Washington Geoduck Growers Environmental Codes of Practice

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These Codes of Practice were originally developed by Taylor Shellfish 1997 and contain annual revisions. Last update June 2005.

INTRODUCTION

Overview of Washington State's Subtidal Geoduck Fishery. In the early 1960's numerous subtidal geoduck beds were identified. Washington State Department of Fisheries conducted extensive surveys and presented a resource assessment to the State Legislature. In 1970, the Legislature authorized the commercial harvesting of the subtidal geoduck and directed the management of the fishery to the Departments of Fish and Wildlife and Natural Resources. Soon after that time, Department of Fish and Wildlife developed enhancement programs that would allow the reseeding of state beds. While some of the experiments proved to be successful, the overall program was not and subsequently lost funding support.

Divers using hand-held water jets harvest the subtidal geoduck fishery. Each animal is individually taken by liquefying the substrate adjacent to it. Much of the geoduck resource is not harvestable because of depth limitations, below commercial densities, and water quality decertifications[1].

Figure 1. Adult geoduck, *Panopea abrupta*

Species Overview. The Northwest geoduck, *Panopea abrupta* (formerly *P. generosa*) is the largest burrowing clam in the world. The average shell length is approximately 5.3 inches with a live weight of approximately 2 pounds. In buried adults, the long contractile siphon may extend 39 inches to the surface. The natural habitat range is from the lower intertidal zone to the subtidal zone of bays and estuaries as deep as 360 feet in Puget Sound. The preferred substrate is normally sand and/or mud. *See Figure 1.*

Intertidal Culture of Geoduck on Private Tidelands. Geoduck culture on private tidelands began in the early 1990's. As a relatively new species for culture, techniques are rapidly evolving and changing. A USDA Small Business Innovative Research (SBIR) grant was obtained by Taylor Resources, Inc. (a participant grower) in1997 to assist with development of optimal culture techniques. As the culture techniques are developed, geoduck growers are striving to ensure potential adverse environmental impacts are minimized. The purpose of this **Environmental Code of Practice (ECOP)** is to provide guidance to geoduck farmers on potential environmental impacts resulting from their operations and demonstrate to

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[1] *Commercial Geoduck Fishery Management Plan and EIS, Departments of Fisheries and Natural Resources,1985*

interested parties, including resource and regulatory agencies, the growers' commitment to protection of the marine environment.

Participating Growers. This is a voluntary undertaking by the geoduck growers in Washington State. Through their participation in the development of this document, growers agree to meet the objectives of this **ECOP**, disclose environmental performance evaluations, and assume responsibility for their actions as well as the actions of other growers and the industry as a whole. A list of participating growers, addresses, and contacts can be requested. Individual companies will maintain planting and harvest records, maps of growing areas, and employee training records.

As the industry continues to grow, new growers will have the opportunity to participate in achieving the objectives of this **ECOP** by completing an **Environmental Performance Checklist** and incorporating the operational strategies into their company activities.

Figure 2. Intertidal geoduck bed planted at +1 to –2 foot tidal elevation.

Statement of Purpose

Washington State Geoduck Growers have collaborated on the development of this document in order to accomplish the following:

Identify strategies to avoid or minimize impacts from geoduck culture activities to the other marine life.

Identify strategies to avoid or minimize impacts to the genetic diversity of Puget Sound and Hood Canal geoduck populations.

Identify strategies to avoid or minimize visual and noise impacts to surrounding properties.

Guide growers in meeting, exceeding or participating in the development of regulatory requirements.

Identify research needs and support research opportunities that provide a better understanding of the geoduck fishery and its potential impacts.

Provide an outlet for disseminating information and practices of geoduck farming.

1. Hatchery and Broodstock Management

1.1. Introduction. The purpose of the hatchery facility is to produce geoduck seed for culture purposes for private shellfish companies as well as for enhancement purposes by the State of Washington.

The Taylor Resources hatchery located on the west shore of Dabob Bay, serves as an example. The facility consists of a 12,000 square foot metal building, 4000 square feet of greenhouse space, and various outdoor tanks of which a designated area is used for geoducks. Seawater is pumped from the bay via 800-foot intake pipes and from there through filters and heat exchangers into the building. There it is used for a variety of purposes relating to all aspects of the operation and returned to the bay. Operations can be divided into several areas: algal production, larval rearing, nursery seed culture and broodstock maintenance.

Figure 3. Several species of algae are cultured in order to supply adequate nutrition for the different life stages of the bivalves.

Algal production consists of growing a variety of single cell algae species for consumption by the larvae, seed, and broodstock animals. Treated seawater is used to fill algal tanks of various sizes and nutrients are added to provide nutrition for microalgae. This is accomplished by filtering and heating or cooling seawater followed by sterilization by any of three methods: pasteurization, UV treatment or by the addition of chlorine to kill microflora followed by neutralization with sodium thiosulphate. A variety of species of microalgae are grown and each is used as an inoculate to start larger cultures to be used as food. Algal cultures are grown under artificial light in several green houses associated with the hatchery facility, in addition to the main hatchery building. See Figure 5. The maximum volume of algae growing at any one time at this facility is currently 240,000 liters. The vast majority of this volume is used for food for broodstock bivalves, larvae and seed or juvenile shellfish.

Larval culture consists of rearing bivalve larvae in static tanks between the time that gametes are spawned by adult shellfish until the larvae "set" or settle out" and loose their ability to swim.

Nursery seed production is the phase of rearing larvae that are nearing settlement. Mature larvae are placed in smaller tanks where they can "settle out" onto screens. Water and microalgae are pumped to these newly set animals. When the seed reaches an approximate size of 5 mm it is transported from the facility to the bay for planting or sold.

Broodstock maintenance consists of feeding and care for adult bivalves used for the State of Washington and from Washington Department of Fish and Wildlife approved areas outside of the State including California, Oregon and Hawaii.

Washington State Department of Fish and Wildlife has identified five genetic geographic regions in Puget Sound. Currently, the progeny of any hatchery spawning is expected to planted in the region from which broodstock was harvested. Genetic research by both industry and State is on-going to determine if this protocol will be required in the future.

Figure 4. Taylor Resource' bivalve hatchery located on Dabob Bay, Hood Canal.

Hatchery and Broodstock Management Environmental Objectives

Minimize potential impacts to water quality

- ∫ Minimize the use of and properly dispose of any production related or experimental chemicals through the use of hazardous waste collection facilities.
- ∫ Use "environmentally friendly" cleaning agents for tank and pipe cleaning.
- ∫ Utilize heat exchanger to recover heat energy from discharge water to preheat new intake water.
- ∫ Minimize the use of antibiotics for use in treating bacterial contamination larval and algal culture.

Minimize and/or prevent potential impacts to other marine life.

- ∫ Equip intake lines with fish-friendly screens to avoid pumping in larger fish and invertebrates.
- ∫ Complete genetic stock research and incorporate results into this ECOP.
- ∫ Culture only well documented or locally- isolated algae species, or obtain algae starts from well-established laboratories.

Minimize the potential for pest and disease transfers.

- ∫ Ensure compliance with Washington State Department of Fish and Wildlife transfer regulations.[2]
- ∫ Ensure broodstock sources are disease and pest-free.
- ∫ Conduct regular pathological exams.

Figure 5. Hatchery-raised geoduck seed.

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[2] *WAC 220-72, Department of Fish and Wildlife regulations*

Figure 6. Nursery systems vary. At left, children's wading pools are used for over-wintering juvenile clams. Below, post-set geoduck are nursed in trays and fed cultured algae.

Performance Measures for Hatchery and Broodstock Management

Record of complaints from adjacent property owners on environmental elements such as light, noise, aesthetics, etc.

Measures taken to address complaints

Record of broodstock origins, outplanting sites, and algae sources

Pathology records for broodstock and source areas

Record of chemicals used in production and cleaning agents

Annual environmental performance review

2. Planting and Management of Geoduck Beds

2.1 Introduction.

Areas for potential plantings are assessed using the following criteria: substrate condition and type, access, water quality, exposure, existing biota, and upland development trends. Because areas for successful culture are limited, planting densities are increased at suitable sites.

Geoduck seed is used for outplanting on private tidelands primarily in the South Puget Sound Region. The seed are approximately 5 mm is size when transported from the hatchery for planting. Geoduck seed is planted in 4-6" PVC pipe cut in approximately 9" lengths. Although polyethylene tubes are less expensive per foot than PVC piping, PVC pipe is less buoyant and does not float free from the substrate thereby exposing the young geoduck to predators and potentially littering beaches and adjacent properties. A length of pipe is pushed into the substrate in the intertidal zone from approximately the –2 tidal elevation to +3 tidal elevation (MLLW) about 12" apart. Approximately 3-4 inches of the PVC pipe is left above the substrate.

Geoduck seed is placed in each pipe at a density of four seed per pipe. A plastic mesh net is secured over the exposed end of the pipe to exclude predators. See Figure 8. Normally the young geoducks will dig down into the substrate almost immediately.

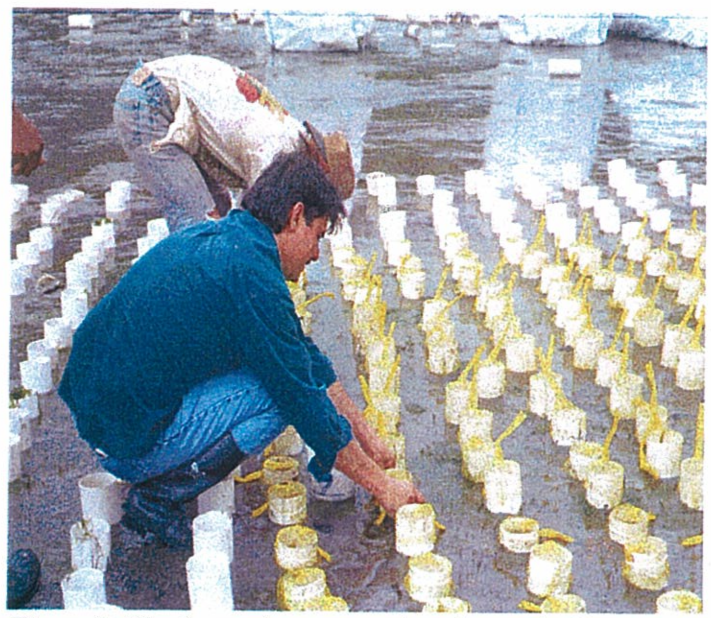

Figure 7. Plastic mesh nets are placed over the PVC tubes to exclude predators. In some cases, the nets are removed within weeks.

Clams must grow and dig to a depth adequate to evade predators (depth refuge). For most sites in South Sound, this ranges from 12-14" in depth at which time the pipes are removed from the substrate.

Farms are periodically checked to ensure adequate growth of geoducks and that predators are adequately excluded. Additionally, all unnatural debris, nets, bands, etc., are maintained and prevented from littering the waters or the beaches.

The State of Washington Department of Fish and Wildlife conducted an environmental review of the intertidal planting of geoduck on public beaches. The purpose was to increase recreational pportunities for the public. A Determination of Nonsignificance was issued for the activity on May 14, 1998.[3]

[3] *SEPA Determination of NonSignificance, Log Number 98031.dns, Department of Fish and Wildlife Lead Agency, May 14, 1998.*

Planting and Management of Geoduck Beds
Environmental Objectives

Integrated Pest/Predator Management

∫ Most of the tidelands cultivated for geoduck are at a low tidal elevation where predation is intense. Crabs (red rock, Dungeness, shore crab) are the dominant predators. Moonsnails can also be a significant predator as well as scoters that bite siphons off resulting in mortality. Exclusion is the primary and preferred strategy to minimize damage by predators. PVC tubes with nets are one example of how this is effectively accomplished.

Minimize impact to surrounding properties.

∫ Maintain farm in an orderly fashion. Install pipe or other predator exclusion devices in straight rows or blocks that are appealing to upland observers. Remove un-natural materials (pipe, nets) as soon as practical when young geoducks are no longer vulnerable to predators. Remove mark stakes and buoys when they are no longer necessary. Where possible, use pipe colored to blend into the surrounding environment.

∫ No un-natural materials should escape from the farm. Pipe, nets, rubber bands occasionally wash out of the beach. Every effort should be made to assure this does not happen. Area beaches should be patrolled on a regular basis to retrieve debris that does escape the farm as well as other non-natural debris. Areas shall be identified where because of wave, current or wind action, debris tends to accumulate and crews shall patrol these areas after weather events to pick up debris. Sometimes the areas are in deepwater and it may be necessary to wade in or dive for debris and litter.

∫ Employee training. Participant companies shall train employees in meeting environmental objectives through a standardized training program. Companies shall be responsible for the their employees' environmental performance.

Minimize and/or prevent impacts to other marine life.

∫ No seeding or culture is done in eelgrass beds, or other biologically sensitive areas such as herring or smelt spawning grounds.

∫ Equipment shall be kept in good repair to prevent leaking and/or inefficient operations.

Performance Measures for Planting and Management of Geoduck Beds

Record of correspondence from adjacent property owners

Measures taken as a result of complaints from adjacent property owners

Record of results of biological surveys and assessments

Recreational users' complaints

Annual environmental performance review

Figure 8. Seattle Shellfish crew methodically plant geoduck seed in each tube.

Figure 8. Ulva, or sea lettuce, often foul the tubes and must be removed.

3. Harvesting the Geoduck Crop

3.1.Introduction.

Intertidal geoduck farming is a new endeavor and the harvest method or methods that will be used to remove the clam from the beaches are still evolving. However three basic methods are likely to be tried and one or two of these will probably be the standard in the future.
Geoducks at harvest size are large clams and will probably average about two pounds each. At this size they live buried in the beach substrates (sand and mud) up to three feet or more. During the harvest process the clams must be carefully extracted from the substrate to prevent broken shells, which may be more fragile for these younger clams than the older clams in the subtidal fishery, or cut siphons (necks) and other damage which would reduce the quality and value of the crop. The three basic harvest methods being considered are as follows:

Harvest with water jets at high tide with divers.

This harvest style is the same method that has been used in the Puget Sound commercial subtidal fishery for the past 28 years. The only difference is the water depth of the harvest. At high tide the intertidal cultured geoducks could be covered by water from a few feet to 18 feet depending on elevation. The non-tribal subtidal harvest occurs in water deeper than the minus 18-foot level (MLLW).

In the subtidal fishery, geoducks are harvested by divers using water jets to emulsify the substrate material immediately around the clam that allows removal by hand. The water jet is a nozzle about 18 inches long with an inside diameter of 5/8" or less. Water pressures are 100 psi or less (measured at the pump). The nozzle is inserted next to the geoduck siphon or the hole left when the siphon is retracted. A short burst of water liquefies the sediment allowing the clam to be pulled from the substrate. Water is supplied to the diver from a pump mounted on a boat anchored next to the divers. The diver places the harvested geoducks in a mesh bag and proceeds to the next geoduck to repeat the process. When the bag is filled it is hauled to the surface and the clams stored in crates. A diver can take several hundred geoducks in one day using this method. Similar nozzle sizes and water pressures will likely be used if this method is employed in the harvest of cultured intertidal geoducks.

Water jet harvest produces some adverse environmental affects that are documented in the geoduck environmental impact statement (EIS)[4]. The water jet creates a hole in the substrate by the removal of the clams, by displacement of sediments, and by the suspension of fine particles in the water. The average size hole produced is about 1/3 cubic feet. A silty plume is produced by the action of the water jet. Normally one hole is produced for each clam harvested however in areas of high geoduck density several geoducks may be taken from a small area, thus reducing the number of holes produced. Some reduction in the numbers and types of associated plants and animals occur with the geoduck harvest.

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[4] *Commercial Geoduck Fishery Management Plan and EIS, Departments of Fisheries and Natural Resources, 1985*

The effects of harvest are minimal, short-lived and not considered significant. (EIS, See footnote 4) Some minor differences may be experienced when harvesting intertidally compared to subtidally. Sediments are generally coarser intertidally so displacement of sediments and siltation are expected to be less. Species of plants and animals are likely to different between the two tidal levels.

Harvest with water jets at low tide after the beaches are de-watered.

This method involves taking geoducks with water jets at low tide by workers on the tidelands. Small gasoline powered water pumps mounted in outboard boats will be used. The boats will be positioned next to the harvest site but will remain floating in the water. Harvest nozzles may be up to two feet long and one inch in diameter. The harvester will not harvest geoduck one at a time producing single holes but will systematically emulsify the substrate with the water jet. The geoduck will float to the surface and will be picked up and packed in crates ready for transport to the plant. After the harvest the area emulsified will be slightly softer than the unharvested beach but will be able to be walked on the few minutes after the harvest. The beach level will be lowered about 1-2 inches by the harvest. The level will normally be restored naturally by wave action and sediment movement during the following few tidal cycles. The action of the water jet in the substrate will be similar to the diver harvest but no silt plumes around and above the site will be produced. Turbid water will trickle down the beach to the existing water level and produce small plumes where the water flow enters the bay. A worker will be able to harvest at least 100 geoduck per hour with this method with very few damaged clams.

Harvest by hand tools at low tide

With this method workers hand dig the geoducks from the substrates with shovels, posthole diggers or other hand tools at low tide on the beach. This method is similar to the way Manila clams and other clams have been dug for many years. Geoducks have been hand dug by sport or personal use fishers for decades in Puget Sound.

Figure 9. Crews conduct experimental hvdraulic harvest.

When a geoduck is dug by had with a shovel the sand and mud is removed from around the clam until the shell can be grasped and pulled from the substrate. A large hole in the beach results with the material from the hole stock piled alongside the hole. This can be a very difficult and time-consuming effort since geoducks are buried so deeply in the substrate. Often sediments cave in from the side of the hole making the hole larger and the amount of material to be moved greater. To prevent the cave in the holes can be cased with an open-ended pipe or tube. Even with the use of a pipe up to 10 cubic feet of material must be moved to harvest a geoduck this way. In a high-density geoduck bed it is conceivable that a trench could be dug along a group of

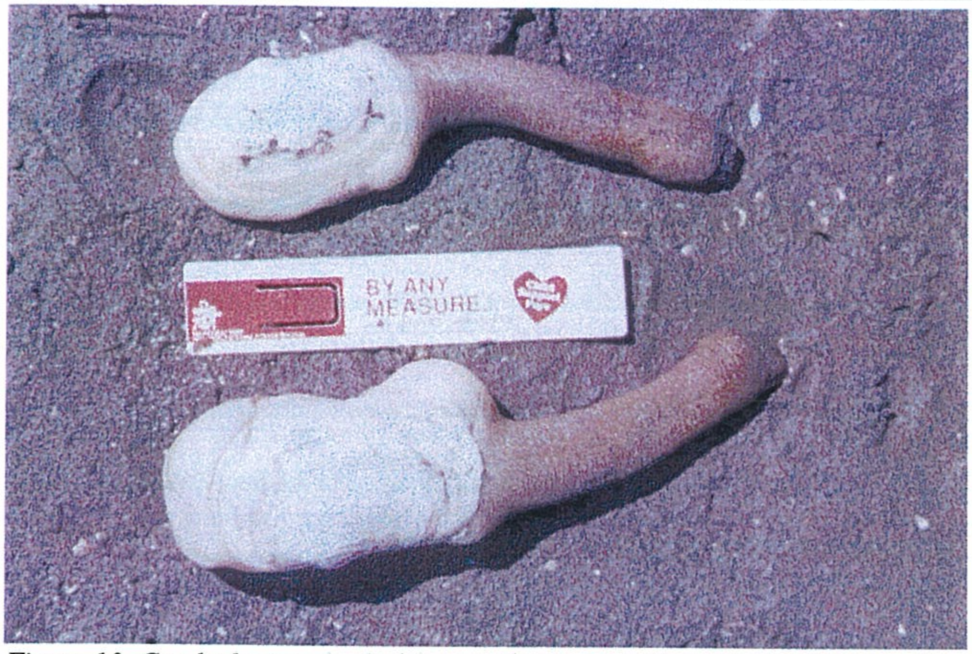

Figure 10. Geoducks are checked frequently to ensure harvest schedules can be maintained. These clams are 14 months old.

geoducks down to the level of the geoduck shell. Then the sides of the trench could be under cut and allowed to fall into the trench, thus exposing the geoducks from the side. This would eliminate the need to dig an individual hole for every geoduck. The hand-dug method will produce the least turbid water and possible siltation but will produce the greatest disturbance of substrate materials. The hand-dug method is likely to be the least efficient and most costly method.

The harvest of geoducks, aside from producing human food, jobs, and reducing the trade deficit with Asian countries, has some positive side effects. Oxygenation by any of the harvest methods can benefit beach sediments that are devoid of or low in oxygen. Oxygenating or sweetening the beach can make it more suitable for shellfish and other marine invertebrates.

The harvest of cultured geoducks can be beneficial by removing nutrients from super rich bays. Some portions of Puget Sound due to the effects of increased human populations have more plant nutrients than needed to maintain balanced and healthy phytoplankton populations. Phytoplankton take up these nutrients which are then transferred to geoducks and other filter feeding organisms. When a crop of geoducks are taken out of a bay during harvest there is a net loss of nutrients in that bay. In super rich areas of Puget Sound such as the shellfish growing areas of South Sound this net loss of nutrients by the harvest of geoducks can be a positive effect in the overall health of the South Sound region.

Harvesting the Geoduck Crop
Environmental Objectives

Minimize impacts to water quality during harvest operations.

∫ Conduct harvest activities during tides where the least amount of turbidity will occur as practicable.

∫ Maintain equipment in good working order to prevent inefficient operations.

∫ Ensure operations continue to be conducted and modified using Best Available Science. A list of relevant scientific publications will be maintained. This listing will be updated as needed to ensure Best Available Science is appropriately applied.

Minimize and/or prevent impacts to other marine life.

∫ Keep area of impact to a minimum by using properly trained employees and well-maintained equipment. Where possible, avoid direct harm to other aquatic species. Keep heavy equipment well maintained to prevent leaking of lubricating or hydraulic fluids on to the beach. Strictly adhere to regulatory-restricted time periods to protect migrating marine species.

Minimize impacts to surrounding properties.

∫ Keep noise down to a minimum as is only necessary for safe and efficient operations. Use "whisper" models of pumps, generators or other mechanical devices when available. Keep lights down to a minimum as is only necessary for safe and efficient night operations. Remove all tools and products of harvest activities from harvest site upon completion. Inform, when possible, adjoining neighbors of potential harvest activities.

Performance Measures for Harvesting the Geoduck Crop

Harvest records

Equipment maintenance records

Record of correspondence from adjacent property owners and recreational users

Measures taken as a result of complaints from adjacent property owners

Record of results of biological surveys

Record of results of vertical profiles of the water column

Annual environmental performance review

Figure 11. Upon removal of the tubes, the beds return to pre-planted condition.

4. Processing

4.1. Introduction.

Because geoduck are sold live, there is very limited processing involved in preparing the animals for market. Geoduck are trucked in baskets to our processing plant immediately following harvest. In order to keep the animals alive and as healthy as possible the geoduck are placed in a live tank system, or wetstorage, upon arrival at the processing plant. As orders are filled, individual geoduck are rubber-banded to prevent separation of the shell from the body and wrapped in bubble-wrap to prevent shell damage during shipping.

Animals damaged during harvest and transport are processed by cleaning and sectioning the body and neck meats. The meats are then packaged and frozen.

All harvest lots are tagged at the time of harvest. The tags stay with the animals through processing to the final consumer.

Figure 12. Adult geoduck.

Processing
Environmental Objectives

Minimize wastewater discharge impacts from processing activities

- Ensure compliance with wastewater discharge permits through Discharge Monitoring Reports.

Minimize potential for disease and pest transfer.

- Keep animals separated and tagged. Adhere to Washington Department of Fish and Wildlife regulations regarding off-loading, processing and transferring of product.

Market geoducks that meet National Shellfish Sanitation Programs requirements.

- Submit required samples to certified lab to ensure geoducks are below maximum allowable toxin levels.

- Harvest geoducks only from certified growing waters in the open status.

Performance Measures for Processing Geoduck

Plant records of inspections

Annual environmental performance review

5. Endangered Species and Unique Marine Areas

5.1. Salmon.

Under the Federal Endangered Species Act, several species of salmonids in Washington State were listed as "threatened." These species of concern include: Puget Sound Chinook, Bull Trout, Hood Canal Summer Chum, Coastal Bull Trout and Coho (proposed). In response to these federal listings, Washington State embarked upon a comprehensive strategy for salmon recovery.

Shellfish and salmon share a common marine environment, and as such, require us as shellfish farmers to interact with salmon and their habitat during the course of our operations. Potential habitat impacts from shellfish farming operations can be positive as well as negative. To understand the nature of these impacts, shellfish growers have promoted and supported scientific research through a variety of organizations and funding sources. Representatives from academia, industry and resource agencies join us in this effort. One of the guiding principles in Washington's Statewide Salmon Recovery Strategy is the use of best available science for developing recovery options. It is our goal to identify and prevent potential negative impacts to salmonids while ensuring the future of a viable aquaculture industry.

The shellfish industry continues to be a leader in promoting water quality protection initiatives at both the local watershed and State levels. Water quality impacts have been identified in the State's salmon plan as one of the impediments to a successful recovery. Our common goal and combined efforts in this area will benefit both fish and shellfish.

This ECOP is a first step toward ensuring compliance with the Endangered Species Act and the State's salmon recovery plan. Additional steps under consideration include development of a Habitat Conservation Plan under Federal authority or a programmatic Environmental Impact Statement under the State's Environmental Policy Act.

Endangered Species Act-Salmon
Environmental Objectives

Ensure our operations support the State's salmon recovery efforts.

∫ Adhere to federal and state guidelines for protection measures for endangered species.

∫ Promote water quality protection through participation at local and State forums.

∫ Minimize habitat alteration.

∫ Continue to promote scientific endeavors that help identify areas of impacts and viable mitigation options.

∫ Identify and expand on those activities that enhance essential salmon habitat.

Performance Measures for Endangered Species Protection

Record of salmon returns in applicable farm areas

Record of water quality participation efforts

Record of scientific studies supported by geoduck companies that address salmon issues

5.2. Eelgrass and other unique marine areas.

Several estuaries in Washington State support eelgrass beds. These beds are considered to be a critical component of the marine ecosystem in the intertidal and shallow subtidal zones. Two species of eelgrass predominate in Washington waters: *Zostera japonica* and *Zostera marina*, the former being an introduced species. Eelgrass beds are nurseries, foraging areas, refuge areas for a variety of fish, including salmon, and their prey.

A variety of bait fish species, including sand lance, smelt, and herring, use the intertidal zone for spawning. These areas are often associated with other critical marine habitats. It is the goal of the geoduck growers to identify those areas through the use of Department of Fish and Wildlife inventories and minimize impacts. Additionally, planting and harvest operations will be avoided during spawning periods. *(Below, various photos of eelgrass beds)*

Eelgrass and Other Unique Environments Environmental Objective

Avoid impacts to existing eelgrass beds

Promote scientific research of eelgrass beds and their functions and values.

Identify eelgrass beds in geoduck growing areas.

Minimize impacts to bait fish

Minimize impacts to the intertidal zone in areas of baitfish use.

Avoid conducting planting and harvesting activities during spawning periods.

5.4. Performance Measures for Eelgrass and other Unique Marine Areas Protections

Record of eelgrass beds in farm areas

Record of research proposals on eelgrass issues

Record of participation on eelgrass studies

Environmental performance reviews

6. Environmental Performance Review

6.1. Environmental Performance Checklist Introduction.

To ensure compliance with the objectives and strategies of this document, an annual evaluation will be completed for each participant grower. This evaluation will help the growers and the oversight committee identify areas where additional objectives are needed. The evaluation will also provide growers with a tool for prioritizing aspects of geoduck culture that may not be well understood and may need additional research as well as target specific environmental goals for achieving a higher level of performance.

This is a living document and will continue to evolve as new approaches, priorities, and objectives are identified.