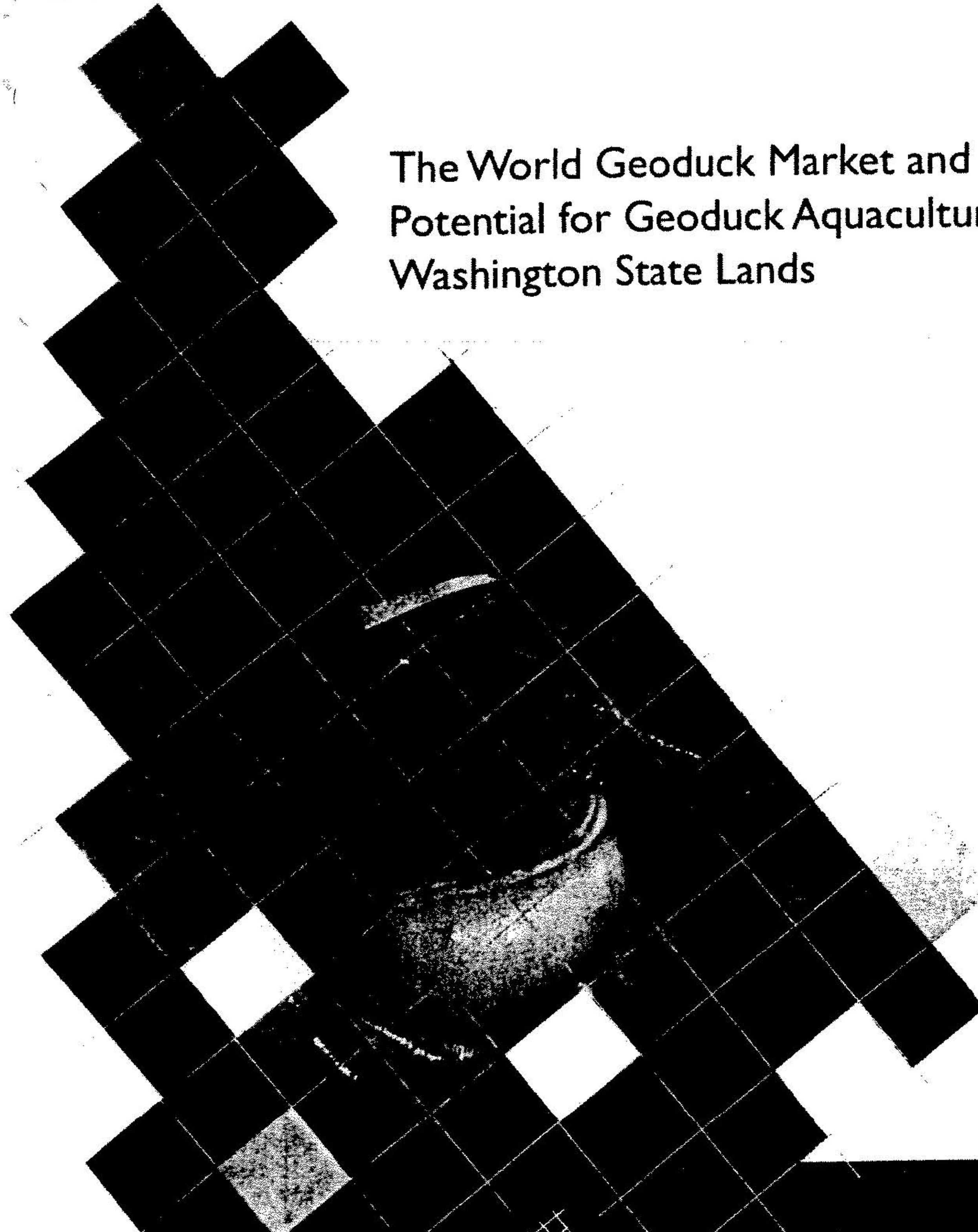
The World Geoduck Market and the Potential for Geoduck Aquaculture on Washington State Lands



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Foreword

This document has been written in a "journalistic style," which presents the most important information to the reader at the beginning of the report in the executive summary. More detailed and ancillary information are contained in the main body of the report which follows the executive summary. The same style is used within each section of the report—the most relevant points are discussed first with remainder of the section providing details that support those findings. Therefore, we encourage the readers to proceed from front to back—skipping to the end of the study to find the conclusions will be unproductive because the conclusions are in the front.

We also encourage readers to examine the footnotes contained in the document. In general, the footnotes provide ancillary information that the authors believe to be important and useful, but which is not provided in the main text so as not to obscure the primary focus of the analysis.

Acknowledgements

The authors of this report wish to acknowledge the assistance of the government officials, market experts, scientists, growers, and wild harvesters we interviewed for this report. Their cooperation made this report possible. We would also like to thank the staff of the Washington Department of Natural Resources and the Washington Department of Fish and Wildlife for their invaluable assistance.

Abbreviations

ACTED	Aquaculture Center for Training, Education, and Demonstration
ADF&G	Alaska Department of Fish & Game
DFO	Canada Department of Fisheries and Oceans
FAO	United Nations Food and Agriculture Organization
HBOI	Harbor Branch Oceanographic Institute
MT	metric tons
NASS	National Agricultural Statistics Service
NMFS	National Marine Fisheries Service
OPI	Ocean Products, Inc.
Project OCEAN	The Oyster and Clam Educational Aquaculture Network
PRR	product recovery rate
PSP	paralytic shellfish poisoning
RCW	Revised Code of Washington
SARS	Severe Acute Respiratory Syndrome
WAC	Washington Administrative Code
WADFW	Washington Department of Fish and Wildlife
WADNR	Washington Department of Natural Resources
Project WAVE	Withlacoochee Aquaculture Vocational Education
USDA	U.S. Department of Agriculture

Executive Summary

Conclusions

The world geoduck market is on the cusp of important changes. This dynamic market, which experienced several transitional periods in the last three decades, is again facing a major change with the advent of inter-tidal geoduck aquaculture. While potential growers have tried to culture geoduck sub-tidally for several decades, only within the last half decade have growers interested in inter-tidal culture succeeded in developing commercially viable techniques for raising geoduck seed and protecting that seed from planting until harvest. These accomplishments have the potential to radically change the geoduck market by increasing supply and changing current distribution channels.

The State of Washington now faces an important decision about whether to allow private geoduck aquaculture on state lands. This decision is multi-faceted: it must include economic, biological, ecological, and social factors. This study focuses primarily on the economic factors of the decision. If the State allows geoduck culture on its lands, it could establish a new source of income that would benefit the people of Washington State. It could also support the development of an emerging industry in Washington with the potential to provide more jobs to state residents. However, private geoduck growers are already in the process of planting geoduck seed on dozens of acres of private inter-tidal land. These growers have the potential to significantly increase the amount of geoduck on the world market. Thus, production on state lands could contribute to a glut in production if the market is unable to readily accept the increased supply from private lands. Such a glut would negatively affect both growers and wild harvesters. So, will production on state lands be economically good for the State of Washington, its citizens, and the shellfish companies based in the State? This study attempts to answer that question.

The study, by topic, concludes the following:

World Wild Production

- Based on expert interviews, the study does not expect significant increased wild production from the three major suppliers of Pacific geoduck: Washington, Alaska, and British Columbia. Wild production from all three sources will continue to be from sub-tidal sources while any farmed production is likely to come from inter-tidal sources (see Section 2.2).
- The study does not expect significant production, or competition, from sources of other geoduck species such as Argentina, Chile, Mexico, or New Zealand. Each of these sources/species faces significant challenges such as limited market acceptance, poor product quality, insufficient infrastructure, or restrictive government regulation. The study does not believe that any of these locations will become a significant source of wild or farmed geoduck in the next five to ten years (see Section 2.2).

Washington-Based Geoduck Culture

- Washington-based companies are already producing aquacultured geoduck on private inter-tidal beds. These companies have the potential to become the dominant players in cultured geoduck production and in the world geoduck market. Production levels from these facilities will continue to rise for the foreseeable future as existing farms increase production and new companies begin production (see Section 3.2).

- The study estimates that the State of Washington produced roughly 4.5 million to 6 million geoduck seed to the planting stage from certified hatcheries in 2004 and planted more than 25 million seed over the last five to seven years. This amount of seed production, which could increase with additional effort by the hatcheries, is enough to fully seed 34.5 to 46 acres of inter-tidal lands per year at standard stocking densities. At an initial stocking density of roughly 3 animals per square foot, the study estimates that this level of seed production is enough to support 172.5 to 322 acres of productive lands in a five to seven year rotating cycle (see Section 3.2).
- This level of seed production will significantly increase the world supply of geoduck and could more than double the amount of product currently produced in the State of Washington. Table ES-1 shows the estimated amount of annual increased production that might be expected from 2004 seed production if all that seed were planted this year and harvested in the same year in the future.[1] The estimates are based on a production-to-planting utilization rate of 90 percent, a planting-to-harvest survival rate of 40 percent to 70 percent, an average harvest weight of 1.8 pounds per animal, and an assumption that all of the animals are harvested at the same time. Estimates of farmed production range from a low of 2.9 million pounds to a high of 6.8 million pounds (see Section 3.2).

  The study team believes that within five to seven years a production level of between 4.3 and 5.1 million pounds (the average projected production level at a 50-60 percent survival rate) is very achievable based on current survival rates and information from industry sources. In 2003, Washington growers using private lands reported producing roughly 484,000 pounds of Washington's 4.8 million pounds of production (WADFW 2004). Growers would raise Washington's annual harvest levels by 79 percent over current levels if they produced 4.3 million pounds per year of farmed product. Production would be raised 97 percent with an annual farmed production level of 5.1 million pounds. These amounts would raise world production from current levels by 43 percent and 53 percent respectively. These amounts are separate from any production that might occur on state lands (see Section 3.2).

Table ES-1. Projected Future Farmed Production Based on 2004 Seed Production

Seed Survival Rate (%)	Low End	Average	High End	Percent Increase over 2003 Washington Production	Percent Increase over 2003 World Production
40	2,916,000	3,402,000	3,888,000	61.48	33.55
50	3,645,000	4,252,500	4,860,000	79.40	43.33
60	4,374,000	5,103,000	5,832,000	97.32	53.11
70	5,103,000	5,953,500	6,804,000	115.24	62.89

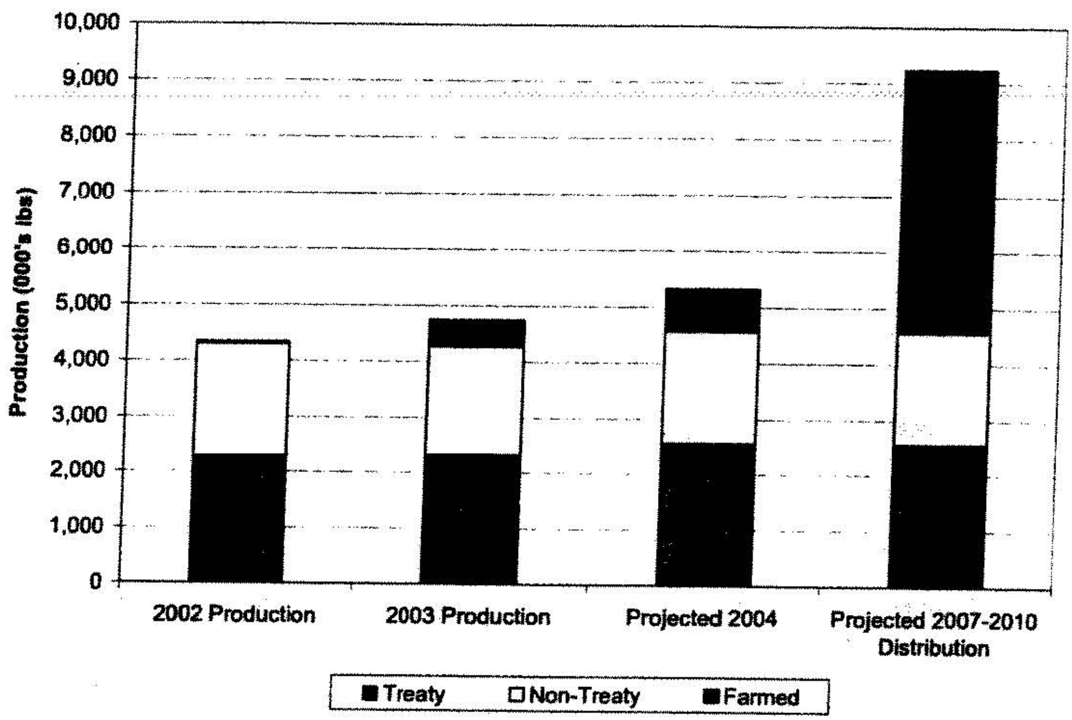
Source: Study Interviews and Northern Economics Projections.

Actual production levels could be higher or lower depending on a variety of factors, such as seed utilization rate, post-planting survival rate, and actual seed production levels.

[1] For convenience, the study assumes that all of the seed that is planted in one year is harvested in aggregate in the future. While this probably won't be the case, if the growers plant roughly the same amount of seed in each year and harvest on a consistent schedule, then their long-term average harvest should be roughly equivalent to the production that could be expected from one year's production of seed.

- The study did not find indications that treaty and non-treaty wild harvests will grow over the next decade (Sizemore 2004). We expect new growth will come primarily from culture production. If the study's projections are accurate, the growth in farmed production will radically change the amount and distribution of Washington's geoduck production and farmed production will become the dominant supplier of Washington geoduck to the world market (See Figure ES-1) (see Section 3.2).

Figure ES-1. Projected Production in Five to Seven Years vs. 2002-2003 Average Production



Source: Washington Department of Fish and Wildlife Data (2004) and Northern Economics, Inc. Projections.

- The supply of available, viable, private tidelands is limited, and Washington growers believe that most of the viable land for inter-tidal culture is already in production. Thus, the growing community is looking to state lands, both inter-tidal and sub-tidal, to relieve this production bottleneck. Thus, the study believes that the industry would be supportive of geoduck culture on state lands (see Section 3.2).

World Geoduck Culture

- Washington's geoduck growers will likely be the dominant source of farmed geoduck production for the foreseeable future. At present, the study team does not believe that significant amounts of new product from the two most likely sources of new farmed production, Canada and Alaska, will be available to the market for at least one geoduck product cycle (5-7 years) and probably no earlier than a decade from now. Neither location has a significant amount of seed currently planted. This fact precludes farmed harvest within the next half decade because it takes five to seven years to grow a geoduck crop.

Additionally, each location faces obstacles before significant amounts of farmed geoduck will be produced (see Sections 3.3 and 3.4).

- Initial cultured geoduck production is most likely to come from inter-tidal beds and not from sub-tidal culture. Growers focusing on sub-tidal culture, primarily in Canada, are finding slower growth rates than their inter-tidal counterparts in Washington and Alaska. These growers also face higher production and harvest costs, greater technological barriers, and a lack of seed for production (see Sections 3.3 and 3.4).
- China is renowned for conquering the technological challenges associated with aquaculture, and is currently the world's largest producer of aquaculture products. In 2002, it produced nearly 6.6 million metric tons of aquacultured products, an amount more than three times larger than the next largest producer, India (FAO FISHSTAT 2004). It is unclear how long it will be before China will begin producing farmed Pacific geoduck. It is even unclear whether they will begin producing farmed product. While industry experts have told us that the Chinese are actively seeking technological information and are attempting to produce seed, we were unable to locate anyone who could confirm or provide proof of current Chinese production of farmed geoduck or geoduck plantings (see Section 3.5).
- Much of the industry believes that if geoduck is farmed in China, this production will serve a second or third-tier domestic market because of quality issues. However, almost all of the industry participants interviewed for the study expressed concern about China producing significant amounts of aquacultured geoduck (see Section 3.5).

Market Acceptance of Cultured Geoduck

- The market will accept cultured geoduck. The question is whether it will be accepted as a premium, average, or lower quality product (see Section 3).
- It is unclear whether farmed geoduck will command an ex-vessel/farmgate price equivalent to that of wild product or if the farmed product will receive a price premium or discount. All indications are that the farmed product will get superior marks from the market for consistency of size, color, and supply, but that the wild product is superior in texture.[2] Wholesalers tend to believe that the texture attribute will win out and that farmed product will command a second-tier price. On the other hand, current geoduck farmers believe that consistency of size, color, and supply will be appreciated by the majority of the market. Current market data indicates that geoduck farmers are receiving the same price for their farmed product as for equivalent-grade wild product (see Section 3).[3]
- As described in Section 2.3, it is inappropriate to utilize traditional elasticity and flexibility measures to estimate the effect of new supply on the market. Thus, the study is unable to identify the point at which new supply will cause significant declines in price, or the magnitude of potential declines. However, interviews with market participants indicated that the market can absorb an additional 20 to 30 percent of new product without substantial price effect. The study estimates that private culture efforts in Washington alone will increase world supply by between 30 and 60 percent within the next five to seven years (see Table 7).

[2] Geoduck develop their characteristic "crunch" over time. Both growers and wholesalers tell us that the cultured product lack the texture associated with older wild animals.

[3] Geoduck growers in Canada are receiving a discounted price for their product relative to the price paid for wild product. The study team has been told that the operation in question is harvesting smaller, younger animals to provide operating capital. Thus, we believe that the price discount is reflective of that company's financial situation and not a market response to the attributes of farmed product.

Potential production in the long-run from these sources is probably much higher, and it is important to remember that these numbers do not include the potential for production from sources such as British Columbia and Alaska. Thus, the study believes that private culture production has the potential to lower—perhaps substantially—the world ex-vessel price for geoduck (See Section 3.10).

Short-term and long-term drops in price would affect several important stakeholder groups within the geoduck market. The Washington Department of Natural Resources generates between $6 million and $7 million dollars annually from the auction of sub-tidal geoduck harvest rights. The study expects that any decline in ex-vessel price would be reflected in sub-tidal auction prices. How quickly that decline occurs could depend largely on the speed at which new product supplies become available. For example, if private producers create a sudden jump in production instead of a gradual increase and the market is unable to absorb the sudden increase, then the WDNR could see a sudden and substantial drop in revenues. The same sudden decrease could occur if the WDNR authorizes aquaculture on its lands and allocates too much land to the program. The sudden increase in production would have the same effect as a sudden increase in production from private lands.

Wild harvesters will also be directly affected by price declines. Unlike growers, who can make up some of the lost revenue from price declines through increased volumes, wild harvesters must live with quotas that are based on biological information and not economic information. This fact means that wild harvesters could end up with a declining slice of market share based on volume and declining profitability if prices decline because of increased aquaculture production. The study expects that wild producers in Alaska would initially suffer the most from any price decline, because their transportation and production costs tend to be higher than Washington producers. Canadian and Washington-based harvesters would fare slightly better, but would still feel the effect of any price decreases directly.

Recommendations

The Washington Department of Natural Resources is currently considering whether to allow the geoduck culture on Washington State lands or maintaining the state quo, which does not provide culture on state lands. The study makes the following recommendations with regards to geoduck management in the State of Washington:

- This study recommends that the State consider leasing a moderate amount of inter-tidal acreage for geoduck culture as a way to support Washington-based industry and to diversify the State's geoduck-based revenue sources.[4] The study believes that a rotating lease system leasing a moderate amount of land per year would support industry, diversify revenue sources, and increase total revenue without flooding the market with new supply.

[4] This recommendation focuses on inter-tidal acreage as the study believes that industry has yet to prove that sub-tidal aquaculture in economically feasible. While the study does not suggest the State of Washington avoid lease sub-tidal lands, it does believe that the majority of a leasing program should be focused on inter-tidal acreage which will have more immediate effect on the market. The State might consider a test program for sub-tidal acreage.

Table ES-2. Effect on Current and Projected Washington and World Supply of Various Lease Plans

Total Annual Leases (Acres)	Projected Annual Production	Current WA Production	2003 World Production	Projected WA Production	Projected World Production
5	588,060	12.4%	6.8%	6.6%	4.6%
10	1,176,120	24.8%	13.5%	13.2%	9.1%
25	2,940,300	62.0%	33.8%	32.9%	22.8%
50	5,880,600	123.9%	67.6%	65.8%	45.6%
75	8,820,900	185.9%	101.4%	98.7%	68.4%

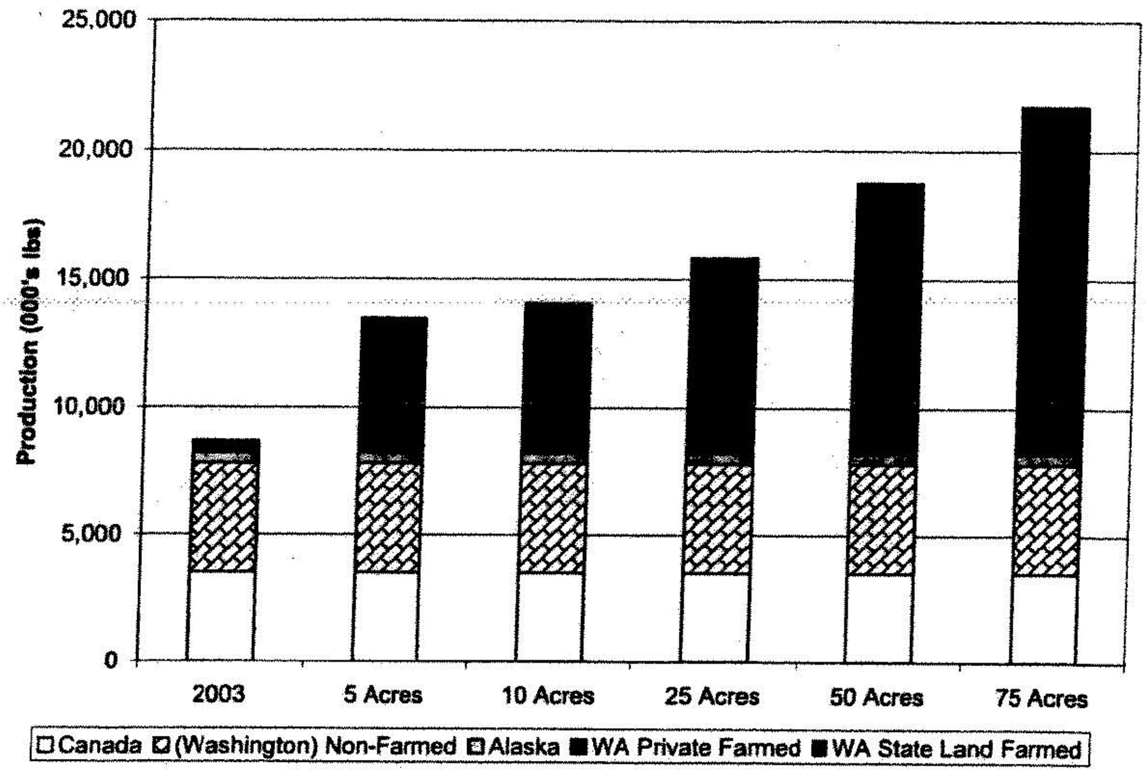
Source: Study Interviews and Northern Economics Projections.

Table ES-2 shows the projected effect of leasing on current and projected product supplies. A plan which leased five acres per year (capped at 35 acres) into production would add roughly 6.8 percent to current world supply, but would only add 4.6 percent to the world supply that the study predicts in five to seven years. A plan which leased ten acres per year (capped at a total of 70 acres) into production would add 13.5 percent to current world supplies and 9.3 percent to projected world supplies in five to seven years. On the other end of the spectrum, a plan leasing 75 acres per year (capped at 525 acres) would nearly triple Washington production and would double world production based on current production figures, and would double Washington production and add nearly 70 percent to world production based on the study's expected world supply in five to seven years. The study team believes that sudden production from a program leasing 50 to 75 acres per year would certainly disrupt the world market, at least in the short-term. A leasing program that leases less than 20 acres per year is less likely to flood world supply and disrupt industry and revenue flows than a program that leases more than 50 acres pear year[5] (see Section 5.1).

Figure ES-2 compares current production, at 2003 levels, with estimated production figures from the leasing scenarios above and the estimated current investment in geoduck culture on private lands. The figure shows that Washington should expect a major increase in production from private culture production efforts. A plan that leased 5 to 10 acres per year (with a maximum lease total of 25 to 70 acres) would add a significant amount to expected production and, as mentioned above, an amount equal to between one-eighth and one-quarter of current production. A program leasing 50 or 75 acres per year would produce substantially higher amounts of product, which could initially overwhelm the ability of the world market to absorb product flows.

[5] Incidentally, the study does not believe that current seed production levels are enough to support a larger leasing program. However, the industry may have reserve production capacity that the study is not aware of at this time. Certainly, more production capacity could be created given time and money.

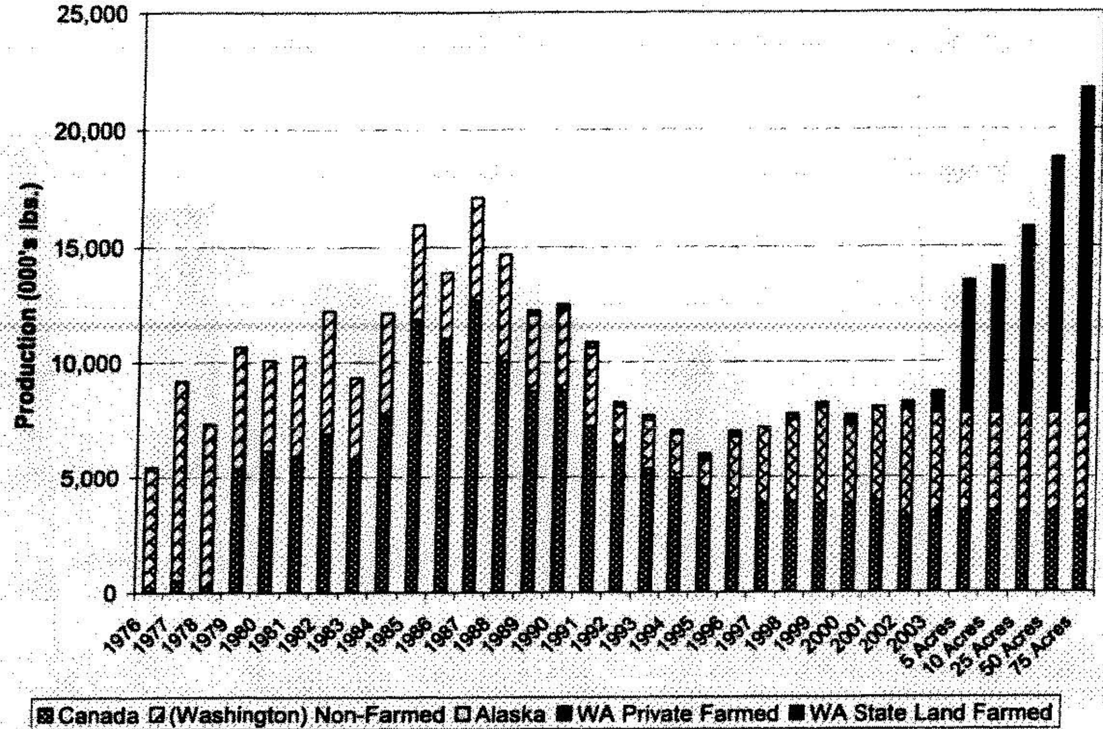
Figure ES-2. Potential Production vs. Current Washington Production



Source: Washington Department of Natural Resource and Northern Economics, Inc Estimates

Figure ES-3 shows the effect of a leasing program on world supply in the context of historical world production levels. The world market should expect that even without a program that leased state lands, supply levels will soon reach volumes not seen since the early 1990s. A state leasing program could rapidly increase world supply levels to record highs. A 75-acre leasing program would result in world supply levels nearly one-third higher than the previous record high of 16.9 million pounds in 1987. Even a small state leasing program of five acres per year will help push world production of geoduck to levels that were only reached in the late 1980s.

Figure ES-3. Potential Production vs. Historical World Production



Source: Statistics Canada, Washington Department of Natural Resources, & the Alaska Department of Fish & Game and Northern Economics, Inc Estimates

- The study believes that it is not in the State of Washington's best interest to knowingly contribute to the classic aquaculture production cycle of high incentives to enter the market, rapidly increasing supply, falling prices, and industry consolidation. Such a cycle would negatively affect both state revenues and weaker producers. There is a real chance that the geoduck industry will go through such a cycle given the rapidly increasing amount of inter-tidal land dedicated to production in Washington, the number of individuals outside of Washington interested in Geoduck aquaculture, and the potential for high returns from aquaculture. Thus, the State must be aware that any decision to allow culture activities on state lands contributes to world supply and may contribute to short-term supply gluts. Thus, while the study recommends leasing state lands, it also recommends that any leasing program consider that the world market will soon be adjusting to a major increase in supply from private land production. The study team does not believe that leasing a moderate acreage amount would disrupt the world market and recommends a gradual and moderate approach that would allow additional acreage to into production if the world market successfully absorbs the upcoming production boom (see Section 5).
- If the State pursues a leasing program, it should work to develop parameters that allow managers to evaluate the program and the program's effect on the world market. The fact that the geoduck production cycle takes several years will complicate these efforts. The best way for program managers to evaluate a program is to closely monitor factors such as total world production, world price, Washington wild production, Washington culture production,

state harvest auction prices, and State-land lease prices. Monitoring these factors on a consistent basis and communicating with industry members will allow managers to assess the program's role in the world market. Managers must also not forget that the market itself will regulate the industry. For example, a producer may have good knowledge of upcoming total production. Thus, he/she may choose not to plant on leased land if there is reason to believe that upcoming production will reduce the world price below a profitable point. If prices increase, then the lease holder could plant a new crop. Managers who communicate with potential lease holders will have a better idea of the program's effect on the world market (see Section 5).

- Public and private support through research and development, especially in the beginning of the industry, can be very helpful to the development of an emerging culture industry. The salmon, catfish, abalone, and hard shell clam case studies (see Section 4) all show that government-funded research and training programs enhance an industry's chances for survival. However, restrictive regulations after these programs are in place (as seen in the case of Norway and the farmed salmon industry) can squander the advantage they created. Thus, the study recommends that the creation of any training programs or government-funded research account for future regulation of the industry by other government organs so that the government does not over-promote an industry it must also regulate (see Section 4).[6]
- As with land-based farming, aquaculture crops that are planted in high densities and without rotation will be subject to higher risks of disease. This aspect of culture production is discussed in the Yesso Scallop case study. Thus, the study recommends that the State of Washington explore the potential for disease transmission in the increased density associated with cultured production. The study also recommends that if the State of Washington chooses to lease its own lands for geoduck production, it consider the increased potential for disease transmission associated with aquaculture in its lease site selection process (see Section 4). For example, the State of Alaska requires that farm tracts and wild harvest sites be separated by five miles. Such a separation would make disease less likely to spread than if the tracts were conterminous.
- Leasing State-owned inter-tidal lands could represent a significant source of revenue for the Department of Natural Resources (see Section 5.5). We estimate that these leases would generate roughly $75,000 over the lease term per leased acre based on the following assumptions:
    - The lease structure follows the current private lease structure of $1,000 per year plus 10 percent of ex-vessel value at harvest.
    - Seed are planted 1-foot on center with 3 seed planted per tube.
    - 50 percent of seed survive to harvest and average harvested weight is 1.8 pounds.
    - 60 percent of harvested product is grade 1 or 1s, 25 percent is grade 2, and 15 percent is grade 3 or less.
    - Ex-vessel prices average $6.75 per pound for grade 1 and 1s, $5.75 per pound for grade 2, and $2.50 per pound for grade 3.

[6] The study team wishes to note an important difference between the industries in the case studies and the current geoduck industry in Washington. Many of the industries in the study received financial support prior to the creation of a viable industry.

- An average six-year product cycle.

- The study recommends that the State explore the idea of auctioning the right to lease state lands instead of following the current private lease arrangement of $1,000 per acre per year and 10 percent of ex-vessel value. Inter-tidal leasing will generate more revenue if the State can develop more favorable lease terms. For example, a lease arrangement of $1,000 per year and 20 percent of ex-vessel revenue would double the value of an acre of leased land to the State to nearly $150,000. While pursuing a higher lease rate may raise questions of competition with private land owners, an auction or sealed bid process would allow the State to capture a much higher portion of rents from the fishery. The study team heard from growers that private land is starting to become scarce. Thus, the study reasonably believes that the State could expect a better lease arrangement than the current private lease arrangements (see Section 5.6).
- Pursing a higher lease rate could also allow the State to generate more revenue with less risk of swamping the world market. For example, as mentioned previously, a system similar to the current private lease structure would require roughly 90 acres to generate revenues equivalent to what the State currently receives from private tidelands. However, this amount of land would sink world prices. On the other hand, if the State captures 40 percent of the ex-vessel revenue from its leases, then it would only need between 20 and 25 acres per year to equal the revenue of the current sub-tidal auction system. As noted in Section 5.1, a program which leases this amount of land is less likely to depress world prices than one which leases 75 acres per year.
- The study recommends that the Washington Department of Natural Resources work with other governmental agencies to require that private growers report the harvest of wild stocks from privately leased land. The current system does not require that type of production to be reported through fish tickets or aquatic farm reports. The current system would also allow growers to report wild harvest as aquatic farm production. We believe that strengthening reporting requirements is in the best interest of the industry and the State. We also believe that strengthening the reporting system for the wild harvest is also in the best interest of the State and the industry as a whole (see Section 3.2).
- The study recommends that the WDNR prepare for and study a potential long-term decline in revenue from sub-tidal geoduck auctions. There exists a strong possibility that the Department will see a decrease in revenue from this source irrespective of any production on state lands (See Section 3.10).
- A key component of Washington State maintaining its edge in farmed geoduck production would be to prevent Washington State from becoming a source to China, or any other country, of seed and production technology. Thus, the study recommends that the State work with growers and other interested parties to safeguard sensitive technology and information (see Section 3.2).

1 Introduction

Pacific Geoducks (*Panopea Abrupta*) are large burrowing clams that range from Alaska to California. These clams are commercially abundant in the waters of Washington, British Columbia, and Alaska. The species supports thriving commercial fisheries in Washington and British Columbia and a smaller fishery in Southeast Alaska. The combined value of these fisheries is more than $50 million.[7]

In Washington, the species supports an industry harvesting more than 4 million pounds of product worth roughly $20 million per year (ex-vessel value), and is the State's most valuable wild-harvest, commercial shellfish. The Washington fishery is managed jointly by the Washington Department of Natural Resources, Washington Department of Fish and Wildlife, and the sixteen tribes of the Puget Sound Treaty, who have the right to 50 percent of the harvestable surplus of geoducks from the State.[8] The Department of Natural Resources is responsible for auctioning the right to harvest on state lands to private harvests (WADNR 2001). The money from these auctions supports programs run by the Department of Natural Resources and the Department of Fish and Wildlife, including the Aquatic Land Enhancement Account, which benefits the people of Washington through increased public access and habitat restoration.

In British Columbia, the fishery produces just over 4 million pounds of product per year, which was worth roughly $25 million in2003. Canada's Department of Fisheries and Oceans (DFO) manages the fishery and sets the yearly harvest maximum. Unlike in Washington, where the fishery is managed through an auction with scheduled harvest times, 55 quota license holders hold the right to harvest a set portion of the Canadian quota at any time during the harvest season. The holders have the right to an equal share of the total allowable catch set by DFO (Blackbourn and Bower 2004). These quota holders work closely with wholesalers based in British Columbia, who control the major geoduck distribution routes. These wholesalers also buy and ship much of the product that Washington produces.[9]

The Alaskan fishery is much smaller than the Washington and British Columbia fisheries. It only produces about 5 percent of the world's annual supply, or roughly 400,000 pounds per year. The harvest has a value of less than $2 million per year. The fishery is handicapped by its relative remoteness and the lack of sufficient infrastructure to reliably transport live product to market. The fishery has also had long-term issues with paralytic shellfish poisoning (PSP), which can prevent the fishery from shipping its product to the live market.

China and Hong Kong are the dominant consumers of Pacific geoduck. They import roughly 25,000 to 30,000 pounds of product per business day. A significant portion of world production, perhaps 20 percent, is consumed by the domestic markets of the major producers. Other countries such as Taiwan, Singapore, and Lithuania demand smaller amounts of the product.

[7] All monetary values in this report are expressed in $US.

[8] The 1994 Rafeedie decision (United State v. Washington, 873 F. Supp. 1422 W.D. Wa 1994) "affirmed and quantified the Puget Sound Treaty Tribes' right to 50 percent of the harvestable surplus of geoduck within their usual and accustomed grounds and stations" (United State v. Washington, 873 F. Supp. 1422 W.D. Wa 1994).

[9] Unlike the Washington system, the Canadian quota management system does not naturally capture any of the fisheries value for the people of Canada. Thus, the Canadian system is likely a more profitable one for license holders than the Washington system which naturally captures a portion of the public resource's value for the public. The study team notes that the license holders in Canada voluntarily support research which benefits there industry and potentially the public.

1.1 The Purpose and Need for the Study

The world geoduck market is on the cusp of important changes. This dynamic market, which has experienced several transitional periods in the last three decades, is again facing a major change with the advent of geoduck aquaculture. While potential growers have tried to sub-tidally culture geoduck for several decades, only within the last half decade have growers interested in inter-tidal culture succeeded in developing commercially viable techniques for raising geoduck seed and protecting that seed from planting until harvest. These accomplishments have the potential to radically change the geoduck market by rapidly increasing supply and changing current distribution channels.

The State of Washington is studying whether to allow private geoduck aquaculture on state lands. This decision is multi-faceted: it includes economic, biological, ecological, and social factors. This study focuses primarily on the economics of the decision. For example, if the State allows geoduck culture on its lands, it could establish a new source of income, which would benefit the people of Washington State. It could also support the development of an emerging industry in Washington with the potential to provide more jobs to state residents. However, private geoduck growers are already in the process of planting geoduck seed on dozens of acres of private inter-tidal land. These growers have the potential to significantly increase the amount of geoduck on the world market. Thus, production on state lands could contribute to a glut in production if the market is unable to readily accept the increased supply from private lands. So, will production on state lands be good for the State of Washington, its citizens, and the shellfish companies based in the State? This study attempts to answer that question.

1.2 The Study Team's Approach

The study team has written this report with the Department of Natural Resources mandate in mind, as defined by RCW 79.90.455. The code states:

> The management of state-owned aquatic lands shall be in conformance with constitutional and statutory requirements. The manager of state-owned aquatic lands shall strive to provide a balance of public benefits for all citizens of the state. The public benefits provided by aquatic lands are varied and include:
>
> 1. Encouraging direct public use and access;
> 2. Fostering water-dependent uses;
> 3. Ensuring environmental protection;
> 4. Utilizing renewable resources.
>
> Generating revenue in a manner consistent with subsections (1) through (4) of this section is a public benefit.

1.3 Document Map

The main body of the document provides relatively concise summaries of the subject matter and then refers readers wishing for more detailed information to a series of appendices. The remainder of the document contains the following sections:

Section 2 describes and summarizes the existing conditions in the world geoduck market including a history of the fishery and description of current supply and demand. The study also discusses future demand and wild supply.

Section 3 describes and summarizes the potential for geoduck aquaculture in Washington, Alaska, Canada, Mexico, China, New Zealand, and Argentina. The study includes projections of future production.

Section 4 includes the aquaculture case studies. The study provides five case studies of species that have moved from primarily wild harvest production technologies to a mix of wild and culture production. The study discusses the lessons that managers can apply from these case studies to the current decision facing the State of Washington.

Section 5 discusses how culture production on Washington State lands could affect the world market. The section also includes recommendations for Washington State in proceeding with aquaculture on state-owned lands and the estimated revenues the state could generate if it proceeded with leasing. Finally, the section discusses the positive and negative aspects of using the current private land lease structure as a basis for negotiating lease contracts.

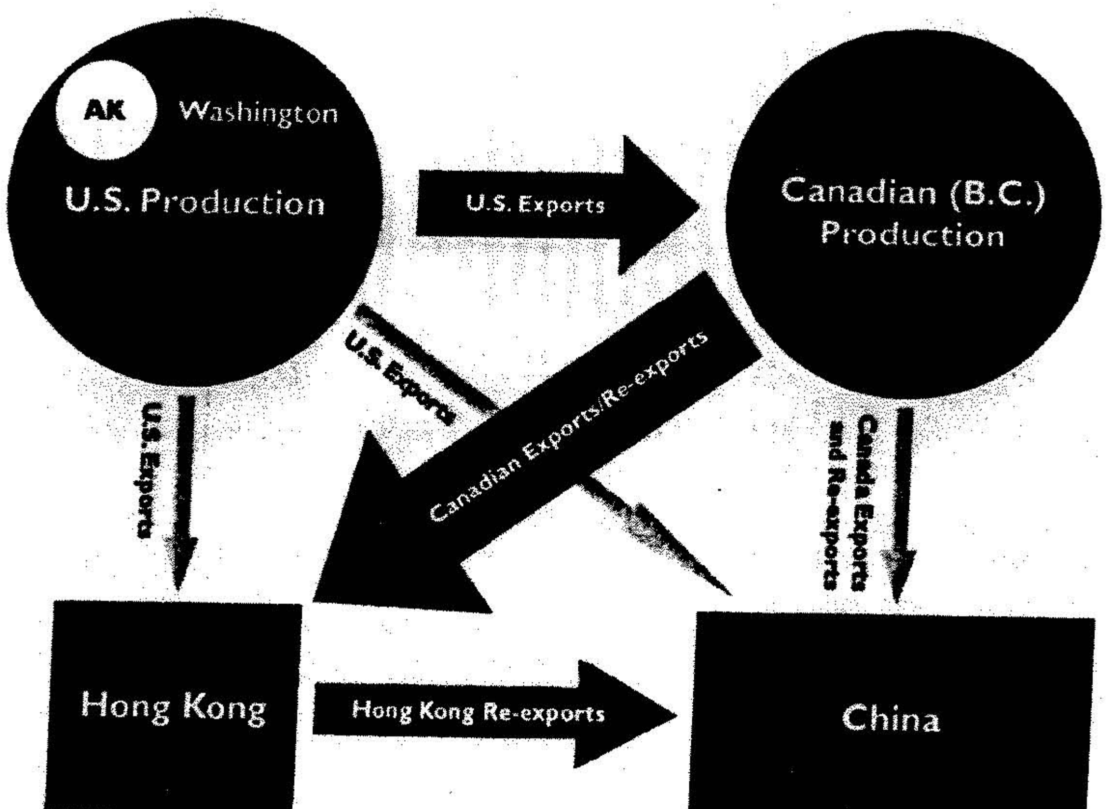
2. The World Geoduck Market

2.1 Introduction

The world geoduck market changed substantially in the last thirty years and is on the verge of another major change. The study expects that the world supply of geoduck from wild sources will remain stable over the next decade while the world supply from culture sources will increase dramatically (See Section 3). The study believes the world demand will increase over the next decade. However, the study is less certain about the magnitude of this increase as it depends on the continued growth of the Chinese economy and the producers and wholesalers developing new distribution channels.

Figure 1 shows how product flows through the world geoduck market. Product is produced by British Columbia, Washington, and to a lesser extent, Alaska. The majority of U.S. product is exported to Canada. Smaller amounts are retained for domestic consumption and shipped directly to the main markets of Hong Kong and China. Canada exports its own production and re-exports much of the product produced by Alaska and Washington. The majority of the product goes to Hong Kong and then on to China. A small, but growing, amount is shipped directly to China. The following sections described world supply and demand in greater detail.

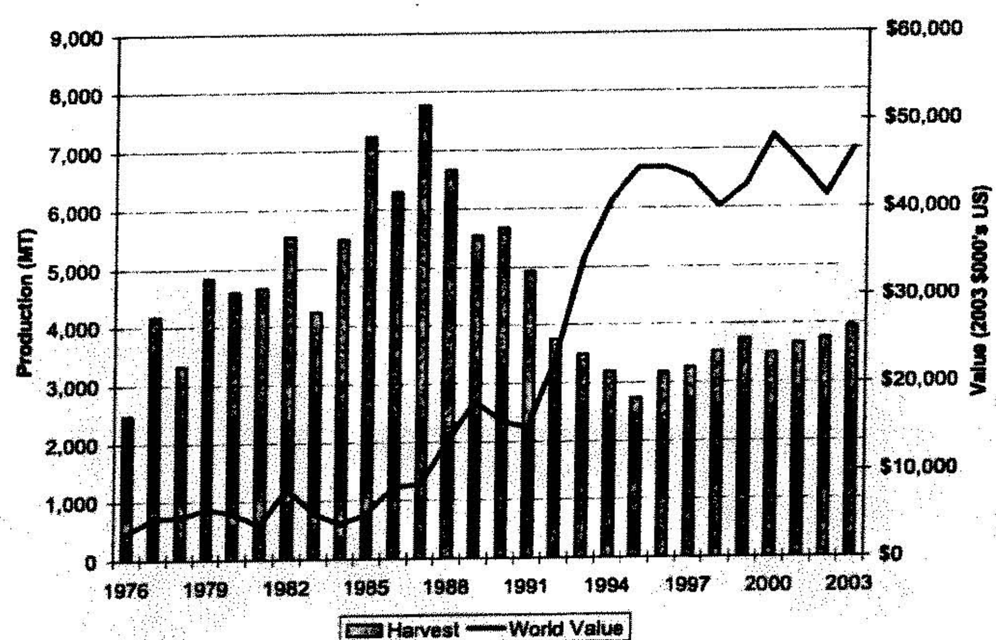
Figure 1. The World Geoduck Market



2.2 World Geoduck Supply

The supply of geoduck to the world comes from three primary sources: British Columbia, the State of Washington, and Alaska.[10] The study team located nearly 30 years of production and value data for this study. This time period can be broken into three broad phases. The first is the period between 1978 and 1987, which saw the rapid expansion of the fishery, particularly in Canada. The second phase occurred from 1987 through the early 1990s. This phase saw a rapid contraction of the fisheries as Canada changed its management system from a derby-style fishery to management utilizing an individual quota license.[11] The third phase encompasses the current period back to the early 1990s and has been characterized by steady, but slowly increasing, production levels and a rapid rise in value. As discussed in Section 3, the study concludes that the market is about to enter a fourth phase dominated by the advent of culture production.

Figure 2. World Production and Value



Source: Statistics Canada, Washington Department of Natural Resources, & the Alaska Department of Fish & Game

Overall, current world production has declined significantly since its peak in the late 1980s.[12] Current world production stands at nearly 4,000 metric tons (MT) (i.e., 8,800,000 pounds) or slightly more

[10] Other areas such as Mexico, New Zealand, and Argentina produce a small amount of geoduck for the domestic and world markets, but the amounts produced by these sources represent an infinitesimal portion of total world production. Production levels are so small that they are not captured by conventional sources such as the Food and Agriculture Organization's (FAO) FISHSTAT II database. Thus, this report focuses on the three major producers of pacific geoduck (*P. abrupta*): British Columbia, Washington, and Alaska.

[11] A derby-style fishery is one where fisherman "race" against one another to harvest as much product as they can while the season is open or before a total allowable catch limit is hit. Such fisheries tend to be less efficient than quota-based fisheries.

[12] All production figures in this section and following sections are for calendar years.

than 50 percent of peak production (see Figure 2 and Table 1). If current production trends continue, total world production in 2004 should be greater than 4,000 MT for the first time since 1991.

Table 1. World Value and Production by Calendar Year

Year	Production	Value	$/MT	Year	Production	Value	$/MT
1976	2,483	$3,083	$1,241	1990	5,685	$15,648	$2,753
1977	4,176	$4,791	$1,147	1991	4,937	$14,997	$3,038
1978	3,332	$4,844	$1,454	1992	3,752	$22,783	$6,073
1979	4,844	$5,843	$1,206	1993	3,499	$34,364	$9,822
1980	4,589	$5,319	$1,159	1994	3,199	$40,956	$12,805
1981	4,660	$3,935	$844	1995	2,739	$44,639	$16,298
1982	5,552	$8,075	$1,454	1996	3,181	$44,674	$14,043
1983	4,243	$5,270	$1,242	1997	3,259	$43,531	$13,358
1984	5,500	$4,013	$730	1998	3,529	$40,179	$11,387
1985	7,249	$5,159	$712	1999	3,747	$42,623	$11,374
1986	6,304	$8,302	$1,317	2000	3,504	$48,248	$13,770
1987	7,772	$8,620	$1,109	2001	3,662	$44,983	$12,283
1988	6,672	$13,472	$2,019	2002	3,757	$41,398	$11,020
1989	5,554	$17,989	$3,239	2003	3,953	$46,675	$11,807

Source: Statistics Canada, Washington Department of Natural Resources, & the Alaska Department of Fish & Game

Note: All Production Numbers in MT. $ Values in 000s 2003 $.

While production has gone through several major shifts and trends, overall ex-vessel value of the geoduck market has followed one major trend: upward. Total value of the geoduck market rose from roughly $3.0 million in 1976 ($ 2003) to a $46.7 million in 2003 (see Figure 2 and Table 1). The market's value increased even though overall production is 50 percent less than peak production because of the phenomenal growth in the per unit value of the product. Current values per metric ton are nearly ten times higher than they were in the 1970s and 1980s (see Figure 3). The different between the 1970s and 1980s, and the 1990s and today, is that the geoduck market transformed from a market primarily dependent on selling a frozen or canned product to one that now sells a high quality, live product to a growing market (see Section 2 for further discussions). The end of the Cold War and the transformation of the Chinese economy from a planned economy to a market-based economy have facilitated transporting a live product to market and expanded the total market for geoduck.[13] The end result has been higher ex-vessel value and higher returns to harvesters and distributors. It is highly doubtful that the current trends in aquaculture (see Section 2.3.1) would exist if the market conditions that existed prior to the 1990s had persisted to the present day.

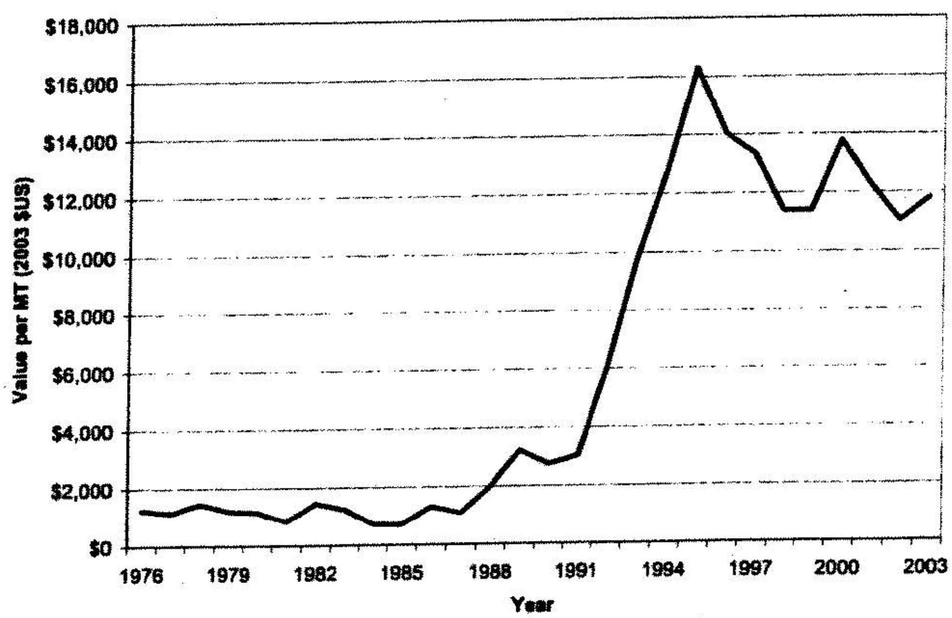
Figure 3 shows per ton ex-vessel values. Per ton values peaked in 1995 as Washington production hit its lowest recorded point following the Rafeedie decision[14] and Canadian production continued to fall

[13] For example, while most geoduck goes to Hong Kong (and has for quite some time), it is now easier to get product to Hong Kong with recently opened polar air routes.

[14] *The 1994 Rafeedie decision (United States v. Washington, 873 F. Supp. 1422 W.D. Wa 1994)* "affirmed and quantified the Puget Sound Treaty Tribes' right to 50 percent of the harvestable surplus of geoduck within their usual and accustomed grounds and stations". Thus, the Tribes have the right to harvest 50 percent of the harvestable surplus from the tracts that the State auctions to private harvesters.

as the Canadian government fined tuned the quota management system. Canadian producers have since stabilized their production and Washington producers increased their production substantially (see Figure 4). Price per unit stabilized as production stabilized. Since 1996/1997, the per unit ex-vessel value of geoduck has stabilized at around $12,000 per metric ton (MT). We attribute the price drop in 2002/2003 to the worldwide outbreak of Severe Acute Respiratory Syndrome (SARS), which was centered in the main market for geoduck, China. Geoduck consumption was hit particularly hard by the SARS outbreak because of the traditional role of geoduck in Chinese culture or cuisine. Geoduck is a central ingredient in the traditional dish of hot pot, which is similar to fondue. The communal dish consists of a variety of ingredients which are cooked quickly and individually in broth or oil. Restaurant consumption of hot pot dishes declined markedly during the SARS outbreak because of concerns about how the virus spread from person to person (Industry Sources 2004).

Figure 3. Per Ton Ex-Vessel Value, 1976-2003



Source: Statistics Canada, Washington Department of Natural Resources, & the Alaska Department of Fish & Game

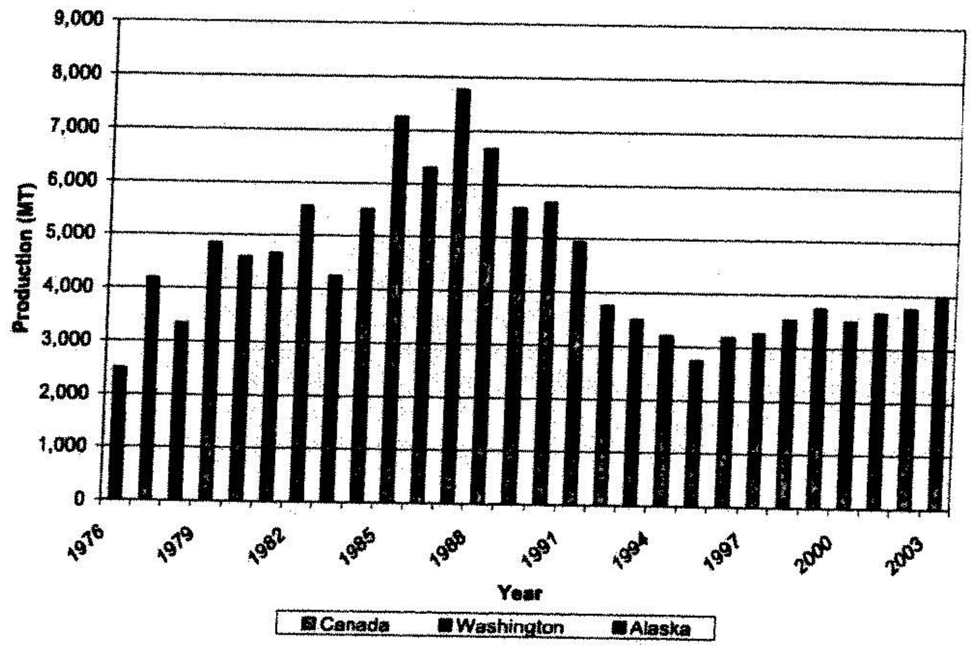
2.2.1 Production and Value by Location

Geoduck production has varied widely by location over the past 30 years (see Figure 4, Figure 5, and Table 2). The State of Washington dominated production in the mid and late 1970s. In the late 1970s Canadian production surpassed Washington production and total production increased to just less than 5,000 MT. Canadian production continued to increase in the 1980s, and peaked in 1987 at 5,700 MT per year. This production peak coincided with a world production peak that has yet to be surpassed. Canadian production declined rapidly after 1987 as the country instituted a licensed quota system, but has since stabilized at between 1,500 and 1,800 MT per year.[15]

Washington production levels peaked in 1977 at 3,900 MT. The State's production then entered into a long period of slow decline that culminated with a production of only 564 MT in the transition year following the Rafeedie Decision. Since 1995, Washington producers have increased their production substantially, and since 2001 Washington has produced more geoduck per year than Canada.

Alaska is a relatively minor player in the production of *P. abrupta*. Alaska Department of Fish and Game (ADF&G) did not record any production from the fishery until 1989 (as Canadian production started to decline and prices started to rise). Alaskan producers generally provide the market with between 50 MT and 200 MT of product per year; an amount roughly equivalent to five percent of total world production. Many of the harvesters involved in the Alaskan fishery are also involved in the Washington fishery.

Figure 4. World Geoduck Supply, by Location



Source: Statistics Canada, Washington Department of Natural Resources, & the Alaska Department of Fish & Game

[15] The quota system distributes a calculated maximum allowable catch amongst 55 license holders. These license holders are then allowed to distribute their catch across the year as they see fit. As discussed in Section 2.2.2 , this structure helps the market to maintain high prices and stable supply.

Table 2. Production in Metric Tons by Year and Location

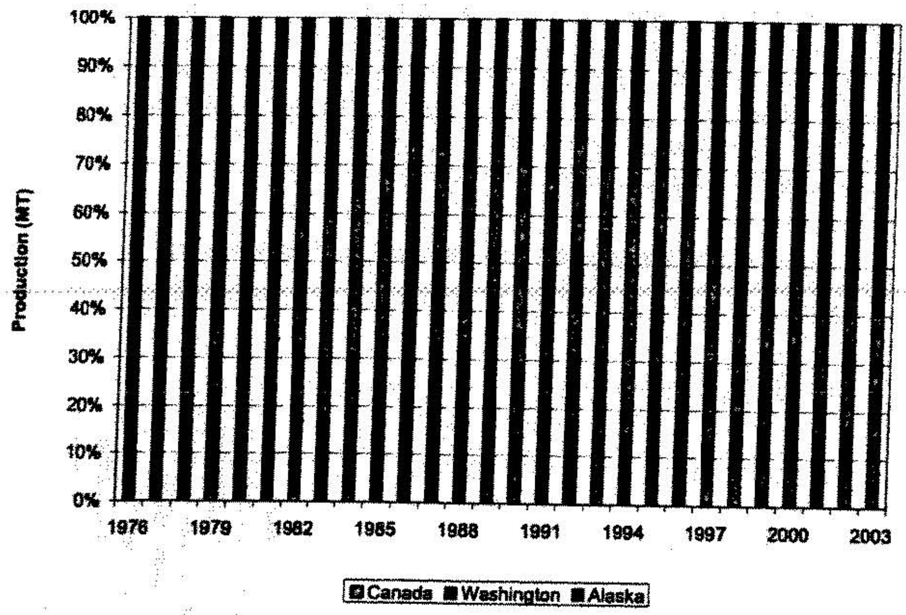
Year	BC Production	WA Production	AK Production	Year	BC Production	WA Production	AK Production
1976	44	2,439	0	1990	3,992	1,570	123
1977	246	3,930	0	1991	3,298	1,526	113
1978	109	3,223	0	1992	2,874	789	89
1979	2,468	2,376	0	1993	2,455	948	95
1980	2,812	1,777	0	1994	2,235	897	67
1981	2,710	1,950	0	1995	2,056	564	119
1982	3,141	2,410	0	1996	1,832	1,253	96
1983	2,641	1,601	0	1997	1,764	1,490	5
1984	3,490	2,010	0	1998	1,784	1,618	126
1985	5,381	1,868	0	1999	1,728	1,925	94
1986	5,016	1,288	0	2000	1,742	1,568	194
1987	5,747	2,025	0	2001	1,803	1,850	9
1988	4,577	2,095	0	2002	1,484	2,144	129
1989	3,976	1,486	92	2003	1,599	2,157	197

Source: Statistics Canada, Washington Department of Natural Resources, & the Alaska Department of Fish & Game

Figure 5 shows the percentage distribution of world geoduck production over time. As discussed above, Washington was an early leader in production until Canada rapidly became the largest world supplier. Washington regained its position as the world's top producer as the Canadian managers lowered the total allowable catch in their fishery to what they believe is a more sustainable level.[16] Alaskan production is highly variable and has always accounted for less than 10 percent of total production. In 2003, Washington produced 54.5 percent of total world production, Canada produced 40.5 percent of total world production, and Alaska produced 5 percent of world production.

[16] Canadian production declined in 2002 as the Department of Fisheries lowered quota levels in certain production areas in response to concerns about over harvesting. Those concerns have since been resolved and the quota should increase from 2002 levels to historic levels in the future (Heizer 2004).

Figure 5. Percentage Distribution of World Geoduck Supply



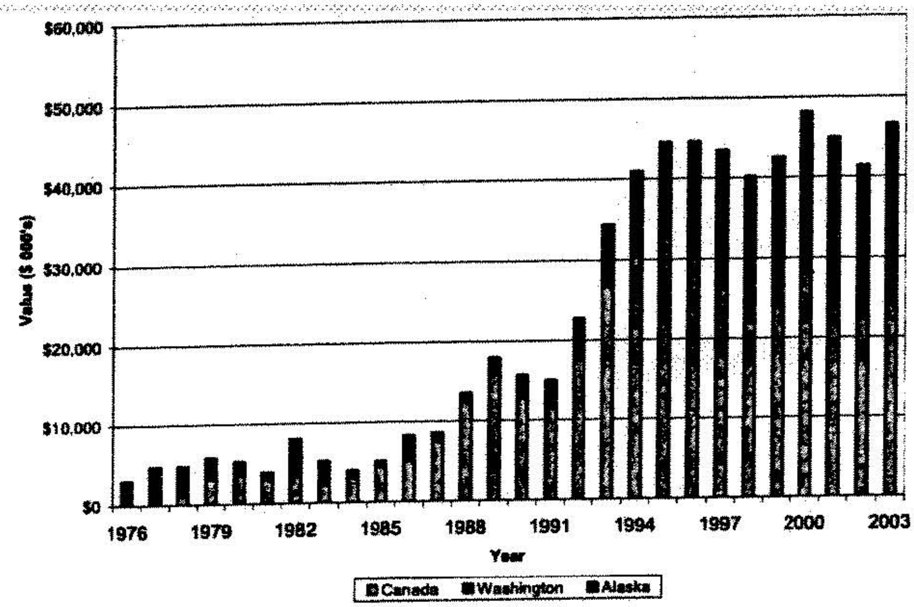
Source: Statistics Canada, Washington Department of Natural Resources, & the Alaska Department of Fish & Game

Figure 6 and Figure 7 show the distribution of the value of the geoduck harvest. While Canada has relinquished lead in total production, they are still the dominant producer with regards to value when value is measured by reported ex-vessel price. The study team believes that difference is the result of several factors, including:

- Interviews with Canadian wholesalers indicated that the wholesale market views Washington product as inferior to Canadian product. Interviews with Washington Department of Fish and Wildlife indicated that Department biologists would not be surprised if current quality from state lands was lower than it has been in the past (Sizemore 2004). This result is to be expected as the fishery is currently nearing the end of its first cycle under the State's *Commercial Geoduck Fishery Management Plan*. Under this plan, and the accompanying Environmental Impact Statement, the State predicts that geoduck beds will take an average of 39 years to recover. The study has records of commercial harvest that date back nearly 30 years. (WADNR 2001). If the state allowed production off tracts with the highest productivity and quality first, then we would expect current harvests to be coming from less productive lands now and for more productive lands to start filtering back into rotation over the next decade.
- The study team believes that the total value of Washington's harvest, as estimated by fish ticket data and ex-vessel value, is low. The study originally looked at fish ticket and aquatic farm data for evidence of a price differential between cultured and wild product. We found little evidence as the reported per pound value for cultured harvests and treaty harvest were very similar. In 2003, culture producers reported an average price of $4.94 per pound while

treaty producers reported an average value of $5.40 per pound.[17] Additionally, these values are very close to the expected average ex-vessel prices. However, values for non-treaty harvest were much lower. These producers reported an average value of $2.88 per pound in 2003. This amount is far lower than the average for the other two groups and is not explained by any difference that the study could identify. If non-treaty production were valued at the average value for cultured and treaty product, the 2003 value of Washington's production would rise more than 20 percent from $20.6 million to $25.2 million. This amount exceeds the value of Canadian production by roughly $1 million.

Figure 6. Inflation Adjusted Value of World Geoduck Production, by Location

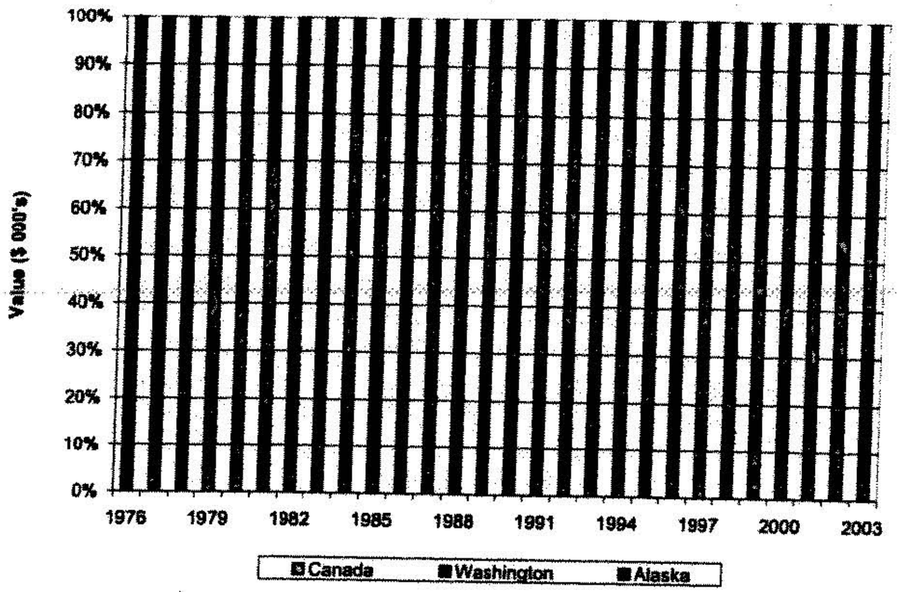


Source: Statistics Canada, Washington Department of Natural Resources, & the Alaska Department of Fish & Game

The study team suggests that WADNR may want to work with harvesters to determine the cause of the discrepancy.

[17] While these differences are statistically significant, indications are that any difference is attributable to the smaller size of the current farmed product. Average size has been increasing each year and the price differential has been shrinking along with it.

Figure 7. Distribution of World Value of Geoduck Production



Source: Statistics Canada, Washington Department of Natural Resources, & the Alaska Department of Fish & Game

2.2.2 Canada

Canada's geoduck production comes solely from British Columbia and is described in the section below.

2.2.2.1 British Columbia

Production in British Columbia is controlled by 55 quota license holders who have the right to harvest all of British Columbia, and hence, Canada's harvest.[18] The Canadian fishery was originally open-access, but license limitation reduced the fleet to 55 in 1981. The government restructured the fishery again in 1989 with the creation of an individual vessel quota system. The quota system restricts the total amount the fishery can harvest, but gives license holders a guaranteed share of the harvest (DFO 2004). While the quota holders face much smaller harvests than they achieved under the derby-style system, they have benefited from the increasing value of their product and the general transformation of the geoduck market from a frozen product market to a live product market. The value of the BC fishery peaked in 1995 when Washington harvester response to the Rafeedie decision limited Washington's production and caused per unit values to spike. Since the mid-1990s, quota production and value have leveled off at roughly 1,500 to 1,800 MT of production valued around $25 million per year (see Figure 8).

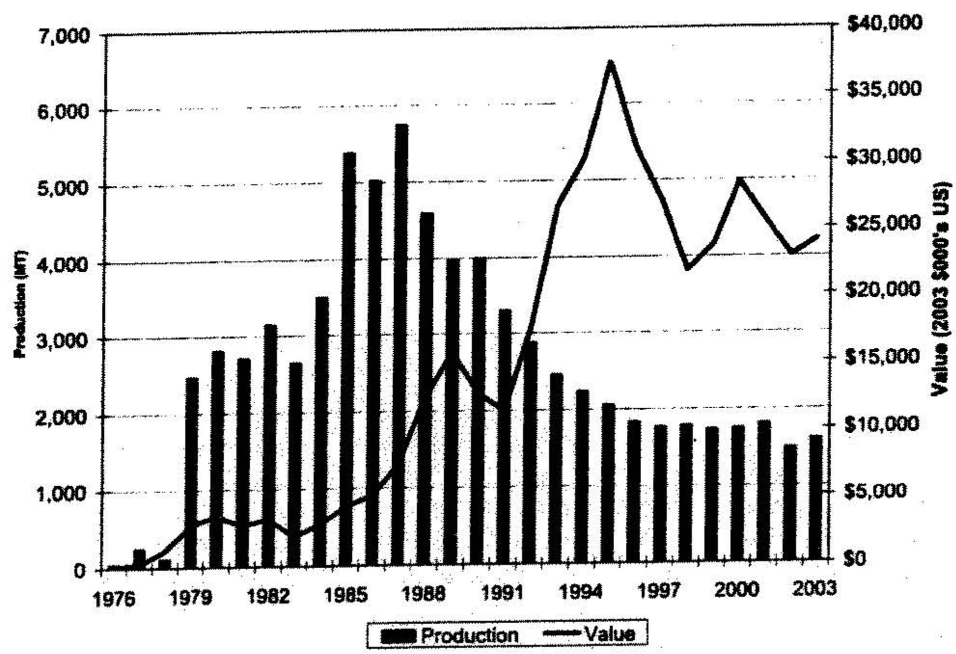
These license holders maintain close ties with the BC-based wholesalers who dominate the geoduck market's distribution system. In fact, some of the license holders work directly with wholesalers who

[18] Canada has at least one producer who is supplying the market with very small amounts of cultured geoduck. These amounts are so small that they are indiscernible from total wild production. This cultured product is grown in a sub-tidal environment. So far, the sub-tidal production process has proven difficult with longer growing times, lower survival rates, and a smaller product. In the long run sub-tidal production may prove uneconomical when compared with inter-tidal production.

tell them when the market needs product and when not to harvest product because supplies are high. This relationship has benefited almost everyone on the supply side of the geoduck including producers in Washington and Alaska. Quota holders act as a release valve for the geoduck market. When the market signals that supplies are tightening, these holders can supply product. At the same time if demand goes slack, or if other producers release a glut of product onto the market, these producers can withhold supply until the market needs more product. Since the quota holders currently control 45 percent of the world supply they can effectively manage the market and stabilize price and supply. The price for geoduck is remarkably stable for a wild harvest product. The main reason for this stability is the ability of quota holders to decide when to harvest product.

This efficacy of this control mechanism will be threatened by the advent of culture production. As farmed production increases, the Canadian quota system will represent a smaller share of world production. Thus, Canadian wholesalers and producers will have less control over the market and be less capable of moderating the effect of large swings in production. However, culture producers will have the same capability to respond to market conditions as the quota holders. In fact, their capacity may even be higher because they are less affected by weather. Thus, the study does not foresee an increase in price volatility with the diminution of the Canadian wild harvest's share of the market, but the study does foresee a transfer of market power from quota producers to culture producers.[19]

Figure 8. Canadian Production and Value, 1976-2003



Source: Statistics Canada, 2004.

[19] Note that price volatility could increase if farmed producers are unable to maintain discipline to the same degree as Canadian quota holders. If culture producers do not act in concert then the production market will be fragmented and price volatility could increase.

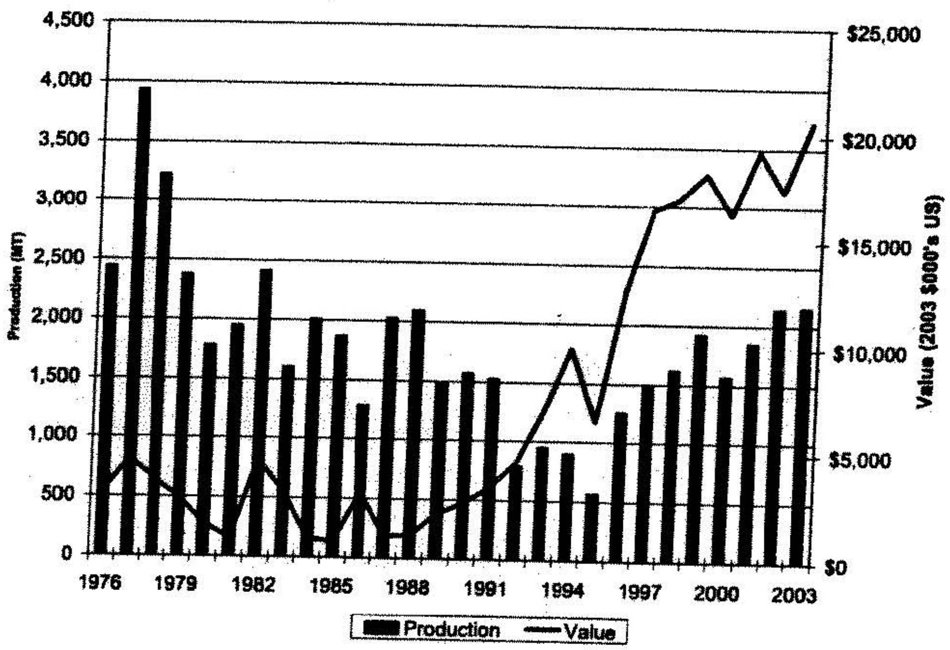
2.2.3 United States

Panopea abrupta is found in all four mainland American states with Pacific coastline. This section describes production and value trends in each of those states.

2.2.3.1 Washington

Washington produced 54.5 percent of the world's geoduck production in 2003. Production in Washington State declined substantially between the late 1970s and the early 1990s. In the years before and immediately after the Rafeedie decision Washington-based harvesters produced lower amounts of product. However, production rebounded in recent years and now stands at nearly 2,200 MT (4.8 million pounds) per year.[20] The value of Washington's production has also risen steadily from an average yearly value of less than $5 million in the 1980s to more than $20 million in 2003.[21]

Figure 9. Washington Production and Value, 1976-2003



Source: Washington Department of Natural Resource, 2004.

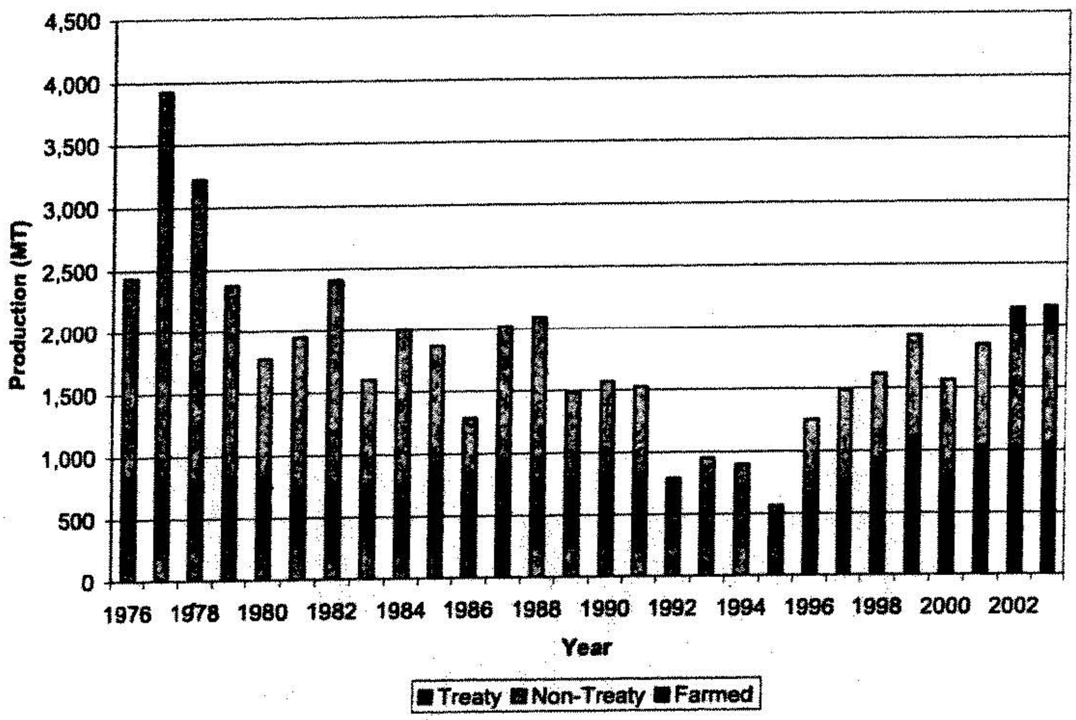
Production in Washington is divided between three groups of producers: non-treaty producers, treaty producers, and farm producers. Non-treaty producers harvest their product from sub-tidal lands owned by the State of Washington and managed under the *Geoduck Commercial Fishery Management Plan* (WDNR 2001). The Washington Department of Natural Resources auctions the rights to harvest these lands to private harvesters (See Section 5). These lands are also the source of geoduck for the second producer groups—the Puget Sound Treaty Tribes (hereafter, the Tribes). The Tribes, whose harvest we denote as "treaty" harvest, are currently the largest producer of geoduck in

[20] Reminder: All production figures are in calendar years.

[21] As explained in the previous section, the study feels that the actual ex-vessel value of Washington State's production was actually closer to $25 million in 2003.

Washington. The 1994 Rafeedie decision (United States v. Washington, 873 F. Supp. 1422 W.D. Wa 1994) "affirmed and quantified the Puget Sound Treaty Tribes' right to 50 percent of the harvestable surplus of geoduck within their usual and accustomed grounds and stations". Thus, the Tribes have the right to harvest up to 50 percent of the harvestable surplus from the tracts that the State auctions to private harvesters. Farmed or cultured producers plant geoduck seed on inter-tidal lands that are privately owned. The plots can be owned by the producers or they can be leased from other owners. Culture producers registered their first production with the state in 2002 and now represent roughly 10 percent of total production (see Figure 10 and Table 3).

Figure 10. Washington Production of Geoduck, by Group



Source: Washington Department of Fish and Wildlife, 2004.

Washington is the only major producer of geoduck whose production increased substantially in the last decade. Total production has risen from 1,253 MT in1996 to 2,157 MT in 2003 (see Table 2). Production is increasing from all sources. The average production from non-treaty sources between 1996 and 1998 was 669 MT per year. Those same sources averaged 869 MT per year between 2001 and 2003, which represents an increase of 30 percent. Over the same time periods, treaty production increased 32 percent from an average of 786 MT per year to 1,044 MT per year.

Table 3. Distribution of Washington Harvest in Metric Tons, Post-Rafeedie Decision

Year	Non-Treaty Production	Treaty Production	Farmed Production	Total Production	Non-Treaty Percent of Total	Treaty Percent of Total	Farmed Percent of Total
1995	437	127	0	564	77.4%	22.6%	0.0%
1996	605	649	0	1,253	48.2%	51.8%	0.0%
1997	716	774	0	1,490	48.0%	52.0%	0.0%
1998	684	935	0	1,618	42.2%	57.8%	0.0%
1999	815	1,111	0	1,925	42.3%	57.7%	0.0%
2000	795	772	0	1,568	50.7%	49.3%	0.0%
2001	811	1,039	0	1,850	43.9%	56.1%	0.0%
2002	915	1,038	192	2,144	42.7%	48.4%	8.9%
2003	883	1,055	220	2,157	40.9%	48.9%	10.2%
Total	6,659	7,499	412	14,570	45.7%	51.5%	2.8%

Source: Washington Department of Fish and Wildlife, 2004.

Since the Rafeedie decision tribal harvesters have consistently harvested more product than non-treaty harvesters (see Table 3). Between 1995 and 2003, non-treaty harvesters produced 6,659 MT from state lands. During the same period the Tribes produced 7,499 MT. These amounts mean that the Tribes harvest 1.12 pounds of geoduck for every pound that is harvested by non-tribal harvesters. So, while the Tribes are guaranteed 50 percent, the data show that they have actually harvested 53 percent of total production. If the first year of after the Rafeedie decision is discounted as a transitional year, then we see that between 1996 and 2003 the tribes harvested roughly 54.2 percent of annual production, or 1.19 pounds of geoduck for every pound harvested by non-treaty harvesters.

Table 3 also shows cultured geoduck production from farmed sources. Farmers produced 192 MT in 2002 and 220 MT in 2003. We view these production data with some skepticism. The study's research and interviews did not indicate that the farmers are required to report the production of wild stock from private lands, but they are required to report private cultured product from the same lands. Hence, the study thinks that production from cultured lands could be higher than is currently reported as growers can use harvest standing wild stocks to provide operative capital, but are not require to report the production (See Section 3.4 for further discussion).

Projected 2004 Production

The study estimates 2004 production based on aquatic farm reports and fish tickets through June 30, 2004. The estimates are derived by taking recorded 2004 production through the end of the second quarter and dividing it by the historical portion of calendar year harvest harvested before July 1.

Table 4 shows estimated 2004 production and 2003 production for comparison. The non-treaty sector produced roughly 880 MT in 2003 and is on track to produce roughly 905 MT in 2004. The study considers this amount to be essentially unchanged year-over-year given the relative accuracy of the estimation method.

The treaty sector produced 1,055 MT in 2003 and is on track to produce 1,168 MT in 2004. This amount is a substantial increase over 2003. If treaty producers harvested the estimated amount then they would be producing 1.29 pounds of geoduck per pound produced by non-treaty producers. This ratio is higher than the historical average of 1.12 to 1.19 pounds of production per pound of non-treaty production. The study also notes that the treaty producers have highly variable production patterns. For example, in 2003, treaty producers harvested 36 percent of their production before July 1st; while in 2001 the treaty producers harvested 63 percent of the product before July 1st. Thus, the study estimates that in 2004 the treaty producers could harvest between 1,020 MT, based on their historical production relative to non-treaty producers, and 1,168 MT, based on the past temporal distribution of their harvests.

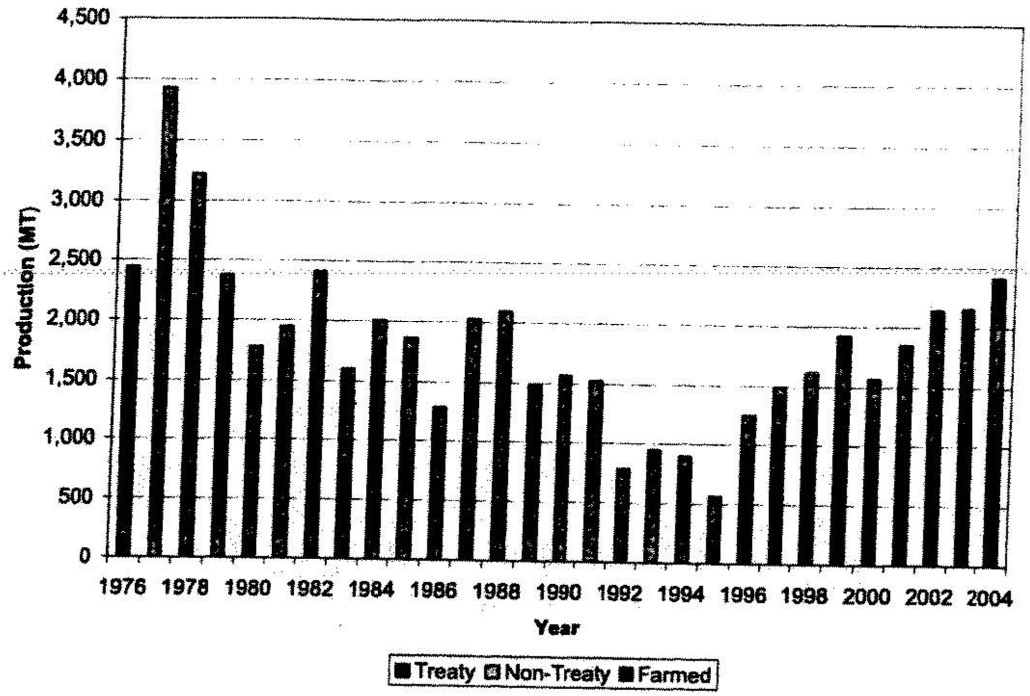
The study estimates that aquaculture production will increase from 220 MT in 2003 to 346 MT in 2004. This change represents a 57 percent increase in culture production. In addition, the sector's share of Washington production will increase from 10.2% in 2003 to 14.3% in 2004. The study expects that that the sector will continue to exhibit double digit year-over-year growth rates for the next several years.

Table 4. 2004 Production Projections

Group	2003 Production (MT)	Amount Harvested Before July 2004 (MT)	Percent Harvested Before July (1998-2003)	Estimated 2004 Production (MT)	2003 Harvest Share	2004 Harvest Share
Non-Treaty	883	434	44.1%	905	40.9%	37.4%
Treaty	1,055	603	48.0%	1168	48.9%	48.3%
Aquaculture	220	153	51.6%	346	10.2%	14.3%
Total	2,157	1,190	50.1%	2,419	100.0%	100.0%

Source: Washington Department of Fish and Wildlife, 2004 and Northern Economics' Estimates.
Note: All estimates are based on the calendar year production.

Figure 11. Washington Production of Geoduck with 2004 Estimated, by Group



Source: Washington Department of Fish and Wildlife, 2004 and Northern Economics' Estimates.
Note: Calendar year production.

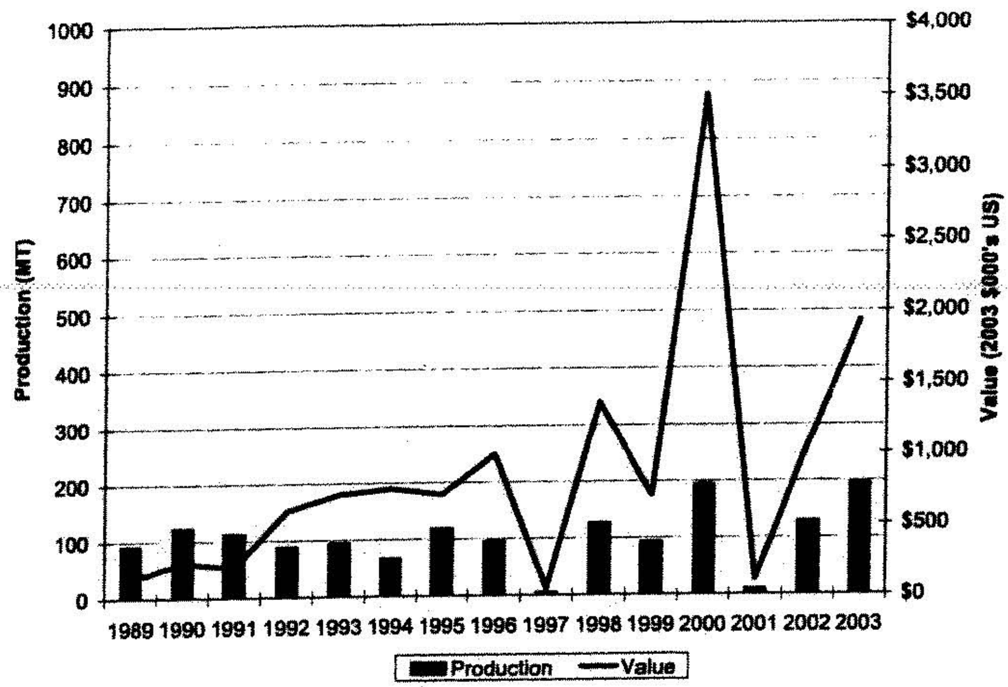
Figure 11shows estimated 2004 production from all three sources. Total production will increase over 2003 levels as the farm/culture sector begins to increase production. This increase will occur regardless of whether the State of Washington allows cultured production on state lands. Production from wild sources should remain relatively constant. The study expects that this production trend will continue for the next several years.

2.2.3.2 Alaska

Alaska's geoduck fishery is a limited-entry, derby-style fishery managed by the ADF&G.[22] The fishery is small relative to the size of the Washington and British Columbia fisheries, and production can be erratic with periodic closures for paralytic shellfish poisoning (PSP). Alaska producers have traditionally had difficulty participating in the live market because of PSP issues and the logistical difficulty of transporting a live animal from remote communities. Alaska producers are furthered disadvantaged because the current dominant market for live geoduck, China, demands a stable and constant product stream. Alaska producers have been generally unable to provide this type of product stream, and thus most of the product is provided to the processed market (Decker 2004).

[22] A limited-entry, derby-style fishery is one with a limited number of participants who still "race" one another to see who can harvest the most product before the fishery closes for the season.

Figure 12. Alaska Production and Value, 1989-2003



Source: Alaska Department of Fish and Game, 2004

2.2.3.3 California and Oregon

The team surveyed data from California and Oregon and found no evidence of commercial harvests in either state (Seabourne 2004).

2.2.4 Argentina

Argentina is currently home to a small, non-commercial fishery for a geoduck species known a *P. abbreviata*, but is not a source of geoduck to the world market. The species is smaller than *P. abrupta*, but has similar color and texture characteristics. The study interviewed Jose Orensanz, Ph.D. of the University of Washington School of Fisheries and the Centro Nacional Patagonico in Argentina. Dr. Orensanz is an expert on the Argentinean geoduck fishery. He indicated that he does not expect an export industry to develop around *P. abbreviata* even though market tests indicate the species is acceptable to the market in terms of size, color, and texture.[23] Argentina's infrastructure is insufficient to transport the species to market live and Argentina's restrictive export laws would prevent the product from reaching the market quickly enough to be sold as live product even if the infrastructure were sufficient. He indicated that it was more likely that the species would be produced in small amounts by Chilean producers who have access to better infrastructure and more export-friendly environment.

[23] Dr. Orensanz indicated that while the Argentinean species is similar to *P. abrupta* in terms of texture and color it is also smaller with a maximum size of 900 to 1,000 grams and a smaller average size of less than 750 grams. The average size foe wild geoduck is roughly 910 grams and the estimated average farmed size is roughly 820 grams.

2.2.5 New Zealand

New Zealand occasionally produces a small amount of the local geoduck species (*P. zealandica*), but is not a significant provider to the world market.[24] The local species has characteristics that the market would not readily accept (see Section 3.7). According to the study's interviews with Paul Gribben, Ph.D., of the University of New South Wales and Rodney Robert, Ph.D., of CAWTHRON, Ltd., *P. zealandica* is too small with poor color and texture characteristics (i.e. gray and "mushy") and recent tests indicate market resistance to the product.[25] The study believes that total wild production is limited to less than 50 MT (110,000 pounds) per year.

2.2.6 Mexico

Study interviews indicate that Mexico currently produces a small amount of geoduck from the area around Baja, California, but that Mexico is not a major source of geoduck to the world market.[26] While the study was unable to find an expert on the Mexican geoduck industry to interview, we were able to talk about the Mexican fishery with several growers in the United States. They felt that increased wild or farmed production out of Mexico was unlikely because the product coming from Mexico was of an inferior grade. The sub-species in that area is accustomed to much warmer water than *P. abrupta,* and dies when chilled below 45 degrees. This fact means it is illegal to ship the product live through the United States because the temperature required to keep the animal alive is higher than allowed by U.S. law for live transport of shellfish. The study was also told that the animal expels a significant amount of its harvest body weight in water during transport, which results in a dehydrated and flaccid product when the animal reaches the market (Lentz 2004; Palzer 2004).

2.2.7 The Future of World Wild Production

The study does not expect an increase in the wild production of Pacific geoduck.[27] Our discussions with personnel from the Department of Fisheries and Oceans in Canada and the Washington Department of Fish and Wildlife indicated that both locations seem satisfied with their current methods of assessing commercially available biomass and that their methodologies are designed to provide stable harvests over the long-run.[28] (Heizer 2004 and Sizemore 2004) The study heard doubts about the long-term health of both stocks from wholesalers, harvesters, and other government officials. However, while the study team does not completely discount the possibility of a stock collapse in either location, the interviews indicated a tendency for interviewees to indicate that the "other person's" stock was going to collapse. Thus, the study leaves these arguments to the management biologists in charge of both fisheries and simply notes their existence.

As reported earlier, several interviewees also reported that they felt that the quality of Washington's wild stocks was declining. Our discussions with staff from the Washington Department of Fish and

[24] We say "occasionally" here because the fishery has been the subject of some litigation and has not produced product on a consistent basis.

[25] The maximum size for this species is roughly 500 grams.

[26] FAO's FISHSTAT database does not record any production of geoduck in Mexico.

[27] The study does not expect production increases of other wild species either.

[28] The Washington fishery is currently managed jointly by the State and the Tribes. If there was no agreement between the parties then each individual party could open its fishery as long as the individual management principles were sound. Thus, while the State has no intention on increasing wild production the Tribes could increase production if they moved away from the joint management agreement and found a sound management methodology that allowed them to increase production (Toba 2004).

Wildlife indicate that such a decline is theoretically possible given the structure of Washington's management plan and that the market should see increased quality from Washington waters within ten to fifteen years (see Section 2.2.1).

2.3 Distribution of Demand

The distribution of the demand for geoduck is best explained by looking at the export data of countries that are supplying that demand. Unfortunately, trade data for geoduck is generally in poor condition. Only Canada has kept readily available, detailed records on geoduck imports and exports. The U.S. has tracked geoduck imports for years, but only started tracking exports on the product level recently at the request of the Washington Department of Natural Resources. Detailed data on U.S. geoduck exports only exists back to the year 2000. China and Hong Kong, the primary markets for U.S. and Canadian geoduck, do not publicly track the geoduck trade at the product level (Hong Kong Census and Statistics 2004). Instead, they lump geoduck in with other live mollusks.[29]

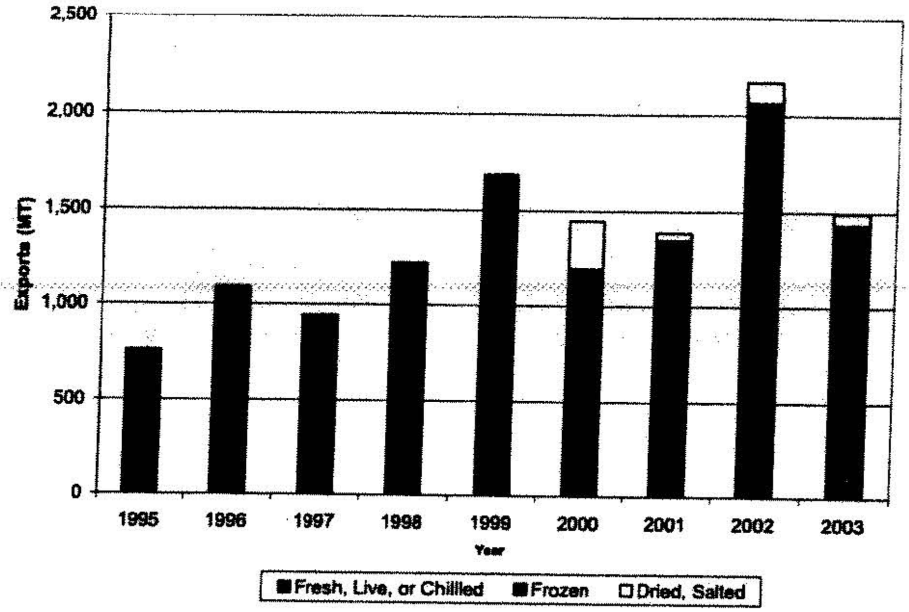
Canada

Canada is the primary distribution point for most of the geoduck trade. Wholesalers based in Canada control much of the market. However, this dominance could eventually be threatened by geoduck growers in Washington. Some of these growers, such as Taylor Shellfish, have the resources and diversity to assume the risk associated with geoduck export. These companies could eventually develop their own distribution systems which might accept product from smaller Washington-based producers. These smaller producers, who are generally too small to establish their own distribution systems, could benefit from the competition created between Washington-based and British Columbia-based wholesalers.

The distribution of Canada's exports is changing in terms of both product composition and export market. Figure 13 shows the distribution of Canada's exports by product. In 1995 and 1996, the country exported 821 MT of fresh product and 1,032 MT of frozen product. Of the fresh product for that period, Canada exported 83 percent to Hong Kong. 12 percent went back to the United States for the U.S. domestic market, 2 percent went to China and Taiwan each, while Singapore received 1 percent of total exports (see Figure 14). Of the frozen product, Canada exported 62 percent to Hong Kong, 28 percent to the United States, 9 percent to Taiwan, and small amounts to Japan and Lithuania (See Figure 14).

[29] The study team believes that detailed data on imports could be acquired from both Hong Kong and China through personal contact with officials responsible for trade data, but that effort would certainly require more money and time than were allocated to this effort.

Figure 13. Product Distribution of Canadian Exports, 1995 to 2003



Source: Statistics Canada, 2004

Figure 14. Distribution of Canadian Exports (Fresh, Live, Chilled), 1995-96

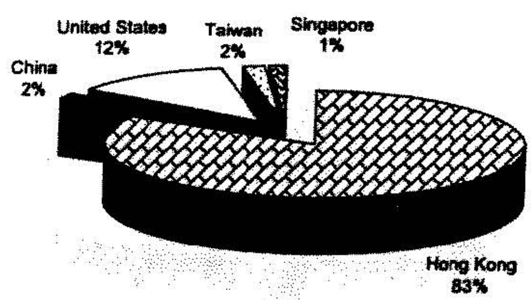
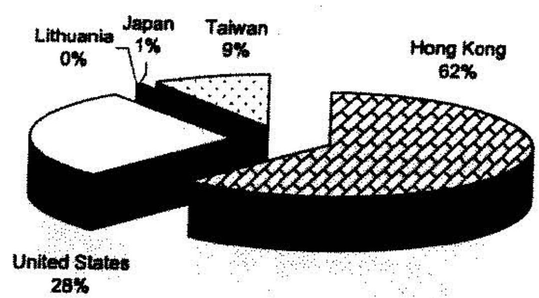


Figure 15. Distribution of Canadian Exports (Frozen), 1995-96



Source: Statistics Canada, 2004

By 2002 and 2003, the production distribution changed dramatically and the export locations showed the importance of direct exports to China. In 2002 and 2003, the country exported 3,400 MT of fresh product, 68 MT of frozen product, and 170 MT of dried product. Of the fresh product for that period, Canada exported 81 percent to Hong Kong, 11 percent to China, 8 percent back to the United States for the U.S. domestic market, and smaller amounts went to Singapore and Taiwan (see Figure 16). Of the frozen product, Canada exported 38 percent to Lithuania, 28 percent to Hong Kong, 19 percent to the United States, 15 percent to Taiwan, and small amounts to Japan (see Figure 17.)

Figure 16. Distribution of Canadian Exports (Fresh, Live, Chilled), 2002-03

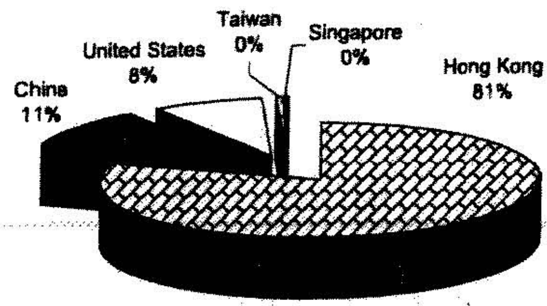
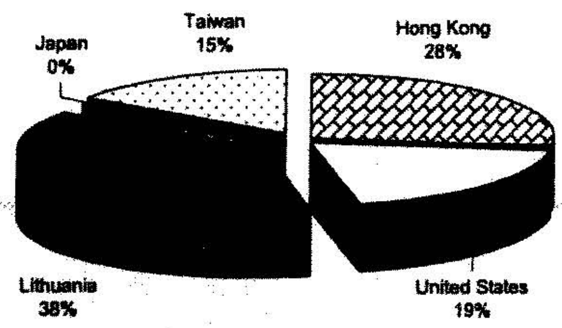


Figure 17. Distribution of Canadian Exports (Frozen), 2002-03



Source: Statistics Canada, 2004

United States

Unfortunately, the U.S. trade data for geoduck is limited. While import information exists back through 1990, export data only exists back to the year 2000. The study team believes that data from 2000 and 2001 are suspect because they do not include significant exports to Canada and it is well known that Canada is the primary destination for U.S. geoduck, which are then exported to Hong Kong and China. This belief is supported by Figure 18 and Figure 19. In 2002 and 2003, the U.S. exported 1,726 MT of fresh product and 107 MT of frozen product.

Figure 18. Distribution of United States Exports (Fresh, Chilled, Live), 2002-03

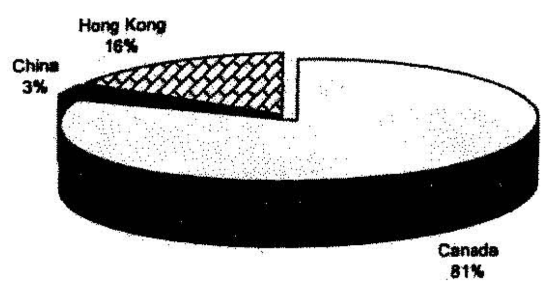
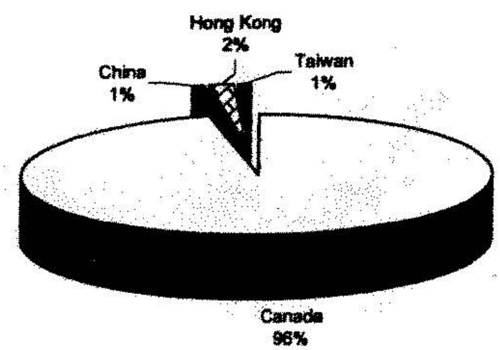


Figure 19. Distribution of United States Exports (Frozen), 2002-03



Source: U.S. Department of Commerce 2004

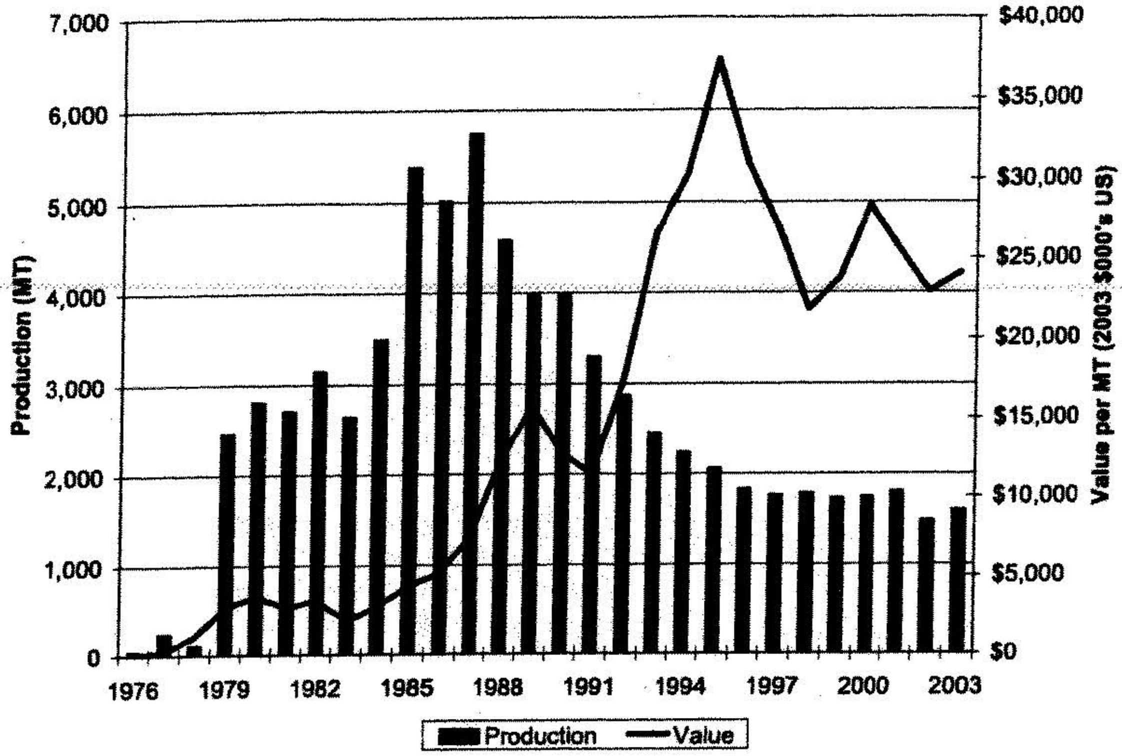
Eighty-one percent of the fresh product went to Canada, while 16 percent was direct shipped to Hong Kong and 3 percent went to China. Ninety-six percent of the frozen product went to Canada while the rest was divided between Hong Kong, China, and Taiwan. The study team expects that direct exports to China and Hong Kong will increase as U.S. culture companies' geoduck operations grow and mature. The key for these companies is that they must supply the Chinese and Hong Kong markets with a steady supply at a consistent price and quality of product and they must develop a personal relationship with the buyer. These markets expect that type of supply, and it is that type of demand that cultured products are uniquely suited to meet.

2.3.1 World Geoduck Demand and the Price for Geoduck

From all indications, world demand for geoduck is very healthy and future demand will continue along current trends. The fact that prices are currently high and that they have remained relatively stable while production has increased since 1996 indicates a high level of demand relative to world supply (see Figure 20). The study attributes a portion of this stability to the ability of Canadian wholesalers to adjust supply based on the needs of the market. However, it is difficult to predict how robust and stable this demand and price will be in the face of the new production from wild or cultured sources. The study received conflicting information from its expert interviews on the issue. China, the largest market, has one of the fastest growing economies is in the world. Past experience shows that when per capita income increases, the demand for luxury products and protein grows as well. The market supplies the Chinese market with a tiny amount of geoduck relative to the size of the Chinese population and currently the geoduck market is concentrated in the major cities of Hong Kong, Guangzhou, Shanghai, Beijing, and Shenzhen. This distribution means that there are dozens of other cities with populations of more than a million people who don't have access to geoduck. Simple demographics indicate the potential for increasing the demand for geoduck is quite high even if the product remains a luxury item.

Figure 20 depicts what appears to be a classic relationship between supply, demand, and prices. Prices rose drastically as supplies fell in the late 1980s and into the early 1990s. However, at this time the geoduck market was also transitioning from one that relied on a frozen, processed product to one that demanded a live product. In the seafood industry, high quality, live products are inherently more valuable on a per pound basis than a frozen product with little secondary preparation. Additionally, this period also saw China's continuing transformation from a planned economy to a full participant in the world market economy. As shown in following sections, Chinese demand for live product is drawing supplies away from other countries that used to demand live product. Thus, given these two major changes in the market, the study team is reluctant to attribute all of the world change in price to a change in world supply.

Figure 20. World Production and Per Unit Price



Source: Statistics Canada, Washington Department of Natural Resources, & the Alaska Department of Fish & Game

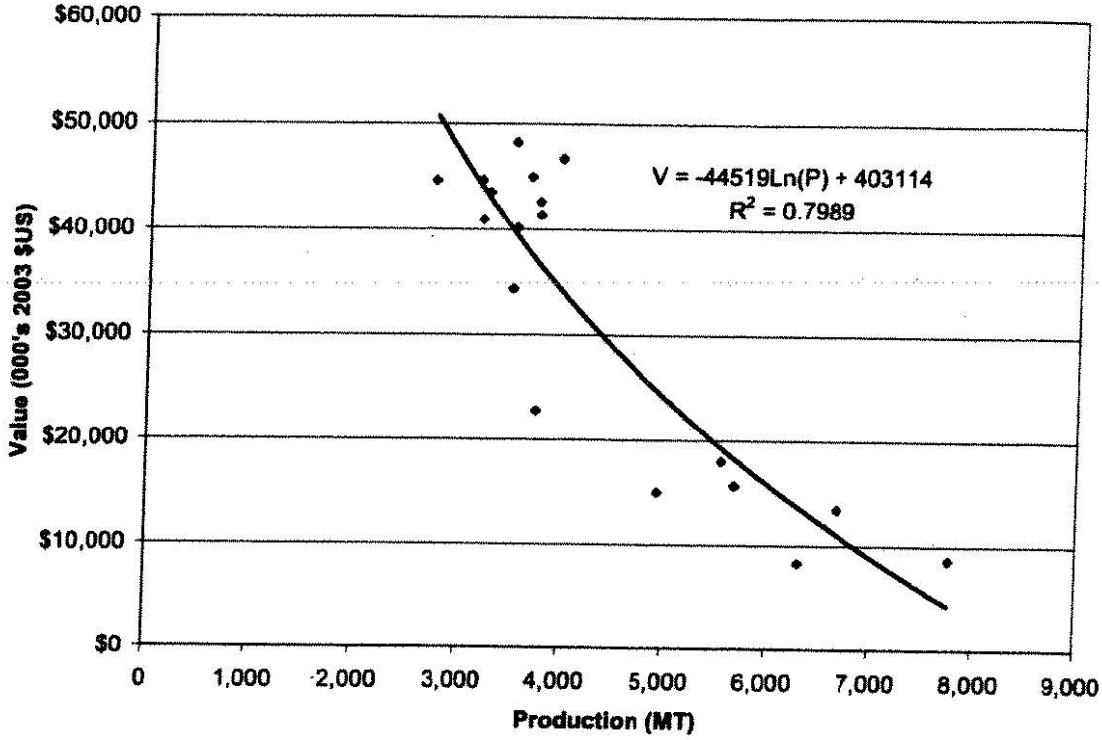
Technical Assessment of Geoduck Demand

The fact that the world market has not only seen major shifts in production, but that the product has changed and the countries demanding the product have changed, makes it very difficult for the study team to predict what will happen if supply increases from wild or culture sources. Traditionally, the study team would look at supply and price over time, derive a demand curve, and calculate an own-price flexibility through an inverse demand model (Anderson and Garmendia 2003).[30] However, simpler forms of these calculations ignore changes in market structure and preference over time.

For example, Figure 21 shows the relationship between supply and price between 1986 and 2003 and an estimated demand curve using a semi-logarithmic functional form. The fitted line explains nearly 80 percent of variation in the value and production relationship. The own-price flexibility at 4,000 MT of production is -1.32. This result means that in the global market for geoduck a 1 percent increase in supply will result in a 1.32 percent decrease in price. If this result were true, we would expect that a major production increase would result in a significantly lower price for geoduck.

[30] Own-price flexibility is defined as the percentage change in the price of a good in response to a one percent increase in quantity marketed (Anderson and Garmendia 2003). It is the inverse of own-price elasticity.

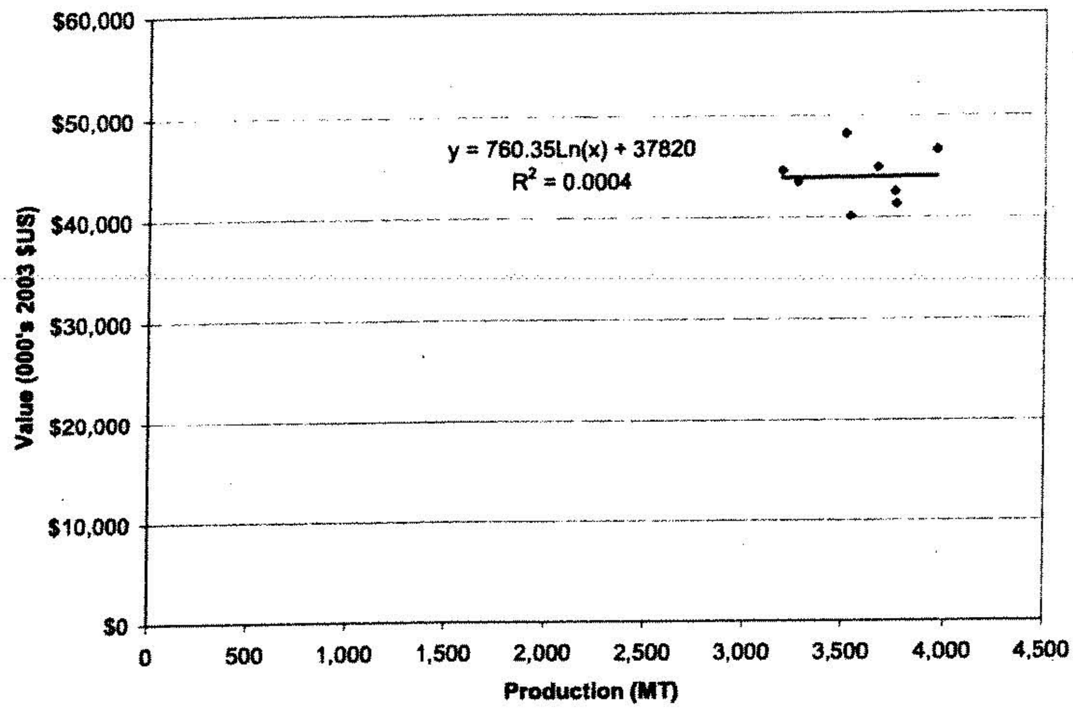
Figure 21. Demand Curve Using World Production and Value, 1986-2003



Source: Statistics Canada, Washington Department of Natural Resources, the Alaska Department of Fish & Game, and Northern Economics Estimates.

The study team believes that the analysis above would provide a false picture of the market because the higher production levels used in the analysis come from the mid-1980s when more product was shipped out in a lower-value frozen form. Thus, we believe that such as analysis should only include the "modern era" of geoduck production which begins after the Rafeedie decision. Figure 22 shows the same analysis using data from 1996 to 2003. The fitted equation only accounts for 0.04 percent of the variation this time, and any calculated flexibility is positive. This result means that based on this analysis we actually expect price and demand to increase when supply increases. For example, the own-price flexibility at 4,000 MT the flexibility equals 0.02. In other words, a one percent increase in supply would result in a 0.02 percent increase in price. We have heard from Canadian wholesalers that the cache of geoduck has increased as price has risen and that the Chinese market appreciates foreign brands with cachet and limited supply. However, given the fact that the fitted line explains so little of the relationship between value and supply, the study is more comfortable saying it appears that in recent years the geoduck market has exhibited inflexible tendencies.

Figure 22. Demand Curve Using World Production and Value, 1996-2003



Source: Statistics Canada, Washington Department of Natural Resources, the Alaska Department of Fish & Game, and Northern Economics Estimates

Market Player Opinion of Geoduck Demand

The study talked with wholesalers who supply the market with product and individuals in Hong Kong and China who import and sell geoduck.[31] They provided very different views of the market that align with the expected interests of the parties.

Geoduck Wholesalers

Canadian wholesalers control nearly all of the distribution routes to the main geoduck market, China. Many of these wholesalers are of Chinese descent and use their family ties and innate knowledge of Chinese culture to distribute geoduck in a highly effective and profitable manner. These wholesalers are also aligned closely with the some of the 55 license holders in the Canadian geoduck fishery. This alignment has allowed the wholesalers to create the current market conditions of high prices and tight supplies, as they are able to tell the license holders when to fish and when to stay in port.

The study interviewed several wholesalers. All indicated that the market could absorb measured amounts of additional supplies without significant price disruptions. The most common estimate that we heard was that a ten to fifteen percent increase in supply would not result in significant price declines. However, these wholesalers also said that significant increase in supply of wild or cultured product would result in severe price declines. Their argument was that geoduck is a super luxury item which only the rich can afford. The product's price in the Chinese market can reach $60 to $100 per

[31] The study notes that all of these individuals asked to remain anonymous within the report.

pound. If the price of the product were to fall by 50 percent, it would still be out of the price range of most of the population. Thus, there isn't a large pool of individuals waiting to eat geoduck even if the price falls substantially because even a reduced price will still be out of the range of the average individual.

On the other hand, these buyers also said that they had no doubt that cultured geoduck would find a place in the market. They said that cultured geoduck would trade at a discount to the wild product because the cultured product isn't old enough to have acquired the texture the market wants in the product. Conversely, Geoduck growers in Washington assert that the cultured product's consistency of size, color, and supply will win out over the texture issues in the long run.

Geoduck Buyers

The study interviewed several Hong Kong and China-based buyers of seafood products about the geoduck market. All indicated that the market was clamoring for more geoduck and all concluded their interviews by asking the interviewer if he knew where they could get more geoduck for their markets. These interviews also indicated that much of the market will ignore the texture issue for consistency in supply, color, and size.

The study asked the buyers about the reputation of American products. They indicated that the market pays a premium for American products, but that American foreign policy can hurt products which market their American origins in an overt manner. The interviews also indicated that Taylor Shellfish of Shelton, WA is establishing brand recognition and a reputation for excellence in the Chinese market. They said "Taylor Shellfish is American Shellfish."

Potential Effects of Increased Geoduck Supply

Please see Section 3.10.

When All Bets Are Off

There are several issues which would cause "all bets to be off" with regard to the world geoduck market. Under these situations, which lie outside the control of players in world geoduck market, the study believes that market players could face serious short and long-term economic harm. These situations include:

- Another outbreak of SARS or an outbreak of a virulent and dangerous disease in Southeast Asia.[32]
- The relationship between China and the U.S. deteriorating over Taiwan or another issue.
- Chinese aquaculturists finding a way to produce geoduck as they have Yesso scallop.

Under these scenarios, the team believes that the predictions and recommendations in this report could cease to be valid.

[32] Theoretically culture producers would be better able to weather another human disease outbreak such as SARS because there is no time limit on there harvest rights. Growers could simply leave their product in the ground until such time as demand returned to normal levels. Harvesters in Washington and British Columbia face yearly quotas and run the risk of permanently losing harvest quota if they were forced to leave product in the ground over the yearly harvest deadline.

3 The Future of Farming Geoduck- A Comparative Analysis

3.1 Summary

The study believes that the State of Washington will be the only significant source of farmed geoduck production for most of the next decade. Geoduck farmers in Washington face the fewest hurdles in establishing significant farmed production. In fact, significant farmed production has already started in the state and will grow substantially in coming years. Based on a survey of publicly available information and key industry informant interviews, the study does not expect that other regions will provide the market with a significant amount of farmed production for nearly a decade.

Geoduck farming will be most successful in areas which substantially meet a number of "environmental" requirements. The requirements, which promote business development, include:

- Access to a market acceptable species (e.g. *P. abrupta*);
- Seed production technology and the capacity to produce adequate seed;
- The infrastructure needed to consistently provide the market with a live, high quality, product;
- A minimal chance of contracting disease that affects the animal or the human consumer;
- Adequate private property rights. Farming geoduck requires a long-term commitment and investment. A lack of enforceable property rights will deter investment in a resource that requires a long-term commitment;
- Access to leasable land from either private or government sources;
- Fewer legislative and regulatory barriers.

The study graded the countries, states, and provinces with the most potential for geoduck aquaculture on each of these factors and synthesized an overall industry outlook for that country or state (see Table 5). The grades ranged from "significant hurdles" in that area to the area being a "significant positive" for the region.

Washington State is already producing farmed geoduck. The study projects that the growers in the state will begin to produce amounts large enough to affect world market within the next several years, and could more than double Washington State production levels within the next five to seven years.

British Columbia and Alaska have the potential to produce farmed geoduck in substantial amounts, but each faces a set of unique hurdles that must be surmounted before firms can successfully establish a farmed industry. China remains the great unknown in the future of farmed geoduck production. The country has the ability to make great things happen in a short amount of time, but the lack of private property rights and other factors argue against the potential for a significant, privately-owned industry. However, a large state-owned or subsidized industry is still possible. It is unlikely that New Zealand, Argentina, or Mexico will contribute substantial amounts of farmed product to the world market in the foreseeable future.[33] These countries currently face too many obstacles to farmed production. The study believes that the earliest that these countries could provide substantial amounts of farmed product to the world market would be a decade from now. However, if current circumstances persist, then it is unlikely that these countries will provide the world market with cultured product.

[33] The study's projections of wild product projections for these countries can be found in 2.2.7.

Table 5. Outlook for Farmed Geoduck Production, by Location

Potential Source	Market Acceptable Species	Seed Availability	Infrastructure	Disease Threat	Private Property Rights	Lease Structure	Legislative Barriers	Overall Outlook
Washington	⬆	⬆	⬆	0	⬆	↘	⬆	⬆
British Columbia	⬆	↘	⬆	0	⬆	⬇	⬇	↗
Alaska	⬆	↘	↘	↘	⬆	⬆	↘	↗
China	⬇	⬇	↘	?	⬇	?	?	?
New Zealand	⬇	⬇	⬆	0	↗	↘	⬇	⬇
Argentina	⬆	⬇	⬇	0	↘	?	⬇	⬇
Mexico	↘	⬇	↘	?	↘	?	?	↘

Key

Significant Hurdle	Minor Hurdle	Neutral	Minor Positive	Significant Positive	Unknown
⬇	↘	0	↗	⬆	?

Source: Publicly Available Data, Key Informant Interviews, and Northern Economics, Inc. projections.

The following sections provide detailed assessments of each of region.

3.2 Washington

As previously stated, we believe that Washington State is the only area which will produce significant quantities of farmed geoduck to the world market over much of the next decade. In fact, the state is already beginning to produce increasing quantities of farmed product.

Table 6. Outlook for Farmed Geoduck Production, Washington

Potential Source	Market Acceptable Species	Seed Availability	Infrastructure	Disease Threat	Private Property Rights	Lease Structure	Legislative Barriers	Overall Outlook
	⬆	⬆	⬆	0	⬆	↘	⬆	⬆

Key

Significant Hurdle	Minor Hurdle	Neutral	Minor Positive	Significant Positive	Unknown
⬇	↘	0	↗	⬆	?

Source: Publicly Available Data, Key Informant Interviews, and Northern Economics, Inc. projections.

The study team scored Washington State as having significantly positive conditions in five of seven categories (see Table 6). The state is the native habitat of the dominant geoduck species on the world market (*P. abrupta*). It also has working seed production facilities and exceptionally high quality infrastructure. Product harvested in Washington State can arrive at the market as fast as, or faster than product from any other production region in the world outside of China. Growers in the state have a well-developed property rights system, which allows them to own or lease inter-tidal areas for geoduck production. Legislative and regulatory barriers to entry are currently minimal. Potential growers are required by Washington Law to register their farmed tract with the Washington Department of Fish and Wildlife and submit quarterly reports on the amount of product harvested from those lands. (WAC 220-76-0101 and WAC 220-69-243) The State of Washington does not currently regulate maximum planting densities or other environmental factors on these lands. The result is a regulatory environment which favors industry development.

Current regulations also do not limit the amount of wild geoduck stock that can be removed from registered farm tracts (Sizemore 2004; Mielke 2004).[34] This fact means that geoduck farmers who are just starting out, and who happen to lease lands with wild stocks, can use the wild stocks on their lands to generate operating capital while they work out any problems in their production systems and wait for their first crops to reach maturity.[35]

It is currently unclear how much geoduck is reaching the market from these lands. The study's research and interviews did not indicate that farmers are required to report these harvests as they would have to report private cultured product from the same lands. WAC 220-69-243 simply states:

> *Every aquatic farmer selling or shipping out-of-state his private sector cultured aquatic products shall keep complete and accurate records showing the quantity of these products sold and the location of the aquatic farm where they were grown, and shall completely, accurately, and legibly prepare an aquatic farm production report. An aquatic farm production report shall be prepared for each aquatic farm and shall be mailed to the department within thirty days of the end of each quarter for which production is reported.*

The regulation does not require the grower to keep similar records of private, wild production or report that production in the aquatic farm report. Thus, it is currently impossible to tell if all of the production coming from registered farmed lands is from private culture stocks or even if all of the total production (i.e. wild + cultured product) from these lands is even being reported.

The one area in which the study scored the industry in Washington as facing a minor hurdle is in having an already established lease structure and system. While the lease structure and system on private lands is well developed, potential lease sites and the structure of leases on State owned lands have not officially been defined.[36] This is a minor hurdle given that so much land is currently in private lease production. Alaska, by comparison, has already defined its lease sites and auctioned those sites off to potential growers.

The study graded the disease outlook for Washington State as neutral. The State does not have the same PSP problems as those faced by Alaskan growers. On the other hand, the State does also not regulate planting densities. As discussed in the Aquaculture Case Studies (see Section4), the higher growing densities that are often associated with aquaculture production, and farming techniques in general, can lead to disease outbreaks that can devastate an industry. While the study team is unaware of a specific disease threat, we believe that it would benefit both growers and wild harvesters if the State were to study potential disease threats, the likelihood of those threats, and the potential benefits of crop rotation and maximum stocking densities.

Inter-tidal geoduck aquaculture is incredibly productive. Standard techniques of planting 3 seed animals per square foot can lead to production of average of more than 120,000 pounds per acre. This amount is 8-10 higher than the average per acre productivity of Washington's sub-tidal wild fishery. Thus, Washington's growers have the ability to affect the world market while utilizing a relatively modest amount of acreage.

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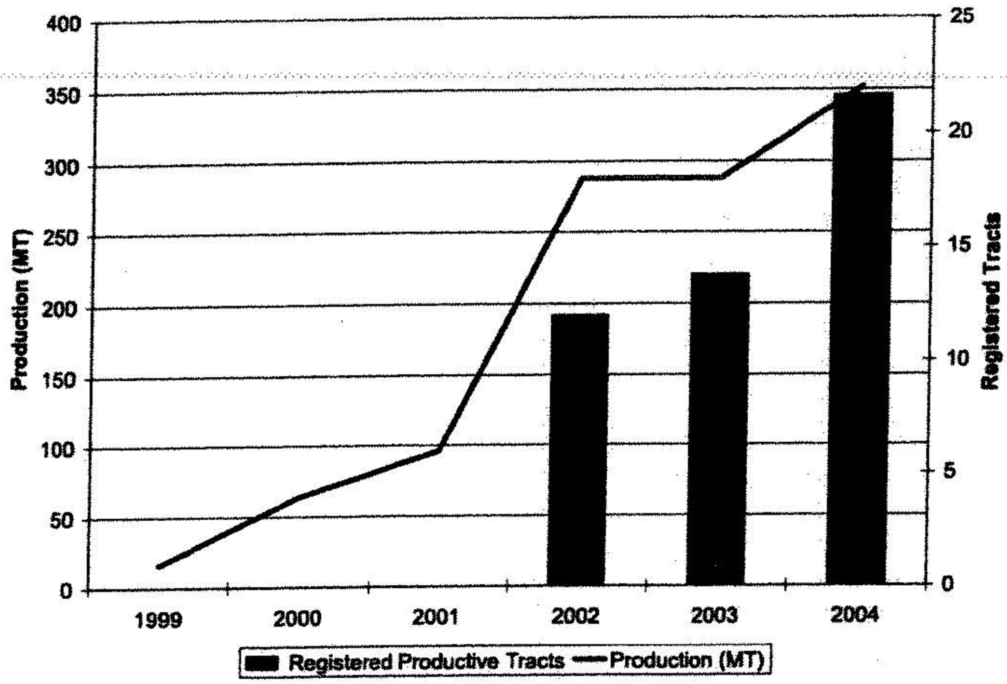
[34] Even though growers are not limited in the amount of wild stock they can harvest from an aquaculture site the law requires that growers offer tribal harvesters the opportunity to harvest 50 percent of the harvestable amount on the land.

[35] Sub-tidal growers in the Canada are also allowed a "purge" fishery, but they can utilize 100 percent of the wild stock. However, Canada is beginning to hear from its "First Nations" on treaty rights issues related to fisheries (Palzer 2004). Thus, this right could change in the future.

[36] Private leases generally pay the landowner 1,000 per acre per year of usage plus 10 percent of the total ex-vessel harvest value (Gibbons 2004; Lentz 2004).

In 2003, registered growers produced 484,000 pounds (220 MT) of product for the market. This amount was equal to roughly 10 percent of Washington's total production (WADFW 2004). The study estimates that growers will produce 761,200 (346 MT) in 2004. Figure 23 shows how cultured geoduck production and the number of registered, productive tracts are increasing year after year.

Figure 23. Washington Cultured Geoduck Production and Total Number of Productive Tracts, 1999-2004 (EST)



Source: Washington Department of Fish and Wildlife, 2004

The study estimates that, based on an estimated seed production level of 4.5 to 6.0 million seed, Washington growers will significantly increase the world supply of geoduck and could more than double the amount of product currently produced in the State of Washington. Table 7 shows the estimated amount of annual increased production that might be expected from 2004 seed production if all that seed were planted at the same time this year and harvested at the same time in the future. The estimates are based on a seed production-to-planting rate of 90 percent, a planting-to-harvest survival rate of 40 percent to 70 percent, an average harvest weight of 1.8 pounds per animal, and an assumption that all of the animals are harvested at the same time. Estimates of farmed production range from a low of 2.9 million pounds to high of 6.8 million pounds.

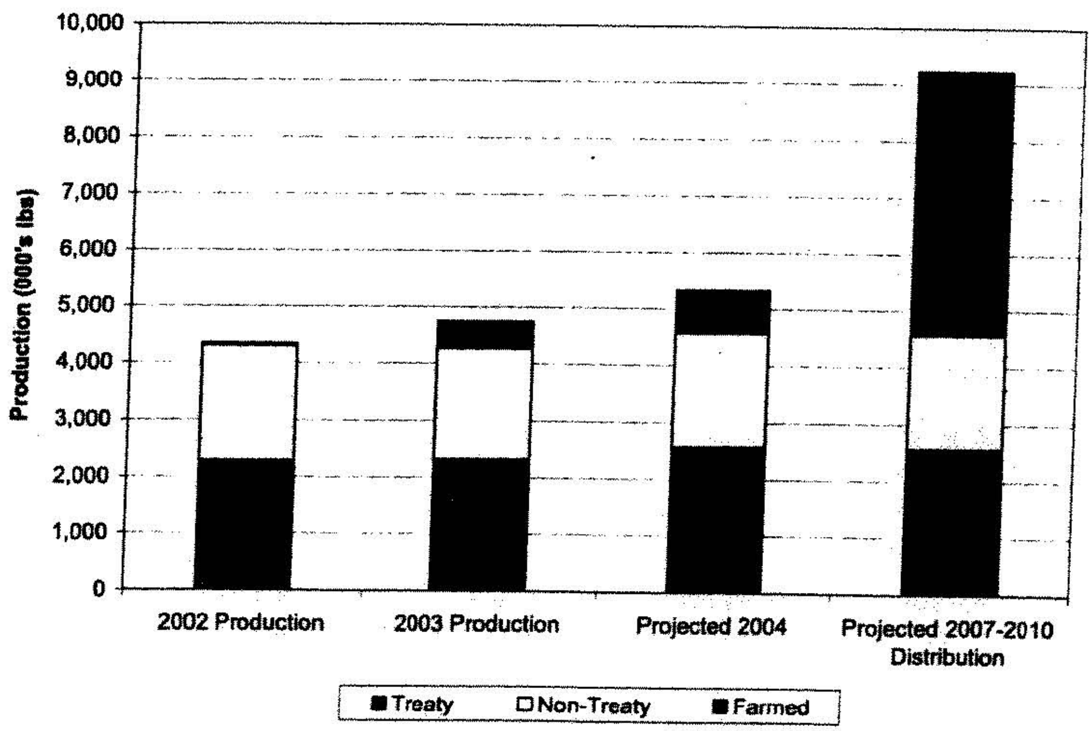
The study team believes that a production level of between 4.3 and 5.1 million pounds (the average projected production level at a 50 to 60 percent survival rate) is very achievable based on current survival rates and information from industry sources. In 2003, Washington growers reported producing roughly 484,000 pounds of Washington's 4.8 million pounds of production (WADFW 2004). Growers would raise Washington's annual harvest levels by 79 percent over current levels if they produced 4.1 million pounds per year of farmed product. Production would be raised 97 percent with an annual farmed production level of 4.9 million pounds. These amounts would raise world production from current levels by 43 percent and 53 percent respectively.

Table 7. Projected Future Farmed Production Based on 2004 Seed Production

Seed Survival Rate	Low End	Average	High End	Percent Increase over 2003 Washington Production	Percent Increase over 2003 World Production
40%	2,916,000	3,402,000	3,888,000	61.48%	33.55%
50%	3,645,000	4,252,500	4,860,000	79.40%	43.33%
60%	4,374,000	5,103,000	5,832,000	97.32%	53.11%
70%	5,103,000	5,953,500	6,804,000	115.24%	62.89%

The study did not find indications that treaty and non-treaty wild harvests will grow over the next decade (Sizemore 2004). This result means that new growth will come primarily from culture production. If the study's projections are accurate, the growth in farmed production will radically change the amount and distribution of Washington's geoduck production and farmed production will become the dominant supplier of Washington geoduck to the world market (see Figure 24).

Figure 24. Projected Production in 2007-2010 vs. 2002-2003 Average Production



Source: Washington Department of Fish and Wildlife Data (2004) and Northern Economics, Inc. Projections.

Actual production levels could be higher or lower depending on a variety of factors, such as seed utilization rate, post-planting survival rate, and actual seed production levels, but the study team is highly confident that Washington growers will provide significant amounts of product to the world market before growers in any other region of the world. The high technological barriers to entry and the long lag time between planting and harvest mean that Washington growers who already have seed in the ground sit in an enviable position. Their early entry into the market could allow them to become the dominant world producer and discourage others from entering the market if their increased production causes world prices to fall.

3.3 Canada

Canadian growers are currently producing a very small amount of farmed geoduck. However, the study team does not expect substantially increased production in the near future given the lack of success in current sub-tidal production efforts and the lack of a steady and reliable supply of seed. Indeed, the study estimates that it could be ten or more years before substantial farmed production comes from Canada.

Table 8. Outlook for Farmed Geoduck Production, Canada

Potential Source	Market Acceptable Species	Seed Availability	Infrastructure	Disease Threat	Private Property Rights	Lease Structure	Legislative Barriers	Overall Outlook
	↑	↘	↑	0	↑	↓	↓	↗

Key

Significant Hurdle	Minor Hurdle	Neutral	Minor Positive	Significant Positive	Unknown
↓	↘	0	↗	↑	?

Source: Publicly Available Data, Key Informant Interviews, and Northern Economics, Inc. projections.

Canada was originally a leader in the attempts to produce significant quantities of farmed geoduck. However, a combination of government regulations, environmental conditions, and bad luck combined to eliminate Canada as a potential source of farmed geoduck in the near future. As with Washington, Canada is in the heart of *P. abrupta*'s range and the Canadians have a thriving fishery which they have managed for more than a decade with a quota system (see Table 8). Unlike Washington, potential growers in Canada have focused on sub-tidal rather than inter-tidal growing systems. Early attempts at planting were not particularly successful (Gant 2004), and it took several years before a successful method and technology for planting in sub-tidal substrates was developed. FAN Seafoods is the leader in the development of this technology. Unfortunately, the company has found that the growth rates for sub-tidal geoduck have been significantly slower than expected and that it is taking much longer for these geoduck to reach a prime, marketable size.[37] This situation has meant that the company is being forced to harvest undersize animals in order to survive until the day when the rest of the crop reaches harvestable size. The company has been harvesting for three years now, and the average size of their animals is roughly 1.5 pounds. The company is also facing difficulty with seed production. There was no seed available for planting this year (Lochmatter 2004). So, while Washington producers planted millions of seed which will be ready in five to seven years, Canadian producers (of which FAN Seafoods is currently the sole producer) planted very little or no seed in 2004.

The other major issue in Canada is that of lease structure/availability and legislative barriers. While Canada has a well-developed system of property rights and the rule of law, the Province of British Columbia and the Federal Government have been unable to come to agreement on how to proceed with regards to aquaculture. The Province would like to promote aquaculture while the Federal Government would like to take a more cautious approach (Heizer 2004). The study interviewed

[37] Our interviews indicated that these sub-tidal geoduck take seven to nine years to reach marketable size versus the five to seven years that it takes inter-tidal seed planted in Washington waters.

several individuals in both Canadian industry and government. These interviews found quite a bit of hope that the leasing and legislative issues could be resolved within the next year or two. However, even if leases and seed were to become available within the next two years, farmed geoduck wouldn't be available for a minimum of seven to nine years at the earliest. Given the host of issues that potential Canadian growers are facing, the study does not expect that Canada will have significant farmed product on the market for at least a decade.

3.4 Alaska

The study estimates that Alaska will be the next region to produce significant amount of farmed geoduck, but these amounts will be significant relative to the State's current production levels and somewhat insignificant relative to the size of the world market.

Table 9 shows the current conditions of factors that the study thinks will affect the development of a farmed geoduck industry in Alaska. Alaska is the northern limit of *P. abrupta's* range, but the animal still grows well enough to support a small, wild dive fishery. In 2003, Alaska's wild fishery produced 423,000 pounds (192.3 MT) of geoduck.[38] Potential geoduck farmers have access to seed through a hatchery located in Seward, Alaska. The hatchery is limited in its production capacity of feed stock (algae) and is currently undergoing renovations to expand its capacity (Agosti 2004). The study believes that the hatchery is currently producing several hundred thousand seed per year. Sustainably doubling Alaska's current geoduck production would require an output of roughly 500,000 seed per year if Alaskan growers were able to achieve survival and growth rates similar to those achieved by Washington growers.

Table 9. Outlook for Farmed Geoduck Production, Alaska

Potential Source	Market Acceptable Species	Seed Availability	Infrastructure	Disease Threat	Private Property Rights	Lease Structure	Legislative Barriers	Overall Outlook
	↑	↘	↘	↘	↑	↑	↘	↗

Key

Significant Hurdle	Minor Hurdle	Neutral	Minor Positive	Significant Positive	Unknown
↓	↘	0	↗	↑	?

Source: Publicly Available Data, Key Informant Interviews, and Northern Economics, Inc. projections.

Alaskan growers face a number of challenges related to infrastructure and disease. According to the Southeast Alaska Regional Dive Fisheries Association and a local geoduck grower, the fishery sent out its first live product in just the last year or two. Product that is harvested in Alaska must make its way from the local community where it is harvested to a regional airport and then on to Seattle or Vancouver. Anchorage simply does not have the daily flights to China and Hong Kong that are needed to establish long-term business relationships. It also does not have the Department of Agriculture staff required for regular exports of live product (Painter 2004). The Chinese market values consistency of product, supply, and price, and Alaska growers are at a disadvantage when it comes to supplying that high-value, live market because they can't move product as easily as harvesters and growers in Seattle (Decker 2004, Manning 2004, Painter 2004). Given that the live market now represents the overwhelming majority of the total geoduck market, the inability to move large

[38] Note that this amount is smaller than the current production of Washington's nascent farmed industry and roughly one-tenth of Washington's total production.

amounts of product is a significant hurdle that Alaska growers and harvesters are going to have to overcome.

Alaska growers also face a hurdle from PSP, which is a chronic issue for shellfish harvesters in Alaska. Not only is PSP a relatively common problem, but the market may resist live, farmed or wild, product from Alaska. The study interviewed several industry sources within the Canadian wholesaler community. The sources, who asked not to be named, indicated that the State of Alaska's testing procedure was woefully outdated and did not lend itself to sending out live product. They said that under Alaska's current testing procedure, product could be in the market before test results came back to the harvester/grower. Sources from the State of Alaska and growers in the area indicate that industry and government are working together to produce a better testing procedure.

Alaska has a leg up on Washington when it comes to designating state-owned leases. Unlike Washington, nearly all of Alaska's shoreline is owned by the State of Alaska. Thus, Alaska growers will be much more dependent on a cooperative State government to provide leasable land. Recently, the State of Alaska has been more than happy to comply with grower requests. In 2002, the Alaska State Legislature required the Alaska Department of Natural Resources to identify 90 sites suitable for aquatic farming. The Department assessed more than 200 sites and selected 158 of these sites for inclusion in the program. In 2004, the Department auctioned 25 inter-tidal, sub-tidal, and suspended farm leases. Several of these sites are expected to enter production as geoduck farms (Timothy and Petree 2004).[39]

The legal status of wild geoduck resources on inter-tidal and sub-tidal leases is currently delaying the development of many of the potential Alaska farm sites. Section 3 of Article 8 of the state's constitution states "wherever occurring in their natural state, fish, wildlife, and waters are reserved to the people for common use." This section raises some question about the disposition of wild resources on leased lands. The Alaska Department of Fish & Game (ADF&G) denied permit applications for certain sites (which the Alaska Department of Natural Resources had auctioned off to potential farmers) because they contained significant, wild, geoduck stocks which ADF&G felt they were constitutionally required to reserve for public use. Alaska Trademark Shellfish, LLC sued the ADF&G for violating the Alaska Aquatic Farming Act. In the end, the State Supreme Court declined to rule on the constitutional issue, but instead ruled that the Alaska Aquatic Farming Act did not give the ADF&G the statutory authority to allow the harvest of wild resource (Lexis 2004). The study's interviews with those involved in the Alaska market believe that the next legislative session will resolve the statutory issue, but that the larger constitutional issue remains.

The study is positive about the long-term outlook for farmed geoduck in Alaska. However, there is no evidence to suggest that a significant amount of production will come from Alaska any time in the next decade. Currently, there are only limited "test" plantings of inter-tidal and sub-tidal tracts.[40] Additionally, seed production within the state is limited and will have to be augmented through in-state hatchery expansion, or seed imports, before it can support a larger industry. We think it will be at least several years before large scale plantings begin and that it will be five to eight years after planting that the geoduck appear on the market. Harvesters will still have to overcome infrastructure and transportation issues. It is important to remember that even if Alaska doubles its current production, it will only add roughly five percent to the world market's total volume.

[39] We note the Alaska requires a 5 mile separation between farm tracts and wild harvest sites.

[40] Currently the best production and early results are coming from inter-tidal tracts. In the long-run, Alaskan producers may find the lower productivity and higher costs associated with sub-tidal culture may not be supported by world prices if supply increases from cheaper sources and overall prices decline.

3.5 China

China remains the great unknown with regards to the future of farmed geoduck production. The study team heard from U.S. industry experts that the Chinese are attempting to culture *P. abrupta* and produce hatchery-raised seed. They indicated, however, that during personal visits to China that they had not confirmed the successful culture of the species. We also heard that the Chinese are experiencing difficulty with their seed production technology. If this information is true, then the study team believes that cultured geoduck production in China is a matter of "when" and not of "if." As shown in the aquaculture case studies (see Section 4), China is an incredibly successful creator and adapter of aquaculture technology, and the country's potential to solve problems in aquaculture should not be understated. The study team believes that a key component of Washington State maintaining its edge in farmed geoduck production would be to prevent Washington State from becoming a source to China, or any other country, of seed and production technology (see section 4.1).

Table 10. Outlook for Farmed Geoduck Production, China

Potential Source	Market Acceptable Species	Seed Availability	Infrastructure	Disease Threat	Private Property Rights	Lease Structure	Legislative Barriers	Overall Outlook
	⬇	⬇	⬂	?	⬇	?	?	?

Key

Significant Hurdle	Minor Hurdle	Neutral	Minor Positive	Significant Positive	Unknown
⬇	⬂	0	⬀	⬆	?

Source: Publicly Available Data, Key Informant Interviews, and Northern Economics, Inc. projections.

As indicated above, industry sources told the study team that China is currently pursuing geoduck production and geoduck production technology. While these reports indicate a push towards production, the team has also heard several good arguments as to why geoduck production in China may be limited in the long-run. First, China has not yet developed strong laws to protect private property rights and encourage investment in resources that may take a while to develop (see Table 10). Geoduck production does not produce short-term rewards. Seed production and planting methods take time to develop and the geoduck itself requires several years to reach marketable size. There is a strong incentive not to invest in opportunities that require several years to mature if your property rights might be expropriated at a moment's notice. Second, the Chinese economy is growing at a rate of more than 9 percent per year (*The Economist* 2003). While this fact may mean that the market for geoduck is growing, it also means that there are other investment opportunities with high rates of return that might be faster. Canadian wholesalers with strong connections to the Chinese market told us that it wasn't in the Chinese cultural characteristic to wait that long for investments to mature.

There is more that is unknown about Chinese attempts at geoduck aquaculture than is known at this point. The study team believes that the country will produce farmed geoduck at some point. However, we think that the cachet associated with North American products will relegate the product to a lower level of market status and that the product will probably trade at a price discount to wild and cultured Washington product. The study also predicts that any such product would remain primarily in the country as part of domestic consumption because the Chinese market is the dominant world market for geoduck, and China's lack of environmental regulations could prevent export to markets such as the European Union.

3.6 Argentina

Argentina is currently home to a small, artisanal fishery for a geoduck species known a *P. abbreviata*. The species is smaller than *P. abrupta*, but has similar color and texture characteristics. The study interviewed Jose Orensanz, Ph.D. of the University of Washington School of Fisheries and the Centro Nacional Patagonico in Argentina. Dr. Orensanz is an expert on the Argentinean geoduck fishery. He indicated that he does not expect an export industry to develop around *P. abbreviata* even though market tests indicate the species is acceptable to the market in terms of size, color, and texture.[41] Argentina's infrastructure is insufficient to transport the species to market live and Argentina's restrictive export laws would prevent the product from reaching the market quickly enough to be sold as live product even if the infrastructure were sufficient. He indicated that it was more likely that the species would be produced in small amounts by Chilean producers who have access to better infrastructure and less restrictive export laws.[42]

Thus, while Argentina has a marketable species, the study does not believe that the other factors needed for significant farmed (or wild in this case) production favor exports leaving the country. There is no commercial seed production facility. Infrastructure is inadequate for the market's purposes and growers would face legislative barriers.

Table 11. Outlook for Farmed Geoduck Production, Argentina

Potential Source	Market Acceptable Species	Seed Availability	Infrastructure	Disease Threat	Private Property Rights	Lease Structure	Legislative Barriers	Overall Outlook
	⬆	⬇	⬇	0	⇘	?	⬇	⬇

Key

Significant Hurdle	Minor Hurdle	Neutral	Minor Positive	Significant Positive	Unknown
⬇	⇘	0	⇗	⬆	?

Source: Publicly Available Data, Key Informant Interviews, and Northern Economics, Inc. projections.

3.7 New Zealand

Potential exporters in New Zealand face the opposite problems of those in Argentina. While the country has an excellent infrastructure, a well-developed system of property rights, and is located closer to major markets than the U.S.; the local species (*P. zealandica*) has characteristics that the market would not readily accept (see Table 12). According to the study's interviews with Paul Gribben, Ph.D., of the University of New South Wales and Rodney Robert, Ph. D., of CAWTHRON, Ltd., *P. zealandica* is too small with poor color and texture characteristics (i.e. gray and "mushy") and recent tests indicate market resistance to the product.[43] Thus, the report doesn't foresee extensive aquaculture or wild production with the native species. We believe that total wild production will be limited to less than 50 MT (110,000 pounds) per year.

[41] Dr. Orensanz indicated that while the Argentinean species is similar to *P. abrupta* in terms of texture and color it is also smaller with a maximum size of 900 to 1,000 grams and a smaller average size.

[42] The report does not include a separate section for Chile as we were unable to find a separate expert for that country within the budget and time allotted for the report. However, while we expect the potential for Chilean exports to be higher than the potential for Argentinean exports, the study team still does not expect production from Chile in the short and medium term.

[43] The maximum size for this species is roughly 500 grams.

New Zealand researchers are looking for ways to grow non-native geoduck in an artificial pond growing environment with a sand sub-strata. The government of New Zealand's reluctance to allow an exotic species into New Zealand's marine environment is spawning an interest in the pond growing methods. However, there is little commercial interest in the method and the project is competing for limited government funds with other aquaculture projects (Roberts 2004). Given these barriers, the study team does not expect to see large amounts of wild or farmed production from New Zealand for the foreseeable future.

Table 12. Outlook for Farmed Geoduck Production, New Zealand

Potential Source	Market Acceptable Species	Seed Availability	Infrastructure	Disease Threat	Private Property Rights	Lease Structure	Legislative Barriers	Overall Outlook
	↓	↓	↑	0	↗	↘	↓	↓

Key

Significant Hurdle	Minor Hurdle	Neutral	Minor Positive	Significant Positive	Unknown
↓	↘	0	↗	↑	?

Source: Publicly Available Data, Key Informant Interviews, and Northern Economics, Inc. projections.

3.8 Mexico

Study interviews indicate that Mexico currently produces a small amount of geoduck from the area around Baja, California.[44] While the study was unable to find an expert on the Mexican geoduck industry to interview, we were able to talk about the Mexican fishery with several growers in the United States. They felt that increased wild or farmed production out of Mexico was unlikely because the product coming from Mexico was of an inferior grade. The sub-species in that area is accustomed to much warmer water than *P. abrupta*, and it dies when chilled below 45 degrees. This fact means it is illegal to ship the product live through the United States or Canada because the temperature required to keep the animal alive is higher than allowed by U.S. law for live transport of shellfish. We were also told that the animal expels a significant amount of its harvest body weight in water during transport which results in a dehydrated and flaccid product when the animal reaches the market. Given these factors, the study does not expect significant wild or aquacultured production from Mexico in the foreseeable future. If production does increase, we believe that Mexican product will serve the lower-quality end of the market because of the attributes described above.

Table 13. Outlook for Farmed Geoduck Production, Mexico

Potential Source	Market Acceptable Species	Seed Availability	Infrastructure	Disease Threat	Private Property Rights	Lease Structure	Legislative Barriers	Overall Outlook
	↑	↓	↓	?	↘	?	↓	↓

Key

Significant Hurdle	Minor Hurdle	Neutral	Minor Positive	Significant Positive	Unknown
↓	↘	0	↗	↑	?

Source: Publicly Available Data, Key Informant Interviews, and Northern Economics, Inc. projections.

[44] FAO's FISHSTAT database does not record any production of geoduck in Mexico.

3.9 Cultured Geoduck and Market Reception

Nearly everyone the study interviewed indicated that they believe that cultured geoduck will find a place in the world market. Even Canadian wholesalers, who were the most skeptical of the product, agreed that the world market will accept culture production. In fact, the study sees little evidence that the cultured product will trade at a price discount to wild product.

The main argument against cultured product is that it doesn't have the texture of wild product. Geoduck take longer to develop the desired texture than the average cultured geoduck is in the ground. The market also grades the product based on size, color, quality, and overall consistency. While farmed geoduck entering the market currently average roughly 1.5 pounds per animal, the industry expects that this average would eventually increase to approximately 1.8 pounds per animal. This average would be close to the wild average of 2.0 pounds per animal, but the product is never expected to compete with the wild product for the segment of the market that prefers a large animal. Study interviews indicated that this market is for animals larger than four pounds.

The Chinese market desires consistency above many other attributes, which means that it places a premium not only on the consistency of size, color, and texture, but also on a consistency of supply and price. For years, Canadian wholesalers have been able to take advantage of this desire as they were generally the only firms large enough to take the risk of exporting a live product on a consistent basis at a consistent price. However, the cultured geoduck has the potential to exhibit these characteristics while being more consistent in color and size. In the future, larger culture firms will be able to provide the market with the same consistency of product availability and price as current wholesalers. The study believes that the ability accept the risk of shipping live product and provide the market with the consistency it so prizes, will allow these companies to establish their own distribution channels independent of the current system. The development of alternative distribution systems could radically change the market for geoduck and stimulate demand if culture companies are able to target regions and markets that have so far been ignored by the traditional distribution system.

The study believes that the culture geoduck will also exhibit a higher product recovery rate than wild product. This attribute should make the product exceptionally attractive to restaurants and those looking for value in their "geoduck dollar." The product recovery rate (PRR) is the percentage of an animal's rough (i.e. whole) weight that can be used as product. In wild product the average PRR is 33 percent. This number means that only one-third of the animal's round weight is edible. So, if you have a three pound wild geoduck you might get one pound of meat. The study's interviews with growers indicate that they expect a PRR of between 50 and 70 percent. The reason for this higher rate is that in the early years of its life the geoduck spends most of its energy growing its siphon and body and less energy thickening its shell.[45] After six to eight years, the animal begins to put more energy into its shell which isn't edible. Thus, a two pound cultured geoduck could provide as much or more usable meat than a wild animal nearly 50 percent larger.

The real question is whether cultured product will trade at a discount to wild product. The study's interviews with the industry leader, Taylor Shellfish Farms, indicate they are receiving the same price for their cultured product as the market is providing for equivalent grade wild geoducks. Given the empirical evidence, and the reasons listed above, the study doesn't find conclusive evidence to support the expectation that cultured product will trade at a discount to wild product.[46]

[45] The downside of this attribute is that cultured animals are thin-shelled relative to their weight and thus more fragile than their wild counterparts. Interviews indicated that the industry is compensating for this problem with additional packing and including additional animals in a shipment to make up for breakage.

[46] The exception to this statement is at the higher weight levels, as we don't expect cultured product to compete with wild product above 4 lbs.

3.10 Potential Effect of Increased Geoduck Supply on Price

As described above, the study estimates that Washington growers will soon produce substantial amounts of farmed geoduck. How this new supply will affect the market depends on several important factors including:

- The ability of the current world market to absorb new supply;
- The ability of producers to identify new markets;
- How quickly new production appears on the market.

As described in Section 2.3, it is inappropriate to utilize traditional elasticity and flexibility measures to estimate the effect of new supply on this particular market, because of the recent shifts in product attributes. Thus, the study is unable to identify the point at which new supply will cause significant declines in price or the magnitude of potential declines. However, interviews with market participants on both the demand and wholesale side of the market indicated that the market can currently absorb an additional 20 to 30 percent of new product without substantial price effect. The study estimates that private culture efforts in Washington alone will increase world supply by between 30 and 60 percent within the next 5 to 7 years (see Table 7). Potential production in the long run from these sources will probably be much higher, and it is important to remember that these numbers do not include the potential for production from sources such as British Columbia and Alaska. Thus, the study believes that private culture production has the potential to lower—perhaps substantially—the world ex-vessel price for geoduck.

Short-term and long-term drops in price would affect several important stakeholder groups within the geoduck market. Wild harvesters in Washington, Canada, and Alaska will be directly affected by price declines. Unlike growers, who can make up some of the lost revenue from price declines through increased volumes, wild harvesters must live with quotas that are based on biological information and not economic information. This fact means that wild harvesters could end up with a declining slice of market share based on volume and declining profitability if prices decline because of increased aquaculture production. The study expects that wild producers in Alaska would initially bear the worst of any price decline, because their transportation and production costs tend to be higher than Washington producers. Canadian and Washington-based harvesters would fare slightly better, but would still feel the effect of any price decreases directly.

The Washington Department of Natural Resources generates between $6 million and $7 million dollars annually from the auction of sub-tidal geoduck harvest rights. The study expects that any decline in ex-vessel price paid to the sub-tidal harvest sector would be reflected in sub-tidal auction prices. How quickly that decline occurs could depend largely on the speed at which new product supplies become available. For example, if private producers create a sudden jump in production instead of a gradual increase, and the market is unable to absorb the sudden increase, then the WDNR could see a sudden and substantial drop in revenues. The same sudden decrease could occur if the WDNR authorizes aquaculture on its lands and allocates too much land to the program. The sudden increase in production would have the same effect as a sudden increase in production from private lands.

The study recommends that the WDNR prepare for and study a potential long-term decline in revenue from sub-tidal geoduck auctions. There exists a strong possibility that the Department will see a decrease in revenue from this source irrespective of any production on state lands.

4 Case Studies in Aquaculture

4.1 Summary

Purpose

The purpose of the aquaculture case studies is to provide examples of what has happened when other species have undergone the transformation from a primarily wild harvest species to one that is harvested by both wild capture and aquaculture methods. The report focused the case studies on three specific features and tries to draw lessons from the studies that may be applicable to the current situation with geoduck. These features are:

- What provided the impetus for the creation of an aquaculture industry around the species?
- What was the role of government in the creation of the industry? Did government hinder or help the development of the industry?
- How did the development of the industry affect the market for that species or other similar products?

Applicable Lessons

The case studies provide several lessons which the study team believes are applicable to the current development of geoduck aquaculture. Some of these lessons directly affect potential management decisions by the State of Washington, while other lessons should make the reader aware of the potential implications of the aquaculture. The lessons from the studies include:

- Aquaculture industries are prone to boom and bust cycles. As seen in the Salmon case study, production increased rapidly as technology spread beyond the originating country. The market responded by requiring lower prices from both wild and culture producers. Eventually the price reached a level that was under the production costs of many producers. Some producers went out of business while healthier companies purchased smaller, weaker competitors. The industry is still working out the long-term effects of consolidation. While some level of consolidation and adaptation is natural to every industry, the level of disruption in the salmon industry was particularly high because of the industry's rapid expansion.
- High prices for a wild product with limited supply are likely to spur aquaculture development. High per unit prices are exactly what are spurring the development of cultured geoduck. Top quality geoduck currently command a ex-vessel/farm gate price in the $7.00 per pound range. This price not only encourages the development of a culture-based industry, it also encourages poaching, under-reporting, and high-grading of the resource.[47]
- Public and private support through research and development, especially in the beginning of the industry, can be very helpful to the development of an industry. The salmon, catfish, abalone, and hard shell clam case studies all show that government-funded research and

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[47] A positive side-effect of a cultured industry is that it can result in lower incentive to high-grade and poach wild resources if the industry results in lower ex-vessel prices. While these lower prices may be detrimental to wild producers, they can actually promote the health of the wild resource. Aquaculture can also help limit poaching by creating a certification process that guarantees the harvest was legally caught by instituting reporting requirements.

training programs enhance a emerging industry's chances for survival. However, restrictive regulations after these programs (as seen in the case of Norway and the farmed salmon industry) can squander the advantage they created. Thus, the study recommends that the creation of any training programs or government funded research account for future regulation of the industry so that the government does not over-promote an industry it will also have to regulate.[48]

- Technology and information are highly mobile. Restrictions on the size of the salmon farms in Norway stimulated the expansion of salmon aquaculture globally, as technology and capital were exported to more business-friendly countries. Washington State growers currently maintain an edge in both seed production technology and general information about how to grow geoduck. The longer this edge remains in place, the longer these growers will have to consolidate their position in the market before producers in other locations can bring product to market. If Washington State-based growers produce enough product to lower the world price for geoduck, then they will also reduce the incentive for others to enter the market by making geoduck production less lucrative. The high cost of developing production technology, the steep learning curve associated with planting seed, and the long lag time between planting and harvest are already barriers to entry in this market. Protecting technological knowledge and information will help to maintain those barriers and help Washington State growers.
- It is not appropriate to assume production will stay in a species' native range. If a species can be raised elsewhere in a more business friendly environment, then the industry may try to move that location. This mistake has been made by many government entities. Alaska assumed that banning finfish aquaculture would help protect the fishery centered on its wild resources. The ban didn't help the industry, and Chile, where salmon are not native, will surpass Norway in total farmed salmon production this year or in 2005. Rhode Island made similar assumptions with hardshell clam aquaculture. The state placed restrictions on farming clams and saw the industry move to Florida. Florida Quahogs now represent a significant share of the hardshell clam market.[49]
- Farmed salmon, catfish, shrimp, and bay scallops currently dominate global capture production of their product groups. There is the potential that geoduck aquaculture production could someday dominate global capture production. This study predicts that farmed geoduck will represent roughly 50 percent of Washington's total production within the next five to seven years.
- An aggressive marketing campaign to increase demand in domestic and international markets can increase consumption. Catfish farmers have successfully run a joint marketing program which helped to increase domestic consumption of their product. While geoduck is unlikely to be accepted by the typical American consumer in the same way these consumers accepted catfish, it could be in the industry's best interest to create and fund a joint marketing campaign in China.[50]

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[48] The study team wishes to note an important difference between the industries in the case studies and the current geoduck industry in Washington. Many of the industries in the study received support prior to the creation *of a viable industry.*

[49] Florida is within the home range of *Mercenaria mercenaria*, but is the southern limit of the species.

[50] The study team would recommend that the industry also work with the Washington Department of Agriculture to explore marketing alternatives. Some companies already work with the Department.

- China is capable of becoming a leading producer of farmed product. The Chinese experience with Yesso scallops shows China's ability to begin producing a cultured product and then dominate world production.
- As with land-based farming, aquaculture crops that are planted in high densities and without rotation will be subject to higher disease risks. Thus, the study recommends that the State of Washington explore the potential for disease transmission in the increased density associated with cultured production. The study also recommends that if the State of Washington chooses to lease its own lands out for geoduck production, it consider the increased potential for disease transmission associated with aquaculture in its lease site selection process.

4.2 Pacific and Atlantic Salmon Aquaculture

4.2.1 Introduction

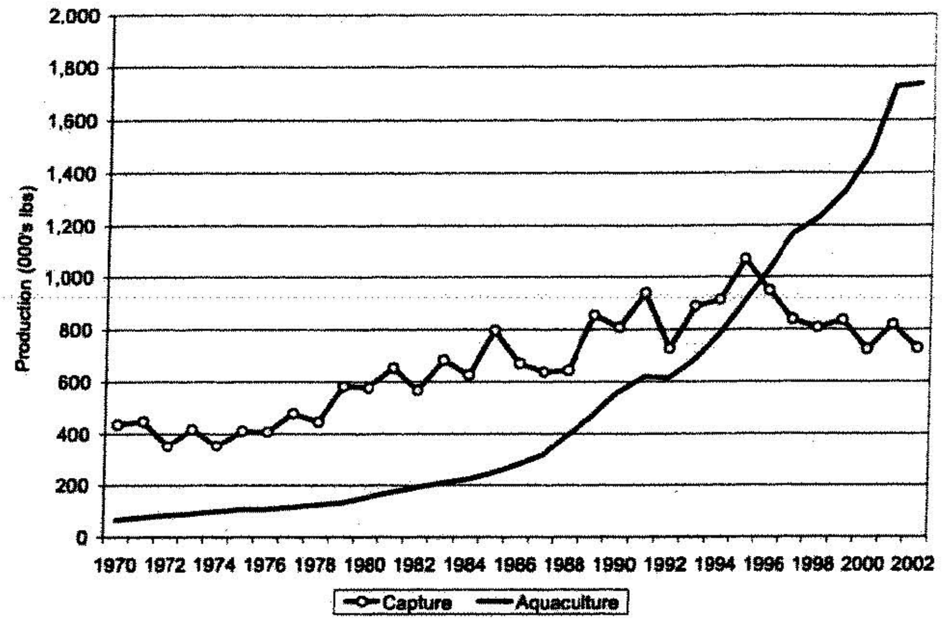
Salmon farming is one of the most successful aquaculture enterprises due to factors such as easily replicated technology, access to suitable topographical conditions, low cost of production, marketing, government support, and corporate ownership (Forster, 2002). While salmon and geoduck are not similar species, those involved in potential geoduck aquaculture can learn several important lessons from the story of salmon aquaculture. These lessons include:

- Public and private support through research and development, especially in the beginning of the industry, can be very helpful to the development of an industry.
- Restrictions on the size of the farms in Norway stimulated the expansion of aquaculture globally, as technology and capital were exported to more business-friendly countries. It is not appropriate to assume production will stay in a species' home range. If the species can be raised elsewhere in a more business friendly environment, then the industry may try to move that location.
- Technology and information are mobile.
- External shocks, including trade restrictions, both helped and hindered various countries.
- Farmed salmon currently dominates global capture production. There is the potential the geoduck aquaculture production could someday dominate global capture production.
- Aquaculture production can lower the price received for wild product and put economic pressure on wild producers.

4.2.2 Industry Development

Atlantic salmon, Coho salmon, and Chinook salmon are well suited for farming due their resistance to diseases, their ability to grow to market size quickly, and their quality of meat. Aquaculture production has expanded worldwide, in a relatively short period of time. Global farmed salmon production exceeded the world's total commercial harvest of wild and ranched Coho and Chinook salmon by the mid-1980s and it exceeded the world's combined production of Coho, Chinook, and sockeye salmon by 1990. By 1996, the world's production of aquacultured salmon exceeded all commercial harvests of wild salmon by 1996 (see Figure 25).

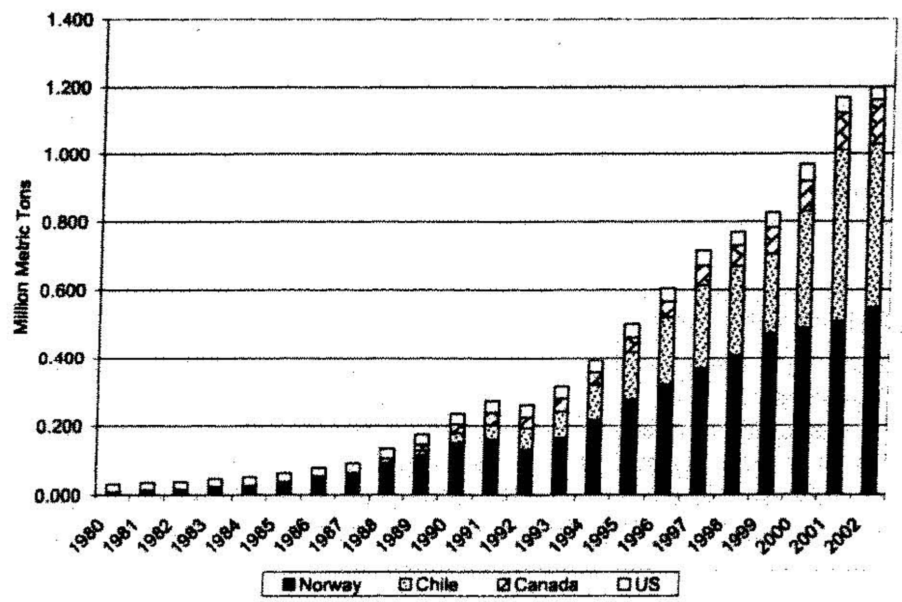
Figure 25. World Production of Salmon and Trout Capture Fisheries vs. Aquaculture



Source: FAO (2004)

Figure 26 shows the transition and growth of aquacultured salmon production. Production started in Norway and the U.S. and rapidly transferred to Canada and Chile. Chile is probably now the largest producer of farmed salmon in the world.

Figure 26. World Growth in Salmon Aquaculture Selected Countries



Source: FAO (2004)

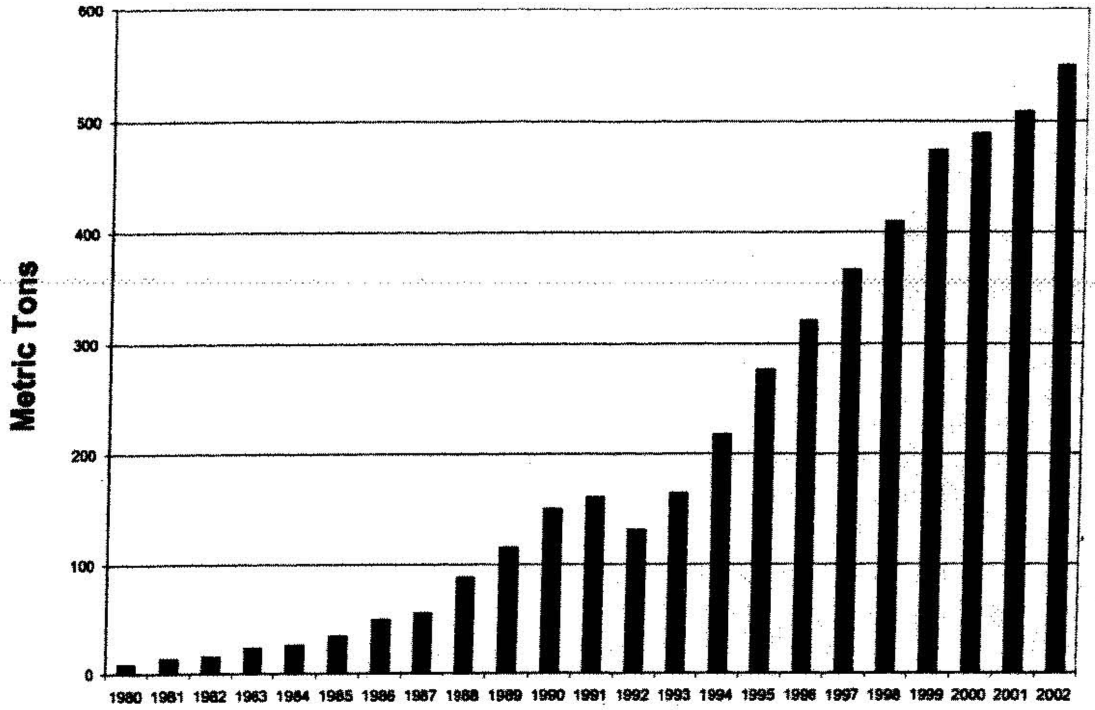
4.2.2.1 Development of the Norwegian Salmon Industry

Norwegian salmon aquaculture began in the 1960s fostered by a strong government program of research and development. This development program grew out of the need for new economic opportunities in depressed coastal fishing areas. The success of the Norwegians in pen-rearing Atlantic salmon was not happenstance; it resulted from a combination of excellent natural endowments, supportive government policy, and an energetic and well-organized industry (Lavin-Riely and Anderson, 1986).

While government assistance in the form of scientific research, capital funds, subsidies and quality controls were effective in helping to develop the industry, other government regulations aimed at increasing employment and controlling the production levels actually hindered the growth and profitability of the Norwegian industry. In fact, the government regulations that hindered domestic growth actually fostered international growth in salmon farming in countries like Ireland, Scotland, Chile, Canada, and the United States. Norwegian regulations restricted the size of the pen volume which was initially set at 8,000 m^3 in 1987 and then increased to 12,000 m^3 in 1989 (Willoughby, 1999). Such regulations effectively drove investment and expansion overseas where investors found not only suitable environmental conditions for raising salmon, but also pro-business governments receptive to establishing a new industry.

In 1991, the Norwegian government relaxed laws governing local ownership thereby allowing farmers to own several farms. New aquaculture laws and increasing market pressure both led to a tremendous decrease in the number of salmon and trout farming companies operating in Norway, from approximately 1,100 in 1990 to 270 in 1998 (Forster, 2002). This consolidation in the industry led to a more vertically integrated industry in hatchery, smolt production, growout and processing. Despite increased production domestically and internationally, falling prices, and a successful anti-dumping suit brought by the United States, over the last three decades the value of the salmon industry in Norway has reached over US$1 billion in 2002 (FAO, 2004).

Figure 27. Norwegian Farmed Salmon Production



Source: FAO (2004)

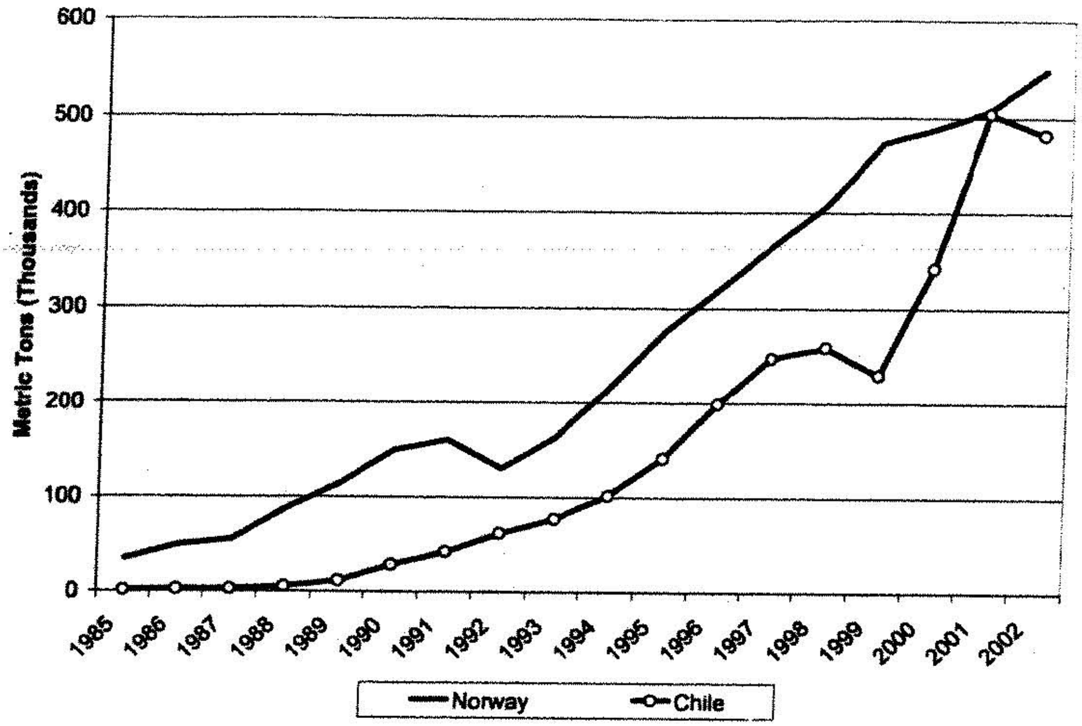
4.2.2.2 Development of the Chilean Salmon Industry

Chile is another example of success in the salmon aquaculture industry, which expanded rapidly in the mid-1980s with technical and financial assistance from many countries, including Japan and Norway.[51] Additional investment, technology and experience from displaced farmers and investors in Norway helped Chile rise to be a major producer in the salmon industry.

By 1992, Chile was the second largest producer of salmon in the world with 62,200 MT, second only to Norway (FAO, 2004). Neither Pacific nor Atlantic Salmon species are native south of the equator. Initially, Chilean aquaculturists farmed predominantly Coho. This dominance of Coho in the early years resulted from Japanese investment in the Chilean industry and their direct experience in Coho production. However, the predominance was short lived. In 1992, Atlantic Salmon production permanently surpassed Coho production. Industry reports indicate that Chile will likely displace Norway as the world's largest salmon producer in terms of both production live and revenue in 2004 (The Wave News Network, March 25, 2004). (See Figure 28)

[51] Salmon farming in Japan began in 1973 when 1,000,000 Coho eggs were imported from the US for freshwater based salmon production (Sylvia, 1989).

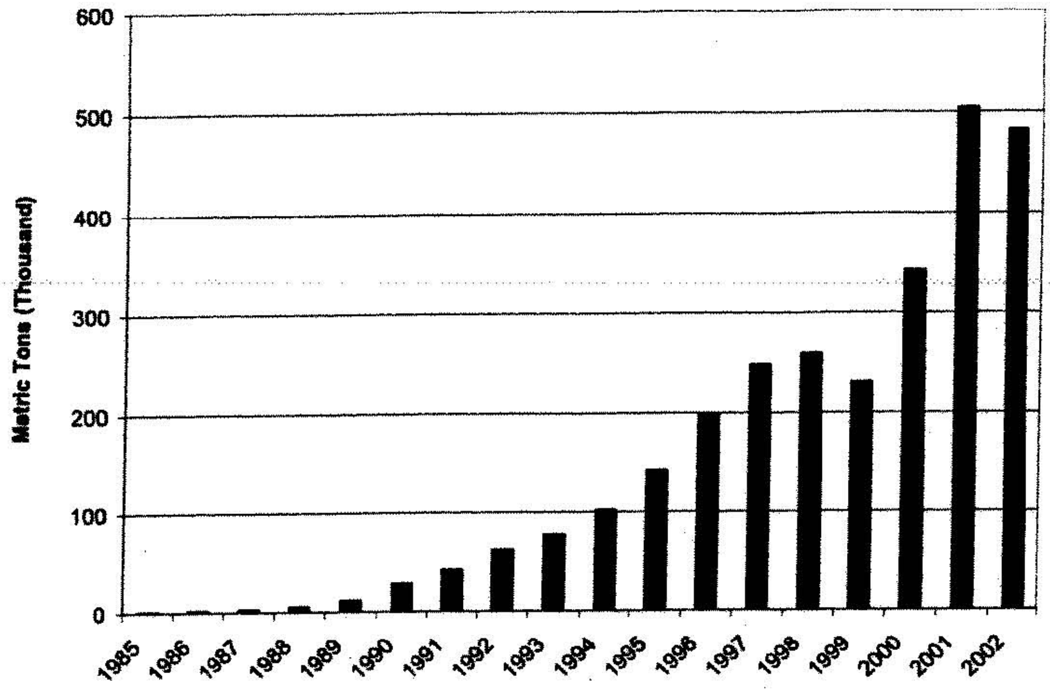
Figure 28. Norway and Chile Farmed Salmon Production



Source: FAO (2004)

Aquaculture in Chile was successful for many economic and environmental reasons. Economically, farmers have easy access to fishmeal for feed, low-cost skilled labor, minimum interference from commercial and recreational fishermen, favorable regulatory climate, and little pressure from environmental groups (Hicks, 1995). Environmentally, Chile has many sheltered areas with water temperatures and salinities that are ideal for raising salmon (see Figure 29). Given that Chile is located in the Southern Hemisphere, its seasons are the opposite of those in the Northern Hemisphere. The Chilean industry has benefited from investment and joint ventures with Norway, Japan, the United Kingdom, and other countries and salmon farming in Chile seems to have a relatively bright future given its favorable environmental and economic climate.

Figure 29. Chilean Farmed Salmon Production



Source: FAO (2004)

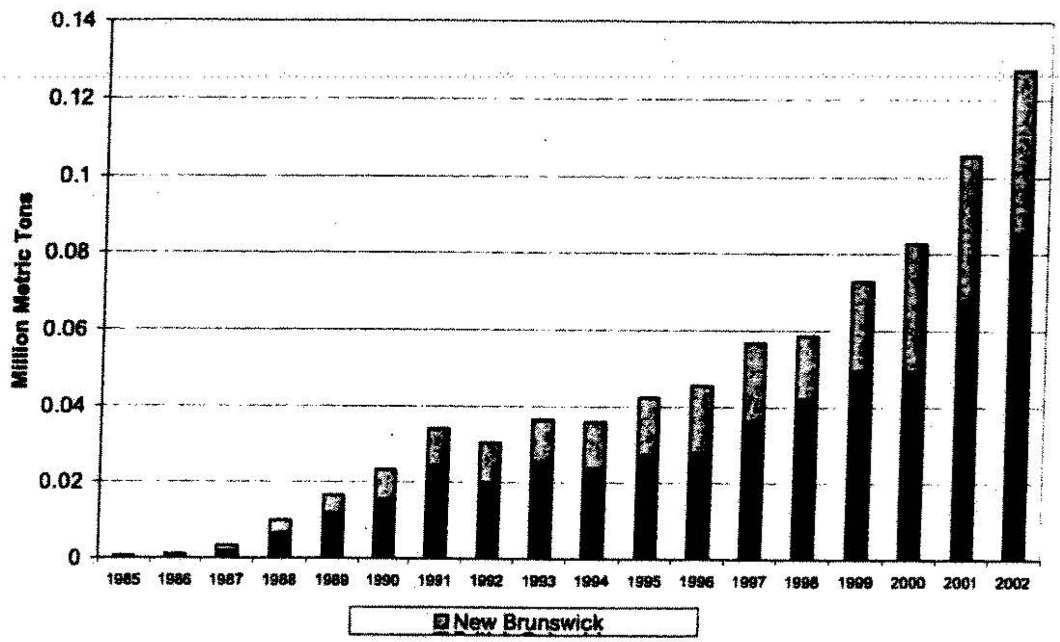
4.2.2.3 Development of the Canadian Salmon Industry

Salmon farming in Canada takes place primarily in British Columbia and New Brunswick (see Figure 30). The British Columbia net-pen industry started in 1972 with the production of small Coho salmon using surplus eggs from a government hatchery (Folsom et al. 1992). In 1985-1986, Norwegian investors selected British Columbia for its favorable environmental climate and proximity to US markets. Roughly 50 percent of all investments in the British Columbia industry came from Norwegian interests (Bjorndal, 1990).

Initially, producers chose to raise native Chinook and Coho salmon as opposed to introducing non-native species such as Atlantic salmon. However, Chinook salmon is not as easily domesticated as Atlantic salmon, and in 1987 Atlantic salmon was introduced in the Pacific Northwest Coast. It surpassed Coho production in 1990, and it surpassed Chinook production in 1992. In 2002, Atlantic salmon accounted for 85 percent of production in British Columbia, followed by Chinook at 12 percent and Coho at 3 percent (FAO, 2004). Atlantic salmon has been and still currently is still the only species of salmon raised in New Brunswick.

Total salmon aquaculture production in British Columbia was 85,500 metric tons in 2002 or 67 percent of total Canadian aquaculture production, while total salmon aquaculture production in New Brunswick was 42,121 metric tons in 2002 or 33 percent of total Canadian aquaculture production (FAO, 2004). Industry growth in Canada in recent years has been hampered by conflicts with commercial and recreational salmon fisheries as well as indigenous peoples and environmental groups. Fear of escapement of fish from the farms and the spread of disease brought stiffer regulations over time. For example, in 1995, there was a moratorium on further expansion in British Columbia, with the ban on new salmon farms just recently lifted in 2002.

Figure 30. Growth in Canadian Farmed Salmon Production



Source: FAO (2004)

4.2.2.4 Development of the US Salmon Industry

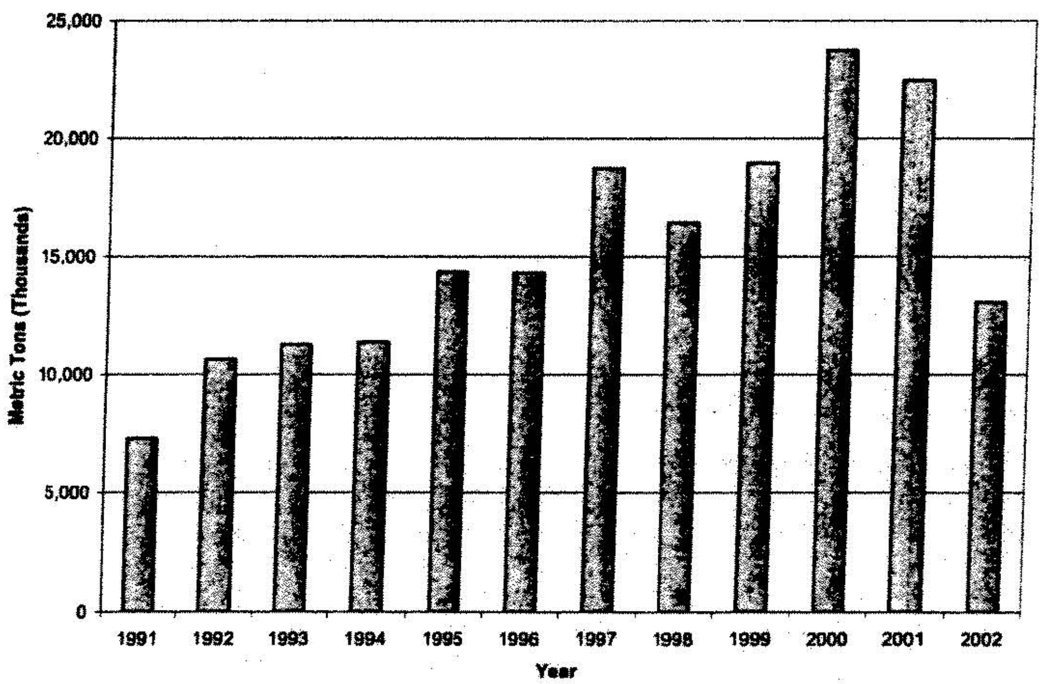
The development of salmon farming in Washington and Maine has paralleled that in the Canadian provinces of British Columbia and New Brunswick. On the West coast, Washington was the first state to conduct experiments on pen-reared salmon in 1969. This research, funded by the National Marine Fisheries Service (NMFS), was conducted at the Manchester Field Station in Puget Sound. The first private operation (Ocean Systems, Inc., later Domsea, a subsidiary of Campbell Soup Company) established Coho and Chinook cage systems in Puget Sound and harvested their first fish in 1971 (Sylvia, 1989). By 1986, producers began to shift from Pacific salmon to Atlantic salmon and by 1994, 95 percent of Washington's production was Atlantic salmon (Willoughby, 1999).

On the East coast, salmon farming was attempted in Maine in the early 1970s. Two companies, Maine Salmon Farms and Fox Island Fisheries, began producing salmon in the early 1970s but by 1979 both companies were out of business (Anderson and Bettencourt, 1992). Due to a high unemployment rate and the decline of the herring fishery, one of the few areas in the U.S. that favored salmon aquaculture was the Eastport-Lubec region in Maine. Ocean Products, Inc. (OPI) began operation in 1982 with smolt produced by a Canadian hatchery and continued operation in 1983 with 100,000 smolt acquired from the U.S. Fish and Wildlife Service. After development of their hatcheries, OPI soon became the largest private salmon operation in the U.S. (Anderson and

Bettencourt, 1992). The industry has since developed, and in 2002, Maine produced 15 million whole pounds (6,804 metric tons) of salmon while utilizing 10 lease sites and 4 hatcheries in Maine (O'Hara et al. 2003). Maine supplies 18 percent of domestic and 2 percent of world farmed salmon consumption (O'Hara et al. 2003).

Citizens and environmentalists have expressed great concern regarding the escapement of the farmed salmon. On both the East and West coasts, salmon aquaculture has found strong opposition by environmentalists, local property owners, and fishermen (Sylvia et al., 2000). In June 1987, Alaska imposed a temporary moratorium on private, for-profit farmed salmon and trout, which eventually became permanent in 1988 (Anderson, 1997). As recently as 2003, a court ruling banned the use of European Atlantic salmon stocks in a case against two of the largest fish farms in Maine, Heritage Salmon and Atlantic Salmon of Maine. Under the new regulations, companies must rotate fish to allow some pens to go fallow for up to three years to prevent salmon waste from degrading sensitive seabeds. The prohibition of European Atlantic salmon coupled with fines and tighter regulations will only exacerbate the strain on an industry that was already struggling to compete with low cost imports from countries like Chile. In Maine, production dropped precipitously from a high of 16,352 tons in 2000 to only 6,798 tons in 2002 (Maine DMR, 2004).

Figure 31. US Farmed Salmon Production

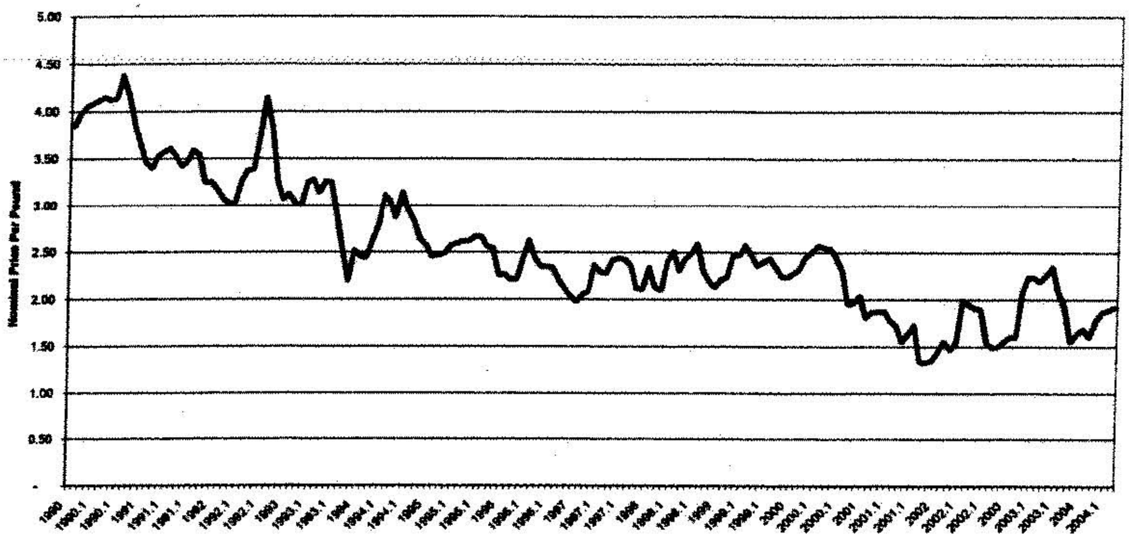


Source: Washington Agricultural Service and Maine Department of Marine Resources

4.2.2.5 Distribution and Market Structure

As the salmon aquaculture industry has grown and consolidated, it has become the dominant supplier in many markets including Europe, the U.S. (outside the Pacific Northwest) and segments of the fresh salmon market in Japan. There are several companies with both horizontal and vertical integration (from hatchery through processing and wholesale distribution). However, despite the consolidation in the salmon industry, no one company clearly dominates and highly competitive market conditions prevail in the most of global salmon market. Prices have trended downward over the past decade for farmed Atlantic salmon as production costs have declined. (See Figure 32.) In addition, prices for farmed salmon have become a primary influence on the price of wild salmon. Thus, harvesters of wild salmon have received lower prices as a result of increased farm production.

Figure 32. US Farmed Atlantic Salmon (8-10 lb) Nominal Wholesale Price



Source: U.S. Department of Commerce 2004

4.3 Hard Shell Clam Aquaculture

4.3.1 Introduction

Wild harvest of the hardshell clam in the United States has fluctuated significantly over the past 50 years. This is attributable to overfishing, pollution, and disease. In an attempt to revive declining stocks and meet market demand, many states and individuals began aquaculture of the hardshell clam. The following case study highlights the emergence of aquaculture in Florida and emphasizes that government-funded research and support can help create a viable and sustainable industry.

4.3.2 Development of the Florida, USA Hardshell clam Industry

Looking for an alternative to large fluctuations in wild hardshell clam harvests, clammers in the Indian River Lagoon area of Florida investigated the potential for aquaculture in the 1970s. In 1983, the Aquaculture Division at the Harbor Branch Oceanographic Institute (HBOI) initiated a research and development program to culture the hardshell clam. The first clam hatchery was located in a small greenhouse, where algae production, broodstock maintenance, spawning, larval development and growout all took place in the same area (*HBOI Website*). However, it was not until the 1990s that the hardshell clam industry in Florida really flourished.

There are two main stimuli attributed to the creation of the industry. First, in 1991, the Food and Drug Administration prohibited oyster harvesting in Suwannee Sound due to excessive bacterial contamination caused by poor and failing septic systems (Colson and Sturmer, 2000). This dictate effectively eliminated the main industry in the small coastal town of Suwannee. In an effort to help alleviate the resulting economic depression in that area, the Florida Department of Labor and Employment Security established a federally funded program in shellfish aquaculture for unemployed and underemployed oyster harvesters and other seafood workers in a four county area (Colson and Sturmer, 2000). The Harbor Branch Oceanographic Institute and the University of Florida's Institute of Food and Agricultural Sciences were both contracted to provide hands-on training and classroom instruction. The training program was known as Project OCEAN (the Oyster and Clam Educational Aquaculture Network). The Cedar Key Satellite Facility of the Harbor Branch Institute opened in 1991 to help retrain displaced fishermen.

In addition to classroom training, approximately 138 participants also received 4-acre leases from county commissioners where they could culture the hardshell clams. The leases were on sandy bottoms located 450-600 meters offshore in 60 centimeters-2.4 meters of water (MacKenzie et al., 2002). Project OCEAN successfully concluded in 1993 having created a new industry on Florida's west coast. Following the completion of Project OCEAN, the Harbor Branch Institute continued to maintain the field station at Cedar Key and provide seed and technical assistance to new and existing farmers. The other main stimuli to the creation of a hardshell clam industry in Florida occurred in 1994, when the State Legislature banned the use of gill and entanglement nets in its coastal waters. This sweeping legislation eliminated Florida's commercial fin fishing industry.

Given the success of Project OCEAN, officials launched Project WAVE (Withlacoochee Aquaculture Vocational Education) to train displaced net fishermen on the west coast (MacKenzie et al., 2002). Again, the Harbor Branch Institute provided training and technical assistance through its Cedar Key Facility. In 1995, the Harbor Branch Institute launched the Aquaculture Center for Training, Education, and Demonstration (ACTED). This center was able to provide hands-on, practical training in production systems. In 1996, 49 fishermen each received 2-acre leases and 76 fishermen were trained in land-based nursery techniques (MacKenzie et al., 2002). Today, Cedar Key Field Station is still providing clam seed and assistance to the maturing clam industry. The Harbor Branch Institute provides about half of the seed to farmers, while several small private hatcheries operating throughout the state provide the rest (MacKenzie et al., 2002). The ACTED program has expanded to provide both workshops and short courses, an Associate in Science degree through the Indian River Community College, and even a middle school and high school education program for students and their teachers (HBOI Website).

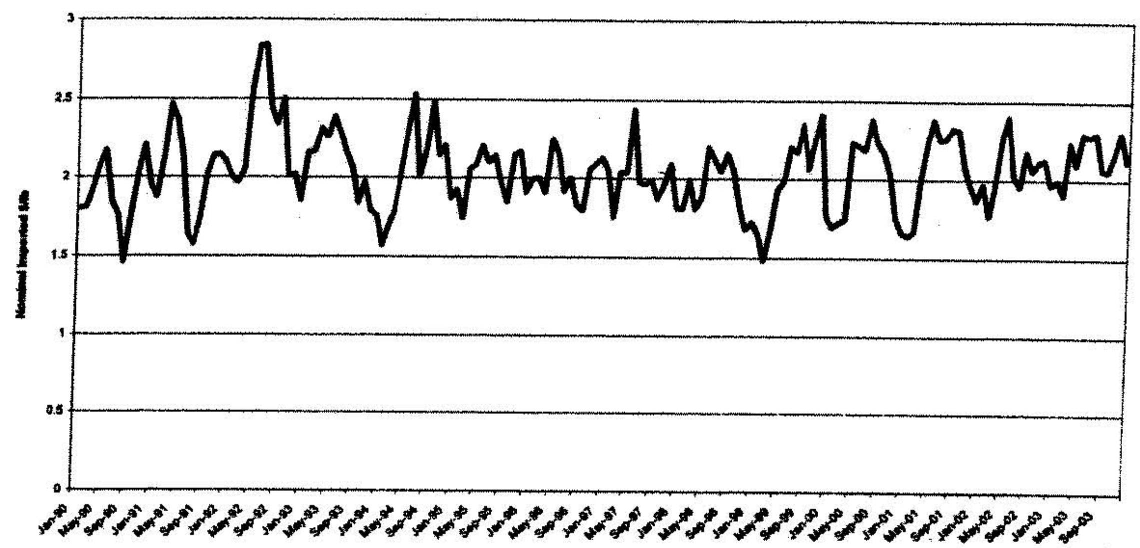
The total value of all aquaculture production in Florida was $95.5 million in 2003, with 544 operations using 6,450 acres of production (Florida Ag. Stats, 2004). There were 244 clam and oyster producers utilizing 955 acres of production and they had net sales of $12.9 million, or 13.6% of the total value of all aquaculture sales (Florida Ag, Stats, 2004). Producers sold 134 million hardshell clams at an average price of 9 cents each in 2003. However, sales of clams, clam seed and oysters decreased $13 million from 2001, when producers received an average price of 11 cents for hardshell clams. This decline can be attributed to a lower demand for clams than in previous years and poor weather conditions, especially in the Southwestern part of the State. Of the 544 operations, 43.9 percent were less than 3 acres in size. These producers represent many of the hardshell clam producers who lease 2 acres of water in the Gulf of Mexico or the Indian River Lagoon.

4.3.2.1 Distribution and Market Structure

The aquaculture of hardshell clams has had considerable impact on the market for clams particularly on the US East Coast; however, wild clam production is still a dominant force influencing prices.

Aquacultured clams have some advantages such as more uniform production of clams. The harvest industry is highly competitive with many producers providing essentially a homogeneous product. There is relatively little valued-added processing of farmed clams and only minor efforts (however considerably more effort than wild clam producers) to develop the market and differentiate the product. As seen in Figure 33, prices for imported live and fresh clams have fluctuated around $2/lb for the past decade. Thus, unlike the case of salmon aquaculture, hard shell clam aquaculture has not had an overwhelmingly detrimental effect on the unit price received by harvesters and growers.

Figure 33. Price of US Imports of Live/Fresh Clams



Source: USDC, 2004

4.4 Abalone Culture

4.4.1 Introduction

There are many similarities between the market for Abalone and the market for geoduck. Both species are high-priced luxury food items that are popular in the Asian market. In addition, both species fetch exceptionally high prices relative to other seafood products. Lastly, both are a favorite food of the sea otter. The following lessons can be learned from this case study:

- High prices for a wild product with limited supply are likely to spur aquaculture development.
- Aquaculture can help limit poaching by creating a certification process that guarantees the harvest was legally caught.

4.4.2 Industry Development

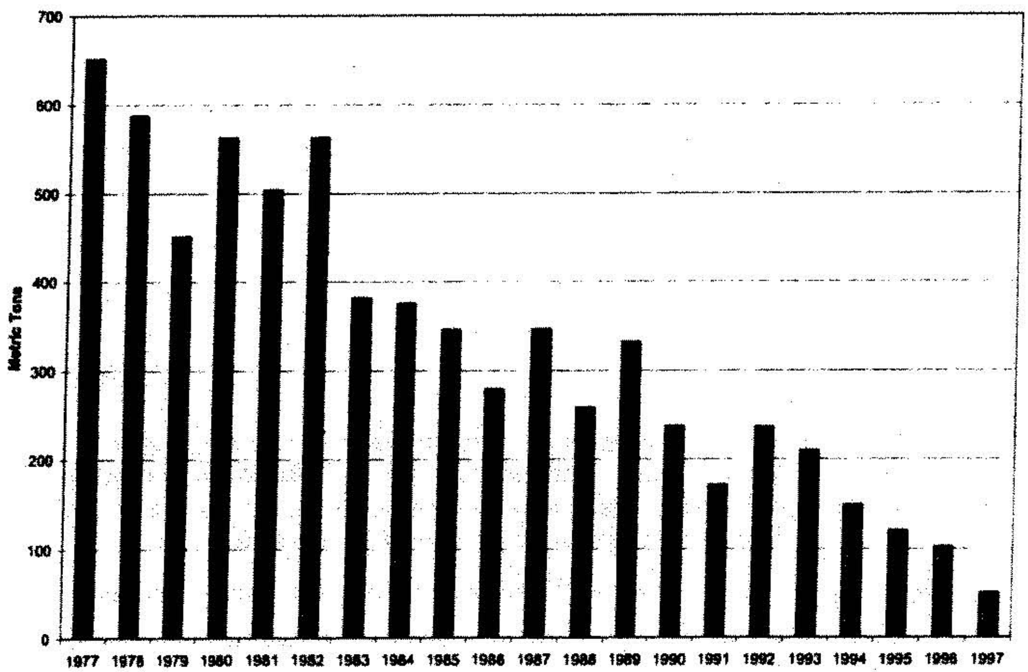
Abalone species have been present on the Pacific coast, from Alaska to Baja California for at least 100 million years. Entirely comprised of the genus *Haliotis*, species located on the northeastern Pacific Coast include red (*H. rufescens*), green (*H. fulgens*), pink (*H. corrugate*), white (*H. sorensensi*), and black (*H. cracherodii*) abalone (Stevens, 2003). However, the current situation for Abalone is not as bright. Wild stocks in California, which constitutes a large part of the genus' range, are compromised by a number of factors, particularly overfishing. Predation by the southern sea otter (*Enhydra lutris nereis*), the main predator of red abalone, as well as other abalone species have further decimated this species (Haaker et. al., 2001). Furthermore, the recovery and expansion of the endangered sea otter has in effect closed much of the central California coast as a source of legal abalones (Haaker et. al., 2001).

The combined species landings peaked at 2,500 tons in 1957 and declined to approximately 140 metric tons in 1994 (McBride and Conte, 1996). As seen in Figure 34, the harvest of abalone has steadily declined and in 1997, the entire California commercial abalone fishery was closed and remains closed to date. A sport fishery remains open north of San Francisco, California.

A number of factors have contributes to the species decline. These include:

- Predation by the sea otter;
- An outbreak of Withering Syndrome—a disease that affects the abalone's foot,
- Pollution of mainland habitat;
- Periodic climatic and oceanographic disturbances, like El Nino (Haaker et al., 2001).

Figure 34. California Abalone Production



Source: Price and Tom (1997)

Over fishing reduced wild abalone fisheries in Japan, Mexico, Australia, South Africa, and Korea as well.[52] The declining world supply, coupled with the high price received for abalone, encouraged the development of aquaculture of abalone both domestically and internationally. It is important to note that due to the high market price for abalone, a significant amount of illegal fishing occurs, not only in California, but also world-wide. This poaching hampers efforts to help revive depleted abalone stocks. Some sort of certification process for either wild, farmed or both, could help assure environmentally sensitive consumers that the product they are buying is not poached. Such a process would create a paper trail of where, when and how the abalone were harvested. Aquaculture could also, unintentionally, reduce the financial incentive to poach, if increased farmed production lowers the ex-vessel value of the product.

Abalone are a highly valued sea delicacy, particularly in Asian markets and abalone culture is present in many countries including the US, Mexico, South Africa, Australia, Japan, China, Taiwan, Ireland, Iceland and others. The market price received for abalone, which can be upwards of $20 per pound, stimulated the creation of the industry (Stevens, 2003). Demand for abalone product far outstrips the wild supply. This attribute is shared with the geoduck which also receives an exceptionally high price at market. Aquaculture production technology would probably not have been developed for either of these species without the high market price and limited supply.

The aquaculture of abalone in the United States began in 1940 at Stanford's Hopkins Marine Station at Pacific Grove, California, where scientists studied the spawning and larval stages of the red abalone (*Haliotis rufescens*). California's commercial abalone industry began as industry research and development in Morro Bay in 1964. Additional research was conducted by both the California Department of Fish and Game and the University of California. These research and development farms finally transitioned into commercially viable farms in the late 1980s (McBride and Conte, 1996). Thus, a key factor in the development of this industry was State and University support through research and development programs, including the California Department of Fish and Game, the University of California system, Oregon State University and the Oregon Sea Grant program

In spite of the fact that US led the world in technology development for abalone culture, the leader in world production is now Taiwan which has more than 450 farms producing 2,500 MT of Abalone per year. This amount compares to the 200 MT produced by US farms each year. US production has been hampered by the lack of general public acceptance for mariculture farms and the introduction of a parasite to US production facilities in the 1980s. Fears of this parasite spreading to wild stocks lead the State of California to ban new farms and prevent existing farms from planting their stocks until they had been certified disease free for a two-year period. In wasn't until the late 1990s that the majority of the industry succeeded in eliminating the disease. In spite of this setback, worldwide aquaculture production increased over 600% during the 1990s (Gordon and Cook, 2001). Much of the production growth occurred overseas, particularly in Taiwan. Still, there is considerable room for growth in this industry, especially in premium markets. In general, the demand for abalone far exceeds supply and world aquaculture production still only accounts for roughly 20% of total Abalone production worldwide (Gordon and Cook, 2001).

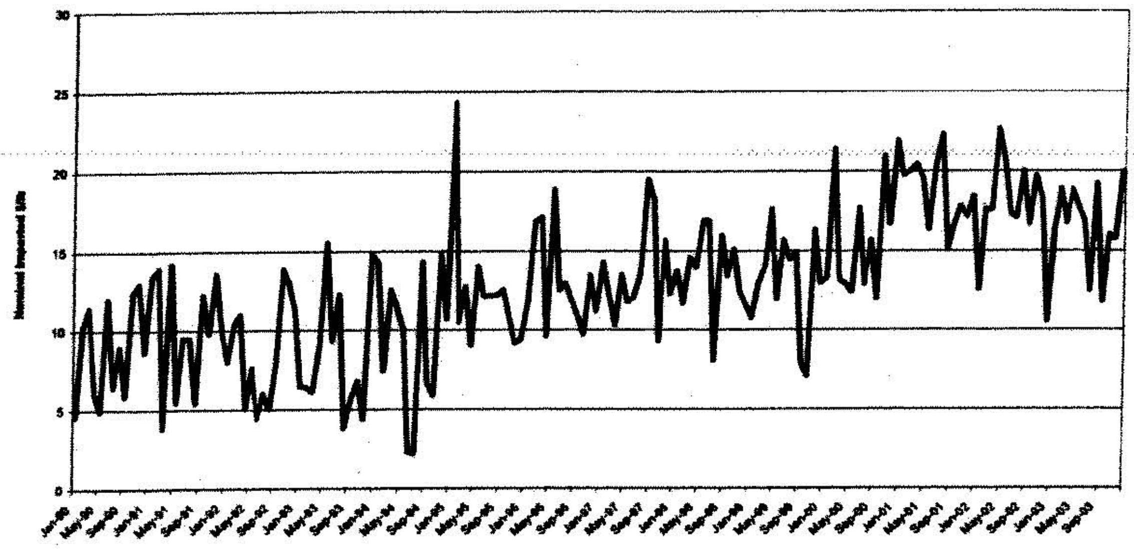
4.4.2.1 Distribution and Market Structure

Abalone currently have a natural niche market where aquaculture comprises a small share of the total harvest of the species. Prices have trended upward over the past decade due to a supply shortage

[52] Only Australia has managed to maintain a sustainable, viable wild fishery. However, even this fishery is reduced from its peak levels. The country now produces roughly 1/3 of total world supply.

(Figure 35). The establishment of a farmed abalone industry could either cause prices to stabilize or decline depending on production levels from both farmed and wild harvests; however, it is unlikely that farmed abalone in the US will have a significant impact on prices in the near future.

Figure 35. Price of US Imported Fresh Abalone



Source: U.S. Department of Commerce 2004

4.5 Catfish Aquaculture

4.5.1 Introduction

Washington holds a strong position in world geoduck production. The State currently produces between 40 and 45 percent of world production. The study team expects that this share will increase as aquacultured geoduck crops that are already planted on private lands come into production over the next several years. If Washington growers are seeking a consistent and orderly development of their industry they might take some lessons from catfish growers in Mississippi. These growers have developed a strong industry by working with local government and universities and by working together to brand their product. The end result has been an industry that contributes to the local economy and has been politically and economically strong enough to withstand foreign competition.

The catfish case study shows:

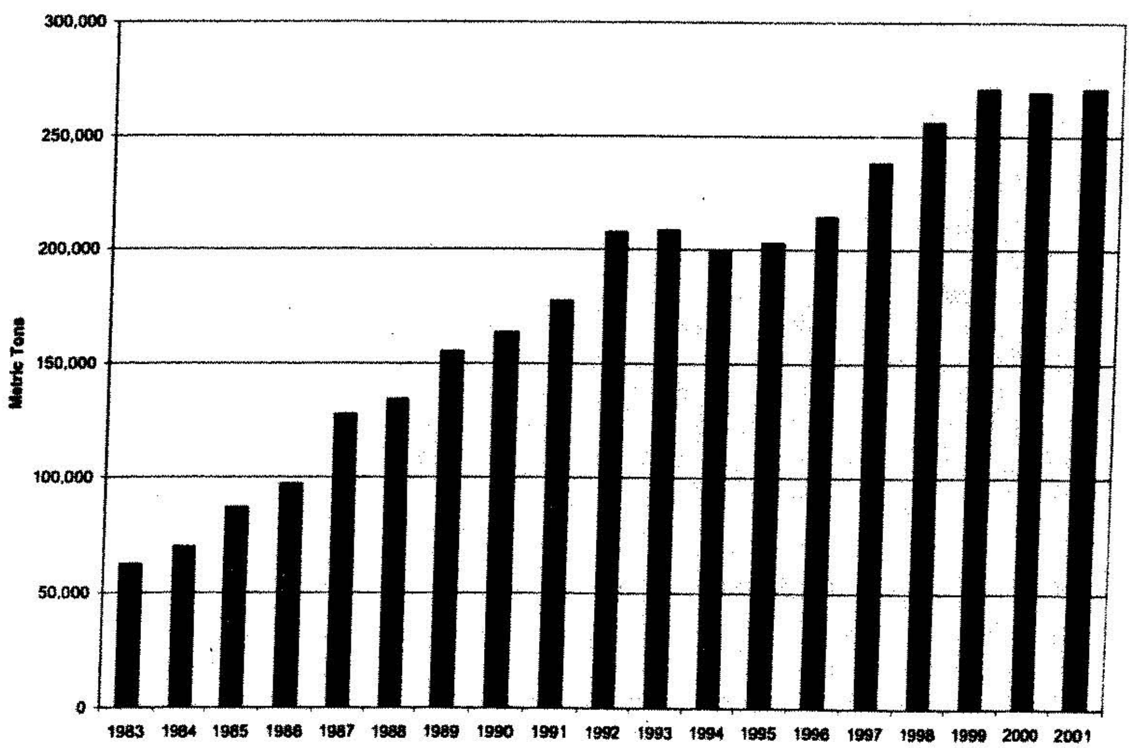
- How important State and University research and training programs can be to the development of an industry.
- How an aggressive marketing campaign to increase demand in domestic and international markets, funded by the farmers themselves via taxes on feed, can increase consumption.
- How a domestic industry can successfully work together to fend off foreign competition.

4.5.2 Industry Development

The modern catfish farming industry originated in the Mississippi Delta in the late 1960s and early 1970s by farmers who were seeking an alternative to low priced row crops grown in clay-based soils (Dean et al., 2003). The near-level land and abundant groundwater found in the Delta gave the area a natural advantage in the production of channel catfish (*Ictalurus punctatus*). In addition, the proximity to the Mississippi River allowed for the relatively cheap transportation of grain from the Midwest and Southeast. Traditionally, catfish were harvested in local lakes and rivers by commercial fishermen. Today, there are 196,590 acres of catfish in the United States and 111,500 of those acres are in Mississippi (Dean et al., 2003). Channel catfish farming is the fastest growing segment of the aquaculture industry in the United States (Lewis and Shelton, undated).

As shown in Figure 36, catfish production grew from 62,256 metric tons in 1983 to 270,846 metric tons in 2001 (USDA NASS Reports). Mississippi's farm-raised catfish industry is a model world-class commercial aquaculture industry that is profitable, sustainable, and environmentally sound. (Dean et. al., 2003). Channel catfish culture in Mississippi began in response to declining profits from traditional agriculture (mostly cotton and soybeans and a desire to diversify agricultural production and make use of land marginally suited for row crops (Thad Cochran NWAC, 2004). Some of the key factors responsible for the development of the industry include prior research and investment in channel catfish rearing, strong State and University partnerships, and industry collaboration.

Figure 36. US Farmed Channel Catfish Production



Source: NMFS, 2004

During the 1920s, channel catfish were cultured in hatchery ponds of many State and Federal facilities (Hargreaves, 2002). Thus, much of the technology and techniques used in production today were established prior to the 1960s. This knowledge, coupled with extensive State and University training to individual farmers and research programs, helped foster the industry's success. Research scientists affiliated with the U.S. Department of Fish and Wildlife Service, Fish Farming Experiment Station in Stuttgart, Arkansas, and Auburn University provided the technical information, culture guidelines, and technical advice necessary to initiate industry development (Hargreaves, 2002). Federally supported research conducted at state land-grant institutions throughout the region provided critical technical support and outreach to the industry (Hargreaves, 2002).

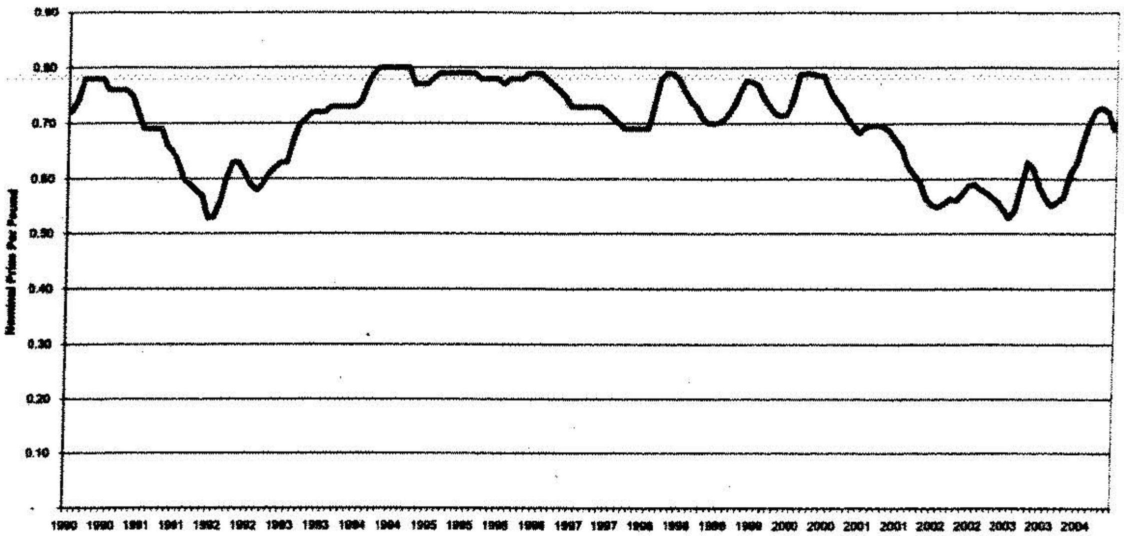
In addition, there was significant industry collaboration through the Catfish Institute and The Catfish Farmers of America—two major associations that aim to promote and protect the US Channel Catfish Industry. Since its creation in 1986, The Catfish Institute has effectively marketed channel catfish nationally, with Americans doubling their per capita consumption of U.S. Farm-Raised Catfish since 1986. The Institute has been dedicated to increasing demand for channel catfish by promoting the positive attributes of farm-raised catfish to consumers and food service professionals through advertising and other promotion programs (Hargreaves, 2002). This non-profit corporation derives its revenues from member feed-mill dues to fund its national and international marketing campaigns. Established in 1987, feed-mill dues were set at $6.00/ton and to date, more than $30 million has been invested in The Catfish Institute (Hargreaves, 2002). This joint marketing effort has raised the public's awareness of catfish. Consumers can now find catfish in almost every major supermarket chain across the country. This availability is in stark contrast to the product's availability 20 years ago when one would not have seen catfish outside of the Southern United States. Despite the measurable gains in catfish marketing attributable to the generic advertising program, the benefit of expanded investment in this program appears possible (Hargreaves, 2002). Kinnucan (1995) suggested that the generic advertising program is under-funded, citing evidence of a large latent demand from U.S. consumers. Catfish supply and demand curves are not affected by price (i.e. price inelastic), a characteristic that creates conditions in which returns from additional investment in advertising can be realized (Hargreaves, 2002). While the study does not expect the same transformation in the geoduck market, evidence suggests that a strong joint marketing program by industry members could maximize industry marketing opportunities.

Through legislative and judicial rulings, the Catfish Farmers of America have successfully united against direct foreign competition from Vietnamese catfish. In 2002, Congress restricted the use of the word "catfish" to strictly refer to catfish from the *Ictaluridae* family, thereby requiring Vietnamese catfish to instead be labeled "tra" or "basa". More importantly, the Catfish Farmers of America won an anti-dumping suit against Vietnamese producers in 2003, resulting in a country-wide tariff of 64% on Vietnamese "tra" and "basa" imports. As a result, "basa" imports have fallen 50% since the tariffs went into effect in June 2003 (Klinkhardt, 2004). The important lesson to be learned from the catfish industry is that despite being comprised of many small players, they have successfully banded together as a powerful political and industry force.

4.5.2.1 Distribution and Market Structure

This industry has had some degree of vertical coordination since its inception. The industry developed from its agricultural roots and formed co-operatives, it has a relatively strong industry organization (The Catfish Institute), and it has support from the USDA Agricultural Extension Service. This industry has never been plagued by the bureaucracy and regulatory complexities that characterize traditional fisheries and coastal aquaculture. Its inland location resulted in the development of high quality fish processing facilities instead of using the processing plants used by the traditional fisheries. This industry has successfully marketed their product, they have developed value-added products, and they have sustained orderly growth of the industry. The industry has been able to reasonably manage the market and prices for catfish have remained essentially stable over the past decade (see Figure 37). Note that the decline in prices (2001-2003) is largely attributed to imports of "tra" and "basa" from Vietnam. In addition, production costs have remained relatively stable over that same time period.

Figure 37. US Farm Raised Catfish: Average Price Paid to Producers



Source: U.S. Department of Agriculture, Agriculture Report 2004

4.6 Yesso Scallop Aquaculture in China

4.6.1 Introduction

The growth in Chinese production of farmed yesso scallops is one of the great success stories of modern day aquaculture. Chinese aquaculturists successfully adapted imported technology to create an industry which in 2002 produced nearly 1 million metric tons (round weight) of product. This story has important aspects which as relevant to the current situation in the world geoduck market. These are that:

- China is capable of becoming a leading producer of farmed product for that species.
- Technology can be successfully transferred between countries.
- As with land-based farming, aquaculture crops which are planted in high densities and without rotation will be subject to higher disease risks.

4.6.2 Industry Development

In 1980, China produced roughly 50 MT of scallops (see Table 14). This amount accounted for less than one percent of world production in that year of 370,000 MT (by round weight). Japan was the number one producer in the world at that time with a production level of roughly 123,000 MT. The United States was the second largest producer in the world with an annual production equal to roughly 114,000 MT. Japanese production came primarily from farmed sources while US production was from wild capture harvests (FAO 2004). Around this same time, the Chinese imported American bay scallops and Japanese farmed production technology and began to produce farmed bay scallops for internal consumption and export.

China successfully adapted foreign technology for domestic production. By 1990, China produced nearly 150,000 MT of scallops or almost the same amount as the United States. This increase in production moved the country from 18th in the world in 1980 to 3rd in the world in 1990 (FAO 2004). Nearly all of the production increase came from the scallops and technology imported just a decade earlier.

China now accounts for almost 50% of world production. The country's farmed scallop production volume of 930,000 MT in 2002 is greater than world production of scallops in 1990. Chinese production grew nearly 20,000 fold between 1980 and 1990 (FAO 2004).

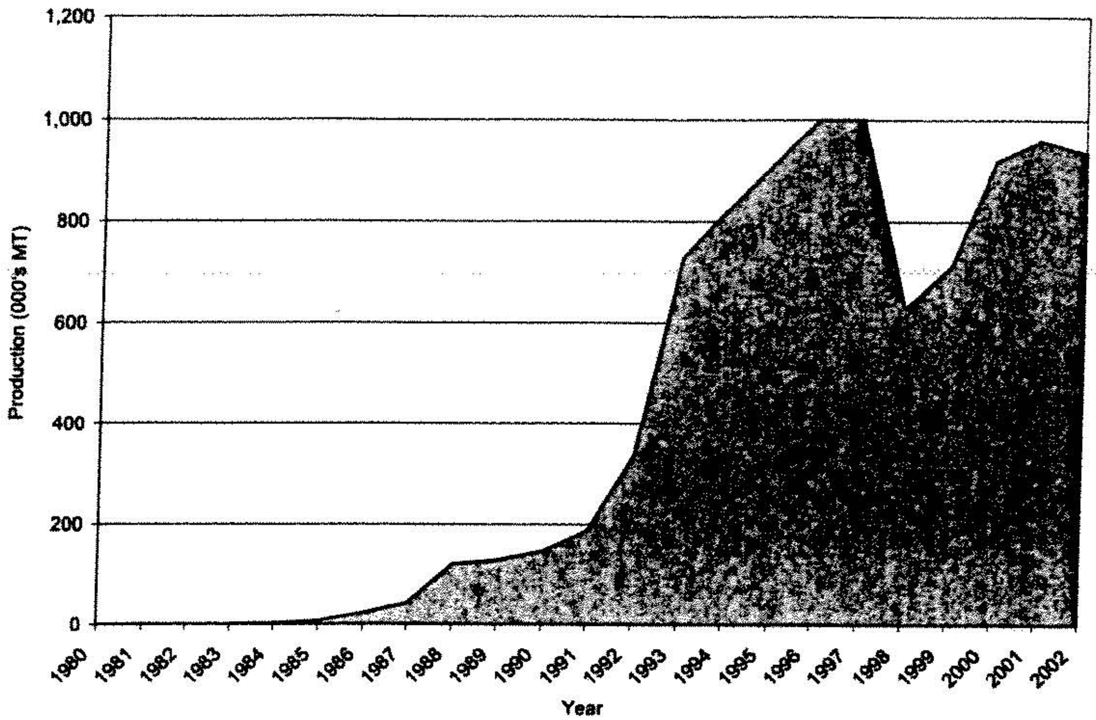
Table 14. Top Twenty Scallop Producers

	1980		1990		2002	
Position	Country	Volume (MT)	Country	Volume (MT)	Country	Volume (MT)
1	Japan	123,533	Japan	421,709	China	935,585
2	USA	114,639	USA	150,090	Japan	578,662
3	Canada	70,473	China	147,003	USA	187,999
4	France	16,258	Canada	83,387	Canada	95,066
5	UK	14,864	Mexico	29,501	Argentina	50,966
6	Iceland	9,079	UK	14,584	UK	29,556
7	Australia	7,244	Iceland	12,117	France	23,894
8	Peru	4,411	Faeroe Islands	8,386	Chile	15,552
9	Isle of Man	3,362	Norway	7,387	Mexico	9,878
10	Faeroe Islands	1,955	France	6,490	Russia	9,404
11	USSR	1,639	Australia	6,185	Australia	5,658
12	New Zealand	1,570	Russia	5,165	Peru	5,419
13	Belgium	354	New Zealand	4,504	Iceland	5,192
14	Ireland	308	Isle of Man	3,131	New Zealand	4,526
15	Indonesia	166	Chile	2,094	Isle of Man	2,632
16	Taiwan	153	Ireland	1,618	Greenland	2,457
17	China	54	Peru	1,030	Ireland	1,265
18	Channel Islands	45	Philippines	466	Norway	760
19	Spain	19	Spain	460	Thailand	666
20	Argentina	8	Argentina	442	Indonesia	480
Total		370,134		905,749		1,965,617

Source: FAO's FISHSTAT 2004

Figure 38 shows the increase in Chinese production over time. Production peaked in the mid-1990s. The next couple of years show one of the dangers of intensive farmed production of a single species. Most of the China's production is contained within a Bohai Bay in Northern China and along the Yellow Sea. This concentrated production system left the industry vulnerable to a disease outbreak which lowered production by nearly 40% over a two-year period. The industry has yet to return to its pre-disease production levels.

Figure 38. Production of Farmed Scallop-China



Source: FAO's FISHSTAT 2004

4.6.2.1 Product Distribution and Market Loci

While the total value of Chinese production has risen substantially over the years, the per-unit value has fallen by more than 25% since the mid-1980s. This decrease is reflected at the seafood counter. It is not unusual for consumers to be able to purchase these scallops for $4.00 per pound; an amount several dollars less then the price prior to increased farmed production. We see this as further evidence that extensive farmed production of a given product can lower ex-vessel and consumer prices by increasing supply. However, the increased in farmed production in Yesso scallops hasn't substantially affected US scallop producers. Much of China's production is used domestically and US scallop producers tend to focus on larger, wild, sea scallops than their smaller cousins and farmed production of bay scallops in this country never really gained a foothold.

5 Washington State Lands and Geoduck Aquaculture

5.1 Summary

This study recommends that the State consider leasing a moderate amount of inter-tidal acreage for geoduck culture as a way to support Washington-based industry and to diversify the State's geoduck-based revenue sources.[53] Also, as discussed in Section 3.10, the study team believes that future production from private growers could have a significant effect on WDNR revenues from sub-tidal auctions. Thus, the study believes that leasing inter-tidal acreage will help the Department meet its statutory mandates with regard to managing geoduck as a productive resource and will also be a prudent diversification of revenue. A rotating lease system leasing a moderate amount of land per year would support industry, diversify revenue sources, and increase total revenue without flooding the market with new supply.

Figure 39 demonstrates how a rotating lease system could look over time. The state would decide how much land to lease in year 1. This land, designated LG1, would be leased and planted in year 1. In year 2, LG2 would be leased and planted while LG1 would be growing. This cycle would continue until year 7 when LG1 would be harvested and LG7 would be leased and planted. In year 8, LG 1 would be leased again while LG 2 would be harvested. If the amount of land in each leasing group stayed the same over time, then we could expect relatively stable level of production from state lands with some variation in production as growers responded to current market conditions by changing the timing of their harvests and future market expectations by changing the amount the planted on leased lands.

Figure 39. A Rotating Lease System Over Time

Lease Group	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8
LG 1	P	G	G	G	G	G		P
LG 2		P	G	G	G	G	G	
LG 3			P	G	G	G	G	G
LG 4				P	G	G	G	G
LG 5					P	G	G	G
LG 6						P	G	G
LG 7							P	G

The leasing of State-owned inter-tidal lands to geoduck growers could represent an important new source of revenue to the people of Washington via the Washington Department of Natural Resources.

[53] *This recommendation focuses on inter-tidal* acreage as the study believes that industry has yet to prove that sub-tidal aquaculture in economically feasible. While the study does not suggest the State of Washington avoid lease sub-tidal lands, it does believe that the majority of a leasing program should be focused on inter-tidal acreage which will have more immediate effect on the market. The State might consider a test program for sub-tidal acreage.

However, if the State decides to lease lands for geoduck culture it should also ensure that the volume of lands released into production does not increase supply in such a manner as to cause prices to fall significantly, thus damaging the State's return from the resource through the current sub-tidal auctions and the returns of both wild and culture producers. As described in Section 3.10, sudden production of substantial amounts of geoduck has the potential to significantly disrupt the world market.

In many ways, the State is analogous to an insurance company that operates in an area prone to natural disasters (e.g. hurricanes). An insurance company which appropriately prices its insurance can encourage people to invest in property at a responsible level that reflects the risk inherent in the area. An insurance company that under-prices its insurance encourages people to ignore the investment's inherent risks and over-invest in property. On the other hand, over-priced insurance retards investment. The State is in a similar circumstance. Releasing an appropriate amount of land for lease will allow industry to invest appropriately. Leasing too little may retard industry development. Leasing too much may result in over supply and the State could be signaling to potential investors that the market has the capacity to absorb more product than it is truly capable of absorbing without significant price disruption.

Table 15. Effect on Current and Projected Washington and World Supply of Various Lease Plans

Total Annual Leases (Acres)	Projected Annual Production	Current WA Production	2003 World Production	Projected WA Production	Projected World Production
5	588,060	12.4%	6.8%	6.6%	4.6%
10	1,176,120	24.8%	13.5%	13.2%	9.1%
25	2,940,300	62.0%	33.8%	32.9%	22.8%
50	5,880,600	123.9%	67.6%	65.8%	45.6%
75	8,820,900	185.9%	101.4%	98.7%	68.4%

Source: Study Interviews and Northern Economics Projections.

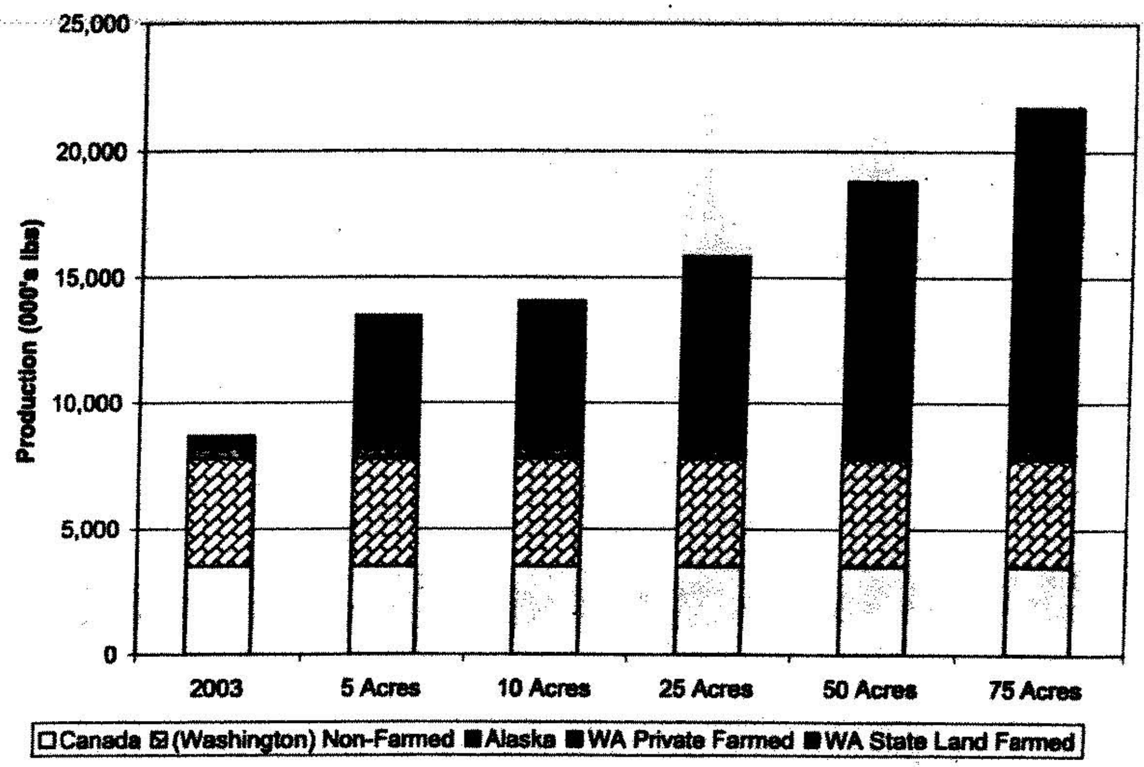
Table 15 shows the projected effect of leasing on current and projected product supplies. A plan which leased five acres per year (capped at 35 acres) into production would add roughly 6.8 percent to current world supply, but would only add 4.6 percent to the world supply that the study predicts in five to seven years. A plan which leased ten acres per year (capped at a total of 70 acres) into production would add 13.5 percent to current world supplies and 9.3 percent to projected world supplies in five to seven years. On the other end of the spectrum, a plan leasing 75 acres per year (capped at 525 acres) would nearly triple Washington production and would double world production based on current production figures, and would double Washington production and add nearly 70 percent to world production based on the study's expected world supply in five to seven years. The study team believes that sudden production from a program leasing 50 to 75 acres per year would certainly disrupt the world market, at least in the short-term. The study team also believes that a leasing program that leases less than 20 acres per year is less likely to flood world supply and disrupt industry and revenue flows than a program that leases more than 50 acres pear year.[54]

Figure 40 compares current production, at 2003 levels, with estimated production figures from the leasing scenarios above and the estimated current investment in geoduck culture on private lands.

[54] Incidentally, the study does not believe that current seed production levels are enough to support a larger leasing program. However, the industry may have reserve production capacity that the study is not aware of at this time. Certainly, more production capacity could be created given time and money.

The figure shows that Washington should expect a major increase in production from private culture production efforts. A plan that leased 5 to 10 acres per year (with a maximum lease total of 25 to 70 acres) would add a significant amount to expected production and, as mentioned above, an amount equal to between one-eighth and one-quarter of current production. A leasing program that leased 50 or 75 acres per year would produce substantially higher amounts of product which could initially overwhelm the ability of the world market to absorb product flows.

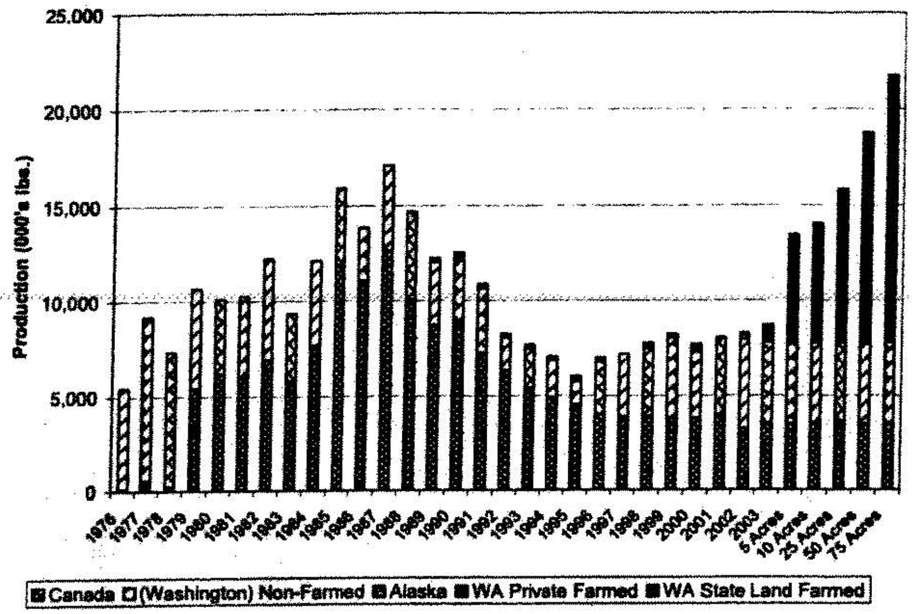
Figure 40. Potential Production vs. Current Washington Production



Source: Washington Department of Natural Resource and Northern Economics, Inc Estimates

Figure 41 shows the effect of a leasing program on world supply in the context of historical world production levels. The world market should expect that even without a program that leased state lands, supply levels will soon reach volumes not seen since the early 1990s. A state leasing program could rapidly increase world supply levels to record highs. A 75-acre leasing program would result in world supply levels nearly one-third higher than the previous record high of 16.9 million pounds in 1987. Even a small state leasing program of five acres per year will help push world production of geoduck to levels that were only reached in the late 1980s.

Figure 41. Potential Production vs. Historical World Production



Source: Statistics Canada, Washington Department of Natural Resources, & the Alaska Department of Fish & Game and Northern Economics, Inc Estimates

The study believes that it is not in the State of Washington's best interest to knowingly contribute to the classic aquaculture production cycle of high incentives to enter the market, rapidly increasing supply, falling prices, and industry consolidation. There is a real chance that the geoduck industry will go through such a cycle irrespective of state lands production, given the rapidly increasing amount of inter-tidal land dedicated to production in Washington, the number of individuals outside of Washington interested in Geoduck aquaculture, and the potential for high returns from aquaculture. Thus, the State must be aware that any decision to allow culture activities on state lands contributes to world supply and may contribute to short-term supply gluts. Thus, while the study recommends leasing state lands, it also recommends that any leasing program consider that the world market will soon be adjusting to a major increase in supply from private land production. The study does not believe that leasing a moderate acreage amount would disrupt the world market, but that leasing higher amounts from the beginning could flood the market when that acreage reaches harvest time. The study recommends a gradual and moderate approach that would allow additional acreage to into production if the world market successfully absorbs the upcoming production boom.

If the State pursues a leasing program, it should work to develop parameters that allow managers to evaluate the program and the program's effect on the world market. The fact that the geoduck production cycle takes several years will complicate these efforts. The best way for program managers to evaluate a program is to closely monitor factors such as total world production, world price, Washington wild production, Washington culture production, state harvest auction prices, and State-land lease prices. Monitoring these factors on a consistent basis and communicating with industry members will allow managers to assess the program's role in the world market.

The study team also recommends that if the State decides to proceed with leasing that it should revisit this issue of the size of the leases on a regular basis to assess. Ideally, the study team believes that the State should assess the relationship between state lands production and the market on a yearly basis and formally assess the program after the expiration of the first lease. Future market conditions may call for more land to be added to production.

Managers must also not forget that the market itself will regulate the industry. For example, a producer may have good knowledge of upcoming total production. Thus, he/she may choose not to plant on leased land if there is reason to believe that upcoming production will reduce the world price below a profitable point. If prices increase, then the lease holder could plant a new crop. Managers who communicate with potential lease holders will have a better idea of the program's effect on the world market.

5.2 The Arguments Against Leasing State Lands[55]

The primary economic argument against leasing on state lands is the one discussed above: that production from those lands might encourage more production than would otherwise naturally occur, thus increasing supply, exceeding world market demand, and potentially lowering price. The counter-argument is that just because the State chooses to lease land doesn't mean that the market will put it into production and that the market (as represented by producers) has the best idea of how much product consumers will demand. Generally, that is the case, but geoduck prices are currently so high that the study feels that some potential growers are looking at the current market prices and not thinking about the future market conditions. This problem will be especially acute for late comers to the culture community. Those individuals may be entering the market based on past return and not future performance. The State should avoid encouraging that type of behavior as it can disrupt markets and livelihoods.

The other argument is that if production from state lands does push prices lower, then it will harm the owners of the right to harvest sub-tidal geoduck. If the total amount of geoduck increases, but prices fall somewhat, growers will probably still come out ahead because they can increase supply and make money on volume. On the other hand, harvesters of wild geoduck are unable to increase supply and make money on volume, because the State probably won't increase the amount of geoduck that can be harvested. Wild harvesters also probably won't be able to substantially adjust world supply as they have in the past, as grower production is expected to become the dominant source in Washington. Thus, wild producers could lose either way as they are essentially stuck with a fixed amount of supply which could face lower ex-vessel prices in the future. The study expects that this scenario could be realized without state lands entering production. However, entering state lands into production raises the probability of the scenario occurring by some unquantifiable, non-zero amount.

5.3 The Arguments for Leasing State Lands

There are several arguments that support leasing state lands for geoduck production. These are that such leases will:

- Help support Washington-based growers become dominant culture geoduck producers, which should lead to more employment for Washington State residents and more tax revenue for the State of Washington.
- Help diversify revenue streams. Private production is already under way. The possibility exists that the Washington Department of Natural Resources will receive less for its sub-tidal auctions to harvest wild stock in the future if world geoduck prices fall. In this

[55] This section only concerns itself with the economic arguments for and against leasing and does not address biological, ecological, or other arguments for or against leasing.

scenario, product from State sub-tidal lands would represent a declining share of world market and generate declining revenues for the State.

- Foster the commercial harvest of geoduck on public lands to generate revenue to benefit the citizens of the State pursuant to RCW 79.68.080 and RCW 79.96.080. Allowing inter-tidal leasing on state lands will generate additional revenue for the State, which will then be used to benefit the citizens of the State.

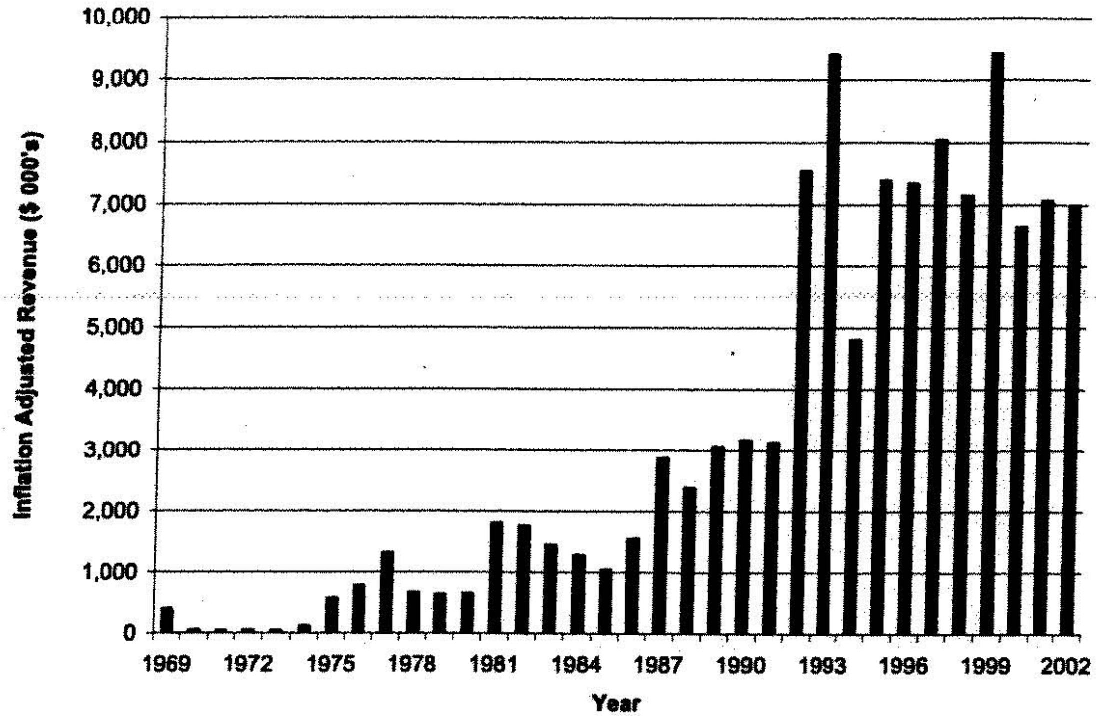
Additionally, it is the policy of the State to foster aquaculture (RCW 79.90.456; RCW 79.90.570; RCW 15.85.010). Allowing geoduck aquaculture on state-owned aquatic lands will diversify the species produced by Washington companies and help foster the development of culture-based industry.

As described in Section 5.5, the potential returns to the State of Washington and its people from State leasing of inter-tidal beds are significant.

5.4 Current Returns from Sub-Tidal Auctions

For more than three decades, the people of Washington have benefited from the Washington Department of Natural Resources auctioning the rights to the sub-tidal harvest of geoduck (see Figure 42). The auctions have developed into a multi-million dollar annual revenue source and have grown with the increasing value of geoduck. For example, between 1993 and 2003, the State of Washington received net income of $74.3 million from auctioning the right to harvest 16.8 million pound of geoduck. Thus, the State realized $4.42 for every pound of geoduck harvested and has been highly effective in capturing a sizable share of the value of the wild geoduck harvest for the State. The study estimates that the State is capturing between 40 percent and 70 percent of the total ex-vessel value of these lands assuming an average ex-vessel price of between $6 and $10 per pound. This result typifies the efficiency of auctions in capturing rents from interested parties, and the State should be commended for effectively capturing these rents for its constituents while promoting a healthy, viable industry.

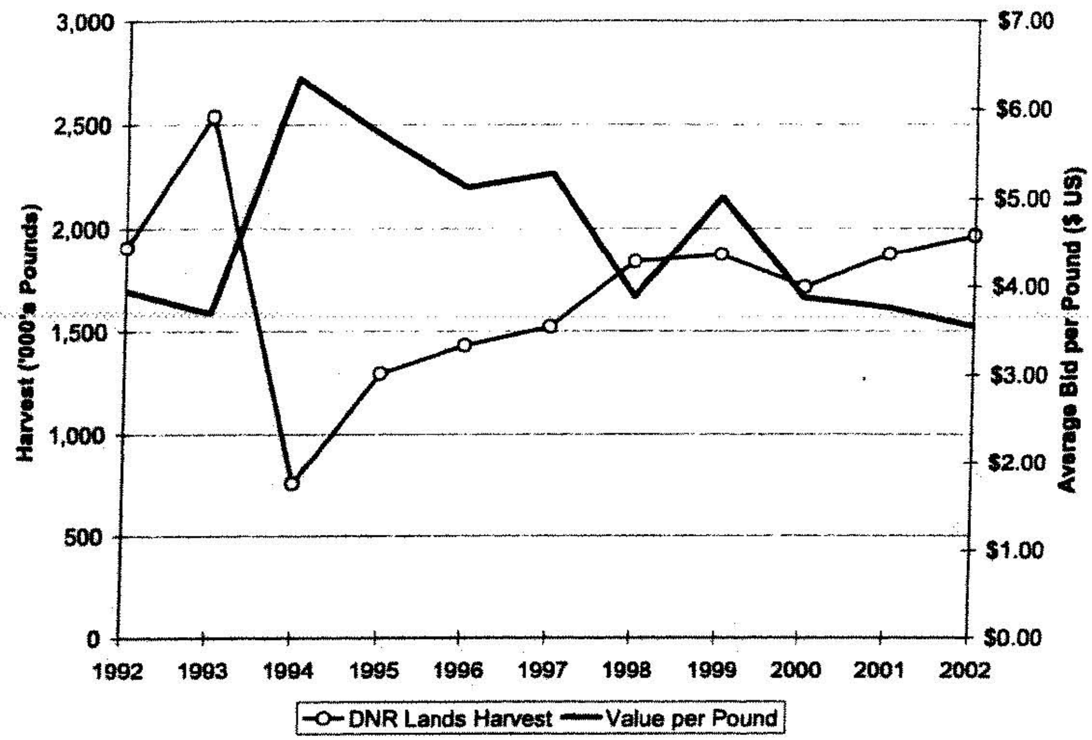
Figure 42. Washington Geoduck Auction Total Inflation-Adjusted Revenues, 1969-2003



Source: Washington Department of Natural Resource, 2004

Figure 43 shows the relationship between non-treaty (auction) harvests from State Lands and average auction prices by Fiscal Year. Generally, when amounts released to harvest have been low, prices have been higher. The study notes that the amount harvested has risen nearly annually since FY 1994 and the per-pound revenues are declining. Total revenues were stagnant in FY 2003 in comparison to FY 2002 in spite of the fact that state lands in 2003 yielded nearly 100,000 pounds more than in 2002. The study team is not sure if this reflects a change in the world market in general as expressed through the price harvesters receive, and/or if it reflects recognition by the market that the quality of geoduck available from state lands is declining and thus not deserving of higher prices.

Figure 43. Washington DNR Lease Auctions Total Harvested Amount and Price per Pound



Source: Washington Department of Natural Resources, 2004

5.5 Potential Returns to Inter-Tidal Leasing[56]

As previously stated, auctioning the rights to harvest sub-tidal lands has generated significant revenues for the people of the State of Washington and the Department of Natural Resources. The Department now faces the decision of whether to allow the cultured production on sub-tidal and inter-tidal lands.[57] As discussed in Section 5.1, leasing of lands would allow the State to generate revenue from geoduck as required by RCW 79.68.080 and RCW 79.96.080, and it would support an emerging industry. However, the State must also consider that rapidly increasing production on state lands could affect the world market and returns to the State's sub-tidal auction program.

Leasing State-owned inter-tidal lands could represent a significant source of revenue for the Department of Natural Resources. We estimate that these leases would generate roughly $75,000 per leased acre over the life of the lease, based on the following assumptions:

- The lease structure follows the current private lease structure of $1,000 per year plus 10 percent of ex-vessel value at harvest.
- Seed are planted 1-foot on center with 3 seed planted per tube.
- 50 percent of seed survive to harvest, and average harvested weight is 1.8 pounds.

[56] Unless otherwise noted, all dollar amounts in this section are nominal (i.e. undiscounted $US)

[57] This report focuses on inter-tidal lands. The market conditions described in the report would apply to sub-tidal lands. Also, the recommendation about the maximum number of acres the State could initially allow for cultivation should also be considered the maximum across both types of land.

- 60 percent of harvested product is grade 1 or 1s, 25 percent is grade 2, and 15 percent is grade 3 or less.
- Ex-vessel prices average $6.75 per pound for grade 1 and 1s, $5.75 per pound for grade 2, and $2.50 per pound for grade 3.
- There is an average six-year product cycle.

Under these assumptions, the value to the growers of the acres would be roughly $690,000 before expenses. If the State were to follow the private lease structure, then it would receive $69,000 as its portion of ex-vessel value plus $6,000 for the per acre lease fee.[58] These assumptions are based on interviews with farmed geoduck industry experts and represent what the study team feels are reasonable approximations of the attributes that farmed production will display in the coming years (Gibbons 2004; Hayes 2004). However, the estimate amount will vary significantly based on market price, productivity per acre, and planting practices.

If the estimate of $75,000 per acre is combined with the recommendation that the State start with leasing 5 to 10 acres based on the geoduck production cycle of five to seven years per crop, then we estimate that the leasing system could produce between $375,000 and $750,000 per year in additional revenue for the State.

The estimate of $75,000 per acre compares favorably to the study's estimated average revenue from sub-tidal auctions of $52,400 per acre.[59] However, revenue from inter-tidal leasing will probably never equal the nearly $7 million generated by sub-tidal auctions. At $75,000 per acre it would take a minimum of 93 acres per year to equal the $7 million produced by sub-tidal leasing. In total, this would require between 465 acres and 650 acres of state inter-tidal lands. The study estimates that an additional 93 acres per year would result in an estimated additional 10.9 million pounds of production per year. We do not currently think that the market could absorb that much new production, in addition to what private growers have already planted, without significant price effects, which would reduce ex-vessel value and require even more land. Thus, pursuing a goal of equaling the revenue stream generated from sub-tidal harvest auctions using the current private leasing structure would prove self-defeating. The productivity of inter-tidal lands means that supply would increase substantially and price would fall, thus lowering lease returns and requiring the leasing of more lands.

5.6 Following the Private Lease Structure vs. Auctioning State Lands

The study estimated potential revenues from inter-tidal leasing using the lease structure most commonly used between growers and private landowners. The price for these leases rose recently with the addition of the $1,000 per-acre, per-year fee (Lentz 2004). However, even with the increases, private growers are essentially finding a cheaper way to do business than is available to those who wish to harvest from State sub-tidal lands. The study estimated that State auctions capture between 40 and 70 percent of the ex-vessel revenue available from sub-tidal harvesting. Private growers are entering into agreements which only obligate them to share slightly more than 10 percent of the potential ex-vessel value of their harvest. Thus, these growers are able to keep a higher portion of the ex-vessel value of their product, before planting and harvesting costs, than harvesters.

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[58] Estimates are not discounted.

[59] This estimate is based on the average price per pound received by DNR auctions over the last five years; an average bed density of 1.61 geoduck per acre as provided by WDFW, and an average weight of 2 pounds (Sizemore 2004).

The study recommends that the State explore the idea of auctioning the right to lease state lands. Inter-tidal leasing will generate more revenue if the State can develop more favorable lease terms. For example, a lease arrangement of $1,000 per year and 20 percent of ex-vessel revenue would double the value of an acre of leased land to the State to nearly $150,000. While pursuing a higher lease rate may raise questions of competition with private land owners, an auction or sealed bid process would allow the State to capture a much higher portion of rents from the fishery.

Pursing a higher lease rate could also allow the State to generate more revenue with less risk of swamping the world market. For example, as mentioned previously, a system similar to the current private lease structure would require roughly 90 acres to generate revenues equivalent to what the State currently receives from private tidelands. However, this amount of land would sink world prices. On the other hand, if the State captures 40 percent of the ex-vessel revenue from its leases, then it would only need between 20 and 25 acres per year to equal the revenue of the current sub-tidal auction system. As noted in Section 5.1, a program which leases this amount of land is less likely to depress world prices than one which leases 75 acres per year.

The study team heard from growers that private land is starting to become scarce. Thus, the study believes that the State could expect a better lease arrangement than what currently dominates the industry.

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Expert Interviews

The study interviewed more than 40 experts from around the world. The names, industry sector, and locations of the interviewees are listed below. Those interviewees who asked to remain anonymous are listed as such without their names or organizations.

Table 16. Expert Interviewees by Sector, Organization and Location

Name	Sector	Organization	Location
Celia Barton	Government	Department of Natural Resources	Washington
Bill Dallas	Government	Department of Agriculture	Washington
Julie Decker	Harvester	SE Alaska Dive Fisheries Assoc.	Alaska
Bill Dewy	Grower	Taylor Shellfish	Washington
Robin Downey	Grower	Pacific Coast Shellfish Growers Assoc.	Washington
Bill Favretto	Distributor	FAVCO Ltd.	Alaska
Greg Fish	Government	Department of Fish and Game	Alaska
Yves Gagnon	Statistician	Statistics Canada	Canada
Eric Gant	Grower	Manatee Holdings	Canada
Jim Gibbons	Grower	Seattle Shellfish	Washington
Bruce Glass	Government	Department of Natural Resources	Washington
Paul Gribben	Researcher	University of NSW	New Zealand
Steve Heizer	Biologist	Department of Fisheries and Oceans	Canada
Eric Hurlbert	Government	Department of Agriculture	Washington
Michelle James	Harvester	Underwater Harvesters Association	Canada
Jeanne Koenings	Government	Department of Natural Resources	Washington
John Lentz	Grower	Chelsea Sea Farms	Washington
Linda Lentz	Grower	Chelsea Sea Farms	Washington
Fred Lochmatter	Grower	FAN Seafoods	Canada
Tom Manning	Grower	Private Individual	Alaska
Kerri Marcus	Biologist	Department of Fisheries and Oceans	Canada
Terry Mielke	Government	Department of Fish and Wildlife	Washington
Jose Orensanz	Researcher	CENTPAT	Argentina
Rodger Painter	Growers	Alaska Shellfish Growers Association	Alaska
Todd Palzer	Government	Department of Natural Resources	Washington
Jeff Pearson	Grower	Taylor Shellfish	Washington
Rodney Roberts	Researcher	Cawthron, Inc	New Zealand
John Seabourne	Government	Department of Fish and Wildlife	Oregon
Bob Sizemore	Biologist	Department of Fish and Wildlife	Washington
Ralph Solomon	Seafood Sales	Lummi Shellfish Hatchery	Washington
Mel Stanley	Statistician	Department of Fish and Wildlife	Washington
Loren Stern	Government	Department of Natural Resources	Washington
Bill Taylor	Grower	Taylor Shellfish	Washington
Paul Taylor	Grower	Taylor Shellfish	Washington

Name	Sector	Organization	Location
Jackie Timothy	Government	Department of Fish and Game	Alaska
Derrick Toba	Government	Department of Natural Resources	Washington
Anita Victory	Government	Department of Fish and Wildlife	Washington
Klayton Waldron	Seafood Sales	Jamestown Seafood	Washington
Name Withheld	Seafood Buyer	Company Withheld	Hong Kong
Name Withheld	Seafood Buyer	Company Withheld	Hong Kong
Name Withheld	Seafood Buyer	Company Withheld	Hong Kong
Name Withheld	Distributor	Company Withheld	Canada
Name Withheld	Harvester	Company Withheld	Washington
Name Withheld	Harvester	Company Withheld	Washington
Name Withheld	Distributor	Company Withheld	Canada
Name Withheld	Seafood Buyer	Company Withheld	Hong Kong

PLANNING WITH LOCAL GOVERNMENTS
EXPLORATORY POINTS

- Local governments engaged or to be engaged in resource planning activities under the Shoreline Management Act (SMA) and the Growth Management Act (GMA) often require information about natural resources priorities (e.g. Washington Department of Fish and Wildlife's Priority Habitats and Species).

- The Washington State Department of Natural Resources (WDNR) under **WAC 332-30-100 (2) (a)** recognizes that "**Planning will be used to prevent conflicts and mitigate** adverse effects of proposed activities involving resources and aquatic land uses of statewide value. Mitigation shall be provided for as set forth in WAC 332-30-107(6)."

- In addition to the above, **WAC 332-30-107** defines in five subsections (1 – 5) the goals and objectives of the aquatic land planning. For our discussion purposes, the table below only shows (3) and (4).

> **(3) Shoreline management.** The Shoreline Management Act and shoreline master program planning, together with supplemental planning as described in subsection (5) of this section, **will be the primary means for identifying and providing appropriate uses [of SOALs] of statewide value**.
>
> **(4) Coordination.** Coordination with shoreline management programs will be accomplished by:
>
> **(a) Identifying aquatic land areas** of particular statewide value for **public access, habitat and water-dependent and renewable resource use**.
>
> **(b) Informing appropriate shoreline planning bodies** of the location and particular value of aquatic lands identified in (a) of this subsection.
>
> **(c) Participating in shoreline planning** and suggesting ways to incorporate and balance statewide values.
>
> **(d) Proposing to the appropriate local jurisdiction** that shoreline plans be updated when new information concerning statewide values becomes available or when existing plans do not adequately address statewide values.

- The Planning Unit is taking part in shoreline and land use planning under the SMA and GMA with several local jurisdictions. Staff has been participating on shoreline advisory committees, presenting information regarding WDNR's issues on a case-by-case basis. The development of comprehensive asset management plans [1] for SOALs at the Aquatic District level would be extremely beneficial for planning purposes. The questions below are for exploring the possibilities/potential for generating information regarding asset management for planning purposes.

Discussion questions:

1. Have the Aquatic District compiled information identifying aquatic lands and their particular values? (Asset Management Plans)
2. With the available Aquatic District's resources, is it possible to generate this information?
3. If not, what it would be required (type of assistance, technology, etc)?
4. What do you think about this ?

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[1] These plans would include information about current land uses and contract agreements on SOALs as well as all the physical and biological attributes of a specific area.

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