Feasibility Research Report for Insuring Aquaculture Bivalve Species

Deliverable 2: Feasibility Report

Contract Number: D11PX18748

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Due Date: November 1, 2011
Compliance with Section 508 of the Rehabilitation Act of 1973 Verified: October 21, 2011

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SECTION I. EXECUTIVE SUMMARY

According to the 2010 United Nations Food and Agriculture Organization report on the State of World Fisheries and Aquaculture, the United States ranks 13th in total aquaculture production with approximately $1 billion in production annually. The 2007 Census of Agriculture reported farmed production of all mollusks was approximately $243 million. While these values include culture of gastropods (specifically abalone), the bulk of molluscan aquaculture in the United States consists of bivalves.

The bivalve aquaculture industry in the United States is extremely diverse. The industry comprises production of domesticated mollusks for human consumption and the production of "seed" for the farming of those bivalves. A wide variety of species are produced. The 2005 Census of Aquaculture and the 2007 Census of Agriculture reports document mollusk farming offshore from every coastal state with the exception of Alabama, Delaware, Mississippi, and Texas.[1] Some harvest of wild mollusks is believed to occur in every coastal state. Good management practices are diverse, varying by state, species, and differences in microenvironments. Furthermore, production is managed for a variety of markets, including niche markets.

Bivalves grown commercially include more than a dozen species primarily identified as clams, mussels, oysters, and scallops. Bivalve farming occurs primarily in tidal and sub-tidal coastal areas and primarily is regulated by state agencies. Consequently, 22 different state regulatory environments are in place, overlain by federal shellfish sanitation and environmental requirements.

Bivalve producers encounter production risks similar to those for field crops. Producers are also subject to substantial institutional risks from regulations related to husbandry, sanitation, and handling.[2] Especially in Florida and the Gulf of Mexico, loss of production to pollution is a major concern expressed by producers, most likely because of recent experiences with the Deepwater Horizon oil spill.[3] Of the concerns identified by bivalve aquaculture producers, only those related to weather problems, unmanageable predation, and uncontrollable disease are typically considered insurable production perils for a federal crop insurance product. While stakeholder input nationwide addressed concerns about the impact of weather and regulatory requirements, much of the feedback was regionally disparate. Collectively, more than three quarters of respondents expressed the need for risk management related to weather; while only a few producers discussed the potential for losses to disease and predation (the likely insurable perils). Instead, regulatory issues and pollution were the predominant themes after weather risks.

There are private risk management products available covering producer-identified weather risks and risk windows (perilous periods). There is also a private aquaculture mortality product

[1] USDA, NASS, 2006, Census of Aquaculture (2005), Table 1. http://www.agcensus.usda.gov/Publications/2002/Aquaculture/aquacen2005_01.pdf, accessed October, 2011; USDA, NASS, 2009, 2007 Census of Agriculture, State Data, Table 23. Mollusk aquaculture was reported in Alabama and Texas in the 1998 Census of Aquaculture.

[2] Many of the institutional risks either fall under the general category of "good farming practice" or occur after the bivalves are removed from the environment where grown. These institutional risks are uninsurable under the Act.

[3] The Contractor recognizes the Deepwater Horizon oil spill would be uninsurable under crop insurance. It is not clear producers presently recognize the distinction between natural events and man-made disasters.

available to cover specific causes of loss identified by the insured (as opposed to mortality caused by multiple perils in a comprehensive multiple peril policy). As currently structured, these private named-peril products have exceptionally high premiums. Considering the experience of the RMA pilots for bivalves, these private products appear to be overrated (or to have rates that include extraordinary loads above and beyond pure risk premiums).

Other than the RMA data for the existing pilots, the Contractor was not able to identify any publicly available data collected consistently over time to support rating or underwriting for aquaculture insurance. Producers in the Pacific Northwest and Virginia indicated a willingness (in Virginia, an eagerness) to share personal farm-level data to support a new development effort and major changes to the existing pilot for clams. However, the Contractor’s efforts to obtain any of these private data were not successful. In the absence of these data, it is difficult to project a scenario under which an individual yield-based insurance program could be developed.

While Adjusted Gross Revenue (AGR/AGR-Lite) products provide a potential risk management tool for bivalve producers, some growers expressed concerns that the requirements for this insurance are particularly burdensome for the industry. Inasmuch as producers are rarely growing more than two species today, limited diversification of production reduces the maximum percentage of the gross revenue that may be insured by limiting the maximum coverage level to 75 percent. Opportunities for diversification will only exist if the different bivalve aquaculture species (and not classes of species) are considered independently. Bivalve producers are unlikely to have sources of income based on land-based farming. The cost of the Cultivated Clam Pilot Insurance as currently structured appears to reflect the risk of production as demonstrated by the insurance experience. However, it should be noted that catastrophic weather events in 2011 affected both the oysters in Louisiana and clams on the East Coast.

The lack of available production data makes it infeasible to develop meaningful premium rates. Only in Virginia and the Pacific Northwest were there indications that farm-level data could and would be supplied for a development effort; although as noted earlier, the Contractor’s efforts to collect these data were not successful. Producers in other areas were either satisfied with the products available under the pilot programs, indifferent to the requirements for development of an RMA product, or too involved in their production activities to take time to communicate with the Contractor.

Production of bivalves has many unique aspects (e.g., indeterminate time period to harvest, inventory that is for all practical purposes invisible, and effects of microenvironments on productivity) in addition to the issues identified previously that would need to be addressed in any insurance development effort. However, under the requirements for feasibility outlined in the Statement of Work (SOW) for this study, with currently available data, development of crop insurance for bivalve production is not feasible.

SECTION II. INTRODUCTION

The Statement of Work (SOW) for Project Number D11PX18748 identifies the objectives of the project as "obtain[ing] analysis and information, determin[ing] the feasibility and identify[ing] issues related to potentially insuring Aquaculture Bivalve species, including but not limited to,

(i) American Oysters (also called Eastern Oyster - *Crassostrea virginica*);
(ii) Hard Clams (*Mercenaria mercenaria*);
(iii) Pacific Oysters (*Crassostrea gigas*);
(iv) Manila Clams (*Tapes philippinarium*); or
(v) Blue Mussels(*Mytilus edulis*),

...[As a result of this effort] a research report [will be produced] that assesses the likelihood of successfully developing an aquaculture insurance program, identify[ing] important issues about potentially insuring these aquaculture species and recommend[ing] the most viable type of insurance plan, if any, that is feasible."[4] This document is the research report required by that SOW.

The United States Shellfish Industry

The commercial shellfish industry in the United States supports sales of crustaceans, echinoderms, and mollusks. While the markets are limited, the industry is diverse, including fresh and processed products from domestic and international sources. Many shellfish are sold live. Production is harvested from wild and farmed populations.

The crustaceans are a sub-phylum[5] of the Phylum Arthropoda. Crustaceans in the U.S. food marketplace include crabs, crayfish (crawfish or crawdads), langoustines, lobsters, and shrimp. Substantial efforts, both in the United States and internationally, have addressed the farming of crustacean species. Generally, crustacean aquaculture is complicated by the extended larval stages of many species as well as multiple molts that characterize species used for human food. In the United States, efforts to grow shrimp and crayfish have been quite successful. More than anything else, this reflects a relatively short growing cycle. Depending on the species and location, these cycles range from two to six months. In contrast, lobsters and crabs have growing cycles measured in years (or even decades). The Contractor found no evidence of commercial crab aquaculture in the United States. In Asia, where shellfish aquaculture is more common, crab aquaculture operations have focused on the production of soft-shelled crabs, a value-added developmental stage in the crab life cycle. These operations depend on the harvest of hard shell crabs from natural populations and maintenance of these crabs until molting occurs. Lobster life cycles are even longer than those of crabs. Raising lobsters to market size requires extraordinary human and physical resources. Commercial production for food is impractical. However, historically, U.S. lobster hatcheries have been maintained to produce juveniles to replenish natural (i.e., wild) stocks depleted by commercial harvests.

Echinoderms are a phylum that includes sea urchins, sea cucumbers, and starfish. Animals in this phylum constitute a very specialized and extremely limited segment of the U.S. shellfish industry. Most U.S. sales of echinoderms are of wild or imported specimens. Farming of

[4] USDA, RMA, 2011, SOW, Project Number: D11PX18748, page 17.
[5] A sub-phylum is a taxonomic rank between a phylum and class representing a group of organisms with morphological and/or developmental similarities.

echinoderm species is concentrated in Asia[6] and Australasia.[7] The Contractor found no evidence of commercial echinoderm aquaculture in the United States. As neither echinoderms nor crustaceans are bivalves, these shellfish types are not further discussed in this report.

Mollusks comprise a diverse phylum of invertebrates, with more than 70,000 recognized species.[8] The most common identifying features of the molluscan body are a complex nervous system, including elaborate sensory organs, a primitive brain, and a mantle,[9] which secretes the shells that characterize many species in the phylum.

The phylum of mollusks is typically divided into eight to ten taxonomic classes, three of which include species commonly used for human foods. The molluscan classes used for food are the gastropods (snails, abalone, and sea slugs), cephalopods (octopus and squid) and bivalves (clams, oysters, mussels, and scallops). As cephalopods and gastropods are not bivalves, these types are not further discussed in this report.

Bivalves have been variously cataloged in taxa named Acephala (without a head), Bivalva, Bivalvia, Lamellibranchia (with thin plate gills), and Pelecypoda (hatchet footed). Regardless of the name used to classify the bivalves, the class is cohesive and relatively easy to identify in nature. The mantle of bivalves produces a shell divided into two elements (valves) connected by a hinge. Among the mollusks, only the bivalves have a shell composed of two hinged elements. Consequently, this distinctive shell morphology allows easy identification of the subjects of this report.

There are more than 9,000 living bivalve species (in more than 1,000 genera and more than 100 families).[10] Most bivalves are potentially edible; few are toxic (although toxic algae may be incorporated into their bodies under unfavorable conditions) and most have high protein content. However, many bivalves are too small to serve as a convenient source of human food. Other species, because of texture or flavor, are not considered palatable. Farmed bivalves are generally species that were first collected in the wild for food value. As wild stocks have been depleted, aquaculture techniques have been used to replenish these stocks. As a consequence, planting of aquaculture "seed" has been introduced into environments where natural seed may also be present. To protect the planted crop, aquaculturists have developed a variety of exclosures (to keep out predators and competitors), enclosures (to maintain the identity and ownership of the crop), and anchoring mechanisms (to contain the crop and allow identification of individuals by age and ownership).

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[6] James, B.D., 2003, Captive breeding of the sea cucumber, Holothuria scabra, from India, http://www.fao.org/docrep/007/y5501e/y5501e17.htm, accessed June, 2011; Xilin, S., 2003, The progress and prospects of studies on artificial propagation and culture of the sea cucumber, *Apostichopus japonicus*, http://www.fao.org/docrep/007/y5501e/y5501e0x.htm, accessed June 2011.

[7] Giraspy, B., 2007, Sea cucumber culture - New profitable aquaculture, http://www.topix.com/forum/business/aquaculture/TIVA49DK9374BJO0Q, accessed June, 2011.

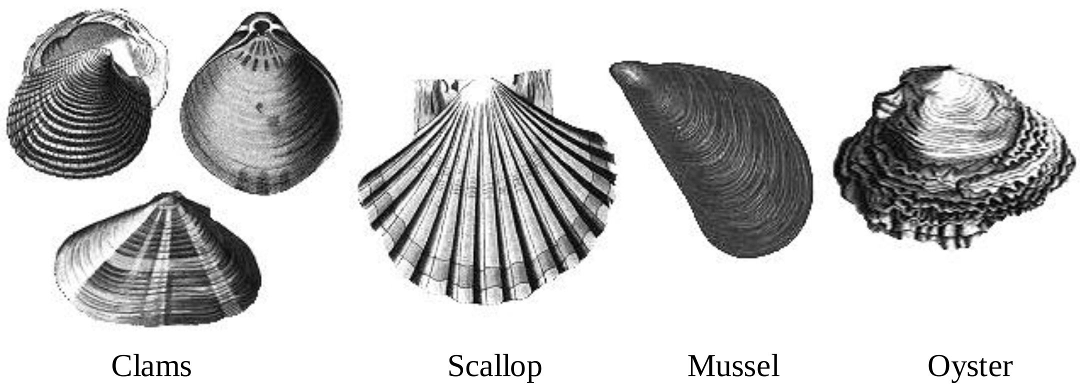
[8] Nicol, D., 1969, The Number of Living Species of Molluscs, Systematic Zoology, Vol. 18, No. 2, pp. 251-254.

[9] The mantle is the dorsal body wall covering the visceral mass. In many, molluscan species the epidermis of the mantle secretes calcium compounds and proteins to create a shell.

[10] Huber, M., 2010, Compendium of Bivalves: A Full-color Guide to 3,300 of the World's Marine Bivalves, ConchBooks, Hackenheim, Germany.

Bivalves used for food are generally categorized as clams, mussels, oysters, or scallops. The specific categorization reflects geographic location (a species called a soft shell clam in one region might be called a cockle in another), shell form (scallops and cockles have bilaterally symmetrical shells, while the shells of mussels are generally thinner and darker than those of clams, cockles, and oysters, see Figure 1), and organization of the visceral[11] mass (the scallop's bodies are more compressed than the bodies of most other farmed bivalves) (Figure 2).

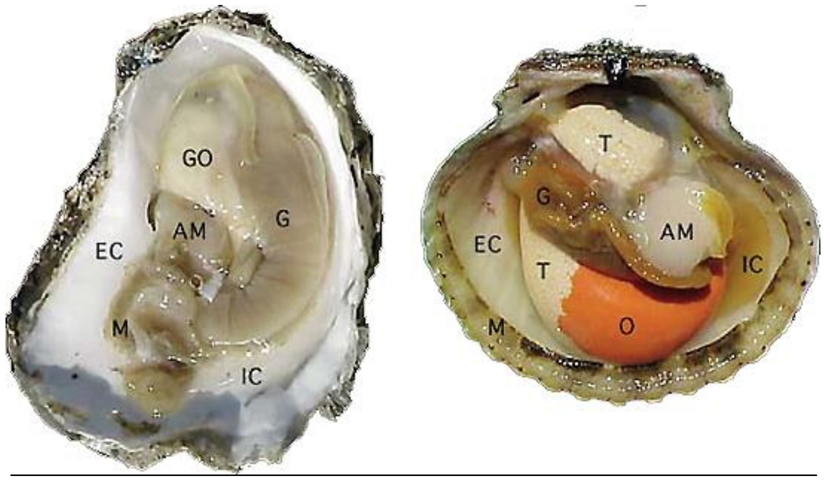
Figure 1. Shells of Bivalves Commonly Used for Food



Source: W&A Research Department after historic illustrations without copyright restrictions.

[11] The soft structures of the body.

Figure 2. Internal Anatomy of Two Bivalves



European Flat Oyster	Calico Scallop
AM - Adductor Muscle	AM - Adductor Muscle
EC - Excurrent Canal	EC - Excurrent Canal
G - Gill	G- Gill
GO - Gonad	IC - Incurrent Canal
IC- Incurrent Canal	M - Mantle
M - Mantle	O - Ovary
	T - Testes

Source: Watts and Associates Research Department after United Nations, Food and Agriculture Organization, 2004, The Hatchery Culture of Bivalves: a Practical Manual, http://www.fao.org/ docrep/007 /y5720e/y5720e07.htm, accessed June, 2011.

Shell mounds demonstrate that bivalves have been a substantial component in the diets of humans since prehistoric times.[12] While these mounds reflect historical harvests of wild populations, more recent harvests by humans have been dominated by aquacultural production (Table 1), primarily on Asian farms.[13]

[12] Gentry, S.D., 1987, Utilization of Marine Mollusks by Inhabitants of the Texas Coast. Bulletin of the Texas Archeological Society 58: 215-248; Maine, Department of Conservation, 2004, http://www.maine.gov/doc/parks/programs/history/whaleback/index.htm, accessed may, 2011.

[13] United Nations, Food and Agriculture Organization, https://www.was.org/meetings/AbstractData.asp?AbstractId=10786, accessed April, 2011.

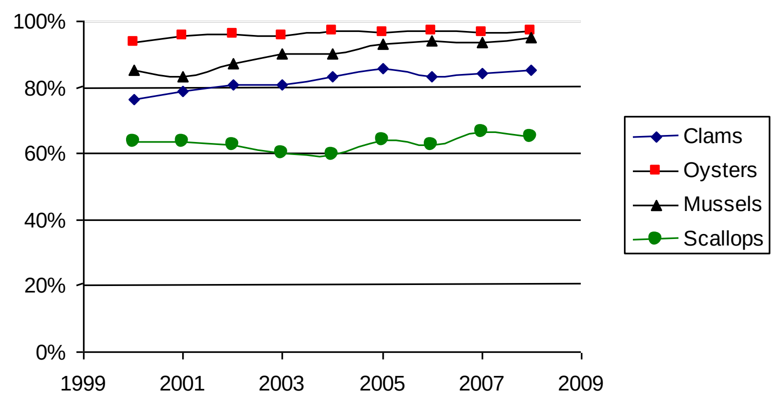
Table 1. Total and Aquaculture Bivalve Production (Metric Tons): 1950 and 2008

	1950		2008	
Category	Total Production	Aquaculture Production	Total Production	Aquaculture Production
Clams, Cockles	247,929	10,354	5,172,298	4,397,183
Mussels	166,975	70,878	1,711,351	1,624,727
Oysters	492,538	199,458	4,291,452	4,164,010
Scallops, Pectens	99,977	N.A.	2,174,345	1,410,830
TOTAL	1,007,419	280,690	13,349,446	11,596,750

Source: W&A Research Department after data from Lovatelli, A. 2006, Bivalve Framing: An overview of world production. United Nations, Food and Agriculture Organization, https://www.was.org/meetings/AbstractData.asp?AbstractId=10786 and National Marine Fisheries Service, National Oceanographic and Atmospheric Administration, United States Department of Commerce, , http://www.st.nmfs.noaa.gov/st1/fus/fus09/04_world2009.pdf, accessed April, 2011.

From 1950 to 2003, world wide bivalve aquaculture production increased almost 40 fold (Table 1). Currently, approximately 95 percent of mussels and oysters, 85 percent of clams, and 65 percent of scallops harvested world-wide are farmed (Figure 3).

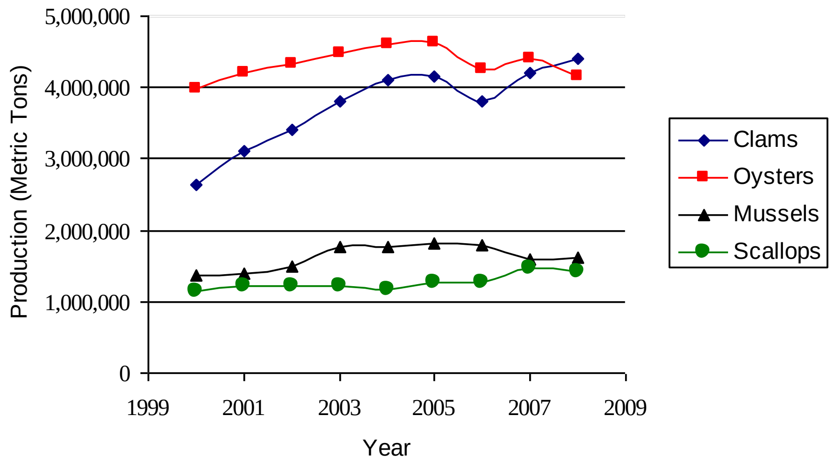
Figure 3. World Bivalve Aquaculture Production as a Proportion of Total World Bivalve Production: 2000 through 2008



Source: W&A Research Department after data from National Marine Fisheries Service, National Oceanographic and Atmospheric Administration, United States Department of Commerce, http://www.st.nmfs.noaa.gov/st1/fus/fus09/04_world2009.pdf and prior years, accessed April, 2011.

The proportions of bivalves derived from farming have trended up slightly over the last ten years. The proportion produced by aquaculture (Figure 3) has not been significantly affected by substantial differences in aquaculture harvests from year to year (Figure 4). Most likely this reflects the relationship between bivalve aquaculture productivity and the productivity of wild stocks.

Figure 4. World Bivalve Aquaculture Production (Metric Tons): 2000 through 2008



Source: W&A Research Department after data from National Marine Fisheries Service, National Oceanographic and Atmospheric Administration, United States Department of Commerce, , http://www.st.nmfs.noaa.gov/st1/fus/fus09/04_world2009.pdf and prior years, accessed April, 2011.

U.S. aquaculture production involves more than a dozen species, including the species identified in the SOW, as well as:

Bay scallops (*Argopecten irradians*),
European flat oyster (*Ostrea edulis*),
Calico scallop (*Argopecten gibbus)*
Geoduck clams (*Panopea abrupta or alternatively P. generosa*),
Giant Clam (*Tridacna gigas*),
Kumamoto oysters (*Crassostrea sikamea*),
Mediterranean Mussels (*Mytilus galloprovencialis*),
Olympia Oysters (*Ostrea lurida*), and
Sea Scallops (*Pecten maximus* and *Placopecten magellanicus*).

The majority of bivalves harvested in U.S. waters are farmed. The sea scallop sector is the one commercial bivalve sector that is an exception to this pattern. While more than half the sea scallops harvested world wide are farmed, U.S. harvests are still primarily wild sea scallops.

A substantial deterrent to scallop farming relative to the farming of other bivalves is the substantial motility of the scallop. Scallops can swim by rapid, and occasionally repeated, closure of the shell. This closure forces water from within the shell, "jetting" the animal as a reaction to the action of the expelled water. A single closure of a sea scallop shell can convey the animal as much as ten meters.[14] Consequently, while most bivalve aquaculture enclosures are used to facilitate harvest and exclude predators, scallop "corrals" are used to assure the crop remains within the producer's "rangeland." In addition, the growth of scallops is substantially impacted by movement of the animal. Enclosures racked by wave action are less productive than those that are more stationary.

[14] Serb, J. 2006, Pecten Resources: Characters: Swimming, http://www.eeob.iastate.edu/faculty/SerbJ/pecten-site/characters.html, accessed June, 2011.

Most U.S. scallop farming focuses on bay and/or calico scallops, which have a shorter production cycle and a smaller range of motion (i.e., they cannot or do not swim as far), and consequently are easier to farm. Nonetheless, sea scallop farming is on the rise in Alaska, Florida, and New England.[15] These efforts to raise this more challenging crop likely reflect the relatively high per-pound price of scallops compared to many other farmed bivalves.

U.S. aquacultural production of all mollusks[16] generates approximately $250 million of farm-level income.[17] To put this value in perspective, the value of U.S. production of fresh market cucumbers is comparable to the value of all molluscan aquaculture production combined. Individual bivalve species generate incomes similar to those of specialty crops such as artichokes, Brussels sprouts, and honeydew melons.

Production Locations

A relatively small number of states dominate bivalve production in the United States (Table 2). The top six bivalve production states accounted for more than 80 percent of annual production in 2005, the most recent date when United States Department of Agriculture (USDA) National Agricultural Statistics Service (NASS) data are available. While the major production states are located near major markets for bivalves, the presence of the market may depend on the availability of the bivalves as much as the location of the production depends on the presence of the markets.

[15] Shumway, S.E. and Parsons, G.J., 2006, Scallops: Biology, Ecology and Aquaculture, Elsevier B.V., Amsterdam.

[16] The USDA Census of Agriculture does not differentiate between different molluscan groups. The 2010 Census of Aquaculture, which allowed the different molluscan groups to be differentiated was "cancelled" prior to the distribution of surveys, http://www.agcensus.usda.gov/Publications/2007/Getting_Started/Guide_to_Census_Products/index.asp, accessed April, 2010.

[17] USDA, NASS, 2008, 2007 Census of Agriculture, Table 23, http://www.agcensus.usda.gov/Publications/2007/Full_Report/Volume_1,_Chapter_2_US_State_Level/usv1.txt, accessed April, 2011.

Table 2. 2005 Bivalve Aquaculture Farms and Production by State

State	Farms	Production Value ($1000)
Alaska	25	(D)
California	21	20,064
Connecticut	27	(D)
Florida	154	10,694
Louisiana	135	28,499
Maine	32	2,861
Massachusetts	138	6,157
New Jersey	67	2,820
New York	13	(D)
North Carolina	56	761
Oregon	21	11,584
Rhode Island	11	(D)
South Carolina	35	2,505
Virginia	53	29,028
Washington	174	63,710
All Other States	18	<6,850
TOTAL	980	203,183

(D) Data withheld to protect confidentiality
Source: USDA, NASS, 2006, Census of Aquaculture (2005), http://www.agcensus.usda.gov/Publications/2002/Aquaculture/AQUACEN.pdf, Accessed April, 2011

The geographic distribution of production, the perishable nature of the crop, and the dependence in most states on leased "land"[18] for farming operations help maintain the relatively modest scale of most bivalve production, processing, and distribution operations.

Data

Data for most segments of the bivalve aquaculture industry and for the industry collectively are extremely limited, sporadic, and in many cases anecdotal. Comparison of data between reports is hampered due to different data collection methods and analytical procedures. For example, some reports of bivalve production are by number grown (inventory), others report numbers harvested, and still others report harvested weight. Harvest weights may or may not include the shell. In production data for scallops, there is a further challenge because only part of the scallop is commonly eaten. While the whole scallop is edible, the adductor muscle[19] (see Figure 2) is the element most commonly eaten. There is also a limited market for adductor muscles with gonads attached. For scallops, harvest data may report the in-shell weight, the weight of the entire fleshy body, or just the weight of the adductor muscle. Similarly, in certain markets only the foot[20] of certain large clams is eaten. For these large clams, the remainder of the visceral mass is waste or a byproduct. Consequently, the "meat weight" for some clams comprises the whole body, while for others it is limited to the weight of the "harvested" foot. These differences

[18] Whether it is seabed or the water column above the leased area.
[19] The adductor muscle, the muscle used to close the shell, is the portion of a scallop eaten in the United States.
[20] In many mollusks the fleshy portion of the body can be divided into a muscular projection called the foot and a softer, more variable visceral mass. The orientation of the muscles in the foot allows the foot to extend or contract.

further complicate analysis of the "total" bivalve production data, particularly when multiple independent sources of data are subject to aggregation.

Commercial fisheries data, including some data for bivalves, are collected by National Marine Fisheries Services (NMFS) regional staff. Weight, quantity, and value data are computed monthly and annually by state, sub-region, and nationwide. However, NMFS commercial landings data for bivalves treats the group generically rather than as individual species and then generally compiles data for both finfish and shellfish, including non-bivalve species, into a comprehensive production measure. Inasmuch as the bivalve valuations represent approximately one percent for the total fisheries harvest values, these comprehensive data are not useful for insurance development. Furthermore, "farm-level" data are not available from these series. Only one series the Contractor has examined provided any farm-level data. That series is the data series collected by RMA for the Cultivated Clam Pilot Insurance Program. Due to the paucity of farm-level data, econometric methods are not suitable to "bridge" between aggregate and farm-level production patterns.

Furthermore, in June of 2011, Cynthia Clark, Administrator of NASS, announced to the Council of Professional Associations on Federal Statistics that the 2010 Census of Aquaculture was suspended due to funding issues.[21] As a result, the most comprehensive snapshot of the U.S. bivalve aquaculture production is in the 2005 Census of Aquaculture, which is already dated.

For the purpose of insurance development, a focus on production value rather than production weight or numbers might be less ambiguous. However, for many producers in the bivalve sectors, revenue involves a substantial added-value component, including potential receipts from processing, wholesale marketing, distribution, and retail sales. As the bivalve aquaculture sector has grown, some larger producers have provided processing and marketing services (at both the wholesale and retail levels) for smaller producers. This change in focus from production to processing complicates the analysis of revenues for vertically integrated producers, yet there are no exceptionally large processors who might supply extensive private data series to support the development for RMA insurance products. Instead, a development effort would require compilation of data from a broad sample of producers of all sizes (though the largest are not exceptionally large by agricultural standards).

Finally, species differences among bivalves as diverse as *Tridacna gigas* and *Argopecten irradian* make it almost impossible to consider bivalves as a single crop. *Tridacna gigas* is a tropical clam that can weigh as much as 500 pounds. When grown using aquaculture techniques, it is generally harvested when it reaches a weight of one to ten pounds. *Argopecten irradians* are bay scallops that grow in cooler marine waters and reach a harvestable size at a weight of about an ounce. Furthermore, substantial varietal differences within a species, especially among oysters and hard clams, make it difficult to extrapolate aquaculture data and information from one geographic region to another since different varieties are grown in different regions.

[21] USDA, NASS, 2011, National Agricultural Statistics Service, http://www.copafs.org/UserFiles/file/NASSPresentation.pdf, accessed July, 2011.

Industry Sectors

Clams and oysters are the preponderant bivalve aquaculture crops (Table 3), representing more than 90 percent of the total U.S. bivalve aquaculture production value in 2005. In 2005, Washington and Virginia generated almost 60 percent of the U.S. clam aquaculture value. Clam production in Virginia was almost exclusively of hard clams; Connecticut and Florida also produced substantial hard clam crops. Clam production in Washington focused on Manila clams, an introduced species, with only limited production of native hard clam species.

Table 3. U.S. Bivalve Aquaculture Production Value: 2005

Group	Production Value ($1,000)
Clams	84,874
Mussels	<6,108
Oysters	102,896
Other Bivalves	>9,305
TOTAL	203,183

Source: W&A Research Department after USDA, NASS, 2006, Census of Aquaculture (2005), http://www.agcensus.usda.gov/Publications/2002/Aquaculture/AQUACEN.pdf, accessed April, 2011

In 2005, Louisiana and Washington generated more than 55 percent of the U.S. oyster aquaculture production value. Oyster production in Louisiana was almost exclusively of eastern oysters; oyster production in Washington focused (just less than 90 percent) on Pacific oysters. California also produces substantial Pacific oyster crops.[22] Stakeholders reported a marked increase in oyster production in Virginia.

In 2005, just over 7.5 percent of U.S. bivalve aquaculture production was of mussels and "other bivalves" (scallops, giant clams, cockles, etc.). Data on these minor types are sparser than are the data for clams and oysters.

It is important to note, the self-identification of production in historic USDA surveys may have masked some production and producer populations. While aquaculture production is considered an agricultural practice by USDA, not all producers consider their activities to be agricultural. Some consider themselves "fisherman," even if they are planting seed to improve their "catch." In general, producers own the bivalves they are raising. To maintain sustainable harvests, many bivalve fishermen have been "seeding" their fishing grounds for decades. What has changed in the last 25 years is an emphasis on leased or owned "cropland" and, to a more limited extent, better mechanisms for distinguishing the farmed crop from wild animals.[23]

The leases of bivalve cropland are generally made with state agencies (e.g., Department of Conservation and Natural Resources (Pennsylvania and New York), Department of Natural Resources (Alaska, Washington, and South Carolina), Fish and Wildlife Conservation Commission (Florida), Marine Resources Commission (Virginia) and similar agencies). The leases generally have a cash basis; consequently, for crop insurance purposes, the lessee can be

[22] USDA, NASS, 2006, Census of Aquaculture (2005), http://www.agcensus.usda.gov/Publications/2002/Aquaculture/AQUACEN.pdf, Accessed April, 2011
[23] These would include enclosure/exclosures and focus on particular species and varieties.

considered to have a 100 percent share of the crop. In this arrangement, the leaser does not retain any of the risk related to crop production.

II.A. Bivalve Trade and Exports

In 2009, about 84 percent of all seafood consumed in the U.S. was imported. Almost half the imported seafood is farmed. Although the U.S. aquaculture industry is "vibrant and diverse," it currently meets less than ten percent of U.S. demand for all seafood. Aquaculture products like clams, mussels, and oysters supply less than two percent of American seafood demand.[24] The United States consistently runs a trade deficit for seafood.

II.B. Programs Supporting Bivalve Aquaculture

Producers can avail themselves of a variety of support programs from the federal, state, and private sectors. Some of these programs specifically address risk. Others assist in risk management by providing information that allows the producer to make informed decisions. Programs available to bivalve aquaculture operations generally are described herein. Purchased risk management programs supporting individual operations are also addressed in this section of the report.

Federal Programs

Federal programs are offered primarily by agencies and services of the USDA, National Oceanographic and Atmospheric Administration (NOAA), and the Environmental Protection Agency (EPA). Agencies within the USDA serving the bivalve industry and services provided are listed first followed by those of the EPA and NOAA. Bivalve producers are not eligible for marketing loans, price supports, or direct payments based on current or historical production. The programs that support the industry are therefore outside the traditional "farm program" umbrella.

Agricultural Marketing Service (AMS)

Bivalve producers benefit from general services of AMS including the following programs:

- Promotion and Research,
- Marketing and Economic Research,
- Organic Standards, and
- Country of Origin Labeling.

Animal and Plant Health Inspection Service (APHIS)

The Animal and Plant Health Inspection Service (APHIS) is responsible for protecting and promoting U.S. agricultural health, administering the Animal Welfare Act, and carrying out wildlife damage management activities. APHIS has been tasked with responsibility for enforcing the obligations of the United States under phytosanitary rules such as the *Codex Alimentarius,* responding to animal and plant health import requirements of other countries, and assisting in negotiating science-based trade restrictions.

[24] National Oceanographic and Atmospheric Administration, Fisheries Service, 2010, FishNews September 10, 2010, http://www.nmfs.noaa.gov/fishnews/2010/09102010.htm, accessed March, 2011.

APHIS programs important to the bivalve industry include:

- Import and Export Services
    - Animal and Animal Product Import and Export Information
    - International Trade
    - Sanitary and Phytosanitary Management (Trade Facilitation)
- Veterinary Services
    - Laboratory Information and Services
    - Monitoring and Surveillance
    - Professional Development Training
- Wildlife Service

National Institute of Food and Agriculture (NIFA, formerly Cooperative State Research, Education, and Extension Service (CSREES))

The NIFA is the federal administrative authority that offers programs in research, extension, and education to provide important educational and consultancy resources for producers in all areas, including bivalve aquaculture producers. The extension services also provide programs for consumers that support consumption of bivalves, including bivalves grown in the United States using aquaculture techniques.

Economic Research Service (ERS)

ERS provides data and analysis on bivalve product supply and demand, as well as information on industry structure, pricing, trade, production policies, production systems, and processing. ERS reports of particular interest include:

- Aquaculture Data: Volume and Value of U.S. Imports of Selected Fish and Shellfish Products
- Animal Production and Marketing Issues Briefing Room
- Trade Codes
- International Trade and Food Safety

Farm Service Agency (FSA)

The Farm Service Agency (FSA) provides financial assistance to producers facing losses from natural disaster (i.e., drought, flood, fire, freeze, tornadoes, pest infestation, and other "calamities"). FSA's Noninsured Crop Disaster Assistance Program (NAP) provides payments to producers of non-insurable crops when low yields, loss of inventory, or prevented planting occur due to a natural disaster. Eligible producers include landowners, tenants, or sharecroppers who share in the risk of producing an eligible crop. The average non-farm adjusted gross income of the producer cannot exceed $500,000. A payment limitation of $100,000 per individual or entity per crop year applies. The natural disaster causing the loss must occur before or during harvest and must directly affect the eligible crop. Bivalves are an insurable crop in some counties with CAT coverage available; NAP assistance payments are not available for those bivalves in the counties where they are insurable. Furthermore, "in previous communication between RMA's Spokane Regional Office (RO) and the Washington State FSA office, the RO was told that the national FSA office determined that shellfish did not meet the definition of a "controlled environment" and therefore did not qualify for coverage under the NAP program."[25]

[25] USDA, RMA, October, 2011, personal communication from the Contracting Officer's Technical Representative.

However, the Contractor received producer testimony of NAP assistance payments for bivalve aquaculture losses in the Mid-Atlantic states and FSA offices in Florida and Massachusetts indicated producers of clams and oysters were eligible for NAP assistance in specified counties. The specific rules for inclusion of aquaculture production under the FSA programs are contained in 7 CFR 1437.303.[26] These appear to exclude native species cultured on the sea floor from NAP assistance programs. Apparent inconsistencies in the application of NAP eligibility rules in different locations may undermine the usefulness of the program as a dependable risk mitigation strategy for producers.

Aquaculture block grants were used in 2006 to support producers adversely affected by hurricanes.

FSA's Supplemental Revenue Assistance Payments (SURE) Program provides benefits to producers for 2008 through 2011 crop year farm revenue losses due to natural disasters. It is the successor to earlier *ad hoc* crop disaster programs. For 2009 and subsequent crop years, producers or legal entities whose average non-farm income exceeds $500,000 are not eligible. A "farm" is eligible for a SURE payment when a portion of the farm is located in a county covered by a qualifying natural disaster declaration (USDA Secretarial Declarations only) or a contiguous county, or the actual production is less than 50 percent of the normal production. For producers to be eligible for SURE payments, they must have obtained available purchased risk management instruments for **all** crops through either the Federal Crop Insurance Act (Act) or NAP. The farm's SURE guarantee cannot exceed 90 percent of the expected revenue for the farm (i.e., there is a ten percent deductible). Producers must suffer a ten percent production loss to at least one crop of economic significance on their farm in order to be eligible for a SURE payment. A qualifying loss must be caused by a natural disaster. A crop of economic significance contributes at least five percent of the expected revenue for a producer's farm. A limit of $100,000 applies to the combination of payments from SURE and the livestock disaster programs.

FSA's Emergency Assistance for Livestock, Honey Bees, & Farm-raised Fish (ELAP) program provides emergency relief to producers of farm-raised "fish" grown in controlled environments. It covers losses from disaster such as adverse weather or other conditions, such as blizzards and wildfires not adequately covered by any other disaster program. Most aquaculture does technically occur in "controlled environments;" producers of bivalve nursery stock may also be eligible because of the controlled production environment for their operations. The Secretary of Agriculture must have declared a disaster in a county for ELAP payments to be made to that county or adjacent counties.

Food Safety and Inspection Service (FSIS)

FSIS employees identify, assess, and define emerging and standing issues affecting procedures, policies, activities, or resources for consideration by the committee. They are responsible for identifying food safety concerns associated with production, transportation, and marketing. These FSIS personnel are also responsible for outreach and liaison activities to develop and sustain risk reduction strategies in agricultural production.

[26] CFR, Title 7, Subtitle B, Chapter XIV, Subchapter B, Part 1437, Subpart D, Section 1437.303.

Foreign Agricultural Service (FAS)
FAS maintains links to relatively limited number of resources for aquaculture producers. These links focus on sites that identify production practices and data, including the UN FAO import and export data.

National Agricultural Statistics Service (NASS)
NASS is the primary data collection and publication service of the USDA. Its data series are widely used by producers, businesses, and researchers. Bivalve aquaculture data were collected as a supplement to the Census of Agriculture in 1998 and again in 2005. The 2010 Census of Aquaculture was suspended due to funding constraints.

Risk Management Agency
The Adjusted Gross Revenue (AGR) and Adjusted Gross Revenue-Lite (AGR-Lite) policies are available to some bivalve producers. These insurance plans provide whole farm revenue insurance coverage, based on a producer's Schedule F of the IRS Form 1040 tax return.

These are whole-farm revenue plans of insurance which protect producers from revenue losses resulting from unavoidable natural disasters and from market fluctuations. Most farm-raised crops, including aquaculture production, are eligible to be insured under these plans. AGR-Lite can be used alone or in conjunction with other federal crop insurance plans, but not in conjunction with AGR insurance. The applicability and utility of AGR and AGR-Lite to bivalve aquaculture are discussed in a separate section of this report. RMA currently offers an individual insurance program for Cultivated Clams and a Group Risk Plan for Oysters. These plans are discussed more extensively later in this report.

Rural Development (RD, formerly Rural Business–Cooperative Service (RBS))
RD is a small agency with limited funding and staff whose purpose is to finance and facilitate development of small and emerging private business enterprises, and promote sustainable economic development in rural communities.[27] This agency could potentially serve aquaculture producers. However, the Contractor was able to identify only limited RBS programs supporting bivalve aquaculture.[28]

<u>Environmental Protection Agency</u>
The Environmental Protection agency has effluent limitations guidelines concentrating on aquatic animal production (aquaculture) facilities. The regulations apply to facilities that generate wastewater from their operations and discharge that wastewater directly into waters of the United States. The guidelines include a focus on total suspended solids. These standards apply to existing and new aquaculture facilities that:

1) Use flow-through, recirculating, or net pen systems;
2) Directly discharge wastewater; and

[27] USDA, RD, 2011, Business, http://www.rurdev.usda.gov/Business.html, accessed May, 2011.
[28] USDA, RD, 2003, Value-added Agricultural Product Market Development Grants, http://www.rurdev.usda.gov/ny/toolbarpages/rbspages/valueadded.htm, accessed July, 2011; USDA, RD, 2005, No Shell Game: Oyster co-op hopes to revive Mystic's faded shellfish industry, http://www.rurdev.usda.gov/rbs/pub/jul05/shell.htm, accessed July, 2011; USDA, RD, 2005, News Release: USDA Grant Supports Maryland Agriculture and Natural Resource Industry, http://www.rurdev.usda.gov/md/MD%20AG%20&%20Nat%20Resource%20-Sep%2005%20-%20PR.htm, accessed July, 2011

3) Produce at least 100,000 pounds of "fish" a year.

National Oceanic & Atmospheric Administration (NOAA)

NOAA's administers the National Sea Grant College Program. The National Sea Grant College Program works with 32 state Sea Grant programs. These state-level programs provide support for scientists, engineers, educators, and outreach experts at more than 300 universities. The Sea Grant program addresses a variety of topics important to bivalve aquaculture and complements the similar efforts of extension programs supported by the USDA.

The Fisheries Statistics Division of the National NOAA Marine Fisheries Service (NMFS) provides data summaries for U.S. commercial fisheries landings. These landings can be sorted by species and include landings of wild and farmed clams, mussels, and oysters. Data are not available for farmed scallops. Landings differ from production, in some ways being more similar to farm-gate sales. Valuation of bivalves is on a meat weight basis. Price data can be extrapolated from these data.

State Government Programs

State programs and regulations affect bivalve production. State statutes or codes generally define an administrative office and/or an administrator responsible for licensing and enforcing minimum husbandry, sanitary, and environmental standards for shellfish operations. Some states have regulations that replace or complement federal sanitary or environmental standards. The various regulations are similar to federal standards, often referencing them as minima. The purpose of these regulations is to reduce risks of diseases and contamination of shellfish products.[29]

States oversee and regulate processing and distribution activities. While regulation not associated with "crop" production is outside the scope of this feasibility assessment, it contributes to institutional risks that may impact producer well-being.

Private Insurance Inventory

Private insurance companies offer coverage to commercial bivalve aquaculture operations; available coverage is described below. These products do not mirror the structure of any existing FCIC insurance, including the existing pilots for bivalves. Instead they focus on limited, producer-identified, named perils. Some of these perils (e.g., hurricane, storm surge, etc.) are also insured causes of loss under the existing RMA bivalve aquaculture pilots. Others (pollution, industrial accidents, etc.) are not insured causes of loss under the existing RMA bivalve aquaculture pilots and are not insurable under the Act.

Mortality (Inventory) Insurance Coverage

Private "mortality" insurance for bivalve aquaculture crops is available from Lloyds.[30] Agents selling this product in the United States indicated the insurance can be structured to cover any

[29] See for example The State of Rhode Island and Providence Plantation, Department of Public Health, 2002, Rules and Regulations Pertaining to the Processing and Distribution of Shellfish, R21-14-SB and State of Alaska, Department of Environmental Conservation, 2007, 18AAc34, Seafood Processing and Inspection.

[30] Global Aquaculture Insurance Consortium, 2009, Products, http://www.globalaquains.com/Products.aspx, accessed April, 2011.

one cause of mortality (e.g., reduction of salinity) or any combination of causes of loss the producer chooses to name. While this insurance is available worldwide and allows the producer to specify the insured causes of loss, the Contractor was not able to identify any participation in the United States. The policy has relatively high premiums and does not cover losses from all causes of loss. However, mortality coverage from Lloyds has generated interest in Asia and South America.

Weather Insurance Coverage
Private weather insurance is available from a number of traditional and online insurance companies. These products are often reinsured by major reinsurance companies (e.g., Munich Re, Swiss Re, Renaissance Re, etc.). The policies are generally "one off" contracts, customized to reflect specific named perils identified by the insured. This insurance can be structured to cover any one weather event (e.g., extreme cold or excessive rainfall) or combinations of weather the producer chooses from available options. These policies have relatively high premiums, are not subject to premium subsidies, and cover losses only from the specific named perils.

Loss of Income Coverage
Loss of income coverage is available to businesses from the private insurance industry. Loss of income insurance covers losses resulting from damage to structures and equipment. Due to the small role of buildings in bivalve aquaculture and the ability to manage risk to equipment through back-up systems, interest in this insurance is limited. Only one stakeholder, a new producer, expressed any interest in this kind of risk management. Loss of income coverage may not be available for older facilities.

Basic Business Liability
Basic liability insurance is available.

Employers Contingent Liability
Employers Contingent Liability is available with the ability to add employees as insureds.

Private Data Services
General information about weekly seafood price (i.e., a U.S. wholesale market summary) is available from Urner Barry's Seafood Price-Current. Testimony about these data indicated they are aggregate data incorporating both farm-gate and processor prices and prices for farmed and wild mollusks. Along with the NOAA landings data, these appear to be the only consistently-collected data for bivalve pricing available.

II.C. Congressional Mandate

Most federally subsidized insurance for agricultural producers focuses on crop plant production or on offering price or margin coverage for certain crops. Price based coverage is also available for many livestock species. The 2008 Farm Bill[31] calls for research activities addressing federally subsidized insurance for aquaculture:

[31] Public Law 110-234 (the 2008 Food, Conservation, and Energy Act). See Title XII (Crop Insurance and Disaster Assistance Programs, Subtitle A - Crop Insurance and Agricultural Disaster Assistance, Section. 12023).

"AQUACULTURE INSURANCE POLICY.—

(A) DEFINITION OF AQUACULTURE.—In this subsection:

(i) IN GENERAL.—The term 'aquaculture' means the propagation and rearing of aquatic species in controlled or selected environments, including shellfish cultivation on grants or leased bottom and ocean ranching.

(ii) EXCLUSION.—The term 'aquaculture' does not include the private ocean ranching of Pacific salmon for profit in any State in which private ocean ranching of Pacific salmon is prohibited by any law (including regulations).

(B) AUTHORITY.—

(i) IN GENERAL.—As soon as practicable after the date of enactment of the Food, Conservation, and Energy Act of 2008, the Corporation shall offer to enter into 3 or more contracts with qualified entities to carry out research and development regarding a policy to insure the production of aquacultural species in aquaculture operations.

(ii) BIVALVE SPECIES.—At least 1 of the contracts described in clause (i) shall address insurance of bivalve species, including—

(I) American oysters (Crassostrea virginica);

(II) hard clams (Mercenaria mercenaria);

(III) Pacific oysters (Crassostrea gigas);

(IV) Manila clams (Tapes philippinarium); or

(V) blue mussels (Mytilus edulis).

(C) RESEARCH AND DEVELOPMENT.—Research and development described in subparagraph (B) shall evaluate the effectiveness of policies and plans of insurance for the production of aquacultural species in aquaculture operations, including policies and plans of insurance that—

(i) are based on market prices and yields;

(ii) to the extent that insufficient data exist to develop a policy based on market prices and yields, evaluate how best to incorporate insuring of production of aquacultural species in aquaculture operations into existing policies covering adjusted gross revenue; and

(iii) provide protection for production or revenue losses, or both."

II.D. Agricultural Risk

Generally, sources of risk in agriculture include production, price (market), financial, institutional, and human (personal) risk. With the exception of an increase in the mobility of disease because of a global market for bivalves, risks associated with the aquaculture industry have not changed substantially over the last three to four decades.

Most U.S. bivalve aquaculture production is on a relatively small scale and is sold into niche markets. Producers for these niche markets are vulnerable due to their modest size and the limited diversity of their operations. A moderate loss of inventory can lead to a much more substantial loss of market. Later, the loss of a market may have a negative impact on revenues, even if the crop can be sold. The highly perishable nature of shellfish creates additional risks for the producer, and gives buyers potentially important market power that can affect the prices actually realized by a producer. As a consequence of these many risks, bivalve aquaculture producers have a need for risk management tools. However, the fundamental question addressed in this report is whether it is feasible to provide federally-subsidized crop insurance under the terms of the Act as an element in the aquaculture producer's risk management tool portfolio.

Production Risk

Mortality is a typical element of bivalve production. Excess seeds are "planted" in the production area to accommodate anticipated losses to "normal" mortality. Excess mortality results in reduced production. Aquaculture production risks include weather, disease, predation, equipment failure, and input (primarily seed) quality. These later two would not be insurable causes of loss under the Act.

Production risk can be systemic or idiosyncratic. Systemic risks, such as wide temperature excursions, affect all operations in a region. Other elements of production risk for bivalve aquaculture operations are idiosyncratic, affecting individual growers. Examples of idiosyncratic production risk include an isolated disease outbreak, localized predation, or a wind-driven drying of a particular production location.

Weather-related production risk in bivalve aquaculture production is caused by high and low temperatures, excess precipitation, and wind. Weather affects the production of a relatively large number of individual producers every year. The effects of the 2011 Mississippi River flooding on oyster production in Louisiana have been documented in a wide variety of paper and digital media. Yet the effects of the flooding did not impact all producers in Louisiana. To further complicate analysis of this flooding, diversion of river water into bayous by the Army Corps of Engineers apportioned the damages in patterns that did not reflect the natural disaster.

Bivalve diseases are caused by bacteria, fungi, protozoa, and viruses. Disease risk includes chronic disease losses and catastrophic diseases. Chronic diseases slowly erode production and consequently affect profits. Catastrophic losses can lead to the ruin of entire industry sectors. Bonamiasis is caused by a parasite called *Bonamia ostreae*. First identified in United States in oysters from Europe, *B. ostreae* was moved to California and then subsequently transported with oyster seed to Brittany, France. There it led to the demise of the flat oyster industry throughout Europe. Fortunately, although catastrophic losses may be directly linked to practices associated with aquaculture of the bivalves, such catastrophic disease losses are rare.

The spread of disease in aquaculture operations differs somewhat from spread of disease in traditional livestock operations because the aqueous environment provides a medium more amenable to movement of the causative agents. Potential disease pathogens may be endemic in the environment where the bivalves are raised. Decreased resistance to disease may result from physical stress characterizing high density production. High concentrations of metabolic waste products, poor nutrition, low oxygen and/or high carbon dioxide concentrations, extremes of acidity or alkalinity, and poor sanitation can all stress the crop. Consequently, good management practices are essential to limiting disease in the aquaculture crop, and producers typically do use appropriate practices to manage their crops.

Price Risk

Bivalve prices, like the prices of most crops, are subject to market forces. As noted previously, much of the seafood sold in the United States is imported. The prices of imported shellfish have an impact on the prices of locally produced shellfish. However, locally produced bivalves command a premium. The size of the premium reflects competitive national and international production. Several processors reported that because of the local premium, which can apply to an area as small as a single bay or estuary, there is no broadly applicable market price for bivalves produced by aquaculture. Import prices could be used to establish a proxy price for the crop, but the proxy could underestimate the value of the crop by a substantial factor. (Threefold differences were reported by one processor for oysters from one bay as compared with those from a nearby location. The differences between local production and imported production are even greater). Nonetheless, risks associated with baseline bivalve prices can result in considerable variability in the economic situation of individual producers and the bivalve aquaculture industry as a whole.

NOAA Fisheries Statistics Division maintains data on commercial fisheries landings. These include aggregate data on quantity and value. Consequently, generalized price data can be extrapolated from the landings data; however, the price is generally based on meat weight. In addition, generic information about weekly seafood price (i.e., a U.S. wholesale market summary) is available from Urner Barry's Seafood Price-Current. Testimony about these data indicated they are also aggregate data and incorporate both farm-gate and processor prices and prices for farmed and wild mollusks. As noted previously, these appear to be the only consistently collected pricing data available.

Inputs in the bivalve aquaculture industry are relatively limited. While input price changes affect the producer, no individual producer or any representative of producers indicated that risks associated with input costs were an issue of great concern.

Financial Risk

A bivalve producer's primary source of financial risk stems from capital and labor investment. Another financial risk is the potential need to borrow funds to manage cash flow. Concern about financial risk was reflected in producer comments concerning both flooding and oil spills in the Gulf of Mexico production region. However, it should be noted, financial risk as it is defined here is not an insurable risk under the Act.

Institutional Risk

Institutional risk of concern to bivalve aquaculture producers includes husbandry standards, environmental policies, and handling standards. In addition to outright bans on marketing, changing sanitary regulations are a constant source of concern.[32] Most quarantines and

[32] e.g., Central Coast News, 2010, Shellfish Quarantine at Morro Bay Estuary, http://www.kcoy.com/story/13762534/shellfish-quarantine-at-morro-bay-estuary?redirected=true, accessed May, 2011; California Department of Public Health, 2011, Preharvest Shellfish Protection and Marine Biotoxin Monitoring Program, http://www.cdph.ca.gov/healthinfo/environhealth/water/Pages/Shellfish.aspx, accessed May, 2011.

restrictions on harvest are short-lived. Nonetheless, any regulatory action that interferes with the normal course of business has the potential to cause loss of revenues and markets.

Furthermore, actions by the Army Corps of Engineers to limit flooding in Louisiana in the spring of 2011 resulted in substantial fresh water flow into estuaries used for bivalve aquaculture. Such practices to control waterway flows represents an institutional risk unique to agriculture in low-lying areas, including elements of the aquaculture industry. It is not clear that the Basic Provisions address the lack of insurability of this risk factor.

Human or Personal Risk
Bivalve aquaculture operations must manage human risk in compliance with the Occupational Safety and Health (OSH) Act and the Fair Labor Standards Act (FLSA). Costs of complying with OSH standards for protecting workers do not appear to have a substantial impact on the cost structure of production operations. Hazards include cuts and abrasions, infection (e.g., tetanus infections), mechanical injury from equipment, drowning, and hearing loss due to excessive noise. In addition, as in most agricultural operations, key personnel are subject to retirement, death, and divorce. These risks would clearly fall outside the purview of federal crop insurance. It should be noted, human and personal risks are not insurable risks under the Act.

II.E. Research Approach

In general, the Contractor's research and analysis of the bivalve aquaculture sectors was guided by the language of the Act and a focus on the criteria for feasibility as outlined in the SOW. The Contractor sought first to develop an understanding of relevant bivalve aquaculture literature, current economic conditions, available government programs, and characteristics of the industry sectors, including currently available risk management tools. The Contractor gathered information concerning stakeholders' potential interest in federally-subsidized insurance products. Subsequently, the Contractor identified perils and economic risks faced by the bivalve aquaculture producers, paying particular attention to stakeholders' most significant risk management concerns and expressed needs. The Contractor completed an analysis of the risks associated with the identified, insurable perils. The Contractor also sought to understand the applicability of an AGR-like product for the industry stakeholders. The Contractor then applied RMA's criteria for feasibility to evaluate the risk management through insurance of the insurable perils identified in the preceding step. Finally, after a systematic analysis, the Contractor assessed the feasibility of developing federally-subsidized, stakeholder-acceptable, actuarially-sound, non-market distorting crop insurance products for bivalve aquaculture production.

RMA's criteria for feasibility identify the requirements to establish an appropriate feasibility recommendation for crop insurance development activities in the broadest terms. Section 2.4.1 of the SOW states:

> *"The contractor when recommending a possible insurance program needs to keep in mind the following criteria:*
> - *Conform to RMA's enabling legislation, regulations, and procedures that cannot be changed;*
> - *The insured's and their agents must be will to pay the appropriate price for the insurance;*

- *The insurance product must be effective, meaningful and reflects the actual risks of the producers;*
- *The perils affecting production must be identified and categorized as insurable and non-insurable;*
- *Be ratable and operable in an actuarially sound manner;*
- *Contain underwriting, rating, pricing, loss measurement, and insurance contract terms and conditions;*
- *There must be an appropriate geographic distribution of production to ensure a sound financial insurance program;*
- *There must be enough interest for the risk to be spread over an acceptable pool of insureds;*
- *Customers must not be able to select insurance only when conditions are adverse;*
- *Moral hazards must be avoidable or controllable;*
- *There must be no change of beneficial gain; and*
- *There must be no change in market behavior or market distortions that change the quantity supplied or shift the supply curve."*

This list by itself provides a context for the evaluation of the feasibility of a proposed insurance product. However, the test of feasibility requires additional context. For this evaluation the additional contextual information is as follows:

The proposed insurance coverage must conform to RMA's enabling legislation, regulations, and procedures that cannot be changed. The enabling legislation is Title 7, Chapter 36, Subchapter I of the U.S. Code, as amended.[33] Amendment of this code requires an act of Congress. The Regulations and Procedures implementing this Act are the responsibility of the FCIC Board of Directors and USDA RMA. While the Crop Insurance Act, as amended by the 2008 Food, Conservation, and Energy Act, requires "research activities addressing federally-subsidized insurance for aquaculture," the research and development "shall evaluate the effectiveness of policies and plans of insurance for the production of aquacultural species in aquaculture operations, including policies and plans of insurance that—

(i) are based on market prices and yields;
(ii) to the extent that insufficient data exist to develop a policy based on market prices and yields, evaluate how best to incorporate insuring of production of aquacultural species in aquaculture operations into existing policies covering adjusted gross revenue; and
(iii) provide protection for production or revenue losses, or both."

Producers or their agents must be willing to pay the appropriate price for the insurance. Since the study was initiated by an Act of Congress, there is *a priori* evidence of some customer interest. The willingness of producers or their agents to pay will be influenced by the coverage available and the costs associated with the insurance offer.

The insurance product must be effective, meaningful and reflect the actual risks of the producers. If the risks are identified and appropriately categorized as to insurability (i.e., reflect

[33] See for example http://www.law.cornell.edu/uscode/7/usc_sup_01_7_10_36_20_I.html.

the actual risks), an effective product will provide insurance that appropriately addresses the frequency and severity of potential losses. The producers' perception of the utility of the insurance and the ability of the insurance to protect the insured from financial failure affect the meaningfulness of the product.

The perils affecting production must be identified and categorized as insurable and non-insurable. The proposed insurance product must address definitive causes of loss that can be observed and quantified, and that are insurable under the authorizing legislation. Measurement of the outcomes of the enterprise must be such that the uninsurable portions of reduction in productivity or production-based revenues can be identified and quantified. If this is not possible, then uninsurable losses may be indemnified to the detriment of the taxpayer and the approved insurance provider.

Insurable causes of loss for FCIC programs must meet at least two criteria. First, a cause of loss must have natural (as opposed to man-made) origins. Second, an insurable cause of loss must result in a determinable and measurable amount of loss. A cause of loss that is due to non-natural events can be easily manipulated by an unscrupulous individual (moral and/or morale hazard). If the existence of the loss or the amount of the loss cannot be established, there is no manner in which an accurate and fair indemnity can be determined.

The development of crop insurance requires identification of perils, classification of those perils as insurable or non-insurable, and actuarial assessment of the risks associated with those perils. Most crop insurance addresses either production risks, price risks, or the combined outcomes in the form of revenue risks. Changes in production and revenues resulting solely from management decisions are not insurable. However, variations in production or revenue caused by natural events beyond the producer's control are potentially insurable, as are changes in revenues resulting from market fluctuations under some accepted approaches.

The insurance product must be ratable and operable in an actuarially sound manner. It must be possible for an actuarially-sound premium rate to be determined. This is fundamentally a question of data availability in terms of quantity of statistically valid observations or of the quality of non-quantifiable (judgmental) observations. It is secondarily a question of the nature of perils and the ability to associate production and/or revenue data with those perils.

The insurance product must contain underwriting, rating, pricing, loss measurement, and insurance contract terms and conditions. To develop these elements, appropriate management practices can be defined and required of stakeholders. Appropriate loss controls must be available. Unless controllable losses are managed and excluded from insurance, an insurance program will not have an actuarially sound basis and will tempt the purchaser to manipulate profits through fraud or deceptive practices.

There must be an appropriate geographic distribution of production to ensure a sound financial insurance program. An appropriate geographic distribution of insurance risk is required to address the need for insurance that is responsible to the taxpayer, since stakeholders operating in a limited geographic area could face collective catastrophic loss not protected by the insurance pool funds. The Contractor understands this requirement to apply to the entire FCIC portfolio in the aggregate, which is distributed throughout the United States. Furthermore, the bivalve aquaculture sectors have wide geographic distribution.

There must be enough interest for the risk to be spread over an acceptable pool of insureds. An appropriate pool size is also required to address the need for insurance that is responsible to the taxpayer, since a limited pool could face collective catastrophic loss not protected by the insurance pool funds. A sufficient number of stakeholders, who are not identically affected by perils, must be willing to buy the insurance as part of an overall farm risk management strategy. Without an appropriate pool of insured enterprises, the insurer faces the risk of catastrophic losses. Indemnities in excess of the realized premiums may occur, increasing the subsidy costs to the taxpayer. The Contractor understands this requirement also applies to the entire FCIC portfolio in the aggregate, which involved more than 1.1 million policies and almost $80 billion of insured liability in 2010.

Customers must not be able to select insurance only when conditions are adverse. At the time of enrollment the purchaser must be unable to predict the outcome. If the purchaser can predict the outcome at the time of enrollment, not only will adverse selection occur, but unscrupulous purchasers could “farm” the insurance to maximize profits. Only unpredictable outcomes fall into the category of appropriately insurable risks. Predictable outcomes do not include risks, but are characterized by certainty.

Moral hazards must be avoidable or controllable. There must be a clearly defined outcome or phenomenon to be insured and the outcome must be subject to random variation; the variation in outcome must be separable into that part which can or might be manipulated, and that part which cannot be controlled.

There can be no chance of beneficial gain. If an insured individual benefits unduly from participation in the program, that gain introduces the possibility that the insurance would change the status of the insured within the pool of stakeholders. Insurance should be only a vehicle to manage risk; there should be no possibility that indemnity payments will become a fundamental element of the typical income stream.

There must be no unacceptable change in market behavior or unacceptable market distortions in terms of either a change in quantity supplied or shift in the supply curve. The intent of crop insurance is not to manage the market, but to manage risks faced by individual producers. If the insurance unduly increases production, shifts production to new regions, or creates unfair advantages for individual stakeholders or particular production regions, then the market distortions will invalidate the rating developed in a neutral market. This presents a danger to stakeholders, to the market itself, and to the insuring entity. Localized interest in insurance has the potential to affect markets if the local area becomes significantly more productive because of the insurance. If the locality is a small element of the market, such broader market distortion is unlikely.

If these criteria are met, insuring a proposed crop should be feasible, appropriate underwriting should be possible, and development of the program will fulfill both the needs of the stakeholder and the requirements of being responsible to taxpayers and to the industry.

The remainder of this report is organized into three elements describing respectively the U.S. bivalve aquaculture species; common production practices, and risks affecting production. These are followed by a general feasibility assessment, a discussion of the adjusted gross revenue approaches, and a summary of findings.

SECTION III. BIVALVE AQUACULTURE SPECIES

Of the more than 9,000 living bivalve species, the SOW identifies the five most commonly grown in the United States as a subject of this report with the stipulation that additional species should not be excluded from consideration. The Contractor identified nine additional species reportedly grown in the United States, including:

Bay scallops (*Argopecten irradians*)[34],
European flat oysters (*Ostrea edulis*)[35],
Calico scallops (*Argopecten gibbus*)[36]
Geoduck clams (*Panopea abrupta or alternatively P. generosa*)[37],
Giant Clams (*Tridacna gigas*)[38],
Kumamoto oysters (*Crassostrea sikamea*) [39],
Mediterranean Mussels (*Mytilus galloprovencialis*)[40],
Olympia Oysters (*Ostrea lurida*) [41], and
Sea Scallops (*Pecten maximus* and *Placopecten magellanicus*)[42]

The major farmed bivalves (i.e., those identified in the SOW), as well as Geoduck clams and blue mussels, were first collected in the United States from the wild for their food value. They are now farmed in relatively large numbers in the regions where they occurred naturally. Other species, such as the European flat oyster, were introduced into the wild as native species, declined, primarily due to over-fishing and changes in the environment due to pollution. Still others, such as *C. sikamea* and *M. galloprovencialis* have been brought to the United States solely for use in aquaculture. Brief descriptions of the 14 species identified as farmed in the United States follow. This discussion includes identification of various production practices that are described in Section IV.

Argopecten gibbus (Calico Scallop)

A. gibbus, a swimming scallop, is native to the shallower waters above the continental shelf from Cape Hatteras to Cape Canaveral. Since wild populations of scallops in North America have

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[34] Blake, N.J., C. Adams, R. Degner, and D. Sweat, 2000, Aquaculture and Marketing of the Florida Bay Scallop in Crystal River, Florida, http://aquaticcommons.org/2550/1/Florida_Bay_Scallops.pdf, accessed May, 2011; Blake, N.J. and S. Shumway, 2006, Bay scallop and calico scallop fisheries, culture and enhancement in eastern North America in Developments in Aquaculture and Fisheries Science, Volume 35: 945-964.

[35] Lavoie, R.E., 2006, Oyster Culture in North America History, Present and Future, The 1st International Oyster Symposium Proceedings, Tokyo, Japan, July 2005. Oyster Research Institute News, 17: 1 – 11.

[36] Blake, N.J. and S. Shumway, 2006, Bay scallop and calico scallop fisheries, culture and enhancement in eastern North America in Developments in Aquaculture and Fisheries Science, Volume 35: 945-964.

[37] Washington State Department of Natural Resources, 2011, DNA and Geoduck Aquaculture, http://www.dnr.wa.gov/BusinessPermits/Topics/ShellfishAquaticLeasing/Pages/aqr_aqua_geoduck_aquaculture.aspx, accessed August, 2011.

[38] Heslinga, G. A., F. E. Perron and O. Orak. 1984. Mass culture of giant clams in Palau. Aquaculture 39, 197-215.; Heslinga, G. A., T. C. Watson and T. Isamu. 1990. Giant Clam Farming. Pacific Fisheries Development Foundation (NMFS/NOAA), Honolulu, Hawaii, 179 p.,

[39] Lavoie, R.E., 2006, Oyster Culture in North America History, Present and Future, The 1st International Oyster Symposium Proceedings, Tokyo, Japan, July 2005. Oyster Research Institute News, 17: 1 – 11.

[40] Taylor Shellfish Farms, 2011, Our Shellfish, http://www.taylorshellfishfarms.com/ourStore-mussels-mediterranean; accessed August, 2011.

[41] Lavoie, R.E., 2006, Oyster Culture in North America History, Present and Future, The 1st International Oyster Symposium Proceedings, Tokyo, Japan, July 2005. Oyster Research Institute News, 17: 1 – 11.

[42] Anonymous, 2007, Edgewater Foods Inte (EDWT) - Description of business, http://www.hotstocked.com/companies/e/edgewater-foods-inte-EDWT-description-62102.html, accessed August, 2011.

only recently declined, aquaculture of scallops is not as well developed in the United States as the culture of clams and oysters. Broodstock for aquaculture of scallops was historically collected from the wild. Less often, spat are collected from the wild. The most common management practice for grow-out, derived from Asian practices, is using tiered (lantern or pearl) nets. Producers suspend the nets containing the crop between buoys. Calico scallops require approximately a year to grow to harvestable size.

***Argopecten irradians* (Bay Scallops)**
A. irradians is native to Atlantic coastal waters from Nova Scotia to Florida with a distinct subspecies (*A. irradians amplicostatus*) in the Gulf of Mexico. Broodstock spawns at one year of age. Larvae initially attach to substrate, but become free swimming as they mature. Bay scallops are minor contributors to the U.S. commercial scallop fisheries, with just over one million pounds of adductor muscle meat from wild and farmed bay scallops harvested annually over the last ten years. Markets are developing for live and half shell scallops, but the survival time after harvest is much shorter than the time the meat can be kept. However, bay scallops can be important to local economies. Bay scallops have been grown out in tanks, lantern nets, floating cages, and in ponds. In southern coastal Georgia and Florida, bay scallops can attain a harvestable size in seven to nine months.

***Crassostrea gigas* (Pacific Oysters)**
C. gigas is native to the Pacific coast of Asia and has been introduced in North America. Due to its fecundity, it is considered an invasive species. The Pacific oyster is out-competing the native Olympia oyster in Puget Sound, Washington. Spat are raised in sea- or land-based upwell systems. Out-growing techniques primarily are sea-based. The oysters may be planted out directly on the sea floor, planted out in bottom cages, or planted out on lines or in cages suspended from docks or floats. The practice chosen depends on local custom and requirements imposed by the local environment. Pacific oysters are ready for harvest in 18 to 30 months.

***Crassostrea virginica* (American or Eastern Oysters)**
C. virginica is native to the Atlantic Coast of North America and the Gulf of Mexico. *C. virginica* has also been introduced into farming operations in the Pacific Northwest. Triploid individuals[43] (which do not interbreed with wild populations) have recently been used for aquaculture, eliminating some of the environmentalists' concerns about escape of farmed specimens into the wild. As with *C. gigas*, spat are raised in sea- or land-based upwell systems or in a combination of the two, with the younger spat being grown on land. Outgrowth is initially in bags and/or cages, with older stock planted out, maintained in on bottom cages, or suspended. Producers and extension staff indicated eastern oysters may be ready for harvest in as little as nine months after planting. However, due to non-uniform rates of growth and a desire to harvest oysters of different sizes, sequential harvests may carry some individuals from a planting cohort for as long as three years.

***Mercenaria mercenaria* (Hard Clams)**
M. mercenaria is native to the east coast of North America and is the most commonly farmed bivalve in the United States. *M. mercenaria* produced on aquaculture operations are generally

[43] Hybrids with three copies of each chromosome.

grown on the bottom under netting or screens, or in cages. Hard clams[44] thrive when they are buried, so there is a tension between the better management of predation in cages and the better access to the sediments when the clams are planted. In the wild, hard clams are found on beaches of mixed sand, gravel, and mud, generally buried just beneath the surface. They are commonly harvested using shovels or rakes. Similar harvest practices are used for cultured clams. Harvest from cages is more efficient.

As with all bivalves, clams have an indeterminate growth pattern; there is not a set final size. Instead, as a clam ages, provided adequate food is available, it generally gets larger. Harvest sizes for hard clams vary enormously with the market. Cultivated clams may be as small as an inch across the shell measured parallel to the hinge when harvested for processing uses. More commonly, progressively larger littleneck, middleneck, topneck, cherrystone, and chowder clams are marketed as supply and demand warrant. Pricing varies somewhat by size, with smaller clams generally commanding a premium per-piece price. Naming conventions vary somewhat by region, as do market units (piece, pound, and bushel being the most common).

***Mytilus edulis* (Blue Mussels)**
M. edulis are native to the Arctic, North Atlantic, and North Pacific Oceans, where they thrive in cold waters. They grow in dense mats, attached by byssal threads to hard surfaces. They are found mainly in protected waters where they can grow to a length of about 3 inches in 12 to 18 months. Mussel seeds are planted in areas where growing conditions are favorable. For suspended culture, mussel spat are collected on short ropes. These are transferred to floats, where the mussels are grown to marketable size. The ropes may be enclosed in mesh tubes to exclude predators. For bottom culture, larger seed mussels, often collected from wild beds, are spread over a lease site. These bottom-cultured mussels grow more rapidly at the reduced densities.

***Mytilus galloprovencialis* (Mediterranean Mussels)**
M. galloprovincialis are native to the Mediterranean, Black, and Adriatic Seas. They have been introduced in the eastern North Atlantic (especially the French, English, and Irish coasts), parts of the western African coast, and in the Pacific Northwest. Mediterranean mussels grow rapidly and have lower oxygen requirements than many native species. They are grown using suspended culture techniques; otherwise their culture is similar to that of native mussel species.

***Ostrea edulis* (European Flat Oysters)**
O. edulis are native to Europe, from Norway to Portugal, and North Africa. European flat oysters have an unusual taste, variously described as metallic or tannic. They are prized for their unique shape (flatter and less rough than most oyster species) and unusual flavor. Consequently, European flat oysters command a premium price. Invasive populations have appeared in eastern North America following introduction in the middle of the 20th Century. *O. edulis* is farmed in California, Maine, and Washington. European populations have declined due to disease, pollution, and over-fishing.

[44] A number of other calms used for food, including Butter clams (*Saxidomus giganteus*) and Mahogany clams (*Arctica islandica*), are also called hard clams. These other hard clams are of limited commercial interest in the United States and the Contractor found no evidence they are farmed in this country.

The culture of European flat oysters is similar to that used for native American species. Growth is somewhat slower and concerns about disease limit interest in adoption as a standard species. In France, European flat oysters harvested from the Bélon River are called Bélon oysters, a name used for marketing some of the cultured European flat oysters in the United States. The disease risk/uncertainty associated with this species likely make it a poor candidate for insurance development at this time.

***Panopea abrupta* (Alternatively *P. generosa* - Geoduck Clams)**

P. abrupta are native to subtidal waters of the Pacific Northwest, Alaska, and British Columbia. The common name, pronounced "gooee-duck" has a variety of spellings including geoduck, goiduck, or gweduck. The geoduck is the largest burrowing clam, historically reaching an average size of over two pounds in the Puget Sound. The largest geoduck verified by the Washington Department of Fish and Wildlife weighed 8.16 pounds. Geoduck clams grow rapidly, generally reaching 1.5 pounds in 3 to 5 years. In the wild, they attain their maximum size by about 15 years, and can live at least as long as 168 years.[45] Unique among the aquaculture species, geoduck clams bury themselves two to three feet deep in the ocean floor. The siphon and mantle are so large they cannot be drawn into the shell. Geoduck clam juveniles are planted in PVC pipes placed in rows and regularly spaced within the row. Consequently, the cropland appears more like a row crop field than bivalve farmland. The PVC pipes are removed as the crop matures. While the long life cycle of the geoduck clam introduces some complications in maintaining an active inventory, the systemic planting patterns simplify that chore.

***Pecten maximus* (Sea or King Scallops)**

P. maximus are native to the eastern North Atlantic Ocean. They are among the largest of the scallops and important to the fisheries where they are native. Due to their large size and high-quality meat, attempts have been made to introduce them in a number of areas. The culture of the king scallops is relatively new. Wild spat are often used and both hatchery and nursery activities are limited. Substantial genetic variation in the resulting crop has limited the utility of this species.

***Placopecten magellanicus* (the Most Common Sea Scallops in U.S. Production)**

P. magellanicus are native to the cooler waters of the North Atlantic Ocean, with important fisheries from Labrador to North Carolina. They prefer cooler waters and consequently thrive in deeper waters the further south they are found. Sea scallops are particularly sensitive to water quality and temperature. Due to their importance to wild fisheries, *P. magellanicus* have been introduced outside endemic locations. The mobility of sea scallops requires substantial enclosures (while most other shellfish are in cages to exclude predators). As sea scallops are sensitive to motion, wave action that moves suspended culture gear can reduce productivity, or in extreme cases increase mortality. Scallops grown in suspension systems are monitored regularly and transferred into bags with larger mesh as they grow. Harvest generally occurs after 18 to 30 months.

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[45] Washington Department of Fish and Wildlife, 2011, Geoduck Clams, http://wdfw.wa.gov/fishing/shellfish/geoduck/, accessed May, 2011.

***Tapes philippinarium* (Manila Clams)**
T. philippinarium are native to the western Pacific Ocean. They have reportedly been farmed in Japanese waters for more than a century. Manila clams were introduced into the waters of the Hawaiian Islands in the early days of the 20th Century. An accidental introduction to the Pacific coasts of the United States in the 1930s in a shipment of *C. gigas* seed led to the establishment of the species and eventual spread along the entire U.S Pacific coast. The rapid growth of the Manila clam makes this species invasive (i.e., it displaces similar native clams from their niche), but also makes the clam a strong candidate for farming. Development of triploid lines for culture has limited the ecological threat from introduction in new aquaculture locations. The culture of Manila clams is similar to that of the hard clam. Marketing focuses on smaller individuals. Regulations to limit the spread of Manila clams to the Gulf of Mexico limit the potential of the species as a crop in the Gulf coastal waters.

***Tridacna gigas* (Giant Clam)**
T. gigas are native to the South Pacific and Indian Oceans. They are one of a number of giant clam species and the largest living bivalve. *T. gigas* rival even the largest extinct bivalve specimens in size. Giant clams are valued for their shell and for their meat. One unique feature of giant clam aquaculture is a potential market for use in saltwater aquariums (i.e., as a pet). Except for their remarkable size and longevity, the culture of *T. gigas* is otherwise similar to the culture of smaller bivalves. Seeds are planted when the nursery crop reaches a size of three to seven inches. Marketable size for meat and shell is achieved after approximately ten years. Marketable size for aquariums is realized sooner. Due to their efficiency as filter feeders and their rapid growth rate, a longer grow-out period yields substantially larger individuals. Giant clams are being cultured in Hawaii, Palau,[46] Australia, the Philippines, and Indonesia. The International Union for Conservation of Nature and Natural Resources lists the giant clam as vulnerable to extinction, introducing a barrier to trade for the aquaculture harvest.

[46] Formerly a United Nations Trust Territory of the Pacific Islands under the administrative authority of the United States, but now independent.

SECTION IV. BIVALVE AQUACULTURE PRACTICES

Aquaculture production of bivalves requires three activities in sequence: hatchery, nursery, and grow-out activities. Biologically, the hatchery element comprises the release of eggs and sperm by broodstock, fertilization of the egg by the sperm, development of free-swimming larvae from the fertilized egg (zygote), and then a series of metamorphoses through various larval stages into a miniature mollusk (the "seed") that looks essentially like a smaller version of the adult bivalve. The one consequential difference between the seed and a mature adult is that the seed does not have reproductive capabilities; the reproductive organs of the seed are immature and incompetent. In the nursery phase, seeds are raised to an appropriate size for planting. In the grow-out phase, the young bivalves are planted and maintained until they reach a marketable size.

Hatchery Activities[47]

The gametes (eggs and sperm) of bivalves are also called spawn. In nature, spawn may be released into the environment or fertilized within the mantle of the bivalve. In either case, the zygotes divide and develop to produce larvae (trochophore, veliger and pediveliger), and then "spat." The spat are miniature versions of the adult bivalves. In aquaculture operations, spat of appropriate size are called seed.

Each time a mature, female bivalve spawns,[48] she produces hundreds of thousands or even millions of eggs.[49] Males release sperm either at the time the female spawns or just afterwards. The sperm fertilize the eggs with a relatively high frequency of success, even in nature. After fertilization, sequential cell divisions produce microscopic larvae that are motile, but in nature generally drift in the currents where they were released. The larvae feed on plankton, grow (through cell division and cell enlargement), and metamorphose (change their structure) from trochophores, to veligers, and finally to pediveligers. The pediveliger larvae eventually settle on a suitable substrate and begin life as juveniles whose growth is then measured by changes in the size of the fleshy body and shell.

The substrate for settling can include rocks, submerged wood or metal, dock pilings, and plant or animal structures. Some settled bivalves are motile, scallops being the most motile, while others are sessile. Mussels, oysters, and giant clams are among the least motile of settled bivalves; they tend to stay where they have settled for the rest of their lives.

Historically, seed bivalves for aquaculture operations were collected from the wild. Since settling of the larvae is dependent on an appropriate substrate, spat could be collected from the

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[47] Helm, M.M. and N. Bourne, 2004, Hatchery Culture of Bivalves: A Practical Manual, Food and Agriculture Organization of the United Nations; Wallace, R.K., P. Waters. and F.S. Rikard, 2008, Oyster Hatchery Techniques, https://srac.tamu.edu/index.cfm/event/getFactSheet/whichfactsheet/206/, accessed May, 2011; N.H. Hadley and J.M. Whetstone, 2007, Hard Clam Hatchery and Nursery Production, https://srac.tamu.edu/index.cfm/event/getFactSheet/whichfactsheet/198/, accessed May, 2011; Braley, R.D., 1992, The Giant Clam: A Hatchery Manual, Australian Centre for International Agricultural Research; Hardy, D, 2006, Scallop Farming, Elsevier; Feldman, K., B. Vadopalas, D. Armstrong, C. Friedman, R. Hilborn, K. Naish, J, Orensanz, J. Valero , J. Ruesink , A. Suhrbier, A. Christy, D. Cheney and J.P. Davis, 2004, Comprehensive Literature Review and Synopsis of Issues Relating to Geoduck (Panopea abrupta) Ecology and Aquaculture Production, Washington State Department of Natural Resources.

[48] "Spawn is both a noun referring to the gametes and a verb referring to the release of the gametes.

[49] Davis, H.C., and P.E. Chanley, 1956, Spawning and Egg Production of Oysters and Clams, Biological Bulletin, Vol. 110, pp. 117-128.

wild by providing appropriate substrate in an area where larval bivalves were developing naturally. The substrate with attached seed could then be moved to a nursery or grow-out area, depending on the size of the seed. Collection of natural spat introduces a substantial element of uncertainty into aquaculture production.

When spat are collected from the wild, there is no control over the characteristics of the broodstock. In some ways this might be seen as an advantage, since natural selection should result in the survival of hardy spat from strong stock. However, since collection of spat from the wild likely involves a number of different parents over a potentially extended period, the developing bivalves are not particularly uniform in age, size, or potential rate of developmental. For a farming activity, these differences produce a less uniform crop than can be obtained from hatchery stock.

The preparation of seed in hatcheries provides a number of advantages over collection of wild spat. In hatchery operations, there is greater control over the selection of broodstock. Diet and water quality can be controlled in the hatchery. Broodstock can be conditioned to spawn based on the requirements (timing, numbers, size, etc.) for seed.

Controlled release of spawn is most commonly achieved by controlling water temperature, water circulation, and salinity in the hatchery environment or by hormonal injection. Following spawning, the larvae are fed a variety of algae, beginning with microalgae and advancing to larger phytoplankton.

One of the principal activities in the hatchery is the culture of the algae to be fed to the larval bivalves. Provision of appropriate nutrients, circulation of the growth medium, and disease control all require relatively sophisticated facilities. Consequently, the hatchery is in many ways more like a laboratory than a farm. The algal culture required for rearing hatchery seed stock is in some ways the equivalent of raising feed to support the growth of livestock (cattle, swine, or poultry). However, one substantial difference between raising feed for a livestock operation and raising algae (feed) for a bivalve hatchery is the scale of the animals being fed. The bivalve larvae are initially so small they can only be observed with the assistance of a microscope.

Due to the plentiful supply of food, settlement of larvae in hatcheries typically occurs somewhat faster than in the wild. Settlement media in the hatchery are designed to assist with the collection of spat and distribution of seed to and on the farming operations. The settlement environment in the hatchery may include coated or roughened plastic sheets, tubes, or mesh; shell chips; whole shells; gravel; and ceramic forms. All these are easily collected and can be handled with minimal damage to the spat. While commercial hatcheries try to minimize loss of spawn and spat, the nature of the development of bivalves in the hatchery phase involves substantial reduction in the number of viable individuals over time. The dynamics and structure of the facilities and operation is designed to accommodate these changes in number. Larvae of similar ages and developmental stages are maintained together. The age cohorts move through the hatchery together. The growing environment is maintained to optimize development of the larvae.

Federal insurance has never been available for bivalve aquaculture hatcheries. Many hatchery operations occur indoors. Weather, disease, and predation risks are managed by the design of the hatchery facilities and the practices used to raise the seed. Private insurance for the facilities (but not necessarily for the stock) is available, as is private business interruption insurance.

Nursery Activities[50]

As mentioned previously, seed are raised in aquaculture nurseries to an appropriate size for planting. Some nurseries operate their own hatcheries, but many bivalve nursery operations purchase seed. If the nursery does purchase seed, smaller seed is less expensive. It is also easier to transport smaller seed because of the reduced volume of each individual within the population.

Nurseries require more space and greater access to seawater than hatcheries. Consequently, although a hatchery may be located away from the shore, nurseries are generally located immediately adjacent to or in the sea. In either case, the principal requirement for a nursery is a current of seawater over the developing bivalve population. The seawater provides food for the developing shellfish as well as a supply of oxygen. Nurseries provide somewhat less control over the environment than do hatcheries. Consequently, nursery operations are exposed to greater unmanageable perils than are hatchery operations. Both land-based and marine (near-shore or off-shore) nurseries are briefly described below.

Land-based Nurseries

In land-based bivalve nurseries, the seed grows to an appropriate size in large tanks (troughs). The seeds are partitioned, either among different troughs or within a trough, into appropriate populations for management. Pumps provide a constant flow of seawater through the troughs (generally drawing water from the ocean and returning it after it has been used). As the seawater flows through the trough, it delivers a steady supply of oxygen and food for the developing seed, and removes metabolic waste products.

A land-based system allows relatively precise control of flow rates and some control of the content of the nutrient stream. The feed water stream can be monitored (manually or automatically) and supplemented with cultured algae and other nutrients as necessary to maintain optimal growth rates. Flow rates can be adjusted to control temperature and nutrient content. The two principal configurations for on-land nurseries are raceway and upwell systems.

In the raceway system the seed are maintained in a large trough. Seawater flows through the trough as a stream, from one end of the trough to the other. This trough system will be familiar to anyone who has visited a fish hatchery. Since the flow covers a large area sequentially, seed in one part of the raceway are exposed to a different growth environment than those in other portions of the tank. Seeds near the end of the raceway are exposed to less food and more waste

[50] Flimlin, 2000, Nursery and Grow-out Methods for Aquacultured Shellfish, http://www.nrac.umd.edu/files/Factsheets/nrac00002_shellmeth.pdf, accessed May, 2011; N.H. Hadley and J.M. Whetstone, 2007, Hard Clam Hatchery and Nursery Production, https://srac.tamu.edu/index.cfm/event/getFactSheet/whichfactsheet/198/, accessed May, 2011; Braley, R.D., 1992, The Giant Clam: A Hatchery Manual, Australian Centre for International Agricultural Research; Hardy, D, 2006, Scallop Farming, Elsevier; Feldman, K., B. Vadopalas, D. Armstrong, C. Friedman, R. Hilborn, K. Naish, J, Orensanz, J. Valero , J. Ruesink , A. Suhrbier, A. Christy, D. Cheney and J.P. Davis, 2004, Comprehensive Literature Review and Synopsis of Issues Relating to Geoduck (Panopea abrupta) Ecology and Aquaculture Production, Washington State Department of Natural Resources.

products than the seeds near the beginning of the raceway. The farther from the input the seeds are located, the lower the nutrient content of the water that flows past them. These differences in water quality are addressed by moving the seed to different locations within the raceway and/or by moving the seed to different raceways as they grow.

Large troughs are also a common element of on-land, upwell nursery systems. However, in the upwell system, the volume within the trough is subdivided by incorporation of a number of "silos" within the trough. Seeds are distributed into racks, bags, nets, or cages within the silos. This facilitates handling.

The feed stream into each silo is from bottom to top (hence the adjective "upwell"). The feed stream in one silo is independent of that in other silos within the trough. Due to this independence and the subdivision of the trough volume, the seed collectively are exposed to a more uniform environment. However, the increased surface area within an upwell system requires substantial additional maintenance of the physical environment. The surfaces within both the raceway and upwell systems must be cleaned of biofilms, macroalgae, and potential competitive or disease organisms, but the upwell systems have substantially greater surface area per unit volume than raceway systems. This increases the effort required for cleaning. There is also a greater resistance to flow within the upwell system. This requires a larger investment in pumping and control equipment for these systems.

A bivalve nursery producer must choose a land-based system that reflects the available financial and labor resources. Balance can be obtained by combining both types of systems, using upwell tanks for younger seed and raceways for larger seed.

Near-shore and Off-shore Nurseries

Near-shore and off-shore nurseries generally incorporate the elements of a land-based upwell nursery system into a dock (near-shore) or float (off-shore). The design of the marine system uses the natural currents and tides to provide some or all of the flow of seawater over the developing seed and limits the need for pumps.

In these marine operations, silos and sluice boxes (to control flow of the water over the seed) are hung below the surface of the water. Mesh bags or screens hold the seed. The physical design of the structure causes the water to move through the nursery from bottom to top. As the seeds grow, they are moved to bags or screens with larger holes and maintained at densities that support appropriate growth.

Both floats and docks are susceptible to damage or losses to weather. Excessive wave action can eject bags from the silos or shift the seed to one side of the float. When the seeds are concentrated in a small area, access to food and oxygen is limited, which in turn limits growth and reduces survival.

All bivalve aquaculture equipment, including nursery bags, floats, silos, netting, and monitoring equipment needs to be cleaned periodically to remove fouling organisms. Some power and a source of water are required for cleaning the seeds and the equipment.

Once seeds are large enough, they can be transferred into nursery bags which can be "planted" inter-tidally or sub-tidally. Under these circumstances, associated nursery activities are equivalent to the grow-out counterparts with the exception that the nursery seeds are smaller than grow-out stock.

Federal insurance for seed in raceways and in nursery bags planted was an element of the Cultivated Clam Pilot (04-0116) insurance program in some counties in some states. Language regarding raceways was eliminated in the 2008 Cultivated Clam Pilot Provisions (08-0116). The Special Provisions of insurance for some counties in Florida still support insurance of nursery-sized clams planted in bags.

Grow-out Activities

During the grow-out stage of bivalve culture, the producer "plants" seed and grows the seed to a larger, marketable size. Typically, the grow-out process starts with seed purchased from a nursery. However, some operations support both nursery and grow-out activities or hatchery, nursery, and grow-out activities.

As with all animal husbandry, growing out bivalves requires provision of food, maintenance of an appropriate environment, prevention of disease, and control of predators. Seed for grow-out is planted either directly on the sea floor, in exclosures on the sea floor, or suspended from floats (in troughs, cages, or bags or suspended on lines) depending on the species being grown, weather conditions, and local custom. Inasmuch as clams require sediments for their development, seed is generally planted on the sea floor covered by netting or in exclosures that in turn are planted on the sea floor. Local experience over time is useful in determining appropriate planting densities. However, it is important to note the specific conditions on a farm will greatly impact the carrying capacity[51] of a particular plot. Consequently, the best planting density in one area can be quite different from the best density in even an immediately adjacent area.

Feeding the bivalve during growing-out entails ensuring an adequate flow of phytoplankton-rich water around the crop. This is accomplished primarily by selection of the "cropland," and by ensuring the seed are planted at an appropriate density. Most cropland is controlled by states and generally involves obtaining a lease from the requisite state authority. In some operations, especially during the earlier grow-out periods, pumps are used to assure an adequate flow of water across the developing racks of shellfish.

The maintenance of an appropriate environment for growth depends first on the selection of the specific planting location within a leasehold (depth, proximity to fresh water flows, substrate, currents, and tides all affect the areas within a lease appropriate for planting), and then on control of fouling organisms. Both algae and invertebrates can foul the seed and the gear that surrounds them. Both types of fouling influence the flow of water and consequently the availability of food, dissolved oxygen concentrations, and the concentration of organic and inorganic waste products in the water.

[51] The carrying capacity is the maximum population of a species the environment can sustain indefinitely.

The fouling organisms are removed by squeegeeing, brushing, or scraping. This maintenance often occurs during inventory and harvest. The antifouling activities can damage the developing seed, especially when it is extremely young.

Unlike many land-based crops planted on a particular day and most commercial livestock born on a specific day, a cohort of bivalves planted on a single day is not ready to harvest at one time. The young bivalves in any given population are generally quite similar at planting, but some grow faster than others. Consequently, some are ready to harvest earlier than others. While general practice is to harvest all the individuals in a single planting cohort within about a year (i.e., there is rarely more than a year between the first harvest from the planting and the last),[52] species, growing conditions, and market forces may extend the total length of the grow-out period for a single age cohort considerably.[53]

Paradoxically, much leased aquaculture land historically has been less productive than land used for natural (not farmed) bivalve populations. The states have considered aquaculture as a mechanism to increase the overall production of shellfish by incorporating management in areas where natural production is smaller. Consequently, regional data on natural bivalve productivity and harvest may not be particularly useful in establishing appropriate practice calendars and the potential productivity of newly leased land. Furthermore, historical productivity focuses on productivity that occurs on the sea floor. Since clams are generally raised on the sea floor, these data may have some relevance to clam aquaculture. However, mussels, oysters, and scallops are frequently farmed using suspended cultures. This limits the utility of data generated from natural populations for aquaculture crops grown under this practice.

The major predators of cultured bivalves are bony fish (e.g., flounder, drum, puffer, and tautog), cartilaginous fish (e.g., rays and sharks), crabs, snails (e.g., whelks, moon snails, oyster drills), starfish, water fowl, and humans. Non-human predators are generally controlled by exclosures. Nets or screens can be used to cover seed planted on the sea floor. These are anchored with weights or attached to the sea floor with stakes. Materials used to weight the edges of nets include rebar, PVC pipes and rods, stone bags, and lead weights or line. Human predators in the form of poachers can be controlled to some extent by signage, monitoring systems, and legal action. Over time, as harvests have increased in aquaculture areas and decreased among natural populations, cultures that tolerated poaching have been replaced by greater respect for the property rights of the producer.

Small seed requires a small mesh for exclosures (as small as 1/8 inch), but these finer exclosures foul more easily and must be cleared more often. Consequently, the smaller meshes are exchanged for larger mesh as the bivalves grow. The structure of the mesh needs to reflect the particular predators present. Plastic is more commonly used, especially for younger seed, but metal or plastic-covered metal may be required when the predominant predators can destroy the plastic mesh. One producer described a scenario in which a large fish took plastic mesh bags into its mouth, consumed the enclosed seed, and then spit out the bag. The fish quickly learned the bags contained easily obtained and abundant food. Such a scenario clearly requires careful selection of exclosure materials, mesh size, and placement.

[52] Karen Hudson, Virginia Institute of Marine Sciences, personal communication.
[53] John Vigloitta, President, Mobjack Bay Seafood, personal communication.

The most important aspect of predator exclusion by nets or screens, as opposed to exclusion in bags and cages, is to ensure the edges are appropriately anchored so even relatively small predators cannot get under the nets. This is one reason bags or cages are favored in some production areas and in some locales within a production area. Depending on the species being grown, bags or cages may be anchored to the sea floor or suspended from floats. Some predators are restricted primarily to the sea floor. Others may prey upon bivalves regardless of whether they are raised in floating bags or being raised on the bottom.

In areas where winter ice forms occasionally, producers may be faced with the dilemma of whether to remove the enclosing mesh or screens. Removal exposes the crop to predators. Failure to remove the cover can result in additional damage if ice does scour the sea floor. In other areas, the mesh or screen are removed as a standard practice. In these areas, the question is the timing of the removal. Premature removal will expose the crop to greater predation. Late removal can result in scouring damage and loss of equipment.

Grow-out success rates are highly variable depending on seed size, locale, and management practices. While the 70 percent survival rate used in the Cultivated Clam Pilot Insurance may have reflected an industry average for clams at the time of development of the pilot, testimony suggests it is likely to be low for the best producers. Several experts and oyster producers indicated they would not be in business if that were the level of their grow-out success. However, the Contractor was not able to obtain data to verify this testimony empirically.

SECTION V. BIVALVE AQUACULTURE RISKS

Growers are sensitive to the difference between common (systemic) risk and idiosyncratic risk. Production risks have not changed substantively over the past several decades. However, during that time natural reproductive populations have changed substantially.

Production Risk

Production risks facing bivalve producers include weather, disease, and predation. Weather-related risks are of greatest concern, generally followed by predation, and finally disease. Disease risk includes both catastrophic losses and chronic disease losses, which more slowly erode profits.

It is useful to keep a sense of the producer's perspectives on loss severity. A "catastrophic loss" means the loss (mortality) of an entire inventory. No quantifiable estimates of variation are available. One of the criteria for feasibility requires "Losses covered under the proposed insurance product must be adjustable." However, adjustment of losses does not appear any more challenging than for many crops, where multiple causes of loss may occur within a growing season and losses are not established until harvest. A method for handling production to count of bivalves that are not harvested on or before the end of the insurance period will present a challenge to development of an effective insurance product.

Weather

During the listening sessions and in interviews, producers identified two distinct categories of weather concerns: severe storms and extended periods of extreme weather. The principal weather perils of concern are those named in the pilot cultivated clam insurance program: hurricane, storm surges (and tidal waves), abrupt and extreme changes in salinity, and winter storm damage (icing and freezing). The data available from this pilot program, including measurement of losses tied to specific weather events, along with existing weather data, provide a mechanism to assess the relative risk of weather for various regions within the production areas. Stakeholders indicated there was not a specific weather event that "kept them awake at night." Instead, abnormally severe weather conditions were a substantial concern.

It is important to note one perilous weather event may have dissimilar effects on different species, different production practices, and different microenvironments within a production region. For example, within an estuary, excessive rainfall may substantially reduce salinity in areas where rivers enter the sea, but have little effect on areas outside the channel cut by the entering river water. During an excessive-wind event during the winter months, the windward side of a bay may experience substantial icing damage, while the leeward side may be insulated from the damage by the movement of the water driven by the winds. Similarly, storm surges do not affect all areas uniformly.

Predation

The major predators of cultured bivalves are bony fish (e.g., flounder, drum, puffer, and tautog), cartilaginous fish (e.g., rays and sharks), crabs, snails (e.g., whelks, moon snails, oyster drills), starfish, water fowl, and humans. Non-human predators are generally controlled by exclosures. Human predators (i.e., poachers), while controlled to some extent by signage, monitoring systems, and legal action, would be an uninsurable cause of loss under any Federal Crop

Insurance Corporation program. Since poaching by definition is an activity carried out stealthily, determining the amount of uninsured loss associated with it is difficult. Stakeholders generally indicated confidence in their ability to manage risks associated with predation. Nonetheless, the required management practices to limit this predation introduce the need for substantial underwriting requirements for any crop insurance program.

<u>Disease</u>

Disease prevention and control are given continual management attention. Hard clams have notably few infectious diseases, compared to other bivalve mollusks, and to date no broad-reaching problems due to infectious diseases have been observed in bivalves raised by aquaculture in the United States. There is, however, a reasonable concern that disease events may increase as production densities increase.[54]

Signs of infectious disease include gaping (inability to hold the valves closed), shell deformities, deposits on the inner shell surfaces, excess mucus production, watery meats, dark, pale, or discolored meats, and lesions or ulcers. However, it should be noted these symptoms also may be associated with adverse environmental conditions. Pathogens can potentially infect all life stages of cultured bivalves. Organisms of particular concern include QPX (Quahog Parasite Unknown), *Perkinsus* spp. (an oyster disease), Chlamydiales, and Rickettsiales. Other locally important disease-causing organisms will likely be identified during a development effort.

Quahog Parasite Unknown (QPX)

QPX is a significant pathogen of hard clams found in high salinity areas. Moderate infections slow growth and reduce the quality of the meat. QPX mortality is highest when additional stressors, such as unusually low temperatures or very high population density, affect the shellfish.

Perkinsus

Perkinsus are protozoans that cause Dermo disease in eastern oysters. Although *Perkinsus* are occasionally found in hard clams, they do not cause disease symptoms in clams. Infection results in failure to thrive, poor meat quality, and loss of adductor muscle strength (leading to gaping). High temperatures and low salinity increase the effects of Dermo disease.

Chlamydia

Chlamydia are common intracellular symbionts in bivalves. Chlamydia-like organisms (CLO) can cause damage to digestive tissues. CLO are found more frequently in cultured bivalves than in wild stocks, likely because of ease of transmission or increased stress in high-density culture.

Rickettsia

Rickettsia are another common intracellular bacteria in bivalves. Rickettsia-like organisms (RLO) cause localized damage to gills, but RLO infections are rarely fatal. Like CLOs, RLOs are found more frequently in cultured bivalves than in wild populations.

[54] Elston, R.A., 1990, Mollusc Diseases: Guide for Shellfish Farmers, University of Washington.

Many marine organisms can parasitize bivalves. These can include parasitic nematodes, flatworms, and copepods. These parasites cause thickened areas of flesh called granulomas. While the number of granulomas in an infected individual is generally too low to cause impairment of function, their presence may affect the marketability of the shellfish.

Proper maintenance of the stock can effectively limit disease losses. By design, aquaculture operations are maintained at high densities relative to natural populations. The stock density (animals per unit area) must be suitable for the animal size to limit transmission of diseases. Furthermore, fouling must be managed to assure adequate flow of the seawater through the population, as poor circulation stresses the stock and can potentially increase the concentration of infective agents. Finally, scouting at appropriate intervals helps to identify problems and assure healthy stock.

Uninsurable Causes of Loss of Interest to Producers

Producers identified concerns about a number of uninsurable causes of loss during the stakeholder information gathering exercises of this study. Foremost among the concerns was the changing regulatory environment in which they operate. While the producers acknowledge the importance of appropriate regulations, the production environment created by frequent changes in leases, sanitation requirements, and food safety issues are of concern. Many of these issues affect post harvest practices and hence are not an insurable cause of loss. Even institutional risk due to quarantine is not likely to be insurable because of the challenges with rating such a risk.

Losses to pollution are a second category of loss of concern to producers that are not insurable under the Act. The movement of water in an aquaculture operation amplifies the effects of point sources of pollution. Consequently, losses are increased both within an operation and between operations. In spite of the significant impacts of major pollution events like the Deepwater Horizon oil spill, pollution should not be an insurable cause of loss, but is more appropriately addressed as a subject of civil actions.

SECTION VI. FEASIBILITY ASSESSMENT

Bivalve producers face production risks. Changes in "yield" result from causes similar to those affecting the yield of field and row crops. However, the variability in production of bivalves grown under appropriate management practices appears to be somewhat lower for bivalves than for plant crops. Under normal circumstances, barring a catastrophic event or dramatic changes in production practices, annual productivity appears to be relatively constant.

Insuring aquaculture production raises challenges that do not complicate development of crop insurance for plants. A single bivalve seed will either survive (and can then be carried to a harvestable size) or die. This rigid dichotomy is not characteristic of most crops.

Due to the unique nature of bivalve production, the feasibility analysis of a production insurance product for this sector must address not only the literature on agricultural risk, but also stakeholders' perceptions about the perils that concern them. A great many risks in the bivalve industry are managed using non-insurance approaches. For example, the crop can be moved from microenvironments where risk is temporarily high (algae bloom) to locations where the risks are lower (an average oceanic environment). Risk can be further mitigated by removing the crop from the sea for short periods (including risky periods), or it can be divided to reduce density. This division consequently manages the risks affected by proximity to other individuals. Furthermore, because there is no moment when the crop is 'ripe,' production harvest timing can be used to avoid periods of exceptional risk. Even under normal management, the crop is removed from the sea, inventoried, culled, and harvested multiple times during the production cycle. The number of times these activities are repeated allows the producer to avoid conditions that might lead to several sources/causes of production losses.

Due to seasonal variations in market price, the timing of harvest can be used to affect total crop revenues. The indefinite size for harvest allows the crop to be maintained until a time that optimizes revenue.

Regardless of their ability to limit the effects of risks on production, producers express concern about weather events and to a lesser extent disease. They are also concerned with domestic and international market outcomes that affect their revenues because these market forces affect prices received. Finally, producers expressed concern about bio-security requirements and competition; stakeholders of bivalves in general are subject to substantial institutional risks from regulations related to husbandry, quarantine, and sanitation.

Of these concerns, only weather and uncontrollable disease are typically considered insurable production perils. Loss of markets due to international competition and institutional risks, while affecting stakeholder's net revenue, are outside the purview of production (yield-based) insurance as it is typically defined.

For bivalves, there is a challenge in establishing harvest attributes so as not to provide insurance past the harvest as is required by the Act. NASS reports the value of aquaculture production sold as established by the Census of Agriculture survey instruments. While the NASS methodology is sound, the valuation is challenged by the level of industry diversity and dispersion as well as by vertical integration within the industry. To some extent, prices are implicit in the ERS reports on exported shellfish.[55] However, it is important to note the ERS reports necessarily address farmed and wild bivalves together and the ERS reports specifically note whole and processed bivalves are aggregated in their analysis.[56] While the data provide an appropriate snapshot of relative changes in bivalve harvest value over time, they are not "farm-gate" prices actually received "at harvest."

There are federal crop insurance programs that insure livestock margins and price, and nursery insurance that addresses nursery inventory rather than yield or revenue based on yield and market price as required by the contract and 7 USC 1522 (12)(C)(i). The margin and price insurance are generally structured on markets that trade in the livestock as a commodity and offer robust price discovery; no such markets exist for bivalves. The inventory insurance for nursery is based on a cumbersome, annual, contracted pricing exercise which would be difficult to duplicate for bivalves. Bivalve prices are local and reflect substantially different geographic outcomes of production. Furthermore, there are no price standards for bivalves beyond the seed stage before they are mature and harvestable. Finally, underwriting and monitoring inventory-based programs have proven to be problematic because of the relatively rapid changes in total inventory from moment to moment.

In addition to the issues raised previously, Section 2.4.1 of the SOW requires the Contractor to keep in mind the criteria of feasibility when recommending a possible insurance program. These are addressed sequentially below.

The proposed insurance coverage must conform to RMA's enabling legislation, regulations, and procedures that cannot be changed. The enabling legislation, Title 7, Chapter 36, Subchapter I of the U.S. Code, as amended has already been used to develop two crop insurance policies for bivalve aquaculture: the Cultivated Clam Pilot Program (see 2008-0116) and the Oyster Group Risk Plan (see 09-grp-oysters). The existence of these plans provides *a priori* evidence RMA's enabling legislation, regulations, and procedures that cannot be changed can support development of appropriate insurance documents for bivalve insurance. Adjusted Gross Revenue insurance in its current forms (whether AGR or AGR-LITE) have little appeal for bivalve producers. Changes in the contracts for these products would likely be required to assure appropriate and attractive coverage for bivalves under an AGR approach.

Producers or their agents must be willing to pay the appropriate price for the insurance. Since the study was initiated by an Act of Congress, there at first glance also appears to be *a priori* evidence of some stakeholder interest in insurance. Furthermore, pilots have been initiated in response to producer interest following a natural disaster (clams after the 1996 hurricane season) and through the development process supported by section 508(h) of the Act (the oyster GRP program). However, as noted previously, the willingness of producers or their agents to pay is influenced by the coverage available and the costs associated with the insurance offer. The declining participation in the clam pilot suggests there is more limited interest in broad, multi-peril insurance than the development of the existing pilots would have suggested.

[55] Clams, mussels, oysters and scallops.
[56] USDA, ERS, 2011, Aquaculture Data: Volume and value of U.S. exports of selected fish and shellfish products, http://www.ers.usda.gov/data/aquaculture/FishShellfishExports.htm, accessed May, 2011.

Furthermore, commercial named peril insurance products are available for bivalve mortality and/or loss-of-income due to named perils.

The insurance product must be effective, meaningful and reflect the actual risks of the producers. Some perils of concern to producers (pollution and regulatory barriers) are uninsurable. The producer's perception of the utility of the insurance will be greatly influenced by exclusion of uninsurable risks that affect the producer's cash flow and revenue. Coverage of insurable perils will not protect the insured from financial failure from many of the perils of concern. Producers have suggested a high deductible is an insurance construct they could endorse to gain access to *ad hoc* disaster programs. They are concerned with the low payment maximum under the NAP program introduced by the 2008 Farm Bill. Their concern appears to be catastrophic losses (though with a higher level of coverage than supported by the Catastrophic Risk Endorsement) rather than protection for smaller year-to-year yield or revenue variability.

The perils affecting production must be identified and categorized as insurable and non-insurable. Due to the nature of the crop, it is difficult to attribute changes in inventory to specific causes of loss. This attribute is no different than many other crops that can be affected by multiple causes of loss during a growing season. Attributing the exact amount of loss to any one of several causes is difficult. However, the evidence that a cause of loss occurred can be found. Substantial underwriting efforts will be required. However, the recent loss history under the Cultivated Clam Pilot insurance program suggests this is **not** an insurmountable barrier.

Be ratable and operable in an actuarially sound manner. Excepting the data collected by RMA for the existing pilot programs, there are no public data to allow rating or underwriting of operation-level yield variability. Published regional data are also limited. Private data documenting regional yields is confidential and sometimes closely held. The Contractor believes in the current environment, it is not feasible to collect sufficient production data for traditional insurance development efforts. Some measure of productivity can be extracted from data on inventories (e.g., the inventory data collected under the Cultivated Clam Pilot program), but the precision of this extrapolated productivity assessment would not be at a level normally used in rating crop insurance. It may be possible to collect production data by survey, particularly in areas where producers have expressed an interest in bivalve insurance for oyster crops. The success of these efforts would depend on participation levels since an unbiased sample would be necessary for insurance development efforts. Such a survey would be limited by the constraints imposed by the Paperwork Reduction Act. At the present time, availability of data for rating is a barrier to feasibility.

Contain underwriting, rating, pricing, loss measurement, and insurance contract terms and conditions. While most diseases are controllable and their impact on production manageable, the conditions which substantially impact production from operation to operation or time to time are limited named perils (generally catastrophic weather events) for which some insurance is commercially available. It is possible to structure an inventory-based policy for these perils similar to the product available for cultivated clams. However, market acceptance would be influenced by price. The experience with participation in the Cultivated Clam Pilot program suggests acceptance of such a product would be limited.

The Contractor spoke to buyers of bivalves at a number of seafood wholesalers. In every case the prices offered were based on the species, supply, demand, the size of the individual bivalves, the waters where the crop was grown and the existing relationships between the producer and the buyer. In other words, every sale is unique and not governed by broader markets. This appears to be the case for both domestic and imported production. No organized exchanges offer futures contracts for live clams or processed clam products (frozen clams, clam meat, etc.). Historical aggregate data are available for purchase. In spite of extensive efforts, the Contractor was unable to identify any long-term data series for farm-level prices, in either public or private domains that were collected and managed by consistent methods. Nonetheless, in the shorter term, the data collected by Urner Barry and by NOAA could be used to establish prices for insurance purposes. Due to the large differences in prices realized, it is unclear if these generic prices would be accepted by producers as a basis for insurances. Some testimony suggested "any insurance" would be welcomed, while others argued it was better to be covered under programs for uninsured crops than to be insured by a program that did not reflect individual producer's financial circumstances.

There must be an appropriate geographic distribution of production to ensure a sound financial insurance program. The Contractor understands this requirement to apply to the FCIC portfolio, which is distributed throughout the United States. Furthermore, the bivalve sector has wide geographic distribution, even if individual species and varieties are grown in more limited geographic areas. This requirement is not seen as an insurmountable barrier to feasibility. That being said, there are two geographic barriers to development. The first is the limited production area within the country, the individual states, and even within individual counties. The risk within the production region (at any scale) is not uniformly spread geographically. Consequently, it is conceivable that producers in areas with limited risk will be less likely to participate than producers in regions with greater risk. Map areas for premium rates most likely would be needed to appropriately match the risk to the rate.

There must be enough interest for the risk to be spread over an acceptable pool of insureds. The Contractor understands this requirement also applies to the FCIC portfolio, which involved more than 1.1 million policies and almost $80 billion of insured liability in 2010. However, the Contractor has noted there was no evidence of broad interest among the bivalve aquaculture stakeholders in most regions for bivalve production insurance.

Customers must not be able to select insurance only when conditions are adverse. The occurrence of potentially insurable perils of greatest concern (weather perils) cannot be predicted by the insured. However, some production units are more susceptible to the impact of adverse weather. Consequently, although adverse selection based on conditions is not possible, adverse selection based on location is possible unless the insurance is appropriately structured. Developing county, bay, estuary, or seabed maps of special risk areas would be a daunting and potentially costly task. However, some insurance structure that recognizes individual risk profiles will be important to assure broad participation in an insurance program.

Moral hazards must be avoidable or controllable. Avoiding moral hazard would require substantial underwriting constraints. This requirement has already been demonstrated in the Cultivated Clam Pilot program. Data for development of the underwriting for species other than clams are limited at best. Although generic appropriate practices can be identified, at the present time, the information asymmetries need to be overcome, requiring a rigorous development effort. Without substantial underwriting efforts, inventory insurance introduces substantial opportunities for fraud, waste, and abuse when the inventory and its valuation are both controlled by the producer.

There can be no chance of beneficial gain. Avoiding the potential for beneficial gain would also require the underwriting constraints described previously. The information asymmetries that exist can only be overcome by substantial and rigorous development effort.

There must be no unacceptable change in market behavior or unacceptable market distortions in terms of either a change in quantity supplied or shift in the supply curve. The industry is minute and subject to substantial changes from year to year. Market forces shape many operational decisions, including harvest times. While market forces will also influence the purchase of insurance, it is unlikely the introduction of appropriately-rated production insurance would change market behavior noticeably. Other market forces will continue to dominate the behavior of the markets and render the effects of crop insurance on the markets less significant. A particular challenge in considering the feasibility of bivalve insurance is the long and somewhat flexible production period.

It does not appear a simple yield policy is feasible for the bivalve industry. Some issues with the adjusted gross revenue insurance products, as they exist, have already been delineated. If a gross revenue approach is to be used for bivalve aquaculture, a development effort to provide an appropriate structure, policy materials, and rating for the industry would need to be undertaken. In such a development, consideration of the incorporation of hatchery and nursery operations as diversifying factors could be undertaken. Moreover, the role of diversification in establishing maximum coverage levels would have to be reexamined to address the specific needs of aquaculture. Diversity of an operation might include different species, different markets, different practices (e.g., on bottom or suspended, in cages or planted out), and geographic factors (e.g., east side or west side of a bay). All these introduce elements of diversity that should buffer the effects of a perilous event on the overall productivity of an operation, and consequently on the effects of that productivity on gross revenues.

An appropriately structured gross revenue product could be attractive to a segment of the industry and might address their risk management needs in a way that was attractive to the insurance industry as well At the same time, some of the moral hazards of yield and inventory based approaches might be mitigated. It is worth noting that many aquaculture operations are vertically integrated, and therefore revised underwriting rules would require special consideration in an AGR framework.

SECTION VII. APPLICABILITY OF THE EXISTING ADJUSTED GROSS REVENUE INSURANCE PRODUCTS TO BIVALVE AQUACULTURE PRODUCTION

AGR and AGR-Lite, as they are currently structured, are not suited for most bivalve aquaculture operations. AGR and AGR-Lite policies insure the revenue of an entire farm rather than insuring the yield of or revenue from an individual crop. Both plans use information from the producer's Schedule F tax forms and current year expected farm revenue to calculate the revenue guarantee.

AGR

The AGR insurance was first offered for crop year 1999. The pilot provides protection against low revenue resulting from unavoidable natural events and market fluctuations during the insurance year. Covered revenue includes income from agricultural commodities, as well as limited amounts of income from animals and animal products (including production from aquaculture in “a controlled environment.”)[57]. The Standards Handbook, Policy Provisions, and Crop Insurance Handbook are mute on the meaning of “controlled environment.” Consequently, the Contractor has interpreted this phrase to indicate the collected aquaculture crop does not consist exclusively of “wild” individuals.[58]

AGR coverage is available to U.S. citizens or legal residents who:

- Have structured their operation in the same way for tax purposes for seven years, unless a change in an operation’s tax structure is reviewed and approved by the insurance provider;
- Produce agricultural commodities primarily in pilot counties (and contiguous non-pilot counties);
- File a calendar-year or fiscal-year farm tax return;
- Have liability not exceeding $6.5 million;
- Purchase traditional federal crop insurance, if available, when more than 50 percent of expected income is from insurable commodities; and
- Earn no more than 35 percent of expected allowable income from animals and animal products.

These constraints, and especially the allowable limit on animal products, provide substantial barriers to participation in the AGR program by bivalve producers, most of whom have bivalve aquaculture as their sole agricultural activity. Furthermore, the premium structure is based on the diversity of the production. This creates a disincentive to participate since rates for operations with limited diversity are substantially higher than the perceived or actual risks faced by bivalve aquaculture producers. The Contractor acknowledges most persons involved in aquaculture produce one or at most two species. Hence, disaggregating bivalve production into individual species will not resolve this issue. Participants in the industry argue that production methods (bottom culture, floats, etc.) are effectively different crops. In addition, they argue that a nursery produces a different crop than the crop produced in the grow-out phase. In other words, they wish to see a single species disaggregated into multiple production practices and production operations to achieve a diversity score.

[57] USDA, RMA, 2007, Adjusted Gross Revenues Standards Handbook, FCIC-18050 (1-2007), page 7.
[58] Especially for crops raised on the bottom, exclusion of wild individuals would be nearly impossible.

The insurable causes of loss for AGR insurance include revenue loss due to "unavoidable natural occurrences during the current or previous insurance year or due to market fluctuations that cause a revenue loss during the current insurance year."[59] "Negligence, mismanagement, or wrongdoing by the policyholder, the policyholder's family, household members, tenants, employees, or contractors; crop abandonment; and bypassing of acreage" are not insurable causes of loss.[60]

The requirement that an aquaculture operation be structured in the same way for tax purposes for seven years likely discourages consideration of AGR by some bivalve aquaculture producers. Several stakeholders indicated their operations changed substantially over relatively short time periods. Entry into the industry is encouraged by existing participants. Many operations recruit family members to join the business as success allows such expansions of ownership and responsibility. In some regions, hatchery and nursery operations (i.e., vertical integration) are incorporated into existing grow-out entities. In both cases, the form of ownership may change from individual to partnership to subchapter S corporation to another form of a "person" as defined by the Basic Provisions.

Many producers do not prepare their own taxes. The IRS indicates aquaculture operations can be appropriately reported on IRS schedules C or F.[61] The requirement that the revenue be reported on Schedule F thus may present an impediment for some producers. Many aquaculturists were fisherman who transitioned to aquaculture production as populations of wild bivalves became more limited. It is less common for a farmer or rancher to become a bivalve aquaculturist. Consequently, a choice to use schedule C to report the enterprise income for tax purposes may present a barrier to eligibility for insurance, especially for vertically integrated enterprises. There is some flexibility in the use of Schedule F data in the establishment of an insurance contract for AGR insurance. The standards for AGR allow for the preparation of substitute Schedule F forms, while AGR-Lite allows "other IRS Schedules that contain allowable income and expense information" to be used. Nonetheless, the additional paperwork and bookkeeping requirements may be perceived by producers as a barrier to participation.

AGR insurance is available in all counties in Connecticut, Delaware, Maine, Massachusetts, New Hampshire, New Jersey, Rhode Island, and Vermont, as well as in specified counties in California, Florida, Idaho, Maryland, Michigan, New York, Oregon, Pennsylvania, Virginia, and Washington. Consequently, as currently available, AGR would exclude insurance of bivalve aquaculture in Alaska, Georgia, Hawaii, Louisiana, Massachusetts, Mississippi, North Carolina, South Carolina, and Texas. Adjustments to the counties where AGR insurance is available would be required to provide bivalve aquaculture insurance in all counties in New York and Washington where bivalves are farmed.

AGR-Lite

The AGR-Lite insurance was first offered for crop year 2003. Like the AGR pilot, the AGR-Lite insurance provides protection against low revenue resulting from unavoidable natural events and

[59] USDA, RMA, 2007, Program Aid Number 1906, http://www.rma.usda.gov/pubs/rme/agr.pdf, accessed July, 2011.
[60] USDA, RMA, 2007, Adjusted Gross revenue-Lite Policy Provisions (07-AGR-Lite), http://www.rma.usda.gov/policies/2007/agr-lite.pdf, accessed August, 2011.
[61] Internal Revenue Service employee 1000221259, personal communication, July, 2011.

market fluctuations during the insurance year. Covered revenue includes income from agricultural plants, animals (including production from aquaculture in "a controlled environment"[62]), and animal products (such as eggs and milk).

The eligibility for AGR-Lite is similar to that for AGR, with the exception that the liability limit for AGR-Lite is $1 million and the limitation on animals and animal products is modified from an upper limit on the percentage of gross income that is allowable (AGR) to a provision that allows rejection of the application if the underwriting capacity for livestock has been exceeded. The constraint on liability introduces an occasional barrier to participation. Most operations are small, but an increase in size is an almost universal goal among producers. The issues with premium structure, as well as issues with coverage level links to diversity of production were clearly identified by producers as barriers to participation. The insurable causes of loss for AGR-Lite are consistent with those identified for AGR. The requirement that an aquaculture operation be structured in the same way for tax purposes for seven years likely discourages consideration of AGR-Lite by bivalve aquaculture producers. As noted previously, stakeholders indicated their operations changed substantially over relatively short time periods. One final barrier to participation is the requirement that the revenue be reported on Schedule F. While this seems logical once a producer has decided to participate in the AGR-Lite program, the requirement for historical records, which reflects appropriate underwriting standards, might require substantial changes in tax documents already filed and introduce challenges regarding documentation of the break-out of expenses into various aspects of a vertically integrated operation.

AGR-Lite is available in Alabama, Connecticut, Delaware, Florida, Georgia, Hawaii, Maine, Maryland, Massachusetts, New Hampshire, New Jersey, North Carolina, Oregon, Rhode Island, South Carolina, Tennessee, Utah, Vermont, Virginia, Washington, West Virginia, Wisconsin, and Wyoming, as well as in specified counties in Alaska, New York, and Pennsylvania. Consequently, as currently available, AGR-Lite would exclude insurance of bivalve aquaculture in California and Louisiana, two states with substantial production already, and in Mississippi and Rhode Island, states with appropriate coastal waters for such production. Depending on the location of production, adjustments might need to be made in the counties in Alaska where AGR-Lite is available.

Conclusions Regarding the Adjusted Gross Revenue Insurance Approach for Insurance of Bivalve Aquaculture Production

There are many attractive elements of the adjusted gross revenue approach for insurance of bivalve aquaculture production. It eliminates some issues related to maintenance of a crop inventory, it establishes a clear set of documentation requirements, and it incorporates IRS fraud penalties as an incentive for appropriate behavior. That being said, simply insuring producers through the existing AGR and/or AGR-Lite products is sure to minimize participation by the aquaculture producer population in crop insurance programs. This has important implications for producer eligibility for both operating loans and disaster payments.

[62] USDA, RMA, 2007, Adjusted Gross Revenues Standards Handbook, FCIC-18050 (1-2007), page 7.

SECTION VIII. SUMMARY OF FINDINGS

Although modest in size, the U.S. bivalve aquaculture industry is vibrant and energetic. It has tremendous potential for growth and the potential to replace imported shellfish with domestic production. Currently, the United States imports more than 80 percent of its seafood, with approximately half of those imports derived from aquaculture operations. While the U.S. agricultural trade balance is favorable, the seafood trade deficit has grown to over $9 billion. According to the 2010 United Nations Food and Agriculture Organization report on the State of World Fisheries and Aquaculture, the United States ranks 13th in total aquaculture production. Total U.S. aquaculture production is about $1 billion annually. Only about 20 percent of U.S. aquaculture production is of marine species; the farming of bivalves accounts for about two-thirds of total U.S. marine aquaculture production.[63]

The bivalve aquaculture industry in the United States is extremely diverse. The 2005 Census of Aquaculture and the 2007 Census of Agriculture reports document mollusk farming off shore from every coastal state with the exception of Alabama, Delaware, Mississippi, and Texas. Mollusk aquaculture was reported in Alabama and Texas in the 1998 Census of Aquaculture. A wide variety of species are produced. Good management practices are diverse, within a state and for a species. The production is managed for a variety of markets, including niche markets. This pattern is best illustrated by the number of sizes by which the hard clams are marketed.

Most bivalve aquaculture producers have modest operations. Nonetheless, stakeholders report an increase in the number of employees on a "typical" operation and establishment of production as a primary source of income. As the industry has matured over the last decade, vertical integration within individual operations has increased. Consequently, a single operation may include hatchery, nursery, grow-out, processing, and even trucking. Less common is the incorporation of wholesale and retail sales into a grow-out operation. One effect of the increased complexity and sophistication of bivalve farms is higher capital costs. This in turn increases the need for risk management strategies, including crop insurance.

As in most agricultural ventures, lending institutions tie operating loans to availability of and participation in insurance programs. Consequently, development of the industry is inhibited by the limited availability of appropriately priced insurance, while availability of insurance is limited by the size of the industry. A few producers indicated NAP provided sufficient "protection" to get a new start after a catastrophic loss. However, the limitations on NAP payments make this true for only the smallest operations. Where FCIC insurance is available, producers outside the pilot area feel they are at a substantial disadvantage.

Over the course of interactions with stakeholders, the Contractor gathered feedback (Appendix A) from 27 producers, 4 processors, 5 extension officers, and 4 individuals representing the insurance industry. While stakeholder input nationwide addressed concerns about the impact of weather and regulatory requirements, much of the feedback was regionally disparate. In the Gulf Coast, much of the producer concern was tied to the potential for losses to pollution, reflecting the Deepwater Horizon spill. In the Northeast and Northwest, concerns focused on catastrophic

[63] United States Department of Commerce, National Oceanic and Atmospheric Administration, 2011, Aquaculture in the United States, http://aquaculture.noaa.gov/us/welcome.html, accessed July, 2011

weather and the implementation of regulatory programs increasing the cost of operations. Collectively, more than three quarters of respondents expressed the need for risk management related to weather; only a few producers discussed the potential for losses to disease and predation. Instead, regulatory issues and pollution were the predominant themes after the weather.

While AGR/AGR-Lite products seem an attractive insurance option for bivalve producers, some expressed concerns that the requirements for this insurance are particularly burdensome for the industry. Limited diversification of production reduces the maximum amounts of insurance and coverage levels available to producers. Market vulnerability is not an insurable cause of loss under any federal crop insurance program, and should not be; yet separating the effects of the international market forces driving much of the revenue from farm-level price issues requires data that are currently not available.

The lack of publicly available production data makes the prospect for development of meaningful premium rates infeasible unless private data is obtained. Only in Virginia and the Pacific Northwest were there indications that farm-level data could and would be supplied for a development effort. As the Contractor is aware from numerous previous efforts, the potential for suitable data and obtaining the data itself are very different things. The Contractor's efforts to obtain any of these private data were not successful. Producers in other areas were either indifferent to the requirements for development of an RMA product, satisfied with the products available under the pilot programs, or too involved in their production activities to take time to communicate with the Contractor.

Any development effort would be challenging and could not simply mirror a field crop development effort. Producers did not express a high degree of satisfaction with the existing Cultivated Clam program; hence, a new model likely will be needed. To be feasible and successful, in addition to being supported by appropriate production and pricing data, any development would need to:

- Address the many unique aspects of production of bivalves, including the substantial diversity between types and locales;
- Acknowledge substantial producer and unit level differences in production and production potential;
- Incorporate appropriate underwriting. Fortunately, good management practices in these regions are more clearly delineated than they were ten years ago. Simply defining predominant practices is a basic essential to developing any product and has been very difficult to date.
- Obtain sufficient producer-level (or unit-level) production data over a series of years in a geographic region representative of the proposed pilot region. Ideally, these would represent a diversity of producers within the region and contain yield information in consistent terms through time.
- Obtain broadly representative market pricing information over a series of seasons (as production is marketed year-round, a continual series would be more useful than annual aggregations) for the equivalent of "farm-gate" production before any post harvest value-added costs are incurred.

As the industry grows nationwide and matures in other states, the lessons learned in the existing Cultivated Clam Pilot and Louisiana Oyster GRP pilot might support the expansion of the industry and the subsequent improvement of the existing risk management tools. However, under the requirements for feasibility outlined in the Statement of Work (SOW) for this study, with currently available data, development of crop insurance for bivalve production is not feasible.

Appendix A

Stakeholder Input

Exhibit 1. Listening Session Agenda
Exhibit 2. Stakeholder Comments
Exhibit 3. Sources of Producer Input

Exhibit 1. Listening Session Agenda

Bivalve Aquaculture Insurance Feasibility Study Listening Session Agenda

Introductions

- Watts and Associates, Inc.
- Attendees

W&A is under contract with the United States Department of Agriculture Risk Management Agency to make an assessment of feasibility under the Crop Insurance Act

- Background Information
    - FCIC Insurance Feasibility Contracts
    - W&A History and Capabilities

Purpose

- Identify risks
- Identify insurance issues
- Identify interest in federally subsidized crop insurance

Feedback

- Interest
- Risks
- Production Activities
- Markets
- Available Data

Questions

Exhibit 2. Stakeholder Comments (sorted by theme[1])

[1] Comments were made by producers unless marked with an (e) to identify a comment made by an extension agent, an (i) to identify a comments made by an insurance industry stakeholder, or a (pr) to identify a comment made by a processor. The Contractor believes all processors who made comments were also producers.

Comments addressing whether producers have knowledge of crop insurance programs

If the price is right I would be interested.

I would be interested.

Depends on the price.

How much would it cost?

After the spill we didn't get a dime from the insurance.

The insurance we have isn't worth a [expletive deleted].

I buy the clam insurance but it hasn't paid off yet.

The NAP insurance [sic] *is all I need.* (pr)

Where can I get a copy of a policy?

Does the government insurance cover me for liability?

How about business interruption?

I don't believe there is insurance available in North Carolina for oysters.

There's a lot of history in Florida that has created the problem there. (i)

For AGR, very few people farm more than one species.

AGR rates are three times what they should be. (i)

I don't see anyone being willing to buy AGR [as it is currently structured]. (e)

The GRP approach might be a reasonable thing to do.

We're interested.

Our company has been coming to the table [to discuss insurance with the Government] *for three years.*

Either revise the insurance or drop it.

We [don't feel] *people at RMA have been listening.*

There are a lot of companies that feel the product doesn't reflect current practices.

The unit structure doesn't reflect our risk or practices. Two separate areas with separate leases are treated as a single entity when they can't be treated that way.

It doesn't make sense to base aquaculture insurance on the structures for land based crops.

The definitions in the [clam] *insurance just don't make sense the way things are done.*

We are just good at what we do and pray for good weather.

This is apples [field crops] *and oranges* [aquaculture].

The risks in the clam insurance are the ones that matter.

A catastrophic policy is what we need.

We would buy-up.

We need something different from what we have.

Comments addressing producers risk management needs

Salinity doesn't affect everyone in the [bay or estuary] *the same.* (e)

The current insurance risks are right: salinity, freeze, hurricane, storm surge.

What species would be covered?

For AGR, very few people farm more than one species.

What risks would be insured? We just don't see losses outside normal attrition.

The Army Corps [of Engineers] *is really messing with our crops.*

The GRP approach might be a reasonable thing to do.

Each operation is different. Even two sides of a stream will be different.

Either revise the insurance or drop it.

Sit down and talk with us about how we actually do things.

The unit structure doesn't reflect our risk or practices. Two separate areas with separate leases are treated as a single entity when they can't be treated that way.

Crops a short distance away may have totally different productive potential.

We are just good at what we do and pray for good weather.

Major weather events are our biggest concern.

We try to control everything we can.

The risks in the clam insurance are the ones that matter.

A catastrophic policy is what we need.

We would buy-up.

We need something different from what we have.

We are open to anything that will give us some [coverage].

Comments addressing willingness to participate in a crop insurance program

If the price is right I would be interested.

I would be interested.

Depends on the price.

How much would it cost?

The insurance we have isn't worth a [expletive deleted].

The NAP insurance [sic] *is all I need.* (pr)

AGR rates are three times what they should be. (i)

I don't see anyone being willing to buy AGR [as it is currently structured]. (e)

The industry is growing and we need insurance to keep it growing.

The GRP approach might be a reasonable thing to do.

Our company has been coming to the table for three years.

We're frustrated.

Either revise the insurance or drop it.

There's a lot of money in aquaculture. If we could just get started with something that works for aquaculture….

A catastrophic policy is what we need [for oysters].

We would buy-up.

We need something different from what we have.

We are open to anything that will give us some [coverage].

Comments addressing what improvements are needed to enhance the effectiveness of the existing insurance programs

The NAP insurance [sic] *is all I need.* (pr).

There's a lot of history in Florida that has created the problem there. (i)

Florida is an outlier.

What species would be covered?

I don't see anyone being willing to buy AGR [as it is currently structured]. (e)

Each operation is different. Even two sides of a stream will be different.

Either revise the insurance or drop it.

The unit structure doesn't reflect our risk or practices. Two separate areas with separate leases are treated as a single entity when they can't be treated that way.

There is a lot of interest [in Virginia] *in sharing our thoughts about how the insurance* [could be improved or should be structured].

It doesn't make sense to base aquaculture insurance on the structures for land based crops.

Crops a short distance away may have totally different productive potential.

The definitions in the [clam] *insurance just don't make sense the way things are done.*

The 30% [natural] *loss has nothing to do with our reality.*

We [Virginia] *have what it takes to develop a program that is actuarially sound.*

Comments addressing other concerns or issues with insurance

After the spill we didn't get a dime from the insurance.

Salinity doesn't affect everyone in the [bay or estuary] *the same.* (e)

The current insurance risks are right: salinity, freeze, hurricane, storm surge.

There's a lot of history in Florida that has created the problem there. (i)

Florida is an outlier.

The industry is growing and we need insurance to keep it growing.

The GRP approach might be a reasonable thing to do.

Each operation is different. Even two sides of a stream will be different.

Regardless of the insurance structure, we will manage our crop to get the best crop. The insurance is asking us to use practices that have been obsolete for 20 years.

There are a lot of companies that feel the product doesn't reflect current practices.

The unit structure doesn't reflect our risk or practices. Two separate areas with separate leases are treated as a single entity when they can't be treated that way.

There is a lot of interest [in Virginia] *in sharing our thoughts about how the insurance* [could be improved or should be structured].

It doesn't make sense to base aquaculture insurance on the structures for land based crops.

Crops a short distance away may have totally different productive potential.

The definitions in the [clam] *insurance just don't make sense the way things are done.*

There's a lot of money in aquaculture. If we could just get started with something that works for aquaculture….

This is apples [field crops] *and oranges* [aquaculture].

Major weather events are our biggest concern.

The risks in the clam insurance are the ones that matter.

A catastrophic policy is what we need.

We would buy-up.

We need something different from what we have.

We are open to anything that will give us some [coverage].

We have what it takes to develop a program that is actuarially sound.

Comments addressing any issues, policy limitations or other factors associated with the existing pilot insurance programs that have inferred or required the growers to change there farming practices to meet insurability requirements

Regardless of the insurance structure, we will manage our crop to get the best crop. The insurance is asking us to use practices that have been obsolete for 20 years.

There are a lot of companies that feel the product doesn't reflect current practices.

The unit structure doesn't reflect our risk or practices. Two separate areas with separate leases are treated as a single entity when they can't be treated that way.

Comments addressing potential underwriting requirements

There's a lot of history in Florida that has created the problem there. (i)

Florida is an outlier.

The GRP approach might be a reasonable thing to do.

Each operation is different. Even two sides of a stream will be different.

Either revise the insurance or drop it.

Regardless of the insurance structure, we will manage our crop to get the best crop. The insurance is asking us to use practices that have been obsolete for 20 years.

There are a lot of companies that feel the product doesn't reflect current practices.

The unit structure doesn't reflect our risk or practices. Two separate areas with separate leases are treated as a single entity when they can't be treated that way.

We can track stuff month to month with oysters [but not with clams].

There is no question we know what goes in and what comes out.

We keep track of bags, cages, lines. We all do that.

Even if it is under a net, we know what we have.

The 30% [natural] *loss has nothing to do with our reality.*

Every clam counts. We know what we have.

Virginia has reasonably mature clam and oyster industry. We have enough shellfish aquaculture going on to merit further study.

We have what it takes to develop a program that is actuarially sound.

Comments addressing what type of risk management model/plan of insurance would be appropriate for the crop

The NAP insurance [sic] *is all I need.* (pr)

For AGR, very few people farm more than one species.

AGR rates are three times what they should be. (i)

I don't see anyone being willing to buy AGR [as it is currently structured]. (e)

The industry is growing and we need insurance to keep it growing.

The GRP approach might be a reasonable thing to do.

Either revise the insurance or drop it.

There is a lot of interest [in Virginia] *in sharing our thoughts about how the insurance* [could be improved or should be structured].

It doesn't make sense to base aquaculture insurance on the structures for land based crops.

There's a lot of money in aquaculture. If we could just get started with something that works for aquaculture….

This is apples [field crops] *and oranges* [aquaculture].

A catastrophic policy is what we need.

We would buy-up.

We need something different from what we have.

I would need to talk to people about how they feel about an inventory approach to insurance.

We are open to anything that will give us some [coverage].

Comments addressing pricing for the crop

I pay as little as I can. (pr)

I sell for what the market will bear.

Each sale is a one-off deal. (pr)

There isn't really a market price. What I can sell a clam for affects what I am willing to pay. (pr)

Comments addressing data availability

I have thirty years of records that I could share.

I have production data from 2000 through the current year.

I would share my records, but I'm not sure you could understand them.

We [don't feel] *people at RMA have been listening.*

We can track stuff month to month with oysters [but not with clams].

There is no question we know what goes in and what comes out.

We keep track of bags, cages, lines. We all do that.

Even if it is under a net, we know what we have.

The 30% [natural] *loss has nothing to do with our reality.*

Every clam counts. We know what we have.

Most of my records are paper records prior to last year.

We would open our books.

We would be happy to collate our records for you.

Exhibit 3. Sources of Stakeholder Input

Sources of Stakeholder Input (by State)

Input was obtained from stakeholders in the states shaded green.