Economics

Todd Gabe, University of Maine School of Economics

With thanks to:

Abby Morrison
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Survey respondents in the Maine aquaculture sector for their support and time

Correspondence and enquiries should be addressed to:

Dr. Anne Langston
Associate Director
Aquaculture Research Institute
University of Maine
5784 York Complex
Building 4
Orono, ME 04469-5784
(207) 581.4397
anne.langston@umit.maine.edu

Dr. Chris Davis
Executive Director
Maine Aquaculture Innovation Center
5717 Corbett Hall, Room 436
Orono, ME 04469-5717
(207) 832.1075
cdavis@midcoast.com

Sebastian Belle
Executive Director
Maine Aquaculture Association
PO Box 148
Hallowell, ME 04347
(207) 622.0136
maineaqua@aol.com

MAINE AQUACULTURE ECONOMIC **IMPACT** REPORT

DECEMBER 2016

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EXECUTIVE SUMMARY

- Maine's aquaculture sector has a direct economic impact of $73.4 million in output, 571 in employment, and $35.7 million in labor income.
- Including multiplier effects, Maine's aquaculture sector generates a statewide annual economic contribution of $137.6 million in output (i.e., sales revenue), 1,078 full- and part-time jobs, and $56.1 million in labor income.
- Since 2007 the total economic impact of aquaculture has almost tripled from $50 million to $137 million dollars.
- The top three species — in terms of 2014 sales — are Atlantic salmon, blue mussels and Eastern oysters.
- All sub-sectors include business entities reporting more than $2 million in sales revenue in 2014. The finfish and service providers sub-sectors did not include pre-revenue business entities in 2014.
- The majority of jobs related to aquaculture production are full-time, all-year positions. Less than 30% of employment is seasonal.
- Thirty-nine percent of the respondents reported $0 revenue. An unknown portion of this percentage represents start-up companies.
- Research services accounts for 47% of the revenue reported by aquaculture business entities providing services.
- Eighty-six percent of aquaculture producers send their produce to wholesalers or distributors.
- A large majority of business entities in the sector made sales in-state in 2014. The shellfish sub-sector reported the greatest percentage of business entities that made sales in-state in 2014.
- For all expenditure categories, feed is the highest cost and accounts for 57% of expenditures. Excluding feed, administration, insurance, and shipping and freight costs are the three highest expenditures.
- Some business entities reported a fall in sales revenue over the last five years, but the majority reported an increase in sales. The greatest increase was reported by the shellfish sub-sector.
- There is substantial optimism in the aquaculture sector with 73% of respondents predicting 51% or greater increase in sales revenue by 2020. This optimism is greatest in the shellfish, sea vegetable and service providers sub-sectors and is probably spurred by the newer companies.
- A large portion of the sector is new; 24% of respondents began operations in the last two years and another 21% began operations in the last three to five years.
- Aquaculture production varies considerably annually in part due to site rotation and fallowing routines. The current study was conducted during a period where finfish production was at a low point in its normal three year rotation cycle. This significantly reduced the level of economic impact found in that sub-sector.

MAINE AQUACULTURE ECONOMIC **IMPACT** REPORT

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INTRODUCTION

WITHIN A competitive world economy, Maine's economic prosperity is dependent on its geography, physical resources and human capital. In this context, Maine's coastline and marine resources represent a unique asset supporting a wide spectrum of interlinked sectors and within this spectrum the aquaculture sector plays a major role.

Aquaculture is the farming of aquatic organisms (such as finfish, shellfish or plants) in water (freshwater or marine). Aquaculture produces food fish, sport fish, bait fish, ornamental fish, crustaceans, mollusks, algae, sea vegetables, research animals, and fish eggs. Aquaculture also includes the production of ornamental fish for the aquarium trade, and growing plant species used in a range of food, pharmaceutical, nutritional, and biotechnology products. Stock restoration or "enhancement" is a form of aquaculture in which hatchery fish and shellfish are released into the wild to rebuild wild populations or coastal habitats such as oyster reefs. Business entities practicing stock enhancement did not report revenue for the purposes of this report.

Aquaculture is the fastest growing food production sector in the world, growing 6.2% annually between 2000 and 2012 (9.5% between 1990 and 2000) (FAO, 2014). It is estimated that 62% of food fish will be produced by aquaculture by the year 2030 (AES, 2013), which will require a 70% increase in global production (NIFA, 2016). The United States is the third largest market for seafood in the world but ranks fifteenth in terms of aquaculture production (FAO, 2014). The United States imports 91% of its seafood, leading to a $11.2 billion trade deficit (NMFS, 2016).

Maine has a long history of supplying North American markets with fresh, healthy seafood and is within a 24 hour truck ride of over 150 million customers. Maine has a reputation for high quality, sustainably produced, longer shelf life, seafood that represents a valued and established brand.

Maine had 107 business entities operating in 2014. Maine's aquaculture sector is composed of marine grow-out farms, marine hatcheries, freshwater grow-out farms, freshwater hatcheries, land-based aquaculture, and aquaponics.

Of the approximate 107 aquaculture businesses in production in Maine in 2014, 71 replied to the 2015 Maine Aquaculture Economic Impact Survey. In order to provide current insights on the nature of Maine's industry, the study aims to provide an up-to-date and accurate understanding of the economic impact aquaculture has on the state of Maine, and to determine aquaculture business owner and farm demographics.

METHODOLOGY

SURVEY DESIGN

THE MAIN purpose of this study is to investigate and quantify the economic impact of the aquaculture sector in Maine. The data also allows for a detailed descriptive analysis of the sub-sectors that make up Maine's aquaculture industry.

This study is a collaborative effort between the Aquaculture Research Institute (ARI) at the University of Maine, the Maine Aquaculture Innovation Center (MAIC), the Maine Aquaculture Association (MAA), and the School of Economics at the University of Maine.

There is no single database for all aquaculture businesses in Maine. Using Department of Marine Resources lease data, MAA membership information and expert consultations, a list of active aquaculture business entities was developed. In July 2015, the ARI mailed a survey to the 107 identified active aquaculture business entities. A postage paid envelope was enclosed, and the option to complete the survey online or over the phone was included. Mail reminders were sent out three weeks and six weeks after the initial mailing. Follow-up phone calls were made at eight weeks, or earlier if requested. The survey team informed farmers that the returned surveys would be handled by limited personnel within ARI to ensure confidentiality.

Of the 107 business owners contacted, 71 responded, yielding a response rate of 66.4%. A similar study for the Massachusetts shellfish industry reported a response rate of 35% (Barnes, 2015).

Twenty (28%) surveys were returned by mail, 34 (48%) were completed by phone, and 17 (24%) were completed online.

In keeping with the USDA National Agricultural Statistics Service's Census of Agriculture, no data are published that would disclose information about the operations of an individual business entity (NASS, 2012). For this reason, certain sub-sector information is withheld in this report.

PART 1: Economic Impact Analysis

THE MAINE aquaculture industry's statewide economic contribution was estimated using the returned survey data on revenue, employment, wages and salaries, and instate sales to value added activities (e.g. wholesaling of Maine aquaculture products, Maine aquaculture products sold within the state, etc.). Industry multiplier effects are estimated using the Maine IMPLAN model, which is an input-output framework (based on the U.S. input-output tables) that traces the flows of expenditures and income through the Maine economy with a complex system of accounts that are uniquely tailored to the region. Underlying these accounts is information regarding transactions occurring among businesses located in Maine, the spending patterns of households, and transactions occurring between Maine businesses and households, and the rest of the world.

Some of the data sources used to develop the IMPLAN model include County Business Patterns of the U.S. Census Bureau, Regional Economic Information System (REIS) data and input-output accounts from the U.S. Bureau of Economic Analysis, and ES-202 statistics from the U.S. Bureau of Labor Statistics.

Although the economic impact analysis is based on information from a sample of 71 operations that completed surveys, the results were extrapolated to the larger population of aquaculture producers. In addition, since the survey asked producers about the value-added chain of their products (e.g., sales to in-state wholesalers, direct-to-consumer sales in Maine, etc.), the economic impact analysis in this report captures the impacts of these value-added activities (e.g., in-state wholesaling of Maine aquaculture products, Maine aquaculture products sold in restaurants located within the state, etc.).

Analysis of the industry's

economic contribution captures the sales revenue, employment and labor income directly associated with Maine's aquaculture industry, as well as the multiplier effects supported by the spending of the aquaculture industry's businesses (i.e., indirect effects) and workers (i.e., induced effects). For the purposes of the economic impact analysis, the aquaculture industry is defined as the aquaculture producers (e.g., businesses raising mussels, Atlantic salmon, oysters, etc.), aquaculture service providers, and the in-state value-added activities that were reported on the survey (e.g., Maine aquaculture products sold in restaurants located within the state, etc.). This means that the direct employment figure represents the workers involved in growing aquaculture products, as well as Maine workers involved in the processing and wholesale/retail trade of in-state aquaculture products, and aquaculture service providers. Likewise, the multiplier effects capture — for example — the spending of workers employed by the aquaculture producers and the purchases made by the value-added operations. (See Appendix A for complete report)

PART 2: Descriptive Analysis

THE MAINE aquaculture sector is diverse and involves many different kinds of economic activity. For the purposes of this study, the aquaculture sector includes finfish, shellfish and sea vegetable production, and companies that provide services specifically to the aquaculture production sector. Companies that provided goods and services to companies beyond the aquaculture sector were not included (e.g. marine supplies, legal and accounting firms). State and federal hatcheries were included in the survey but did not report revenue. Research and academic institutions were not included in this survey but do make important additional economic impact.

Due to the small number of businesses in some of the sub-sectors, similar businesses were grouped together for analysis. The groups are as follows:

— **Finfish Aquaculture:** Atlantic salmon, baitfish, trout for resale, fish species reared in aquaponics systems, finfish species reared in land-based aquaculture systems, and ornamental finfish.

— **Shellfish Aquaculture:** oysters, mussels, clams, scallops, urchins.

— **Sea vegetables:** various kelp, red and green macroalgal species.

— **Service Providers:** consultancy, biotechnology, animal health services and other services.

This descriptive analysis reports the percentage summary of each variable. Medians are reported as a measure of central tendency. The purpose is to characterize the Maine aquaculture sector more vividly.

RESULTS
ECONOMIC IMPACT

PART 1: Economic Impact Analysis

The full economic impact report is shown in Appendix A.

TABLE 1 summarizes the annual statewide economic contribution of Maine's aquaculture industry. The direct impact of $73.4 million in output, 571 in employment, and $35.7 million in labor income can be interpreted as the sales revenue, full- and part-time jobs, and wages and salaries associated with Maine's aquaculture producers (e.g., operations that grow Atlantic salmon, oysters, mussels, etc.) as well as the economic activity associated with Maine companies involved in value-added activities (e.g., in-state wholesaling of Maine aquaculture products, Maine aquaculture products sold in restaurants located within the state, etc.). The multiplier effects measure the additional economic activity in Maine supported by the expenditures made by aquaculture producers and the companies involved in value-added activities, and the spending of their workers. The Maine aquaculture sector generates a statewide annual economic contribution, including multiplier effects, of an estimated $137.6 million in output (i.e., sales revenue), 1,078 full- and part-time jobs, and $56.1 million in labor income.

Results from the survey of Maine's aquaculture producers show the industry is characterized by mostly small (e.g., fewer than five workers) and start-up operations with a few large producers.

The top three species — in terms of 2014 sales — are Atlantic salmon, blue mussels and Eastern oysters.

Table 1. Annual Statewide Economic Contribution of the Maine Aquaculture Industry, 2014

	Direct Impact	Multiplier	Multiplier Effects	Total Impact
Output	$73,410,609	1.875	$64,237,661	$137,648,270
Employment	571	1.888	507	1,078
Labor Income	$35,675,486	1.572	$20,411,758	$56,087,244

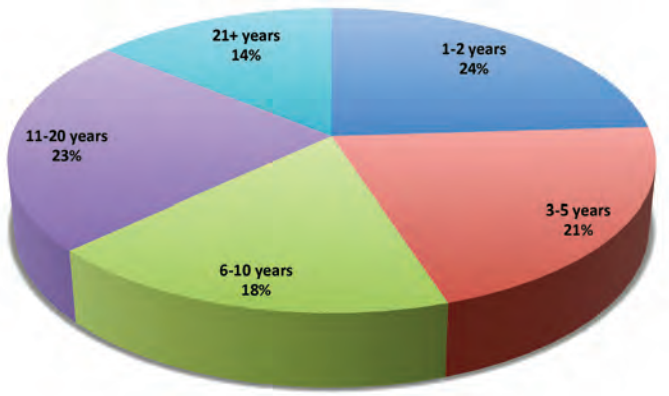
Notes. Direct impacts capture the output, employment and labor income of the aquaculture producers (e.g., businesses raising mussels, oysters, etc.) and the in-state value-added activities that were reported on the survey (e.g., Maine aquaculture products sold in restaurants located within the state, etc.). These direct impacts are based on information from the 2015 survey of aquaculture producers, and figures estimated by the Maine IMPLAN model. Multiplier effects are estimated by the Maine IMPLAN model.

PART 2: Descriptive Analysis

■ BUSINESS AGE

SURVEY RESPONDENTS were asked, "What year did your business begin operations?" Of the 107 business entities surveyed in 2014, 71 (66.4%) responded to this question. The average starting year for respondents was 2005. The median starting year was 2009. Figure 1 illustrates the distribution in age of businesses responding to the survey.

Figure 1. Distribution of responding company's reported number of years in operation



How long has your company been in operation?

These results illustrate a broad distribution of young, medium and late stage aquaculture business entities operating in Maine. Forty-five percent of operations that responded to the survey are less than 5 years old, and 37% are more than ten years old. This appears to demonstrate two distinct cohorts of aquaculture businesses in terms of years in operation.

The finfish sub-sector is the sub-sector with the oldest business entities. The average starting year for respondents was 1999 and the median starting year was 2003.

The shellfish sub-sector has two distinct populations, one group of older companies and one group of newer companies. The average starting year for respondents was 2005. Given that the median starting year was 2010, it's clear that the majority of respondents represent newer operations.

The average starting year for sea vegetable respondents was 2002 and the median starting year was 2011.

The average starting year for service provider respondents was 1998 and the median starting year was 2004.

■ FARM SIZE

SURVEY RESPONDENTS were asked two questions pertaining to acreage and numbers of leases/LPAs.

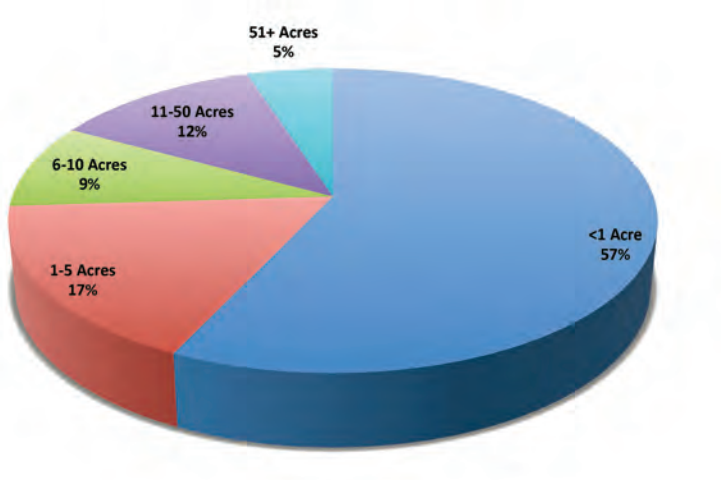
"How many acres did your business operate in 2014?"

"How many leases did your business hold in 2014?"

Of the 107 business entities surveyed, 57 (53.3%) responded to the question, "How many acres did your business operate in 2014?" Not all leased acreage is operated or actively farmed. In 2014, respondents were actively farming 727 acres (57%) of the total 1281.77 acres that were leased. The average acreage held by the respondents was approximately 14.3 acres. The median acreage held was <1 acre, and is skewed because of the large of respondents holding Limited Purpose Aquaculture Permits (LPAs). Each LPA occupies less than 0.01 acre (400 square feet) (See Figure 2).

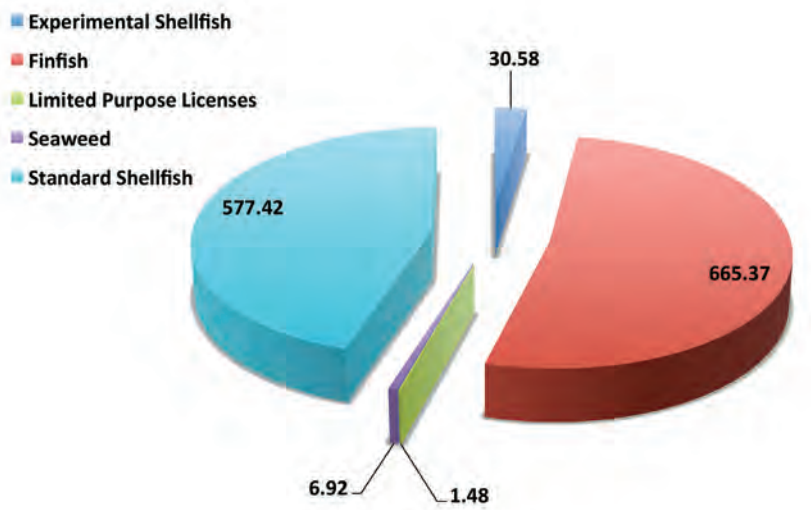
Figure 2. Distribution of total acreage for respondents in 2014

How many acres did your company operate in 2014?



Fifty-seven percent of respondents operated less than one acre, and when compared with the Maine Department of Marine Resources (DMR) data from 2014 (see Figure 3) it is likely that this predominantly represents LPA holders. However, the respondents to this survey also include land-based and freshwater aquaculture businesses. While not all LPAs are start-up businesses, when taken together with the age of the companies responding (Figure 1) and the high number of companies reporting zero revenue, it illustrates a large number of start-up companies responding to the survey. For the shellfish sub-sector, the average acreage held was 8.84 acres and the median acreage held was less than one acre. For the sea vegetables sub-sector, the average acreage held was 9.6 acres and the median acreage held was 3.5 acres.

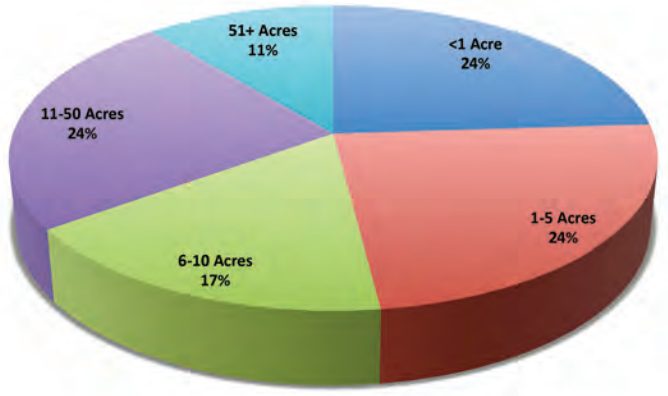
Figure 3. Total acreage by lease type according to 2014 ME Dept. of Marine Resources data



Acreage of Maine waters for aquaculture categorized by lease type

Excluding pre-revenue (zero revenue) businesses, the average acreage held by respondents is 34.2 acres and the median acreage held was 10 acres. This indicates that the sector is mostly composed of small to medium-sized business entities as shown in Figure 4, which shows that 65% of revenue generating companies operate with less than ten acres.

Figure 4. Distribution farm size (acres) for revenue-generating companies responding to the survey

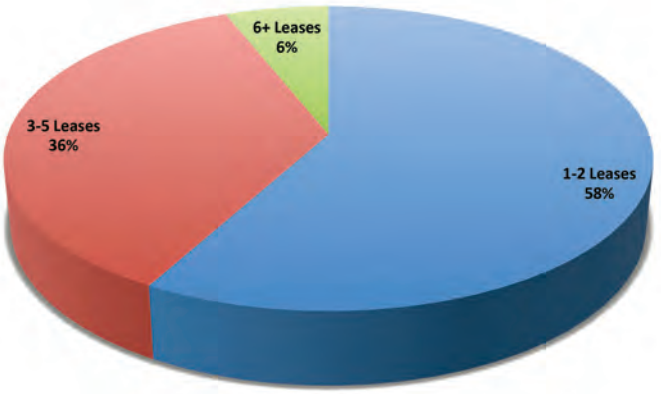


How many acres did you operate in 2014 (excluding pre-revenue companies?)

Of the 107 business entities surveyed, 53 (49.5%) responded to the question, "How many leases did your business hold in 2014?" Of the 336 leases active in 2014 (including Limited Purpose Aquaculture Licenses), the respondents accounted for 169 (50.2%) of those leases (see Figure 5). The average number of leases held by respondents was 3.25, including LPAs. The median number of leases held by respondents was 2, including LPAs. We conclude from this that the respondents represent fifty percent of the total leases and LPA's.

Figure 5. Number of leases and LPA's held by responding companies

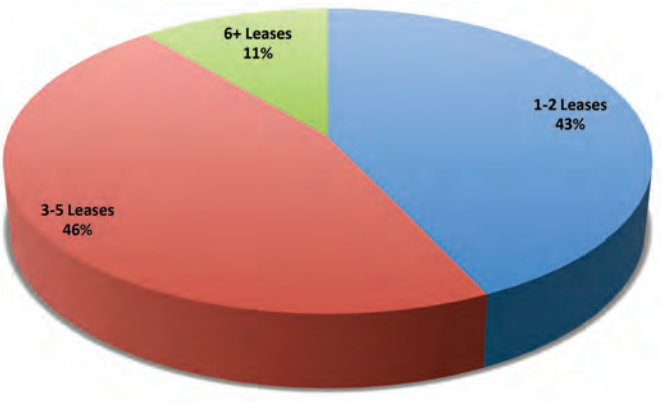
How many leases did your company hold in 2014?



Excluding pre-revenue businesses, the average number of leases held by respondents was 4.2 leases including LPAs, and the median number of leases held was 3 leases including LPAs (see Figure 6). This indicates that the sector is mostly composed of small to medium-sized business entities. For the shellfish sub-sector, the average number of leases held was 2.93 leases and the median number of leases held was 2. For the sea vegetables sub-sector, the average number of leases held was 2 leases and the median number of leases held was 1.5.

Figure 6. Number of leases and LPA's held by revenue-generating responding companies

How many leases did your company hold in 2014 (excluding pre-revenue companies)?



■ PRIMARY LEASEHOLDER DEMOGRAPHICS

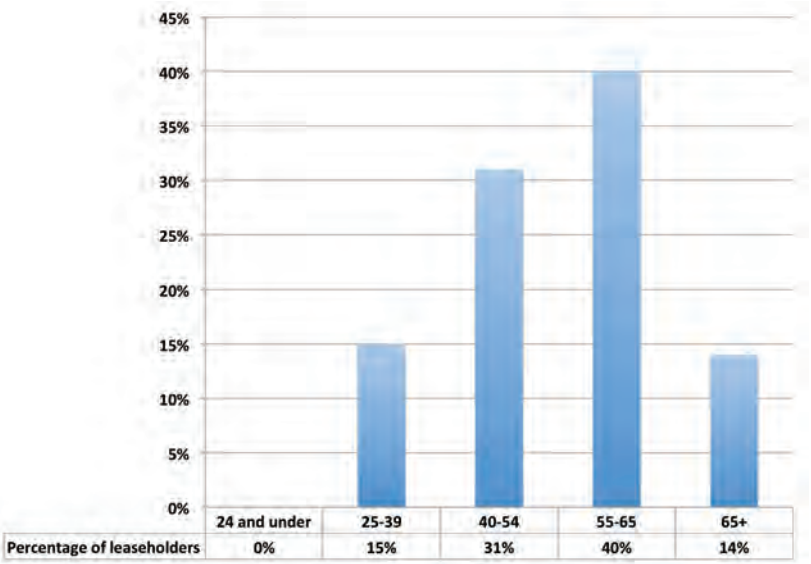
SURVEY RESPONDENTS were asked the question, "What is the age of the primary leaseholder?" Of the 107 business entities surveyed, 58 (54.2%) responded. The data for this question represents the age distribution of the responding primary lease-holders and not that of the workforce as a whole.

No respondents were ages 24 and under and 14% of respondents were ages 65 and over (See Figure 7). Seventy-one percent of the respondents were between the ages of 40 and 65 years old.

For the primary leaseholders responding within the finfish sub-sector, 100% of respondents were ages 55 to 65. For the shellfish sub-sector, 14% of respondents were ages 25 to 39, 32% of respondents were ages 40 to 54, 38% of respondents were ages 55 to 65, and 16% of respondents were ages 65 and up.

For the sea vegetables sub-sector, 17% of respondents were ages 25 to 39, 33% of respondents were ages 40 to 54 and 50% of respondents were ages 55 to 65. For the service providers, 33% of respondents were ages 40 to 54 and 66% of respondents were ages 55 to 65.

Figure 7. Age distribution of primary lease holders responding to the survey



What is the age of the primary leaseholder?

■ SALES REVENUE

OF THE 107 business entities surveyed, 71 (66.4%) responded to the question, "What was your business's sales revenue in 2014?" (see Figure 8). Thirty-nine percent of respondents reported $0 (pre-revenue) in 2014 sales revenue. Approximately one quarter of respondents reported gross revenues of less than $50,000 most likely representing startup and younger companies. Seventeen percent of the responding companies were generating greater than $1,000,000 in sales revenues.

For the purposes of confidentiality, we can not report specific data for the finfish sub-sector.

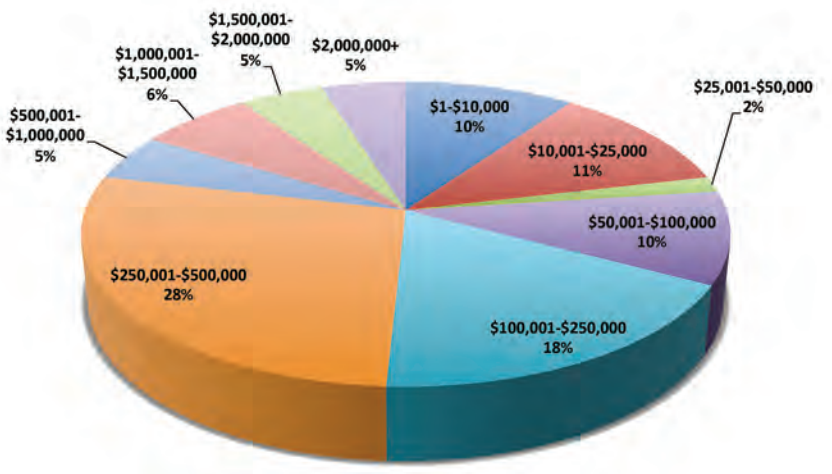
For the shellfish sub-sector, 46% of respondents reported $0 (pre-revenue) in 2014 sales revenue, 5% of respondents reported revenue between $1 and $10,000, 7% reported revenue between $10,001 and $25,000, 4% reported revenue between $25,001 and $100,000, 12% reported revenue between $100,001 and $250,000, 16% reported revenue between $250,000 and $500,000 and 10% reported revenue greater than $1,000,000.

For the sea vegetables sub-sector, 42% percent of respondents reported less than $100,000, 29% reported revenue between $250,000 and $500,000 and 28% reported revenue greater than $1,000,000.

For service providers, 37.5% of respondents reported revenue less than $500,000, 25% reported revenue between $500,001 and $1,000,000, 37.5% reported revenue greater than $1,000,000.

Figure 8. Reported 2014 sales revenue for companies responding to the survey

What was your company's sales revenue in 2014 (excluding pre-revenue companies)?



■ EMPLOYMENT

OF THE 107 entities surveyed, 64 (59.8%) responded to the question, "How many employees did your business have in 2014 (including owners)?" (see Figure 9). The respondents reported a total of 202 (63% of total jobs) full-time, all year employees; 31 (10%) full-time, seasonal employees; 38 (12%) part-time, all year employees; and 47 (15%) part-time, seasonal employees (these numbers include owners). Respondents reported jobs related only to aquaculture production. Jobs for processing were not included.

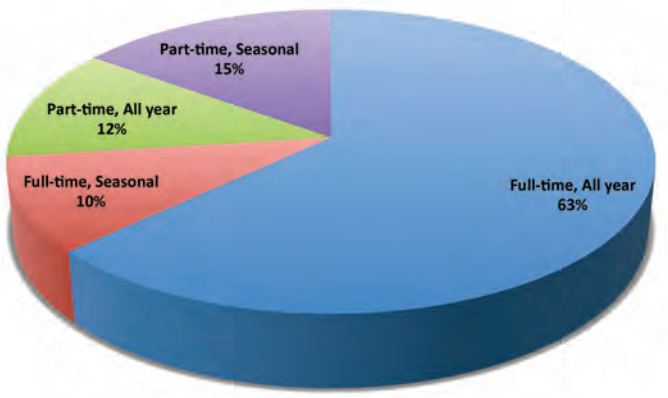
For the purposes of confidentiality, we cannot report specific data for the finfish sub-sector.

For the shellfish sub-sector, the respondents reported a total of 75 (43.4% of total jobs) full-time, all year employees; 25 (14.5%) full-time, seasonal employees; 29 (16.7%) part-time, all year employees; and 44 (25.4%) part-time, seasonal employees.

For the sea vegetables sub-sector, the respondents reported a total of nine (60% of total jobs) full-time, all year employees; one (6.7%) full-time, seasonal employee; three (20%) part-time, all year employees; and two (13.3%) part-time, seasonal employees.

The majority of jobs related to aquaculture production are full-time, all year positions. Less than 30% of employment is seasonal.

Figure 9. Distribution of full-time and seasonal employees for responding companies (including owners)

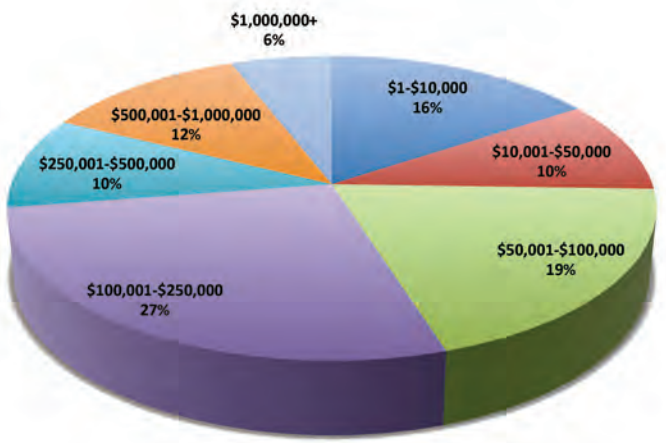


How many employees did your company have in 2014 (including owners)?

Survey respondents were also asked the question, "What was your business's total compensation to employees and owners in 2014 (including benefits)?" and of the 107 entities surveyed, 64 (59.8%) responded. Forty-nine percent of respondents reported no compensation to employees and owners in 2014, reflecting the large number of pre-revenue company respondents to the survey. Figure 10 illustrates the distribution of payroll for revenue generating companies indicating that 75% of the respondents reported payroll and benefit expenditures greater than $50,000.

Figure 10. Distribution of total annual compensation paid to employees and owners including benefits in 2014 (excluding pre-revenue respondents)

What was your business's total compensation to employees and owners in 2014 (excluding pre-revenue businesses)?



■ PRODUCTS AND SERVICES

SURVEY RESPONDENTS were asked the question, "What did your company produce in 2014?" and of the 107 business entities surveyed, 44 (41%) responded (see Table 2). Similar sub-sectors were grouped together as follows: finfish aquaculture includes Atlantic salmon, baitfish, trout for resale, fish species reared in aquaponics systems, and finfish species reared in land-based aquaculture systems, but due to confidentially concerns, aggregate data in this sub-sector can not be reported. Shellfish aquaculture includes oysters, mussels, clams, scallops and seed sales. Sea vegetables include kelp species.

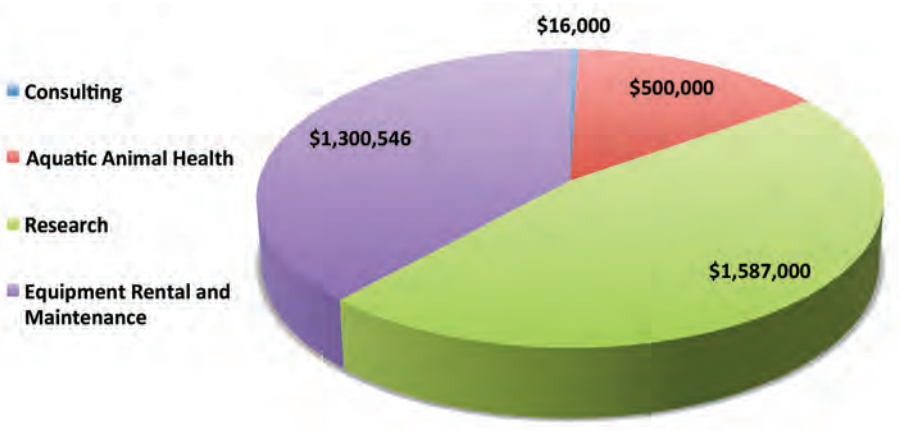
Table 2. Farm yield by sub-sector, 2014

Category	Amount Produced	2014 Farm Gate Sales
Finfish	1	1
Shellfish and Seed (Sales)	11,068,980 pieces[2]	$5,268,596
Sea Vegetables	54,301 pounds	$520,342

- [1]For the purposes of confidentiality, we cannot report specific numbers for this sub-sector. (See Appendix B)
- [2]Excludes seed production

Service providers were asked, "Which service did you provide?" and of the 107 business entities surveyed, 11 (10.3%) responded (see Figure 11). The aquaculture services provided by respondents accounted for a total of $3,403,546 in revenue.

Figure 11. Distribution of revenues for responding service providers in 2014



For service providers, which service did your company provide?

■ END DESTINATION OF PRODUCE

SURVEY RESPONDENTS were asked, "Where does your business send its produce?" and of the 107 businesses surveyed, 31 (29%) revenue-generating companies responded (see Table 3).

For the finfish sub-sector, 29% of respondents sent their produce to wholesalers or distributors in Maine, 29% sent their produce to end users (restaurants, markets, direct to consumer) in Maine, 29% sent their produce to wholesalers or distributors in the United States, 14% sent their produce to end users in the United States and 14% sent their produce to international processors.

For the shellfish sub-sector, 84% percent of respondents sent their produce to wholesalers or distributors in Maine, 54% sent their produce to end users (restaurants, markets, direct to consumer) in Maine, 35% sent their produce to wholesalers or distributors in the United States, 13% sent their produce to end users in the United States, 3% sent their produce to processors in the United States.

For the sea vegetables sub-sector, 25% of respondents sent their produce to wholesalers or distributors in Maine, 50% sent their produce to end users (restaurants, markets, direct to consumer) in Maine, 25% sent their produce to processors in Maine, 50% sent their produce to wholesalers or distributors in the United States, 25% sent their produce to end users in the United States.

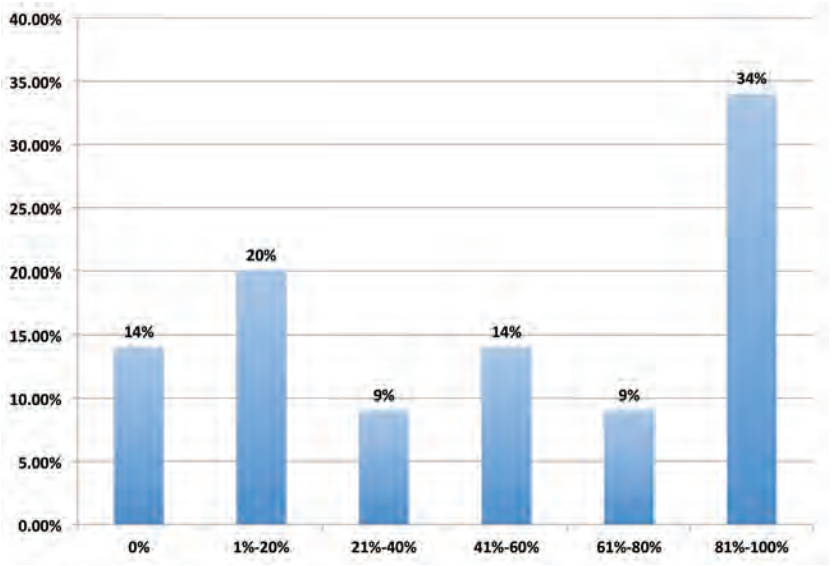
Table 3. Produce Destination by Type for 2014

Location	Wholesaler/Distributor	End User	Processor
Maine	81%	52%	0%
USA	52%	19%	3%
International	0%	3%	3%

Note: Percentages represent the business entities across the entire sector that send at least some of their produce to each destination. Percentage totals sum to more than 100% because a single business entity can send produce to multiple destinations.

In a separate question, survey respondents were asked, "What percent of your business's sales were in-state in 2014?" Of the 107 business entities surveyed, 55 (51.4%) responded.

Figure 12. Percent of sales that were in-state in 2014



What percent of your business's sales are in-state (excluding pre-revenue businesses)?

A large majority of revenue-generating respondents made sales in-state in 2014, and 34% said their business made 81-100% of their sales in-state. The shellfish sub-sector reported the greatest percentage of business entities that made sales in-state in 2014.

■ BUSINESS EXPENDITURES

SURVEY RESPONDENTS were asked, "Approximately how much did you spend on each of the following in 2014?"

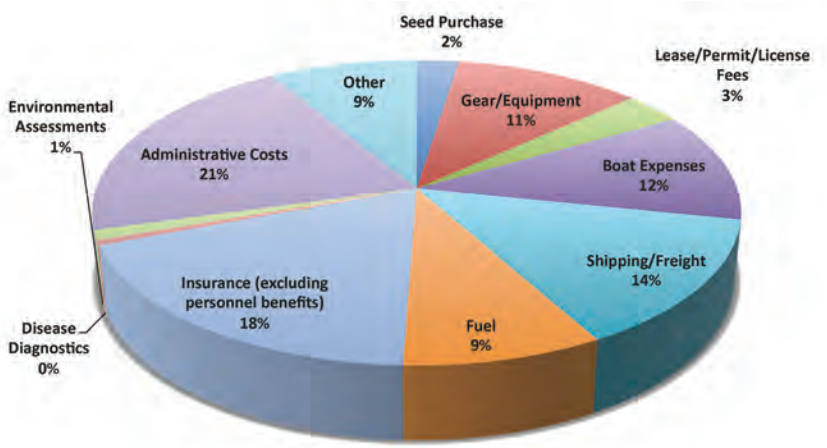
Of the 107 business entities surveyed, 54 (50.5%) responded. Respondents reported a total of $24,501,661 for all expenditures in 2014. Feed accounted for a high percentage of expenditures for the entire sector and thus was excluded from the report due to a need to maintain confidentiality among the respondents. Excluding feed, administration, insurance, and shipping and freight costs are the three highest expenditures.

For the finfish sub-sector, for the purposes of confidentiality, we cannot report specific numbers for this sub-sector.

For the shellfish sub-sector, respondents reported the distribution of expenditures as follows: 10.9% went towards seed purchase; 26% towards gear and equipment, 3.4% towards leases, permits and license fees; 9.4% towards boat expenses; 11.3% towards freight and shipping; 7% towards fuel; 9.2% towards insurance; 20.2% towards administrative costs; and 2.1% towards other costs.

For the sea vegetables sub-sector, respondents reported the distribution of expenditures as follows: 10.5% went towards seed purchase; 31.8% towards gear and equipment, 4.7% towards leases, permits and license fees; 7.0% towards boat expenses; 6.5% towards freight and shipping; 6.5% towards fuel; 6.0% towards insurance; 1.3% towards disease diagnostics; 25.6% towards administrative costs; and 2.1% towards other costs.

Figure 13. Expenditures (excluding feed) by Maine aquaculture businesses in 2014



2014 Maine aquaculture expenditures by type (excluding feed)

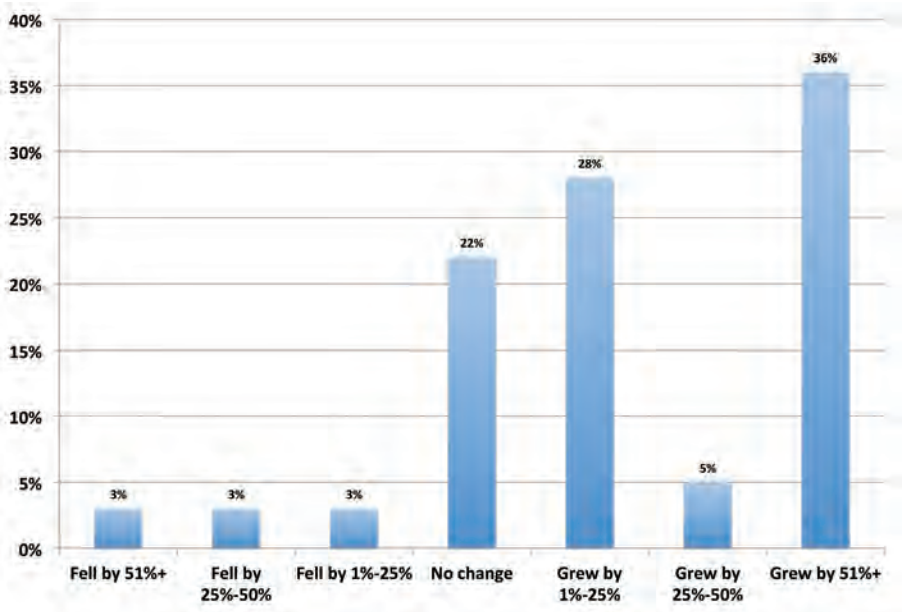
Survey respondents were also asked a question regarding capital investment: "Approximately how much did you did you spend on capital investments in the past three years (2012-2014)?" Of the 107 business entities surveyed, 64 (59.8%) responded. Respondents reported a total of $10,765,341 in capital expenditures over the last three years. The average investment made was $192,238 and the median investment was $14,500. For the shellfish sub-sector, the average investment made was $61,369 and the median investment was $11,000. For the sea vegetable sub-sector, the average investment made was $42,000 and the median was $5,000.

■ REFLECTING ON THE PAST AND THE FUTURE

OF THE 107 business entities survey, 61 (57.0%) responded to the question, "By how much has your company's sales revenue changed over the last five years?" (see Figure 17). Twenty-five (40.1%) of the respondents answered saying this question was not applicable because they were new businesses. Of the respondents that indicated that sales revenue had changed for their company, 91% of respondents reported stable or increased growth between 2009-2014. The greatest increase was reported by the shellfish sub-sector.

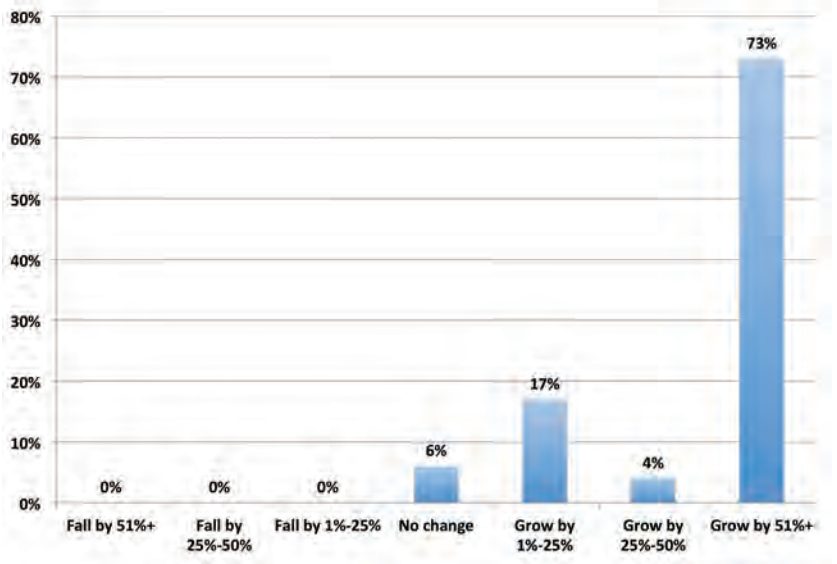
Figure 14. Self-reported sales revenue changes between 2009-2014 (all sectors)

How much has your company's sales revenue changes over the last 5 years?



Survey respondents were also asked, "By how much do you expect your business's sales revenue to change by 2020?" Of the 107 business entities surveyed, 60 (56.1%) responded (See Figure 18). Ten (16.7%) of the respondents answered saying this question was not applicable.

Figure 15. Self-reported sales growth projections between 2014–2020 (all sectors)



How much do you expect your business's sales revenue to change by 2020?

For the respondents to which this question applied, none expected a fall in revenue by 2020, although 6% of businesses predicted their revenue would not change. There is substantial optimism in the aquaculture sector with 73% of respondents predicting 51% or greater increase in sales revenue by 2020. This optimism is greatest in the shellfish, sea vegetable and service providers sub-sectors and is probably spurred by the newer companies.


SPECIALS

CONCLUSIONS
ECONOMIC IMPACT

- In 2014 Maine's aquaculture sector had a DIRECT economic impact of $73.4 million in output, 571 in employment, and $35.7 million in labor income.

- Including multiplier effects, Maine's aquaculture sector generates a statewide annual economic contribution of $137.6 million in output (i.e., sales revenue), 1,078 full- and part-time jobs, and $56.1 million in labor income.

Table 5. Annual Statewide Economic Contribution of the Maine Aquaculture Industry, 2003

	Direct Impact	Multiplier	Multiplier Effects	Total Impact
Output	$81,902,000	1.875	$48,589,000	$130,491,000
Employment	524	1.887	837	1,361
Labor Income	$29,225,000	1.572	$26,589,000	$55,814,000

Table 6. Annual Statewide Economic Contribution of the Maine Aquaculture Industry, 2007

	Direct Impact	Multiplier	Multiplier Effects	Total Impact
Output	$30,000,000	1.666	$20,000,000	$50,000,000
Employment	550	1.364	200	750
Labor Income	$16,000,000	1.375	$6,000,000	$22,000,000

Table 7. Annual Statewide Economic Contribution of the Maine Aquaculture Industry, 2014

	Direct Impact	Multiplier	Multiplier Effects	Total Impact
Output	$73,410,609	1.875	$64,237,661	$137,648,270
Employment	571	1.888	507	1,078
Labor Income	$35,675,486	1.572	$20,411,758	$56,087,244

Trends between economic impact studies in 2003, 2007 and 2014 show a dip in the total economic impact in 2007 that has recovered by 2014.

It should be noted that total economic impact is highly influenced by the three-year bay management production cycle of Atlantic salmon, and 2014 represented the lowest year in that three-year cycle.

Insights into the Sector

- The top three species — in terms of 2014 sales — are Atlantic salmon, blue mussels and Eastern oysters.
- All sub-sectors include business entities reporting more than $2 million in sales revenue in 2014. The finfish and service providers sub-sectors did not include pre-revenue business entities in 2014.
- The majority of jobs related to aquaculture production are full-time, all year positions. Less than 30% of employment is seasonal.
- Thirty-nine percent of the respondents reported $0 revenue. An unknown portion of this percentage represents start-up companies.
- Research services accounts for 47% of the revenue reported by aquaculture business entities providing services.
- For all expenditure categories, feed is the highest cost and accounts for 57% of expenditures. Excluding feed, administration, insurance, and shipping and freight costs are the three highest expenditures.

Development of Sector

- A large portion of the sector is new. Twenty-four percent of respondents began operations in the last two years and another 21% began operations in the last three to five years.
- The sector's expansion is reflected by the fact that a large portion of the sector is pre-revenue. Thirty-nine percent of respondents reported $0 (pre-revenue) in 2014 sales revenue.
- The majority of the sector is composed of small to medium-sized businesses. Size of business is demonstrated in revenue, leases held and farm acreage.
- These businesses are growing. Some business entities reported a fall in sales revenue over the last five years, but the majority reported an increase in sales. The greatest increase was reported by the shellfish sub-sector.

Insight into Sales

- Eighty-six percent of aquaculture producers send their produce to wholesalers or distributors.
- A large majority of business entities in the sector made sales in-state in 2014. The shellfish sub-sector reported the greatest percentage of business entities that made sales in-state in 2014.

Future Optimism

- The survey results suggest substantial optimism in the aquaculture sector with 73% of respondents predicting 51% or greater increase in sales revenue by 2020. This optimism is greatest in the shellfish, sea vegetable and service providers sub-sectors and is probably spurred by the newer companies.
- Comments mentioned by respondents within the survey referred to two key barriers to growth: regulatory issues, and access to capital.

REFERENCES

AES (Agriculture and Environmental Services), The World Bank, 2013. Fish to 2030: Prospects for Fisheries and Agriculture [Internet]. [Cited 17 May 2016.] http://www.fao.org/docrep/019/i3640e/i3640e.pdf

Barnes, Nora Ganim. 2015. Massachusetts Shellfish Aquaculture Economic Impact Study. University of Massachusetts Dartmouth, Charlton College of Business, Center for Marketing Research.

FAO, 2014. The State of World Fisheries and Aquaculture 2014 [Internet]. [Cited 17 May 2016.] http://www.fao.org/3/a-i3720e/i3720e01.pdf

Gabe T, McConnon J. 2016. Economic Contribution of Maine's Aquaculture Industry [Report]. University of Maine, School of Economics. (See Appendix A)

NASS (National Agricultural Statistics Service), USDA, 2012. 2012 Census of Agriculture Appendix A: Statistical Methodology [Internet]. [Cited 17 May 2016.]
https://www.agcensus.usda.gov/Publications/2012/Full_Report/Volume_1,_Chapter_1_US/usappxa.pdf

NIFA (National Institute of Food and Agriculture), USDA, 2016. Aquaculture [Internet]. [Cited 17 May 2016.] https://nifa.usda.gov/program/aquaculture

NMFS (National Marine Fisheries Service), NOAA, 2016. Aquaculture in the United States [Internet]. [Cited 17 May 2016.]
http://www.nmfs.noaa.gov/aquaculture/aquaculture_in_us.html

APPENDICES

APPENDIX A

ECONOMIC CONTRIBUTION OF MAINE'S AQUACULTURE INDUSTRY[1]

University of Maine, School of Economics, Staff Paper #623

Todd Gabe, Professor of Economics (todd.gabe@maine.edu)

James C. McConnon, Jr., Extension Business and Economics Specialist and Professor of Economics (mcconnon@maine.edu)

SUMMARY OF MAIN FINDINGS

MAINE'S AQUACULTURE industry includes businesses, educational and non-profit organizations, and individuals involved in activities such as (but not limited to) the production of aquaculture goods (e.g., oysters, mussels, kelp, Atlantic salmon); value-added activities including wholesaling, direct-to-consumer and retail sales, and processing of aquaculture products; and research and development related to the issues facing the aquaculture industry.

The results presented in this report are based on a survey of Maine's aquaculture industry conducted in 2015 (the survey collected data covering 2014) as a collaborative effort by the University of Maine Aquaculture Research Institute, Maine Aquaculture Association, and Maine Aquaculture Innovation Center. The survey effort identified (and attempted to survey) 107 aquaculture producers in Maine. Although our analysis is based on information from a sample of 71 operations that completed surveys, the results are "scaled up" to the larger population of aquaculture producers. In addition, since the survey asked producers about the value-added chain of their products (e.g., sales to in-state wholesalers, direct-to-consumer sales in Maine, etc.), the economic impact analysis in this report captures the impacts of these value-added activities (e.g., in-state wholesaling of Maine aquaculture products, Maine aquaculture products sold in restaurants located within the state, etc.).

The operations covered in the 2015 survey capture the diversity of the industry in Maine. According to the survey, the top three species by number of producers are oysters, mussels and kelp. The top three species by 2014 sales revenue (i.e., farm gate sales) are Atlantic salmon, mussels and oysters.

Figure 1 shows the 2014 employment size distribution of the operations covered in the survey. Maine's aquaculture sector is characterized by a large percentage of very small (and start-up) producers, as well as a few large operations. About three-quarters of the survey respondents employ fewer than five workers, while only about 1 in 10 aquaculture producers employ more than eight workers.

The Maine aquaculture industry's statewide economic contribution is estimated using data provided by the producers on revenue, employment, wages and salaries, and in-state sales to value-added activities (e.g., wholesaling of Maine aquaculture products, Maine aquaculture products sold in restaurants located within the state, etc.). Industry multiplier effects are estimated using the Maine IMPLAN model, which is an input-output framework (based on U.S. input-output tables) that traces the flows of expenditures and income through the Maine economy with a complex system of accounts that are uniquely tailored to the region. Underlying these accounts is information regarding transactions occurring among businesses located in Maine, the spending patterns of households, and transactions occurring between Maine business and households and the rest of the world. Some of the data sources used to develop the IMPLAN model include County Business Patterns of the U.S. Census Bureau, Regional Economic Information System (REIS) data and input-output accounts from the U.S. Bureau of Economic Analysis, and ES-202 statistics from the U.S. Bureau of Labor Statistics.

Analysis of the industry's

economic contribution captures the sales revenue, employment and labor income directly associated with Maine's aquaculture industry, as well as the multiplier effects supported by the spending of the aquaculture industry's businesses (i.e., indirect effects) and workers (i.e., induced effects). For the purposes of the analysis, the aquaculture industry is defined as the aquaculture producers (e.g., businesses raising mussels, Atlantic salmon, oysters, etc.) and the in-state value-added activities that were reported on the survey (e.g., Maine aquaculture products sold in restaurants located within the state, etc.). This means that the direct employment figure represents the workers involved in growing aquaculture products, as well as Maine workers involved in the processing and wholesale/retail trade of in-state aquaculture products. Likewise, the multiplier effects capture — for example — the spending of workers employed by the aquaculture producers and the purchases made by the value-added operations.[2]

Table 1 summarizes the annual statewide economic contribution of Maine's aquaculture industry. The direct impact of $73.4 million in output, 571 in employment, and $35.7 million in labor income can be interpreted as the sales revenue, full- and part-time jobs, and wages and salaries associated with Maine's aquaculture producers (e.g., operations that grow Atlantic salmon, oysters, mussels, etc.) as well as the economic activity associated with Maine companies involved in value-added activities (e.g., in-state wholesaling of Maine aquaculture products, Maine aquaculture products sold in restaurants located within the state, etc.). The multiplier effects measure the additional economic activity in Maine supported by the expenditures made by aquaculture producers and the companies involved in value-added activities, and the spending of their workers. The Maine aquaculture sector generates a statewide annual

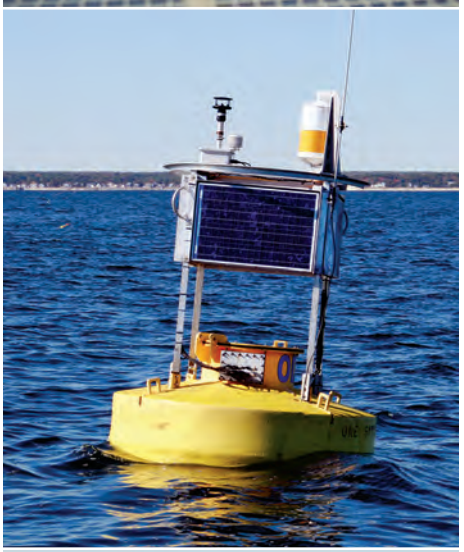
Table 1. Annual Statewide Economic Contribution of the Maine Aquaculture Industry, 2014

	Direct Impact	Multiplier Effects	Total Impact
Output	$73,410,609	$64,237,661	$137,648,270
Employment	571	507	1,078
Labor Income	$35,675,486	$20,411,758	$56,087,244

Notes. Direct impacts capture the output, employment and labor income of the aquaculture producers (e.g., businesses raising mussels, oysters, etc.) and the in-state value-added activities that were reported on the survey (e.g., Maine aquaculture products sold in restaurants located within the state, etc.). These direct impacts are based on information from the 2015 survey of aquaculture producers, and figures estimated by the Maine IMPLAN model. Multiplier effects are estimated by the Maine IMPLAN model.

[1] Supported by National Science Foundation award #1355457 to Maine EPSCoR at the University of Maine. This work is also based upon research supported in part by Hatch Multistate Grant # ME0-L-7-00525-13 (NE 1049) from the USDA National Institute of Food & Agriculture. The authors of this report thank Avery Cole, Anne Langston and the entire aquaculture industry survey team (University of Maine Aquaculture Research Institute, Maine Aquaculture Association, and Maine Aquaculture Innovation Center) for their efforts in collecting the data that made this study possible. Finally, the authors thank Caroline Noblet and Mario Teisl for comments on an earlier draft of the report.

[2] Adjustments were made to the economic impact model to prevent double counting of impacts within the industry.



economic contribution, including multiplier effects, of an estimated $137.6 million in output (i.e., sales revenue), 1,078 full- and part-time jobs, and $56.1 million in labor income.

In summary, results from a survey of Maine's aquaculture producers show the industry is characterized by mostly small (e.g., fewer than five workers) and start-up operations with a few large producers, and the top three species — in terms of 2014 sales — are Atlantic salmon, mussels and oysters. Overall, the Maine aquaculture sector generates a statewide annual economic contribution, including multiplier effects, of an estimated $137.6 million in output (i.e., sales revenue), 1,078 full- and part-time jobs, and $56.1 million in labor income.

Appendix B

AQUACULTURE SUBSECTOR RANKINGS

	Rank	
	1	2
Acres	Shellfish	Finfish
Leases	Shellfish	Finfish
Revenue	Finfish	Shellfish
Jobs	Shellfish*	Finfish*
Farm Gate Sales	Finfish	Shellfish

*The Finfish subsector is host to more full-time, all-year jobs. Shellfish has more jobs in total.

Appendix C

SPECIES FARMED BY SURVEY RESPONDENTS IN 2014

Finfish	Shellfish	Sea Vegetables
Salmon	Oysters	Kelp
Trout	Mussels	
Baitfish	Scallops	
Smelt		

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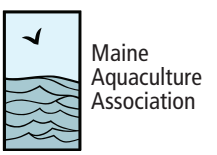
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