Executive Summary

The potential economic impact of a fully developed mariculture industry in Alaska is not well understood by industry or policymakers. It is also not entirely clear what is needed to move from Alaska's current micro industry to a fully developed industry. The Alaska Fisheries Development Foundation (AFDF) has been awarded a grant from NOAA in order to spearhead the Alaska Mariculture Initiative (AMI) with the following goals: (1) expand the stakeholder base, create partnerships, and increase capacity to be effective; and (2) develop a clear and comprehensive strategic plan, including a written commitment to implement the plan by the various stakeholders and agencies. Northern Economics, Inc. was contracted by AFDF to conduct an economic analysis to help inform decisions to be made in the creation of the AMI strategic plan. The economic analysis will contain three phases:

- Phase I: Comparative case studies which outline examples of successful mariculture industries in different regions of the world
- Phase II: Preliminary economic analysis to support the development of a statewide strategic plan
- Phase III: Analysis of the costs, benefits, and economic impact of the statewide strategic plan developed as part of the AMI

This report represents the work completed for Phase 1. Funding for Phases II and III is pending.

In this report we describe nine case studies. Drawing on existing literature, each case study includes (1) a description of the industry; (2) the current economic impact of the industry, (3) the history and reasons for the industry's growth, as well as past and current obstacles to growth; (4) best available estimates of private and public investments in order to reach current levels of development; (5) estimates of costs and benefits of the return on investment in these regions; and similarities and contrasts to Alaska (e.g., workforce, transportation, government support programs) and relevance and applicability of the industry's experiences to Alaska. Case studies completed include:

- Alaska salmon enhancement
- Alaska king crab enhancement
- Washington geoduck
- Florida hard cams
- Ireland Seaweed
- Spanish mussels
- Prince Edward Island mussels
- New Zealand mussels
- British Columbia First Nations aquaculture

These case studies provide insights into best practices in development of strategic mariculture initiatives, and attributes and characteristics (such as access to markets, employment base, government and public support, etc.) that have led to the success of mariculture development in other parts of the world. These factors can be compared to the current social, economic, regulatory, investment and political climate in Alaska to allow for efficient and effective development planning and implementation. The following subsections provide brief descriptions of each case study.

Alaska salmon enhancement

In response to precipitous declines in salmon harvests in the 1950s and 1960s, the State of Alaska initiated its salmon fisheries enhancement program in 1971. In that year, the state legislature created the Division of Fisheries Rehabilitation, Enhancement and Development within the Alaska Department of Fish and Game and tasked the division with planning the rehabilitation, enhancement and development of all aspects of the state's fisheries to insure perpetual and increasing production and use, and encourage investment by private enterprise. Perhaps the most distinctive feature of Alaska's salmon fisheries enhancement program is that most hatcheries in the program are owned and operated by private, nonprofit "regional associations" comprised of commercial, recreational and subsistence fishermen, seafood processors, conservationists, and local civic interests. A 2008 economic impact analysis estimated that hatchery operations and the commercial harvesting and processing of salmon produced by three regional associations in southeast Alaska produced $233 million in total (direct, indirect, and induced) economic output and generated a total of 1,192 jobs and $59 million in labor income.

Alaska king crab enhancement

The Alaska King Crab Research Rehabilitation and Biology program was established in 2006 with the mission of understanding the large-scale culturing needs of red and blue king crab, and perfecting strategies for hatching and rearing these species to a stage where they can be released into the wild and contribute to reversing low wild stock abundance in Alaska. Acquiring this knowledge base will aid policymakers in making informed decisions about whether to pursue active rehabilitation of Alaska's long-depressed wild king crab stocks through hatchery enhancement. Several more years of developmental research are probably required before a full-scale hatchery-enhancement operation is feasible. Once initial cultivation and releases have occurred, at least another seven years will be required before released crabs grow to sizes that could be recaptured, and the success of a rehabilitation and enhancement program can be determined. Therefore, any potential economic benefit from a king crab enhancement program is at least 10 to 15 years off in the future.

Washington Geoduck

The commercial dive harvest of geoduck began in the early 1970s as a managed fishery producing a relatively low value product (< $1 per pound [lb]). However, by the early 1990s a developing market in Asia transformed geoduck into a much higher valued product. These initial steps led to successful development of commercial geoduck aquaculture in the State of Washington and a significant expansion of production volumes and values for both cultured and dive harvested geoduck. Challenges remain, however, with continual demand for hatchery-produced geoduck seed, slow growth, and an ongoing presence of Paralytic Shellfish Poisoning contamination. Nevertheless, the future growth of the industry looks promising, especially for growers interested in the long-term production of a high-value product. Aquaculture production has increased significantly over the last 20 years from zero pounds in 1995 to over a million pounds since 2008. The average yearly value of production (2003–2012) is over $10 million, with 2012 recording a record value of $16,432,111.

Florida hard clam

Hard clam aquaculture began in Cedar Key following the ban on the use of gill nets in Florida state waters. As a result many commercial fishermen were out of work. Clam culture training was begun to offer new employment opportunities and train fishermen to become aquatic farmers. In addition, shellfish aquaculture leases were identified, permitted, and marked, allowing for placement of

trainees onto farm sites in Cedar Key and other coastal areas of Florida. These measures resulted in a rapid expansion of clam aquaculture. Statewide production in 1987 was about 100,000 lb. By 1999, 351 growers produced over 4.5 million pounds of farm production. Corresponding farm gate sales have also increased, with the value in 2012 reported at $38.7 million. Although the hard clam industry endured challenging events, such as the 2004 and 2005 hurricane seasons, the 2007–2012 recession, and the 2010 Deepwater Horizon oil spill, the industry exhibits a resiliency that allows for recovery and continued future market expansion. Associated with the increased shellfish farming activity was the development of spin-off businesses in support of the industry. Farm expansions also led to an increased level of public and private sector research on a broad range of issues, including market expansion, genetics, diseases and the possible culture of other shellfish species. Currently, clam farming is a mature industry in Florida, and an excellent example of a successful and community driven transition from an at-risk fishery dependent culture.

Ireland Seaweed

As part of the Sea Change strategy (and with the support of the Marine Institute and the Marine Research Sub-program of the *National Development Plan, 2007–2013*) a project was carried out to develop and demonstrate the viability of cultivation methodologies for seaweed species with known commercial potential. This project was led by the Bord Iascaigh Mhara (Irish Sea Fisheries Board or BIM) and involved two universities and six enterprises. The project operated from 2008–2011 and aimed to farm three commercially important species, *Palmaria palmata, Laminaria digitata,* and *Porphyra sp.* This project has proved to be pivotal in development of the industry, as it identified crucial data that ensures strategic investment. It clearly demonstrated that brown seaweeds (kelp) can be farmed, and provided business plans and economic analyses for hatchery and grow-out businesses. The project concluded that the price for brown seaweed (off the farm) needs to be about $1,275/wet metric ton to be profitable. The project also highlighted the limitations for farming *Palmaria*, and concluded that currently farming *Porphyria* is not viable. The funding required to make this project possible is not publicly available information. Through coordinated and focused industry development led by BIM, seaweed aquaculture in Ireland is now a viable but fledgling industry. Going forward, the main obstacle will be labor costs. Development of mechanized seaweed cultivation will be required to achieve cost objectives.

Spanish mussels

Mussel raft culture originated in the Mediterranean region of Spain (Barcelona) in the early twentieth century. The number of floating raft farms established in the Galician rias experienced growth from 10 rafts in 1946 to over 3,300 in 1997. During this 30-year period, there were a large number of lease areas granted, mostly to family entities which owned one or two rafts each. The number of rafts has stayed the same for nearly 40 years, with raft size increasing from about 2,691 to 5,382 square feet, and culture ropes from 33 to 39 feet long through the 1990s. Since production has reached its maximum levels in Spain, some of the original companies have established operations in Chile, where they grow 8,000–10,000 tons of mussels per year (with a production capacity of 30,000 tons) and export frozen mussel meat and mussels on the half shell. The mussel raft aquaculture industry in northwest Spain grows an annual crop of over 200,000 metric tons, and is the second largest mussel farming area in the world behind China. The industry is composed of approximately 3,300 rafts with a production as high as 75 tons per raft. Production has maximized since the early 1990s, and there have been no additional rafts or lease sites since 1976. The economic impact of mussel aquaculture, in the growing, services, and processing sectors in terms of jobs and value makes it a very valuable component of the sustainable economic activity in Galicia.

New Zealand mussels

The New Zealand aquaculture industry began in the mid-1960s with marine farming of oysters and then mussels, typically by small, innovative operations. It quickly established a domestic market and began making inroads into export markets in the 1970s. As aquaculture techniques and value chains became more sophisticated in the 1980s, small owner-operator farms became less common and aquaculture/seafood-related companies expanded and consolidated. There are now approximately 645 mussel farms in New Zealand over seven major regions. Production efficiency, control of stock, and cost reduction dominated industry thinking as export markets expanded. During the 1990s global competition in seafood products intensified, driving further consolidation of the industry in an attempt to achieve increased production and marketing efficiencies. With the introduction of the Resource Management Act in 1991, the expanding industry began to focus on sustainable production, acknowledging its associated environmental and social issues. In 2011, New Zealand produced 101,000 tons of mussels, worth $197 million, providing three-quarters of the country's seafood export value. The New Zealand mussel industry has developed over 30 years to become the world's leader in efficiency of mussel farming technologies, value added processing, and mussel research and development.

Prince Edward Island mussels

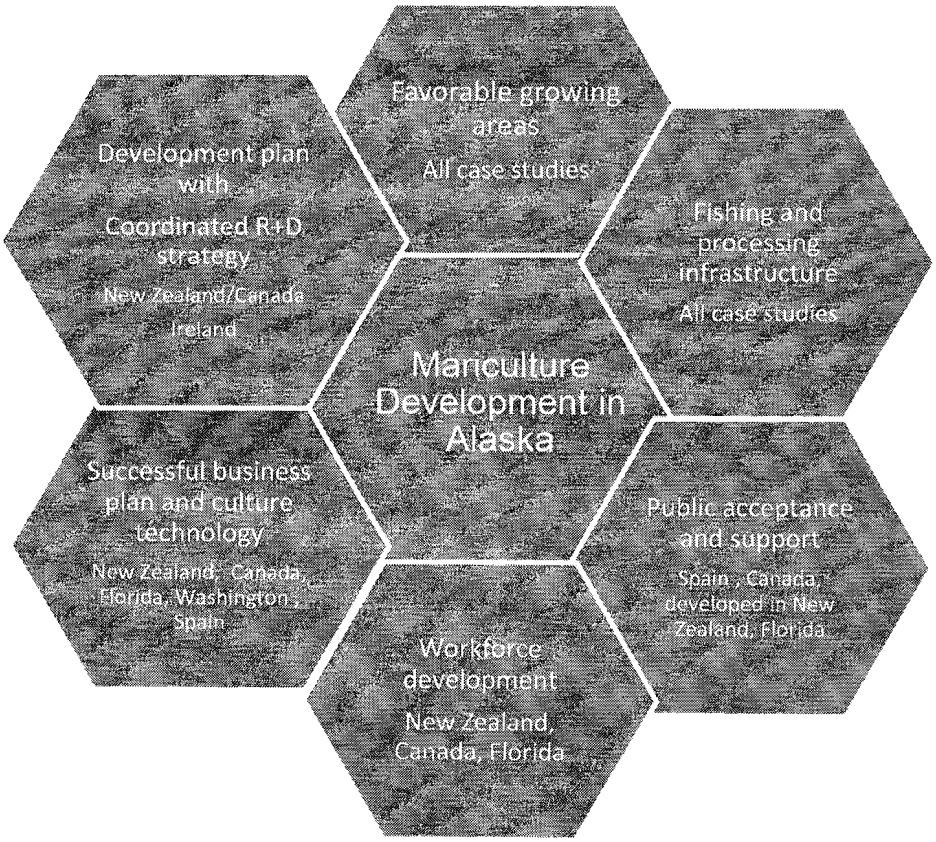
Prince Edward Island (PEI) mussel production has not grown much since 2000, when landings were nearly 18 million lb. Most of the growth of the industry took place between 1986 and 2001 due to skilled entrepreneurs. During the last decade, there has been consolidation of numerous smaller operations resulting in five large companies with an economy of scale. The utilization of long-line technology allowed for efficient seeding and harvesting, and adaptation to the relatively shallow waters in the enclosed PEI bays. Canada (and the maritime provinces) benefit from a strong federal aquaculture development policy, regional development centers, and financial support for outcome-based research and development. Mussel leases account for a total of 10,932 acres. In 2013, PEI produced 22.9 million pounds of mussels with a farm gate value of $29.43 million. Prince Edward Island's aquaculture industry contributes significantly to the PEI tax base, contributing $24 million in gross value added to local economies annually. The industry is also a vital component of the Island economy providing approximately 2,500 direct and indirect jobs. Many of these jobs provide year-round employment in local rural communities.

British Columbia First Nations aquaculture

Canada's First Nations communities are uniquely positioned to benefit from aquaculture due to hunting, fishing and gathering rights, and access to aquaculture development sites. In many cases, the necessary skills and infrastructure for aquaculture development already exist because of past involvement in traditional fisheries. There are currently 50 Aboriginal groups across Canada that have developed aquaculture business ventures and partnerships, with many more expressing interest and a desire to get involved in new aquaculture sector opportunities. In British Columbia, 21 First Nations are engaged in shellfish aquaculture activities and 14 First Nations are engaged in finfish aquaculture. There are currently 56 different species of finfish, shellfish and aquatic plants commercially cultivated, generating about $1.81 billion in total economic activity, much of which takes place in rural and coastal communities. Immediate opportunities exist for further development of finfish, shellfish and freshwater aquaculture endeavors, with additional longer-term opportunities for species such as geoduck, scallop, sablefish, sea cucumber and rockfish, where culture technology is under development.

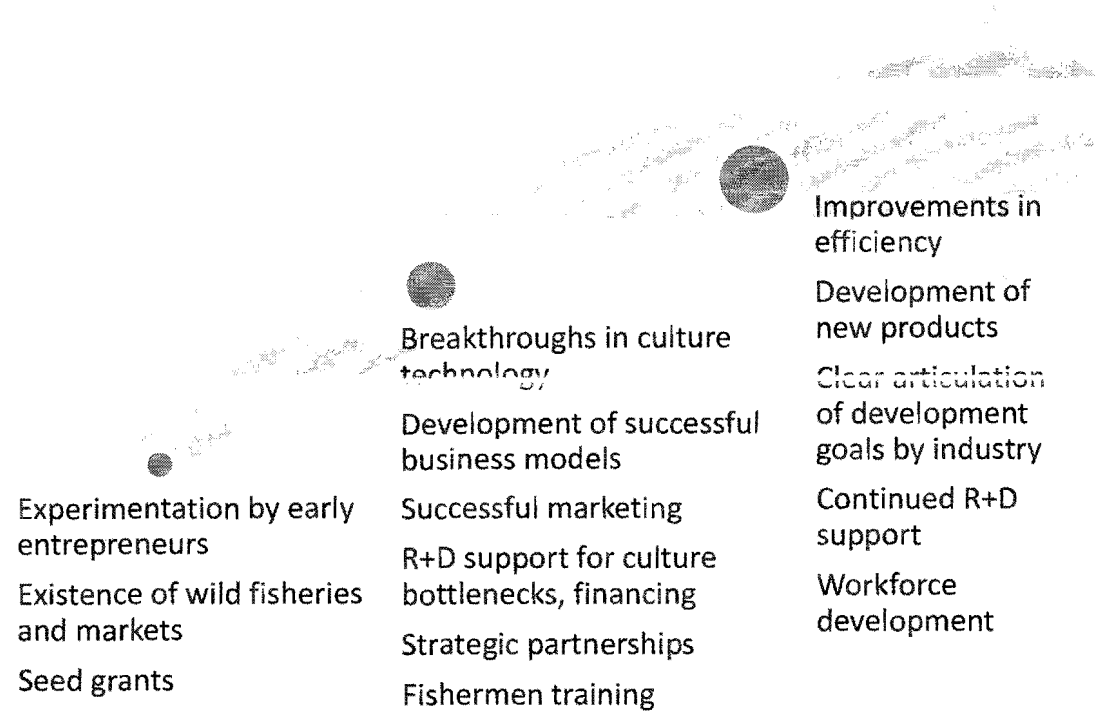
During the process of this investigation we have identified key elements for sustainable mariculture development—necessary factors in the success of mariculture development around the world. Figure ES-1 illustrates these elements and which case studies contain them. Figure ES-2 further illustrates the elements observed in the successful growth over time of the mariculture industries in the case studies reviewed.

Figure ES-1. Key Elements for Sustainable Mariculture Development



Source: Maine Shellfish Research and Development, 2015

Figure ES-2. Elements of Successful Mariculture Industry Growth



Source: Maine Shellfish Research and Development, 2015