Alaska Mariculture Task Force

Established by Governor Walker's Administrative Order #280

Directive: *"to provide recommendations to develop a viable and sustainable mariculture industry producing shellfish and aquatic plants for the long-term benefit of Alaska's economy, environment and communities*

AGENDA - *Draft*

April 26, 2017, 8:30am-12:30pm

DCCED Commissioner's Conference Room, 333 W Willoughby 9th Floor, Juneau, AK

Teleconference info: 1-800-315-6338 access code: 29660

1) Roll Call
2) Review and approve agenda
3) Review and approve minutes: March 14, 2017
4) Public introductions & comments
5) Old business
    a. McDowell Group discussion (~1 hour):
        i. Report on progress to date – presentation of Chpt. 1
        ii. Discuss in context of outline of Phase 2 project
        iii. Discussion of integration of AC work
    b. Updates from Advisory Committee (AC) Chairs
        i. Mike Stekoll – Research, Development & Environmental Info AC
        ii. Sam Rabung – Regulatory Issues AC
        iii. Angel Drobnica & Jeff Hetrick – Investment & Infrastructure AC
        iv. Paula Cullenberg – Workforce Development AC
        v. Heather McCarty – Public Education & Marketing AC
    c. Update on legislation
        i. HB 76 / SB 95 - Mariculture Revolving Loan Fund
        Sponsors (4): REPRESENTATIVES ORTIZ, Kreiss-Tomkins, Kito, Gara
        Sponsors (5): SENATORS STEVENS, Costello, Bishop, Micciche, Gardner
        ii. HB 128 / SB 89 – Shellfish Enhancement
        Sponsor (1): REPRESENTATIVE ORTIZ
        Sponsors (2): SENATORS STEVENS, Micciche
    d. Communications:
        i. Past presentations: SE Conference, Sitka Chamber, others?
        ii. Future presentations: NXN, Julie Decker, May 12 in Anchorage; Others
        iii. Press release options: legislation, aquatic farm permit applications, other topics?
    e. Update on ARPA-E – final application due May 15

6) New Business
    a. Discussion: Scotland's Aquaculture Strategic Plan
    b. Discuss NOAA Marine Aquaculture Strategic Plan
    c. Discuss invitations for expert speakers for future Skype conferences
    d. Discuss diagram of comprehensive planning process
    e. Update on Alaska Sea Grant NOAA grant applications (Cullenberg)
    f. Update on old NOAA facility in Juneau (Stekoll)
7) Next Steps & homework assignments
8) Set next 3 meetings - date/time/place (May 25, June 28, ?)
9) Task Force members sign form for documenting NOAA in-kind match
10) Closing Comments

**The first commercial harvest of Alaska-grown seaweed took place on April, 20, 2017.*

Attachments:

- MTF Minutes, March 14, 2017 – DRAFT
- McDowell Group – Chapter 1 – DRAFT
- Outline of Phase 2 by McDowell Group
- Advisory Committee Agendas/Minutes/Notes (see MTF website)
- HB 76 / SB 95– Mariculture Revolving Loan Fund Bill (see page link)
- HB 128 / SB 89 - Shellfish Enhancement Bill (see page link)
- Aquaculture Growth to 2030: A Strategic Plan for farming Scotland's Seas (2017)
- NOAA Marine Aquaculture Strategic Plan 2016-2020 (excerpt only)
- Diagram of Comprehensive Planning Process (TBD)
- NOAA In-Kind Match Form (TBD)
- The New Zealand Aquaculture Strategy (*links provided only* – hardcopies were included in original MTF binders):
    - Phase I (2006)
    - Aquaculture in New Zealand (Investment New Zealand) (2006)
    - New Zealand Aquaculture: Market Development Strategy (2008)
    - Aquaculture New Zealand: Research Strategy (2009)
    - Aquaculture Growth Strategy Phase II (2011)
    - Phase II – 5-year Action Plan (2012)
    - New Zealand Aquaculture: A Sustainable Growth Story (2011)

THE STATE of ALASKA
GOVERNOR BILL WALKER

Department of Commerce, Community, and Economic Development

OFFICE OF THE COMMISSIONER

P.O. Box 110800
Juneau, AK 99811-0800
Main: 907.465.2500
Fax: 907.465.5442

Alaska Mariculture Task Force (MTF) Meeting Minutes
March 14, 2017

Attendees
Mariculture Task Force members attending: Julie Decker, Angel Drobnica, Sam Rabung, Jeff Hetrick, Paula Cullenberg, Mike Stekoll, Heather McCarty, Chris Whitehead, Chris Hladick
Members of the Public: Tamsen Peeples-Blue Evolution, Kirsten Shelton-Walker and Stephanie Warpinksi- McDowell Group, Charlotte Regula-Whitefield- Knauss Fellow at Senator Murkowski's office, Eva Bornstein- Juneau Economic Development Council, Amanda Compton, Mark Scheer- Alaska Fisheries Development Foundation,
Barbara Blake- Office of Lieutenant Governor Byron Mallott
Cynthia Pring-ham- Department of Fish and Game
Linda Mattson - Department of Commerce, Community, and Economic Development

Materials distributed to task force members included: Agenda for March 14 meeting, minutes from February 17 meeting, AFDF Documentation form, advisory committee minutes, HB 76, draft letters of support for draft bills, HB 128, McDowell Group Phase 2 Report Outline, MTF Planning diagram, New Zealand Aquaculture Strategy Five-Year Action Plan handout

1:07am Chairman Chris Hladick called the meeting to order

Agenda was reviewed
Sam Rabung motioned to approve the agenda/ Jeff Hetrick seconded
Heather McCarty requested to add agenda items under 6d to include discussion of the plan itself and not just the planning process. Agenda was approved as amended by consensus.

February 17 meeting minutes were reviewed
Julie Decker motioned to approve the minutes from the February 17th meeting/ Heather McCarty seconded.
Sam Rabung requested that the spellings of both his and Charlotte Regula-Whitefield be adjusted to reflect the correct spellings. Charlotte is a SeaGrant Knauss Fellow working in Senator Murkowski's office.

Public Introductions & Comment
1:11- Commissioner Hladick opened public comment
No public comment
1:11- Commissioner Hladick closed public comment

Old Business: Updates from Advisory Committee Chairs

Mike Stekoll AC met 3/10 spoke at length regarding the short term goals of the AC

- The short term goal that they have initially identified is to look for research priorities for oysters, geoducks, and seaweed. They have members researching those three items to start.
- Heather McCarty asked if Mike would consider additional items to look at. She will send her questions to Mike

Sam Rabung- AC met 3/13 and have their next meeting scheduled for 3/24. They will discuss opportunities and fixes for regulatory issues at their 3/24 meeting and expect to have a draft to the whole task force by 4/17

Angel Drobnica- Met 3/9

- Discussed opportunities for funding the mariculture industry
- Discussed existing barriers including business development and scale as well as labor costs
- Discussed the idea of creating an interactive map targeted at potential investors as a possible recommendation

Paula Cullenberg- haven't had an official meeting since 2/17 but had an informal meeting with Julie Decker, Barbara Blake, and Myrna Gardner.

Discussed the possibility of hosting a month long training on mariculture

Heather McCarty- Met 3/13 will have notes to distribute shortly

- Discussed marketing and the need for it
- Discussed with McDowell how their outline identifies markets but does not flesh them out
- Discussed different impediments to marketing the mariculture industry including transportation, sickness such as Paralytic Shellfish Poisoning, and others
- Discussed the idea of making videos to use for public education

Form to document MTF member time for in-kind match to NOAA Grant

Form was passed around to the task force members to indicate their time worked

Updates on Legislation

- HB 76 update
  - Julie Decker and Heather McCarty updated the task force on HB 76 will be heard 3/16 but that the committee will not be taking public testimony
  - The need to have more sponsors was discussed
  - Angel Drobnica suggested an update to the lines on page 2 lines 10-15 with regards to the starting point for creating a loan for the hatcheries versus the farms. Heather McCarty clarified that January 1, 2018 would be the start date for the division and that it would be divided permanently to avoid the shifting of percentages.
  - Sam Rabung suggested to clarify the changes in the regulation process instead of updating the item through the Legislative Legal Division
- HB 128 was scheduled to be heard either 3/21 or 3/23
- Julie Decker will keep the task force updated as the bills move through the legislative process
- Senator Stevens has offered to sponsor Senate versions of the House bills. He has submitted SB 89 as a companion bill to HB 128 but as of 3/14, there were no Senate hearing scheduled

New Business
Upcoming Presentations

- Julie Decker is presenting at Southeast Conference and will report back at the next meeting if there is anything to report

McDowell Group Discussion
McDowell group presented a draft outline to identify the best case scenario for the economic future of the mariculture industry

- Discussion was had on how the work the McDowell Group will do will fit into the Comprehensive Economic Plan
- Questions were asked by task force members and answered by Ms. Kirsten Shelton-Walker of the McDowell Group
- A tentative due date was identified for the McDowell Group to have completed chapters 2 and 3 of their economic analysis report by June
- Heather McCarty wanted to be sure that the McDowell Group included that the distinction between the farm model and the enhancement model in the final report as well as reasons as to why the State of Alaska should be interested in enhancement
- Sam Rabung mentioned that all mariculture definitions can be found under the umbrella of enhancement because you use similar techniques for all of them. He also explained the differences between restoration, rehabilitation, and enhancement
  - Restoration-working with an extirpated stock to bring it back to natural levels of productivity
  - Rehabilitation- working with a depressed stock to bring it back to natural levels of productivity
  - Enhancement- produce an increment above what natural productivity can produce specifically for harvest
- Julie Decker motioned to direct McDowell Group to move forward with a draft plan understanding that there will be changes/ Sam Rabung seconded

Discuss New Zealand Aquaculture Strategy

- Angel highlighted that the whole first page articulates the governments commitment to the mariculture industry and why they support it and the importance of highlighting the benefits to Alaska's public regarding this industry
- Paula Cullenberg requested if a budget document had been prepared to go along with the plan. Julie Decker will reach out to Carter Newell to see if he has any information or if he has a contact that can call into a future Mariculture Task Force meeting.
- Angel suggested to have a short document that will encompass the strategic plan that we can hand out that provides a quick summary of the plan. She also mentioned that this report should look accessible to the general public and not like a huge book.

Updated Outline of Comprehensive Planning Process

- Discussion among task force members regarding ways on which they are proceeding with their plan
  - Sam Rabung explained that the goal was to promote the industry
  - Heather McCarty asked the task force to identify the group goal and ways to achieve it. She also requested clarification on what the plan would encompass

  - Sam Rabung stressed the importance of providing a tool to the mariculture industry not a guarantee that the plan would be a success
  - Julie Decker recommended that part of the recommendations that should come out of the task force would be a supplemental group whose responsibility it would be to look for ways to implement the plan
  - Paula Cullenberg was curious to know what the long term commitment of the industry would be when the task force submitted their recommendations to Governor Walker
  - Sam Rabung mentioned that a good goal for the industry would be to get organized in some sort of association that can speak for the industry
  - Heather McCarty asked about the actual drafting of the outline once the task force receives the AC recommendations; she would like to see where the task force is headed and who is going to be the framer of the framework
  - Jeff Hetrick was curious to know about the history of the mariculture industry and requested that the McDowell Group include a brief history of the industry in their report
- Sam Rabung suggested that at the 4/28 meeting to appoint a drafting committee to work with the plan and the recommendations from the advisory committees
- Commissioner Hladick instructed the AC's to take into consideration what the outline might look like and bring those ideas forward at the 4/28 meeting. Also bring as many recommendations as you can whether they are practical or not.

Closing comments

Jeff Hetrick thanked the advisory committees for their work

Sam Rabung expressed his eagerness in looking forward to work continued

Paula Cullenberg mentioned that if anyone has any recommendations in responding to their aquaculture RFP as well as an encouragement to everyone to write to their Congressional Delegation and tell them to not zero Sea Grant out of the federal budget

Angel Drobnica was excited that the advisory committees are engaged and is looking forward to getting a work product on the table

Julie Decker encouraged the task force to look into the Fish 2.0 workshop and to pass it on to others who might be interested. She mentioned that Charlotte Regula-Whitefield is looking for feedback on what congressional support they can provide from Washington DC

Heather McCarty stressed the importance of submitting letters of support to the bills that impact the mariculture industry

Next meeting dates:

April 26, 2017 from 9am to 1pm
TENT: May 25, 2017 from 8am to 12pm
PLANNING PURPOSES: June 28, 2017 from 8am to 12pm

2:36pm Meeting adjourned by Chairman Hladick

MEMORANDUM

Date: April 21, 2017

To: Alaska Governor's Mariculture Task Force

From: Jim Calvin, Principal, McDowell Group, Inc.

RE: Alaska's Mariculture Industry Today

McDowell Group is pleased to present this initial draft of Chapter 1, the first of five chapters that will ultimately comprise McDowell Group's Phase 2 report for the Mariculture Task Force (MTF) comprehensive planning process. This chapter is intended to provide an overview of baseline conditions in Alaska's mariculture industry. As a reminder, the full report will include the following components:

Chapter 1. Overview of Alaska's Mariculture Industry Today (draft attached)

Chapter 2. Alaska's Mariculture Development Opportunities and Challenges

Chapter 3: Mariculture Industry Investment Sources

Chapter 4: Economic Model for Development of Alaska's Mariculture Industry

Chapter 5: Strategic Development Goals, Pathways and Outcomes

Chapter 1 serves as an important foundation for the report, as content of the chapter will provide important context for the other chapters. The attached Chapter 1 draft includes:

- A description of current mariculture production practices for all actively farmed species, including production volumes, sales, participation and employment, markets, trends, and other relevant information as available.
- A status report on mariculture research and development efforts, by species.

METHODOLOGY

To provide the most comprehensive description of baseline conditions in Alaska's mariculture industry possible, the McDowell Group team utilized a variety of information sources. Secondary sources for information include reports, academic literature, presentations, meeting minutes, and other documents. Findings were supplemented by interviews with farmers, regulatory agency personnel, processing companies, buyers, and retailers. In total, the team talked with thirty-three individuals during this part of the analysis. Also, information from MTF advisory committee progress was a critical component of this research.

While baseline information is provided in Chapter 1, results from our research thus far include a great deal more information relevant to this project. Such material is better suited for, and will be included in, other chapters of the report.

PROCESS NOTES AND NEXT STEPS

It is important to emphasize this document is a draft intended for review, discussion, and input from MTF and advisory committee members. We look forward to discussing our findings with the task force and developing a final draft.

We also anticipate working closely with MTF members and advisory committees to complete Chapters 2 and 3 of the Phase II report. We are confident the work to date by the committees will provide a solid base from which to build on those chapters.

The following findings, as summarized below, are included in the attached draft.

ALASKA'S MARICULTURE INDUSTRY TODAY - SUMMARY OF FINDINGS

Current Production

- Current mariculture production focuses on four main species: Pacific oysters, blue mussels, geoducks, and sugar kelp.
- Farming techniques vary within each species and by farm site. At this time, no standard farming practice exists for any mariculture species in Alaska.

Oysters

- Alaska mariculture production is dominated by oysters, with 43 permitted oyster farms in 2017.
- Oysters accounted for 92 percent of Alaska aquatic farm sales in 2015, with oyster sales near 1.2 million oysters, and statewide oyster inventory of 15 million.
- Southeast farms account for slightly more than half of the state's oyster production, with the balance grown in Southcentral.
- Oyster prices and inventory are trending up, with statewide average prices rising from under $5 to over $8 per dozen in the past decade.
- An estimated three-quarters of Alaska oyster production is sold and consumed within the state, with primary markets outside of Alaska on the West Coast.

Mussels

- Prior to 2014, most mussel production and sales in Alaska were incidental, as mariculture farmers of other species harvested mussels that naturally set on their gear.
- Mussel production increased significantly in 2014-2015 as a result of the Alaska Mussel Technology Transfer Project (AMTTP). Production and sales peaked at 16,700 pounds and $70,800 in sales in 2015.
- The status of mussel production as a result of the AMTTP is unknown.
- Mussels may serve as a source of supplemental income on oyster farms.
- In-state demand for mussels appears robust, and well over current production, at potentially 70,000 pounds or more annually.

Geoducks

- Due to confidentiality regulations and ADF&G reporting, which combines production and sales of all clam species, geoduck farm harvest volume is unknown but likely small.
- Over the last few years, Paralytic Shellfish Poisoning (PSP) issues and a Chinese ban (now lifted) on geoduck importation have likely affected potential harvest.
- Alaska's geoduck farm inventory is potentially highly valuable, with over 900,000 clams that can reach harvestable size over the coming decade.
- Average price per pound for commercially harvested Alaska geoduck varies widely, averaging $5.90 in the decade between the 2006/2007 and 2015/2016 season, with a peak price of $10.31 in 2010/2011.
- All permitted geoduck farm sites are located in Southeast.

Kelp

- Kelp farming is just developing in Alaska, with no material historical volume or sales.
- Research is ongoing into how well kelp will grow in Alaska, and on ideal growing density.
- Three aquatic farms, two in Kodiak and one in Southeast, are actively culturing kelp in Alaska in 2017.
- 2017 marks the first material harvest of sugar kelp in the state.
- All three Alaska kelp farms plan to sell 2017 production to the only large-scale seaweed buyer operating in Alaska at this time.

Species in Development

- Species under consideration for mariculture development include king crab, sea cucumbers, abalone, clams (aside from geoduck), purple-hinged scallops, sea urchins, and cockles.
- Current research resources focus on king crab, and sea cucumber to some degree.

King Crab

- A statewide collaborative research effort, *Alaska King Crab Research, Rehabilitation, and Biology* (AKCRRAB), is currently underway to rehabilitate diminished wild king crab stocks.
- Experimental releases of crab stock from the AKCRRAB enhancement effort are under observation.
- The project is in a phase of attracting industry investment and working to change Alaska's regulatory environment to allow for crab enhancement.

Abalone

- Pinto abalone, the only abalone species found Alaska, are listed as a "species of concern" under the Endangered Species Act.
- Abalone mariculture was developed in response to rapidly declining stocks around the world due, in part, to high demand for this mollusk.
- One hatchery in Alaska is the only facility actively growing pinto abalone seed in the state. The seed is currently being produced with a focus on conservation.

Sea Cucumbers

- Sea cucumber enhancement research is currently occurring in Alaska through a partnership between Alutiiq Pride Shellfish Hatchery in Seward and the Southeast Alaska Regional Dive Fisheries Association.
- Wild sea cucumber populations have declined in Southeast with the rise of sea otter populations, with potentially significant impacts on wild sea cucumber commercial harvests.
- Poly-culture technique research and development is promising for sea cucumber farming, making work with oyster farms or salmon hatcheries an attractive option.

Clams

- Pacific littleneck clams, razor clams, and butter clams are of varying degrees of interest for mariculture in Alaska.
- Though data shows a limited volume of farmed clams have been sold in Alaska in the past, with a peak of $157,000 worth of littleneck clams sold in 2004, no clam sales occurred in Alaska in 2015.
- Pacific littleneck clams farming in Alaska is focused on diversifying product lines in current mariculture operations, as well as enhancing wild stocks.
- Razor clam efforts appear focused on local enhancement goals rather than commercial harvests.
- Research suggests butter clams may be a viable product for aquatic farming in Alaska, with the first experimental outstocking of butter clams occurring in spring 2017.

Purple-Hinged Rock Scallops

- Attempts have been made to farm all three types of scallops that live in Alaska waters, with little success for weathervane and bay scallops.
- Unlike the other scallop species, purple-hinged rock scallops may be successfully reared in mariculture, as the species can uniquely permanently attach to rocky substrates.
- In 2015, four Alaska farms were permitted to raise rock scallops.
- Research continues on rock scallop seed production and grow out techniques.

Sea Urchins

- In 2015, four farms were permitted to culture green sea urchins. One farm was permitted to culture purple and one to culture red sea urchins.
- Due to confidentiality regulations, the status of sea urchin mariculture efforts is not included in published data.

Cockles

- Three Alaska farms are currently permitted to raise cockles. Due to confidentiality restrictions, it is unclear whether the farms are producing.
- Research and development efforts on this relatively fast-growing species are promising, though current research to address containment of mobile cockles during grow out, and to address short shelf-life of the product, are ongoing.

Chapter 1. Alaska's Mariculture Industry Today

This chapter describes the mariculture industry in Alaska, with a focus on current production and research and development activity. As of 2016, mariculture activity in Alaska consists of approximately 75 operations, including 65 permitted farms, seven nurseries, and two hatcheries. Most operations are located along the coastline in either Southeast or Southcentral.

Photo credit: Bob Koenitzer.

Production in the industry is regulated and tracked by the Alaska Departments of Fish and Game (ADF&G) and Natural Resources (DNR). ADF&G issues permits for aquatic farm, nursery, and hatchery operations, as well as stock acquisition and transport. ADF&G also approves seed sourcing. DNR issues permits for the use of tide and submerged lands for aquatic farming activity, shellfish processing and shipping, and for shucking and packing shellfish.

Current organisms permitted for mariculture include a number of shellfish species and macroalgae, though few of these species are produced for market in Alaska at this time.

Table 1. Organisms Approved for Culture at Permitted Operations

Aquatic Farms and Nurseries	
Shellfish	Pacific Oyster, Blue Mussel, Geoduck, Littleneck Clam, Purple-Hinged Rock Scallop, Pink Scallop, Spiny Scallop, Cockle, Green Sea Urchin, Purple Sea Urchin, Red Sea Urchin, Sea Cucumber
Macroalgae	Sugar Kelp, Giant Kelp, Bull Kelp, Ribbon Kelp, Red Ribbon Kelp, Three Ribbed Kelp, Nori, Sea Lettuce
Hatcheries	
Shellfish	Pacific Oyster, Blue Mussel, Geoduck, Littleneck Clam, Purple-Hinged Rock Scallop, Cockle, Pacific Razor Clam, Butter Clam, Blue King Crab, Red King Crab
Macroalgae	Dark Sea Lettuce, Dulse, Kombu, Nori, Ribbon Kelp, Sea Lettuce, Three Ribbed Kelp, Sugar Kelp, Bullwhip Kelp

Source: ADF&G.

Photo credits (from left to right): Alutiiq Pride Shellfish Hatchery, Bob Koenitzer, and Bob Koenitzer.

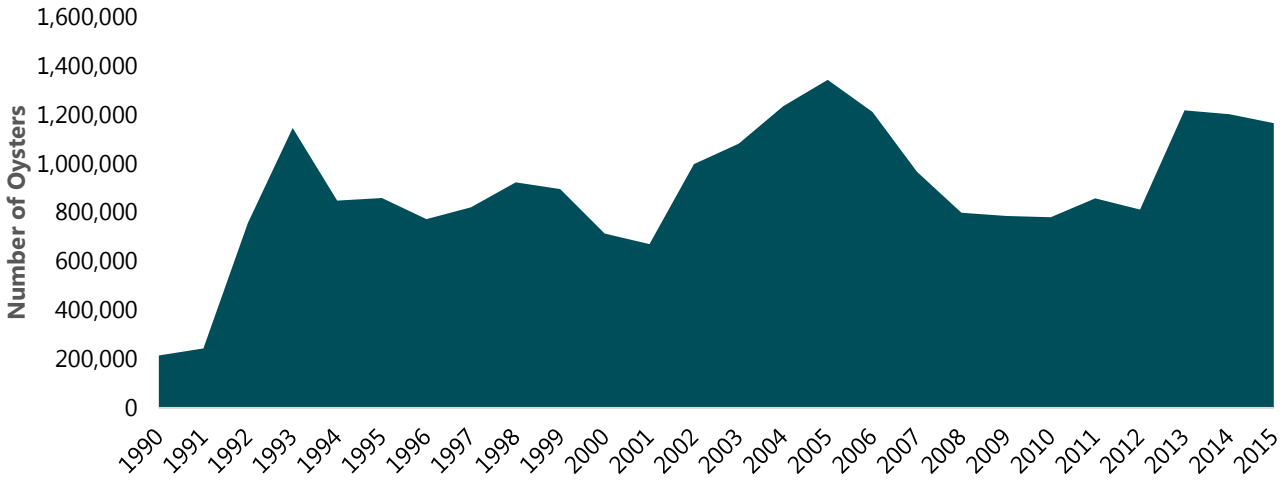
Production

Over the past 25 years, many organisms have been produced and sold from Alaska mariculture operations, though some at a very small scale. Since 1990, production has included Pacific oyster, geoduck, blue mussel, green sea urchin, littleneck clam, pink scallop, purple-hinged scallop, spiny scallop, red ribbon, sea cucumber, bull kelp, and sugar kelp.

Today, mariculture production in Alaska is primarily focused on oysters, with 31 permitted oyster farms in 2015, almost 1.2 million oysters sold, and statewide inventory of 15 million. In 2017, 43 farms are permitted. In terms of production volume, oysters are followed by blue mussels, with four permitted farms, almost 17,000 pounds sold in 2015, and an inventory of 8 million. Also, an Alaska geoduck harvest is planned for 2017. In 2015, 16 permitted operations for geoducks accounted for 910,000 in inventory for this slow-growing species. Finally, while Pacific littleneck clam production once topped 68,000 pounds sold, there were no sales in 2015.

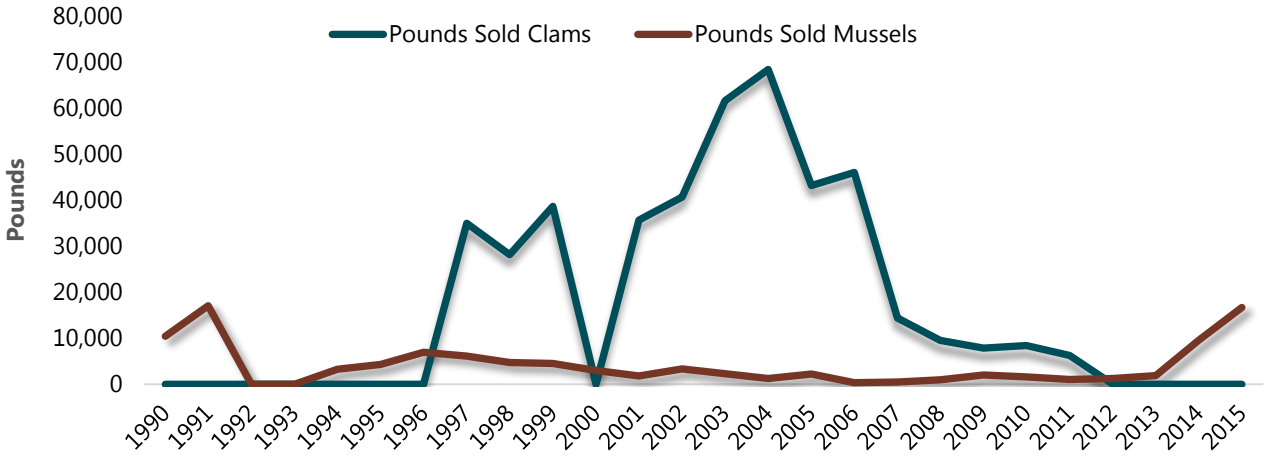
In addition to these shellfish species, sugar kelp harvests are planned for spring 2017.

Figure 1. Oyster Production in Alaska, 1990-2015



Source: ADF&G.

Figure 2. Clam and Mussel Production in Alaska, 1990-2015

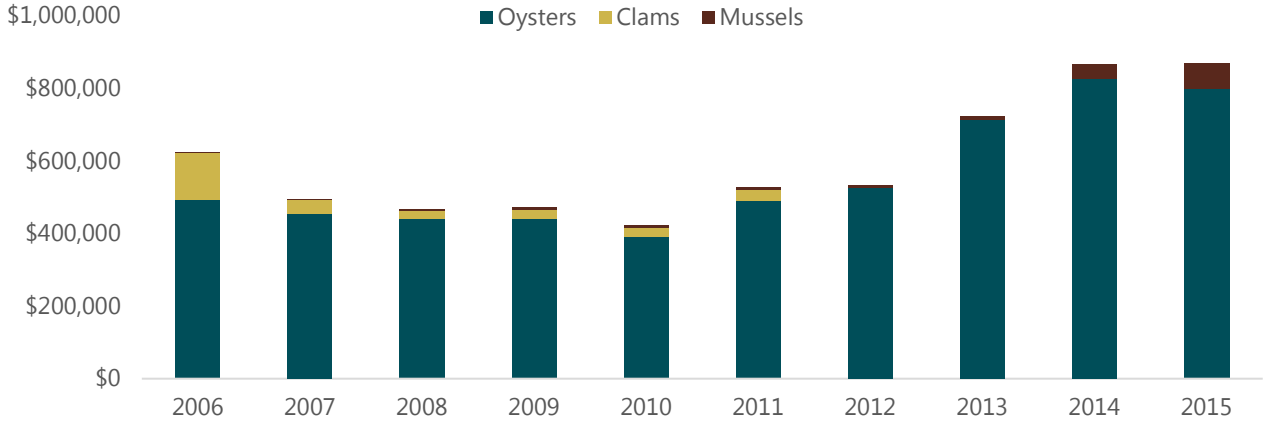


Note: For years with fewer than three operators reporting, production numbers are confidential and reported as zero.
Source: ADF&G.

Sales

Overall sales of shellfish and aquatic plants, including seed, topped $1.1 million in 2015. Aquatic farm oyster sales totaled almost $800,000, along with $71,000 in mussel sales, for a combined total of $870,000 in shellfish sales. Of that value, $421,000 in sales occurred from oyster production in Southeast, with the remainder (oyster and mussel) in Southcentral. No sales of farmed clams (including geoducks) occurred in 2015.

Figure 3. Alaska Aquatic Farm Sales, by Species, 2006-2015



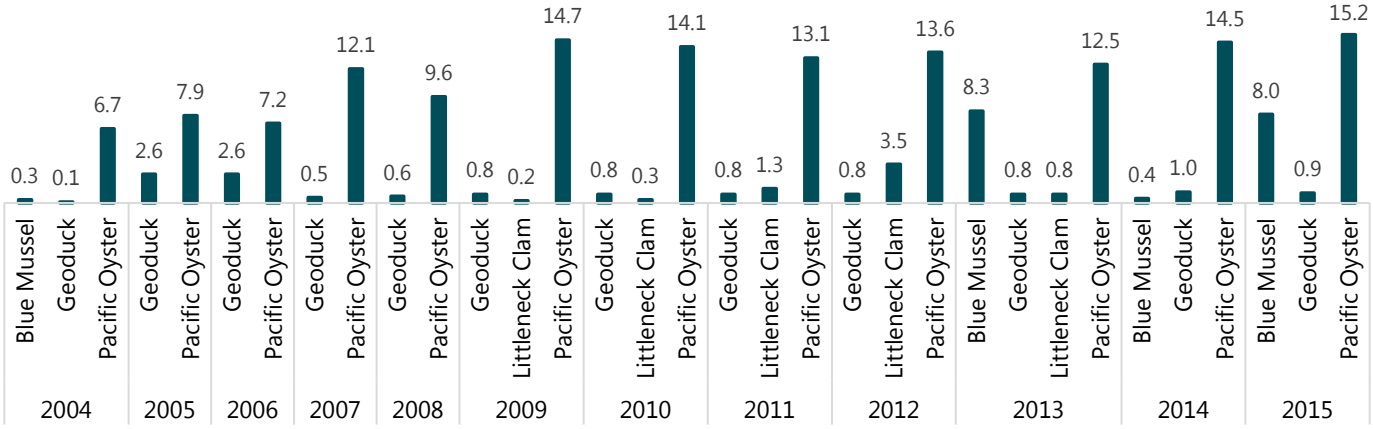
Note: For years with fewer than three operators reporting, production numbers are confidential and reported as zero.
Source: ADF&G and DNR.

In addition to farm sales, hatcheries and nurseries logged $267,000 in sales statewide, all of oyster larvae or seed. This included $215,000 in sales from Southeast operations, and $51,000 from Southcentral.

Inventory

Since 2004, mariculture product inventory has mostly consisted of Pacific oysters, blue mussels, littleneck clams, geoducks, and a small number of purple-hinged rock scallops. Kelp inventory began to grow in 2016.

Figure 4. Alaska Aquatic Farm Shellfish Inventory, Number in Millions, 2004-2015



Note: For years with fewer than three operators reporting, production numbers are confidential and reported as zero. Data is not reported above for species with less than .1 million in inventory.
Source: ADF&G.

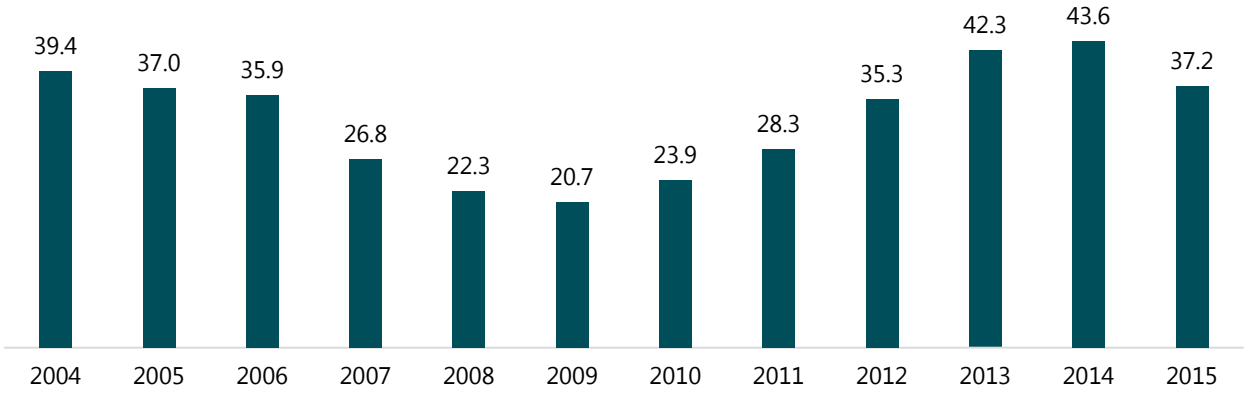
While no other species are currently in production, several are or have been in research and development stages, including kelp, king crab, abalone, sea urchin, and sea cucumber.

Employment

Alaska aquatic farm employment included a total of 138 positions in 2015, down from 185 in 2014. Two-thirds of these positions were laborers, with permit holders and owners making up most of the other positions. In total, workers worked a total of 9,664 workdays in 2015, down from 11,345 in 2014. A combined 37.2 FTE were employed in 2015, down from 43.6 in 2014.

Mariculture employment in hatcheries and nurseries totaled 36 in 2015, with 3,420 total workdays. Nine out of ten (92 percent) of hatchery and nursery positions were filled by laborers.

Figure 5. Total Annual Alaska Aquatic Farm FTE, 2004-2015



Source: ADF&G.

Organization of the Chapter

The following sections of this report detail the status and important trends for each species in the Alaska mariculture industry. Particular attention is given to species currently in production and with inventory. Research and development on other species with promise for Alaska are also discussed. Each species is in different stages of development in the state and, therefore, each section is organized to convey the most current available information for that species. When possible, costs of production, volumes produced, values of product, and current and potential markets are addressed.

The following sections are included in this chapter, in order of current production volume. The final section provides an overview of research and development efforts for king crab, abalone, and other mariculture species.

- Oyster Industry
- Mussel Industry
- Geoduck Industry
- Kelp Industry
- Species in Development

Oyster Development Status and Potential

Oyster farming, first authorized in the Alaska in 1988, is the most well-developed component of the mariculture industry in the state. Oyster sales represented slightly less than three-quarters of all mariculture revenue in 2015.

Oysters (*Crassostrea gigas)* do not spawn in the wild in Alaska. Thus, oyster seed is sourced from outside the state for grow-out in Alaska nurseries and farms. The 31 farms permitted in 2015 may be classified into three size categories based on 2015 revenue; there were 13 small farms (less than $25,000 in sales), three medium farms ($25,000 to $49,999) and, six large farms ($50,000 to $200,000).

Photo credit: ADF&G.

While total industry net profit is unknown, individual businesses profits are likely modest, particularly for small farms. Many of these small farms are considered hobby or lifestyle farms, allowing the operators to work and perhaps live in remote locations and supplement other sources of income. Following is a more detailed analysis of Alaska's oyster industry.

Oyster Production and Value

As of February 2017, 43 farms were permitted to grow oysters in Alaska. Among the 31 farms permitted in 2015, 22 reported oyster sales that year, the most recent year for which harvest data is available.

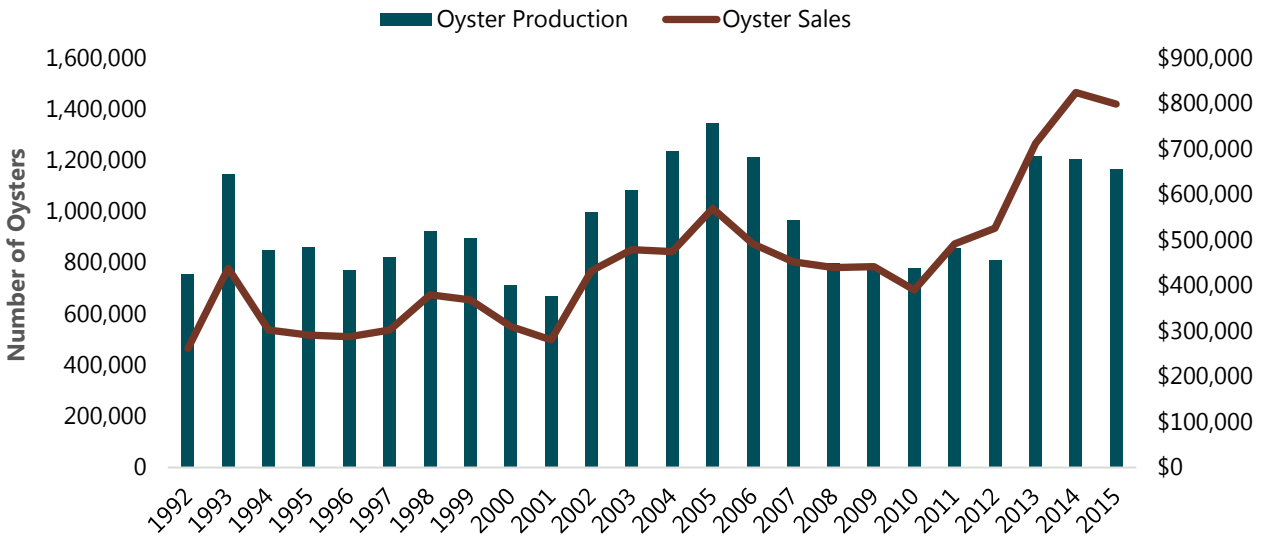
Table 2. Alaska Farms with Oyster Sales, 2011-2015

Year	Permitted Farms	Farms Reporting Sales
2015	31	22
2014	32	26
2013	35	27
2012	34	26
2011	32	27

Source: ADF&G.

In total, farmers produced an annual average of 954,000 oysters between 1992 and 2015. Oyster production in Alaska peaked in 2005, when 1,334,934 oysters were produced, then declined to 781,000 in 2010. It is unclear what led to the peak and subsequent decline, though lack of oyster seed may have been a factor. Oyster production and sales have increased significantly since 2012. Annual sales from 2013 to 2015 were close to 1.2 million oysters, slightly below industry production in the 2003 to 2006 period. Statewide oyster production in 2015 totaled 1.17 million. Revenue from oyster sales increased steadily to about $800,000 in 2014 and 2015.

Figure 6. Statewide Oyster Production and Value, 1992-2015

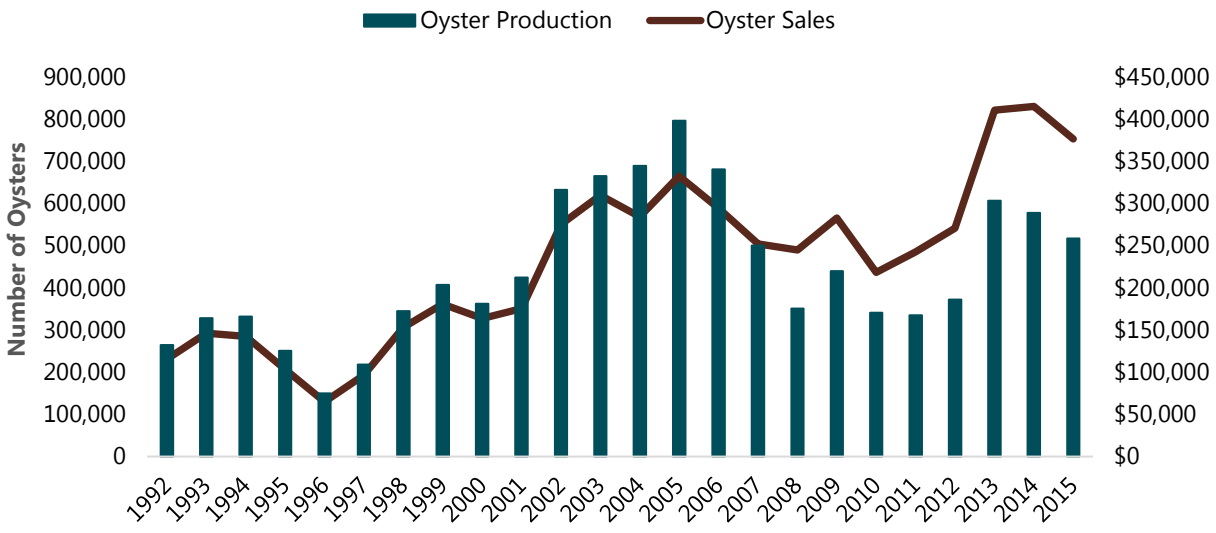


Source: ADF&G and DNR.

REGIONAL PRODUCTION AND SALES

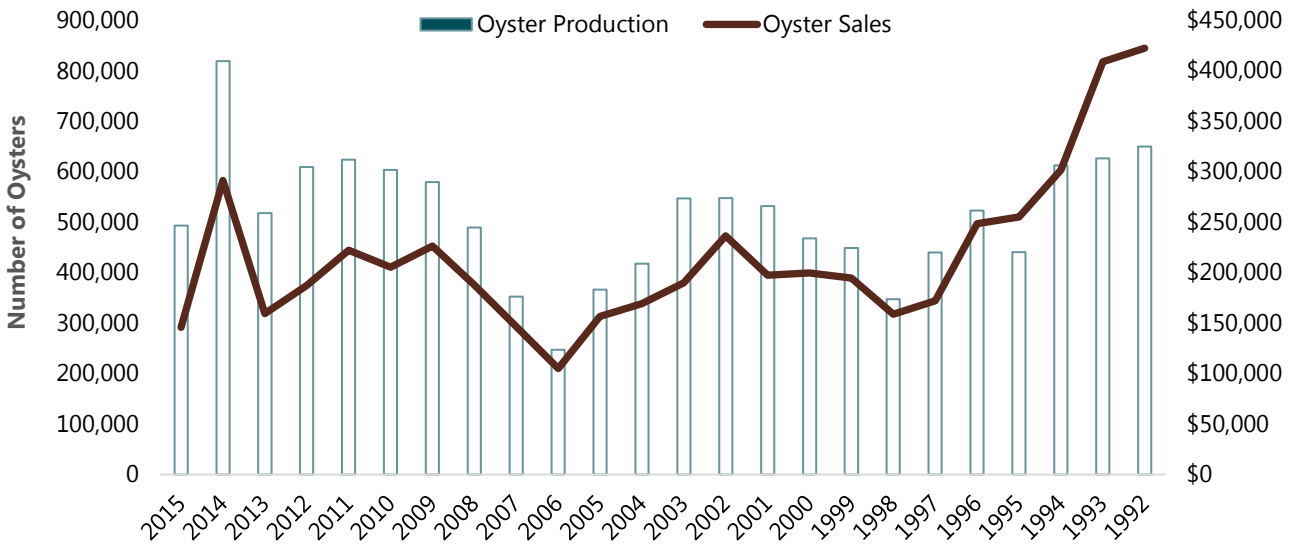
Slightly more than half of the state's oysters produced from 2011 to 2015 (54 percent) came from Southeast, while 46 percent were grown in Southcentral. For the same period, Southcentral generated 51 percent of statewide oyster sales revenue.

Figure 7. Southcentral Oyster Production and Value, 1992-2015



Source: ADF&G and DNR.

Figure 8. Southeast Oyster Production and Value, 1992-2015



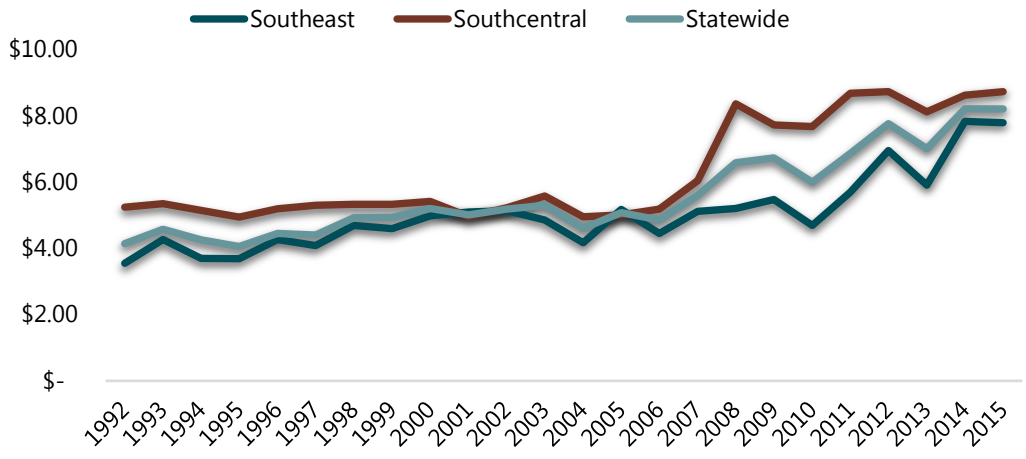
Source: ADF&G and DNR.

Oyster Prices

The average price per dozen Alaskan oysters was $8.21 in 2015. Southcentral farmers sold oysters for an average $8.73 per dozen, while Southeast farmers sold for an average $7.80. Prices statewide have risen relatively steadily from $4.86 per dozen oysters in 2006.

Between 2000 and 2005, oyster prices in Southcentral and Southeast were relatively similar. In 2006, Southcentral prices began to significantly outpace prices received by Southeast farmers. The price gap between the regions narrowed in 2014 and 2015. Statewide, from 1992 to 2015, price per dozen has outpaced inflation (98 percent increase versus 68 percent inflation).[1]

Figure 9. Alaska Oyster Price per Dozen, Statewide and by Region, 1992-2015



Note: Prices are nominal.
Source: ADF&G and DNR.

[1] Based on Anchorage CPI.

Oyster Inventory

Alaska oyster farm inventory as of 2015 was slightly more than 15.2 million oysters, an increase of about 22 percent over 2013. A relative abundance of oyster seed, and a new large grower in Southeast, suggests inventory may continue to increase in the near future.

Table 3. Alaska Statewide Oyster Inventory, 2011-2015

Year	Inventory
2015	15,211,352
2014	14,494,889
2013	12,522,981
2012	13,585,632
2011	13,134,556

Source: ADF&G.

Oyster Farm Operations

Most Alaska oysters are grown in lantern nets (hung from buoys or from ropes strung from buoy-to-buoy), or in trays suspended from rafts. One farm grows oysters on the ocean floor in the intertidal zone (areas where the sea floor is exposed at low tide). Each farm in the state operates somewhat differently. Farmers learn over time what equipment and techniques work best for their specific location. Availability of funding for equipment such as tumblers, sorters, and mechanized machinery is also a factor in operational efficiency. The following description generally reflects the process of growing, harvesting, and processing oysters, though it may not reflect all the specific processes used on all farms.

Photo Credit: Tom Henderson.

Oysters typically take two to five years to grow from seed (generally 5mm to 20mm) to a saleable size. Growth rates depend on a variety of factors including; quality of seed, water temperature, food availability, density of oysters, amount of handling, time of year the seed is planted, and other environmental factors. Producers interviewed for this study stated that grow-out times have declined over the last decade as farming practices have evolved.

During the grow-out period, oysters must be periodically inspected and cleaned to remove barnacles, tube worms, and other growth from the shell. Unhealthy product is discarded. Currently, many farmers use tumblers to clean and sort oysters. In addition to removing growth, tumbling trims the shell edges, resulting in a deeper cup which is more desirable in the marketplace. Oysters can be hand scrubbed, though that process is laborious and inefficient. After cleaning, the oysters are sorted by size and returned to trays or nets. The cleaning and sorting process occurs multiple times before oysters reach marketable size.

LABOR REQUIREMENTS

Oyster farms in Alaska are primarily small operations. Many farms are tended solely by the owner, while larger operations employ additional labor. According to ADF&G, for oyster farms with sales in 2015, on average, 3.95 workers (including owners) were employed per farm, working a total of 329 days per farm. Average FTE per farm was 1.26.

Table 4. Alaska Oyster Farms with Sales, Production and Employment, 2011-2015

Year	Number of Farms Reporting*	Total Oysters Sold	Average Number of Workers	Average Days Worked	Average Number of Days per Worker	Average FTE's
2015	21	1,167,254	3.95	329	83	1.26
2014	26	1,203,904	3.42	266	78	1.02
2013	27	1,218,861	3.89	281	72	1.06
2012	26	812,448	3.27	285	87	1.10
2011	25	858,357	3.36	215	64	0.83

*Note: Not all farms with sales reported employment data in 2011 and 2015.
Source: ADF&G.

FARM SIZE

Oyster farms may be measured in terms of acreage or volume of production and sales. However, farm size by sales provides the best measure to evaluate the current industry in Alaska, as some larger farms by acreage are only producing a small number of oysters, while some smaller farms are achieving higher production. The following tables highlight a variety of measures by farm size for both acreage and sales.

Farm Size by Acreage

Of the 22 farms selling oysters in 2015, slightly more than half (55 percent) were permitted for up to four acres, nearly one-third were between four and 12 acres, and 14 percent were over 12 acres. The three largest farms produced more than one-third of oysters and sales in 2015.

Table 5. Alaska Oyster Farm Size by Acreage, 2015

Farm Size	Number of Permits	% of Total Permits	Average Farm Acreage	Total Production (no. of oysters)	% of Total Production	Total Sales	% of Total Sales
Small (0-3.99 acres)	12	55%	1.64	332,810	29%	$228,545	29%
Medium (4-11.99 acres)	7	32%	6.21	421,032	36%	$284,643	36%
Large (12-24 acres)	3	14%	19.57	413,404	35%	$285,546	36%
Total	**22**	**100%**	**5.54**	**1,167,246**	**100%**	**$798,733**	**100%**

Source: ADF&G, including farm categories, and DNR.

Farm Size by Sales

In 2015, six farms reported sales between $50,000 and $200,000. These farms were responsible for slightly more than three-quarters of all oyster production and sales.

Table 6. Alaska Oyster Farm Size by Sales, 2015

Total Sales	Number of Permits	% of Total Permits	Average Farm Acreage	Total Production	% of Total Production	Total Sales	% of Total Sales
$50,000 - $200,000	6	27%	12.08	893,812	76.6%	$603,604	76%
$25,000 - $49,999	3	14%	5.94	146,082	12.5%	$103,721	13%
$10,000 - $24,999	4	18%	3.74	78,173	6.7%	$57,111	7%
$5,000 - $9,999	3	14%	2.50	32,673	2.8%	$20,365	3%
$1 - $4,999	6	27%	1.51	16,506	1.4%	$13,933	2%
Total	**22**	**100%**	**5.54**	**1,167,246**	**100.0%**	**$798,733**	**100%**

Source: ADF&G and DNR.
Note: Columns may not add due to rounding.

HARVESTING, PROCESSING, AND PACKAGING

When oysters have reached a marketable size, operators often (but not always) "harden" the oysters. Hardening involves holding oysters in bags in intertidal areas. As the tides come and go, the oysters strengthen their abductor muscles. This results in tighter shells and better moisture retention, and longer shelf life. After hardening, the oysters are again sorted and returned to trays or nets for a period of recovery. Hardening produces a higher-quality oyster, though the process increases labor costs as the process can take up to two months. An exception to this methodology is the single permitted intertidal farm. This operation spreads seed directly onto the ocean floor and the oysters are naturally hardened by the tides.

Photo credit: ADF&G.

Once hardened and allowed to recover, oysters are ready for testing and sale. Typically, the farmer pulls enough oysters to cover anticipated demand for the next two weeks. The oysters are removed from trays or nets and moved to an ADEC approved processing area (either on location or land-based). Oysters are typically held in a cooler either boxed, ready for shipping, or in bulk. A sample from the lot is sent to an approved lab in Anchorage for PSP testing. Typically, test results are returned within 36 to 48 hours. Once the operator has approval, oysters are packaged and prepared for shipping.

Packaging and shipping is dependent on the location of the buyer. Packaging is generally done in wet-lock boxes with liners and freezer gel packs included. If shipping duration is longer than 12 hours, insulation may be added to the box. Oyster temperatures are measured when they reach their final destination to assure proper handling. The farmers generally bear the cost of packaging materials.

TRANSPORTATION

Two primary hurdles for growers attempting to sell to the Lower 48 are transportation cost and logistics. While Alaska oysters are a premium product, added cost of freight drives prices up to a point where they become less competitive with Washington or British Columbia oysters. Shipping oysters from a remote dock in Alaska to destinations in the lower 48 can incur shipping charges of $2 to $4 per pound, and perhaps more for East Coast destinations. Additionally, some buyers incur delivery charges from the nearest airport to their location. The result is that buyer's cost for Alaska oysters can exceed the cost of other high-quality Pacific Northwest oysters by $3 or more per dozen depending on the destination. Alaska growers operate on relatively thin margins and it can be a challenge to reduce prices to offset transportation expenses and still generate a profit.

Photo credit: Oceans Alaska.

Multiple modes of transportation may be utilized in delivering oysters to market, depending on final destination. Alaska oyster farms are primarily located in remote areas, requiring water transport to the nearest dock. Oysters are either processed and packed at the remote facility or sent to a shore-based facility for packaging. Most oysters are landed in small communities where the product must then be shipped via small plane or ferry to a hub community for sales or to be transferred to jet aircraft to be delivered to the final destination. Typically, oysters are priced per dozen, FOB the closest dock to the aquatic farm. This means that transportation costs between the dock and the destination are the responsibility of the buyer.

Some oysters are shipped in bulk to wholesalers, others are shipped directly to end users such as restaurants, grocery stores, and other retailers. Multiple factors affect shipping costs for the purchaser, including number of boxes, oysters per box, number of carriers, and distance to final destination.

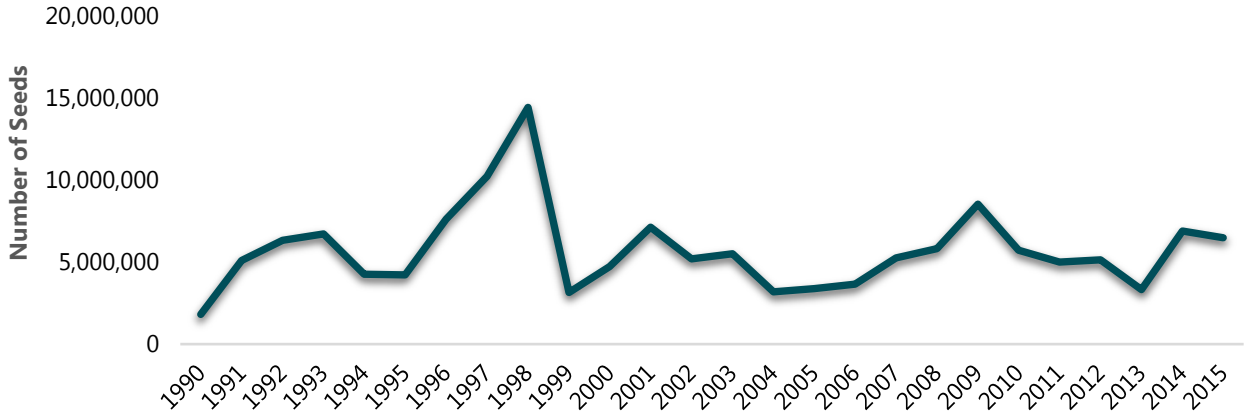
Oyster Seed

Two permitted shellfish hatcheries operate in the state, Oceans Alaska and Alutiiq Pride Shellfish Hatchery (APSH). Oceans Alaska has never successfully spawned oysters. APSH has successfully spawned oysters, though due to the high cost of production they are currently not hatching oyster seed. APSH does not intend to spawn oysters in the foreseeable future as it is cost prohibitive (mainly due to the cost of heating water) compared to purchasing larvae from out of state.

All oyster seed purchased by Alaskan farmers comes to Alaska as larvae from a ADF&G permitted source outside of the state. Currently, there is only one permitted source of larvae for Alaska, Hawaiian Shellfish, LLC. As of 2015, only Oceans Alaska is importing larvae and growing oyster seed for sale. Oceans Alaska sets the larvae and grows them out until they are ready for sale to a permitted nursery. There are seven ADF&G permitted nurseries in the state, four of them are permitted for seed sales to farmers. Nurseries hold the small seed in a floating upweller system (FLUPSY) for further grow-out. Seed size at the time of sale to a farmer varies but is generally 5mm to 20mm. Seed availability has been an issue for farmers in the past and some have concern that with only one provider of larvae and one hatchery producing seed, the state's seed security is tenuous.

Seed acquisition by farmers peaked in 2007 (10.2 million) and 2008 (14.5 million), then declined precipitously. The lowest level of seed acquisition between 2011 and 2015 was 3.3 million in 2013. Acquisition increased significantly in 2014 (6.9 million) and 2015 (6.5 million).

Figure 10. Alaska Aquatic Farm Pacific Oyster Seed Acquisitions, 1990-2015

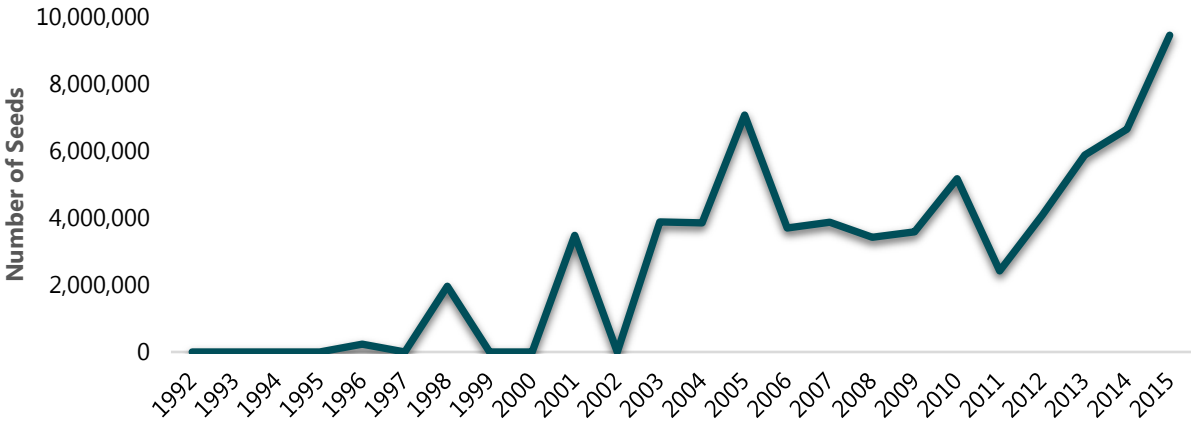


Note: Acquisitions includes data for count of permits 3 and greater.
Source: ADF&G.

OYSTER SEED STOCK

Pacific oyster seed inventory for hatchery and nursery operations reached the highest ever recorded at 10.3 million in 2015, an increase of 42 percent from 2014.

Figure 11. Statewide Hatchery and Nursery Operations Seedstock Production, 1992-2015



Note: Seedstock production includes data for count of permits 3 and greater.
Source: ADF&G.

Oyster Markets

Globally, oysters are sold live, shucked, frozen, cooked and canned, brined, smoked and canned in oil, dried, breaded and frozen, reduced for oyster sauce, and in a range of other value-added products. The highest value for an individual oyster is when sold fresh on the half-shell, though most world oyster production is sold in processed form rather than on the half-shell or fresh shucked market. Nearly all of Alaska's current oyster production is sold on the half-shell market.

Photo credit: Virginia Sea Grant.

MARKETS FOR ALASKA OYSTERS

The State of Alaska does not track oyster sales by location. Interviews with farmers and other knowledgeable sources resulted in an estimate that three-quarters of Alaska oysters are sold and consumed within the state.[2] Consumption of oysters increases significantly in the summer months when Alaska hosts roughly 1.8 million visitors. Concurrently, the volume of oysters produced in the summer months is significantly higher than for the remainder of the year.

Primary markets outside Alaska are located on the West Coast, with less volume sent farther east. These markets include both wholesale distributors and restaurants. Little or no Alaska oysters are currently shipped to locations outside the U.S.

Growers interviewed for this study report that, at this point, they can sell all their product in the state. However, there is some concern in the industry that demand within Alaska may be reaching a saturation point. This is especially the case during fall, winter, and spring, as in-state oyster demand is significantly lower that time of year. Historically, there have been fewer farmers harvesting in the winter months, though some evidence suggests that winter production may be increasing.

Additionally, a new farm entering production in Southeast plans to produce a significantly higher volume than current industry participants. If the operation produces oysters at the volume anticipated, it may impact Southeast markets in terms of price.

If Alaska oyster production increases significantly beyond 1.2 million oysters, at some point growers will likely need to expand to markets outside of Alaska and/or look for new product forms.

[2] Based on interviews with a selection of Alaska oyster farmers and wholesale buyers. Not all farmers were interviewed for this report.

Oyster Production in Canada

The Canadian oyster industry is active on Prince Edward Island, in Nova Scotia, New Brunswick, and British Columbia. Canada produced 11,153 metrics tons, live weight, of oysters in 2015, valued at $36.5 million (CAD). British Columbia produced 6,587 metrics tons, live weight, of oysters in 2015, valued at $14.4 million (CAD).

Table 7. Canada and British Columbia Oyster Production, Metric Tons, and Value (CAD), 2010-2015

	Canada		British Columbia	
Year	Production (mt)	Value (000's)	Production (mt)	Value (000's)
2015	11,153	$36,547	6,587	$14,425
2014	10,662	$30,646	6,184	$13,015
2013	10,835	$28,469	6,452	$12,498
2012	10,497	$24,228	6,487	$10,251
2011	9,779	$18,541	6,242	$8,380
2010	11,113	$18,876	7,550	$8,957

Source: Statistics Canada.

United States Oyster Production

The U.S. produced 124,986 metric tons of live weight oysters in 2014. Exports of live oysters from the U.S. grew from 2.6 million kilos, with a value of nearly $18 million in 2012, to 3.1 million kilos, with a value of $22.6 million in 2014.

Table 8. U.S. Oyster Exports, 2012 – 2014 (Value in USD)

	2012 kg	2012 Value	2013 kg	2013 Value	2014 kg	2014 Value
Live/Fresh Oysters	2,554,610	$17,988,360	2,661,708	$18,945,423	3,099,486	$22,594,774
% Change			**4%**	**5%**	**16%**	**19%**

Source: National Marine Fisheries Service, Fisheries Statistics and Economics Division.

U.S. Oyster Exports by Country

In 2014, nearly half (46 percent) of U.S. exports of live oysters by weight were to Canada. The second largest U.S. market was China at 23 percent. The third and fourth largest markets for live oysters were Malaysia (9 percent) and Singapore (8 percent).

Table 9. U.S. Live/Fresh Oyster Exports, by Country, 2014

Country	Volume Exported kg	Value (USD)	% of Total Volume Exported
Canada	1,420,347	$12,955,148	46%
China	723,547	$4,844,729	23%
Malaysia	265,459	$1,219,855	9%
Singapore	262,178	$1,373,638	8%
All Others	427,955	$2,201,404	14%
Total Export	**3,099,486**	**$22,594,774**	

Source: National Marine Fisheries Service, Fisheries Statistics and Economics Division.

U.S. Oyster Imports

Most U.S. oyster imports (89 percent) were farmed product in 2014. The U.S imported a total of 4.1 million kilos of live weight oysters in 2014, a 15 percent increase from 2012. Total 2014 import value was $24.6 million (USD).

Table 10. U.S. Oyster Imports in U.S. ($), 2012-2014

	2012 kg	2012 Value	2013 kg	2013 Value	2014 kg	2014 Value
Live/fresh farmed	3,384,475	$17,871,139	2,958,376	$18,766,401	3,666,561	$21,770,034
Live/fresh wild	195,537	$1,019,249	578,200	$3,281,567	436,429	$2,800,816
Total	3,580,012	$18,890,388	3,536,576	$22,047,968	4,102,990	$24,570,850
% Change			**-1%**	**17%**	**16%**	**11%**

Source: National Marine Fisheries Service, Fisheries Statistics and Economics Division

In 2014, more than half (57 percent) of U.S. farmed oyster imports, by weight, came from Canada. Mexico also provided a significant volume of U.S. oyster imports at 41 percent.

Table 11. U.S. Oyster Imports, Live/Farmed by Country, 2014

Country	Volume Imported (kg)	Value	% of Total Volume Imported
Canada	2,092,639	$15,725,111	57%
Mexico	1,498,148	$5,473,806	41%
South Korea	56,078	$503,602	2%
All Others	19,696	$67,515	1%
Total Imports	**3,666,561**	**$21,770,034**	

Source: National Marine Fisheries Service, Fisheries Statistics and Economics Division.

Global Oyster Production

World oyster production totaled nearly 5.2 million metric tons, live weight, in 2015, a 15 percent increase from 2010. The majority of oysters harvested globally are farmed. China produced 85 percent of the world's oyster supply in 2015, while the U.S. ranked fourth in production with 125,000 metric tons.

Table 12. World Oyster Production, Metric Tons, 2010-2014

Land Area	2010	2011	2012	2013	2014
China	3,642,829	3,756,310	3,948,817	4,218,644	4,352,053
Republic of Korea	267,776	281,022	284,856	239,779	283,232
Japan	200,298	165,910	161,116	164,139	184,100
United States of America	137,630	97,889	131,853	128,658	124,986
France	96,040	84,454	82,910	77,511	76,610
Taiwan Province of China	36,056	34,643	26,923	27,793	25,276
Philippines	22,525	21,462	20,648	22,070	22,355
Thailand	28,090	8,377	16,129	17,595	17,187
Canada	11,114	9,779	10,497	9,975	12,604
Australia	14,931	13,927	12,559	12,530	11,403
All Others	29,766	28,760	28,054	29,889	35,142
Total production	**4,487,055**	**4,502,533**	**4,724,362**	**4,948,582**	**5,144,948**

Source: FAO.

Mussel Development Status and Potential

Blue mussels (*Mytilus trossulus*) are viewed by many in the Alaska aquatic farm industry as an area with significant growth potential. Mussels have a shorter grow-out period to marketable size than oysters. For oyster growers, adding mussels to their operation may provide supplemental income while the oysters grow to a saleable size. Mussels also naturally reproduce in Alaska, providing free spat for farmers and, therefore, reducing operational expenses. Significant demand for mussels also makes this product appealing to growers.

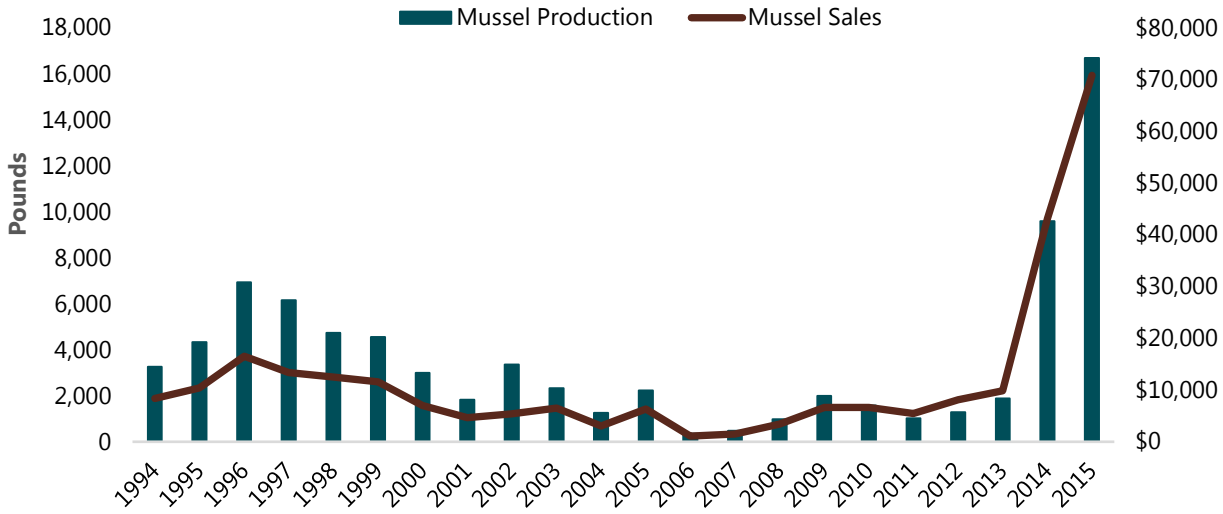
Mussel Production and Value

Between 1992 and 2014, an average 2,700 pounds of mussels were harvested and sold annually in Alaska. Most of those sales were incidental rather than cultivated, meaning that farmers harvested product that naturally set on their floats or other equipment, rather than trying to grow mussels. In 2015, only four farms were permitted to produce mussels, down from five in 2013 and 2014.

Photo Credit: Alutiiq Pride Shellfish Hatchery.

In 2012, a project was launched to better understand mussel growing technology and jump-start the industry (see Alaska Mussel Technology Transfer Project [AMTTP]) following the tables below). As a result, mussel production increased from 1,889 pounds in 2013 to 9,594 pounds in 2014, and jumped to 16,688 pounds in 2015. Revenues from mussel sales increased from $9,837 in 2013 to $43,112 in 2014 and to $70,800 in 2015.

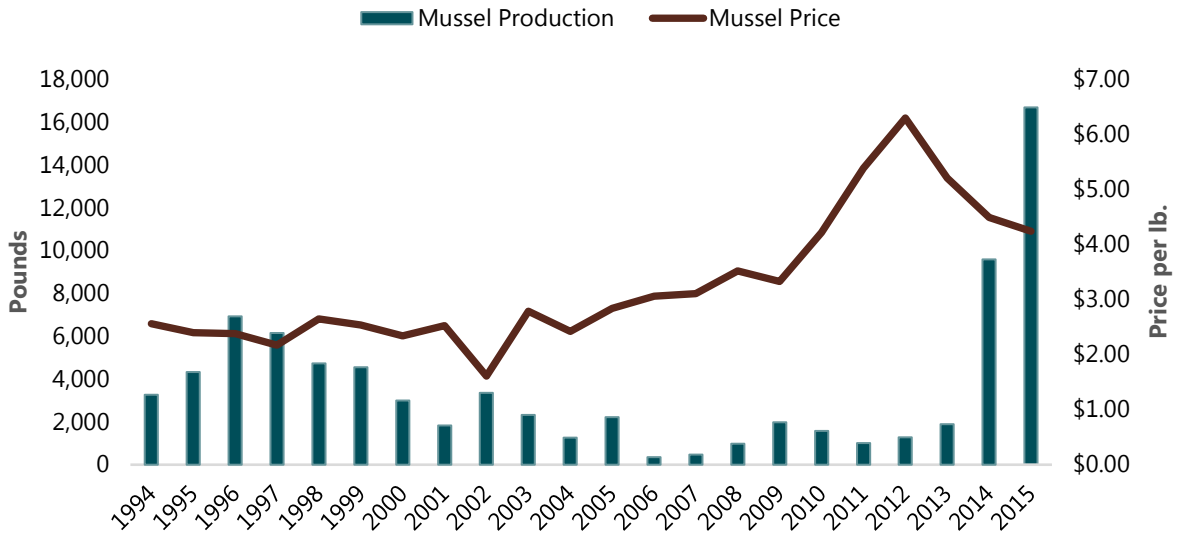
Figure 12. Alaska Mussel Production and Sales, 1994-2015



Note: For years with fewer than three operators reporting, production numbers are confidential and reported as zero
Source: ADF&G and DNR.

The average price per pound declined from $5.21 in 2013 to $4.49 in 2014 and to $4.24 in 2015. The decline was likely related to the significant increase in supply over that period.

Figure 13. Alaska Mussel Production and Average Price per Pound, 1994-2015



Source: ADF&G and DNR.

Mussel Inventory

Alaska's cultivated blue mussel inventory as of 2015 was slightly more than 8 million. The inventory has grown significantly since 2011, when it totaled only 7,198. Mussel inventory rose in 2013 to 8 million, fell to 425,000 in 2014 and rose again to 8 million in 2015.[3] It is unknown why inventory fluctuated year to year, though possible reasons include variation in volume of natural larval sets (that can vary significantly from year to year) and possible variations in farm counting methodology.

Table 13. Statewide Mussel Inventory, 2011-2015

Year	Inventory
2015	8,017,400
2014	424,520
2013	8,269,540
2012	10,200
2011	7,198

Source: ADF&G.

Mussel Farm Operations

Mussels typically spawn during the summer months in Alaska. Following spawning, the shelled larvae are free swimming. The mobile larvae will eventually attach itself to any surface available but prefer rough textured surfaces. Synthetic ropes are a favorable medium for the larvae to attach. As they grow, they are transformed into "spat." Spat can move about until they locate a suitable location with adequate food. Mussels feed naturally

[3] Data provided by ADF&G is self-reported by farmers.

by filtering food from the water. If grown too closely, competition for food may inhibit growth. Water temperature also is a factor in mussel growth.

Purposeful mussel farming in Alaska involves capturing the spat after it sets. Ropes suspended from rafts capture the set. Once mussels have grown to a certain size, they are mechanically stripped from the ropes and stored in mesh bags hung from a raft by ropes to grow to a saleable size. To process efficiently, pulling the ropes, harvesting, cleaning, and sorting a large volume of mussels requires mechanical lifting devices and sorters.

Mussels must undergo the same testing process for PSP as oysters and other shellfish.

ALASKA MUSSEL FARMING DEMONSTRATION PROJECT (AMFDP)

In 2012, Halibut Cove Community Organization received a $300,000 state grant to develop a large-scale test farm for mussel production.

Photo Credit: NOAA.

The project was intended to demonstrate the economic and technical feasibility of large-scale mussel farming in Alaska. Alaskan Shellfish Growers Association (ASGA) and Alaska Shellfish Farms (ASF) were to implement the project with technical assistance from the Marine Advisory Program (MAP), including marketing and business planning. Grant recipients estimated they would produce $560,000 in annual gross sales within two years and eventually produce 1.2 million pounds annually of high quality mussels worth $2 million. They also estimated the operation would employ ten local residents. ASGA and MAP were to write a mussel farmer's manual designed to assist with future mussel farm development in the state.

Alaska Sea Farms was tasked with construction and operation of four 40' x 40' mussel rafts, from which mussels would be grown suspended on lines hung from the rafts, surrounded by predator nets. Initially, two rafts were to be used for seed collection in July from wild sets before all four were stocked with seed for grow-out to market size. Each raft was estimated to be capable of producing 70,000 pounds of mussels in 18 to 24 months.

Project plans state that mussel processing equipment is necessary for production of any volume of product, as harvesting and processing can be labor-intensive without equipment. A hopper feed conveyer is used to declump and grade mussels. This equipment provides market sized product for a debysser to remove seed mussels. Mussels are then graded and placed in harvest sacks in mussel roll sizer equipment and then stored in containers with flowing seawater until shipping time. Such equipment allows for harvest of one ton of mussels in 4 hours.

The current and future status of the demonstration project and production are not known. The growers involved in the project were not available to be interviewed for this study. The first crop of mussels was scheduled to be harvested in late 2014, and data shows an increase in mussel inventory and sales around that time. According to a wholesaler report no mussels have been sold by the grower since mid-to-late 2016.

MUSSEL MARKETS AND DEMAND

Based on interviews for this study, there appears to be significant in-state demand for mussels. One wholesaler estimated that the Southcentral market alone could absorb 1,500 to 2,000 pounds of mussels per week during the summer. Assuming significantly lower fall, winter, and spring sales, annual statewide demand could reach 60,000 to 70,000 pounds or more, significantly higher than 2016 production of about 17,000 pounds.

With short self-lives (approximately 5 days), and transportation hurdles, selling product outside the state will be challenging. The premier mussel grower on the West Coast, Penn Cove, harvests mussels to order and ships them quickly. It would be a logistical challenge for Alaska growers to replicate that business model.

Geoduck Development Status and Potential

Geoducks (*Panopea generosa*) are a species of large saltwater clam prized in Asia for the meat of its siphon (long neck), which can exceed three feet in length. Geoducks are indigenous to the West Coast of the U.S. and Canada, with commercially harvested and farmed product available from Washington, British Columbia, and Alaska. Juveniles will dig up to three feet deep in the ocean bed and live their entire lives in that position. The clam extends its siphon up to the ocean bottom and acquires nutrients by filtering seawater. Mature live geoducks typically weigh from two to four pounds but can grow larger. The clams are long-lived, with some specimens living more than 140 years. The average age of commercially harvested geoducks in Alaska is 44 years. The highest value is received for the sale of live product.

Geoduck Harvest and Value

FARMED

As of February 2017, 19 aquatic farms in Alaska were permitted for geoducks, as well as two permitted hatcheries and two nursery operations. All permitted farm sites are in Southeast, with the majority in the Ketchikan/ Prince of Wales (POW) area. One site is located near Sitka, one north of Juneau, and one south of Juneau.

Photo credit: SARFDA.

There is one permitted nursery located in Ketchikan and one near Sitka. Nurseries serve as holding facilities to allow juvenile seed to acclimate to local waters and grow-out before being planted.

The Alutiiq Pride Shellfish Hatchery developed methods to hatch and rear geoduck seed. Oceans Alaska in Ketchikan is permitted as a hatchery but has not been successful in spawning.

Since 2010, ADF&G has reported farmed geoduck harvest and value combined with all other clam harvests and value. Because of strict confidentially regulations, ADF&G cannot report production or sales when less than three growers report. This has resulted in no useable data for analysis of farmed geoduck production and sales. Following is an analysis of the commercial dive harvest of geoducks in Alaska. The data provides some insight into the level of effort and value of geoducks.

WILD

The number of geoduck permits fished between 2006 and 2015 ranged from a high of 70 in 2012 to a low of 55 in 2009. The annual average number of permits fished for the ten-year period was 63.

Table 14. Commercial Geoduck Permits Fished, Calendar Year, 2006-2015

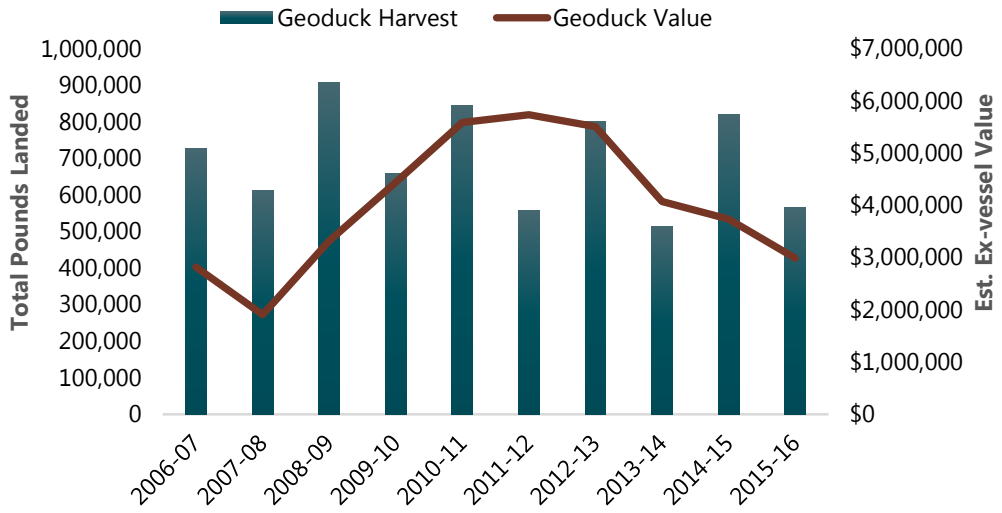
Year	Total Permits Fished
2015	60
2014	61
2013	69
2012	70
2011	61
2010	69
2009	55
2008	57
2007	62
2006	61

Source: CFEC.

Between 2006 and 2016, wild geoduck harvest volume varied significantly, ranging from a high of nearly 907,000 pounds in 2008-2009, to a low of 514,000 pounds in 2013-2014. Seasonal harvest for the ten-year period averaged 700,000 pounds.

Estimated ex-vessel value ranged from a high of $5.7 million in the 2011-2012 season to a low of $1.9 million in the 2007-2008 season. Average annual harvest value for the ten-year period totaled $4 million. Ex-vessel value for the 2015-2016 season was $3 million.

Figure 14. Alaska Wild Geoduck Harvest and Value, 2006-2015

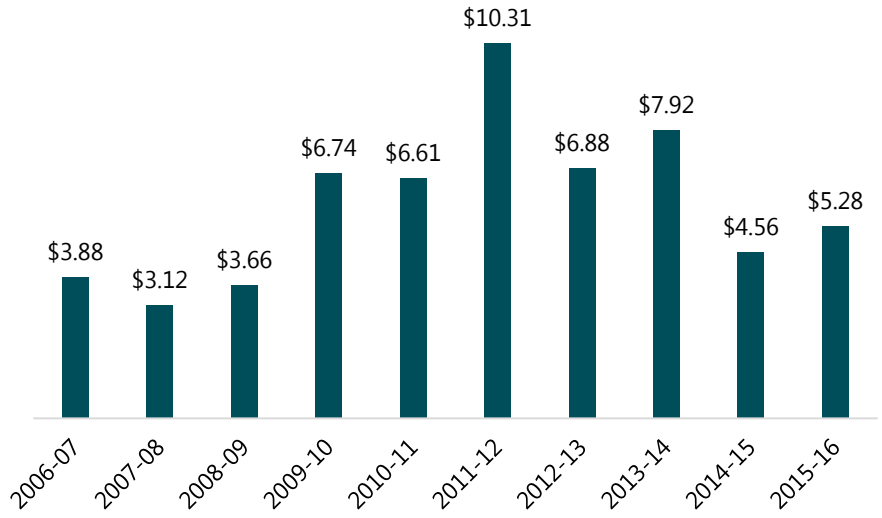


Source: ADF&G.

GEODUCK PRICES

Average geoduck prices vary widely. Between 2006/2007 and 2015/2016, price per pound ranged from a high of $10.31 in 2011-2012 to a low of $3.12 in 2007-2008. Average price per pound for the ten-year period was $5.90. Price for the 2015-2016 season was $5.28 per pound.

Figure 15. Geoduck Wild Harvest Average Price per Pound, 2006-2016



Source: ADF&G.

Geoduck Farm Inventory

ADF&G reports geoduck farm inventory totaled 910,926 in 2015, a 6 percent decrease from 968,526 in 2014.

The current volume of harvestable geoducks in unknown. Due to the slow growth of the clams, inventory will reach harvestable size over a period of many years. Farmers also have the option of harvesting when market prices are favorable.

Table 15. Geoduck Inventory, 2011-2015

Year	Number of Animals
2015	910,926
2014	968,526
2013	837,296
2012	832,244
2011	819,976

Source: ADF&G.

For purposes of understanding total resource value, if the total 2015 inventory were harvestable and weighed an average of 2.5 pounds, the farm inventory would be about 2.3 million pounds. At a price of $5 per pound, this inventory would have a total value of approximately $11.4 million. This estimated value could be significantly higher or lower depending on clam size at harvest and prevailing market prices at the time of sale.

Geoduck Farming Operations

Farming the giant clams began in the early 1990s in Washington and in 2000 in Alaska. Geoduck larvae are raised in hatcheries to an approximate size of one to three millimeters. The small clams are called spat or seed. The small seed can be planted, but in most cases, spend additional time in a nursery to allow for acclimation to local waters and grow-out to a larger size. Spat is generally three to 20 mm in size when planted. Growers report that larger and healthier seeds have a better chance of survival. Poor quality seed can result in significant mortality rates.

Geoduck farming in Alaska can occur in intertidal or subtidal areas (where the sea floor is never exposed). Intertidal farming involves placing the seed in PVC tubes inserted in the seabed. Two to five seed are usually planted in each tube with hope of one to four surviving to maturity. Tube openings are covered with protective nets to discourage predators. The nets are removed when the clam has burrowed into the ocean floor.

Subtidal farming involves planting the spat directly in the ocean floor (without tubes), covered with a predator exclusion device. The exclusion devices are mats or mesh tarps that covers the seabed and keep predators away from the clams. The exclusion device is removed when the clam has burrowed into the ocean bottom.

Research related to time required for a geoduck to reach harvestable size is ongoing. Anecdotally, geoducks could reach a harvestable size in eight to ten years. The clams appear to be slower growing in northern Southeast than in southern Southeast.

Subtidal geoducks are harvested by divers using pressurized air hoses to blast the bottom material away from the clam.

Geoduck Seed

Growers interviewed for this study report quality of seed available in Alaska has varied and, at times, poor quality has led to high mortality rates. Alaska hatcheries with geoduck seed report there is little to no demand for their product or that they did not sell in 2015 or 2016. This resulted in no current source for geoduck seed.

Oceans Alaska had a successful spawn in 2016. The seed grew well for 22 days. Unusually warm weather resulted in higher than normal water temperatures and the spat died. Oceans Alaska plans to acquire spat from APSH in 2017 and attempt to grow them to plantable size. They hope that will allow the spat to acclimatize better to local waters and provide a higher quality product. A facility representative reported that there is not a huge demand for geoduck seed, perhaps 500,000 currently. The market for geoduck seed outside Alaska is very limited. They plan to start with a small volume of spat and work on the process. Additionally, Oceans Alaska has limited space to grow geoduck, without hindering their ability to expand oyster production.

Geoduck Markets

Most of the geoduck harvest is sold in China and other Asian markets. A smaller, unknown quality is sold within Alaska, the U.S., and to other international markets. In December 2013, China banned importation of shellfish from Alaska and Washington citing inorganic arsenic found in a shipment of Washington geoducks. The ban severely impacted geoduck markets, divers, and farmers in Alaska and Washington. The ban was lifted in June 2016.

In 2014, the U.S. produced 5,534 metric tons of geoducks (farmed and wild), while Canada produced 1,494 metric tons (farmed and wild). Overall harvest in 2014 was 7,028 metric tons, up 18 percent from 5,997 metric tons in 2012, but only slightly higher than the 6,949 metric tons harvested in 2010.

Table 16. Pacific Geoduck Harvest, U.S. and Canada, in Metric Tons, 2010-2014

Year	Canada	U.S.	Total
2014	1,494	5,534	**7,028**
2013	1,346	5,194	**6,540**
2012	997	5,000	**5,997**
2011	1,562	5,114	**6,676**
2010	1,330	5,619	**6,949**

Note: Includes wild and farmed product.
Source: FAO.

Seaweed Development Status and Potential

A variety of seaweed species are currently approved for cultivation on aquatic farms and nurseries in Alaska, including sugar kelp, giant kelp, bull kelp, ribbon kelp, red ribbon kelp, three ribbed kelp, nori, and sea lettuce. Species approved for hatchery operations include dark sea lettuce, dulse, kombu, nori, ribbon kelp, sea lettuce, three ribbed kelp, sugar kelp, and bullwhip kelp. Among these species, only bull kelp laver has been reported as produced and sold.

Photo credit: Bob Koenitzer.

Kelp, a name that applies to many brown seaweed species, is the only type of seaweed currently in production in Alaska; 2017 will mark the state's first material harvest volume. Alaska's seaweed farmers are focusing on sugar kelp (*Saccharina latissima*). Though kelp species are not the most valuable type of seaweed, they grow fast, are likely to thrive in Alaska waters, and may complement the fish harvest season.

With growing market demand, seaweed appears to have a lot of potential in Alaska. The industry presents numerous attractive attributes for development in the state:

- Plentiful accessible undeveloped coastline
- A potential workforce with necessary marine skills
- Local fleets that could provide effective harvesting platforms
- A product that grows quickly, can be planted in the fall and harvested in the spring (times of the year when fishermen are typically in between fisheries)

At the same time, many unknowns exist in this nascent Alaska industry, such as growth rates, actual market demand/prices, processing procedures, and best industry practices for growing and harvesting.

Kelp Production and Value

Fourteen aquatic farmers in Alaska are permitted to grow kelp, though only three are actively culturing plants in 2017. Kodiak is home to two kelp farms, with the other active site located near Ketchikan.

In addition to farm production, a small volume of wild kelp is harvested in Southeast for use in locally produced niche products/markets. Coastal areas are occasionally opened for commercial harvest, though achieving any significant scale or schedule of production will likely occur via permitted farms. For example, Wild Alaska Kelp Company, which currently produces products from wet kelp, such as salsa, currently harvests wild kelp and is transitioning into a kelp farm model.

KELP PRICES

According to one industry participant, sugar kelp prices range from $0.25 to $1.00 per pound (for wet kelp), though "if you can produce wet (sugar) kelp in Alaska for less than $0.50 per pound. the world is your oyster."[4]

More generally, seaweed pricing works according to a market hierarchy similar to seafood. Pharmaceutical products, which are specialized and almost always sold in small volumes, can be the highest priced at over $100,000 per metric ton. Food and nutritional supplements offer the next highest value. Dried seaweed products fit for human consumption can fetch over $10,000 per metric ton. Seaweed powders are also valuable ingredients for livestock and aquaculture feed manufacturers, though they are usually valued at less than $4,000 per metric ton. Biofuels are at the bottom of the market hierarchy. Kelp can be used to produce biofuels like ethanol; however, the yield is such that dried kelp powder prices would probably have to be around $50 per metric ton to be competitive with petroleum-based fuels.[5] Many projects have looked at creating systems capable of producing kelp biofuels efficiently, but none has achieved commercial success.

The human ingredient/food market may make the most sense for Alaska farmers, as it offers the best mix of higher prices and larger market volumes. Seaweed fit for human consumption imported from China and South Korea (likely powder-like material) averaged $11,369 per metric ton and $10,496 per metric ton, respectively, in 2016. A price of $11,000 per metric ton of dried kelp powder is equivalent to $5.00 per pound. Applying a yield of 20 percent and converting the price to a wet basis produces a wet value of $1.00 per pound. This is not an ex-vessel proxy price, as it does not include costs involved with processing, storage, shipping, and sales.

KELP PRODUCTION VALUES

As seaweed farming is just developing in Alaska, no historical value and production volume data exist. However, interviews with industry participants and research on farms in other regions provide some basis for estimating a range of potential production values.

In addition to prices (which will fluctuate with market conditions), another critical variable is yield per acre. The table below outlines one range of possible production values.

Table 17. Estimated Kelp Production Value per 100 Acres

	5 rows/acre	10 rows/acre	20 rows/acre
Wet Pounds Produced[1]	783,750	1,567,500	3,135,000
Estimated Ex-Vessel Wet Price per Pound	$0.60	$0.60	$0.60
Farm Revenue	$470,250	$940,500	$1,881,000
First Wholesale Value of Dried Powder per Metric Ton	$12,000	$12,000	$12,000
Dried Powder Produced (Metric Tons)	71	142	284
First Wholesale Value of Dried Powder per Pound	$5.44	$5.44	$5.44
First Wholesale Value per Wet Pound[2]	$1.09	$1.09	$1.09
First Wholesale Revenue (less ex-vessel payments)	$382,958	$768,075	$1,536,150
First Wholesale Revenue	**$853,208**	**$1,708,575**	**$3,417,150**

[1] Assumes 209 ft. rows producing 7.5 pounds of wet product per linear foot.
[2] Assuming 20 percent yield, going from wet product to dried powder.
Source: McDowell Group estimates.

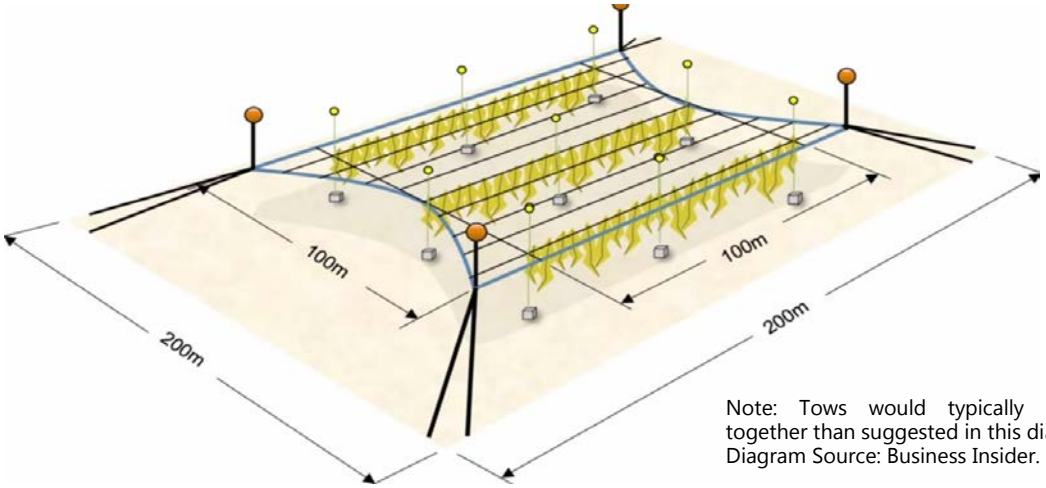
[4] Perry, personal communication.
[5] Lenstra, Jip; Van Hal, Jaap; and Reith, Hans. "Economic aspects of open ocean seaweed cultivation." Energy Research Center of the Netherlands. Presented at the Alg'n Chem 2011, Montpellier, France.

Kelp Farming Operations

Kelp are grown from partially submerged longlines attached to floats (see diagram below). Kelp seeds are spread onto small diameter twine at a nursery facility. Seeded twine is sent to farms spooled around PVC pipe. Farmers wrap twine around partially submerged longlines (usually 4-8 feet). Kelp is usually planted in the fall (September or October) and typically take five to seven months to reach harvestable size.

Plants are harvested prior to spore production to achieve optimal quality. Harvests typically employ winches, hooks, rollers, or net bags. Boats with a block and plenty of deck space, like seiners, are an excellent harvest platform. Some farms in Maine and Connecticut practice "3-D" farming, which is essentially a polyculture approach where kelps, mussels, scallops, and oysters are grown along the same line.

Figure 16. Kelp Farming Operations



Note: Tows would typically be closer together than suggested in this diagram.
Diagram Source: Business Insider.

Once harvested, wet kelp may be cut and frozen or processed into a dry, stable powder with a grinding/drying machine. Kelp powder may be stored for over a year without refrigeration, allowing for drastically lower shipping and storage costs compared to frozen or fresh products.

Research is ongoing into how well kelp will grow in Alaska, and on ideal density per unit of space. Some aquatic farms space rows only a few yards apart while others may leave over 40 feet between rows, depending on the harvesting methods and equipment used. This growing density presents major implications for yields per acre.

As operations scale up, there will likely be greater capital investments in processing equipment and new or refurbished buildings where seaweed may be processed and stored. Initially, Alaska's lone kelp buyer plans on using a mobile, trailer-mounted processing unit that will be transported to farm sites around the state. This approach makes greater use of the processing unit, though if volumes increase another processing machine may be necessary. Farmers may also decide to become wholesalers and process their own product, which would require localized processing facilities.

Initial capital expenditure requirements for kelp farming include buying lines/buoys and processing machinery used to dry and grind seaweed. Relatively low capital investment requirements and ability to utilize existing

labor and vessels outside of the fishing season are reasons many are optimistic the industry can flourish in Alaska.[6]

Kelp Markets

Alaska Markets

All three Alaska kelp farms plan to sell 2017 production to San Francisco-based Premium Oceanic, LLC, a company with seaweed production facilities in Mexico. The company, which is the only large-scale seaweed buyer operating in Alaska at this time, operates under the brand name Blue Evolution. The company produces a CPG (consumer packaged good) pasta product line that includes kelp.

Photo credit: Blue Evolution.

Premium Oceanic, which also sources seaweed from onshore grow-out facilities in Mexico, has identified potential for high volume production in Alaska.[7] Alaska has access to more undeveloped coastline than other areas in the lower 48, where achieving larger farm sizes would likely meet with resistance. Marine skills of coastal Alaskans and vessels potentially available for use are also important advantages over other areas in North America or Europe. In an effort to expand its product line beyond pasta, Premium Oceanic also investigating other markets where kelp powder could be an ingredient.

The company owns a mobile drying/processing unit capable of transforming mass quantities of wet Alaskan kelp into a stable powder format. The company reports a desire to expand production in Alaska, although producing seed is challenging due to strict regulations about sourcing plants from local areas. If kelp ventures succeed, Alaska could face competition from British Columbia and eastern U.S. states, which may dilute the market and lead to lower prices.

U.S. and Global Markets

Alaska producers will likely target North American markets, rather than compete with low-cost Asian producers or European producers in their native markets. With virtually no domestic production, most seaweed utilized in the U.S. (and Canada) comes from imports. Last year the U.S. imported 40,259 metric tons of seaweed and intermediate products derived from seaweed worth $205 million. Seaweed imports fell 16 percent by value in

[6] Future projections concerning value and economic costs/benefits will rely heavily on hypothetical assumptions gleaned from interviews with industry.
[7] Personal communication.

2016 but were relatively stable in previous years. Carrageenan-based thickeners have trended down in volume and value since 2014, possibly due to research linking them to a myriad of health problems.[8] This downward trend is likely to accelerate following a November 2016 ban by the National Organic Standards Board that stipulates carrageenan-based additives will no longer be allowed for use in foods carrying the "USDA Organic" label. The ban and research findings should not impact demand for kelp; however, as carrageenan is typically derived from Asian green or red seaweeds (such as Euchema and Elkhorn Sea Moss).

Table 18. U.S. Seaweed Imports by Product Type, 2012-2016

Volume (Metric Tons)	2012	2013	2014	2015	2016
Agar	1,428	1,420	1,417	1,565	1,383
Seaweed/Algae (not for Human Consumption)	19,539	23,652	18,030	14,826	20,959
Seaweed/Algae (for Human Consumption)	7,789	6,370	7,180	10,711	8,701
Seaweed Carrageenan-based Thickeners	10,245	9,105	9,965	9,981	9,216
Total	**39,002**	**40,547**	**36,592**	**37,084**	**40,259**
Value ($Millions)	**2012**	**2013**	**2014**	**2015**	**2016**
Agar	$29	$32	$34	$38	$32
Seaweed/Algae (not for Human Consumption)	43	49	47	36	38
Seaweed/Algae (for Human Consumption)	51	61	61	73	58
Seaweed Carrageenan-based Thickeners	89	88	102	96	76
Total	**$212**	**$230**	**$244**	**$244**	**$205**

Source: NMFS Trade Data.

The U.S. imported seaweed products from 38 different countries in 2016. These import statistics provide some indications of potential value of Alaska kelp. It is likely that much of the kelp the U.S. imports from China consists of dried kelp powder or flakes. The U.S. imported 1,922 metric tons of seaweed and other algae fit for human consumption in 2016, worth $21.9 million. This works out to $11,369 per (dried) metric ton, or $0.77 per wet pound assuming a 15 percent dry/wet yield. It is important to again note that $0.77 per pound may not be a good proxy for "ex-vessel" Alaska kelp prices, as the import unit value includes processing, storage, shipping, and other operating costs. Still, the value of Chinese product (fit for human consumption) would likely represent at least the lower end of Alaska's potential wholesale value range.

Asian countries account for the vast majority of seaweed consumption, though the market for kelp and other sea vegetables is expanding rapidly in the U.S. and Europe. This expansion is fueled by changing consumer eating patterns, broadening palates, and seaweed's anointment as a "superfood." Plant based diets, specifically veganism, are on the rise – up 360 percent in the last decade - and that trend shows no sign of slowing down.[9] U.S. retail sales of kelp chips and crackers were valued at over $250 million in 2014.[10]

Kelp is growing in popularity, from nutritionists who tout its many health benefits, to chefs who welcome its unique taste profile, to environmentalists who value its ability to absorb carbon dioxide and reduce ocean

[8] http://www.npr.org/sections/thesalt/2016/12/12/504558025/carrageenan-backlash-why-food-firms-are-ousting-a-popular-additive.
[9] http://www.telegraph.co.uk/wellbeing/diet/say-goodbye-kale-superfood-trends-2017-five-new-ingredients/
[10] http://www.nbcnews.com/news/us-news/red-tape-slows-bloom-seaweed-farming-s-green-revolution-n613526

acidification. In addition, nutraceutical and cosmetic companies are also using kelp and other marine plants more.[11] Kelp's list of marketable qualities includes:

- Food – Detoxification, Anti-Oxidants, and Chelating Properties: helps the human body draw out waste, toxins, and heavy metals and reduces inflammation. Also helps to purify blood.
- Food – Healthy Thyroid, Healthy Waistlines: kelp contains relatively high levels of iodine, which is essential for the thyroid gland and regulating metabolism. Iodine deficiency is a concern in both developing and developed countries, especially with people consuming more sea salt (and less iodized salt) as well as the addition of bromine to some foods, which blocks iodine absorption.[12]
- Food – Alkalizing Acidic Bodies: seaweeds can help alkalize blood, neutralizing the effects of our modern diet as well as reducing the acids in foods where they are added as an ingredient.
- Food – Bioavailable Nutrients: kelp contain high amounts of potassium, magnesium, calcium, iron, vitamins, amino acids, omega-3 fats, and fiber which are absorbed easier by human bodies than pill-based supplements.
- Skin – High-end Elixirs: popular skin creams can reduce wrinkles and reduce skin blotches.
- Environment – Cleaning the Air and Oceans: kelp absorbs five times as much carbon dioxide as land-based plants, filters nitrogen/phosphorus, and reduces ocean acidification.[13]
- Environment – Habitat Supports Life: kelp farms provide habitat for fish, increasing local ocean productivity.
- Infrastructure – Protection from the Storms: kelp farms can slow down storm surges.
- Biofuel – Kelp-anol: Researchers around the world have been working with macroalgaes like kelp on biofuel production methods.
- Animal Feeds – Growing Healthier Everything: kelp/seaweed can produce demonstrable benefits when added to feeds for aquaculture and animals, even at low percentages (2 percent), making it a valuable feed additive.

[11] http://www.cosmeticsdesign.com/Formulation-Science/Researchers-at-work-on-new-kelp-source-for-natural-cosmetics
[12] https://www.ncbi.nlm.nih.gov/pubmed/19460960
[13] http://e360.yale.edu/features/new_breed_of_ocean_farmer_aims_to_revive_global_seas

Species in Research and Development

While little or no production is occurring in the Alaska mariculture industry for species other than oysters, mussels, geoducks, and kelp, several other species are under consideration for potential development. Only a few species have advanced into substantial research and development stages. A great deal of resources have been placed on king crab enhancement, while some effort is also going into sea cucumbers and abalone. Clams (aside from geoduck), purple-hinged rock scallops, sea urchins, and cockles are being researched.

King Crab

King crab are an important commercial species in Alaska, though stocks have declined and not rebounded in the Gulf of Alaska since the 1980s. A statewide collaborative research effort, *Alaska King Crab Research, Rehabilitation, and Biology* (AKCRRAB), is currently underway to rehabilitate stocks. Recent experimental releases of crab stock are under observation and the next and final phase of the research effort is underway. Next steps will be to attract industry investment and ensure the Alaska regulatory environment will allow for crab enhancement.

King crab enhancement has the potential to be immensely profitable. Ex-vessel prices are at a record-high and king crab products are in high demand around the globe. In addition, fishing operations and processing operations already harvest and process crab, so there wouldn't be an issue with establishing new relationships, distribution channels, or markets. Most major processing centers (Kodiak, Bering Sea, and Southeast) purchase king crab regularly and would likely welcome enhanced crab stocks due to their high market value.

Crab enhancement research is in its infancy yet has produced a wealth of information. Funding has been shared between Community Development Quota (CDQ) groups, public agencies, and industry, but it has been a costly endeavor that has yet to produce commercial crab. Maintaining funding now will be a key factor for future success.[14] AKCRRAB's third and final phase is to invoke industry participation, now that they've developed the pathway to red king crab rearing. The AKCRRAB team has proven that gathering broodstock, incubating king crab in salt water tanks for 2 months, and outstocking them is a relatively low-cost effort.

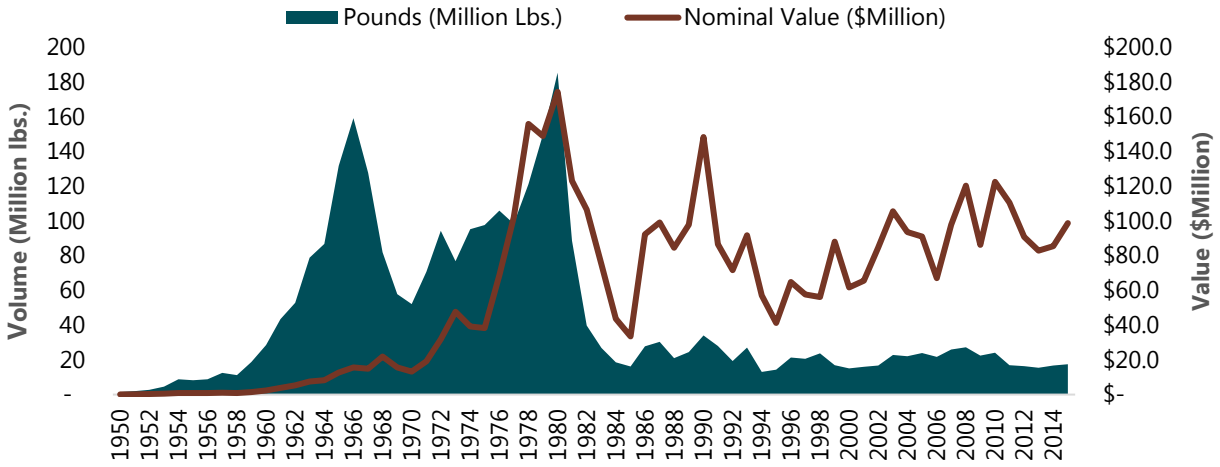
The greatest challenge before commercial hatcheries can operate is costly genetics monitoring that the State of Alaska requires. Scientists are unsure on how hatchery crab would impact natural stocks. The experimental outstocking conducted in the Kodiak basin remain in localized populations and the natural crab population is so depleted around Kodiak Island that scientists are unable to observe stock interactions.

INDUSTRY OVERVIEW

King crab, the largest crab species in the U.S., harvested in the Bering Sea, are a highly valuable commercial species. In 2015, king crab harvests totaled 17.5 million pounds worth $98.6 million. Crab fishing is jointly managed by NMFS and ADF&G.

[14] http://www.bsfrf.org/pdf/DraftAKCRRAB_1pager.pdf

Figure 17. King Crab Harvests and Value, 1950-2015



Source: NMFS Landings.

Red king crab (*Paralithodes camtschaticus*) inhabit a continuous, wide range from the Aleutian Chain, Bering Sea, and the Gulf of Alaska.[15] Blue king crab (*Lithodes aequispinus*) inhabit discrete areas in the Bering Sea, and tend to live in shallower water than red king crab. Both species are long-lived, typically not large enough to harvest until 7 to 9 years of age.[16] Both red and blue king crab commercial fishing peaked in the mid-1980s and stocks have not fully recovered from overfishing. Blue king crab near the Pribilof Islands are the only federally-listed overfished species in Alaska. Recently, ocean acidification and ocean temperature fluctuations have been linked to lowered king crab survival rates.[17]

In 2005, king crab fisheries were rationalized with allocations, or Individual Fishing Quotas, based on historic harvests. The red king crab fishery has opened each year for directed fishing.[18] Most recently the Bristol Bay red king crab fishery had a Total Allowable Catch (TAC) of 8.5 million pounds for the 2016/2017 season.[19] The most recent season that blue king crab was open near St. Matthew Island was for the 2015/2016 season, with a TAC of 411,000 pounds.[20]

RESEARCH AND DEVELOPMENT IN ALASKA

In response to declining stocks and potential environmental changes, and the highly lucrative king crab commercial fishery, king crab wild stock enhancement has been a research priority for ADF&G since 1991.[21] In particular, near the Pribilof Islands, enhanced blue king crab population would reduce impacts on other local fisheries that are closed to avoid blue king crab interactions.[22] Additionally, coastal Alaskan communities would

[15] http://www.afsc.noaa.gov/Education/factsheets/10_rkc_fs.pdf
[16] http://www.adfg.alaska.gov/index.cfm?adfg=wildlifenews.view_article&articles_id=544
[17] https://access.afsc.noaa.gov/pubs/posters/pdfs/pFoy02_ocean-acid-research.pdf
[18] http://www.afsc.noaa.gov/Education/factsheets/10_rkc_fs.pdf
[19] https://alaskafisheries.noaa.gov/sites/default/files/reports/2016_17bbrkc.pdf
[20] https://alaskafisheries.noaa.gov/sites/default/files/reports/2015_16smbkc.pdf
[21] http://www.adfg.alaska.gov/index.cfm?adfg=wildlifenews.view_article&articles_id=544
[22] http://www.nmfs.noaa.gov/sfa/fisheries_eco/status_of_fisheries/archive/2015/2015_status_of_stocks_updated.pdf

benefit from crab enhancement through quota allocations held by shoreside processors, fishermen, crew members, and CDQ groups.[23]

NMFS operates a shellfish research laboratory in Kodiak, where scientists conduct research on king crab habitat, life cycle, behavior, and response to climate change.

Around the world, crab aquaculture has yet to move beyond the development phase. Maryland blue crab enhancement began in 2002 with subsequent release of 150,000 crab. Japan attempted king crab enhancement research in the 1980s, though efforts did not continue.[24] Russians introduced king crab in the Barents Sea, where it was not native, to increase commercial fishing opportunities in the 1980s.[25]

Alaska King Crab Research, Rehabilitation, and Biology (AKCRRAB)

The first crab restoration project in Alaska, the AKCRRAB Program, is an Alaska Sea Grant partnership funded by fishery associations, CDQ groups, NOAA, the University of Alaska Fairbanks, and private industry. This long-term research effort, which commenced in 2006, focuses on raising and releasing red and blue king crabs to enhance depressed king crab populations throughout Alaska. [26] The project also includes monitoring of ocean acidification impacts on crustaceans, such as juvenile shell growth rates.

Alutiiq Pride Shellfish Hatchery, located in Seward, is the only hatchery in Alaska that has produced crustacean larvae. When the larvae reach a certain age, they are shipped to the NOAA Kodiak Laboratory where they have recently (in 2013-2015) been released into pens near Kodiak and Old Harbor (Kodiak Island) and monitored for survival rates. Only red king crab have been outstocked; blue king crab efforts are behind the red crab program by three to four years due to biological differences between the species. Hatchery production increased from 1,000 juveniles to 100,000 juveniles between 2007 and 2010.[27] In 2014-2015, 21,000 juveniles were released. Currently the mortality rate after release is 15 percent. Since Kodiak lacks any local king crab population, monitoring efforts can assume all observed juvenile crab are AKCRRAB experiments. The next release is anticipated for 2018 and will outstock 100,000 juvenile crab near Kodiak.

[23] The Western Alaska Community Development Quota (CDQ) Program allocates a percentage of all Bering Sea and Aleutian Islands quotas for groundfish, prohibited species, halibut, and crab to eligible communities. The purpose of the CDQ Program is to (i) to provide eligible western Alaska villages with the opportunity to participate and invest in fisheries in the Bering Sea and Aleutian Islands Management Area; (ii) to support economic development in western Alaska; (iii) to alleviate poverty and provide economic and social benefits for residents of western Alaska; and (iv) to achieve sustainable and diversified local economies in western Alaska. (NMFS)
[24] https://seagrant.uaf.edu/research/projects/kingcrab/docs/presentations/Eckert-lobster-crab-enhancement.pdf
[25] http://flseagrant.ifas.ufl.edu/newsletter/2012/07/an-amazing-story-red-king-crab-introduced-to-barents-sea/
[26] https://seagrant.uaf.edu/research/projects/kingcrab/docs/presentations/Persselin-2009-comfish.pdf
[27] http://www.adfg.alaska.gov/index.cfm?adfg=wildlifenews.view_article&articles_id=544

AKCRRAB operates in three phases to achieve its goal of eventual rehabilitation of king crab that it hopes to accomplish by 2019.[28]

- Phase I: Developing and improving methods of hatchery rearing juvenile king crab.
- Phase II: Understanding optimal release strategies, appropriate habitat, and potential impacts on existing ecosystems.
- Phase III: The final phase aims to transition AKCRRAB from a research coalition to implementation by different industry user groups.

AKCRRAB Operations

Since 2007, king crab broodstock have been collected under ADF&G research permits. The Alutiiq Pride Shellfish Hatchery monitors and cares for the adult broodstock and their offspring. Thousands of eggs hatch in early spring and the larvae become juveniles two months later. Survival rates for king crab were 31 percent in 2013.[29] Hatchery startup required $600,000 in equipment. Hatchery operations currently cost between $305,100 to $333,800 a year.[30]

Juvenile red king crab.
Photo credit: Celeste Leroux, Alaska Sea Grant.

Broodstock for hatchery production is developed from wild crab. In past years, it has been collected from Alitak Bay and Old Harbor on Kodiak Island, the Pribilof Islands, and Little Diomede. Currently, broodstock comes from Alitak Bay. From broodstock, larvae are raised in at APSH in Seward for two months and then outstocked before the juveniles become cannibalistic. A 10 percent survival rate at the juvenile stage, produces 100,000 juveniles annually.[31] Raising larvae in a controlled environment greatly reduces natural mortality.

Table 19. Estimated Costs of King Crab Enhancement, 2009

Operating Costs	$250,000
Start Up Cost	$150,000
Cost to Produce 1 Million Juveniles	$0.25/juvenile
Survival Rate	8%
Number of Survivors	80,000
50% Male	40,000
Exploitation of 15%	6,000
Typical King Crab (in lbs.)	6.5
Typical King Crab Price/lb.	$8.00
Potential Future Value	$312,000

Note: Survival rate refers to juveniles reaching adulthood (seven years).
Source: Glaser (2009). Rehabilitation of the Alaskan red king crab through large-scale hatchery culture and restock: Cost-Benefit Analysis.

[28] https://seagrant.uaf.edu/research/projects/kingcrab/docs/akcrrab-strategic-plan-2015-2019.pdf
[29] http://alaskaberingseacrabbers.org/article.php?article=90
[30] https://seagrant.uaf.edu/factsheets/kingcrab/kingcrab-financial-web.pdf
[31] https://seagrant.uaf.edu/research/projects/kingcrab/docs/presentations/Persselin-2009-comfish.pdf

Since AKCRRAB is in research and development, current costs are substantial. From 2008-2010, total costs were $2.5 million in Alaska Sea Grant funds.[32]

Research and Development

There is a comprehensive body of knowledge published on king crab species, including diet, effects of water temperature, effects of light, molting, and survival that contributes to a better understanding of how to successfully enhance wild stocks.[33] Since its infancy, AKCRRAB has enlisted the research efforts and collaboration of eight University of Alaska Fairbanks students.[34] In addition, more than 30 visiting scientists have contributed to the ongoing body of research. Three Alaska Sea Grant staff and three NMFS researchers have also worked on AKCRRAB efforts.[35]

Community Investment

As AKCRRAB phases out public investment and seeks private interest, tribes and CDQ groups stand out as potential catalysts for bringing crab enhancement to fruition. CDQ groups receive crab allocations and would benefit from an increased supply of crab. Tribes representing rural communities, such as St. Paul, would greatly benefit from increased economic activity through hatchery efforts as well as fishing activity.

King crab requires diving for broodstock, a facility, equipment, and expertise to hold crab for two months, and the ability to release them. St. Paul Island has a NOAA facility and expertise in crab biology. In addition, Central Bering Sea Fishermen's Association, the region's CDQ group, holds sizeable amounts of crab quota and investing in crab enhancement and science could be modeled after Bristol Bay Economic Development Association's Bristol Bay Science and Research Institute, which is the scientific research subsidiary of BBEDC.[36]

Kodiak Island's current involvement in crab enhancement and its sizable commercial crab fleet and processing facilities makes it an ideal candidate for long-term investment. The NOAA Kodiak Laboratory, which is currently extensively involved in the king crab outstocking research, also houses the federal shellfish stock assessment scientists.

[32] https://seagrant.uaf.edu/factsheets/kingcrab/kingcrab-financial-web.pdf
[33] https://seagrant.uaf.edu/research/projects/kingcrab/docs/presentations/Persselin-2009-comfish.pdf
[34] https://seagrant.uaf.edu/research/projects/kingcrab/general/graduate-students.php
[35] https://seagrant.uaf.edu/research/projects/kingcrab/staff/index.php
[36] http://www.bbedc.com/?page_id=195

Pinto Abalone

The pinto abalone (*Haliotis kamtschatkana*), or the northern abalone, is the only abalone species found in Alaska. This single-shelled mollusk inhabits shallow kelp beds from Southeast Alaska to California.[37] In Alaska, this species is typically found between Dixon Entrance and Icy Straits in outside waters of Southeast Alaska. This abalone species is slow-growing, with the length of time required to grow to a commercial size unknown.

A commercial fishery for pinto abalone existed in Southeast Alaska from the 1970s to the late 1990s, when it was closed due to overfishing.[38] Concurrently, a growing Southeast Alaska sea otter population placed pressure on the abalone biomass, further limiting its capacity to rebuild.[39] Pinto abalone have been listed as a "species of concern" under the Endangered Species Act, since 2004, which allows proactive conservation action to limit further stock declines.[40] Subsistence harvests of abalone in Alaska are limited to 5 abalone a year with a minimum size of 3.5 inches.[41]

INDUSTRY OVERVIEW

Abalone mariculture was developed in response to rapidly declining stocks around the world due, in part, to high demand for this mollusk. China produces most of the world's commercial abalone grown in aquaculture operations, while very little is grown in the U.S. On the U.S. West Coast, abalone mariculture is a cottage industry with several small-scale farms producing live and canned abalone that sell for up to $100 per pound.

The Alutiiq Pride Shellfish Hatchery in Seward is the only Alaska mariculture facility actively growing pinto abalone seed. That seed is produced for conservation purposes only.[42] Potential exists for abalone production to increase in Alaska, given high market prices for wild and fresh abalone and a pristine environment that is optimal for growers.

PRODUCTION AND SUPPLY

In 2014, the U.S. produced 750,000 pounds of abalone, worth $4.8 million. Abalone producers on the West Coast market their products as fresh, either as steaks or whole. Depending on the species and product form, abalone market prices range from $15-$30 for a single abalone, $125 for 1 pound of abalone steaks, and $15 for a 4.8 oz. can.[43,44,45]

To supplement domestic production, the U.S. imported approximately 1 million pounds of abalone in 2016, worth between $9 to $17 per pound. Australia accounted for 34 percent of total supply, followed by Hong Kong with 22 percent.

[37] http://www.adfg.alaska.gov/index.cfm?adfg=abalone.main
[38] http://www.fisheries.noaa.gov/pr/species/Status%20Reviews/pinto-abalone-status-review-2014.pdf
[39] http://www.haidagwaiiobserver.com/news/413095193.html
[40] http://www.fisheries.noaa.gov/pr/species/invertebrates/abalone/pinto-abalone.html
[41] http://www.adfg.alaska.gov/index.cfm?adfg=PersonalUsebyAreaSoutheastSCA.regs
[42] http://alutiiqpridehatchery.com/pinto-abalone/
[43] http://bigislandabalone.com/buyonline.html
[44] https://www.giovannisfishmarket.com/seafood-online/abalone/live-abalone.aspx
[45] https://www.giovannisfishmarket.com/seafood-online/abalone/abalone-steaks-one-pound.aspx?IID=816308

Table 20. Top U.S. Abalone Import Source, 2016

Country	Value ($Millions)	Quantity (Lbs.)	Avg. Price Per Lb.
Australia	$4.3	359,350	$11.97
Hong Kong	$2.5	240,301	$10.20
Mexico	$2.1	154,322	$13.55
Chile	$1.3	141,094	$9.04
China	$1.7	141,094	$12.17
South Korea	$0.2	11,023	$17.83
Other	$0.2	22,046	$9.61
Total	**$12.2**	**1,069,230**	**$11.45**

Note: Includes live, fresh, chilled, and non-specified abalone products.
Source: Global Trade Atlas.

Global Production

Abalone mariculture operations produce approximately two-thirds of the annual world commercial abalone supply. In 2014, global mariculture supply of abalone totaled 516,618 metric tons, of which 70 percent was produced in farming operations.

U.S. domestic abalone production is minor in comparison to China and Korea. Chinese producers supplied 348,246 metric tons of farmed abalone, worth $678 million in 2014, or 96 percent of total farmed abalone. Korea produced 8,977 metric tons worth $39 million.

Table 21. Global Aquaculture Supply of Abalone, in Metric Tons and $000s, 2010-2014

Region	2010	2011	2012	2013	2014
China	264,349	280,052	305,040	323,224	348,246
Korea	6,228	6,779	6,564	7,479	8,977
South Africa	1,015	1,036	1,111	1,100	1,150
Chile	794	841	853	1,134	1,146
Australia	1,985	491	605	724	859
U.S.	250	250	250	201	341
Other	80	114	101	77	87
Total Aquaculture Volume (mt)	**274,701**	**289,563**	**314,524**	**333,939**	**360,806**
Total Aquaculture and Wild (mt)	**431,806**	**435,487**	**472,796**	**500,291**	**516,618**
Pct. Aquaculture	**64%**	**66%**	**67%**	**67%**	**70%**

Note: Data contains some conches and winkles.
Source: FAO Fish Stats.

Globally, abalone are typically sold alive, which is when they are the freshest. Farmers have sold them deshelled in frozen vacuum packs and in cans. China and Japan consumers use dried abalone for its alleged medicinal and aphrodisiac qualities, in addition to a wide variety of other dishes. Abalone flavor is so popular in Asia that there is a faux vegetarian version available.[46]

[46] https://giantonline.com.sg/catalog/product/view/name/vegetarian-abalone-285g-5016909

Table 22. Global Aquaculture Supply of Abalone, in $000s, 2010-2014

Region	2010	2011	2012	2013	2014
China	$389,557	$481,047	$552,478	$643,102	$678,634
Korea	$197,708	$215,713	$213,237	$226,285	$282,115
South Africa	$48,596	$40,867	$49,509	$41,710	$38,702
Chile	$26,202	$29,274	$65,833	$81,018	$105,266
Australia	$14,197	$16,917	$19,879	$22,937	$24,195
U.S.	$8,818	$8,818	$8,818	$8,538	$4,818
Other	$2,020	$3,788	$2,756	$2,305	$2,870
Total Value ($000s)	**$687,098**	**$796,424**	**$912,509**	**$1,025,896**	**$1,136,599**

Note: Data contains some conches and winkles.
Source: FAO Fish Stats.

ALASKA ABALONE FARMING

Alutiiq Pride Shellfish Hatchery is producing seed for pinto abalone with a focus on species preservation. However, there may be potential for mirroring commercial mariculture efforts for abalone that California and British Columbia farmers have successfully developed.

Since abalone farming is not occurring in Alaska at this time, operating cost information is not available. However, potential farmers might consider several factors:

- Abalone farmers in California see a profit margin of 15-18 percent per abalone above their operating costs and the common price they receive per live abalone is $15.
- Abalone are a slow-growing species. Based on industry interviews, shellfish farmers would see more success with abalone rearing after first building a base of a faster growing species like oysters or mussels.
- Careful planning to protect farmed abalone from natural predators, like sea otters, could be important.
- Costs to grow abalone are likely comparable to other shellfish operations, like geoducks, which take several years to mature but are more valuable on a per pound basis than oysters or clams.

The Cultured Abalone Farm

The Cultured Abalone Farm (Goleta, CA) is a land-based operation that consists of 400 1,000 gallon tanks that produce 1,500 pounds of abalone each week. They are fed a composite diet of local kelp and are sold at $15 per pound whole and live to buyers. They typically operate at a 15-18 percent margin on gross sales.

The following table provides a hypothetical operating model for abalone production. It is based on interviews with California abalone farmers, who are permitted to grow up to 500,000 abalone each. Prices were assumed to be approximately $20 per pound with producers growing between 60,000-80,000 with seed purchased from Alutiiq Pride Shellfish Hatchery. Based on these assumptions, annual gross revenue from abalone sales would be between $1.2-1.6 million per farm. In California, the cost of producing one abalone is $3.50-$12, depending if operations are ocean or land-based.

Table 23. Potential Alaska Abalone Production

Annual Production	60,000-80,000 abalone
Average Farmgate Value per Pound	$15-23/lb. $20/lb. average
Annual Earnings	$1.2-1.6 million
Profit Margin	15-18% of Revenue
Annual Labor Cost	50% of operating costs
Employment	9-12 year-round employees

Source: McDowell Group estimates.

Alaska producers could anticipate entering a market where abalone prices range between $15 to $30 per pound. It is likely that Alaska-produced abalone prices could be in the upper range due to their quality and the price premium that Alaska seafood often commands.

Sea Cucumbers

Sea cucumbers, also known globally as bêche-de-mer, are a delicacy in Asian countries. Commercially, hundreds of sea cucumbers species are priced and graded by size, species, and imperfections. In addition to food consumption, they are also used in biomedical and pharmaceutical applications.

Giant red sea cucumbers (*Parastichopus californicus*) are the only commercially harvested sea cucumber in Alaska. The species, found in the Pacific Ocean from Mexico to the Aleutian Islands, can grow up to 50 cm (19 inches) long.[47] Giant red sea cucumbers reach adult size and sexually maturity after 4 years.[48]

Photo credit: ADF&G.

In 2015, sea cucumber mariculture contributed 83 percent to the world supply. The remaining 17 percent was wild harvest. Sea cucumber mariculture operations vary, with many regions practicing "poly-culture." As sea cucumbers are filter-feeders, they consume detritus from other species, making them potentially useful for minimizing waste from farms or processing plant discharge zones. Sea cucumber mariculture may also be used to enhance wild stocks.

PRODUCTION AND VALUE

Currently no commercial sea cucumber mariculture operations exist in Alaska, though a wild harvest does occur.

Farmed Sea Cucumbers

Sea cucumber mariculture is in its infancy in Alaska and the rest of the U.S., with most U.S. production from wild harvest. In Alaska, sea cucumber mariculture efforts are in the research and development phase.[49] Southeast Alaska Regional Dive Fisheries Association (SARDFA) supports sea cucumber enhancement research in Seward at APSH and in Ketchikan.

SARDFA is interested in developing mariculture to address sea cucumber population declines due to a rise in sea otter populations in Southeast. SARDFA is concerned sea otter depredation of sea cucumbers will decimate the population to the extent that commercial fishing access will close entirely in Southeast. Since poly-culture has been successful with sea cucumbers, SARDFA has expressed interested in working with oyster farms or salmon hatcheries.

Operations in other areas of the world may help inform efforts in Alaska. Many countries produce hatchery-raised sea cucumbers for both enhancement and commercial production, with much of the effort in China, other Asian countries, and the Pacific Islands including Australia and New Zealand.[50] In 2015, China produced 98

[47] http://www.adfg.alaska.gov/index.cfm?adfg=redseacucumber.main
[48] http://peninsulaclarion.com/news/2011-07-17/spawning-sea-possibilities?utm_source=Morris%20Digital%20Works&utm_medium=email&utm_campaign=Recurring_Daily%20Headlines
[49] http://alutiiqpridehatchery.com/sea-cucumber/
[50] http://seagrant.umaine.edu/files/pdf-global/SeaCucumberManual_062614.pdf

percent of total sea cucumber global supply, totaling 205,791 metric tons, worth $715 million. In China, sea cucumbers are raised in artificial ponds and man-made tide pools.

Table 24. Global Supply of Farmed Sea Cucumbers, in Metric Tons, 2011-2015

Region	2011	2012	2013	2014	2015
China	137,754	170,830	193,705	200,969	205,791
Indonesia	219	475	206	138	2,029
Other	213	211	237	918	128
Total Mariculture Volume (mt)	**138,186**	**171,516**	**194,148**	**202,025**	**207,948**
Total Mariculture and Wild (mt)	**181,092**	**211,670**	**232,909**	**238,137**	**250,940**
Pct. Mariculture	**76%**	**81%**	**83%**	**85%**	**83%**

Source: FAO Fish Stats.

Table 25. Value of Global Supply of Farmed Sea Cucumbers, in $000s, 2011-2015

Region	2010	2011	2012	2013	2014
China	$478,006	$592,780	$672,156	$697,362	$714,095
Indonesia	$3,119	$6,328	$2,473	$1,455	$18,817
Other	$1,586	$1,576	$1,711	$5,906	$1,274
Total Value ($000s)	**$482,712**	**$600,684**	**$676,340**	**$704,723**	**$734,186**

Source: FAO Fish Stats.

Wild Harvest Sea Cucumbers

The U.S. only produces wild harvest sea cucumbers and contributes a small fraction to global supply. Alaska harvests the most sea cucumbers in the country, followed by Washington, Maine, and California.

Table 26. U.S. Wild Sea Cucumber Landings, Metric Tons and Value, by Region, 2013-2015

	2013 mt	2013 Value	2014 mt	2014 Value	2015 mt	2015 Value
Alaska	752	$6,523,020	546	$4,815,197	740	$5,747,153
East Coast	483	$305,580	230	$177,080	9	$18,511
West Coast	477	$3,811,179	444	$3,846,897	505	$5,182,903
Total Harvested	**1,712**	**$10,639,779**	**1,220**	**$8,839,174**	**1,253**	**$10,948,567**

Source: National Marine Fisheries Service, Fisheries Statistics and Economics Division.

In Alaska, commercial dive harvests began near Ketchikan in 1983. In addition to harvest in the commercial dive fishery, the species is a traditional subsistence food. Commercial diving for sea cucumbers is largely concentrated in Southeast, with smaller fisheries in Kodiak and Chignik.[51] Divers use scuba gear to hand pick sea cucumbers off benthic (sea floor) habitats and transport them to the surface in mesh bags.[52] ADF&G rotates fishery areas every three years to prevent overharvest. Stock assessments are partially-funded by SARDFA.

[51] http://www.adfg.alaska.gov/index.cfm?adfg=CommercialByFisheryDive.seacucumber
[52] http://www.adfg.alaska.gov/index.cfm?adfg=redseacucumber.main

Statewide harvests averaged slightly over 1.6 million pounds per year between the winter 2011/12 and 2015/16 seasons.[53] Harvests in Southeast Alaska averaged 1.5 million pounds per year, with about 186 divers participating. In 2016, the season average price per pound for sea cucumbers in Southeast was $4.00. The fishery's value has increased recently due to rising prices in China, the top importer of Alaska's sea cucumbers.

Table 27. Southeast Alaska Sea Cucumber Harvests, 2011-2016

Season	Guideline Harvest Level (lbs.)	Total Landed (lbs.)	Average Price/lb.	Ex vessel Value	Number of Divers
2011/12	999,000	1,023,834	$5.06	$5,180,600	189
2012/13	1,476,000	1,512,895	$4.05	$6,127,225	199
2013/14	1,472,600	1,556,983	$3.97	$6,181,223	198
2014/15	1,084,800	1,073,554	$4.00	$4,294,216	171
2015/16	1,439,900	1,525,387	$3.50	$5,338,855	175

Source: ADF&G Commercial Fishing Division.
Note: Some harvest data is not included in this table due to confidentiality restrictions.

SEA CUCUMBER PROCESSING AND OPERATIONS

China and Japan were the first to develop successful hatchery technology for sea cucumbers. Operations require broodstock and tanks with circulating seawater. The animals are held in shallow pens and cages on the seafloor in open water or grown in ponds. In China, large concrete ponds with natural tidal flows hold sea cucumbers that feed on algae and other natural food sources. In New Zealand, many aquaculture farms combine mussels and sea cucumbers. Sea cucumbers subsist on the detritus of many other mariculture species.

In Alaska, SARDFA provides APSH adult sea cucumbers as broodstock, from which the hatchery develops seed and then ships juveniles to Alaska Shellfish Hatchery in Ketchikan where the seed grow in a controlled environment.[54] In 2016, APSH successfully shipped a batch of young cucumbers to Ketchikan, and after a period of acclimation, the cucumbers were reared in a pen on the ocean floor near the facility. The test was successful and the cucumbers grew to three or four inches over a summer. At this time, there is no hard data available on mortality rates or how long it will take to grow the sea cucumbers to marketable size.

Photo credit: Kirsten Shelton-Walker

Sea cucumbers are processed into frozen or fresh muscle strips and dried skins or sections. The skin is cooked and then dried into a product known as trepang or bêche-de-mer. Sea cucumbers are sold in a variety of product forms, the predominant being frozen, salted, or dried.

[53] Based on annual ADF&G harvest data for years not confidential. Kodiak and Chignik harvests are purchased by a single buyer, which makes harvest data confidential. According to an ADF&G contact, GHL of 140,000 lbs. in Kodiak and 20,000 lbs. in Chignik is consistently met each year.
[54] http://alutiiqpridehatchery.com/sea-cucumber/

MARKETS

Sea cucumber products are marketed primarily in Asia, with a small niche in Asian food markets in the U.S. Primary markets are China and Japan, where the sea cucumber is valued for "aphrodisiac qualities." Wild Alaska sea cucumbers tend to be much larger and have higher nutritional value, and therefore command a premium price in the Chinese market.[55]

Table 28. U.S. Sea Cucumber Exports, by Product Type, 2013 – 2015

	2013 kg	2013 Value	2014 kg	2014 Value	2015 kg	2015 Value
Frozen/Salted/Dried	1,198,566	$30.8	428,688	$16.1	435,009	$13.6
Live/Fresh	277,677	$3.5	137,619	$1.8	95,985	$1.1
Prepared/Preserved	804,197	$6.7	452,760	$4.3	179,261	$1.6
Total Exports	**2,280,440**	**$41.0**	**1,019,067**	**$22.2**	**710,255**	**$16.3**

Source: National Marine Fisheries Service, Fisheries Statistics and Economics Division.

Table 29. U.S. Sea Cucumber Exports, by Country, 2013 – 2015

	2013 kg	2013 Value	2014 kg	2014 Value	2015 kg	2015 Value
China	1,854,415	$33.7	672,325	$14.7	444,668	$10.2
Canada	134,757	$1.6	101,003	$1.5	103,359	$1.8
South Korea	169,825	$3.8	144,836	$3.8	99,974	$3.1
Vietnam	93,741	$1.6	31,077	$0.7	44,625	$0.8
Other	27,702	$0.3	69,826	$1.5	17,629	$0.4
Total	**2,280,440**	**$41.0**	**1,019,067**	**$22.2**	**710,255**	**$16.3**

Source: National Marine Fisheries Service, Fisheries Statistics and Economics Division.

[55] https://www.scribd.com/document/74857876/MCDOWELL-GROUP-2011-Sea-Otter-Impacts-Report

Clams

Several clam species, aside from geoducks, are of interest for mariculture in Alaska. These include Pacific littleneck clams, razor clams, and butter clams.

PRODUCTION AND VALUE

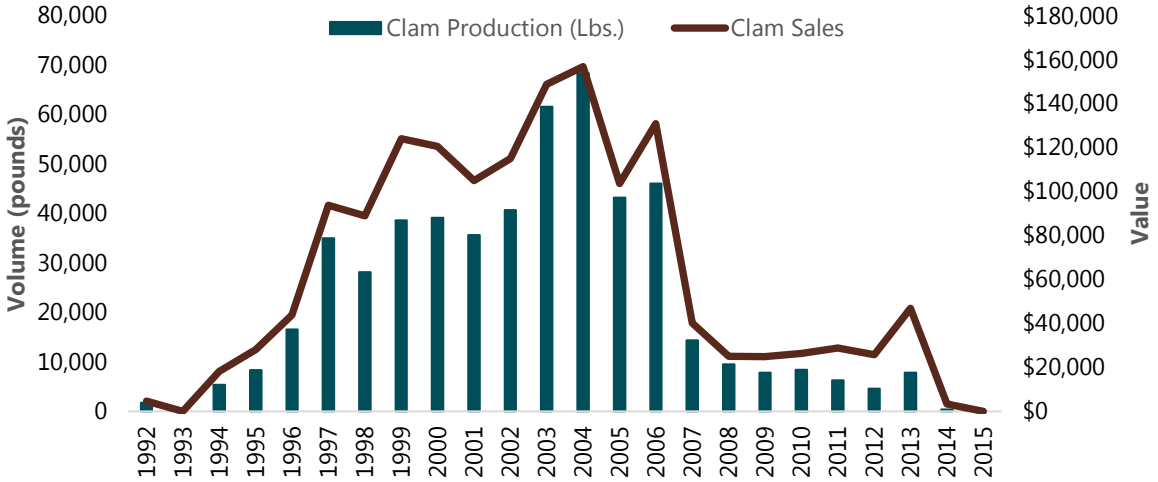
ADF&G has approved on-bottom aquatic farm sites for clams since 1999. In 2015, there were four permits in Alaska to culture clam (aside from geoducks) and one hatchery was permitted to grow seed.[56]

Alutiiq Pride Shellfish Hatchery has developed a process to rear and grow clams. The hatchery sold seed for a number of years, though they are not currently producing littleneck clam spat.

Littleneck clams, also known as steamer clams, have been farmed more than other clam species in the state, with a peak of $157,000 worth of littleneck clams sold in 2004. Since 2004, clam production and sales have declined significantly. In 2010, ADF&G began reporting farmed geoduck harvest in combination with other clams, complicating analysis of harvest trends for both species. It is known, however, that no littleneck clams were sold in 2015. Anecdotally, farmers have identified several potential issues related to declining clam mariculture harvests after 2004:

- Predation, especially by sea otters and sea stars, has been a factor at some sites.
- Farms are allowed to harvest wildstock on farm sites. After a period of time, the amount of wildstock available may have declined.
- Survival rates of hatchery raised clams has been variable.
- Slow growth rates for hatchery reared clams can delay return on investment, reducing interest in farming this product.

Figure 18. Alaska Clam Production and Sales, 1994-2015



Note: All clam sales through 2009 are for Pacific littleneck clams. Beginning in 2010, clam sales include both Pacific littleneck clams and Pacific geoduck clams.
Source: ADF&G and DNR.

[56] http://www.adfg.alaska.gov/index.cfm?adfg=fishingaquaticfarming.aquaticfarminfo_permit_status

LITTLENECK CLAMS

Interest in farming Pacific littleneck clams (*Protothaca staminea*) in Alaska is focused on diversifying product lines in current mariculture operations, as well as enhancing wild stocks.[57]

Littleneck clams grow in protected, mud beaches, burrowing about 6 inches deep. Clam farm sites exist on swathes of these non-rocky beaches, with a potential challenge being to contain farmed clams from wild populations.

Grow-out time for aquatic farm stock from seedstock to a marketable size is three to seven years. Recent research conducted by ADF&G suggests predator exclusion netting can enhance Pacific littleneck clam survival and growth in Southeast Alaska.

Spat is not currently available for littleneck clams, though, as noted above, APSH has sold seed in the past and produced clams for many years. The hatchery has developed culture and grow out techniques for this species. The hatchery also seeded over 1 million clams at Tatitlek and other villages in lower Cook Inlet in 2000 and 2001, with variable success and growth, for enhancement purposes.[58]

RAZOR CLAMS

Razor clams (*Siliqua patula*) can grow up to 7 inches and are found in sandy beaches from California to the Aleutian Islands.

Photo credit: ADF&G.

Historically, razor clams were harvested commercially near Cordova from 1916 until the 1950s.[59] The species was a popular canned shellfish item in grocery stores until less expensive substitutes outcompeted them. The local Cordova population was overexploited during this period.

Today, the largest commercial wild fishery for razor clams in the state occurs in lower Cook Inlet, where the harvest has ranged between 625,000 and 1.3 million clams annually since 1973.[60] The species is fished commercially for crab bait and for consumption.[61] The most recent data available shows the ex-vessel price for razor clams at $0.65/lb.[62]

In 2004, razor clams were planted near the village of Eyak, near Cordova, for enhancement purposes.[63]

APSH has raised this species from seed with success, though it is assumed razor clams would fulfill local enhancement goals rather than be farmed for commercial harvest.

---

[57] https://seagrant.uaf.edu/map/aquaculture/shellfish/presentations/Introduction%20to%20clam%20farming.pdf.
[58] http://www.sf.adfg.state.ak.us/FedAidPDFs/RIR.5J.2004.05.pdf.
[59] http://www.adfg.alaska.gov/static/fishing/PDFs/aquaticfarming/razor_clam_pws.pdf.
[60] http://www.adfg.alaska.gov/index.cfm?adfg=ByAreaSouthcentralLowerCookInlet.research.
[61] http://www.adfg.alaska.gov/index.cfm?adfg=razorclam.uses.
[62] ADF&G (COAR).
[63] http://www.adfg.alaska.gov/static/fishing/PDFs/aquaticfarming/eyak_razorclam_report.pdf.

BUTTER CLAMS

Butter clams (*Saxidomus gigantea*) are found from Alaska to California. This species grows up to five inches in length. Ideal butter clam habitat occurs in sandy beaches in protected bays. The clam burrows deeper than littleneck clams, up to 12 inches.[64] Katchemak Bay hosts a notable concentration of butter clams.

Like razor and littleneck, butter clams are popular for personal use and subsistence. A commercial fishery for butter clams does not currently occur in the state.

APSH has grown butter clams successfully for two years (2015-2017), with high survival and growth rates. The hatchery expects butter clams to be a viable product for aquatic farming in Alaska. APSH's first experimental outstocking of butter clams will occur in spring 2017. One challenge with butter clams is their propensity to retain PSP.

U.S. PRODUCTION

Similar to oysters and mussels, clam mariculture is common throughout the world. In the U.S., approximately 11 percent of clams are farmed. In 2014, 10.4 million pounds of clams were produced on farms in the country, worth $120.7 million.[65] Including farmed and wild-caught clams, 90.7 million pounds of clams were commercially landed, worth $214.7 million.[66]

[64] https://www.adfg.alaska.gov/static-sf/Region2/pdfpubs/HardshellClams.pdf
[65] https://www.st.nmfs.noaa.gov/Assets/commercial/fus/fus15/documents/03_%20Aquaculture2015.pdf.
[66] https://www.st.nmfs.noaa.gov/Assets/commercial/fus/fus15/documents/02_Commercial2015.pdf.

Purple-Hinged Rock Scallops

Purple-hinged rock scallops (*Crassadoma gigantea*) are intertidal bivalves that range from Southeast Alaska to Mexico.[67] This species of scallop is smaller, at up to 10 inches in height, than the only commercially harvested scallop species in Alaska, the Pacific weathervane scallop.[68] Unlike the weathervane, purple-hinged rock scallops may be successfully reared in mariculture because of their unique ability among scallop species to permanently attach to rocky substrates. [69]

Scallops, common in the U.S. and worldwide, are delicacies, consumed for their sweet, mild meat. In 2015, over 35.8 million pounds of wild-harvest scallops were landed in the U.S., worth $440.5 million.[70] Edible meat yield is 10 percent from live weight. Prices are higher for larger scallops.

In Alaska, most wild scallop harvest occurs near Kodiak with dredge gear. Additional beds in Cook Inlet, Prince William Sound, and Southeast are closed or limited to fishing due to low yields. Alaska scallops are directly marketed to food service businesses, restaurants, and retail establishments. Harvest for the 2014/15 season totaled 308,888 pounds of shucked meat.[71]

Photo credit: Joth Davis.

Scallops are produced in aquaculture around the world, including Canada and Washington.[72] In Alaska, there have been attempts to farm all three types of scallops that live in Alaska waters. Weathervane, the largest and the only ones commercially harvested, are difficult to farm and remain only wild-caught. Bay scallops, commonly sold live and whole, have also not been commercially produced in Alaska through mariculture. Rock scallops have the most potential for hatchery production because they readily attach to substrate and grow to marketable size in approximately three to five years.[73] Rock scallop spat can be hatchery produced. The one downside to rock scallops is their habit of cementing to hard surfaces, which can destroy gear during harvest.[74]

In 2015, four Alaska farms were permitted to raise rock scallops.[75] Alaska Sea Grant and APSH collaborated on two batches of rock scallop seed production. A research endeavor for lantern net grow-out was successful for bay scallops. Rock scallop research is currently underway using similar techniques to grow seed to maturity.

[67] Purple-hinged rock scallops, giant rock scallops, and rock scallops all refer to the same species *Crassadoma gigantea.*
[68] http://nsgl.gso.uri.edu/aku/akug98002.pdf.
[69] http://nsgl.gso.uri.edu/aku/akug98002.pdf.
[70] https://www.st.nmfs.noaa.gov/Assets/commercial/fus/fus15/documents/02_Commercial2015.pdf.
[71] https://www.npfmc.org/wp-content/PDFdocuments/resources/SAFE/ScallopSAFE/ScallopSAFE2016.pdf.
[72] http://www.dfo-mpo.gc.ca/aquaculture/farmed-elevage/listing-eng.htm.
[73] http://alutiiqpridehatchery.com/alaska-shellfish-farming/.
[74] http://www.adfg.alaska.gov/static/fishing/PDFs/aquaticfarming/growing_shellfish_in_alaska.pdf.
[75] http://www.adfg.alaska.gov/index.cfm?adfg=fishingaquaticfarming.aquaticfarminfo_permit_status.

Sea Urchins

Fresh whole sea urchins are consumed in many countries, including Chile, Hong Kong, and Southern Europe.[76] Sea urchin 'uni' (gonads) are prized in Japan, served primarily in sushi restaurants. Urchins are sourced from many countries, including Chile, China, Mexico, Russia, and the U.S.

Sea urchin mariculture research efforts have emerged in response to overfishing in less-regulated countries. China and Chile are two of the largest commercial producers of farmed sea urchins.

All sea urchin harvests in the U.S. are by divers. In 2015, over 11.1 million pounds of wild-harvest sea urchins were landed in the U.S., worth $13.1 million.[77] California produces the most sea urchins, followed by Maine.

Three varieties of sea urchins grow in Alaska, green, purple, and red. In 2015, four farms were permitted to culture green sea urchins. One farm was permitted to culture purple and one to culture red sea urchins.[78] Due to confidentiality, the status of these efforts is not included in published data.

The red sea urchin (*Strongylocentrotus franciscanus*), the larger sea urchin species in Alaska, is the target of the state's largest urchin fishery in Southeast Alaska. A commercial fishery for green sea urchin (*Strongylocentrotus droebachiensis)* in Southeast was assessed in 1999, though a biomass survey deemed the population too small for commercial harvest.[79,80] According to available data, fisheries for sea urchins in Kodiak and other regions have opened intermittently, though no current harvests occur outside of Southeast.

Since 2012, the annual Guideline Harvest Level for sea urchins averaged 3.5 million pounds, with total harvest landed by divers at approximately 550,000 pounds. For the 2015/16 season, 12 divers participated.

Table 30. Southeast Alaska Red Sea Urchin Harvests, 2012-2017

Season	Guideline Harvest Level (lbs.)	Total Landed (lbs.)	Average Price/lb.	Ex vessel Value	Number of Divers
2012/13	3,275,300	357,679	$0.37	$133,082	8
2013/14	3,275,300	544,591	$0.47	$253,410	10
2014/15	3,310,700	634,430	$0.37	$231,758	12
2015/16	3,838,900	677,202	$0.49	$336,513	12

Source: ADF&G Commercial Fishing Division.

[76] http://nsgl.gso.uri.edu/casg/casgr05025.pdf
[77] https://www.st.nmfs.noaa.gov/Assets/commercial/fus/fus15/documents/02_Commercial2015.pdf
[78] http://www.adfg.alaska.gov/static/fishing/PDFs/aquaticfarming/2015_af_highlights.pdf
[79] http://www.adfg.alaska.gov/index.cfm?adfg=CommercialByFisheryDive.seaurchin
[80] https://www.nationalfisherman.com/alaska/market-report-alaska-sea-urchins/

Cockles

Cockles (*Clinocardium nuttallii*) are a traditional subsistence and personal use shellfish resource in Alaska. Cockles range from the Bering Sea to Southern California and can grow up to 6 inches.[81] A variety of cockle species around the world are in demand for their sweet, mild-flavor that can be used in a variety of dishes.

Cockles are not typically a target for commercial harvest because they occur in low concentrations that have not been profitable to harvest. In the U.S., no commercial fishery for cockles occurs, only personal use and subsistence. In Alaska, cockles are often harvested with a rake or garden shovel in shallow water.

APSH raised cockles with promising results. The species grows quickly, reaching market size in 12 to 16 months, and does well in lantern nets. Cockle shelf-life is short, which will be a hurdle if the species is developed commercially. They are a mobile species, making containment for a commercial operation an issue to address as well.

Three Alaska farms are currently permitted to raise cockles, though due to confidentiality restrictions it is unclear whether they are producing at this time.[82]

[81] http://nsgl.gso.uri.edu/aku/akug98002.pdf
[82] http://www.adfg.alaska.gov/index.cfm?adfg=fishingaquaticfarming.aquaticfarminfo_permit_status

Alaska Mariculture Initiative: Economic Analysis to Inform the Comprehensive Plan: Phase 2 Report Outline

Executive Summary

Introduction

(McDowell Group)

Purpose and Scope of Phase 2

Mariculture Defined

Methodology

Report Organization

Chapter 1. Alaska's Mariculture Industry Today

(McDowell Group)

Shellfish (numbers of permits, operating farms, production volume and value, prices, trends, farming practices, current markets and market conditions)

Macroalgae (status of development efforts, production levels, farming practices, etc)

Enhancement Activity (overview of current research activity, plans, goals, budgets)

Integrated Operations (multi-species farm practices, vertical integration, etc.)

Summary Status of Alaska's Mariculture Industry

Chapter 2. Alaska's Mariculture Development Challenges and Opportunities

(McDowell Group and MTF Advisory Committees)

Barriers to Entry

Research Needs/Gaps

Regulatory Framework

Operating Costs/Logistics/Production Inputs

Access to Capital/Capital Requirements

Access to Markets and Market Development

Chapter 3. Investment Sources

(McDowell Group and MTF Advisory Committees)

Current Mariculture Financing Overview

Overview of Investment Strategies

Overview of Investment Opportunities

Sources of Capital **(Private, Public, Public-Private Partnerships, Tribal, other)**

Current State and Federal Funding Environment

Chapter 4. Economic Model for Development of Alaska's Mariculture Industry

(McDowell Group)

Farm Model Assumptions and Inputs

- Development scenarios, 30-year horizon
  - Pace of new farm development
  - Scale of farming operations (small, mid-size, large)
- Critical variables and sources of uncertainty

Farm Economic Impact Model Outputs

- Farm-gate and wholesale production volumes and values
- Employment and labor income (direct and indirect)
- State lease fees and harvest tax revenues

Farm Economic Impact Return on Capital Investment

Enhancement Model Assumptions and Inputs

- Annual investment in research/enhancement activity
- Timing and scale of enhance common property harvests
- Critical variables and sources of uncertainty

Enhancement Economic Impact Model Outputs

- Ex-vessel and first wholesale value of enhanced common property harvests
- Direct and indirect economic impacts (labor income, taxes) of enhanced common property harvests

Chapter 5. Strategic Development Goals, Pathways, and Outcomes

(McDowell Group and MTF Advisory Committees)

Economic Analysis of Potential Investment Strategies

- Farm Investment
- Enhancement Investment

Recommendations for Phase 3 Analysis

CS FOR HOUSE BILL NO. 76(FSH)

IN THE LEGISLATURE OF THE STATE OF ALASKA

THIRTIETH LEGISLATURE - FIRST SESSION

BY THE HOUSE SPECIAL COMMITTEE ON FISHERIES

Offered: 3/29/17
Referred: Finance

Sponsor(s): REPRESENTATIVES ORTIZ, Kreiss-Tomkins, Kito, Gara

A BILL

FOR AN ACT ENTITLED

"An Act relating to the mariculture revolving loan fund and loans and grants from the fund; and providing for an effective date."

BE IT ENACTED BY THE LEGISLATURE OF THE STATE OF ALASKA:

*** Section 1.** AS 16.10 is amended by adding a new section to article 14 to read:

Sec. 16.10.890. Declaration of policy. It is the policy of the state, under AS 16.10.890 - 16.10.945, to promote mariculture and the enhancement of the state's shellfish fisheries by means of grants and long-term, low-interest loans.

*** Sec. 2.** AS 16.10.900 is amended to read:

Sec. 16.10.900. Mariculture revolving loan fund. (a) The mariculture revolving loan fund is created **in** [WITHIN] the Department of Commerce, Community, and Economic Development to carry out the purposes of **AS 16.10.890 - 16.10.945** [AS 16.10.900 - 16.10.945].

(b) The mariculture revolving loan fund consists of the following:

(1) money appropriated to, transferred to, or received by gift, grant,

devise, bequest, or donation to the fund;

(2) principal and interest payments or other income earned on loans or investments of the fund; and

(3) money chargeable to principal or interest that is collected through liquidation by foreclosure or other process on loans made under **AS 16.10.890 - 16.10.945** [AS 16.10.900 - 16.10.945].

(c) Money in the fund may be used by the legislature to make appropriations for costs of administering **AS 16.10.890 - 16.10.945** [AS 16.10.900 - 16.10.945].

*** Sec. 3.** AS 16.10.900 is amended by adding a new subsection to read:

(d) Of the total amount available annually to the department to carry out the purposes of AS 16.10.890 - 16.10.945, less any funds appropriated under (c) of this section, 60 percent shall be available solely for making loans under AS 16.10.910(a)(1) and the remainder shall be available solely for making loans under AS 16.10.910(a)(2) and grants under AS 16.10.905(9).

*** Sec. 4.** AS 16.10.905 is amended to read:

Sec. 16.10.905. Powers and duties of the department. The department may

(1) make loans to eligible applicants under **AS 16.10.890 - 16.10.945** [AS 16.10.900 - 16.10.945] for the planning, construction, and operation of a

(A) mariculture business;

(B) hatchery that artificially propagates marine aquatic plants or shellfish; or

(C) a shellfish enhancement project;

(2) receive, take, hold, and administer any appropriation, transfer, gift, grant, bequest, devise, or donation of money for the fund;

(3) establish amortization plans for repayment of loans, including extensions of the terms of loans;

(4) allow an assumption of a loan if

(A) the applicant meets the requirements established under this section; and

(B) approval of the assumption would be consistent with the purposes of **AS 16.10.890 - 16.10.945** [AS 16.10.900 - 16.10.945];

(5) establish the rate of interest for loans consistent with law;

(6) charge and collect fees for services provided under **AS 16.10.890 - 16.10.945** [AS 16.10.900 - 16.10.945];

(7) adopt regulations under AS 44.62 necessary to carry out the provisions of **AS 16.10.890 - 16.10.945** [AS 16.10.900 - 16.10.945], including regulations to establish reasonable fees for services provided; [AND]

(8) designate agents and delegate powers as necessary to the agents**;**

(9) make one-time grants for organizational and planning purposes to nonprofit organizations eligible for loans under AS 16.10.910(a)(2) in amounts not exceeding $100,000.

*** Sec. 5.** AS 16.10.905 is amended by adding a new subsection to read:

(b) The department may not make more than $500,000 in aggregate grants under (a)(9) of this section.

*** Sec. 6.** AS 16.10.910(a) is amended to read:

(a) For an applicant to be eligible for a loan under **AS 16.10.890 - 16.10.945** [AS 16.10.900 - 16.10.945], the applicant shall **be**

(1) [BE] a resident of the state **who has**

(A) [, AS DETERMINED UNDER (c) OF THIS SECTION; (2) HAVE] a permitted mariculture farm location in this state; and

(B) [(3) HAVE] experience or training in the mariculture industry**; or**

(2) a resident of the state or entity organized under the laws of this state that

(A) holds a permit under AS 16.40.100 to operate a hatchery for the purpose of producing aquatic plants or shellfish; or

(B) conducts shellfish enhancement projects.

*** Sec. 7.** AS 16.10.910(c) is amended to read:

(c) To meet the residency requirements of (a) of this section, **an individual** [THE] applicant

(1) shall physically reside in this state and maintain a domicile in this state during the 24 consecutive months preceding the date of application for the

program; and

(2) may not have

(A) declared or established residency in another state; or

(B) received residency or a benefit based on residency from another state.

*** Sec. 8.** AS 16.10.915(a) is amended to read:

(a) Except as provided in (b) and (c) of this section, a loan under **AS 16.10.890 - 16.10.945** [AS 16.10.900 - 16.10.945]

(1) may not exceed

(A) $100,000 a year **for an applicant under AS 16.10.910(a)(1); or**

(B) $1,000,000 a year for an applicant under AS 16.10.910(a)(2);

(2) may not**, unless extended under AS 16.10.905,** exceed a term of

(A) 20 years **for an applicant under AS 16.10.910(a)(1); or**

(B) 30 years for an applicant under AS 16.10.910(a)(2) [, EXCEPT FOR EXTENSIONS UNDER AS 16.10.905];

(3) may not bear interest at a rate greater than the prime rate, as defined in AS 44.88.599, plus one percentage point, but which may not be less than five percent a year or more than nine percent a year;

(4) must be secured by a first priority lien on collateral acceptable to the department; and

(5) may not be made to a person who has a past due child support obligation established by court order or by the child support services agency under AS 25.27.160 - 25.27.220 at the time of application.

*** Sec. 9.** AS 16.10.915(b) is amended to read:

(b) Subsequent loans may be made to **a** [THE] borrower under

(1) AS 16.10.910(a)(1), [AS 16.10.910] if the total of the balances outstanding on the loans received by the borrower does not exceed $300,000**; or**

(2) AS 16.10.910(a)(2), if the total of the balances outstanding on the loans received by the borrower does not exceed $1,000,000.

*** Sec. 10.** AS 16.10.915(c) is amended to read:

(c) A loan under AS 16.10.910 may be made for the purchase of boats or vessels determined to be integral to the operation of the farm **or hatchery**.

*** Sec. 11.** AS 16.10.915(d) is amended to read:

(d) For a loan made under **AS 16.10.890 - 16.10.945** [AS 16.10.900 - 16.10.945], the department may provide a reduction of the interest rate of not more than two percent if at least 50 percent of the loan proceeds are used by the borrower for purchasing products manufactured or produced in the state. When the department offers a reduction under this subsection, the department shall provide the reduction to all loan applicants who meet the criterion described in this subsection. In this subsection, "manufactured or produced" means processing, developing, or making an item into a new item with a distinct character and use.

*** Sec. 12.** AS 16.10.915 is amended by adding a new subsection to read:

(e) The department may not make a loan to an applicant under AS 16.10.910(a)(2) for a hatchery or shellfish enhancement project unless the department determines that the hatchery or enhancement project will

(1) be managed in a financially viable manner that is reasonably expected to result in repayment of the loan; and

(2) provide a significant contribution to common property fisheries, or otherwise benefit the public interest.

*** Sec. 13.** AS 16.10.920 is amended to read:

Sec. 16.10.920. Repayment of principal of and interest on loans. The department may not require the repayment of **the** principal **of** and interest on a loan made under AS 16.10.910 during the first six years of the loan. Interest on the principal of a loan made under **AS 16.10.910(a)(1)** [AS 16.10.910] may **not** be deferred for a period of [NOT] more than the first six years of the loan. **The department may defer principal of and interest on a loan made under AS 16.10.910(a)(2) for a period of up to 11 years after the loan is made. The department may provide that interest on the principal of a loan made under AS 16.10.910(a)(2) may not accrue during a period of not less than six years and not more than 11 years after the loan is made.**

*** Sec. 14.** AS 16.10 is amended by adding a new section to read:

Sec. 16.10.923. Voluntary assessment on sale of shellfish. (a) An association of persons who hold entry permits under AS 16.43 comprising at least 51 percent of the persons holding entry permits and actively participating in a fishery to be benefited by a hatchery program may levy and collect an assessment from among its members for the purpose of securing and repaying a loan made under AS 16.10.890 - 16.10.945.

(b) Upon satisfactory demonstration to the department that an assessment levied under this section may reasonably be relied on to secure and repay a loan to be made under AS 16.10.890 - 16.10.945, the department may make the loan.

*** Sec. 15.** AS 16.10.935 is amended to read:

Sec. 16.10.935. Disposal of property acquired after default. The department shall dispose of property acquired through default of a loan made under **AS 16.10.890 - 16.10.945** [AS 16.10.900 - 16.10.945]. Disposal must be made in a manner that serves the best interest of the state and may include the amortization of payments over a period of years.

*** Sec. 16.** AS 16.10.945 is amended to read:

Sec. 16.10.945. Definitions. In **AS 16.10.890 - 16.10.945** [AS 16.10.900 - 16.10.945],

(1) "commissioner" means the commissioner of commerce, community, and economic development;

(2) "department" means the Department of Commerce, Community, and Economic Development;

(3) **"hatchery" has the meaning given in AS 16.40.199;**

(4) "mariculture" means the farming of shellfish and aquatic plants as defined in AS 16.40.199**;**

(5) "shellfish enhancement project" means a project to

(A) augment the yield or harvest of shellfish above naturally occurring levels using a natural, artificial, or semiartificial production system; or

(B) rehabilitate a shellfish stock by restoring it to its naturally occurring levels of productivity.

*** Sec. 17.** The uncodified law of the State of Alaska is amended by adding a new section to read:

APPLICABILITY. Changes made by this Act to the terms of loans made under AS 16.10.890 - 16.10.945 do not apply to a loan made before the effective date of this Act.

*** Sec. 18.** This Act takes effect immediately under AS 01.10.070(c).

HOUSE BILL NO. 128

IN THE LEGISLATURE OF THE STATE OF ALASKA

THIRTIETH LEGISLATURE - FIRST SESSION

BY REPRESENTATIVE ORTIZ

Introduced: 2/15/17
Referred: House Special Committee on Fisheries, Finance

A BILL

FOR AN ACT ENTITLED

"An Act relating to management of enhanced stocks of shellfish; authorizing certain nonprofit organizations to engage in shellfish enhancement projects; relating to application fees for salmon hatchery permits; and providing for an effective date."

BE IT ENACTED BY THE LEGISLATURE OF THE STATE OF ALASKA:

*** Section 1.** AS 16.05.730(c) is amended to read:

(c) The board may

(1) consider the need of enhancement projects authorized under AS 16.10.400 and contractors who operate state-owned enhancement projects under AS 16.10.480 to harvest and sell fish produced by the enhancement project that are not needed for brood stock to obtain funds for the purposes allowed under AS 16.10.450 or 16.10.480(d)**;**

(2) consider the need of enhancement projects authorized under AS 16.12.010 to harvest and sell shellfish that are not needed for brood stock to obtain funds for the purposes allowed under AS 16.12.080;

(3) [. THE BOARD MAY] exercise its authority under this title as it considers necessary to direct the department to provide a reasonable harvest of fish, in addition to the fish needed for brood stock, to an enhancement project to obtain funds for the enhancement project if the harvest is consistent with sustained yield of wild fish stocks**; and**

(4) [. THE BOARD MAY] adopt a fishery management plan to provide fish to an enhancement project to obtain funds for the purposes allowed under AS 16.10.450**,** [OR] 16.10.480(d)**, or AS 16.12.080**.

*** Sec. 2.** AS 16.10.400(b) is amended to read:

(b) The application for a permit under this section shall be on a form prescribed by the department and be accompanied by an application fee of **$1,000** [$100]. The commissioner may waive the submission of an application for a permit to operate a hatchery under AS 16.10.480.

*** Sec. 3.** AS 16 is amended by adding a new chapter to read:

Chapter 12. Shellfish Enhancement Projects.

Sec. 16.12.010. Permits for shellfish enhancement projects. (a) Subject to the restrictions imposed by statute or regulation under this chapter, the commissioner may issue a permit to a nonprofit corporation organized under AS 10.20 for a shellfish enhancement project.

(b) Each applicant for a permit under this section shall apply in a format prescribed by the department and pay an application fee of $1,000.

(c) A permit issued under this section is nontransferable. If a permit holder sells or leases a facility for which a permit has been issued under this section, the new operator shall apply for a permit under this section.

(d) The commissioner shall consult with and solicit recommendations from federal and state agencies and technical experts in the relevant area regarding permit stipulations and issuance.

(e) The commissioner may not issue a permit under this section unless the commissioner determines that the action would result in substantial public benefits and would not jeopardize natural stocks.

Sec. 16.12.020. Hearings before permit issuance. (a) At least 30 days before

the issuance of a permit under AS 16.12.010, the department shall hold a public hearing in a central location in the vicinity of the proposed release of shellfish.

(b) Notice of the hearing shall be published in a newspaper of general circulation once a week for three consecutive weeks, with completion of the notice at least five days before the hearing.

(c) The department shall conduct the hearing. The applicant shall present a plan for the proposed shellfish enhancement project describing relevant facts that may be of interest to the department or to the public and the capacity of the facility. The department shall give interested members of the public an opportunity to be heard.

(d) The department shall record and consider objections and recommendations offered by the public at the hearing conducted under this section. The department shall respond in writing, not later than 30 days after the hearing is held, to a specific objection offered by a member of the public at the hearing.

Sec. 16.12.030. Conditions of a permit. The department shall require, in a permit issued under this chapter, that the permit holder

(1) procure shellfish from the department or a source approved by the department;

(2) place shellfish only in water of the state specifically designated in the permit;

(3) not procure or place genetically modified shellfish into the water of the state;

(4) not resell or transfer shellfish sold to a permit holder by the state or by another party approved by the department;

(5) not release shellfish before approval of the department, and, for purposes of pathological examination and approval, that the permit holder notify the department at least 15 days before the date of the proposed release of shellfish;

(6) destroy diseased shellfish in a specific manner and place designated by the department;

(7) harvest shellfish only at specific locations and under specific conditions as designated by the department;

(8) make surplus shellfish available for sale first to the department and

then, after inspection and approval by the department, to other permit holders operating under this chapter;

(9) provide a copy of the sales transaction to the department if surplus shellfish are sold by a permit holder to another permit holder;

(10) release shellfish in an area where the shellfish will be available to traditional fisheries, subject to the provisions of this chapter and regulations adopted under this chapter.

Sec. 16.12.040. Alteration, suspension, or revocation of permit. (a) If a permit holder fails to comply with the conditions and terms of the permit issued under AS 16.12.010 within a reasonable period after notification by the department of noncompliance, the permit may be suspended or revoked, in the discretion of the commissioner.

(b) If the commissioner finds that the operation of the permitted activity is not in the best interests of the public, the commissioner may alter the conditions of the permit to mitigate the adverse effects of the operation or, if the adverse effects are irreversible and cannot be mitigated sufficiently, initiate a termination of the operation under the permit over a reasonable period under the circumstances, not to exceed four years. During the period that the operation is being terminated, the permit holder may harvest shellfish under the terms of the permit but may not release additional shellfish.

Sec. 16.12.050. Regulations relating to released shellfish. (a) Shellfish released into the natural water of the state by a permit holder under this chapter are available to the people for common use and are subject to regulation under applicable law in the same way as shellfish occurring in their natural state except when they are in a special location designated by the department for harvest by a permit holder.

(b) The Board of Fisheries may, after the issuance of a permit by the commissioner, amend by regulation adopted in accordance with AS 44.62 (Administrative Procedure Act), the terms of the permit relating to the source of brood stock, the harvest of shellfish by permit holders, and the specific locations designated by the department for harvest. The Board of Fisheries may not adopt a regulation or take an action regarding the issuance or denial of a permit required in this chapter.

Sec. 16.12.060. Department assistance and cooperation. (a) Before and after

permit issuance under AS 16.12.010, the department shall make reasonable efforts, within the limits of time and resources, to advise and assist applicants or permit holders, as appropriate, as to shellfish enhancement projects, including the planning, construction, and operation of facilities.

(b) Nothing in this section exempts an applicant or permit holder from compliance with this chapter or from compliance with the regulations or restrictions adopted under this chapter.

Sec. 16.12.070. Brood stock sources. (a) The department shall approve the source and number of shellfish taken for use as brood stock under AS 16.12.010 - 16.12.199.

(b) Where feasible, a permit holder shall first take shellfish from stocks native to the area in which the shellfish will be released.

Sec. 16.12.080. Sale of shellfish; use of proceeds; quality and price. (a) A permit holder that sells shellfish harvested from the natural water of the state, or sells shellfish to another permit holder under this chapter, shall use the funds only for reasonable operating costs, including debt retirement, expanding its facilities, shellfish enhancement projects, shellfish research, or to assist in meeting the department's costs of managing the affected fisheries for the area in which the shellfish release is located.

(b) A permit holder shall ensure that shellfish harvested and sold for human consumption are of comparable quality to shellfish harvested by commercial fisheries in the area and are sold at prices commensurate with the current market.

Sec. 16.12.090. Cost recovery fisheries. (a) A permit holder may harvest shellfish for a shellfish enhancement project in

(1) a special harvest area through agents or employees of or persons under contract with the permit holder as provided under a permit from the department or regulations of the Board of Fisheries; or

(2) a special harvest area through the common property fishery under this section.

(b) A permit holder may, by a majority vote of the membership of the permit holder's board, elect to harvest shellfish in a special harvest area established for an enhancement project through the common property fishery. At the request of the

permit holder and if the commissioner determines that there are no allocative issues involved, and after reasonable consultation with affected commercial fishermen, the commissioner may adopt regulations governing the harvest of shellfish in a special harvest area through a common property fishery. The regulations must specify the terms, conditions, and rules under which the common property fishery in the special harvest area shall be conducted, including requirements for holding inspections and reporting of harvests and sales of shellfish taken in the special harvest area. Following adoption of regulations by the department, before January 15 of each year, the permit holder's board of directors, by a majority vote of the board's membership, may determine whether the permit holder will operate under the regulations adopted under this subsection during the current calendar year and shall notify the department if the permit holder intends to operate under the regulations adopted under this subsection. The Board of Fisheries may adopt regulations under AS 16.05.251 regarding a fisheries management plan governing operations under this subsection in a special harvest area, including allocation plans. Participation in the fishery must be open to all interim-use permit and entry permit holders who hold permits to operate a type of gear that may be used in the fishing district in which the special harvest area is located if that type of gear is authorized by regulation to be used in the special harvest area. An interim-use permit holder or an entry permit holder who takes shellfish in a common property fishery in a special harvest area may sell the shellfish to a fish buyer or processor who is licensed to do business in the state.

(c) As a condition of participation in a common property shellfish fishery in a special harvest area under this section, a fisherman who participates in the fishery is subject to the payment of the assessment levied under (d) of this section on the projected value of the shellfish or on the pounds of shellfish harvested. The assessment is levied on the shellfish that the fisherman takes in the special harvest area and sells to a licensed buyer. The buyer of the shellfish must be licensed under AS 43.75, and the buyer shall collect the assessment on shellfish taken in a special harvest area at the time of purchase and remit the assessment to the Department of Revenue in accordance with regulations adopted by the Department of Revenue.

(d) The Department of Revenue may, by regulation, annually, by March 1 of

each year, set the assessment levied on shellfish taken in a special harvest area in consultation with the Department of Commerce, Community, and Economic Development, the permit holder, and representatives of affected commercial fishermen. The assessment shall provide sufficient revenue to cover debt service, reasonable operating expenses, reasonable maintenance expenses, and development or maintenance of a reserve fund up to 100 percent of annual operating costs of the permit holder's shellfish enhancement project. In setting the assessment, the department shall consider the estimated harvest of shellfish in the special harvest area, the projected price to be paid for shellfish in the region, the amount of the existing reserve held by the permit holder, and the amount by which the assessment collected in previous years exceeded or fell short of the amount anticipated to be collected. The assessment may not exceed 50 percent of the value of the shellfish. The department may levy the assessment as a percentage of the projected value of the shellfish harvested in the special harvest area or as a flat rate on each pound of shellfish harvested in the area, to the nearest whole cent.

(e) The Department of Revenue shall deposit the assessments collected under this section in the general fund. The legislature may appropriate the funds collected under this section to the permit holder who is carrying out an enhancement project, including the operation of a facility, in the special harvest area in which the assessment was levied. A permit holder shall use funds appropriated under this subsection for the purposes set out under AS 16.12.080(a). The legislature may also appropriate funds collected under this section to the Department of Revenue for costs incurred by the department under this section.

(f) A person who violates a regulation adopted under (b) of this section is guilty of a violation under AS 16.05.722 or a misdemeanor under AS 16.05.723. A person who violates a regulation adopted by the Department of Revenue under (c) of this section is guilty of a class A misdemeanor.

(g) In this section,

(1) "special harvest area" means an area designated by the commissioner or the Board of Fisheries where shellfish may be harvested by permit holders under this chapter and by the common property fishery;

(2) "value" has the meaning given in AS 43.75.290.

Sec. 16.12.100. Inspection by the department. (a) A permit holder shall allow the department to inspect the permit holder's enhancement project facility at any time the enhancement project facility is in operation. The department shall conduct the inspection in a reasonable manner.

(b) The department shall bear the cost of an inspection performed under this section.

Sec. 16.12.110. Annual report. A person who holds a permit under this chapter shall submit an annual report not later than December 15 to the department. The report must be made on a form prescribed by the department and contain information pertaining to

(1) species;

(2) the brood stock source;

(3) the number, age, gender, and size of spawners;

(4) the number of eggs collected and juveniles produced; and

(5) the number, age, gender, and size of harvested shellfish attributable to releases by the permit holder.

Sec. 16.12.199. Definitions. In this chapter,

(1) "enhancement project" means a project to

(A) augment the yield and harvest of shellfish above naturally occurring levels by natural, artificial, or semi-artificial production systems;

(B) rehabilitate a shellfish stock by restoring it to its natural levels of productivity; or

(C) increase the area of productive natural shellfish habitat;

(2) "facility" means a hatchery or other facility for a shellfish enhancement project;

(3) "genetically modified shellfish" means shellfish whose genetic structure has been altered at the molecular level by recombinant DNA and RNA techniques, cell fusion, gene deletion or doubling, introduction of exogenous genetic material, alteration of the position of a gene, or other similar procedure using artificial processes;

(4) "hatchery" means a facility for the artificial propagation of stock, including rearing of shellfish and release of shellfish into the natural water of the state;

(5) "shellfish" means a species of crustacean, mollusk, or other invertebrate, in any stage of its life cycle, that is indigenous to state water.

*** Sec. 4.** AS 16.43.400(a) is amended to read:

(a) In addition to entry permits, interim-use permits, and educational permits, the commission may issue special harvest area entry permits to

(1) holders of private, nonprofit hatchery permits issued by the Department of Fish and Game under AS 16.10.400 - 16.10.475 **for salmon; or**

(2) nonprofit organizations holding a permit under AS 16.12 for a shellfish enhancement project.

*** Sec. 5.** AS 16.43.430 is amended to read:

Sec. 16.43.430. Authorized gear. For the purposes of harvesting salmon **or shellfish**, a special harvest area entry permit holder may employ any fishing gear designated as legal gear in the applicable special harvest area by the Board of Fisheries.

*** Sec. 6.** AS 17.20.049(b)(1) is amended to read:

(1) "farmed fish" means fish that is propagated, farmed, or cultivated in a facility that grows, farms, or cultivates the fish in captivity or under positive control but that is not a salmon hatchery that is owned by the state or that holds a salmon hatchery permit under AS 16.10.400 **or a shellfish facility that is permitted under AS 16.12.010**; in this paragraph, "positive control" has the meaning given in AS 16.40.199;

*** Sec. 7.** AS 43.20.012(a) is amended to read:

(a) The tax imposed by this chapter does not

(1) apply to an individual;

(2) apply to a fiduciary;

(3) for a tax year beginning after December 31, 2012, apply to an Alaska corporation that is a qualified small business and that meets the active business requirement in 26 U.S.C. 1202(e) as that subsection read on January 1, 2012; [OR]

(4) for a tax year beginning after June 30, 2007, apply to the income

received by a regional association qualified under AS 16.10.380 or nonprofit corporation holding a hatchery permit under AS 16.10.400 from the sale of salmon or salmon eggs under AS 16.10.450 or from a cost recovery fishery under AS 16.10.455**; or**

(5) apply to income received by a nonprofit corporation holding a permit under AS 16.12.010 from the sale of shellfish under AS 16.12.080 or from a cost recovery fishery under AS 16.12.090.

*** Sec. 8.** AS 43.20.012(a), as repealed and reenacted by sec. 2, ch. 55, SLA 2013, is amended to read

(a) The tax imposed by this chapter does not apply to

(1) an individual;

(2) a fiduciary; [OR]

(3) the income received by a regional association qualified under AS 16.10.380 or nonprofit corporation holding a hatchery permit under AS 16.10.400 from the sale of salmon or salmon eggs under AS 16.10.450 or from a cost recovery fishery under AS 16.10.455**; or**

(4) the income received by a nonprofit corporation holding a permit under AS 16.12.010 from the sale of shellfish under AS 16.12.080 or from a cost recovery fishery under AS 16.12.090.

*** Sec. 9.** AS 43.76.390 is amended to read:

Sec. 43.76.390. Exemption. AS 43.76.350 - 43.76.399 do not apply to salmon **or shellfish** harvested under a special harvest area entry permit issued under AS 16.43.400.

*** Sec. 10.** The uncodified law of the State of Alaska is amended by adding a new section to read:

APPLICABILITY. AS 16.10.400(b), as amended by sec. 2 of this Act, applies to salmon hatchery permits applied for on or after the effective date of sec. 2 of this Act.

*** Sec. 11.** The uncodified law of the State of Alaska is amended by adding a new section to read:

TRANSITION: REGULATIONS. The Department of Fish and Game may adopt regulations necessary to implement this Act. The regulations take effect under AS 44.62

(Administrative Procedure Act), but not before the effective date of the law implemented by the regulation.

*** Sec. 12.** Section 11 of this Act takes effect immediately under AS 01.10.070(c).

*** Sec. 13.** Section 8 of this Act takes effect on the effective date of sec. 2, ch. 55, SLA 2013.

Aquaculture Growth to 2030

A Strategic Plan for farming Scotland's seas

Scotland Food & Drink

3 The Royal Highland Centre

Ingliston, Edinburgh EH28 8NB

0131 335 0940

www.foodanddrink.scot

Follow us on Twitter @scotfooddrink

Scotland
A LAND OF food and drink

Contents

Aquaculture contributes over £1.8bn annually to Scotland's economy

1 Executive Summary

In 2016, a Working Group of leading aquaculture businesses and organisations came together to create a growth strategy for aquaculture in Scotland to 2030. The aim was to deliver an ambitious, industry-led plan for sustainable growth across the entire aquaculture value chain.

Aquaculture in Scotland is diverse, from the farming of salmon and other finfish species, to the production of mussels and oysters, to the harvesting of seaweed. It contributes over £1.8bn annually to Scotland's economy and sustains the economic and social fabric of the Highlands and Islands in particular. But the potential contribution of farming Scotland's seas is far greater. Research points to a potential annual contribution of £3.6bn or more by 2030. The number of jobs supported by the sector could reach 18,000.

STRATEGIC PRIORITIES FOR THE SECTOR

For Scotland to deliver high levels of sustainable growth by 2030 and beyond, the Working Group identified six strategic priority areas for effective collaboration between regulators, industry, researchers and other stakeholders. These are:

- industry leadership and ambition
- enabling and proportionate regulation
- accelerating innovation
- skills development
- finance
- infrastructure.

In addressing these, aquaculture policy and regulation should give equal weight to the three pillars of sustainable growth: economic development, social development and environmental protection.

KEY RECOMMENDATIONS

Within these six areas of strategic focus, the Working Group recommended 20 specific actions. In particular, the Working Group believe three actions are critical to the sustainable growth of aquaculture in Scotland:

- the formation of an Industry Leadership Group (ILG) to drive sector growth and ensure alignment between industry and government
- an examination of the role of Marine Scotland as both regulator and policy advocate for development. There is an opportunity to align with other food and drink sectors in Scotland by moving the development role into the Scottish Government's Food, Drink & Rural Communities Division
- the introduction of Innovation Sites, to allow controlled trials and development of innovative equipment, technologies, disease control measures, and regulation.

In 2030, Scotland has the opportunity to be a world-leading player in an industry that is vital for future food security and has one of the lowest carbon footprints of any major form of animal protein production.

The delivery of these 20 recommendations should permit the sector to grasp that opportunity and reap long-term social and economic benefits for Scotland.

2 A vision for aquaculture growth in Scotland

A thriving aquaculture sector could boost the Scottish economy by £3.6bn per annum.

Scottish farmed salmon was voted best in the world in 2014 by retail and foodservice buyers

£600M salmon and seafood exported annually

The farming of Scotland's seas contributes over £1.8 billion annually to the Scottish economy. The aquaculture sector supports around 8,800 jobs, many in remote and rural areas.[1] And it sustains the economic and social fabric of the Highlands and Islands, as an anchor industry that keeps communities and career prospects alive.

But the success and substantial social and economic contribution of Scotland's finfish, shellfish and seaweed producers and their supply chain, is not even close to its full potential. By 2030, sustainable growth in aquaculture production, the wider supply chain and the value-adding sectors in Scotland could double the sector's contribution.

Research among key stakeholders points to a potential contribution to Scotland of £3.6 billion or more each year. This Strategic Plan sets out a vision and route for achieving that growth and for ensuring that the sector can deliver the priorities in Scotland's economic strategy: innovation, internationalisation, investment and inclusive growth. It provides a key contribution to the development of the new Scotland Food & Drink 2030 industry strategy, encompassing the entire food and drink sector.

A LEADER IN A KEY GLOBAL SECTOR

The importance of farming Scotland's seas goes beyond economic considerations.

With world population projected to rise to well over 8.5 billion in 2030, growing per capita consumption of protein and wild-catch volumes stagnating, aquaculture has a crucial role in food security. As a source of protein, finfish and shellfish production is highly efficient in terms of water consumption, CO^2 emissions and feed conversion.

The further development of aquaculture in Scotland would ensure we make a major and growing contribution to strengthening global food security and tackling climate change, arguably the defining issues of our time.

A world-class aquaculture industry here will position Scotland as a global leader in sustainable protein production.

A COMPELLING OPPORTUNITY

In this global landscape – where the vision of the European aquaculture industry is to provide 4.5 million tonnes of sustainable food products annually[2] – Scotland is a key player. We are one of a handful of countries with the climatic and hydrographic conditions to farm salmon. Our pristine waters make our seas and coasts an ideal location for growing finfish, shellfish and seaweeds.

Our ambitions for sustainable growth should therefore match the richness of our resources and the size of the global opportunity. This is a sector in which Scotland can be world-leading, but only if all stakeholders – government, industry, academics, regulators – address the industry's challenges.

We set out here the actions we believe necessary for the industry to deliver this accessible opportunity for Scotland.

"We must start using the sea as farmers instead of hunters. That is what civilisation is all about – farming replacing hunting."

Jacques Cousteau

Towards 2030: potential gains and growth.

Setting precise targets for finfish and shellfish production in Scotland is beyond the scope of this Strategic Plan, but sustainably achievable projections for 2030 could be in the range of 300,000 to 400,000 tonnes per annum for finfish production. In shellfish production there is potential to reach 21,000 tonnes of mussels per annum by 2030 and to significantly increase the value of oyster production.

Extrapolating from the figures set out in Marine Scotland s An Assessment of the Benefits to Scotland of Aquaculture (2013), a median production figure of 350,000 tonnes of salmon would double aquaculture s current economic value of £1.8 billion to the Scottish economy, to £3.6 billion. To reach this tonnage from current levels would require year on year production growth of less than 5%.

According to An Assessment of the Benefits to Scotland of Aquaculture, the sector directly employs over 4,500 people in its supply chain. Using the report s methodology for calculating the employment gains linked to raising aquaculture production, an increase in finfish and shellfish production to approximately 300,000 400,000 tonnes and 21,000 tonnes respectively in 2030 could increase the number of jobs in the sector to approximately 18,000, with a move from production only jobs towards job creation in the supply chain.

It is clear that aquaculture has a critical role to play in protecting and strengthening Scotland s rural communities and economy, both now and in the decades to come.

3 How to unlock growth

Aquaculture stakeholders must focus on six key strategic priorities to develop market share and realise the industry's growth potential.

The economic opportunity for Scotland's aquaculture sector is huge. But growth in production, exports or the supply chain is not guaranteed.

The global market share of Scottish salmon has fallen from around 10% in 2005 to less than 7%, as other aquaculture nations raise productivity. A variety of factors have slowed production growth in Scotland and – without work to address them – will continue to do so.

CHALLENGES FOR THE SECTOR

The biological challenges facing producers in Scotland are well known and also face producers in competitor nations. The salmon industry in Scotland has been investing almost £30 million annually over the past five years in measures to improve sea lice control and it is driving forward industry-academic collaboration through the Scottish Aquaculture Innovation Centre (SAIC). Its investments in biological and engineering-based solutions for sea lice control will help to reduce the use of medicinal treatments – a demonstration of the sector's commitment to environmental sustainability.

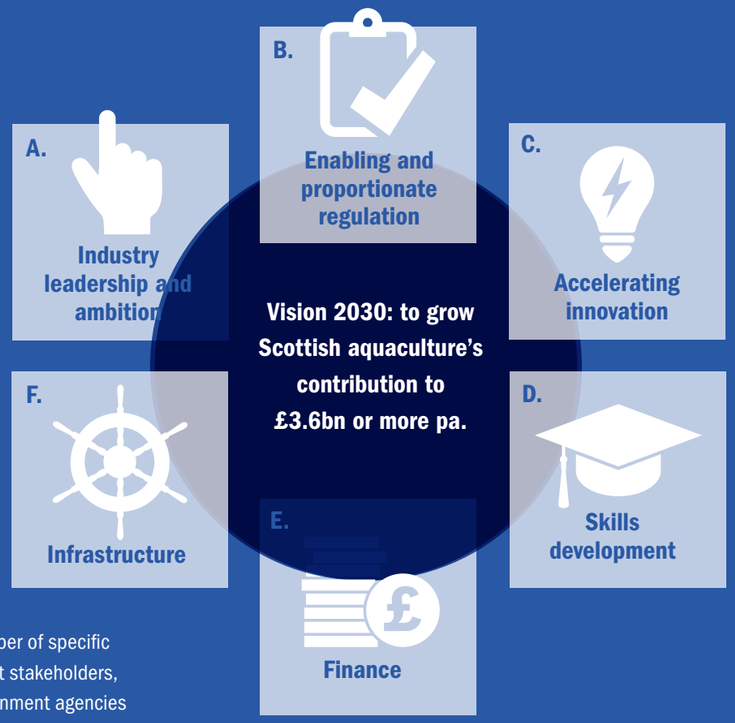
Yet, biological challenges are far from the only obstacles in the way of Scotland's aquaculture sector achieving its huge potential.

Other blockers to sustainable growth include: the lack of an industry-led, all-stakeholder growth strategy; issues around consenting for aquaculture sites and the application of planning policy; workforce issues; access to finance; and the limitations of Scotland's rural infrastructure.

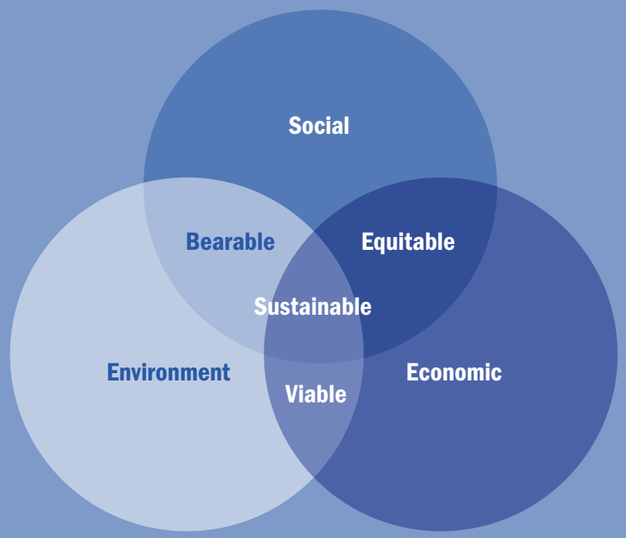
STRATEGIC PRIORITIES

To tackle these blockers, the sector must focus on six inter related strategic priorities, spread over the short, medium and longer term. These priorities are:

A. Industry leadership and ambition
B. Enabling and proportionate regulation
C. Accelerating innovation
D. Skills development
E. Finance
F. Infrastructure



Within each area of strategic focus are a number of specific actions requiring to be undertaken by different stakeholders, including industry, regulators, ministers, government agencies and Scotland's research base. These are set out in this Strategic Plan.



BALANCING THE THREE PILLARS OF SUSTAINABILITY

Government agencies and regulators in Scotland tend to use subtly different interpretations of sustainability and this can blur clarity when policy and regulation are implemented.

The 2005 World Summit on Social Development identified that sustainability is a combination of three pillars: economic development, social development and environmental protection.[3]

We support this definition and recommend that all three pillars be given equal weight in the development and implementation of aquaculture policy and regulation in Scotland. This may require a re balancing of existing approaches.

Sustainable development and growth sits at the confluence of three constituent parts: social development, economic development and environmental protection (source: Scott Cato)[4].

4 Snapshot: a world-leading sector in 2030

The characteristics of a thriving aquaculture sector range from globally-leading regulation to world-class research and skills.

With key challenges addressed, the Scottish aquaculture sector can flourish, offering long-term prospects to young people all over Scotland and keeping communities sustainable. It can compete globally in the blue economy and farm the seas profitably and sustainably.

In planning a growth strategy for the industry to 2030, we wish to see an industry with the following characteristics.

A globally-leading regulatory/policy landscape, allowing Scottish businesses to compete on cost as well as quality. When aquaculture policy is developed and regulation is applied, all three pillars of sustainability – social development, economic development and environmental stewardship – should be balanced.

A diverse industry. While Atlantic salmon will continue to dominate the Scottish production for the foreseeable future, there is an opportunity to increase the value of non-salmonid farmed fish including halibut and trout, and shellfish and seaweed.

There are also opportunities to support diversity of ownership. Evidence from other sectors suggests that resilience is strengthened if business ownership across the value chain extends from global groups to micro-enterprises. This requires a regulatory and financial landscape that supports the growth of innovative SMEs across the value chain and allows for new entrants and new business models.

Growth in scale. Production growth in the salmon industry will be facilitated by new and expanded farms, including the development of exposed sites and new site architecture. Crucial for this will be a planning framework that enables innovation and a faster decision-making process.

Within the shellfish sector, production will be more balanced across the regions, with current low-volume production areas gaining critical mass to support new infrastructure in these locations. The current permitted capacity in Scotland will be almost fully utilised. At least one commercial hatchery will be in operation providing mussel and oyster seed along with spat for new farmed species. Highly efficient farming practices will be the norm and costs of farming will be well understood and competitive.

An internationally-competitive equipment manufacturing and supply sector. Increased scale will also encompass the aquaculture supply chain. This will have at least doubled in size, having grown its market share of goods and services for Scottish suppliers to Scottish aquaculture by 2030; it will have developed export markets for these goods and services of similar scale to its Scottish market and there will be a substantial number of new, well-paid technology-based jobs in the sector.

World-class aquaculture research, development and education. World-class science is the foundation for a successful industry. The higher education courses relevant to aquaculture and provided by Scotland's universities (on-site or remotely) will be regarded as the gold standard at home and abroad.

Scottish research establishments will operate at the highest international research levels, collaborating closely with the industry on commercially-relevant applied research.

A skilled and diverse workforce. Aquaculture recruits will have a range of relevant qualifications or experience, including in fish health and husbandry, engineering, environmental science, software development and business management. Aquaculture in Scotland will be seen as an attractive and responsible industry, offering compelling career prospects and development opportunities.

The workforce will be diverse – in terms of gender, nationality, experience and age – and will have access to a wide and ongoing range of opportunities for training and skills development.

5 Strategic priorities and recommendations

Lead Recommendations !!

Recommendation	Strategic Priority	Responsibility	Timeframe	No. and Page
Formation of an Industry Leadership Group (ILG)	Industry leadership and ambition	Lead responsibility: Vision 2030 Working Group Co-responsibility: SG, SFD, HIE, SSPO, ASSG, SAIC	By July 2017	Rec 1 (p 08)
The role of Marine Scotland	Enabling and proportionate regulation	SG	By July 2017	Rec 5 (p 09)
Development of Innovation Sites in Scotland	Accelerating innovation	Lead responsibility: ILG when formed Co-responsibility: SAIC, Marine Scotland Science, SEPA, Industry	Ongoing	Rec 11 (p 11)
Mapping of future skills requirements	Skills development	ILG when formed, SDS, HIE, SAIC	Commencing immediately and ongoing	Rec 16 (p 13)
Finance for Scottish aquaculture	Finance	SE, SIB, HIE	By end 2017	Rec 17 (p 14)
Essential investment in infrastructure	Infrastructure	HITRANS, with input from ILG when formed	By November 2017 and then ongoing	Rec 19 (p 15)

High Priority Recommendations !

Recommendation	Strategic Priority	Responsibility	Timeframe	No. and Page
Aquaculture to become a core growth sector	Industry leadership and ambition	Lead responsibility: HIE Co-responsibility: SE	By July 2017	Rec 2 (p 08)
Short-term improvements to consenting processes	Enabling and proportionate regulation	Marine Scotland and as outlined in Independent Review of Scottish Aquaculture Consenting and overseen by ILG when formed	By May 2017	Rec 6 (p 10)
Clarity in the Scottish Planning Policy and National Planning Framework	Enabling and proportionate regulation	Chief Planner	By end 2018	Rec 7 (p 10)
Medium and longer-term improvements to planning	Enabling and proportionate regulation	Marine Scotland, overseen by ILG when formed	By 2020	Rec 8 (p 10)
SEPA modelling and collaboration: **Implementation of DEPOMOD and DZR** **Development of new models**	Enabling and proportionate regulation	SEPA Industry, led by SSPO, supported by SAIC	By May 2017 Ongoing	Rec 10 (p 11)
Alignment and delivery of RD&I in Scotland to support growth	Accelerating innovation	Lead responsibility: SAIC in conjunction with ILG when formed Co-responsibility: Marine Scotland Science, SEPA, Scottish Funding Council, UK Research Councils	Ongoing	Rec 12 (p 12)
Approaches to sea lice	Accelerating innovation	Lead responsibility: Industry Co-responsibility: SSPO, SAIC, SEPA, Marine Scotland Science	Ongoing	Rec 13 (p 12)
Support for the indigenous supply chain, including processing	Accelerating innovation	Lead responsibility: HIE Co-responsibility: SAIC	By end 2017	Rec 14 (p 13)

Lower Priority Recommendations

Recommendation	Strategic Priority	Responsibility	Timeframe	No. and Page
Marketing of Scottish farmed seafood	Industry leadership and ambition	SG, Seafood Scotland, SSPO, SFD	By November 2017	Rec 3 (p 08)
Crown Estate fees and benefits to local communities	Industry leadership and ambition	Crown Estate	By November 2017	Rec 4 (p 09)
Development of a Social and Economic Benefits Report	Enabling and proportionate regulation	Scottish Aquaculture Industry	With immediate effect for new applications	Rec 9 (p 10)
Manufacturing excellence and continuous improvement	Accelerating innovation	ILG when formed	Ongoing	Rec 15 (p 13)
Export finance	Finance	SG	By November 2017	Rec 18 (p 14)
Digital connectivity	Infrastructure	SG	By 2021	Rec 20 (p 15)

Abbreviations

ASSG Association of Scottish Shellfish Growers
HIE Highlands and Islands Enterprise
ILG Industry Leadership Group
SAIC Scottish Aquaculture Innovation Centre
SDS Skills Development Scotland
SE Scottish Enterprise
SEPA Scottish Environment Protection Agency
SFD Scotland Food & Drink
SG Scottish Government
SIB Scottish Investment Bank
SSPO Scottish Salmon Producers Organisation

A: INDUSTRY LEADERSHIP AND AMBITION

In the global aquaculture sector, Scotland competes against nations with huge ambitions, more competitive regulatory frameworks and clear roadmaps for growth. To increase market share and exports, the Scottish aquaculture sector requires its own industry-wide strategic vision and for government and industry to join together in driving sustainable growth. Sector-wide leadership, alignment, ambitions and roadmaps are required for individual companies to thrive in a competitive global marketplace.

Recommendation 1: Formation of an Industry Leadership Group

!!

A number of successful sectors in Scotland, from technology to tourism, have Industry Leadership Groups (ILGs). These are pivotal to developing and delivering industry-led sector strategies and to creating productive collaboration between government and industry.

We strongly recommend the formation of an ILG for aquaculture, representing the wider stakeholder group, bringing together key figures from the private and public sectors to drive sector growth and ensure alignment between industry and government.

The aquaculture ILG should have clear objectives for growth and monitor progress through quantifiable outcomes and impacts. These will include the measures set out in this Strategic Plan and its successors and be updated from time to time. The implementation of these recommendations, through the formation of the ILG, will ensure effective implementation of this Strategic Plan. We expect an aquaculture ILG will work closely and collaboratively with, and form part of, the food and drink sector wide ILG, Scotland Food & Drink

Lead responsibility: Vision 2030 Working Group
Co-responsibility: Scottish Government, Scotland Food & Drink, Highlands and Islands Enterprise, Scottish Salmon Producers Organisation, Association of Scottish Shellfish Growers, Scottish Aquaculture Innovation Centre
Timeframe: By July 2017

Recommendation 2: Aquaculture to become a core-growth sector for Highlands and Islands Enterprise

!

The aquaculture sector supports some 5,000 jobs across the Highlands and Islands economy[5] and Highlands and Islands Enterprise (HIE) is supportive of the industry's growth. However, at present, aquaculture straddles two different Scottish Enterprise and HIE growth sectors: Life Sciences and Food and Drink. This perhaps diminishes awareness of the sector's economic and social importance and growth potential.

In order to optimise support for the sector, we recommend that aquaculture be elevated to a core growth sector within HIE, with an increased funding allocation. This would focus support more productively and enable a more joined-up approach to growing the sector.

Lead responsibility: Highlands and Islands Enterprise
Co-responsibility: Scottish Enterprise
Timeframe: By July 2017

Recommendation 3: Marketing of Scottish farmed seafood

There is a strong and growing market domestically and internationally for farmed seafood, which presents huge opportunities for Scotland. A strengthening reputation for premium quality and provenance are key to our marketing success, as demonstrated by Scottish farmed salmon which is the nation's top food export and is exported to over 60 countries.

Yet, despite a strong market position developed in recent years, there are still significant opportunities for market development at both home and overseas for all our farmed seafood species. Indeed, this will be critical in the context of growing production that this report sets the framework for. There is scope in particular to capitalise further on provenance through innovation in, for example, product development, packaging and marketing.

The bulk of salmon marketing overseas is done in-house by individual companies, complemented by generic reputation work led by the Scottish Salmon Producers Organisation (SSPO) and supported by Seafood Scotland, Scotland Food & Drink and Scottish Development International. Alongside that, shellfish and smaller finfish producers consider that Seafood Scotland is doing a good job of helping to promote Scottish aquaculture produce in key markets and providing them with an affordable platform to develop their own export business.

The development of the Scotland, a Land of Food & Drink brand in international markets is still in its relative infancy but early success has been noted. To that end, the continued collaboration of the aquaculture sector with other sectors of food and drink to raise awareness of Scotland as the source of world-class products will be critical. The Scotland Food & Drink Export Partnership has brought both the industry and government together behind a single export strategy and operating plan. Continued support for that approach by both industry and government is central to the sector's market development ambitions.

It is recognised, however, that the current funding of Seafood Scotland is tenuous and we recommend that further discussion about its future role and sustainable funding are prioritised in order to provide the platform for increased market development activity.

Responsible: Scottish Government, Seafood Scotland, SSPO, Scotland Food & Drink
Timeframe: By November 2017

Recommendation 4: Crown Estate fees and benefits to local communities

The Scottish Government has committed to ensuring that coastal and island communities benefit from net revenues from Crown Estate property in Scotland from marine activities out to 12 nautical miles.

We recommend going further, with all Crown Estate lease fees channelled back to host communities. This would ensure that communities across Scotland benefit further from the nation's coastal resources and are incentivised by and share in the benefits of a growing industry.

To ensure parity of treatment for aquaculture across Scotland, we recommend that independent arbitration be in place to review rents.

Responsible: Crown Estate
Timeframe: By November 2017

B: ENABLING AND PROPORTIONATE REGULATION

For Scotland's aquaculture producers and wider supply chain to compete globally, the regulatory and policy environment in Scotland must be conducive to sustainable economic growth.

In setting policy and applying regulation, it is important that government and local government consider what aquaculture means for Scotland's economy and communities and take into account that sustainability has three pillars: economic development, social development and environmental stewardship. All three pillars should be given equal weight by public-sector stakeholders in their determination and implementation of aquaculture policy and regulation.

The delivery of sustainable growth by the industry also requires a fit-for-purpose planning framework that provides better consistency of response and speed of process. The framework should enable regulators to keep pace with innovation and change in the industry – not just in finfish and shellfish production, but in emerging areas such as seaweed growing or harvesting.

Recommendation 5: The role of Marine Scotland

!!

Marine Scotland's purpose is to 'manage Scotland's seas for prosperity and environmental sustainability'. These dual roles as regulator and policy advocate for development are unusual within government and even contradictory.

There is an opportunity here to align aquaculture with other food and drink sectors in Scotland, by moving away from the current model where the regulator is also responsible for the development of the sector.

We recommend that Marine Scotland's industry development remit would sit more logically with the Scottish Government's Food, Drink & Rural Communities Division and that Marine Scotland could focus on regulation. We recommend that, in regulating the sector, Marine Scotland use a proportionate and enabling approach, with decision-making and weighting that take account of aquaculture's potential economic contribution to the Scottish economy.

We also recommend that Marine Scotland consider the formation of a virtual Aquaculture Scotland Public Body – with relevant staff seconded and matrix managed, from organisations that interface with industry, for example Marine Scotland, the Scottish Government Food & Drink team, the Scottish Environment Protection Agency (SEPA) and Scottish Natural Heritage (SNH).

The body should be led by a senior official tasked with delivering the public-sector elements of this Strategic Plan and with enabling the industry to deliver on its responsibilities.

Responsible: Scottish Government
Timeframe: By July 2017

Recommendation 6: Short-term improvements to consenting processes

The processes governing the establishment of new marine aquaculture operations are often viewed by industry as slow, disjointed and unpredictable in terms of application outcomes.

Under the current system of consenting for aquaculture activity, there is perceived duplication, with overlaps between the input of Local Planning Authorities (LPAs), Marine Scotland, the Scottish Environment Protection Agency (SEPA) and other bodies. These can cause delays, expense and avoidable uncertainty of outcome.

The Independent Review of Scottish Aquaculture Consenting (IRSAC), published in 2016, made eight quick-win recommendations to reduce duplication and cut timeframes for consenting. An action plan has been prepared by the current Capacity Working Group for the implementation of these quick wins; the issue is the time taken to implement them, since many should have been implemented long before now.

We therefore recommend the implementation of all the quick-win recommendations in IRSAC within six months.

Responsible: Marine Scotland and as outlined in the Independent Review of Scottish Aquaculture Consenting (IRSAC) and overseen by ILG when formed
Timeframe: By May 2017

Recommendation 7: Clarity in the Scottish Planning Policy and National Planning Framework

The Scottish Planning Policy (SPP) is consistently supportive of the sustainable development of aquaculture to meet industry targets. However, its application is inconsistent across Local Planning Authorities (LPAs). Moreover, there is insufficient clarity in some parts of the SPP, in particular with regard to the consideration given to the benefits of economic and social development in aquaculture planning applications.

We recommend that in the next review of the SPP the definition of 'sustainable development' be refined to spell out more clearly the weighting to be given to economic development and social benefits in relation to environmental impact. We also recommend that the revised 2030 industry targets for aquaculture production set out in this Strategic Plan be included in the SPP. Additionally, LPAs should be provided with further guidance on meeting their obligations to work towards enabling this target.

Furthermore, for consistency, the National Planning Framework should specifically state, 'we will support the sustainable economic growth of the aquaculture sector in meeting its 2030 targets'.

Responsible: Chief Planner
Timeframe: By end 2018

Recommendation 8: Medium and longer-term improvements to planning

The Independent Review of Scottish Aquaculture Consenting (IRSAC) considered five options for change to the consenting approach, in addition to the quick-win recommendations referred to in Recommendation 6 above. We recommend the consideration of these five options, noting that further industry dialogue is required around actions relating to option 5.

Longer-term, we believe the sustainable growth of aquaculture is not effectively served within the Town and Country Planning system as it currently stands. The planning of most marine activities, other than aquaculture, is controlled through the marine planning framework. Given that the industry is now developing open-water aquaculture sites, it is timely to address this anomaly. Consideration should be given to a marine licensing system, similar to that for other marine activities such as marine renewables.

Within the National Marine Plan and to enable the delivery of the sustainable aquaculture growth targets in this Strategic Plan, we recommend the development of a Spatial Plan for Scotland's marine resource. This should set out: areas that are presumed to be suitable for aquaculture developments; areas that are deemed unsuitable, including areas set aside for other marine activities and areas that share the resource with other activities but could be considered for aquaculture developments.

Responsible: Marine Scotland, overseen by ILG when formed
Timeframe: By 2020

Recommendation 9: Development of a Social and Economic Benefits Report

To supplement the currently required Environmental Impact Assessments (EIA), we recommend that the industry develop a template for a Social and Economic Benefits Report to accompany all planning applications for aquaculture developments. This could spell out the economic and social benefits of the development, including investment and spend with the Scottish supply chain. It should use established Scottish Government economic multipliers and align with Scottish Planning Policy.

The use of such a template could lead to coherent and consistent consideration of planning applications across Local Planning Authorities and of each application's social and economic benefits.

Responsible: Scottish Aquaculture Industry
Timeframe: With immediate effect for new applications

Recommendation 10: SEPA modelling and collaboration

The Scottish Environment Protection Agency's (SEPA) new DEPOMOD model has been on the horizon for some time and time-slips on the launch of the model have delayed the introduction of the new Deposition Zone of Regulation (DZR) in aquaculture licensing.

The industry is broadly supportive of DZR; however, there is uncertainty over its implementation. We recommend that SEPA set out a clear timetable and inform industry well in advance how to use DZR and DEPOMOD.

Longer-term, there is an opportunity for SEPA and the industry to develop new and innovative ways to monitor benthic impacts and the industry may benefit greatly in investing in new models. There is also scope for SEPA and the industry to collaborate more actively to ensure that the regulatory framework and its delivery are fit for purpose and to consider 'beyond compliance' approaches.

We invite the industry – supported by SEPA, academics and the Scottish Aquaculture Innovation Centre (SAIC) – to consider investing in real-time, responsive modelling and monitoring systems, which will balance sustainable growth with environmental protection. We also invite the industry and SEPA to continue to collaborate actively, at senior level, to enable this Strategic Plan for growth.

Implementation of DEPOMOD and DZR
Responsible: SEPA
Timeframe: By May 2017

Development of new models
Responsible: Industry, led by SSPO, supported by SAIC
Timeframe: Ongoing

C: ACCELERATING INNOVATION

Research, development and innovation (RD&I) in Scotland must address the challenges faced by the aquaculture industry, including climate change. Investment in RD&I in Scotland must support the sustainable growth and global competitiveness of the sector (including the supply chain) and reflect the industry's priorities.

Currently, these priorities include reducing the risk and impact of biological threats; a shift to new production models, including exposed sites and on-shore 'super-smolt' facilities;the availability of shellfish spat and the development of a commercial hatchery for the Scottish shellfish industry and greater knowledge of shellfish biology.

In addition, there is an opportunity to provide economic and social benefit from the commercialisation of Scottish innovation. The innovation landscape in Scotland must support this, facilitating the export of Scottish know-how and fostering growth in the Scottish supply chain.

A new Industry Leadership Group (proposed in Recommendation 1) could play an important role in determining and monitoring Scotland's RD&I priorities and ensuring they meet the needs of industry.

Recommendation 11: Development of Innovation Sites in Scotland

Successful RD&I requires an ability to trial new techniques. Yet with the outcomes and impacts of these not fully known, this can carry some risk. Since positive outcomes could yield significant economic and environmental benefits, tolerance for risk-inherent innovation needs to be embraced by regulatory bodies.

We therefore recommend that regulators consider how to enable the growth of the Scottish industry through the selective use of Innovation Site status for controlled trials and development of equipment, technologies or disease control measures and regulation.

Proposals could be invited from the market for Innovation Sites with applicants stating the potential social and economic benefits to Scotland along with the Environmental Impact Assessment (see Recommendation 9). Applicants should also state what aspects of current equipment and practice are to

be trialled, how they propose to share the learning and how that would benefit the Scottish Aquaculture Industry and its supply chain as a whole. Collaborative developments would be encouraged.

We recommend that an Industry Leadership Group, when formed, collaborate with Marine Scotland, the Scottish Aquaculture Innovation Centre (SAIC), Scottish Environment Protection Agency (SEPA) and the industry to develop a workable scheme, including developing the arrangements for how long Innovation Site status is granted; options for reverting to normal operations after that period; the number of Innovation Sites permitted, both overall and per operator and the eligibility of new operators to apply.

Lead responsibility: ILG when formed
Co-responsibility: Marine Scotland, SAIC, SEPA, industry
Timeframe: Ongoing

Recommendation 12: Alignment and delivery of RD&I in Scotland to support growth

RD&I priorities for the Scottish Aquaculture Innovation Centre (SAIC), Highlands and Islands Enterprise (HIE), Marine Scotland Science, Scottish Environment Protection Agency (SEPA), Scottish Funding Council, UK Research Councils and other publicly-funded organisations must mesh fully with the needs and ambitions of the industry, across the full supply chain in Scotland. The major issues prioritised by industry must be funded and applied research on them accelerated along with improved direct funding and support for supply chain innovation.

To this end, in 2016 SAIC commissioned an innovation roadmap and sector needs study, carried out by Imani, entitled 'Scottish Aquaculture: A View towards 2030'. We recommend that an Industry Leadership Group adopt Imani's detailed innovation roadmap to 2030 in order to drive innovation across the supply chain and in public-sector regulatory bodies.

We also recommend further pre-competitive cross-industry collaboration on a variety of applied research and innovation projects, in line with SAIC's current and future priority innovation areas.

Finally, we support the growth and development of SAIC beyond 2019 through to 2030, through continued public and private sector collaboration.

Lead responsibility: SAIC in conjunction with ILG when formed
Co-responsibility: Marine Scotland Science, SEPA, Scottish Funding Council, UK Research Councils
Timeframe: Ongoing

Recommendation 13: Approaches to sea lice

Sea lice are currently one of the factors limiting growth in salmon production in Scotland – not just through lost production, but by impacting regulatory confidence and therefore, investment in the sector. The aquaculture industry recognises the imperative to address the sea lice challenge and has been investing almost £30 million annually over the past five years to enhance and add new techniques to its longstanding approach to integrated pest management strategies.

We support the industry's continuing commitment to investing in innovative methods to control sea lice, including biological and engineering-based solutions. The industry should consider sea lice as a pre-competitive issue.

Regulators must also work in collaboration with industry to fully understand sea lice and other fish health challenges and to support industry in its work on dealing with these.

Producers should continue to provide the comprehensive information published by the Scottish Salmon Producers Organisation (SSPO) on a quarterly basis and Marine Scotland should work with SSPO to ensure that a supportive narrative comes from government.

Lastly, regulators, industry and researchers in Scotland should continue to share information on sea lice control with other jurisdictions and continue to draw on the best international knowledge and expertise.

Lead responsibility: Industry
Co-responsibility: SSPO, SAIC, SEPA, Marine Scotland Science
Timeframe: Ongoing

Recommendation 14: Support for the indigenous supply chain, including processing

Supporting innovation in Scottish equipment manufacturing and technology, including processing technology, could create substantial economic gain through import substitution and create global export opportunities. Other aquaculture nations such as Norway and Iceland offer valuable models in terms of developing indigenous manufactured equipment and technology for aquaculture and processing and recognising its strategic importance.

To support the development of the indigenous Scottish equipment supply chain, we recommend the allocation of additional funding – in the region of £5 million pa – to supplement current Highlands and Islands Enterprise (HIE) and Scottish Aquaculture Innovation Centre (SAIC) support for innovation. This could be administered through an 'Accelerating Aquaculture Innovation' scheme which would extend HIE's potential to increase current intervention rates and directly support SME-generated innovation in equipment and technology. The delivery of such a scheme could draw on SAIC's networks and expertise.

Lead responsibility: HIE
Co-responsibility: SAIC
Timeframe: Launch of 'Accelerating Aquaculture Innovation' scheme by end 2017

Recommendation 15: Manufacturing excellence and continuous improvement

In recent decades, industries from car-making to media have been transformed by the introduction of new technologies and business models. Like all sectors, aquaculture can learn from this.

In particular, in subsectors such as processing, where many operations are repetitive in nature, there is potential for fresh thinking about the technology and processes involved. Given the global nature of aquaculture and the potential transferability of processing technology to other food sectors, the market opportunity is vast.

We therefore recommend that the equipment supply and processing sector in Scotland and the Scottish research base, give focused and ongoing consideration to supporting innovation and improvement in this sphere.

Responsible: ILG when formed
Timeframe: Ongoing

D: SKILLS DEVELOPMENT

To thrive globally, the aquaculture sector in Scotland needs a diverse workforce with the right skills – for 5 years' time, 15 years' time and beyond.

As technologies and competition change, these skills must evolve. Collaboration between the private and public sectors is essential to ensure the current and future workforce is equipped to make Scottish aquaculture a world leader.

In addition, there is an opportunity for Scotland to develop globally-respected executive education provision in the food and drink sector, including aquaculture – not only developing its own cohort of skilled industry leaders but attracting people from all over the world to study for Scottish qualifications.

Recommendation 16: Mapping of future skills requirements

To plan for a thriving industry in the future requires mapping of the current workforce composition and future workforce requirements.

We recommend that Skills Development Scotland (SDS) and Highlands and Islands Enterprise (HIE), in collaboration with the industry and the Scottish Aquaculture Innovation Centre (SAIC), map the existing workforce skills composition of the aquaculture sector, including the supply chain. Based on planned increased tonnages in 2030 and beyond, a gap analysis should be undertaken and skills development delivery planned.

Such mapping would allow HIE and SDS to provide the right skills for growth in the industry – from apprenticeships to leadership development and executive education. It will also facilitate the promotion of aquaculture careers to young people throughout Scotland.

We also recommend the formation of an industry skills group within a newly-formed Industry Leadership Group to liaise with SDS and HIE on an ongoing basis. This will ensure that skills development planning is fit for purpose and takes account of new skills required.

Responsible: ILG when formed, SDS, HIE, SAIC
Timeframe: Commencing immediately and ongoing to 2030

E: FINANCE

Access to finance is an ongoing challenge for many SMEs in the sector. This can stifle their ability to invest in innovation and growth or compete with larger or overseas competitors. Scottish equipment manufacturers' ability to compete with overseas competitors is hampered by overseas competitors' ability to offer finance and by restrictions on the export finance available to Scottish manufacturers. A further limit on growth is lack of awareness among investors of the growth potential in Scottish aquaculture. There are good opportunities to address all of these issues.

Recommendation 17: Finance for Scottish aquaculture

!!

We recommend the launch of a dedicated investment fund for aquaculture, through Scottish Enterprise, Highlands and Islands Enterprise (HIE) and the Scottish Investment Bank.

This could improve SMEs' access to funding, including co-investment and gap funding and improve investor awareness of the sector.

Responsible: Scottish Enterprise, Scottish Investment Bank, HIE
Timeframe: By November 2017

Recommendation 18: Export finance

In order to grow Scottish aquaculture technology and equipment, manufacturers must be able to compete internationally in terms of trade finance. We recommend that consideration be given to the creation of an export finance scheme comparable to that available in Norway which would allow Scottish manufacturing companies in target sectors to extend credit finance to customers in target markets with shared risk. Such a scheme need not be limited to aquaculture equipment and technology and the wider benefit to the whole Scottish economy could be considerable.

Responsible: Scottish Government
Timeframe: By November 2017

F: INFRASTRUCTURE

Growth in aquaculture in Scotland will require – but also facilitate – investment in infrastructure such as ports and piers and innovation in the design of vessels and vehicles.

Scottish producers and supply chain have the capacity and expertise to develop the logistics, vessels and infrastructure required to support a flourish industry in 2030. However, a number of developments are critical to the industry's sustainable growth.

Recommendation 19: Essential investment in infrastructure

!!

We recommend a sectoral mapping exercise to determine aquaculture's current transport and logistical constraints and future requirements to 2030, in terms of roads, ports, harbours and ferry services, along similar lines to HITRANS's Whisky Logistics Study (2011). This should be used to inform future investment plans in infrastructure improvement in Scotland.

We also recommend the industry feed into Transport Scotland's Strategic Transport Projects Review over the next 12–24 months.

Responsible: HITRANS, with input from ILG when formed
Timeframe: By November 2017 and then ongoing

Recommendation 20: Digital connectivity

To compete effectively, aquaculture companies all over Scotland need access to fit-for-purpose IT and phone connectivity.

As aquaculture will require to be carried out in more remote and exposed areas and equipment will require to be remotely operated and more technology dependent, the digitally connected infrastructure will become a critical barrier to growth in remote areas if not addressed.

We therefore recommend that the Scottish Government's plan for digital connectivity in terms of area coverage and broadband speeds take account of the planned industry footprint to 2030. Specifically, a Spatial Plan produced by Marine Scotland (see Recommendation 8) should be considered when digital coverage is being planned and in line with Scottish Government commitments, all aquaculture shore-based properties should have superfast broadband by 2021.

Responsible: Scottish Government
Timeframe: By 2021

6 REFERENCES

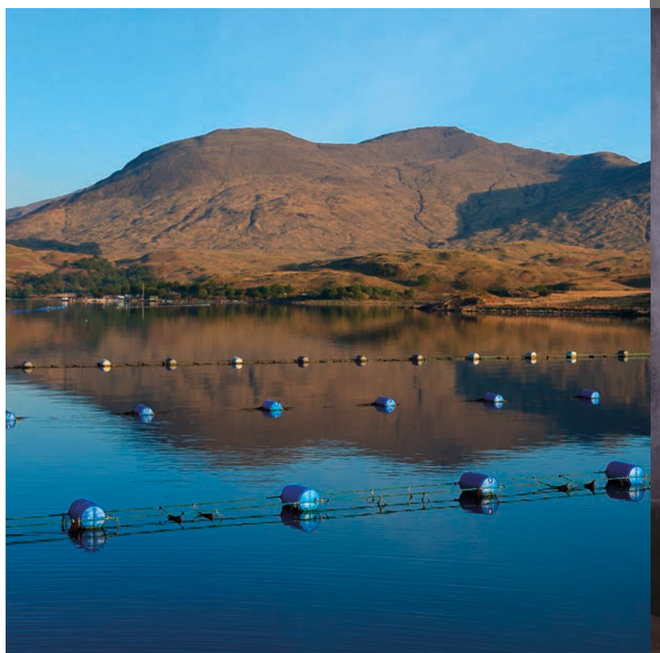
[1] Marine Scotland (2013), An Assessment of the Benefits to Scotland of Aquaculture.

[2] EATIP (2012), The Future of European Aquaculture.

[3] United Nations (2005) General Assembly, Resolution adopted by the General Assembly [without reference to a Main Committee (A/60/L.1)] 60/1: 2005 World Summit Outcome, A/RES/60/1 (24 October 2005).

[4] Scott Cato, M. (2009), Green Economics. London: Earthscan.

[5] Marine Scotland (2013), An Assessment of the Benefits to Scotland of Aquaculture.



6 ACKNOWLEDGMENTS

We are grateful for the valuable contribution of all the core members of the Vision 2030 Working Group:

Dennis Overton, Aquascot – from the value addition sector (co-chair)

Stewart Graham, Gael Force Group – from the equipment supply sector (co-chair)

Alasdair Ferguson, Ferguson Transport & Shipping – from the logistics and infrastructure sector

Anne MacColl, Scottish Salmon Producers Organisation – representing finfish interests

Gilpin Bradley, Wester Ross Salmon – from the independent finfish production sector

Heather Jones, Scottish Aquaculture Innovation Centre – representing innovation and research

James Withers, Scotland Food & Drink

Michael Tait, Shetland Mussels & Scottish Shellfish Marketing Group – from the shellfish sector

Stuart Black, Highland Council

Andrew Sloan – Bank of Scotland

Andy Rosie – Scottish Environment Protection Agency

Charlotte Wright – Highlands and Islands Enterprise

David Moody – Highland Council

David Reid – Highlands and Islands Enterprise

Douglas Sinclair – Scottish Environment Protection Agency

Elaine Jamieson – Highlands and Islands Enterprise

Gerry McBride – Skills Development Scotland

Graham Young – Scotland Food & Drink

Ian Mitchelmore – Scottish Investment Bank

Jason Cleaversmith – Scottish Aquaculture Innovation Centre

Jimmie Hepburn – Soil Association's Aquaculture & Trade Standards Committee

Mark Nash – Facilitator

Natalie Bell – Seafood Scotland

Phil Nickells – Macrae Seafoods

Ronnie Soutar – Fish Veterinary Society

Rucha Mirashi – Intern Gael Force Group

Steve Bracken – Marine Harvest

Su Cox – Scottish Salmon Company

We are also grateful to the following for their support, contributions, submissions and presentations to the group:

Association of Scottish Shellfish Growers

Highlands and Islands Enterprise

Scotland Food & Drink

Scottish Aquaculture Innovation Centre

Scottish Salmon Producers Organisation

Alistair Barge – Otter Ferry

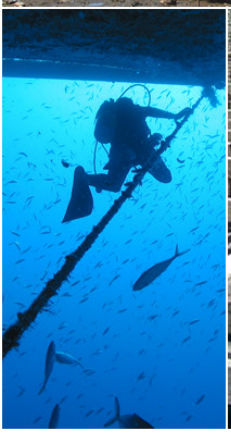
Thanks also go to Rhiann Graham of Gael Force Group, for organising and supporting the Working Group's meetings and work throughout 2016 and to Sarah Burnett, for writing this Strategic Plan.

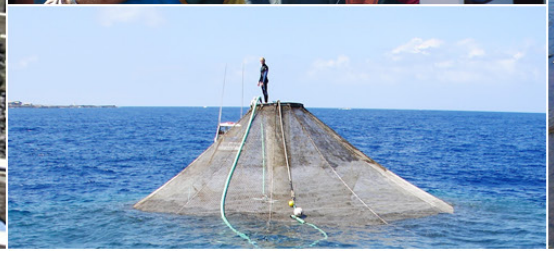
NOAA FISHERIES

Marine Aquaculture

Strategic Plan

FY 2016-2020


Deliverables

The table below displays selected deliverables and actions for the Aquaculture Program for the FY 2016-2020 time period. A comprehensive list of program activities will be developed annually in an Aquaculture Annual Operating Plan.

Organization	Deliverables	FY 16	FY 17	FY 18	FY 19	FY 20
Headquarters	Finalize a Memorandum of Understanding among federal agencies for aquaculture permitting in federal waters of the Gulf of Mexico (Goal 1)	✓				
	Complete Aquaculture Science Review and develop and implement Aquaculture Science Strategic Plan (Goals 2, 3)	✓	✓			
	Expand external funding opportunities for aquaculture including Saltonstall-Kennedy, SBIR, Sea Grant competitions and public-private partnerships (Goals 2, 3)	✓	✓	✓	✓	✓
	Improve aquaculture online resources particularly science web-pages (Goals 1, 2, 3, 4)	✓	✓			
	Complete an economic impact analysis for marine aquaculture and improve the accuracy of annual aquaculture production statistics (Goal 3)	✓	✓	✓	✓	✓
All Regions	Assist with grants management, including Saltonstall-Kennedy (Goal 2, 3)	✓	✓	✓	✓	✓
	Collaborate with Protected Resources and Habitat Conservation programs to complete Endangered Species Act/Essential Fish Habitat consultations on Army Corps of Engineers permits, as appropriate (Goal 1)	✓	✓	✓	✓	✓
	Improve reporting of regional aquaculture production statistics (Goal 3)	✓	✓	✓	✓	✓
	Actively engage other offices within NOAA and other agencies involved in permitting aquaculture offshore, to disseminate scientific findings in key NOAA and outside scientific research to establish a sound, scientific rationale for the review of permit applications, and for establishing siting, monitoring, and BMP requirements of permittees (Goals 1, 2)	✓	✓	✓	✓	✓
Greater Atlantic Regional Office	Work with state and federal partners to identify and implement ways to improve the permit processes for aquaculture, particularly for shellfish aquaculture (Goal 1)	✓	✓	✓	✓	✓
	Conduct a review of mussel aquaculture and protected resource interactions (Goal 1)	✓	✓			
Southeast Regional Office	In coordination with federal agencies, develop a regional permit review process and implement the Fishery Management Plan for Offshore Aquaculture in the Gulf of Mexico (Goal 1)	✓	✓			
	Support the development of off-bottom shellfish aquaculture in the Gulf of Mexico (Goals 1, 3)	✓	✓	✓	✓	✓

Organization	Deliverables	FY 16	FY 17	FY 18	FY 19	FY 20
West Coast Regional Office	Complete NOAA actions identified under the Washington, California, and Oregon Shellfish Initiatives (Goals 1, 2, 3, 4)	✓	✓	✓	✓	✓
	Work with state agencies and local governments in Washington to improve aquaculture guidance for updates of Shoreline Master Programs (Goal 1)	✓	✓			
	Work with local, state, and federal partners to ensure timely and efficient permitting decisions for proposed projects in state and federal waters (Goal 1)	✓	✓	✓	✓	✓
Pacific Islands Regional Office	Provide regulatory guidance through the Offshore Aquaculture working group (Goal 1)	✓	✓	✓	✓	✓
	Support aquaculture amendments for the Western Pacific Fishery Management Council and develop capability to issue permits for commercial-scale aquaculture in federal waters (Goal 1)	✓	✓	✓		
	Support the issuance of programmatic permits for restoration of Hawaiian fish ponds (Goal 1)	✓	✓	✓	✓	✓
Alaska Regional Office	Coordinate with partners to support Alaska shellfish initiative (Goals 1, 2, 3, 4)	✓	✓	✓	✓	✓
Northeast Fisheries Science Center*	Provide technical assistance for shellfish hatchery methods, probiotics, and micro-algae culture (Goal 3)	✓	✓	✓	✓	✓
	Conduct research on the ecosystem services of aquaculture and the response of shellfish to changing environmental conditions (Goals 2, 3)	✓	✓	✓	✓	✓
Southeast Fisheries Science Center*	Support the Southeast Regional Office in assessing the environmental effects of prospective aquaculture in federal waters of the Gulf of Mexico in Collaboration with the NWFSC and NCCOS (Goal 2)	✓	✓	✓	✓	✓
Northwest Fisheries Science Center*	Operationalize and apply the OMEGA (genetic impacts) model to additional species/stocks (e.g., red drum) (Goal 2)	✓	✓	✓	✓	
	Complete research products on the environmental effects and ecosystem services of shellfish aquaculture (Goals 2, 3)	✓	✓	✓	✓	✓
	Work with partners to advance production methods (i.e., larval rearing technology, genetics, and genomics) for key species including sablefish, Olympia oysters, salmon, seaweed, and abalone (Goals 2, 3)	✓	✓	✓	✓	✓
	Develop "tools for rules" for disease modeling (Goals 2, 3)		✓	✓	✓	
Southwest Fisheries Science Center*	Provide scientific support to assess the environmental effects of aquaculture in federal waters off California (Goal 2, 3)		✓	✓	✓	✓
	Expand captive breeding programs and out-planting for endangered abalone, consistent with NOAA Fisheries policy and recovery plans (Goal 2)	✓	✓	✓	✓	✓
	Advance production methods (i.e., larval rearing technology, genetics, and genomics) for key species including yellowtail, white seabass and endangered abalone (Goals 2, 3)	✓	✓	✓	✓	✓

Organization	Deliverables	FY 16	FY 17	FY 18	FY 19	FY 20
Pacific Islands Fisheries Science Center*	Provide science support to assess the environmental effects of aquaculture in federal waters off Hawaii (Goal 2, 3)		✓	✓	✓	✓
Alaska Fisheries Science Center*	Develop husbandry techniques to raise king crab to enhance wild populations	✓	✓	✓	✓	✓
	Use aquaculture as a tool to investigate the effects of climate change on wild king salmon life history and genetics.	✓	✓	✓	✓	✓
OAR National Sea Grant College Program**	Effectively manage aquaculture grant competitions for aquaculture development and extension and coordinate work of aquaculture extension agents (Goal 3)	✓	✓	✓	✓	✓
NOS National Centers for Coastal Ocean Science (NCCOS)**	Develop tools for coastal managers, including ecological assessments and forecasts, spatial planning tools, climate change assessments, and innovative technologies (Goals 1, 2, 3, 4)	✓	✓	✓	✓	✓

* Additional aquaculture science deliverables, including those addressing emerging science needs, will be identified through the NOAA Aquaculture Science Review in 2016.

** The OAR National Sea Grant College Program and NOS NCCOS are each in the process of developing aquaculture strategic plans specific to their respective organization

Appendix 2 - NOAA Aquaculture Funding History

Table A1: Total NOAA Fisheries Aquaculture Funding (Thousands of Dollars)

Organization	FY 2007	FY 2008	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013	FY2014	FY 2015
NOAA Fisheries HQ (e.g., management, outreach)	$2,361	$1,736	$1,705	$1,953	$1,360	$1,569	$1,406	$1,433	$1,328
Regional Coordinators	$135	$132	$229	$428	$589	$906	$873	$908	$887
Northeast Fisheries Science Center	$3,132	$3,758	$4,200	$4,850	$4,802	$4,176	$4,320	$3,420	$3,095
Northwest Fisheries Science Center	$1,838	$2,248	$2,591	$3,457	$3,187	$3,092	$2,636	$2,687	$2,905
Other Fisheries Science Centers	$335	$0	$54	$161	$726	$239	$205	$144	$172
Transfers to OAR and NOS	$19	$733	$494	$433	$282	$475	$296	$257	$314
Total	$7,820	$8,607	$9,273	$11,282	$10,946	$10,457	$9,736	$8,849	$8,701

Table A2: Extramural Funding for Aquaculture Under Saltonstall-Kennedy Grants Program

	FY 2008**	FY2009	FY 2010	FY 2011*	FY 2012*	FY 2013	FY 2014***	FY 2015****
# 0f aquaculture projects funded	1	19	8	-	-	-	6	16
Total funding for aquaculture projects	$69,791	$4,202,438	$1,471,129	-	-	-	$1,561,297	$4,763,458
Total S-K grant competition	$2,613,479	$8,605,617	$4,835,204	-	-	-	$10,511,660	$25,000,000
% funding to aquaculture projects	3%	49%	30%	-	-	-	15%	19%

* There was no S-K grant competition in FY 2011, 2012, 2013 **Aquaculture was not a funding priority in FY 2008 *** FY 2014 competition includes FY 2013 funds ****FY 2015 competition includes FY 2014 fund

Table A3: Extramural Funding for Aquaculture Under NOAA/Department of Commerce SBIR Program

	FY 2007	FY 2008	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015
# of aquaculture projects funded	3	3	3	4	2	1	2	1	3
SBIR Phase 1 funding	$187,895	$94,651	$180,975	$376,998	-	$95,000	$95,000	$94,999	$189,647
SBIR Phase 2 funding	$300,000	$559,000	$299,998	-	$598,427	-	$397,510	_	$399,999
Total aquaculture project funding	$487,895	$653,651	$480,973	$376,998	$598,427	$95,000	$492,510	$94,999	$589,646

Table A4: Extramural Funding for Aquaculture under OAR National Sea Grant College Program*

	FY 2008	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015
# of aquaculture projects funded	23	11	36	33	40	47	25	30
Total aquaculture project funding	$4,603	$1,578	$4,800	$4,313	$4,318	$4,147	$4,363	$4,388

* Table includes core funding