GEODUCK CLAM RESEARCH AND MANAGEMENT: PACIFIC SHELLFISH INSTITUTE COMPONENT

DELIVERABLE 3: REPORT ON POTENTIAL SITING AND ENVIRONMENTAL CONSIDERATIONS IN GEODUCK FARMING AND SUMMARY OF SUBTIDAL METHODOLOGY ADVANCEMENTS.

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Introduction

Deliverable 3 is a synthesis of available information from commercial geoduck interests on three major components: siting criteria, environmental considerations and subtidal methodology advancements. Each component is divided into its own section for ease of use. For this deliverable, PSI employees surveyed a majority of Washington state geoduck farmers and aquaculture interests in Alaska and British Columbia in person, via phone, or by e-mail. See Appendices for complete transcripts of interviews.

Intertidal geoduck culture in Puget Sound is far ahead of current British Columbia (and Alaska) intertidal culture operations. Conversely, subtidal geoduck culture is far more advanced in British Columbia as compared with Puget Sound where subtidal culture is limited to small research plots. Accordingly, most of the knowledge gained from this study on intertidal siting criteria, environmental considerations are the result of information gathered from WA geoduck interests. Generally, subtidal elements of environmental considerations, siting and methodologies are a result of interviews with BC growers and public officials.

In direct result of this split of component sources, some objectives are more complete than others. Initial communication with BC geoduck interests resulted in promising information. Discussions faltered as soon word was passed around that information gathered by this study had the possibility of being spread to competing geoduck producers, namely China. Subsequently, key BC geoduck subtidal farmers and biologists refused to provide detailed information and in the worst case refused to be interviewed.

Illustrations of characteristic intertidal farm sites, planting and harvest methods, and geoduck predators are shown in Figures 1 to 3

Siting Criteria

There are a myriad of variables that can be considered in determining if a section of beach or seafloor is suitable for geoduck aquaculture. The following is a discussion of a short list of variables that commercial interests included in their criteria:

Substrate: Overall, a sandy substrate was preferred for geoduck culture by all of those interviewed including BC interests. A small percentage of the substrate can consist of mud, or pea gravel but most should be sandy. Substantial amounts of shell, cobble, and woody debris should be avoided as it may impede growth, and result in off color and odd-shaped geoducks. This debris may also lead to increased mortalities by preventing geoducks from burrowing to a suitable refuge level.

Specifically for intertidal areas, growers noted that sand grain size is a key factor, as the larger the grain size the better chance the beach has to dry out. This allows for more siphon shows since it is harder to see shows in wet sand. The highly sandy substrates should extend to a depth of at least 3 feet. One farmer suggested a higher percentage of pea gravel should be targeted as it will produce better looking geoducks. Many noted that a high percentage of mud may produce off color geoducks.

Out of all siting characteristics, substrate was deemed the most valuable. Most growers survey areas for substrate content and depth before leasing, purchasing, or planting for geoduck aquaculture.

Temperature: While ambient water temperatures in Puget Sound, Strait of Juan de Fuca, and the Strait of Georgia are generally suitable for rearing geoduck, intertidal surface water temperatures must be closely monitored during out-planting of geoduck seed. High temperatures can kill or immobilize seed before they are able to bury into the substrate. Exact temperatures at which seed undergoes stress resulting in mortality were generally not discussed in an effort by participants to avoid distributing sensitive or proprietary information. While elevated incoming surface water temperatures may sometimes be of concern, the primary consideration on whether or not to plant seed is more directly related to air temperature and sun exposure during planting. Growers avoid planting during periods of high air temperatures and attempt to seed tubes only during an incoming tide to reduce temperature exposure.

Salinity/Riverine Influences: Laboratory/hatchery studies demonstrate that juvenile geoducks exhibit reduced burrowing rates and increased mortalities when challenged with low or reduced salinities. In efforts to circumvent this problem, research in now underway to determine if geoduck seed can be conditioned to withstand lower salinities. If so, seed could possibly be planted in areas and at times that where unfavorable in the past, opening up more ground and increasing planting times. While it is believed that low salinity may only influence geoduck seed, research targeting affects on larger geoducks has yet to be conducted.

Currently, the industry is dealing with potential low salinity problems by siting operations in areas that are not strongly influenced by freshwater. Some intertidal growers avoid planting near larger streams or rivers. In doing so, they also avoid other negative affects of riverine systems such as tube and net burial from increased sediment transport. Two growers suggested that all areas which experience salinities of 26 ppt and below should be avoided, noted it may be difficult to account for freshwater runoff during large rainfall events. One grower noted that siting on intertidal land that juts out at the mouths of inlets is an effective way to avoid this problem.

Conversely, it was suggested that subtidal geoduck may grow better in areas that are influenced by creeks. This observation was based on their wild harvest experience where subtidal areas offshore from creek channels were "loaded with geoduck". Other diver observations suggested that areas heavily influenced by rivers in North Puget Sound produced far few numbers of wild geoduck. Low salinity was pointed out as a possible reason for these low populations. If the above low salinity conditioning trials prove to be successful then perhaps cultured geoduck could be planted effectively in these areas.

pH and Dissolved Oxygen: These water quality variables were not considered to be key siting issues to the group interviewed.

Phytoplankton (chlorophyll) and Nutrients: Growers consider phytoplankton (chlorophyll) and nutrient levels to be major factors influencing the siting of geoduck farms. While, only anecdotal information was available from growers on nutrient and plankton levels; limited quantitative data for select Puget Sound locations are available from Washington Department of Ecology (WDOE) (Jan Newton), PSI (Aimee Christy), University of Washington Department of

Oceanography (Rita Horner) and Evergreen State College (Gerado Chin-Leo). Water clarity and growth in other shellfish species are indirect ways growers can assess phytoplankton and nutrient levels. Phytoplankton are seasonally abundant in most of Puget Sound, but especially in South Sound. Growers prefer locating their farms in the South Sound region because of this detail. South Sound is thought to have such an ample supply of nutrients that increased geoduck aquaculture is viewed as a way to reduce the potential of nutrient overloading. The northern regions of Hood Canal are also considered suitable since phytoplankton is made available from strong mixing and tidal currents. While abundant in nutrients, other regions of Hood Canal may produce slower growing geoduck due to low mixing.

Elevation: Tidal elevation is closely evaluated by growers, especially at the times geoduck are out-planted. Some growers are limited to certain bottom elevations due to the presence of eelgrass or poor substrate in otherwise suitable elevations. Most growers agree on suitable ranges. For intertidal culture, they focus on +2-ft MLLW (Mean Lower Low Water) to -4-ft MLLW or extreme low water. If ground is available, some growers will extend their planting from the upper +2-ft MLLW elevation to +4-ft MLLW. These higher elevations are not ideal, as they will produce a slower growing geoduck; however, they are used when other ground is limited.

Subtidally, growers would like to stay in the phototrophic zone of -4-ft MLLW to -25-ft MLLW, but are willing to go deeper to -70-ft MLLW or, for one grower, as deep as -120-ft MLLW. In staying in the phototrophic zone, growers believe geoduck will have access to an increased supply of food (both phytoplankton and benthic microalgae) and exhibit faster growth than geoducks in deeper waters where there is reduced light penetration. However, one grower observed that the phototrophic zone may need to be avoided due to higher levels of macroalgae and eelgrass (*Zostera marina*) at these bottom elevations.

Biotoxins: The presence of marine biotoxins, Paralytic Shellfish Poisoning (PSP) in particular, is a major siting consideration for most growers. A majority of growers will reference past records and historical data on PSP closures before leasing or purchasing a site. There is a fear the PSP closures are spreading to areas that once were free of the toxin. Certainly, PSP levels will be closely watched and highly valued siting criteria. Growers in WA that are affected by PSP have to submit to increased and costly monitoring. Harvest restrictions may prevent them marketing product during periods of high demand.

One grower suggested that there are other ways to circumvent this problem as Alaskan geoduck harvesters have done in the past. In most instances, he stated, the toxins lay in the liver and intestinal organs or "gut ball" of the geoduck. This gut ball is taken out and the remaining geoduck is sold to the Asian market for a lower price. This process enables harvesters to work during seasons when PSP is prevalent, thus providing stable jobs and a more constant supply of geoduck to the market. However, this observation is not consistent with the ongoing Washington Department of Health (WDOH) practice to assess harvest risks and PSP closures based upon whole animal samples.

Human influence: If possible, it would be desirable to stay away from large upland human populations and access points. Bacteria from septic systems can close beaches and people have a history of trespassing, poaching, and vandalizing geoduck grow-out areas. Areas with histories of health closures must be avoided or assessed with great care. The WDOH is the lead agency in

charge of certifying beaches for harvesting by issuing a required Heath License, and staff can be contacted directly regarding commercial requirements. Additional information is available at: http://www.doh.wa.gov/ehp/sf/Commercial.htm. Sites that are conditionally opened to harvesting (harvest is not allowed during periods of heavy rainfall or sewage overflows) may still be of interest to geoduck growers due to other favorable siting characteristics such as substrate and proximity to other operations.

Proximity to access points such as state parks should be avoided as people have a history of trespassing onto private geoduck ground to dig up geoduck adults and seed. Areas that have closed or limited access have few or no incidences of this behavior. Upland owners who lease their tidelands to geoduck farmers or are provided access rights will more than likely be concerned about new development taking place on what they consider "their" beach Communication with upland owners is important in establishing healthy relationships where concerns can be voiced and resolved amicably.

Growers should also employ husbandry practices that reduce the chance of confrontation. Some beach users may not like to see the expanse of white tubes on the beach especially when it is concert with increased noise from cars, people and harvest pumps. Farm debris and trash is another major concern, as it can accumulate quickly if not policed. Possible sources include: floats, mesh, stakes, rope, tubes, lines and cigarette butts. It is up to the farmer to keep abreast of potential farm waste and trash problems, and to retain acceptance of upland owners and other land users. Since farm waste is most noticeable in intertidal areas some growers believe that its effects will be reduced if geoduck are farmed subtidally. Unfortunately, they noted if farm waste is not controlled on-site it can eventually wash up on the adjacent beaches, plus it is harder to police subtidally due to money (diver) constraints. Perhaps, they observed, the DNR Codes of Practices or BMPs for geoduck aquaculture should include provisions for site clean up, noise control, and other possible human activity.

Current (water velocity): This criteria was deemed critical by interviewed growers. While increased water currents and tidal flows appear to enhance geoduck growth by boosting food availability, too much current can also become a problem. Strong currents may bury, dislodge and wash up predator exclusion devices. Moderate currents are favored by most growers for the above reasons. Exact velocity information is not available and has not been measured on farm sites; however, all of the existing intertidal farms are located in areas of low to moderate velocities with primarily long-shore water currents.

Wind/Wave action: While wind and wave action can influence currents, which is critical to site selection, little thought has been put into other possible benefits or detriments. Wind waves and boat wakes are a primary concern during planting and must be avoided. Seed can be washed out of planting tubes by very modest wave activity. One grower suggested that areas that are heavily influenced by wind accompanied with a large fetch can result in problems during growout. The resulting wave action can increase sediment movement similar to the affect of strong currents. Predator netting can also be torn off of PVC tubes if wind and wave action is strong. This results in a loss of predator exclusion protection as well as a trash problem that must be addressed to avoid a negative public image. One the other hand, one grower stated that areas with large fetches and southerly wind exposure were good as they provided warm surface water to intertidal geoduck grow-out areas. Overall though, most growers avoid areas that are influenced by wind over a large fetch since this can produce increased and undesirable wave affects.

Existing Geoduck Populations: The presence of an existing or nearby wild geoduck population is seen as a positive characteristic. This provides an immediate and definitive answer as to whether or not geoduck will grow in the proposed planting area. Growers noted that areas without wild populations on site or nearby may still have potential (see the Geographic Region section) and suggested it may be wise for DNR to consider such areas to avoid compensation and chain of custody issues.

Ulva/Enteromorpha: Macroalgae, specifically *Ulva* and *Enteromorpha*, have caused operational problems in the past as they are prone to settle on predator exclusion devises. High densities of these macroalgae can decrease circulation of food which in turn can decrease geoduck growth. Also, when the macroalgae die and decompose the resulting low oxygen and hydrogen sulfide (H_2S) rich conditions can cause seed and juvenile mortality, and the discoloration of harvestable animals. While it is thought nearly impossible to avoid areas where macroalgae will settle, there may be areas where it is less abundant and less of a problem. No one presented a clear understanding of criteria to determine where these areas are located

Geographic Region: A majority of established geoduck growers preferred sites located in south Puget Sound (SPS) and it is of no coincidence that a majority of geoduck operations are located is this region. The proximity to current culture operations is certainly a deciding factor for growers, as this reduces travel time and cost by eliminating the addition of infrastructure to other areas. Some growers have noted that SPS DNR beaches and subtidal areas hold similar promising characteristics. As noted above, food (phytoplankton) in SPS is abundant and in some cases overabundant through nutrient loading from increasing human populations. SPS also has substantial concentrations of wild geoduck -- a promising characteristic for farm siting.

Successful pilot scale operations have also been located in Sequim Bay and Thorndyke Bay (north Hood Canal). Sequim Bay and the nearby Dungeness spit present favorable farm siting characteristics, including the presence of wild geoduck, an adequate food supply, good infrastructure, and generally suitable substrate. While south and central Hood Canal is considered less suited to geoduck culture due to minimal mixing and slow growth, north Hood Canal has better potential since it is subjected to increased mixing and currents. Substantial wild populations are present in this area, which increases the likelihood it may be suitable for geoduck farming operations. There is also recent interest in the Hood Canal region to apply subtidal geoduck aquaculture as a tool to remediate nutrient overloading and worsening low dissolved oxygen levels

North Puget Sound wild geoduck populations are lower than SPS, although there are large areas of suitable bottom habitat. The decreased wild populations may be a result of lower salinities from major rivers in the region or the abundant population of Dungeness crab which prey on geoduck. One grower believed that low salinities may only be affecting wild geoduck recruitment and that hatchery seed could be acclimated to lower salinities before out-planting. To overcome Dungeness crab predation, [illegible] suggested one could protect the geoduck as they do in current operations.

Progress in Subtidal Culture

Subtidal planting of geoduck is still in the experimental stage in WA but new technology has recently been developed and subtidal trials have been initiated. Subtidal test plots in South East AK have been planted in 2002 with additional subtidal tenures just opening up to aquaculture. The Underwater harvesters Association (UHA) and FAN Seafoods Limited (FAN) in BC have 10 and 11 years respectively, of subtidal planting experience. Accordingly, the majority of information on subtidal culture methodology is a result from discussions with BC geoduck interests.

Washington: Washington experimental sites are very limited. Of the information gathered, only 3 growers have experimented in subtidal culture. Growers have used paper and PVC tubes and large Vexar® netting. One grower has developed a prototype seeding machine while another has access to a BC based machine.

While expensive, time intensive and laborious, PVC tubes have been used subtidally and have delivered some success. From the small data collected from one grower, it was found that survival rates were excellent in 2" tubes (75%) and good in 4" tubes (50%). Other growers did not reveal survival rates for PVC tubes.

Some success was seen during limited trials in the use of paper tubes to protect geoduck from predators. However, the paper did not biodegrade as hoped resulting in the blacking of the geoduck necks. This discoloration is a major concern for any geoduck farmer as it will greatly reduce the market value. Paper tubes may become an option in the future, and are still of interest to some growers, if a source of biodegradable tubes is found.

Covering areas with mesh for controlling predators is becoming a popular experimental method subtidally. Long tracts of netting 14-ft in width and 3,000-ft in length are being tested by one individual, who had no information on survival rates. Floating ¾-inch mesh netting has also been utilized in subtidal experiments and survival rates are expected to reach that of PVC tubes. Fouling is considered an issue in using large amounts of mesh as macroalgae has been known to attach to netting in intertidal areas causing flow and hydrogen sulfide problems. This has not been the case in the few subtidal experiments so far, so current results have been encouraging.

Many growers are anxious to see if subtidal planting via machine is feasible. Most are not willing to invest in the technology until it is a proven technology though. One grower, who is developing his own machine, has planted 4,000 seed on intertidal ground during high tide during machine trials. Information regarding survival rates was not divulged. None-the-less, this grower is willing to rent out or license this machine to other growers. Another grower has access to perhaps a more advanced machine through a BC business partnership. It is very likely that this relationship will be further explored if subtidal leases are made available.

Alaska: Experiments in subtidal geoduck planting are in their early stages. Groups have been focusing on the use of heavy Vexar® netting to protect the geoduck from predators. This netting is expensive and may become an issue if costs become a problem. More information was sought for Alaskan subtidal methodologies but phone calls and emails to Alaska geoduck interests were not returned. A paper regarding the final decision of leasing subtidal areas to Stephen Lacroix, a

major geoduck aquaculture interest in AK was acquired through an internet search. This paper, from the State of Alaska Department of Natural Resources Division of Mining, Land and Water South Central Regional Land Office (attached), describes methodologies for the proposed subtidal lease:

Geoduck were proposed to be planted at a depth of -40-ft to -60-ft MLLW over a plot 597-ft x 359-ft x 502-ft x 253-ft in size. Predator control methods were to utilize 2-inch square by 6-inch long tubes space 1-ft apart. Geoduck were to be planted via diver at 2 to 4 per tube. After planting, areas with tubes were to be covered with ½ to ¾-inch mesh held down by stakes Corners of the planting areas were to be marked on the surface using buoys. Survival results obviously are not available since this operation is still in its early stages.

British Columbia: Some subtidal plantings have been successful in BC where mechanized seeding is preferred. The key players are the UHA, FAN, and Manatee Holdings Ltd. (Manatee). FAN is the only large tenure holder of subtidal lands. The UHA is a cooperative of every wild BC geoduck harvester. Only holders of an Individual Vessel Quota (IVQ) are able to harvest geoduck in BC, currently there are 55 IVQ holders. IVQ holders were determined when the wild geoduck shifted from an open fishery to a quota fishery. Most involved in the wild fishery were allocated an IVQ, in essence a 1/55 cut of the fishery. The UHA has been planting only on common resource grounds while Manatee has a small nursery tenure. There may be more leases available in 2005 but there is concern that additional leases will eliminate wild fishery ground which would directly affect UHA member fishing quotas. Establishing a stable hatchery system is needed for the advancement of this industry as US seed has been too expensive and difficult to acquire across international borders. Every key player has at least attempted to establish a hatchery system to provide seed for their efforts, but as of January 2004, there was not a successful geoduck hatchery in operation in BC. This is largely due to the high start up and operating costs and the lack of technological advancements. However, hatcheries are still of interest to all the major parties in BC and operations may start up again soon.

FAN, the leader in subtidal aquaculture, started operations in 1993 and holds most of the subtidal tenures. Unfortunately representatives were not interested in providing specific details, but information was gathered via other sources. FAN has 5 subtidal tenures established 9 years ago and totaling 86.5ha (213.8 acres) in the Strait of Georgia east of Vancouver Island. The tenures had to be harvested or "purged" of wild geoduck populations before seeding could be initiated. Geoduck were purged by UHA members and applied to their IVQ. A particular purge operation, initiated in 1994, took 4 years to accomplish due to the fact that after the majority of geoduck were harvested; there was little interest in harvesting in areas that had low geoduck densities. Harvesting in these areas would decrease harvester's catch per unit effort thus reducing the profit gained. Still, there are contentions from members of the UHA that wild geoduck remain in the area and should be included in the overall wild geoduck biomass predictions and not be harvested by FAN.

FAN has worked with Island Scallops in the past to produce geoduck seed. While successful in producing seed, Island Scallops decided to abandon its geoduck hatchery operation due to financial constraints. Subtidal planting was first initiated 9 years ago and planting and protection methodologies have been evolving ever since. FAN employs a partially mechanized method of planting and reports a 30 to 60% survival rate. Planting only takes place during certain times of

year to avoid predators. Nets are used for predator control and are kept in place for 18 months to ensure maximum survival. Proper planting densities are still being assessed.

Currently FAN is in their 3rd year of harvesting 6 year old geoducks averaging 1.5lbs. The ideal target weight for harvesting farmed BC geoduck is 1kg (2.2 lbs) but FAN harvests at a smaller size primarily to provide income to cover expenses. It was suggested by another BC representative that it is a direct result of FAN not selecting particularly good sites.

The UHA's main focus in planting geoduck is to enhance common resource grounds. The UHA so far has planted 25 million geoduck on these grounds over 13 sites in the Strait of Georgia. Surprisingly, there is no guarantee that these areas will be open to UHA harvest in the future. The UHA is resistant to subtidal aquaculture and considers their plantings as enhancement of wild grounds. They contend that it is too costly for aquaculture to be successful, as it is too expensive to produce seed, plant and operate the farm. Also it is great financial burden to take on initially as it will take 8 to 10 years until a profit is seen. Although these points are valid, it should be noted that UHA's position, along with others, may be biased as opening up additional subtidal lands to aquaculture may decrease their fishing quotas.

Hatchery development is in the works for the UHA, although some problems have been rumored. In the past, the UHA has purchased geoduck seed from BC companies such as Island Scallops which no longer is a geoduck seed supplier. Even though it is expected to take 8 to 10 years of growth to produce a harvestable geoduck, UHA representatives have said this to be acceptable since the areas that are planted were of need of wild recruitment. The UHA have been working with several seeding and protective methodologies. Machine seeding is the sole method of planting, but there are variations of its use.

Early protective methods employed protective mesh placed directly on the seeded ground. A machine would seed an area while dragging protective netting to cover the just seeded area. The netting was then held in place with rebar. The netting, made up of light plastic was 4 feet wide and 328 feet long. Netting was to cover the geoduck for 16 to 36 months. While protecting the geoduck from predators, it did not allow geoduck necks to grow freely and in some cases necks grew into the mesh. Mesh is now taken off of these areas earlier than expected due to that difficulty. The presence of kelp prevents this problem as when it is attached to the mesh, it promotes enough net movement that the necks don't grow through. Rather than rely on luck, another method was developed to completely solve this problem. This method is the current one being employed by the UHA.
Seed are planted by dropping seed via machine over a Vexar® netting canopy that is held into the substrate using rebar. By using a canopy, geoduck are able to freely move their necks without the possibility of being caught up in the mesh. The size of the netting is similar to the one used in previous trials, 4 feet wide and 328 feet long. Target densities are at 2 yd^2 or .22 ft^2 with planting rows spaced 5 ft apart. The seeding machine is said to be able to plant 20,000 to 100,000 geoduck onto the surface per day.

Manatee currently is focusing on acquiring lands for tenure and is in the process of shutting down their hatchery operation. The hatchery operation had been producing seed for 3 years and may be operational next year, depending on land acquirement. Presently, they only have a small tenure solely as a nursery to store and grow 500,000 seed until out-plant. Manatee is pressuring the Department of Fisheries and Oceans Canada (DFO) to open up an additional 20 ha (50 acres)

on common resource land, not only for themselves but for others as well. They are promoting the establishment of an aquaculture park where other interests (1st nations, non-profits, fishermen, aquaculturists, etc) could get involved in geoduck aquaculture. Sites for this "park" have been surveyed under a joint venture with groups forming the Alliance of Independent Companies (AIC). For more information regarding this aquaculture park please see the attached, "Chain of Custody Conference Paper" authored by Eric Gant of AIC. Another topic of interest in this paper is that of sea otters. Manatee contends that sea otters are a major problem for wild harvesters and growers in BC waters. In the "Chain of Custody" paper it is detailed that sea otters should be eliminated inside the aquaculture park

AIC was formed to further develop underwater seeding gear and to solve seed and hatchery problems. Companies involved in AIC contain two 50% shareholders where Manatee is one and the other is another aquaculture interest. In agreements between the companies, Manatee is designated to be the major supplier of seed and will be in charge of seeding. The other shareholder is designated as being in charge of the overall growout operation on yet to be determined lease/tenure sites. Manatee is very interested in shifting its focus from BC to US waters if DNR opens up lands. Manatee has formed a joint company under AIC with a SPS grower and is willing to share information if subtidal lands become available.

When areas are opened up to plant, Manatee plans on planting at lower densities than are currently in practice. At these lower densities, which will be similar to wild harvest densities, it is thought that growth would be increased and mortality decreased. Manatee contends that their survival rate is at 50% and grow-out cycle will take 7 years.

Interest in Future DNR Leases/Studies:

All interviewed Washington geoduck growers expressed interest in DNR geoduck aquaculture leases and/or pilot projects in the near future (Table 1). Some concern was expressed regarding the overall process and possible fee structure. One grower suggested that the lease process should be similar to that of AK subtidal leases. Only one Washington grower did not want to participate in pilot scale projects with DNR. The remaining growers were willing to participate in intertidal and subtidal experiments if pilot leases could be available at no or minimal cost. Smaller, start-up companies also showed interest in leases and pilot projects but could not provide further details.

Table 1. Grower/tribal interest in a geoduck pilot project or leases, rated in level of interest from 0 (none), 1 (moderate) to 2 (highest).

Company:	Intertidal Pilot Project	Subtidal Pilot Project	Intertidal Leases	Subtidal Leases	Area
Chelsea Farms	2	1	2	1	South Sound/ North Hood Canal
Hama Hama Co.	2	1	2	1	Hood Canal
Seattle Shellfish LLC	1	2	2	1	South Sound
Washington Shellfish, Inc.	0	2	0	2	South Sound
Arcadia Point Shellfish	0	0	2	0	South Sound
Baywater Inc.	2	1	2	1	Hood Canal/Puget Sound
Sound Shellfish	1	2	1	2	South Sound
Taylor Shellfish Farms	2	1	2		South Sound
Jamestown S'Klallam Tribe	2	1	2	1	Dungeness Spit

Conclusions

Siting: Table 2 summarizes siting criteria that apply to both subtidal and intertidal geoduck aquaculture. Substrate, nutrients, phytoplankton, and geographic region were identified as vital siting characteristics by all geoduck interests interviewed. While the proper substrate properties, 3 feet of sand, can be found in all regions of Puget Sound, SPS is preferred by many growers as it has abundant seasonal phytoplankton levels and is close to many current operations.

Additional criteria such as Salinity/Riverine Influence, Elevation, Biotoxins, Human Influence, and Currents where highly regarded. Areas that have limited low salinity and riverine influences, a wide range of useable elevations, no history of PSP closures, decreased human interaction, and with moderate currents will be highly valuable. Characteristics that were deemed not as vital included: Temperature, Wind/Wave Action, Geoduck Populations, and Ulva/Enteromorpha. In determining a proper site these criteria should be factored in as long as they do not interfere with more important criteria. While ph and dissolved oxygen levels may be key grow-out issues in the future, sites selection is not presently based on their levels.

Examples of Proven Intertidal Sites: A majority of areas that growers recommended as proven to grow geoduck effectively intertidally are located in SPS. Specific areas include: Eld Inlet, Totten Inlet, Hartstene Island and the Purdy spit. Other sites beyond SPS include Sequim Bay and Thorndyke Bay in northern Hood Canal. One grower suggested that any area with the right substrate will work, and one does not need to know other aspects of site suitability. Another suggested that all areas that are close to existing commercial sites should be considered by DNR for lease as they hold the most promise.

Examples of Proven Subtidal Sites: A small subtidal area adjacent to Purdy spit is also now being farmed in Washington State. Several subtidal sites have been established harvested in British Columbia east of Vancouver Island in the Strait of Georgia.

Table 2: Summary of siting criteria with priority scale: 1 (low priority) to 5 (high priority) and related key components.

Criteria	*Priority*	*Key Components*
Substrate:	5	High Percentage of Sand, Depth (3 ft)
Temperature:	3	Low Surface Water Temperature, Low Ambient Water Temperatures
Salinity/Riverine Influence:	4	Salinity above 26ppt, Freshwater Avoidance
pH/Dissolved Oxygen:	1	None noted
Phytoplankton/Nutrients:	5	Abundance
Elevation:	4	Intertidally: -2ft to -4ft MLLW, Subtidally: -4ft to -25ft MLLW
Biotoxins:	4	No PSP History
Human Influence:	4	Limited Access Points, Proper Husbandry Practices
Currents:	4	Moderate Current
Wind/Wave Action:	3	Small Fetch
Geoduck Populations:	3	Presence
Ulva/Enteromorpha:	3	Avoidance
Geographic Region:	5	Proximity to Current Operations, South Puget Sound preference

Subtidal methodologies: A recurring comment from those involved with subtidal aquaculture is that there is need of improvement. Subtidal planting is in it's infancy in Alaska and Washington. BC interests have developed a great deal of improvements but still are aware of their limitations such as a longer grow-out cycle, predator control, fouling, stable seed supply, and ownership issues.

It is possible for Washington growers to make rapid advancements in subtidal geoduck culture based on their dive harvesting experience, connections with BC interests, subtidal small scale trials and intertidal culture knowledge. Washington growers possess the infrastructure to begin subtidal geoduck culture. Geoduck seed supply is not as limited as it is in BC, and several producers have excellent research capabilities.

Figure 2. . Seeding and harvest. A. Large-scale seeding of tubes in a south Sound intertidal site. B. Close-up of planting process. C and D. Experimental harvest of near-market-ready geoducks using a hydraulic water jet at an intertidal site in Hammersley Inlet.

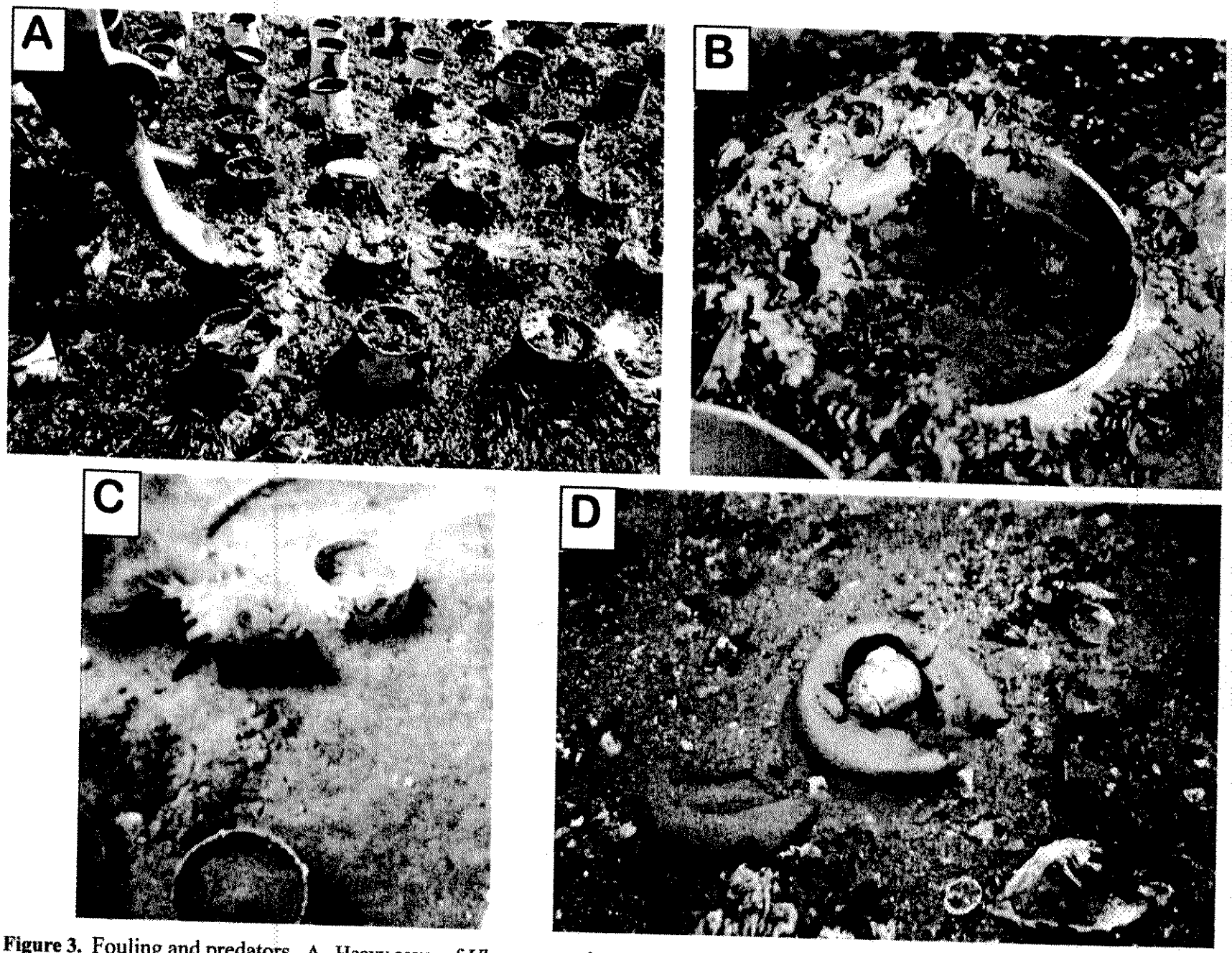

Figure 3. Fouling and predators. A. Heavy cover of *Ulva* on recently seeded tubes, Nisqually Reach. B. Close-up of the same with an extended geoduck siphon. C. Starry flounder exiting a tube, from video, Stretch Island. D. Moon snail with egg case.

APPENDIX 1

Transcripts of interviews with growers and biologists

Role in Geoduck Aquaculture: Researcher/Biologist for WDFW and Dive Crew Leader/Consultant

Siting Criteria

Substrate: Sand is the best, low levels of mud ok. Should be at least 3 feet deep of said substrate, other wise you will not get good growth and will be more vulnerable to predators. Same for both sub and inter tidal areas.

WQ: High temperatures can kill seed while out planting. Geoduck are cold water critters, 75*C and below is ok, but 75*C and higher results in mortality unless planting through the water column getting away from the initial heat shock of the incoming tide. Getting away from using tubes and using net may circumvent some temperature problems but predators can hide under the net, and in the substrate (crab, moonsnails) while the net is put on. Low salinity may have an effect.

Elevation: +2 to extreme low water for intertidal areas extreme low are harder to harvest though. For subtidal areas, any area from +4 to -70 ft would work. Wild geoduck populations increase density with depth but also get smaller with depth. This increase in density may be a result of increased predation in shallower areas.

Geographic Region: Central to South Sound are the best as they are proven and have wild stocks. The North Sound has a lot of great substrate but low wild geoduck populations which may be a low salinity consideration that only affects the embryos. Hatchery seed may be ok in this environment since they are big enough to withstand some lower salinities. Dungeness populations may be another reason why wild populations don't flourish in the North Sound, so protect your geoduck with screen or mesh. Hood canal may be a consideration to reduce nutrients but still have a huge circulation problem.

Human Influence: Stay away from large upland influences. Bacteria from septics and other human influences can become problems. Stay away from state parks as you will have problems with people coming over and digging. This has happened in some commercial beds already.

Oceanic Influence: N/A

Freshwater/Riverine influences: Low salinity may have an effect.

Nutrients or Plankon: Not a problem in South Sound, there maybe too much. Too many people increase our nutrient loads, so need shellfish!

Current: Very important, need moderate current. Not too fast or too slow.

Wind/Wave action: If there is too much of a fetch in one area you will have a problem with sand movement.

Examples of Proven sites: All Taylor and Seattle Shellfish Operations. Hartstine (subtidal and intertidal), Eld and Totten inlets.

Other: For DNR's perspective it would be wise to site areas that do not have wild stocks, but for the grower, it would be better to have areas that do. Ulva and enteromorpha can create problems as they can decrease circulation which in turn decreases available food, also when these plants decompose, H2S can settle inside the tubes. Try to find leases that don't have too much of a problem with these macroalgae, most sites have it but some have it in abundance.

Predation:

Predators and their effects: Mostly seed predation, but some can kill adults. Starfish can target medium to large geoduck that can't get down to 3 feet (1 meter). So substrate is consideration, since if geoduck can't get down to the refuge zone they have a higher probability of being preyed upon. There is a constant low level of predation until harvest time, look for pits (cone shaped) and will find an anesthetized siphon on occasion. Predation maybe a combination of diving ducks then crabs at high tide. Putting mesh (old salmon farm netting) on the whole area after pulling tubes might work.

The primary consideration is predator control, which should only be removed after it is causing a problem (tubes are being pushed out). Remove net only when it is causing a circulation problem, and then recover with larger mesh (salmon netting).

Moonsnails:

Cancer Gracilis: Will eat geoduck if predator net is taken off too soon. As they can get inside the tube. Will only eat tissue.
Cancer Magister: Will only eat tissue.
Cancer Productis: Will only eat tissue.
Pisaster brevispinus: Will target all sizes of geoduck.
Pycnopodia helianthoides: Will target all sizes of geoduck.
Flatfish (soles, Starry flounder, etc): Will take whole geoduck.

Siphon Snipping: Huge concern. Mainly juveniles, after tubes are pulled during/after the 2nd year until harvested. So, whenever protection is gone, snipping will occur even if at just a minor level. Has seen a siphon tip in a dogfish gut.

Birds: Most likely Scoters, as they probably rip out seed and siphons but hasn't seen. Gulls and Crows are also probable seed and siphon scavengers.

Environmental Factors: None known, most factors are farming related. How and how long you protect the geoduck.

Locational Effects: Yes but it is very complicated, each bed is different. There are differences on even the same bed.

Geographical Effects: It is very site specific. Hard to quantify.

Timing of Year: Early spring and fall are usually a time of higher predator abundance. But has not been out on winter tide to assess damage. During the first year of net recovery.

Other Operational Considerations:

Optimal Planting Density: The closer they are the smaller they will be. Conducted a grid study looking at these differences. He actually saw differences on geoduck to geoduck level. SS has used 4" tubes with 1 foot spacing, giving 4 per square foot. SS is now planting 2-3 per square foot.

Optimal Harvest Density: SS is looking for a 2 per square foot harvest density. Maybe 1 to 1.5 per square foot. This depends on site considerations: food, current, and predation.
Densities Site Specific: YES

Toxins: PSP is minor problem now but its range is increasing. Will have to work to avoid areas affected.

Depuration: WDFW lab was able to depurate for human sewage in 2 days.

Subtidal Planting Techniques: Yes they work.

Hand Seeding: Is very expensive and slow when using tubes but there is a lot of land available.

Survival: Over 18 million geoduck were seeded over several years for 100 unprotected experiments. Seeding worked in Arcadia with out protection so decided to try it again but never was able to successfully plant after the Arcadia experience.

Scatter Seeding: Not protecting the seed does not work!

Machine Seeding: Canadian machine works well, but does not have first hand knowledge.

Environmental Effects of Production and Harvest:

Influence of Predation exclusion devices:

Species Abundance/Diversity: Ulva, enteromorpha, laminaria, and broad leaf fauna attach to the tubes. Geoduck fertilize eelgrass. No study has been conducted looking at juvenile salmonid food influence, pro or con.

Sand flats do not have much biomass on top which is visible. Aquaculture increases the visible biomass and biodiversity. Mussels, barnacles, ulva, etc. In the substrate though, not much is changed.

Do not lease out areas that contain eelgrass as the eelgrass will be damaged during harvest.

Harvest Practices: Sediment plumes increase turbidity and displace sediment into the water column. Maybe loose a small portion of the fines. Harvest kills ulva, enteromorpha and other benthic organisms but this effect is short lived, around 1 year. Overall harvest will reduce the species diversity for a short while.
Oxygen is added to the substrate by harvesting which may increase species diversity for species of interest to man.
Dungeness will leave during harvest but will come back to disturbed areas as soon as human leave.

Genetics: Studies have found that there are no genetic specific populations. But, it is important to always use wild broodstock (from anywhere in WA), never use hatchery raised broodstock since the use will keep narrowing the gene pool.

Sediment: Harvest effects, may loose some of the fine material.

Other: People do not like all the white tubes, pump noises, cars, increased number of people, boats, trash, etc. on the beach. Workers can sometimes use profanity. Trash is a big issue as floats, mesh, stakes, ropes, tubes, lines, cigarette butts, etc can wash up on the beach, it is important for the farmer to keep ahead of the trash in order to be a good neighbor. Even shallow subtidal areas can deposit trash on the upper beach with good wave action. Subtidal areas are less visible which can be good and bad, good that upland owners can't see but bad since the farmer can't see as frequently either.

General:

Studies: Will send us a list of his publications. He has conducted a species profile paper. DNR and Fisheries papers, and 40-50 internal use papers.

Roles in Geoduck Aquaculture: Farmers -- Dual Interview

Farming:

Duration: 1999 to present (5 years)
Depth: Intertidally for only one planting, -2 to -4 MLLW
Location: Hood Canal

Siting Criteria

Substrate: Sandy
WQ: N/A
Elevation: Limited by substrate; has planted from -2 to -4 ft.
Human Influence: N/A
Oceanic Influence: N/A
Freshwater/Riverine influences: Not seen, area is highly influenced by the large river.

Nutrients or Plankon: Yes, important but has yet to deal with specifics. Food is limiting factor in the Canal. Oysters take 6 years to get to market size. Clams take up to 5 years.

Current: Yes, important but has yet to deal with specifics.
Other: N/A
Examples of Proven sites: N/A
Geographic Region: N/A

Predation:

Predators and their effects: N/A
Siphon Snipping: N/A
Birds: N/A
Environmental Factors: N/A
Surrounding Specie Influence: N/A
Planting Density: N/A
Neighboring Populations: N/A
WQ: N/A
Locational Effects: N/A
Planting Elevation: N/A
Other: N/A
Time of year: N/A

Other Operational Considerations: N/A

Optimal Planting Density: N/A
Optimal Harvest Density: N/A

Densities Site Specific: N/A
Toxins: N/A
Other: N/A

Subtidal Planting Techniques: N/A

Environmental Effects of Production and Harvest: N/A

Influence of Predation exclusion devices: N/A
Species Abundance/Diversity: N/A
Harvest Practices: N/A
Sediment: N/A
Other: N/A

General: N/A

Studies: N/A

Future: Interest in planting out more geoduck but has to pass idea through the board.

Private land:

DNR Land: Interest in planting out more geoduck but has to pass idea through the board. Either sub or intertidal.

DNR Pilot Project: Interest in planting out more geoduck but has to pass idea through the board. Either sub or intertidal.

Role in Geoduck Aquaculture: Tribal Biologist
Farming:

Duration: 2004 to present
Depth: Intertidal
Location: Sequim Bay

Siting Criteria

Substrate: A sandy substrate is preferred, this is key siting criteria.

WQ: N/A

Elevation: Currently planting at -1 to -2ft MLLW.

Human Influence: Septics a concern as they can fail and close beaches to harvest. Has not seen too much human influence on planted grounds due to limited access.

Oceanic Influence:

Freshwater/Riverine influences:

Nutrients or Plankon: Definitely a consideration, the more plankton the better.

Current:

Wind/Wave action: Has been a problem in the past as tube netting has been blown off the tubes.

Other:

Examples of Proven sites: Dungeness Spit and Sequim Bay. Good growth has been seen in Sequim Bay.

Geographic Region:

Other Operational Considerations:

Optimal Planting Density: Planting 4 per tube on 18" centers.

Optimal Harvest Density: N/A

Densities Site Specific: Assumes they are.

Subtidal Planting Techniques:

N/A

Environmental Effects of Production and Harvest:

Influence of Predation exclusion devices: N/A

Species Abundance/Diversity: N/A

Harvest Practices: N/A

Sediment: N/A

Other: Geoduck provide for better water quality as they are biofilters.

General:

Studies: None

Future: Interested in leasing DNR land.

Private land: no.

DNR Land: Is interested in leasing intertidal lands, more than subtidal. A intertidal lease of 5 acres would be a good start.

DNR Pilot Project: Is very interested in intertidal pilot projects.

OTHER: Is very new to geoduck aquaculture and would like to learn more. Previous Geoduck aquaculture experiments in Sequim bay was conducted by personnel that have left the tribe.

Role in Geoduck Aquaculture: Harvester/Farmer/Consultant/Seed Producer

Farmer:

Duration: Late 90's to present (~ 6 years)
Depth: 3rd year planting Subtidal (60%) and started Intertidal in late '90's (40%)
Total Acres: about 200 of total acres with litigation pending on some
Location: All over Puget Sound and Hood Canal (25 to 26 different sites)

Siting Criteria

Substrate: Real important, has had a UW graduate work on a sediment study for him looking at growth and digging. Conducts profiling survey of beaches using stainless steel pins. Grids out a beach using GPS, 300 feet transects, taking samples every 30 feet, then moving down the beach 30 feet.

WQ: Takes daily temperature, salinities, and pH readings at the hatchery. Also looks at ammonia levels.

Elevation: +1 on down, machine is capable of -120 feet.

Plankton: Looks at Plankton blooms at hatchery as well.

Geographic Region: Looks for Southern exposure so southerly winds bring warm surface water to intertidal area.

Human Influence: Gets a Health Department Certification

Freshwater/Riverine influence: Small creek areas good subtidally, (loaded with wild geoduck subtidally).

Current: Stays away from stagnant areas, looks for stronger currents which are good for growth.

Geoduck: Looks for geoduck proximity, subharvest levels important, if they are there, then it will be good site.

Proven Sites: Purdy Spit, DNR folks welcome to come out.

Predation: Mainly seed predation seen.

Predators:
Crab: seed
Starfish: seed/adults
Moonsnails: Siphon does not react to animal unless grains of sand go down the siphon…
Flatfish: Seed
Octopus: no

Birds: none noted

Siphon nipping: Not a concern

Locational effects: Yes, in the intertidal it is worse. That is why machine will work better as it can utilize the subtidal areas.

Other Operational Considerations:

Density: There is an optimal/maximum density. Look at what is present in the wild and consider lowering your planting density. Assess current and historical density information (.2 per ft^2 subtidally?). If more areas are opened, you won't have the areas that are too dense. Right now, intertidal planting is too dense, Doug plants a geoduck for every 2 square feet, on average. He then expects 50% mortality. More land is needed.

Harvest Density: 1 per 2 square feet.

Neighboring Geoduck populations: Important, if not already in the present area, they should be neighboring at least.

Depuration: Looking into heavily, assessing a hybrid semi-closed system for Fecals and PSP. Is in the process of getting patents.

Subtidal Planting Techniques:

Hand Seeding: Has used tubes with and without predator netting.
Survival: *Varies greatly, not willing to give details.*

Scatter Seeding: Yes, under Predator nets. 14' wide by 3000' long, holds down with stainless steel rods.
Survival: Not willing to give details.

Machine Seeding: Has conducted trials during a high tide on intertidal area. Seeded 4,000 geoduck.
Survival: Not willing to give details

Environmental Effects of Production and Harvest:

Exclusion devices: Devices catch things, tubes unsightly, gear gets loose on occasion. Subtidal tubes if left in for more than a year will create a reef system and provide anchorage for kelp which increases fish diversity.

Harvest Practices: Yes! DNR study of plumes and sedimentation is a joke. Only one (desirable to give + results) site was used, overall the study inaccurate and did not show enough affect. Harvesting tears up the ground and varies from site to site. Intertidally it tears up the beach. If you increase the land useage, you can decrease the density of aquaculture sites thus lessening the impacts. Need a study on the impacts of dragging of the hose. Water jets and hose denudes the vegetation.

Other: Substrate movement an issue.

General:

Scientific studies: Has completed studies and has in house documents. He is willing to sell copies of them. Studies are on hatchery and depuration techniques.

Future:

Private Lands: Possibly leasing or purchasing private lands.

DNR: Is interested but needs DNR to hurry up! State process is now driven by hypersensitive folks. Considers moving out of state to Alaska. Interested in Subtidal lands only, 3000 acres. Has submitted application for lands in the past, has sent in 70 applications twice.

Pilot Project: Very interested, has gotten the process moving.

OTHER:

Reestablish rate is flawed, and politically motivated. Need to assess actually recovery rate, when are geoduck coming back? Subtidal wild harvest 3 month rotation of harvest beds does not provide enough recovery time. Show data is flawed as well, needs a study to evaluate locational effects before putting the "show constant" (.75) into Bob Sizemore's equilibrium theorem.

Role in Geoduck Aquaculture: Geoduck grower
Farmer:

Duration: 11 Years
Depth: Subtidal, 86.5 ha
Location: Strait of Georgia

Siting Criteria

Substrate: Sand, Shell
WQ: N/A
Elevation: N/A
Human Influence: N/A
Oceanic Influence: N/A
Freshwater/Riverine influences:
Nutrients or Plankon:
Other: N/A
Examples of Proven sites: N/A
Geographic Region: N/A

Predation:

Predators and their effects: Moonsnails, crab, starfish
Siphon Snipping: Somewhat a concern. No differences seen in Juvenile or Adults.
Birds: N/A
Environmental Factors: N/A
Surrounding Specie Influence: N/A
Planting Density: N/A
Neighboring Populations: N/A
WQ: N/A
Locational Effects: N/A
Planting Elevation: N/A
Other: N/A
Time of year: N/A

Other Operational Considerations:

Optimal Planting Density: Still figuring out
Optimal Harvest Density: N/A
Densities Site Specific: Yes
Toxins: A concern, no depuration techniques available.
Other: N/A

Subtidal Planting Techniques:

Mechanized: Getting 30 to 60% survival. Predator nets are kept on for 18 months ensuring maximum survival.

Environmental Effects of Production and Harvest: N/A

Influence of Predation exclusion devices: N/A
Species Abundance/Diversity: N/A
Harvest Practices: N/A
Sediment: N/A
Other: N/A

General:

Studies: N/A
Future: N/A
Private land: N/A
DNR Land: N/A
DNR Pilot Project: N/A

Role in Geoduck Aquaculture: Farmer

Farming

Duration: 2004 to present (0 years)
Depth: Small Intertidal plot, will seed this year
Location: BC: Vancouver Island

Just getting started in intertidal farming so no information is available. Referred to Washington growers.

Role in Geoduck Aquaculture: Seed supplier, intertidal farmer

Farming:

Duration: 2000 to present (4 years)
Depth: Small Intertidal plot
Location: BC: Lasqueti Island

Started Hatchery in 1976, started producing geoduck seed 4 years ago, stopped this year due to $$ considerations. Stopped planting geoduck this year as well due to financial considerations. Site has not been too successful.

Unable to gather more information as further email/telephone communication was not responded to.

Role in Geoduck Aquaculture: Extension agent.

Siting Criteria:

Substrate: Sand is key. Mud and silty substrate might be ok.

WQ: Temperature is important, the colder the better

Elevation: +2 to -3 feet

Other populations: Presence of other geoduck populations important.

Predators: People have taken seed out of tubes in the past. Fouling an issue with Jingle shells (*Anomia simplex*). Otherwise, your standard predator will target geoduck.

Siphon snipping: Not seen.

Waterfowl: Possibly Scoters.

Terrestrial Birds: Not seen.

Other Operational Considerations:

Density: 3 to 5 per tube, with 1 ft centers during planting.

Toxins: PSP a consideration in some areas.

Environmental Effects of Production and Harvest:

Exclusion devices: Increase habitat for crab, jingle shells, sea weed, barnacles. This effect is site dependant

Epiflora: Maybe eelgrass.

Genetics: Need to use broodstock from area close to out-plant site.

OTHER:

Has assisted people grow geoduck for private use. Also has participated in out-plantings to reward public involvement. Uses geoduck for outreach and education: for "gee wiz" tool, for reminding of pollution impacts, and green aquaculture.

Is interested in continuing geoduck plantings, volunteers could learn from experimental plot planting. Intertidal areas would be ok for DNR to lease but subtidal maybe not. It may develop the fishery into a put and take fishery. Perhaps reduce the wild harvest to offset this effect. Kitsap EIS is online, DNR needs to have the ability to be proactive on some issues. Maybe consider reducing the number of areas that are harvested at one time. This would reduce the overall effect of suspension of sediments. Farmers not harvesters should be involved.

Polyculture: Would be interested in developing areas into polyculture not just the monoculture of geoduck.

Size: Leased sites shouldn't be too large, to avoid flooding the market with product. Perhaps reduce the wild harvest?

Carrying capacity: Study should be conducted for each bay regardless of cost.

Money Allocation: Money should go to other projects as well that are influenced by increased aquaculture: WDFW, DOH, Septic remediation, Oyster reserves fund. This should not become a business partnership with DNR and the industry

Role in Geoduck Aquaculture: Biologist

Planting:

UHA has been using subtidal planting machine as its sole method of planting. The machine plants between 20,000 to 100,000 seed per day in the subsurface. It drags a roll of netting behind it which covers the geoducks from predators. The netting is held to the substrate by using rebar. The netting, made up of a light plastic, is 4 feet wide and 328 feet long. The netting covers the geoduck for 16 to 24 months, or up to 3 years in some cases, depending on predators. It takes 8 to 10 years to have a harvestable geoduck. This is fine since most of the areas that are being seeded are also areas that are in need of recruitment.

Predation seems site specific but pre-surveys of areas for predators is fruitless as predators will travel to seeded sites. "As if a dinner bell has rung."

There has been trouble with geoduck siphons growing into the protective mesh. This is why the mesh has to be taken off. Problems can occurs when sand covers the net and the siphon must protrude through the net. Kelp growing on the net can help alleviate this problem as there is enough net movement to move sand under the net.

The split pea technique was used by hand seeders early on. Using split peas to mimic geoduck dispersal, divers found that the peas were readily taken up by flatfish. In order to reduce geoduck mortality the area to be hand seeded was first saturated by split peas. When the flatfish became full, the area was hand seeded with geoducks. Increased survival was not achieved since other predators came and ate up the geoduck seed. Every carnivorous sea creature likes them, tasty?

Nursery:

UHA does not utilize nursery techniques to bring up the size of their seed. They have conducted many trials using pearl nets, bags and pools and found them too labor intensive. UHA enhancement only employs 3 people.

Research needs:

Better hatchery techniques, to provide for a better, cheaper and faster growing geoduck. As of now there is no geoduck hatchery in B.C. This is due to the high cost of starting up and running a hatchery. A few are going out of business all together.

Establish and record geoduck genetic markers in order to follow recruitment patterns. This would enable people to establish how far and where geoduck larvae travel.

Unable to gather more information as further email/telephone communication was not responded to.

Roles in Geoduck Aquaculture: Farmers/Biologists -- Dual Interview

Farming:

Duration: 1997 to present (7 years)
Depth: Intertidally
Location: South Puget Sound

Siting Criteria

Substrate: Deep Sand.

WQ: Salinity should be above 26ppt and water temperature below 16*C while seeding.

Elevation: +2' to -2'

Human Influence: N/A

Oceanic Influence: N/A

Freshwater/Riverine influences: Avoids freshwater run-off areas for salinity and siltation issues.

Nutrients or Plankton:

Current:

Other:

Examples of Proven sites:

Geographic Region: Mostly Puget Sound

Predation:

Predators and their effects: Moonsnails eat siphons or cause the geoduck to move. Crab eat siphons or pull up entire geoduck if small enough. Fish may also be a predator.

Siphon Snipping: Is a concern, there maybe a difference seen in effect on juvenile vs. adult geoduck.

Birds: Scoter ducks pull up small geoduck or nip adult siphons. Seagulls, crows, and eagles are a predators as well.

Environmental Factors: N/A
Surrounding Specie Influence: N/A
Planting Density: N/A
Neighboring Populations: N/A
WQ: N/A
Locational Effects: Yes but details not known.
Planting Elevation: Those planted at lower elevation are hit the hardest.
Geography: Yes, crab populations vary from area to area.
Other: N/A
Time of year: N/A

Other Operational Considerations: N/A

Optimal Planting Density: 1.4 to 2 per square foot
Optimal Harvest Density: 1.4 to 2 per square foot
Densities Site Specific: Yes
Toxins: A concern, PSP has closed some beds. No depuration techniques known
Other: N/A

Subtidal Planting Techniques: N/A

Environmental Effects of Production and Harvest: N/A

Influence of Predation exclusion devices: They can cause an increased abundance of flora and fauna.

Species Abundance/Diversity: N/A

Harvest Practices: Predators probably move in to feed after an area is harvested, to pick up exposed clams and worms. Harvest produces some turbidity in the local area of harvest.

Sediment: N/A
WQ: N/A
Other: N/A

General: N/A

Studies: N/A
Private land: Plans on leasing private lands.
DNR Land: Might be interested.
DNR Pilot Project: Interesting South Sound Pilot project both sub-tidally and inter-tidally.

Role in Geoduck Aquaculture: Agency Biologists

Geoduck aquaculture discussion points: Road blocks, areas that we can learn from B.C. Other advice/suggestions/comments.

Tenures: Subtidal experimental sites were established by FAN seafoods 9 years ago in 80ha (197acres). All are -10 feet and below. Right now they are in their 3rd year of harvest of 6 year old geoduck which average 1.5lbs, a bit undersized but are needed to cover expenses. FAN has not been too willing to share information. There has been video assessment of the experimental sites.

Eric has a small experimental site and is more willing to share/participate in environmental studies. These sites have been set up for nurseries.

A third site 6ha (15 acres) has been opened by "Mr. Dan" who wanted to convert oyster ground to geoduck ground. It was found that there were wild geoduck populations on the ground even though the leasee stated there wasn't.

There may be more leases available in 2005 but this will reduce the wild fishery's allocation. There is a major concern that aquaculture will eliminate wild geoduck ground. UHA does not want to be displaced. DFO will be releasing a bed allocation paper in November using existing data and classifying harvest areas.

Purge Fishery: It is hard to fish out sites, as there are still issues to be discussed.

Intertidal: 1st nations are at 70% of intertidal shellfish sites as they have become more interested in aquaculture. There are a lot of headaches surrounding geoduck aquaculture and there is not enough information either. LWBC is not in a hurry to lease out lands unless there is a payback to the common good. So LWBC is on the fence waiting to see what happens on current leases. The Ministry of Agriculture Fisheries and Food's (MAFF) reserves are opening up for intertidal lands. FAN is diver bases so they don't have enough knowledge on intertidal lands or even farming. Intertidal farmers are not that educated or well off so are not having the best success. There are currently 4 intertidal sites that have not done well. There have been problems with tubes popping out due to wind exposure.

LWBC may not want to expand for concern of upland owners. Who is a better tax/infrastructure base? Shellfish farmers or summer time residents?

Polyculture: There has been a concern expressed by UHA (Michelle James) that LWBC leases of floating aquaculture is above geoduck beds. There might be a way to establish aquaculture at both levels, subsurface and in the water column. It would decrease costs and adding a culture method would be a smaller investment. (Ray) The possibility of moving the floating sites is of interest too to let the land lay fallow.

Eelgrass: Very important issue but DFO doesn't have the staff to check eelgrass and rocky habitats.

Role in Geoduck Aquaculture: Farmer

Farmer:

Duration: 2001 to present (3 years)
Depth: Intertidal
Location: Arcadia (North Totten), Totten

Siting Criteria: *Would not divulge any other information* except beach energy (wind/wave action) is an important criteria. Marginal beaches have increased wave action.

Predation: *Would not divulge any information.*

Other Operational Considerations: *Would not divulge any other information.*

Subtidal Planting Techniques: Does not have knowledge of techniques.

Environmental Effects of Production and Harvest: *Would not divulge any other information except* his concern over environmental issues. He would be choosy on which ones to pursue/study and have clear idea of what the outcome would be (positive). He would also be choosy in who (UW researcher etc.) conducts the research. Some may have an agenda.

General:

Would not divulge any other information besides the following:

Future: Interested in intertidal areas, but is flexible in size.

Private land: Is interested in leasing/purchasing intertidal lands.

DNR Land: Is interested in leasing intertidal lands. Depending on the cost. Would prefer sites in the South Sound due to transportation/infrastructure and other costs. Does not see a benefit in the DNR completing the permiting work. He would rather do that himself, which would give him and edge over others. Also he thinks that the work involved to get the permits will be passed on to him anyway. Suggests a lottery instead of a bidding war.

DNR Pilot Project: No

Others interested: N/A

Role in Geoduck Aquaculture: Director of Harvesters Association.

Geoduck Planting Involvement: 1994 to present
Depth: Subtidal
Location: BC: East of Vancouver Island in the Strait of Georgia

Sitting: Not much information out there, it is part of their experiment which has 13 sites along the straight of Georgia. Areas should be free of wild populations of geoduck. Looking at substrate as the key siting criterion.

Underwater Aquaculture of geoduck: It is possible but it is costly. There is a large seed hurdle in Canada right now, it is too expensive to produce the seed. Actually the whole operation is too expensive. Looking at a 8 to 10 year grow-out cycle which means there is a financial burden for many years before a potential profit.

Refered to enhancement biologist for more information.

Role in Geoduck Aquaculture: Farmer/Consultant

Farming

Duration: 1997 to present (8 years)
Depth: Subtidal (small plot) and Intertidal (60 acres)
Location: WA: Hartstene Island - /Totten Inlet/Nisqually/Eld - Hunter Point/Hartstene-Wilson Point

Siting Criteria:

Substrate: Stable Sand, 3 feet deep
WQ: pollution
Elevation: Lower (intertidal) the better, long sand flat, in the (subtidal) phototrophic zone -4 to -25

Geographic Region: South Sound
Human influence: Pollution
Freshwater: Yes, but smaller streams ok.
Nutrients/Plankton: Not a concern below the Narrow's bridge
Current: The more the better
Other: Avoid Eelgrass, large fetches = wave action
Proven Sites? Does not have to be proven to work. All intertidal with right substrate will work. Sub?

Seed Survival: Proprietary.

Predators:

Crab: Siphon Damage
Moonsnail: May dissolve siphon?
Seagulls: Intertidal
Crows: Intertidal
Flatfish
Starfish: Not seen, doubt the predate
Sea Otters: Possible in the Straight?

Siphon snipping: Is a concern if deep enough. Not a quality issue but a survival issue. Juvenile animals more vulnerable to snipping, after 3rd year you do not see as much of and effect.

Waterfowl: Scoters? Have not seen yet.

Terrestrial Birds: YES, crows and Seagulls (seagulls follow the crews around)

Locational effects: Yes, you see a geographic difference but for little reason, will not move, will just protect the geoduck longer.

Timing: Timing is and issue

Other Operational Considerations:

Density: Proprietary
Toxins: PSP is a problem, will try and stay away from problem areas.

Subtidal Planting Techniques:

Hand Seeding: Predator netting, 90% survival in first 2 years, nets taken off and 10% survival 1 year later. Siltation and fouling are big issues.

Machine Seeding: Canada UHA trials – dropping seed over vexar ($$) netting canopy, 18'' long, 4'' deep. Seeding rows 5 feet apart, density 2 per/yard^2. Looking at a 10 year harvest cycle.

Environmental Effects of Production and Harvest:

Exclusion devices: Create Habitat, 2* set of wild cockles and horseclams settle inside protected areas. Of course protecting them from predators. Creates habitat for fish.

Epiflora: increases with tubes and nets

Waterfowl and terrestrial birds: See more seagulls, follow geoduck crews.

Harvest Practices: See ENTREX study for siltation issues.

Other: Loss of .5% of nets can add up. Need to be proactive in tube recovery. Aesthetics of the before mentioned. Subtidal areas are beneficial as the public won't see the predator exclusion devices.

GENERAL:

Future Goals:

Lease Private lands: planning on ramping up production, acquiring more seed, 139000/10 acres. Need more acres, 20 more in 2006.

Lease DNR lands: Yes, it would be nice to have DNR out there because of their stature. Subtidal and Intertidal, subtidal 1*.

Pilot Project Interest: Subtidally to support of the process, but maybe not too much acreage. Intertidal, 10 acres.

OTHER

Canadians are ahead of the process where they have 2 experimental leases. AK has moved forward as well.

Subtidal: There is a need to make sure there is a good operator involved so you don't end up with a big mess. Stay away from wild populations as poachers will use lease to access wild geoduck. Avoid parks for PR reasons. Avoid macroalgae. Hood canal is a possibility.

Role in Geoduck Aquaculture: Researcher and Farmer

Farming: 1998 to present (company since 1989)
Intertidal Only, Thorndyke Bay

Siting Criteria

Substrate: Has not looked at too much, was lucky that his site is mainly sand with some shell that goes down at least 3ft. The drier the sand the easier it is to see the siphon, less alga and less pooling of water. So if had a choice would chose sand with a larger grain size that allows for drier sand. With wet sand, it is harder to see siphons.

WQ: Beyond predators, geoduck survive very well after initial planting shock. Heat may have and effect on survival during seeding, planting during times of high temperature increases mortality. Warm water (65-70*F) exposure stresses the seed resulting in death, has seed low (30%) survival due to warm water. This last year survival should be better (80-90%) as seed were not exposed to high temps, water was subjected to cooler (57-59*F) temperatures. Seeding is done in a 10 day window, there is improved success if seed immediately after putting in tubes. If not seeded immediately, organic material will settle in the tube. He does not know whether or not he should allow the seed to sit inside the tube. Seeding at the end of the tidal cycle reduces air/temperature exposures and allows the seed to acclimate for 8 to 10 days before being subjected to exposures.

Elevation: Seeds at +2.5 to -2.5 ft, stops at -2.5ft due to eelgrass and it is hard to get to. Never plant in a puddle or shallow dip area where water flow slows down or is trapped.

Human Influence: N/A

Oceanic Influence: N/A

Freshwater/Riverine influences: Salinity can be an important factor. But there may be a way to acclimate the seed.

Nutrients or Plankon:

Current: N/A

Other: N/A

Examples of Proven sites: N/A

Geographic Region: N/A

Predation:

Predators and their effects: Takes netting off the first year and has not seen predator effect afterwards. Has to leave tubes in for 3 years, if he doesn't scoters and flatfish may predate on the geoduck. This has happened in the past when he removed tubes after 1 year. Leaving tubes in costs money in materials and clean up.

Crab: Maybe, has not seen. Dungeness and Red Rock, will eat clams (manila) that settle inside the tubes.
Flatfish: Yes, they may target seed via snipping.

Siphon Snipping: Yes, it is important to protect geoduck from scoters and flatfish. Enough of the siphon was missing that the geoduck could not reach the water. Has had damage to 1 year old geoduck that were not protected.

Birds: Yes, Scoters may target seed via snipping.
Environmental Factors: N/A
Surrounding Specie Influence: N/A
Planting Density: N/A
Neighboring Populations: N/A
WQ: N/A
Locational Effects: N/A
Planting Elevation: N/A
Other: N/A
Time of year: N/A

Other Operational Considerations:

Optimal Planting Density: Has used 6" and 4" tubes, but now only uses 4". Has planted 5,000 geoduck per year. Starting planting with 1' centers in 1998, but after 1999 started using 1.5' centers. In 1998-99 planted 4 per tube but now only 3 per tube. Leaves tubes in for 3 years, tubes get messy after 3 years. Tubes tip over, fill in with sediment or pop out. So, would like to remove tubes in 2 years to get away from the above and to rotate his tubes to new plantings. He will have his first harvest (199 plant) in the spring of 2005. Takes netting off the first year and has not seen predator effect afterwards.

Optimal Harvest Density: Looking at 1.5 lbs after 6 years, density is a factor, there may be not enough food to go around.

Densities Site Specific: N/A
Toxins: N/A

Other: Usually the larger the seed the better but there is a limit. 10 to 12mm seed is optimal as they will dig in after 10 minutes. Larger geoduck may not burrow in as readily, and in some cases may not burrow in at all.
You need to clean the tubes before planting to reduce decay in the sediment.

Subtidal Planting Techniques: N/A

Environmental Effects of Production and Harvest:

Influence of Predation exclusion devices: N/A

Species Abundance/Diversity: Sees a large ulva and enteromorpha set in the summer. This can be a big problem as it reaches a critical thickness, it begins to rot and settle into the tubes. Geoduck can handle a certain amount of hydrogen sulfide but there is a limit. Too much settlement by ulva or enteromorpha may result in anoxic death to the geoduck. Grower has to hand pick off the ulva/enteromorpha. Has thought of a way to harvest the seaweed.

Has seen manila clams and horseclams settle inside the tubes.

Harvest Practices: N/A
Sediment: N/A
Other: N/A
Studies: N/A
Future: Interested
Private land: Interested

DNR Land: Interested in subtidal areas. More interested in intertidal areas on good ground.

DNR Pilot Project: Would like to be involved in the pilot study, via intertidal or subtidal.

Role in Geoduck Aquaculture: Harvester/Farmer/Consultant

Farming

Duration: 1987 to present (17 years)
Depth: Subtidal and Intertidal
Location: WA: Henderson Inlet/Eld Inlet/Hartstene Island/Totten Inlet
AK: South of Ketchikan

Siting Criteria:

Substrate: Sandy or Sandy with pea gravel / Needs 3 feet of unobstructed sediment (no cobble/shell/woody debris) / Color (black) is not much of a factor

WQ: Surface Salinities of 28 to 29 ppt. (over 26ppt at least) Puget Sound does not vary enough for concern if staying at the points.

Elevation: Varies, generally -3 to +2 ft, growth is slower above +2 feet. Subtidally look for where the food is, from intertidal areas on out. Slope is not an issue except a gentle slope provides for more area.

Geographic Region: Points of inlets where current is the strongest, tend to see more wild populations there. Look for presence of wild populations. Avoid where rivers come in.

Human influence: Concern of septic systems but DOH takes care of that. Need good relations with upland owner, no big problems yet beside verbal.

Freshwater: Avoid areas where you see runoff, sometimes it is hard to account for runoff when you have large rain events.

Nutrients/Plankton: Doesn't look for, already knows that points have good mixing and where geoduck already are. More concerned with geoduck density than plankton.

Currents: Yes, need areas with fairly strong current, points, see above.

Examples of proven sites: Look for places close to commercial areas (sub and int). Look at product in these areas as well, for scabbing, color, etc.

What effects seed survival?

Environmental:

Turbidity – geoduck won't dig in as fast when water are turbid. Salinity can affect survivorship, as large rain events, rivers, streams can result in die-offs, under 26ppt = problems. Temp – 57 *F perfect.
D.O.: He does not monitor for D.O. as he puts the seed in water (sink float or tube) as soon as he can.

Seed Size: The larger the better, does not use seed smaller than 5mm.

Weather: 85*F or lower, avoid periods where waves are present, avoid major boating weekends.

Human interactions: Not much of a problem, no intentional sabotage seen.

Time of planting: April to June are the best, April to September ok, has planted in the winter but has lower survival.

Tide Cycle: Plants on the outgoing tide.

Locations: Stay clear from fresh influence. Plant were ducks where, at points.

Other: Geoduck do not like floating/hanging systems, it will take them longer to burrow in (a lot longer). Stay away from high current areas, which may occur in SS, not in AK (not much current) so far. You need to be able to make and instant decision while out seeding, to be able to seed or not seed. Geoduck will dig in, under favorable conditions, 5-10 minutes intertidally, 20 min or longer subtially. If broadcast seeding, be sure to be aware of currents and the tide cycle, as they can disrupt digging and carry seed somewhere else.

Seed Predators

Seed Predators: Anything. Flounder, crab (can target larger geoduck too), diving ducks, other birds (crows, seagulls), starfish (large white 5 legged in AK), moonsnails (hasn't seen though, may prefer cockles, some have seen them eat through a neck).

How do they predate? Do not give them the opportunity!

Snipping: Snipping is a concern if the predator (crab/duck) gets deep enough. This may be site specific (for others). Maybe in Kitsap. Predators will take the whole animal (seed) if small enough.

Environmental factors: No known environmental factors that increase predation. No density, neighboring geoduck or WQ effects seen.

Locational Effects: There are locational effects on predation. Crab tend to populate certain areas. These locational effects change when you put out food (geoduck, clams, etc).

Time of year: Sees higher predation in the summer.

Other Operational Considerations

Optimal planting density: Intertidal: 4 per sq foot / Subtidal: maybe lower
There may be a limit to farm size as well…

Optimal harvest density: Intertidal: 1.5 to 2 per sq foot (50% survival) / Subtidal: maybe lower. Density considerations are site specific.

Toxins: Look at past records/history. But if like AK where psp closures are often, just take out the gut ball (able to sell as live product to Asia but get lower price). Hard to do depuration for PSP since it resides so long.

Holding: Cooling the product does not increase shelf life. Shelf live is actually long in the winter (4-5 days) compared with 1 day in the summer.

Subtidal Planting

Hand seeding: PVC – 2" tubes work the best (75%), 4" tubes work good (50%). Has tried paper tubes but needs biodegradable tubes, ones he used persisted causing blacking of geoduck neck. Tubes are the way to go so far but expensive.

Scatter seeding: Uses large netting (more and more intertidally) in experiments. Fouling not too much of a problem, uses floats on netting. Survivorship may be close to what you see in tubes but has not conducted count yet. Work in subtidal in AK, uses heavy vexar mesh. WA ¾'' mesh.

Machine: – Not much info. Waiting to see what others come up with.

Environmental Effects on Predation and Harvest:

Referred to ENTREX and Initial Fisheries EIS study.

Exclusion devices: ENTREX study: Tubes = Eelgrass. Increases biodiversity, EpiFlora and EpiFauna. See top predators (Crows) as a result from putting food out there. Provides habitat.

Harvest Practices: See ENTREX study: localized effect, does not go up or down the tide range, parallel to the beach.

WQ: Has not seen. Does lower plankton which increases clarity. There may be too much algae in the water anyway from human nutrient inputs.

GENERAL

Future: Plans on acquiring more areas and increasing planting and harvesting. Plans on giving input to legislature and DNR.

Hood Canal: Interested in some pieces on the North portion of the canal. Sisters to Thorndyke, Bridge to Bangor area.

DNR land: Is interested in leasing DNR land if price is right. AK made the process very easy as they took care of all the permits. Cost in AK is $125/acre/year after initial winning bid cost. Is interested in locations near his current operations. Subtidal: 2*
Intertidal: 1*

Other Thoughts

Tends to think that our baseline plankton levels may be higher than historic levels from anthropogenic sources. There is a need to be careful in how we decide what baseline levels are.

DNR needs to make the process easy if they are going to lease lands. See Alaska process, where they completed all the permits, provide a 10 year lease. AK requires a $1,200 per acre/year lease fee on top of the bid price. Growers also need to provide a operations plan. Sites are 5 miles from commercial sites.

Role in Geoduck Aquaculture: Underwater Harvester/Researcher/Subtidal Seeding Methodologies/Seed Producer/Farmer

Farmer:

Duration: 1989 to present (14 years) – probably more
Depth: Subtidal
Location: BC: Vancouver Island

THOUGHTS:

Density: Plant lower densities, by allowing larger tenures which would allow industry to plant at lower densities. Plant at densities similar to wild harvest densities. If too close you might see an increase in disease, decrease in growth and increase in mortality. 7 year grow out cycle.

Tenure: Would like to see 20 ha (50 acres) of land leased out by DFO of B.C.'s common resource subtidal land. Establish an aquaculture park where other interests can get involved: 1st nations, non-profits, fishermen, aquaculturists, etc. Has surveyed other sites for the AIC and found sites and gave information to DFO in a document. Good sites exist from Campbell river to Nanaimo.

UHA has seeded 25 million geoduck on common resource grounds but may not be able to harvest since it is on common resource grounds.

Currently, British Columbia (DFO) has set aside 5 subtidal tenures for FAN totaling 80 useable ha (197acres) out of 160 ha (395 acres). DFO set purge fishery which was put on fisherman's IFQ's, one area took 4 years to purge. FAN seeded grounds are not in good sites. Both FAN and UHA are slow in the whole process.

Has a small tenure. But AIC does not have growout sites, only nursery sites.

Is interested in shifting focus to U.S. waters as B.C. government officials have been hesitant in leasing out lands.

Grow out cycle: 7 Years.

Subtidal vs. Intertidal: It is hard to lease out intertidal land for geoduck in B.C. since it is all crown land (LWBC) and is very limited in usefulness.

Wild Fishery: There are 20,000 ha (49,421 acres) of known wild geoduck. UHA is harvesting 4 million lbs a year. Recruitment levels estimated at 1% a year.

Subtidal Planting Technique (Does it work? Feasible? Interest? Vs Subtidal?): Yes it does work, he is getting 50% survival.

Predation: Sea Otters a major problem, experienced their voracity 20 years ago on the west coast of Vancouver Island during a dive. Otters dug trenches 3ft deep and ate most of geoduck. There are limited predators for sea otters now, so their populations may expand. An aquaculture park may be influenced by them so, they would be restricted to areas outside the park. If they came in they would be shot and their pelts sold. Money from the high priced pelts would in turn be used in other programs such as poacher (human and otter) control.

Is attempting to get away from protecting the geoduck, technology is still in the works.

Growout: Utilizes different technologies at different areas but there is still a lot to learn. Has good survival rates (50%) and is willing to share information if DNR gives something (lease) in return.

Seed: Would like to see more seed sources (8-10) and the border opened up for seed export/import.

Human Influence (upland): Baynes Sound Island Trust has stopped aquaculture operations. Concerns stemmed from garbage and noise.

Other: B.C. industry lacks the moral and mental maturity to move ahead progressively. B.C. has a lot of subtidal areas but does not move forward quick enough. Would like DNR to change its position and allow for subtidal geoduck aquaculture. Unity SeaFarms are ready to participate in subtidal leases. If allowed to farm on DNR land, he is willing to show the technology to DNR. This may allow for more jobs down in WA and show B.C. that it has been too slow in leasing out additional areas. He is interested in job centers and training opportunities. DFO has oppressed the industry for ecology. Has good survival rates (50%) and is willing to share information if DNR gives something (lease) in return.

Role in Geoduck Aquaculture: Tribal Biologist/Diver/Farmer
Farmer:

Duration: 1997 to present (6 years)
Depth: Intertidal
Location: Eld Inlet

Siting Criteria

Substrate: Very important, look for sand and pea gravel. Pea gravel may be the best as far as look of the geoduck. Muddy sites are not terrible but produce a black geoduck.

WQ: Has only been concerned with toxin closures. So picked Eld since of its history of not having PSP closures, this is a major sitting factor.

Elevation: Best zone is from 0 to -2 (67-69%), but has planted up to +5 and below -2. Definitely sees lower survival and growth beyond the "love zone" of 0 to -2.

Human Influence: Honda pumps disturbs the upland owners, especially at night. Suggests using a diesel engine with converter, solar, or electric.

Oceanic Influence: N/A

Freshwater/Riverine influences: Yes, seed do not do well in lower salinities. May also cause the burial of tubes which is not worth the price to set out the tubes and geoduck. Stay away from creeks as well.

Nutrients or Plankon: Doesn't worry about, all of SS is ok.

Current: Yes, it increases growth.

Other: Horseclams, which settle inside the tubes, tend to blacken the shell/siphon on neighboring geoduck, so try to stay away from horseclams. Looks for presence of wild neighboring geoduck populations, presence determines a good site.

Examples of Proven sites: ELD

Geographic Region: All of south sound.

Predation:

Predators and their effects:

Predators: Every fish

Moonsnails: Targets seed and juveniles. Has witnessed moonsnails come in after 1 week of pulling tubes from less than 1 year olds. Moonsnails attached to the siphon of the geoduck and ate inside of the siphon and shell.

Spiny Starfish (Pisaster brevispinus): Can go down deep, 20" in some cases subtidally. Target seed and juveniles.

Crab: Target seed.

Flatfish: Have not witnessed.

Octopus: Have not seen.

Siphon Snipping: Not a real concern, crabs can snip off siphon but do not go deep enough.

Birds: Has not seen.

Environmental Factors: "As tide comes in, the table is set" Geoduck aquaculture increases biodiversity which increases predators.

Surrounding Specie Influence: Oysters and clams may increase moonsnail abundance.

Planting Density: No

Neighboring Populations: No.

WQ: No

Locational Effects: No, all species at both sites.

Planting Elevation: Starfish cannot travel to higher elevations.

Other: Cobble/Pea gravel shows an increase in moonsnail recruitment. They work up the beach after turning carnivorous.

Time of year: Scoters in the winter. Moonsnails arrive in the last spring then move up the beach after turning carnivorous.

Other Operational Considerations:

Optimal Planting Density: Planting 3.5 per tube on 16" centers, but trying for 3 per tube and 18" centers. Wants to be able to walk through the site.

Optimal Harvest Density: Expects 67-70% survival, so 2 to 3 per tube. Giving a harvest weight of 3lb per ft^2.

Densities Site Specific: Assumes they are.

Toxins: Stays away from sites with PSP history. Is concerned that PSP is not very predictive. There is a need for more PSP research, on site and specie specific information.

Other: Presence of horse clams makes the ground sour. Small seed is ok, it is cheaper and has provided good survival. Need to have a tube full of water to plant in, otherwise seed is out of water for too long.

Subtidal Planting Techniques:

Has not delved in subtidal planting, but is very interested in starting subtidal operation. Intertidal land is very scarce. It would provide more land, avoid other issues. It would get away from the use of PVC and leaves the culture operation out of site from the public/upland owners. If you get below the photo layer, you would lessen your chance of eelgrass issues. Slow growth, +7 years ok.

Environmental Effects of Production and Harvest:

Influence of Predation exclusion devices: Mussels get into the PVC and leave only a small 1" opening. Cockles settle sporadically (changes year to year) inside the tubes. Snails live in the tubes. Only docile welks live inside the tubes. Horseclams and barnacles as well.

Species Abundance/Diversity: Outside of the tubes, annelids numbers increase. More Cancer gracilis crabs are present, as well as forage fish. Has yet to see an increase in eelgrass. Laminaria sp. and Fucus sp., both macroalgae tend to use tubes as holdfast in the -2 and below zone. Birds (crows & seagulls) are more abundant.

Harvest Practices: Harvest destroys eelgrass, you do get less disruption when working underwater. During intertidal harvests one has to go over the same piece 12 to 15 times to harvest all of the geoduck.
Sediment: Intertidal sediment runs off. In larger scale operations, harvesters liquefy a larger portion of the beach. His operation does not harvest quite as intensively so little is seen as far as been erosion. Starting to harvest during high tide.

Other: Gas pumps create noise and air pollution.

General:

Studies: Has not completed. Is interested in weather eelgrass goes dormant or not.

Future: Interested in 7 acres next year, 4 acres per year thereafter.

Private land: Is interested in leasing/purchasing intertidal lands.

DNR Land: Is interested in leasing subtidal lands, more than intertidal. Depending on cost. Would like to see South Sound area with sand. Intertidal lands are of interest as well

DNR Pilot Project: Is interested in both depths but more in subtidal lands.

OTHER:

DNR: Would like the aquatics land division to pay more attention to the leasing of aquatic lands. Realizes that for subtidal farm, -4 to -18 feet would be great for growth but thinks it should be lower than -18 feet. That way it is away from eelgrass, the photo zone, and goes around a messy issue with the underwater harvesters. Would like permiting and the whole process to be easier.

Disease: Should consider disease issues. Farmed geoduck as vector of disease, higher densities may provide good area for opportunistic pathogens. A closer look at blisters and puss filled siphons on geoduck.

Hatchery: Worried about hatchery broodstock practices. Would like all hatcheries do what Lummi's do, ask for broodstock from general geographic region where planting will be taking place. Need some oversite on what is being planted.

APPENDIX 2

Copies of Alaska permit decision and BC chain of custody report

STATE OF ALASKA
DEPARTMENT OF NATURAL RESOURCES
DIVISION OF MINING, LAND AND WATER
SOUTHCENTRAL REGIONAL LAND OFFICE

FINAL FINDING AND DECISION
STEPHEN LACROIX
DBA SEA FARMS ALASKA
ADL 107001

This final finding and decision is intended to complement and update the respective preliminary finding and decision dated June 23, 2003. The Regional Manager of the Southcentral Regional Land Office (SCRO) of the Division of Mining, Land and Water, Department of Natural Resources (DNR), finds it to be in the state's best interest to lease the subject tide and submerged lands in accordance with 11 AAC 63.050(b). However, due to the proximity of the proposal to the area approved for auction under the new one-time Aquatic Farm Disposal Program (HB 208) and as an effort to provide equal opportunities for all who may be interested, the site will be included in that program's auction. The project description, public notice requirements, responses to public/agency comments, and basis for this finding are provided below.

REQUESTED ACTION: The applicant proposes to place an aquatic farmsite on state-owned tide and submerged lands located in an unnamed bight approximately one mile west of Pt. Alava, south Revillagigedo Island, and approximately 19 miles southeast of Ketchikan, southeast Alaska. The applicant proposes to culture geoduck clams, subtidally within a depth of between -40 feet and -60 feet at mean lower low water. The area measures approximately 597 feet by 359 feet by 502 feet by 253 feet. The applicant proposes to use 2-inch square by 6-inch long tube culture placed on one-foot centers, planting 2-4 geoduck spat in each tube. The tubes are to be placed in the substrate manually by divers. The tubes would then be covered with ½-inch by ¾-inch mesh, staked and weighted, to protect the spat from predators. The site is to be marked by four corner surface buoys connected by poly line to concrete anchors. Spat is to be purchased from the Qutekcak Hatchery in Seward.

Access to the site is by boat. The proposed location is only accessible by boat or floatplane. No hardening area or floating facilities are requested. All support facilities are to be located in Ketchikan. The applicant applied for a total of 3.88 acres and is depicted on the attached map.

LEGAL DESCRIPTION: Township 77 South, Range 94 East, Copper River Meridian, Section 14

LATITUDE / LONGITUDE: Corner No. 1 - 55° 11.723' N 131° 13.141' W

AUTHORITY: AS 38.05.035; AS 38.05.070; AS 38.05.075; AS 38.05.083; AS 38.05.127; AS 38.05.128; 11 AAC 51; 11 AAC 63; and 11 AAC 67.008

The authority at 11 AAC 67.008 was added. This regulation addresses applicants who are in default with a state contract or lease. This regulation is in the process of revision and currently applies to the aquatic farm program.

PUBLIC NOTICE: The public and agency comment period began on July 1, 2003 and ended on August 29, 2003. The comment period was held for 60 days rather than the required 30 days due to the simultaneous administration of the new one-time Aquatic Farm Disposal Program. Notice and review of the preliminary decisions were accomplished in accordance with AS 38.05.945. Notice was published in the following southeast Alaska newspapers:

Newspaper	Date of Display Ads
Ketchikan Daily News	July 21, 2003 (Monday)
Island News	July 21, 2003 (Monday)

Copies of the notice were also mailed to the following applicable entities: Alaska Department of Fish and Game Advisory Committees; Alaska Department of Fish and Game; Alaska Department of Environmental Conservation; Alaska Division of Project Management and Permitting/Alaska Coastal Management Program section and affected coastal districts; U.S. Army Corps of Engineers; U.S. Forest Service Ranger Districts; native corporations and villages; local governments; city and village post offices; aquatic farm applicants; and adjacent upland owners. In addition, copies of the notice were sent to approximately 700 individuals and interested parties that are included on DNR's general mailing list, required under 11 AAC 63.060(c).

No public hearings were requested. As an effort to increase public awareness and participation, the DNR, Division of Mining, Land and Water, and the Department of Fish and Game (DFG) conducted public meetings at Ketchikan (August 11), Metlakatla (August 12), Naukati (August 13), and Wrangell (August 14). Notice of the meetings was published in the following papers:

Newspaper	Date of Display Ads
Ketchikan Daily News	July 28, 2003 (Monday)
Island News	July 28, 2003 (Monday)
Wrangell Sentinel	July 31, 2003 (Thursday)

Nineteen aquatic farm applications were submitted during the 2003 opening of which 3 were rejected and closed. Of the remaining 16 applications, 3 are located in southcentral Alaska and 13 are located in southeast Alaska. In addition, 3 of the 16 applications are requests to modify existing farm sites.

PUBLIC COMMENTS: Except for the meetings held at the communities of Ketchikan and Naukati, most meetings were poorly attended, with only 3 to 5 attendees. During the 60-day combined public comment period, very few comments were received on the 16 applications. Although no hearings were requested or conducted during this review and comment period, all comments provided at the public meetings and received in writing, have been reviewed and considered in this decision process. In addition, all comments are on file and can be reviewed upon request.

The majority of comments received during this review period were specific to proposals for the new Aquatic Farm Disposal Program sites, referred to as the "HB 208" program and mandated under Chapter 81, SLA 2002. The few general comments received were concerned with the aquatic farming program as a whole and included support as well as opposition.

Any fisheries-related comments that fall under the management authority of the Department of Fish and Game (DFG) have been forwarded for their consideration. Any comments related to water quality, product storing, handling, and/or packaging fall under the management authority of the Department of Environmental Conservation (DEC) and have been forwarded for their consideration. In addition, any comments related to consistency with the Alaska Coastal Management Program (ACMP) have been forwarded to DNR/Division of Project Management and Permitting/ACMP Section for their consideration

under that program. Where other agency-related issues may be addressed in this decision, their purpose is to provide information only. This decision is limited in scope to that which falls under the SCRO's authorities.

Written comments specific to this proposal were received from the DNR/State Historic Preservation Office and the U.S. Forest Service/Tongass National Forest and are addressed below. General written comments were received from the U.S. Forest Service/Tongass National Forest, U.S. Fish and Wildlife Service, National Wildlife Federation, and Sealaska Corporation. Comments were also presented during the meeting in Ketchikan on August 11, 2003. These general comments are also addressed below. No changes were made to the applicant's proposal as a result of the 60-day public/agency review.

RESPONSES TO COMMENTS:

General Comments

Comments received regarding the aquatic farm program, in general, expressed concerns with the new applications and/or the HB 208 nominations and the potential conflicts with existing uses of the sites, including uses of subsistence, personal/commercial harvest, and anchorage. Other concerns included potential conflicts with current adjacent upland management objectives and potential impacts to aesthetics in areas with upland designations intended for retaining natural settings, with no development.

Personal and commercial uses of state-managed lands are increasing annually. The SCRO's decision-making about these varied uses, while it may be case-by-case, is comprehensive and builds upon a continuing dialog established between the applicant, interested and involved members of the public, adjacent landowners, other interested parties, and people with appropriate expertise. In response to public comments received during the 2001 comment period, both SCRO and DFG expanded public outreach during the 2003 comment period as an effort to increase public participation, educate the public regarding aquatic farming methods as well as provide information regarding the overall program process.

This department's mission is to facilitate public use of state lands and waters for multiple purposes. Management of the state's tide and submerged lands is accomplished under guidance from the state's constitution, Title 38 of Alaska's Statutes, department management plans, and the Public Trust Doctrine. The Public Trust Doctrine additionally identifies the tide and submerged lands as being available for the benefit of the public to support commerce, navigation, fishing and other related public purposes. Guidance from these sources is sought when considering other uses of the area, the needs and desires of adjacent landowners and, consequently, when making determinations regarding the state's best interest.

Opposition to all types of aquatic farming has been expressed numerous times during past application reviews. However, the SCRO has found that after further clarification is offered, the concerns are usually alleviated. For example, some people believe that leasing lands for on-bottom culture would restrict the public from accessing resources sought by personal or subsistence users. In response to this, the SCRO believes that on-bottom farming does not preclude the public from uses/resources protected under the Public Trust Doctrine. Access to public trust resources, other than the species being farmed, is ensured to the extent that such access does not disrupt the operation of the farm, disturb the species being cultured, or damage any of the farm site improvements. The aquatic

farm lease provides the lessee with use of the site for farming purposes only, including placing any pre-approved gear/equipment/facilities necessary in their farming operations. Although, a lessee has the right to protect his/her authorized use and possessions, this right must not unreasonably interfere with the rights of the state, other authorized users, and any uses protected under the Public Trust Doctrine. All aquatic farm leases are subject to the Public Trust Doctrine (please refer to this section on page 12).

Comments in support of the aquatic farm program have also been expressed numerous times over the past years to the SCRO, asserting that aquatic farming: provides opportunities for struggling coastal residents and communities to recover from declining logging and fishing industries; helps diversify the state's economy; is a clean industry and aids in preservation or rejuvenation of the surrounding environment, including water quality, fish and wildlife and their habitat; and, provides opportunities to purchase locally-grown shellfish. Furthermore, existing farms have shown they can operate in concert with other coastal resource users. Overall, the SCRO concurs with these statements.

Other comments received during this review expressed concerns with aquatic farms precluding future development of important natural resources on adjacent uplands. Any upland development adjacent to aquatic farming, including existing and future - planned or not, is an issue that SCRO must consider and address. The following may or may not apply to the proposal; it is included for purposes of providing further information on this subject.

The perception of prohibited or restricted future development on uplands adjacent to proposed farm sites has been a major concern expressed many times by both public and private upland owners. Aquatic farmsites do not preclude a wide range of development options on adjacent uplands, whether public or private in nature. Conversely, adjacent upland development does not necessarily preclude aquatic farm activities. Any development, from residential/recreational to industrial must comply with the state's clean water standards. These standards are the same for any development. The standard does not change in the presence of an existing shellfish farm; nor would the standard change for an existing upland or shore-based development project in light of an incoming shellfish farm. If standards (for sewage treatment and discharge into public water systems) for the development project are met, both activities can co-exist. Although both activities may be able to co-exist, it is not to infer that shellfish operations may be located at the end of an outfall pipe. Shellfish operations must always find and occupy sites which maximize their potential for success. Those sites provide adequate flushing from tidal actions and currents to disallow any number of negative elements to build up at the site. Project designers must consider the existing situation and, to the extent reasonable and prudent, employ design criteria that maximize the success of all legitimate projects.

With respect to water quality, there are two issues to consider: the Department of Environmental Conservation (DEC) standards for sewage treatment and discharge into public waters (addressed above); and the DEC certification of public waters as clean and safe as it relates to shellfish production and consumption.

The DEC water quality certification process is a separate operation conducted to ensure the safety of waters used for the production of shellfish product destined to the commercial market where it may be purchased for consumption. Water certification must meet both the DEC requirements and the requirements under the National Shellfish Sanitation Program. The certification process focuses on the amount of fecal coliform present in the water. To be certified, waters must reflect a fecal coliform count that is within acceptable, legal limits. If coliform counts exceed allowable limits, shellfish harvest and sale activities may be restricted at certain times by DEC. High fecal coliform counts do

not necessarily point to a human polluter (either from individuals or development projects). A wide variety of land and sea based mammals, as well as humans, may be the cause. If unacceptable high counts of fecal coliform can be reasonably traced to a human source, it does not mean that source will suddenly be subject to meeting higher standards. Rather, it is more probable that the source is out of compliance with the DEC sewage and discharge standards.

Finally, with respect to aquatic farm activities and development of adjacent uplands, regardless of ownership, the SCRO believes the proper procedures, lease requirements, and laws are in place to responsibly address the needs and desires of both the upland owner(s) and potential aquatic farmers.

Alternatively, comments expressed concerns with potential impacts from aquatic farming in areas where the adjacent upland management objectives are to retain the natural characteristics and not allow development. General comments were received from the U.S. Forest Service (USFS), Tongass National Forest that expressed concerns with this issue and possible impacts to subsistence users, commercial and other public users. These issues are closely related and are jointly addressed below. The lands adjacent to this proposal are USFS lands and are designated Old-Growth Habitat. The USFS indicated that they had no site-specific concerns regarding this proposal. The USFS stated that although they have pointed out several concerns and conflicts with other proposals in certain locations, they are committed to assisting as much as possible with this "economically beneficial" program. The SCRO assures the USFS that it desires a cooperative working relationship with them in these matters and that before and/or during the next aquatic farm review, the SCRO will meet with them for further discussion and development of site criteria, where possible.

The SCRO realizes that those marine waters suitable for aquatic farming are often the very same areas sought by many other users of public land for recreation; personal, commercial and subsistence uses, including fishing and digging for clams; safe harbors for anchoring, or just to experience the area's qualities of solitude. In addition, many uplands adjacent to suitable aquatic farm sites have management objectives of protecting the natural, scenic or recreational resource values that exist, with a main goal of non-development. These uplands most likely lie within state legislatively designated areas, federal conservation units, or unique designations such as those lands subject to the Exxon Valdez acquisition agreements. The SCRO realizes that although most marine waters are not part of these upland designations, they are integral to the upland's ecosystem and the resource values for which they were designated, requiring protection and special consideration.

Management of public resources includes identification and understanding of areas exhibiting certain resource or environmental sensitivities, and may include limiting or restricting public activities in favor of recognized sensitivities. Such restrictions will be considered by SCRO with convincing evidence that resources are clearly at risk, public safety is clearly threatened or that any negative environmental or social impacts clearly outweigh the public benefits of a particular project. Visual impacts and aesthetic values are highly subjective and we recognize that individuals may have varying degrees of interpretation. With respect to the aquatic farming program, experience leads us to believe that farm sites can be designed and implemented with a minimum of visual intrusion. The SCRO has worked with interested parties, farmers and the U.S. Coast Guard to craft lease stipulations designed to minimize visual impacts of farm sites to the extent feasibly possible. Aquatic farm proposals within these sensitive areas have been, and will continue to be, evaluated carefully and given special consideration. When the state's best interest is to be served by authorizing a particular use in light of adjacent landowner objections, the SCRO not only strives, but has an obligation to mitigate the impacts of the proposed activity to the extent possible. Should no mitigation measures be identified to sufficiently alleviate or

eliminate a perceived or real impact, the proposed activity would not be allowed.

Applications for aquatic farming include a variety of shellfish and aquatic plants and various successful and experimental culture methods. While most suspended culture of oysters utilize gear consisting of lantern nets suspended from longlines and surface buoys, which are more visible and may pose conflicts with existing users of the area, intertidal culture of littleneck clams conducted in the intertidal zone and subtidal culture of geoduck clams (currently only in Southeast Alaska) conducted in -40 to -60 water depths, are more innocuous and would most likely not impact the same type of users. For example, an intertidal clam operation would not impact the adjacent use of an area for anchorage or the adjacent uplands for hunting. A subtidal operation is unlikely to impact adjacent intertidal uses for clam harvesting. Additionally, while some suspended culture proposals may pose impacts to an anchorage, small proposals within a large-capacity anchorage may be allowed. Because of the variables involved in aquatic farming, not only with the known species and culture methods, but with new and developing species and improved culture methods, applications for these activities must continue to be considered on a case-by-case basis. Broad restrictions placed on these activities may not always apply. In addition, impacts to existing and traditional uses, such as anchorage, navigation, recreation and subsistence, are considered as required under 11 AAC 63.050(b), including cumulative impacts from aquatic farming activities within the overall area.

It is important to note that most aquatic farm operations do not involve the use of on-site floating facilities. Many aquatic farmers in the state use their own vessels instead of a floating workraft for cleaning and sorting. Processing of the product also can be accomplished on-board a vessel. Currently, of the 62 farms authorized statewide, only 16% utilize floating facilities. In fact, aquatic farming of subtidal geoduck clams, as in this case, can be achieved by boat visits for maintenance and harvesting. Furthermore, the proposal does not include floating facilities and the SCRO believes the proposal is feasible without their use.

The USFS also expressed concerns with shoreline access, asserting that activities located on the tidelands or floating in a bay would have a direct effect on these uses. The USFS stated they have authorized various uses on their adjacent uplands under special use permits for log transfer sites, Forest Service public recreation cabins, and established outfitter and guide activities. In response to this issue, the public's access to and along navigable and public waters is protected under the Public Trust Doctrine and the laws at AS 38.05.127 and .128. The implementing regulations are 11 AAC 51.045 and require the easement to be continuous, unless topography or land status prevents this, and extend at least 50 feet from the mean high water line, seaward. All aquatic farm leases are subject to the Public Trust Doctrine and the requirements of these laws.

The USFS expressed concerns with aquatic farmers' unauthorized use of adjacent USFS uplands and requested the SCRO inform potential applicants that use of these lands is not authorized without the applicant first obtaining permission from the USFS, by means of their Special Use Permit (SUP). The USFS provided steps the applicant must take to apply for a SUP and listed some policies from their Forest Service Handbook 2709.11, Special Uses Handbook, specifically addressing mariculture sites. A few of the policies include: no permits will be authorized in wilderness areas; permits for upland facilities at a mariculture site will be initially limited to non-ground disturbing uses and limited to a one-year, renewable term; no permits for cabin facilities will be issued for the first five years, or until the mariculture operation is commercially viable – if a cabin is authorized, it will be deeded to, and become the property of, the United States Government upon completion of construction. Other policies included justification for the upland permit and that the SUP is dependent upon the farmer

obtaining the proper state authorizations. In addition, annual rent and a cleanup and restoration bond are required. The applicants have not requested any type of upland use in their proposal. The SCRO believes the applicant's proposal is feasible without the use of adjacent uplands. As required by regulation, without the upland owner's prior written consent, the lessee is prohibited in the lease agreement to use adjacent uplands for any purposes.

The USFS also expressed concerns regarding the use of predator-exclusion netting. Although the USFS recommended predator netting not be allowed adjacent to areas designated "wilderness", if they are allowed, the USFS recommended they be made of natural-appearing materials and installed and managed in such a way as to minimize visual impacts. The proposal involves subtidal gear that will not be visible from the surface. In addition, the extent of predator-exclusion netting is minimal, using ½-inch by ¾-inch mesh placed over 2-inch square by 6-inch long tubes, staked and weighted, to protect the spat from predators.

In addition, the USFS expressed concerns with potential impacts to fish and wildlife, such as bald eagle nests. Over the past 13 years since the Aquatic Farm Act became law in 1988, siting guidelines have been developed and are provided in the application packet. These guidelines include areas or sensitive resources needing protection, such as bald eagle nests, and list areas found unacceptable for aquatic farming or require separation distances. Additionally, the guidelines continue to evolve as regulatory agencies and the farmers learn from present farming practices and new technologies regularly discovered in this industry.

General comments were presented from the U.S. Forest Service (USFS), Wrangell Ranger District, at the meeting held in Wrangell on August 14, 2003. The USFS indicated that should any of aquatic farms find it necessary to use the uplands in their operations, they must obtain a special use permit. This issue has been addressed above.

Other general comments were presented during the meeting in Naukati on August 13, 2003 and included concerns with the Department of Environmental Conservation's (DEC) water quality testing. The concerns included: the integrity of the water samples after federal airline safety inspectors "open and sniff" the samples before sending; difficulties getting processing and shipping facilities permitted; and why water quality sampling is conducted from the surface water when the animals cultured are located in lower water depths, i.e. suspended culture of oysters and on-bottom culture that occurs in the substrate for geoduck clams.

The DEC provided the following responses to the above concerns: The DEC was unaware of the assertions that airline security were opening any water sample bottles and contacted them directly. The DEC learned that the airline inspectors are not supposed to be using this practice. A federal security director stated that he will communicate these concerns to his Southeast Alaska counterpart and confirmed to DEC that there is no need to open a bottle, let alone sniff the contents. Their procedure is to test the exterior of the bottles using a device known as an Explosive Trace Detector - ETD. If the exterior tests positive for explosive residue, the container may not be transported aboard an aircraft. The director stated that they will endeavor to ensure all screening personnel are aware of the proper procedure and, should this problem persist, to provide him with the specifics of names, dates and places and they will focus their training in that area.

The DEC stated that, primarily, all processing facilities are evaluated against the National Shellfish Sanitation Model Ordinance. Requirements vary only when shucking is anticipated, which involves

more specifics. All processing facilities must operate in a sanitary manner and any violations noted during an inspection require a deadline for correction. All facilities must be recertified annually in order to stay on the Interstate Certified Shellfish Shippers List for shipping products into interstate commerce. A Plan Improvement Program (PIP) is negotiated with permittees who have facilities needing major improvements, either structurally or equipment-wise, before the permit would be renewed.

DEC also indicated that surface water samples are taken and the data are used to classify an area. Surface samples represent the fresh water pollution occurring on or affecting a site. Being less dense, lighter and warmer, the fresh water tends to remain in the upper layers of the water column and, to date, this is the only acceptable method of sampling for fecal coliform. DEC advises that if members of the public wish to change the method of water sampling, they must submit this issue to the Interstate Shellfish Sanitation Conference (ISSC) and, if possible, attend the conference to support the issue. The ISSC meets every two years and the next conference is scheduled for 2005 in Mobile, Alabama. More information on this matter can be obtained by contacting Mike Ostasz at DEC.

Other comments were presented during the meeting in Ketchikan on August 11, 2003 and included specific concerns with the proposals under HB 208. No comments were presented regarding this proposal.

On August 29, 2003, SCRO received written comments from the U.S. Fish and Wildlife Service (USFWS) concerning the HB 208 nominations for on-bottom culture. The USFWS expressed concerns with the potential adverse effects to fish and wildlife with the use of predator-exclusion netting, particularly in areas of high fish and wildlife use. The operational aspect of this issue falls under the jurisdiction of DFG. Due to the fact that predator-exclusion netting is an improvement placed within the leased area, the SCRO also has requirements in the lease agreement addressing proper weighting, securing/anchoring to prevent these devices as well as other farm site improvements from becoming obstructions to navigation.

Comments were received from the National Wildlife Federation (NWF) on September 12, 2003 and also focused on the HB 208 proposals. Although the comments were received after the public comment period ended on August 29, 2003, meaning they have no rights to appeal the final decision(s), the SCRO wants to assure the NWF that their concerns are acknowledged and addressed in this decision. The NWF stated that while they have received notices in the past, they did not receive notice of the regular Aquatic Farm Program or the new HB 208 program during this review period and for this reason, submitted their comments late. The SCRO regrets that the NWF was not included on the distribution list and will take steps to ensure they are included on all future distribution lists related to the aquatic farming program.

The NWF expressed concerns with past questions of the legality of the aquatic farm program. The SCRO is mandated to implement this program under the Aquatic Farm Act of 1988, Alaska Statute 38.05.083, and further defined in regulations at 11 AAC 63. In addition, the new one-time Aquatic Farm Disposal Program (HB 208) was enacted under Chapter 81, SLA 2002.

The NWF also expressed concerns with aquatic farming and the adjacent upland management objectives of the U.S. Forest Service. This issue is addressed above.

On August 21, 2003, general and specific comments were received from Sealaska Corporation regarding the proposals under the HB 208 program and expressed support for the aquatic farm program as a whole. Sealaska Corporation stated that "during the past several years the rural areas of Southeast Alaska have suffered economically due to the loss of employment opportunities in the forest products and fisheries industry. Therefore, the State of Alaska is to be commended for its effort to help this segment of the Alaska community by creating the potential for more jobs."

Sealaska Corporation recommended the state be cautious when considering siting of the farms to ensure the upland owner's access and existing transportation routes for forest products are not impaired. Public access concerns are addressed above. In addition, transportation routes or navigation channels are not appropriate places to site a farm and a review and approval of the applicant's development plan ensures this does not occur.

Specific Comments

The DNR/Division of Parks and Outdoor Recreation/State Historic Preservation Office (SHPO) reviewed the proposal and had no comments.

On August 29, 2003, the DFG sent a letter to the applicant informing him that an operation permit would not be issued for the proposal because staff survey results found the site to contain an abundance of geoduck clams that would support a limited entry commercial fishery (5 AAC 41.240(b)(1)(F)(i)). The applicant filed an appeal with the DFG's Commissioner on September 21, 2003.

In the case of geoduck clams, the DFG defines significance as "an abundance that would support a limited entry commercial fishery" (5 AAC 41.240 (b)(1)(F)(i). This definition allows the department to evaluate subtidal aquatic farm applications based on, among other things, the density and distribution of animals on a proposed site, the poundage of animals on a proposed site, the size of the proposed site and the proximity of the proposed site to an existing commercial fishery.

The DFG indicated that four transects were plotted and surveyed along 180 meters near Point Alava on August 24, 2003. Good to excellent geoduck habitat was observed throughout the survey area. The estimated number of geoducks at Point Alava was 6,497 with an estimated biomass of 16,371 pounds. Average density of geoducks for transect sections measured at Point Alava was 0.64 geoducks per square meter.

After further evaluation, though the proposed site at Point Alava has a higher number of geoducks per square meter than the department has permitted in the past, it is a small, 3.88 acre site, with a fairly low estimated biomass of 16,371 pounds. This area is not located near other known potential or current geoducks fisheries and is therefore not likely to be combined with a larger area for a commercial fishery. Therefore, Commissioner Duffy made the determination on October 29, 2003 that the department will issue an Operation Permit upon a finding of consistency with the Alaska Coastal Management Program and the issuance of an Aquatic Farm Lease.

No additional information was received during the public/agency comment period that would potentially affect the proposal. The SCRO believes the proposal would have minimal impacts to traditional and existing public trust uses in this area.

PUBLIC TRUST DOCTRINE: The lands within the proposed aquatic farm application are subject to the Public Trust Doctrine. The Public Trust Doctrine provides that public trust lands, waters and living resources in a State are held by the State in trust for the benefit of all the people, and establishes the right of the public to fully enjoy public trust lands, waters and living resources for a wide variety of recognized public uses. The Public Trust Doctrine is applicable whenever navigable waters or the lands beneath are altered, developed, conveyed, or otherwise managed or preserved. In addition, it applies whether the trust lands are owned publicly or privately.

LAND DISPOSAL IN THE UNORGANIZED BOROUGH (AS 38.05.830) AND TRADITIONAL EXISTING USES (11 AAC 63.050(b)(5)(B)): It is not expected, nor is there any evidence, that an aquatic farm application to culture geoduck clams will have an effect on the density of the population in the vicinity of the site nor pose significant conflicts with existing traditional uses of the lands, on or adjacent to, the proposed aquatic farmsite.

ALASKA COASTAL MANAGEMENT PROGRAM (ACMP): This project was reviewed for consistency with the Alaska Coastal Management Program under 6 AAC 50. The DNR/Office of Project Management and Permitting, ACMP Section will issue a finding for the project under AK 0307-30J. In accordance with 6 AAC 80.010(b), an aquatic farm lease can only be issued with a positive finding of consistency under this program.

FINAL FINDING AND DECISION: The Southcentral Regional Land Office of the Division of Mining, Land and Water recommends approval of the 3.88-acre proposal, in accordance with 11 AAC 63.050(b), subject to the following condition and stipulations, which will be included in any resultant lease agreement. The proposal will be included in the Aquatic Farm Disposal Program and offered at public auction.

Lease Compensation: An administrative lease fee schedule for aquatic farmsites has been approved by the Division of Mining, Land and Water on August 1, 2003 under Appraisal Report 2522-7. The lease fee schedule is subject to review every two years. The annual rent for the proposal based on a 3.88-acre farmsite, is **$650.00**. (The annual fee is calculated at $350 for the first acre, or fraction thereof, plus $100 for each additional acre, or fraction thereof.)

Lease Special Stipulations: In addition to the standard stipulations listed within the lease document, the following special stipulations will be incorporated as part of the lease and identified as Attachment A. The Regional Manager reserves the right to modify the following stipulations or include additional stipulations as necessary.

1. A proposed amendment to the lease development plan must be submitted to the department for approval before a change in development occurs, and must be accompanied by the amendment fee required by 11 AAC 05.010. However, under this paragraph:

   (A) the following changes do not require an amendment of the lease development plan nor do they constitute a significant modification requiring a new determination of consistency with the Alaska Coastal Management Program:

      (i) any change in the species or number of shellfish or aquatic plants being raised if the change is permitted by the Department of Fish and Game;

(ii) a change in the number or type of rearing structures authorized within the lease boundaries, if the change does not increase obstructions to navigation or to other public use;

(B) the department will not authorize a proposed amendment to the lease development plan for a "change of use"; for the purpose of this subparagraph and AS 38.05.083(d), "change of use" means a change from the raising of shellfish and aquatic plants to any other use; and

(C) the approval of an amendment of an aquatic farm site lease does not relieve the lessee of the obligation to obtain other necessary authorizations.

2. A lessee shall comply with the approved development plan. Failure to comply with the commercial-use requirement set out in 11 AAC 63.030(b) is a default and cause for termination, unless the lessee shows to the Regional Manager's satisfaction that the failure is due to circumstances beyond the lessee's reasonable ability to foresee or control.

The lessee shall report annually to the department, no later than January 31, on sales during the previous year of shellfish and aquatic plants raised on the lease site, not including sales of commercially harvested wild stock that had been stored at the lease site. If the lessee provides this sales information to the Department of Fish and Game by an annual report, or by other means, the lessee may fulfill this paragraph's requirement for a sales report by asking the Department of Fish and Game to give a copy of the information to the department.

The commercial-use requirement for this 3.88-acre lease is $12,000.00 in annual sales, and must be met by the commencement of the sixth year of the term and continued annually for the remaining lease term.

3. The department reserves the right:

(A) of reasonable access to the leasehold for purposes of inspection, including the lessee's improvements and rearing structures; when the department inspects the lessee's rearing structures, the department will not lift or handle underwater rearing structures without prior notice to the lessee; the notice to the lessee may include notice by the Department of Fish and Game in accordance with AS 16.40.150(b); and

(B) upon 10 days' prior notice, to inspect records of the lessee necessary to verify the lessee's compliance with the lease provisions.

4. A bond, cash deposit, certificate of deposit, or other form of security acceptable to the Regional Manager at a minimum of **$2,500.00** must be posted and maintained during the life of this lease. The bond may be used to cover the cost of site cleanup and restoration and any associated cleanup costs after termination of the lease, including any unpaid rentals or other obligations accruing until site restoration is complete. The lessee is responsible for the full cost of site cleanup and restoration in the event the costs exceed the posted bond amount.

If three or more lessees post an association bond to cover all of their leases, the minimum

security amount is 50 percent of the amount individually calculated for each lease. The association must designate an agent for notification purposes. The association has the right to be notified of the termination of a lease covered by its association bond. If neither the former lessee nor the association completes the site restoration as required by AS 38.05.090, the department will use the association bond for this purpose, up to 100 percent of the amount individually calculated for that lease. The association may remove a lease in good standing from the coverage of its association bond after 60 days' notice to the department, during which time the affected lessee must make other arrangements to comply with this section. A lease that is in default or that has been terminated with site restoration still pending may not be removed from the coverage of the association bond.

5. If cultural or paleontological resources are discovered as a result of this activity, work that would disturb such resources must be stopped and the Alaska Office of History and Archaeology shall be contacted immediately at (907) 269-8721.

6. The United States Coast Guard (USCG) shall be contacted prior to placing any aquatic farm structures under this lease to determine lighting or marking requirements, such as buoys, necessary for the protection of maritime navigation, in accordance with Title 33, Code of Federal Regulations, Part 64. Required markings of this nature are Private Aids to Navigation, and must be subject to an approved permit. The USCG may be reached at the following address and phone number: Commander (oan), 17th Coast Guard District, P. O. Box 25517, Juneau, AK 99802-5517, telephone (907) 463-2254.

7. Floating facilities, such as those used for workrafts, processing, storage, and caretaker facilities, are not authorized under this lease agreement.

8. The lessee is required to visibly mark the corners of the site and in accordance with USCG marking requirements. If a site is not in full operation, marking the corners of the operational area is acceptable. At least one corner marker is required to clearly identify the lessee's name, telephone number, and SCRO's file (ADL) number.

9. The use of predator-exclusion devices is subject to the approval and requirements of the DFG. Any predator-exclusion devices must be installed and maintained to prevent obstructions to navigation.

10. All improvements shall be secured utilizing anchoring methods with sufficient weight and holding capability to keep them in their authorized location(s) and must be retrievable upon expiration, termination, or cancellation of the lease. Anchoring systems for floating facilities moored for periods of more than 14 days must be approved by the Regional Manager and the USCG.

11. The use of adjacent uplands for activities related to the aquatic farm site, including shore ties, is not authorized under this lease. Written permission from the upland owner and authorization from this department must be obtained prior to any use of the adjacent uplands.

12. Commercially harvested wild stock acquired under AS 16 is subject to the approval and requirements of the DFG. If DFG allows this activity within the lease boundary, the lessee is required to comply with DFG's operation permit requirements.

The finding presented above has been reviewed and considered. The case file has been found to be complete and the requirements of all applicable statutes and regulations have been satisfied. It is the finding of the Regional Manager that it is in the best interest of the state to proceed with this disposal under the authority of AS 38.05.083.

Richard B. Thompson, Regional Manager
Southcentral Regional Land Office

Date

APPEAL PROVISION:

A person affected by this decision who provided timely written comment or public hearing testimony on this decision may appeal it, in accordance with 11 AAC 02. Any appeal must be received by **November 19, 2003** and may be mailed or delivered to Thomas E. Irwin, Commissioner, Department of Natural Resources, 550 W. 7th Avenue, Suite 1400, Anchorage, Alaska 99501-3561; faxed to 1-907-269-8918; or sent by electronic mail to dnr_appeals@dnr.state.ak.us. **If no appeal is filed by that date, this decision goes into effect as a final order and decision on December 1, 2003**. An eligible person must first appeal this decision in accordance with 11 AAC 02 before appealing this decision to Superior Court. A copy of 11 AAC 02 is enclosed for your information.

AIC

CHAIN OF CUSTODY

CONFERENCE PAPER

JUNE 3, 2004

AUTHOR
E.W. GANT

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Chain of Custody Conference

Purpose

The purpose of this paper is to explain how to forge the first link in the Chain of Custody. Then to show how we can fill that first link with an increased amount of product, which we will need in the future to pass down through the rest of the chain.

Introduction to the Existing System of Management

It is generally considered that the wild Geoduck fishery is one of the best managed fisheries in the world. It is now time to recognize that the present system of management for the Geoduck industry needs to be adapted to the changing times. The first step in this adaptation process is to define the inherent flaws within the existing system.

Flaws Within the Existing System of Management

At present there are forty-one boats harvesting about four million pounds of product each year. Four million pounds a year could be harvested with only four boats. No business should expect to last that uses forty-one employees to do a job that can be done by four.

Harvesting costs in the wild fishery have gone from about twenty cents a pound to approximately two dollars a pound. These harvesting costs could easily be cut in half. At the same time, the wages of the people doing the harvesting could be significantly increased.

There are less than 150 part-time jobs in the harvesting fishery. Under the AIC's recommended system of management our industry could provide thousands of full-time jobs.

The management plan for the fishery has gone from a two page document to one that is now the size of a small telephone directory. The bed-by-bed management strategy being put into place this year will increase both the complexity and the cost of the existing system of management. We are moving contrary to a fundamentally important business strategy commonly referred to as the KISS principle.

The management costs of the Geoduck fishery are rising, but the gross revenue is not. The revenue from the fishery will probably go down over the next few years under the existing system of management because of the uncertainty of sustainability in the fishery, and because of aquaculture product entering the world market place.

The fishery's productivity is probably going to be reduced over the next few years because the area that's available to the fishery will decrease for a variety of reasons.

Twenty years ago, a harvesting competitor for our product was introduced into the food chain along the B.C. coast. At that time, people laughed at the idea that this competitor could actually destroy our entire industry. In the past two years, I haven't noticed anyone laughing about the Sea Otter.

Under the existing system of management, we need to guard 30,000 kilometres of coastline against human poachers. This can't be done in a realistic manner.

The most fundamental flaw in the existing system is that it is based upon the necessity for us to know something that it is simply not humanly possible to know. Tens of thousands of man-hours, and millions of dollars, have been spent trying to determine the feral Geoduck biomass distribution, and its natural recruitment. We need to know this in order to say with reasonable certainty that we are harvesting at a sustainable level of maximum productivity. But after all our investment in time, money, and effort we still can't claim reasonable certainty. We do not even know the total area of commercial concentrations within the overall biomass. Nor do we do not know how much of the area of commercially concentrated stocks is actually diggable. We do not have a realistic awareness of densities, nor the recruitment rates. Most importantly, we do not know how to get the fishermen to harvest each bed at a sustainable level of maximum productivity. The reality is that the only thing we actually know with reasonable certainty is that each bed is most probably being over-harvested or under-harvested every year.

All of these flaws within the system are merely at the mechanical level. The essence of what really matters - what really needs to change - lies within an aspect of our human nature that tends to defeat our best efforts at every turn. Hundreds of millions of dollars worth of totally unnecessary damage has been done to the industry over the years because of this problem. People have had their lives made unnecessarily miserable in a multitude of ways. Some have even died. It is as if we are involved in some type of malignant game intended to make each of us defeat the other at every turn, all the while that most of us are striving to be of value as individuals within the whole.

Bringing this inherent flaw in human nature up to the surface and defining it in the light of day, is not enough to eliminate it. Perhaps it is better to show how a new managerial framework can be set up that allows for the finer aspects of our nature to prevail. Then focus on how to protect that aspect of ourselves within the new framework.

In short, the flaws within the structure of the system are relatively easy to resolve with simple changes to its framework. But if we are going to be effective within this new framework, we must define within our own minds that which we want to see prevail.

Securing the First Link in the Chain of Custody

The first link in the Chain of Custody is to protect the product from poachers while it is still in the ground. There are four basic types of poachers that we need to consider.

The most damaging poacher of all is the Sea Otter. This conference is pointless if it does not realistically solve the problem of how to retain custody of Geoduck stocks in the face of the growing Sea Otter population.

Because of its listing under the Species at Risk Act (SARA), and its popularity within the environmentalist movement, I think it is reasonable to assume that the Sea Otter will rebuild their population in B.C. to about fifty thousand animals. I've been told that an adult animal needs about two thousand pounds of food a year. This means that a population of fifty thousand animals will need about one hundred million pounds of food each year to survive. In order to consume a hundred million pounds of food the Sea Otter has to kill more than that weight in animals. The eatable portion of a Sea Urchin, for example, may only be ten per cent of its total body weight. This means that fifty thousand Sea Otters would have to kill about a billion Sea Urchins each year. This amount of Urchin is worth about a billion dollars on the world market.

Sea Otters fit into the natural ecology by breeding beyond the limits of their available food supply. Then they migrate to a new area once they begin to starve. This means that, before the animal decides to migrate, it will first wipe out all commercial concentrations of Geoduck, regardless of whether they are feral or cultured.

A hundred million pounds of feral Geoduck per year is worth about a billion dollars. The Geoduck aquaculture industry has the potential to produce about a billion dollars worth of cultured product each year under the right system of management. But the more we produce, the more the Sea Otter population will be able to expand. No matter how you look at it the Sea Otter is a billion dollar poacher that the Chain of Custody must address.

Just as we are losing the business race to the U.S. and China for world market share because of our present system of management, and its underlying paradigm, we are also going to lose our very existence to the Sea Otter over time for exactly the same reason.

The other three types of poachers are human. We are defining the first type as the "Insider Poacher". There are two subtypes. One is the licensed fisherman who uses his legal harvesting operation as a front for poaching from the common resource. In the future, he will probably try to poach from tenures. The other is the licensed aquaculturist who uses his tenure as a front for poaching, either from the common resource, or from other tenures.

The next type of poacher is the "Cross-Over Poacher". This is a person who once worked within the industry and learned what he needed to know in order to poach full time outside the industry.

The last type is the "Outsider Poacher". This poacher has no work history within the industry. This makes it very difficult for anyone to know that he exists. However, we have reason to believe that he does.

The Concept of the Culture Park

All four of these basic poacher types can be effectively dealt with using the managerial strategy of the Culture Park. The idea is to create large shellfish aquaculture areas in appropriate locations throughout B.C. The legitimate industry would then be better able to protect itself from poachers within these Culture Park areas.

An independent company would be set up by the industry within each Culture Park to prevent poaching within the Park. The activities of this Poaching Controller company would be monitored by government, similar to the way Validators are treated within the wild fisheries. One of the tasks of the Poaching Controller would be to harvest all Sea Otters that migrate into the Culture Park.

During the last few years of the Sea Otter fur industry, pelts sold for the modern day equivalent of tens of thousands of dollars apiece. It is reasonable to assume that if the pelts are marketed properly they could become a significant source of additional revenue for the Culture Park area. This revenue could then be used in a multitude of ways by the aquaculture industry to advance the economic, social, and environmental aspects of the Culture Park.

Under the existing system, Sea Otters must be viewed by our industry as a kill-or-be-killed competitor. Under the Culture Park system, the industry would consider the Sea Otter biomass outside of the Park areas as a low maintenance asset creating a steady flow of revenue into the Culture Parks. Our industry would become supportive of the environmental work to sustain the existence of this valuable animal.

Under the present system, individual environmentalists are putting themselves in positions of jeopardy. In the future they could be held individually accountable for the massive amount of economic damage that they are causing to their fellow human beings in their crusade to bring back the Sea Otter. Under the Culture Park system they would be lauded for their work.

Those on either side of the issue that would resist this solution to the situation would only be defining themselves as people who want to be in conflict for the sake of being in conflict. It would be up to the rest of us to see that these conflictive individuals are not allowed to prevail. This is an example of how we can decide as individuals what we allow to prevail within the new system of management.

The Poaching Controller in the Culture Park would also be able to deal with human poachers more effectively because the Culture Parks would be much smaller than the entire coastal area of B.C.

The effectiveness of these Poaching Controllers within the Parks will be significantly improved upon in the near future with the commercialization of Satellite monitoring.

Another technological tool that will upgrade the security system within the Culture Parks will be Video Monitoring Stations utilizing telescopic, infrared, generation three light enhancement systems, coupled with radar, and tied into security websites accessed by personal computers via the cellular network. This video/radar/cellular/PC system gives the website viewer mouse control over the on site video cameras. Individuals would be able to log onto these security web sites in order to monitor the tenured areas, night or day, in all types of weather. Company managers would be able to communicate much better with their field workers. Shareholders would be better able to keep a eye on their investment. DFO biological managers, and their enforcement officers, would also become more effective. Even the Coast Guard would be able to access the satellite and video systems to assist in their rescue operations.

Culture Parks would become such well-viewed areas that they would be the last place in which a poacher would be able to operate. This would secure the first link in the Chain of Custody.

Park Concepts

Introduction

It is axiomatic to say that creating the right system of management for an industry as a whole is critical to the prosperity of its parts. Periodically, in the evolutionary development of an industry's system of management, a political window of opportunity for change may open up that allows for the industry to evolve, not only to a new level of productivity and profit, but also to a new level of moral and mental maturity. This is such a time for the Geoduck clam industry.

The following are some of the components of an expanding critical mass capable of changing the Geoduck industry's system of management from one that is based upon natural recruitment, to one that is based upon the Culture Park concept.

- The present uncertainty of the sustainability of the wild Geoduck fishery.
- The increasing world demand for Geoduck.
- The successful development of rudimentary, commercial scale Geoduck culture technology.
- The change in DFO's attitude towards aquaculture.
- The use of shellfish tenures to help settle the land claims of First Nations.
- The creation of the Center for Shellfish Research (CSR).
- The birth of the Alliance of Independent Companies (AIC).
- The increased need for generic Research and Development (R&D) funding at a time when government assistance is in decline.
- The shift around the world from fishing to aquaculture.

It is critical at this time that the right socio-economic catalysts are added into the mix to help cure the industry of its immaturity as it rises to its next level of productivity. The AIC is proposing three socio-economic catalysts of change based upon the Culture Park strategy. The first concept is the GATE Park. The second is the Fishermen's Mitigation Park. The final concept is the First Nations Park.

GATE Park

The GATE Park is a concept designed to help us move, as if thru a gateway, into a new way of thinking. The AIC is recommending that an experimental shellfish culture area be set up where Generic Entities, working altruistically on behalf of the whole, would each be allowed to secure an independently controlled shellfish tenure. Each Generic Entity, by conditions of tenure specific to the GATE Park area, would work in a spirit of open cooperation with the other Generic Entities in the area to advance the well being of the whole. This is a fundamental paradigm shift from the individual and group, competitive, adversarial gamesmanship upon which the existing system is based.

The AIC is advising that the Generic Entities in the GATE Park should be allowed to utilize the residual natural stocks on their respective sites in order to help accelerate the aquacultural development of the tenures in the GATE area. Once developed, each Generic Entity's tenure would generate funds for its work on behalf of the whole.

Candidates

The following are the Generic Entities that we are advising should be considered for this Culture Park area.

- The **Center for Shellfish Research (CSR)** – Besides producing revenue for the Center, this tenure would also be used as a student training ground, and as a site for scientific research.
- The **Pacific Biological Station (PBS)** – This Entity would be the Federal complement to the CSR in this area.
- The **Alliance of Independent Companies (AIC)** – This Entity is at the cutting edge of technology development in the Geoduck culture industry. It intends to continue with this work, not only for the sake of its own member companies, but also for the sake of the industry as a whole.
- **Geoduck Enhancement Aquaculture Research (GEAR)** – The mandate of this Entity would be to focus its tenure revenue on cooperative market development. It could provide significant support for such programs as Can-Trace.
- The private industry members of the **Underwater Harvesters Association (UHA)** and the **British Columbia Shellfish Growers Association (BCSGA)** would be allowed to go to the tenures of their respective Generic Entities in the GATE Park to learn of the latest advances in the industry. The members would also have the opportunity to interview graduate students working in the Park prior to their moving into the private sector.
- As individual First Nation tribes become working realities in the Geoduck industry they could also elect to send a representative Altruistic Generic Entity to the park. This **First Nations** Entity would bring its unique perspective into the mix of minds working within the spirit of cooperation in the GATE Park area.

Other Entities may also qualify. Their entry would depend upon their willingness and ability to be of value to the well being of the industry as a whole. It would also depend upon them acting in a spirit of honest communication and cooperation with the other Altruistic Generic Entities within the GATE Park.

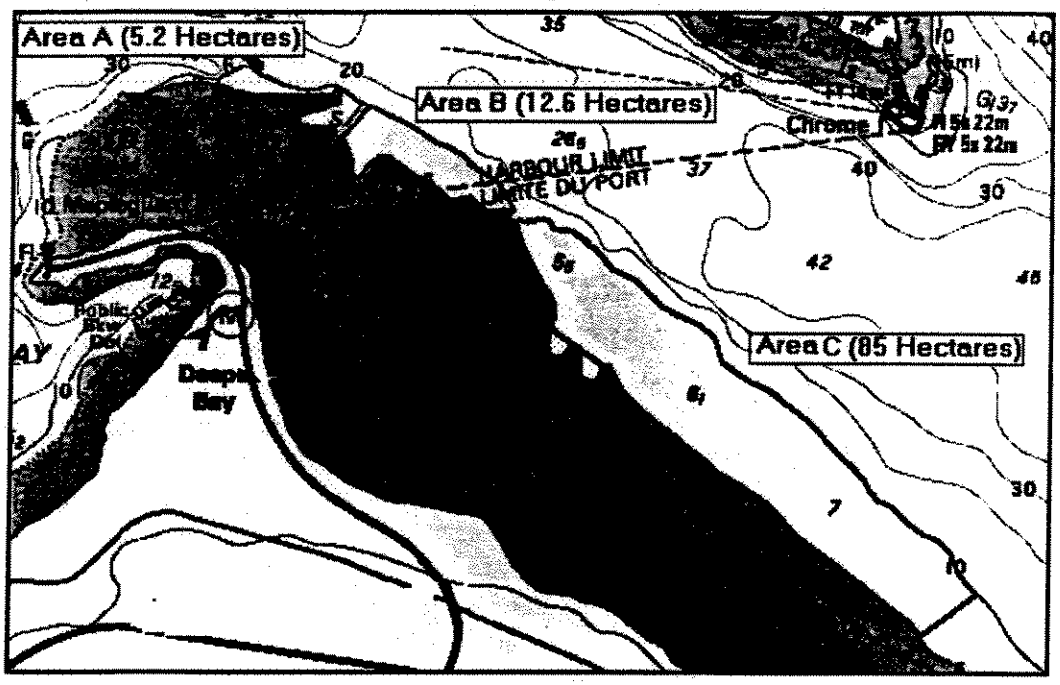
Code of Practice for the GATE Park

This model area could lead industry by example towards the maturation and legalization of a Code of Practice that would advance the industry to a new level of economic, social and environmental maturity. The boats used on the Generic sites would be clean, neat, good looking, and quiet. Our AIC technology would allow the ocean in this area to maintain its pristine natural appearance, free of any surface gear. New technologies and practices for ecological caretaking which are already being pioneered into place by the AIC would continue to be developed in the area. The area could evolve over time into a place of pride, a showpiece for public relations, an enclave for student education, and an area for industry to explore new ways to improve upon their productivity, economy, and profit. It could become a proving ground for invention, and a sanctuary for scientists. Essentially, the GATE Park would become a protected place where the finer side of human nature would be able to prevail.

Area of Location

The following area has been defined by the AIC as suitable as a Park area for the **Generic Altruistic Tenured Entities (GATE).** In addition to having the suitable biophysical conditions necessary for Geoduck, the location is also suitable for the culture of other shellfish species, such as Horse clams. The area falls within the Baynes Sound Action Plan for shellfish culture development. It would be in proximity to **CSR's** planned field facility and tenures. It is close to the sheltered port of Deep Bay, which will make access to the tenures relatively easy, economical, and safe. The area has a massive potential for expansion to the South. To our knowledge, the zone has the lowest historical occurrence of Sea Otter in the Province. It will be relatively easy to protect from poachers. It is away from parks, power lines, anchorages, industrial pollution, and areas of First Nation's priority. It will create employment in an economically depressed area. Because of the AIC technology, work in this area will not constitute a traffic hazard. This area, not only has significant natural residual stocks to financially help the Generic Entities to accelerate the development of their respective tenures, it also had a spat set that took place about four years ago, giving us access to juvenile stocks for study, and for market development. There is a market building in China for Geoducks of various sizes. We need to both study and supply these markets as they develop, so that the long term cash flow problem of growing Geoducks to the one kilogram size can be mitigated by marketing some of the product at an earlier stage in its growth cycle. Harvesting small product will present us with new technological challenges.

GATE Proposal Area



Area A on the chart has extreme tidal currents, and direct exposure to the massive algae flow from Baynes Sound. This will create both technological challenges and biophysical opportunities. Area C has exposed shoreline, creating significantly different logistic and geophysical challenges. Area B is a blending of both. The substrate and product quality varies as well in the three sub areas, allowing for a rich field of investigative possibilities.

Fisherman's Mitigation Culture Park

This is the second type of Culture Park that we are recommending. This type of park can be set up in different locations so that the fishermen could choose a park location that is convenient to where they live. These parks do not have to be the exclusive domain of the fishermen. Other entities, such as First Nation tribes or aquaculture companies in the vicinity, could also secure tenures in the area.

The basic concept of the Fisherman's Mitigation Culture Park is to have areas where fishermen would be granted appropriately sized tenures, within a Culture Park of their choice, in order to compensate them for their loss of access to fishing some of the common resource.

If we assume a tenure mathematical model of five adult Geoducks per square meter, grown to two pounds apiece, with a seven year grow out period, then a fisherman could theoretically culture several times his present fishing quota of 72,000 pounds on about 20 hectares. We believe this sized tenure would allow the fisherman to hold his own in the

future when the present world supply of Geoduck increases from ten million pounds a year to several times that amount. The basic mathematical model for this position is as follows:

5 Geoducks/sq. meter x 2lb./geoduck x 10,000sq. meters/hectare = 100,000lbs/hectare

100,000lbs/hectare x 21 hectares/ 7 year grow out period = 300,000lbs/year

The fisherman's harvest from his tenure would be more productive and efficient relative to his wild harvesting activities. Their tenured stocks would also be much better protected within the Culture Park than the wild stocks in the common resource.

First Nations Culture Parks

The concept of the Culture Park fits naturally into the spiritual heritage of First Nations. Culture Park areas could be set up within the traditional First Nations area surrounding each coastal village. Members of industry that are willing to help First Nations develop their village tenures in this type of Park would be granted tenures within these Parks in appreciation for their help.

The creation of this mutually beneficial spirit within the First Nations Culture Parks would help to lay the foundation in the future for cooperative marketing, with the generic support of GEAR. Cultured Geoduck does not have the cost of containment and feeding associated with farmed Salmon. Nor does it have a short live span. This means that the only reason why we would dump product onto the market place, deflating the price, is if we allow the adversarial side of our nature to cause us to refuse to work together to market our product in a cooperative manner.

The fishing industry already has a practical, cooperative marketing mechanism working effectively to maintain a healthy price for our product. What we have to do is build upon that which already exists.

Residual Feral Stocks on Prospective Aquaculture Tenures

The protocol for purging the residual feral stocks from the first Geoduck aquaculture sites was obstructive, grossly inefficient, unnecessarily expensive, and time consuming. It also created conflict where none needed to exist. The AIC paradigm shift would significantly reduce the waste created by the underlying adversarialism of the past.

Under the AIC paradigm no one would try to profess concern about feral stocks on intertidal sites as these stocks are almost nonexistent.

It would not be necessary to use only a G licensed vessel to purge residual feral stocks from subtidal tenures. What would matter is that the boat was properly qualified and

monitored. The vessel would be allowed to harvest at a time of the year when the stocks are the easiest to harvest. This is from late March, when the animals first start to feed in preparation for spawning, up to the onset of the summer time plankton blooms, which reduce diver visibility. A second window of opportunity occurs after the worst of the summer blooms, and prior to the onset of the winter storms.

The boat would harvest several sites in series at the same time. This way the vessel could work non-stop from site to site harvesting each site in a multitude of cycles. This approach would allow each site a short rest period in between each harvest so that the remaining stocks would have the time they need to reappear prior to the next harvest.

The purge harvest of feral stocks would not be done on a boat daily rate, as this would drag out the process. Rather, the harvesting vessel would be contracted to work at a dollar a pound until it could no longer make a profit. If anyone insisted on challenging the right of the tenure holder to have what was left on the sites once the boat was finished, then a second boat could be contracted at one half of the market value of the product until it also could no longer make a profit. If necessary, even a final boat could be contracted at just below market price.

Under the new paradigm, the profits from the purging would go towards the development of the GATE Culture Park on the grounds that the work in this area is being done for the benefit of all concerned. We would no longer be trying to prevent the valid aquaculturist from having a few feral stocks at the time of his first harvest of cultured stocks. The fishermen have had free access to the stocks for 27 years. Why shouldn't some of the stocks now be utilized to help advance the aquaculture industry?

This strategy would allow the sites to be satisfactorily cleared in four months, rather than in four years.

Conclusion

The inherent flaws within the existing system of management can be resolved by forging the first link in our chain of custody with a new managerial framework. This new framework will enable us to have an industry that is more secure and productive. In order to do this properly we must also make a simple paradigm shift that will allow for the cooperative side of our nature to prevail, while protecting us from the adversarial.

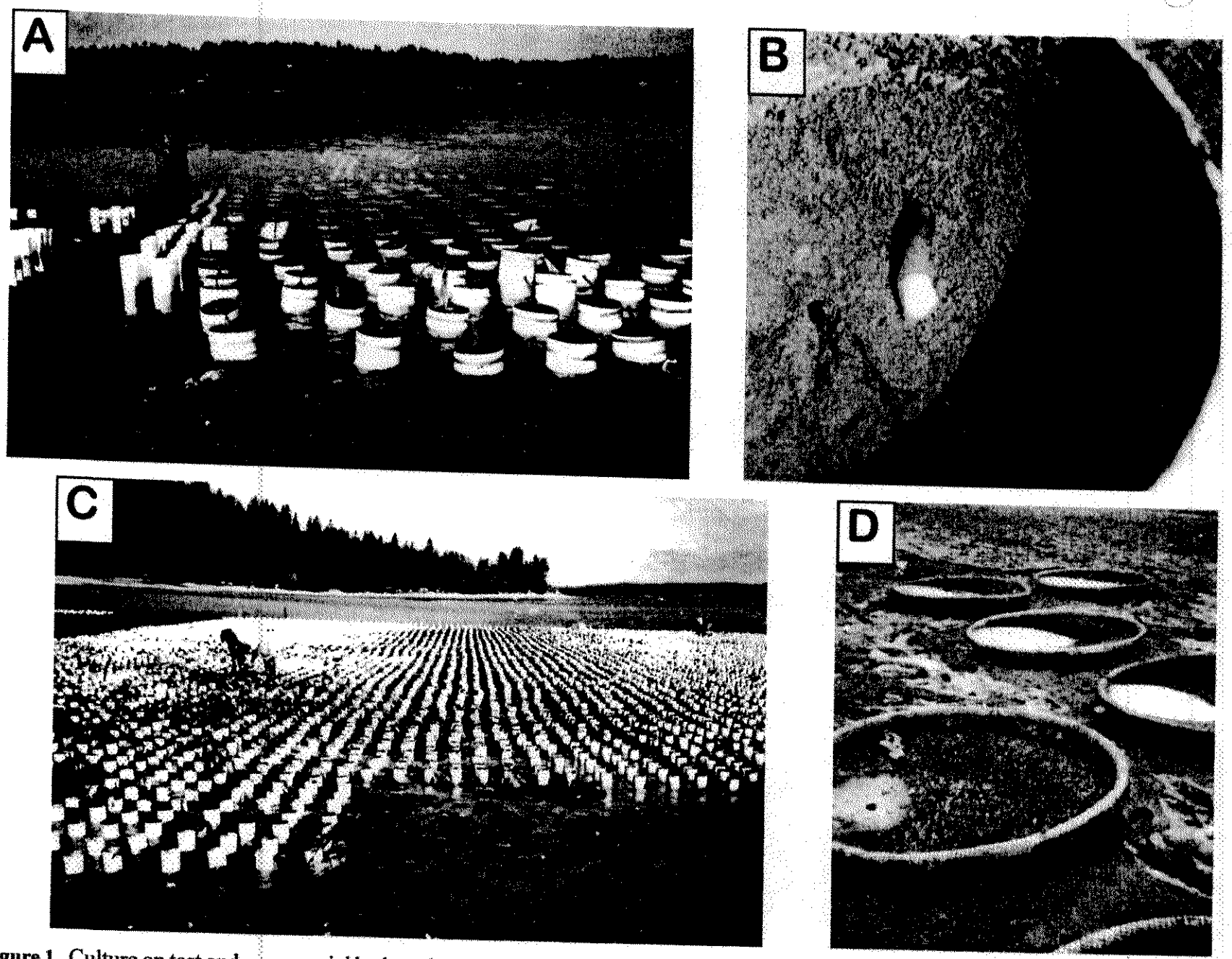


Figure 1. Culture on test and commercial beds and nursery. A. Example of a field experiment testing the effectiveness of different tube diameters. B. Geoduck seed in the process of digging into the sediment. C. Recently planted, commercial-scale tube array, Stretch Island. D. "Wading-pool" nursery system for rearing small seed prior to planting.