State of Washington, Department of Natural Resources W.P.

State of Washington

Department of Natural Resources

Department of Fisheries

Management Plan for the Puget Sound Commercial Subtidal Hardshell Clam Fishery

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MANAGEMENT PLAN FOR THE COMMERCIAL SUBTIDAL HARDSHELL CLAM FISHERY

State of Washington
Department of Fisheries
Shellfish Program AX-11
Olympia, WA 98504

State of Washington
Department of Natural Resources
Marine Land Management Division QW-21
Olympia, WA 98504

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November, 1981

FOREWORD

This is the combined commercial subtidal hardshell clam fishery management plan of the Washington Department of Fisheries (WDF) and Natural Resources (DNR). These agencies have major responsibilities for management of commercial subtidal hardshell clam harvest. Each Department has prepared a plan for its harvest management program. Preparation of these plans was closely coordinated to avoid duplication of work and to ensure consistency. It was logical, then, to combine the two plans into one document so that the public could better understand the state's program.

This plan consists of three sections and an appendix. The first section states the management procedures and policies which will be used to guide tract selection, environmental evaluation, interagency coordination, harvest monitoring and enforcement. The second section, prepared by WDF, gives background information on clam biology, the fishery, and management objectives. The third section, prepared by DNR, discusses the Department's marine land management objectives and their relationship to management of commercial hardshell clam harvest. The fourth section of the plan is the appendix. This contains background material and program documents which will need periodic updating.

Management of the subtidal hardshell clam fishery is not static. Changes in the market demands and economics affect the fishery and its management as do knowledge of the biology and population dynamics of the hardshell clam resource and the fluctuating social and political climate. Given this situation, this document is intended as a flexible outline for the management of this clam fishery. Changes and improvements are anticipated and will be made through the mutual consent of the co-managers of the fishery - the Departments of Fisheries and Natural Resources.

Glossary

Bed - A relatively contiguous dense assemblage of clams - may be a few to several hundred acres.

Bed, Commercial - A major bed which is suitable for harvest based upon technological, economic and environmental criteria.

Bed, Major - A clam bed having greater than 0.25 lbs/sq.ft. of harvestable clams

DNR - Department of Natural Resources.

DOE - Department of Ecology.,

MHW - Mean high water - 4.2-14.0 feet feet above MLLW in Puget Sound.

MLLW - Mean lower low water - 0 tide level.

MSY - Maximum sustainable yield - the maximum annual harvest which can be taken each year, year after year.

Optimal Yield - The maximum sustainable yield adjusted for relevant environmental, economic and social factors. Also, the yield which produces the greatest net benefit to the citizens of the state.

RCW - Revised Code of Washington - state laws passed by the legislature.

Recruitment - The entry of new clams into the harvestable population. It is those clams which are spawned, and then grow and survive to replace clams lost to natural mortality and to fishing.

SEPA - State Environmental Policy Act of 1971 (RCW 43.21).

Shoreline Master Plan - County plan for shoreline use as mandated by the Shoreline Management Act and included in WAC 173-19.

SMA - Shoreline Management Act of 1971 (RCW 90.58).

Tract - A defined section of a commercial clam bed which is leased for harvest by Department of Natural Resources.

WAC - Washington Administrative Code, departmental regulations.

WDF - Washington Department of Fisheries.

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INTRODUCTION

Puget Sound contains a vast renewable resource of high quality protein in the form of subtidal hardshell clams. This is a resource which has only partially been utilized and which may never be utilized to its full potential without coordinated action by state, local and federal agencies. Over 170 million pounds of subtidal hardshell clams are estimated to be on clam beds of commercial density, but only a small proportion of these beds are suitable for harvest given current technology and environmental limitations. Still it is estimated that the fishery could produce over 2 million pounds per year. Not only is this fishery a potential source of food, jobs and income, but it also provides a strong economic justification for maintenance of the high water quality in Puget Sound which is essential to the culture and production of shellfish as well as the enjoyment of all who use the water.

The Department of Natural Resources (DNR) manages subtidal clam harvest in cooperation with the Department of Fisheries (WDF). DNR is authorized to lease lands for this use by RCW 79.01.568 which states that, "The beds of all navigable waters in this state lying below extreme low tide ... shall be subject to lease ... for the purpose of planting and cultivating clams or other edible shellfish, or for other aquaculture use, for periods not to exceed ten years." The Washington Department of Fisheries is responsible for managing and protecting the clam resource. RCW 75.28.282 requires that owners and leasees operating clam farms obtain clam farm licenses. RCW 75.28.287 requires that a license be obtained for mechanical and hydraulic devices operated for the purpose of taking clams from the beds of navigable waters in Washington.

In practice, DNR and WDF work closely together in making areas available for harvest. The WDF conducts surveys of subtidal clam beds to identify those which are suitable for commercial harvest. WDF recommends these beds to the DNR which leases the grounds. The leases are written in cooperation with WDF to ensure that the leases support the WDF fishery management program.

The species involved in subtidal commercial hardshell clam harvest are butter, native littleneck, and horse clams. Cockles may also be taken but these are encountered infrequently and in limited numbers. Harvesting is restricted to designated subtidal tracts located seaward of the extreme low tide line. These clams are beyond the reach of sport clam diggers except for SCUBA divers.

The most often used equipment for harvest of subtidal hardshell clams is a boat with a hydraulic escalator attached. The escalator harvester is fitted with water jets which loosen the bottom material to a depth of 12 to 18 inches. The loosened material is washed onto a conveyor belt of one inch steel mesh which permits sediment and smaller clams to fall through onto the bottom. Clams, gravel, shell and other material too large to pass through the mesh are carried to the surface. Harvestable clams are collected and the other debris drops back into the water.

This management plan is based on the assumption that the hydraulic escalator harvester will continue to be the dominant harvest method. The environmental impacts of harvest with this equipment are fairly well understood. Another harvest technique using a diver-held venturi suction device is used near Point Roberts. However, the economics and environmental effects of this method have not been adequately evaluated and a fishery based on harvest completely submerged and out of sight would lead to new enforcement problems. Therefore, venturi harvest is treated as a method with limited applicability for the foreseeable future.

This plan sets out specific procedures for long and short range planning, harvest monitoring and fishery management enforcement and enhancement. These procedures should improve interagency coordination and early identification and mitigation or elimination of adverse site related environmental impacts. In 1978, DNR and WDF wrote a programmatic environmental impact statement (EIS) (Vining 1978) for commercial harvest of subtidal hardshell clams with a hydraulic escalator shellfish harvester. Each tract proposed for lease will be evaluated under SEPA and site specific supplemental environmental impact statement will be written.

SECTION I - MANAGEMENT PROCEDURES AND POLICIES

The following procedures will be followed by the Departments of Fisheries and Natural Resources when assessing the proposed subtidal hardshell clam tracts for commercial harvest. These procedures are intended to ensure an adequate environmental evaluation of the tracts before harvest and consideration of the concerns of local citizens and residents relative to the proposed harvest.

Identification and Allocation of Subtidal Hardshell Clam Beds for Eventual Harvest

1. The Department of Fisheries has provided the Department of Natural Resources with a list of subtidal hardshell clam beds in Puget Sound suitable for commercial harvest. Forty-seven major beds have been identified of which 14 are presently considered to be suitable for harvest. These beds must meet the following criteria:
   a. Beds are in shallow water and accessible with current harvest gear.
   b. Clams occur in high densities suitable for harvest.
   c. Substrate is suitable for harvest.
   d. Beds are free from pollution and certifiable by the Department of Social and Health Services.
   e. Harvest will not interfere with other human activities or create long-term, adverse impacts on the surrounding environment or on important habitats.

2. The Department of Natural Resources will allocate these beds for future clam harvest. It is assumed that all subtidal hardshell clam beds meeting these criteria will eventually be harvested. DNR will maintain maps as Appendix A of this plan showing the areas in Washington which are allocated for commercial harvest of hardshell clams. The maps will be updated as necessary to reflect discovery and addition of new beds, and reevaluation and deletion of previously allocated beds.

3. The Department of Natural Resources will maintain as Appendix B of this plan a summary of the current environmental information on each tract. This summary will be updated as new information becomes available.

4. The maps and environmental summaries will be circulated by DNR to interested agencies. These agencies will be encouraged to inform DNR of any potential conflicts with clam harvest at these sites and to prevent pollution or other damage of these beds.

5. The Departments of Fisheries and Natural Resources will not allow uses under their control other than commercial clam harvest to occur within the hardshell clam beds shown in Appendix A, unless the use will not conflict with this harvest or unless the Departments determine that the public benefits of the other use outweigh the loss of the clam harvest. The alternative use will be required to pay for the value of the resource withdrawn from use (WAC 332-30-125(7)). DNR will not normally approve leases for activities which might pollute or destroy commercial clam beds.

6. The Departments of Fisheries and Natural Resources will encourage local governments to require adequate point and non-point source pollution controls for development near allocated clam beds and especially those which the Department of Social and Health Services has identified as being at risk (see Appendix B).

7. Consideration and evaluation of specific clam tracts for harvest will be initiated by:
   a. A prospective harvester submitting a request to DNR.
   b. DNR initiating the evaluation. DNR intends to eventually bring all suitable clam beds under harvest and will, at its convenience, propose specific tracts for evaluation and eventual harvest.

Environmental Assessment and Interagency Coordination

1. Upon request for tract evaluation, WDF and DNR will meet with county officials to present the proposal, to solicit county concerns and anticipated requirements, and to organize a public meeting. WDF will request comments on the proposal from the various state and federal agencies which have particular interests or expertise in the fishery. These agencies are listed in Appendix C.

2. A public meeting will be held near the proposed harvest site well in advance of the lease date. Notice of this meeting will be given to a local newspaper, to interested local, state, and federal agencies, and to the subtidal hardshell clam industry. At the meeting, DNR and WDF will review the programmatic EIS and any other available information about the subtidal hardshell clam resource, harvest operations, and potential environmental impacts at the site. The audience will be asked to point out any concerns about the proposed harvest. A mailing list will be started for those who wish to review the draft supplemental EIS.

3. DNR and WDF will conduct environmental investigations giving special attention to issues raised in steps 1 and 2 above. WDF is responsible for evaluating the effect of harvest upon the marine environment. WDF will conduct diver surveys of the tract to assess the economic potential, the resource abundance, and the environmental suitability of the tract for harvest based on the criteria presented in the programmatic EIS and WAC 220-52-018 (Appendices D and E present the pertinent laws and regulations of the Departments of Fisheries and Natural Resources, respectively). Site specific studies will be conducted to answer questions identified by WDF, DNR, local officials, state and federal agencies, and through public input. Participation by these agencies in the surveys will be encouraged. WDF will prepare a written evaluation of the environmental suitability of the tract including:

1. Clam abundance, species composition, population structure, estimated value.
2. Abundance and distribution of eelgrass on the tract.
3. Presence and abundance of any unique or important biota.
4. Results of substrate analysis.
5. Other information as needed or specified through agency and citizen review and input.
6. Anticipated harvest effects.
7. Recommended harvest limitations to minimize adverse environmental impacts (adjustment of tract boundaries, seasonal restrictions, etc.)
8. Recommendation to lease or not lease tract.

4. DNR will evaluate environmental impacts of harvest on other marine activities and the shoreline community. This will include noise monitoring in the tract vicinity and surveys of activities and developments in the area. DNR will prepare draft and final environmental impact statements in accordance with the procedures contained in Appendix F. During this process, boundaries of individual tracts and any necessary restrictions on harvest will be determined. If there is sufficient public interest, DNR and WDF will hold public hearings or meetings to discuss the findings of any draft supplemental EIS prior to preparation of the final. DNR will apply for the Shoreline Substantial Development permit and U.S. Army Corps of Engineers permits.

5. Before harvest begins, WDF and DNR will hold a public informational meeting in the neighborhood of the harvest operation to discuss what is involved in clam harvesting; what the local residents may expect; the benefits and effects of clam harvesting; the regulations, conditions, and limitations with which the harvester must comply; enforcement responsibilities; and whom to contact concerning questions, violations, etc. WDF and DNR will also make personnel available for public meetings, presentations, etc. upon request of the community. The tract operator will be encouraged to attend these meetings.

6. At any point prior to the issuance of a DNR tract harvest lease agreement and WDF clam farm license, this procedure may be terminated by WDF or DNR if present environmental circumstances are deemed to preclude harvest.

Conditions During Harvest

1. While the state noise emission standards set maximum levels, lower noise levels may be desirable due to special local circumstances. Site evaluation and harvest monitoring will pay special attention to the need for noise reduction and to compliance with noise standards. Leases will specify whether special noise standards, hours of operation, or other measures will be imposed to control noise.

2. DNR will ensure that all tract boundaries are clearly defined so that the harvester and shoreline residents can both see the boundaries. DNR will establish sight lines for tract boundaries which are keyed to natural landmarks or to markers set on shore. DNR will also establish or require the harvester to establish buoys to mark the landward tract boundary.

3. Harvest will be managed so as not to interfere with military exercises or with navigational uses.

4. Harvest activities will be managed so as not to interfere with the migrations or spawning of salmon, herring, surf smelt, or other important fish.

5. Failure to comply with contractual requirements during the lease term will be grounds for cancellation or non-renewal of the lease.

6. Detailed leasing procedures are being developed by DNR. These will be distributed for public review before implementation.

Monitoring and Enforcement

1. WDF is responsible for monitoring and assuring compliance with DNR lease conditions and with WDF permit conditions for harvest. Fisheries patrol officers are specifically assigned to the subtidal clam fisheries

(including geoducks) and are supplemented by other WDF patrol officers and local law enforcement officers. WDF enforcement personnel will routinely inspect the harvester and its operations to determine that harvest is in compliance with pertinent laws and regulations and with applicable permit requirements. Specific observations will include:

a. Checking boundary marker locations.
b. Checking harvest machine operation for compliance with WDF regulations.
c. Ensuring that harvest is in compliance with shoreline and Corps of Engineers permits.
d. Checking harvest logs and other required reports.
e. Sampling harvested clams to determine that small or immature clams are not harvested.

WDF enforcement personnel will also be available to investigate specific complaints.

2. WDF divers will periodically survey harvest tracts to monitor harvest effects, improper harvest operations, subtidal trespass, incursion into eelgrass, etc. Studies and additional monitoring will be conducted as needed, or as required under the conditions of the Shoreline or U.S. Army Corps of Engineers permits.

3. WDF will prepare an annual summary report of harvest activities for each tract which will include:
   a. Pounds of clams landed.
   b. Catch per unit effort on tract.
   c. Size composition of catch.
   d. Hours and days of harvest.
   e. Results of diver surveys.
   f. Results of progress of studies and special monitoring.
   g. Summary of complaints, violations, and their disposition.

   This report will be sent to interested agencies and citizens. If requested, DNR and WDF will meet with local officials to discuss the report and answer any questions.

SECTION II - DEPARTMENT OF FISHERIES

INTRODUCTION

Background of Controversy

In the late 1950's, the Hank's hydraulic harvester was introduced into Puget Sound from the East Coast. This device permitted harvest of the previously unexploited subtidal clam resources of Puget Sound and provided the basis for a new fishery. At the peak of the fishery, four harvesters were operating in Puget Sound and in 1977 harvest reached 1,008,000 pounds. Estimates of the annual harvest which could be sustained indefinitely from the commercially available resource are 2-2.5 million pounds.

During the same period that this fishery was developing, the public was demonstrating its increased environmental awareness and concern over the uses of our natural resources. This lead to the implementation of the State Environmental Policy Act (SEPA) and the Shorelines Management Act (SMA) in 1971. SEPA requires the identification and publication of the significant environmental effects of decisions made by state and local agencies, thus opening these decisions to public review. The Shoreline Management Act mandates local government to establish policies for the use of the shorelines and marine waters within their jurisdiction. These policies, as Shoreline Master Programs, have the force of law and are used to regulate development and to decide what activities are appropriate in these areas. These two laws give the local government considerable power to control their shorelines.

During this same time frame another change was occurring. For centuries Puget Sound has been used as a source of food and as a means of transportation. Over the last few decades, with the influx of people to the area and the expanding economy, the shorelines have become used more and more for residential and recreational activities. Those people who live along the shores have a major interest in the activities which take place in the waters before them - activities which can affect their property values, the aestetic values for which they selected their homesites, and the general environment of the area. With SEPA and especially SMA the residents have a vehicle for expressing their interests and deciding which competing uses of the shoreline resources will prevail.

The new-found rights of the shoreline resident have not had much effect upon the traditional fisheries in Puget Sound. For the most part these fisheries are accepted and, for many, enhance the local atmosphere.

Mechanical hardshell clam harvest does not have this history on Puget Sound, unlike the East Coast where hundreds of such boats have operated for the last 30 years. The boats and gear used in the fishery are perceived as unusual and unsightly by some. They are slow moving, have tended to be noisy and, unlike most fisheries often work close to shore for prolonged periods. In addition there has been concern over the environmental effects of harvest.

The harvest of subtidal clams is a controversial issue of particular concern to shoreline residents. In some cases the Departments of Fisheries and Natural Resources have worked together with the local county and citizens and with the clam harvester to resolve many of these concerns, thus harvest has been allowed. In a few counties, however, subtidal clam harvesting has been strongly opposed by shoreline residents and by the county. This has lead to a confrontation with the state over the use of the clam resource, over the respective authorities of the state and counties to manage this use and over the relative benefits of harvest to the citizens of the state versus its impacts on the local community.

These counties contend that clam harvest must be limited or prohibited to protect the rights of the shoreline residents. WDF and DNR contend that under their management the commercial harvest of subtidal clams will not infringe on any legal rights and that the benefits to all the citizens of the state through the generation of food, jobs, trade, etc. justify the limited inconvenience to other shoreline users. Also, because the clam stocks do not recognize county boundaries, rational management for the most beneficial use of the resource and for its protection necessitates management on the basis of the state-wide resource, and not county-by-county. WDF also feels, based upon its own studies, that the environmental effects of properly conducted hydraulic clam harvesting are temporary and do not significantly impact the marine environment.

Objectives of Management Plan

As with many issues pertaining to the marine environment, no single agency

or entity has exclusive jurisdiction over clam harvest and responsibilities for its management and control are shared by many agencies. To resolve the problems surrounding subtidal clam harvest will, therefore, necessitate the combined efforts of all the parties involved. As part of this effort the Department of Ecology has revised its Shoreline Management Guidelines pertinent to aquaculture and the counties are presently revising their Master Plans to better address the issues of mechanical clam harvest. To assist in this process, WDF and DNR have each preparing management plans for their respective functions in the subtidal clam fisheries to present their management goals, rational and to better address local concerns. WDF's objectives in preparing its management plan for the subtidal hardshell clam fishery are: (1) to document the goals and intent or WDF's management of this fishery; (2) to provide a source of information for the fishery and its management; (3) to ensure adequate environmental review of the proposed harvest operations; and (4) to provide a mechanism for improved citizen and agency participation in the management of the fishery. It is hoped that this plan and the activities proposed in it will lead to improved cooperation and communication between the various agencies and groups interested in the fishery and ultimately allow the full, rational utilization of this resource.

Management Plan Implementation

This plan will be implemented through adoption of its basic elements into the regulations of the Department of Fisheries, as appropriate. The management plan and codified procedures will then serve as the basis for future management and resource allocation decisions. Copies of the plan will be distributed to the interested parties, agencies, and libraries in those counties having commercial hardshell clam resources. This plan has been prepared in close cooperation with the Department of Natural Resources to ensure that it is complimentary and consistent with their plan for management of the subtidal hardshell clam beds.

The Hardshell Clam Resource

Species Harvested

The commercial subtidal hardshell clam harvest is based upon four species - the butter clam (*Saxidomus giganteus*), the native littleneck

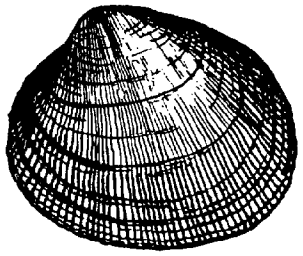
(Protothecа staminea) and the horse clam (Tresus nuttalli and capax) (Figure 1). The primary species is the butter clam which has traditionally supported major sport and commercial fisheries in Washington and British Columbia. It may reach 6-inches in shell length and is notable for its heavy, eggshaped shell and concentric rings. The shell is usually chalky white, but may be brownish or bluish-gray depending upon the substrate type. Another notable feature of the butter clam is the short, black-tipped neck.

The native littleneck clam is the most valuable per pound of the three species (wholesaling for up to $1.00/lb) and is "farmed" extensively in northern Puget Sound and Discovery Bay on intertidal beaches. This species reaches sizes up to 2-1/2 inches long. The shell is rounded to slightly oval and is generally white, although clams may have almost geometric patterns of light brown. The shell also has prominent radiating ridges in addition to the concentric growth rings.

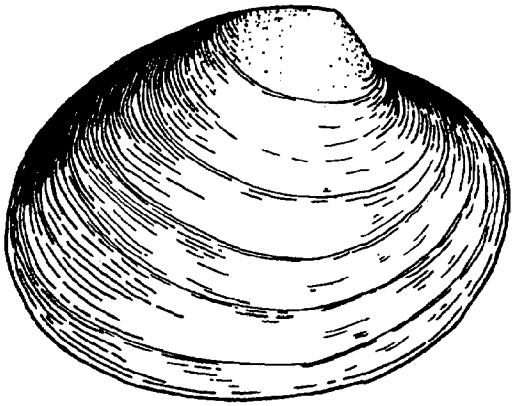
The horse clams are the largest of the species harvested (up to 8-inches and 4-lbs.) and have only recently become a desired species for commercial harvest. The clams are readily distinquishable by the large neck which cannot be completely retracted (giving them the common name "gaper clam") and is often mistaken for a geoduck. On the beach the horse clam is readily distinquished from a geoduck by the presence of two leathery flaps on the end of the siphon which are absent on the geoduck. The shell is chalky white with a thin brown skin or periostracum, especically near the edges. The shell is also enlarged at one end to accomodate the large siphon. Tresus nuttalli is distinguished from T. capax by the asymmetrical shell which is elongated towards the siphon end. T. capax is the species most frequently harvested in this fishery.

Abundance and Distribution

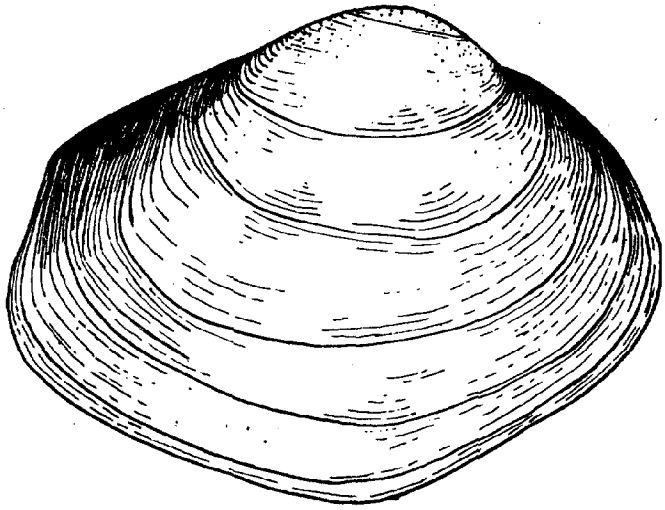
These species are generaly found in the same areas, with similar substrate preferences and ranges. All four clams generally range from California to Alaska, being found on the mid to low intertidal beaches out into shallow subtidal areas. The littleneck is found highest on the beach, up to the mid-intertidal area while the butter clam prefers lower beach heights where it spends more time in the water. The horse clams, which cannot seal their shells



Native Littleneck Clam
(Protothaca staminea)



Butter Clam
(Saxidomus giganteus)



Horse or Gaper Clam
(Tresus capax)

Figure 1. Shells of the three commercially harvested subtidal hardshell clam species. Drawn at about one-half scale.

are least adapted to being out of the water, and are found low on the beach. All these clams reach their peak abundance in the low intertidal and shallow subtidal areas. Both clam abundance and clam density decline rapidly beyond 30-feet below MLLW (Goodwin 1973).

The distribution of the clams is quite patchy, dependant upon the presence of suitable substrate which may be the factor limiting hardshell clam abundance. The dominant clams harvested prefer a relatively coarse substrate comprised of shell and gravel with some mud for stability. Tresus nuttalli, however, is usually found in almost pure sand. Areas of coarse substrate are limited - occurring only where strong currents remove the finer materials, or in intertidal and shallow subtidal areas where wave action has a similar effect. Slight differences in substrate preference cause various mixtures of the three species from almost pure, single species beds to any combination or proportion of the three. This allows a commercial harvester to control which species is harvested by selecting a particular bed or part of a bed for harvest.

Beginning in 1967 WDF began detailed inventories of the subtidal hard-shell plan population in Puget Sound. The inital results were reported in WDF Technical Report No. 14 (Goodwin 1973) and then updated to 1977 in Progress Report No. 44 (Goodwin and Shaul 1978). Sample areas were generally limited to those areas less than about 70-feet deep which had sufficient water movement and suitable substrates to support major clam beds.

While all three species are found intertidally throughout the Puget Sound most of the subtidal clam resource occurs in Admiralty Inlet, North Hood Canal, Central Sound with few subtidal hardshell clams being found in southern Puget Sound. No estimate is available for the total number of hard-shell clams in Puget Sound. The WDF surveys have, however, discovered 5,350 acres of major subtidal clam beds having clam densities greater than 0.25 lb./sq.ft. These beds represent 170 million pounds of clams - 114 million pounds of butter clams, 28 million pounds of littleneck clams, and 27 million pounds of horse clams. The major beds are listed in Appendix G. Beds allocated for commercial harvest by DNR are shown in Figure 2. The tract numbers refer to Appendices A and B.

The preparation of this report was financially aided through a grant from the Washington State Department of Ecology with funds obtained from the National Oceanic and Atmospheric Administration and appropriated for Section 306 of the Coastal Zone Management Act of 1972

Figure 2.

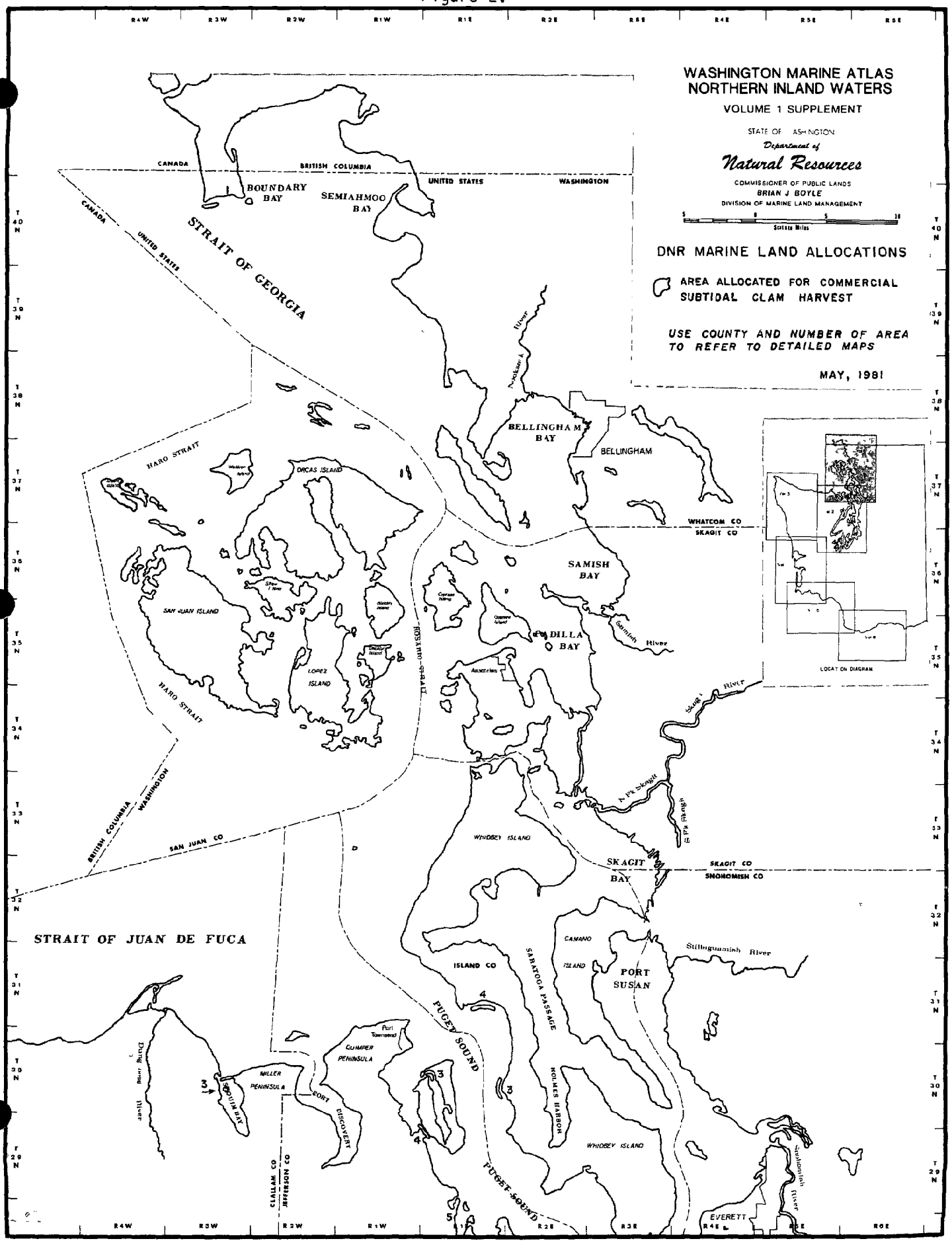


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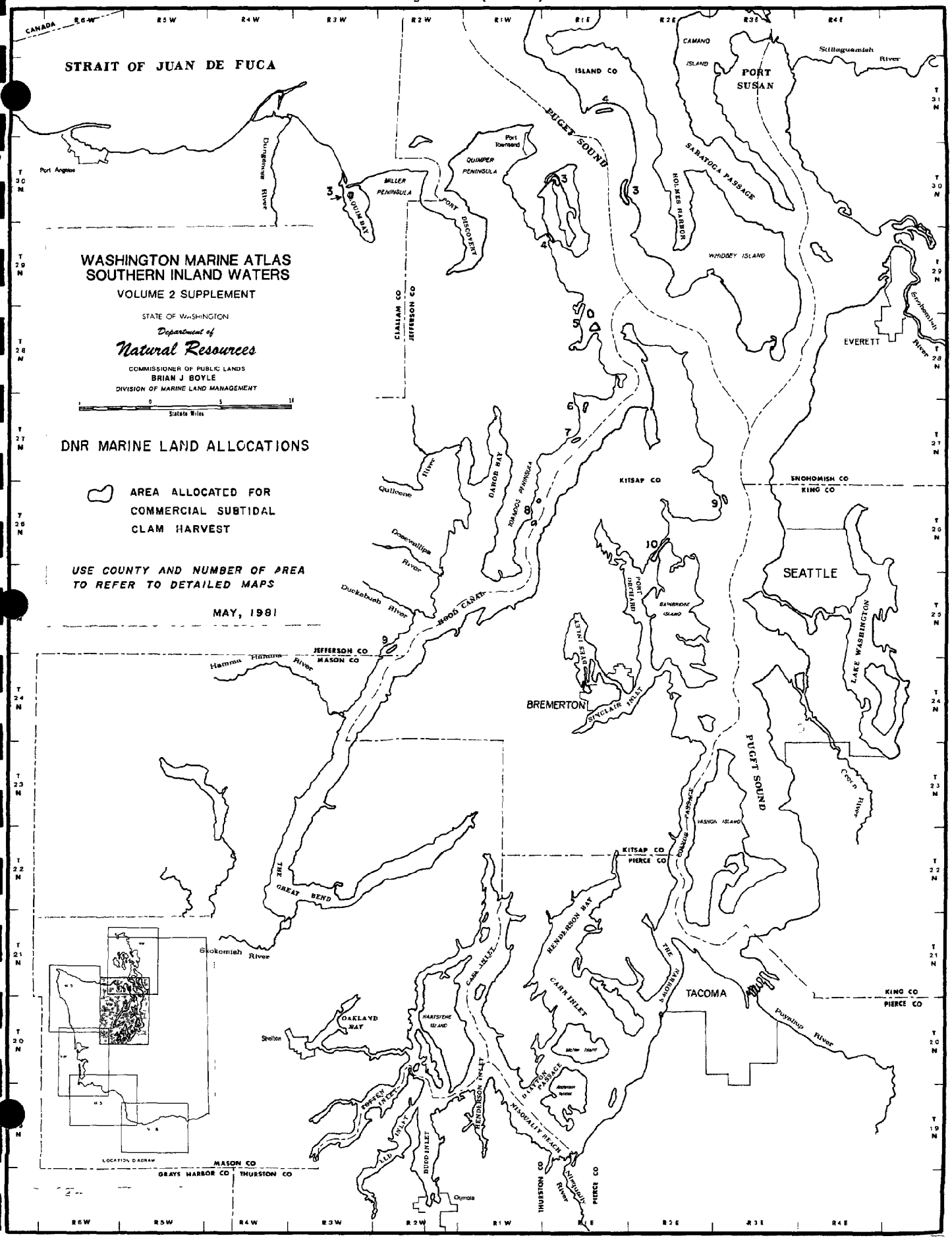
Figure 2 (Cont.)



Biology

Anatomy. Although the three species are externally distinct, their internal anatomy is quite similar (Figure 3). The most obvious features of the internal anatomy are the siphon or neck, which provides a tube to the surface through which water is inhaled and discharged to bring in food particles. The neck is muscular and can be quickly retracted. Neck length among and within species is variable depending upon borrow depth.

Food particles are filtered out of the water by specially modified gills. Much of the clam is composed of digestive and reproductive tissue and the thin mantle which lines the shell. Also present are the two adductor muscles which close the shell and the muscular foot which is used for burrowing.

Feeding. Clams are highly specialized and very efficient filter feeders relying on plankton in the water for nutrition. Plankton-rich water is sucked in through the inhalant siphon by the beating of the fine cilia on the highly developed gills which filter out and concentrate the food particles. The gills are very selective as to the size of the food particles filtered - with single cell algae and bacteria generally preferred. To collect sufficient food, a clam must pump large volumes of water (e.g., an oyster may pump 150 gal./day). The rate of feeding increases both when food is more abundant and when the water is warmer (Walne 1972) and is, therefore, greatest during spring, summer and fall. Feeding slows or ceases during winter when plankton abundance and water temperature drop. Inedible material and oversized particles filtered by the clam are mixed with mucous and expelled.

Growth. The general pattern of clam growth is rapid growth between about March and October when temperatures increase and plankton abundance is greatest, followed by much slower growth or a cessation during winter when temperature and food supplies decline. This pattern of growth is often shown in the shell as rings indicating the slowed growth during the winter. Careful counting

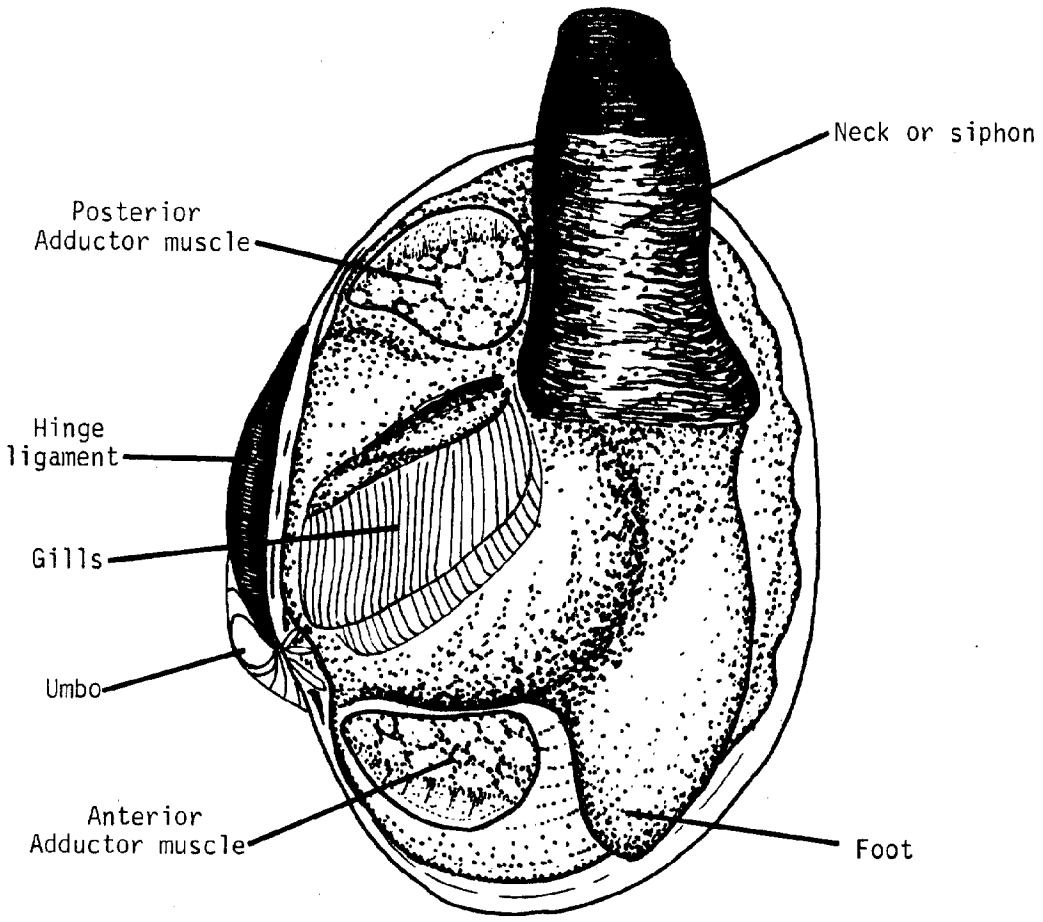


Figure 3. Body parts of a typical clam.

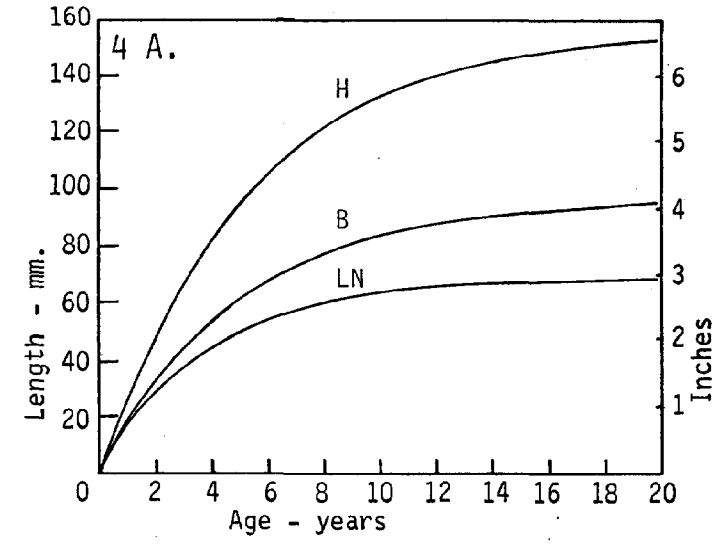
of these rings provides the age of clams just as in aging trees. Environmental conditions can greatly affect the rate of growth and the age at which a clam reaches harvestable size. During the series of warm years a littleneck clam, for example, in some parts of Puget Sound may approach harvestable size in about 2 years. In other areas or during a series of cold years this could take 5 years.

Figure 4 compares the growth of intertidal horse, butter and littleneck clams from the Strait of Georgia, British Columbia (Quayle and Bourne 1972). These figures should be fairly representative of Puget Sound, although these growth rates may be slower than those locally. The littleneck clam is the smallest of the three reaching only about 2-1/2 inches maximum shell length. Sexual maturity in clams is a function of size, and littleneck clams reach maturity when about 25 mm long, usually within 2-years. They are usually harvested 1 to 2 years later at a size of about 40 mm.

Butter clams grow faster but enter the fishery at a larger size. Butter reach sizes of up to 4-inches reaching sexual maturity at about 35 mm (2-1/2 years) and harvestable size of 60 mm at 4-5 years. Horse clams are the largest and fastest growing of the clams reaching sizes up to about 6 inches (150 mm) long. Sexual maturity occurs at around 70 mm (3 years). Again harvest occurs about 2 years after maturity - allowing 2 years of spawning before harvest at a size of about 4-inches (100 mm).

Figure 4B shows clam growth in terms of whole weight. Weight gain in very young clams is relatively slow, as it is for older clams with the rate of growth reaching a maximum at intermediate ages when the accumulation of weight is greatest per year (Figure 4C). Littlenecks reach their maximum growth at about four years of age at which point a clam would gain about 12 grams per year. Butter clams' maximum growth rate is about 23 grams/year when 5-6 years old while horse clams gain over 70 grams/year at peak growth at about 6 years. In all cases, the clams reach maximum growth shortly after reaching harvestable size.

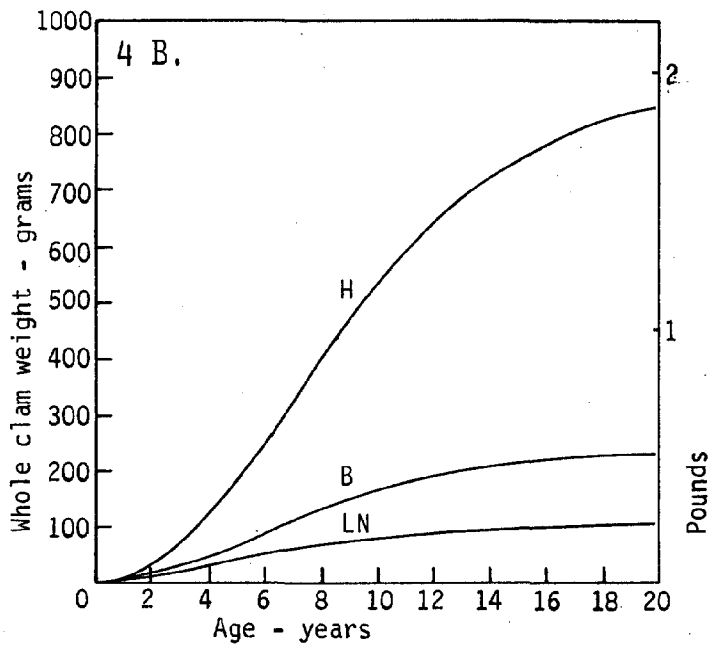
Reproduction. Clams, like many sessile organisms, are broadcast spawners simultaneously releasing eggs and sperm into the water column where fertilization



LN - Littleneck clam

B - Butter clam

H - Horse clam



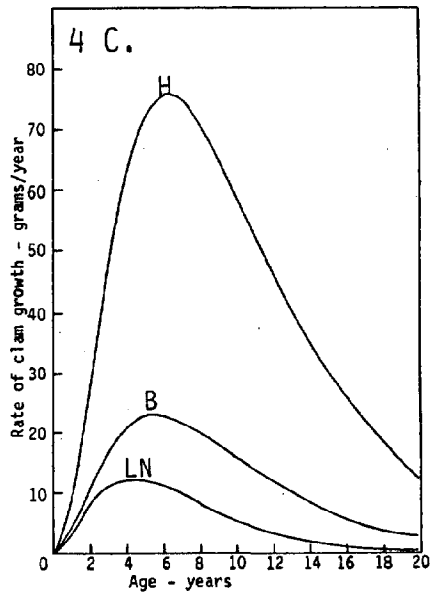


Figure 4. Growth of the three commerical hardshell clam species.
4 A. Growth in shell length
4 B. Growth in weight of the whole clam
4 C. Annual rate of growth

occurs (Figure 5). During the year the gonads develop and enlarge, then when the proper environmental circumstances occur, especially water temperature and food abundance, spawning occurs. In a ripe population the sex products in the water stimulate further spawning and thus ensures that the sperm and eggs are in the water at the same time to maximize the chance of successful fertilization. Depending upon species and clam size, a single female clam may release many million eggs during a single spawn.

For each species there is generally one time of the year when most spawning occurs. Smaller sporadic spawns may occur during other times, especially during warm summers when the clams may recover from an early spawn in time to spawn again. Littleneck clams generally spawn in early spring and may spawn sporadically during the summer. Butter clams spawn in late spring and sometimes again in late fall. In British Columbia *Tresus capax* spawns in late winter and early spring while in Humboldt Bay, California spawning is as early as January (Breed-Willeke and Hancock, 1980).

Larval Development. Immediately upon fertilization, the eggs divide and rapidly develop into free swimming larvae. The larval period generally lasts 3-4 weeks depending upon species, temperature and food availability. The larvae go through a number of developmental stages, feeding on small plankton. Swimming ability is limited and the larvae are carried with the currents which may disperse them many miles from their parental beds.

At some optimal size (about .25-.30 mm or 0.01 inch) the clam settles to to find a suitable substrate. Upon settlement, the clam temporarily adheres to a pebble or piece of shell with a byssal thread. As the clam grows, it burrows deeper into the substrate, with the depth of the burrow limited by the length of the siphon. The clam burrows are generally permanent with additional burrowing occurring only if the clam is disturbed or removed. Large butter and littleneck clams can burrow only with great difficulty and mature horse clams may loose all ability to reburrow.

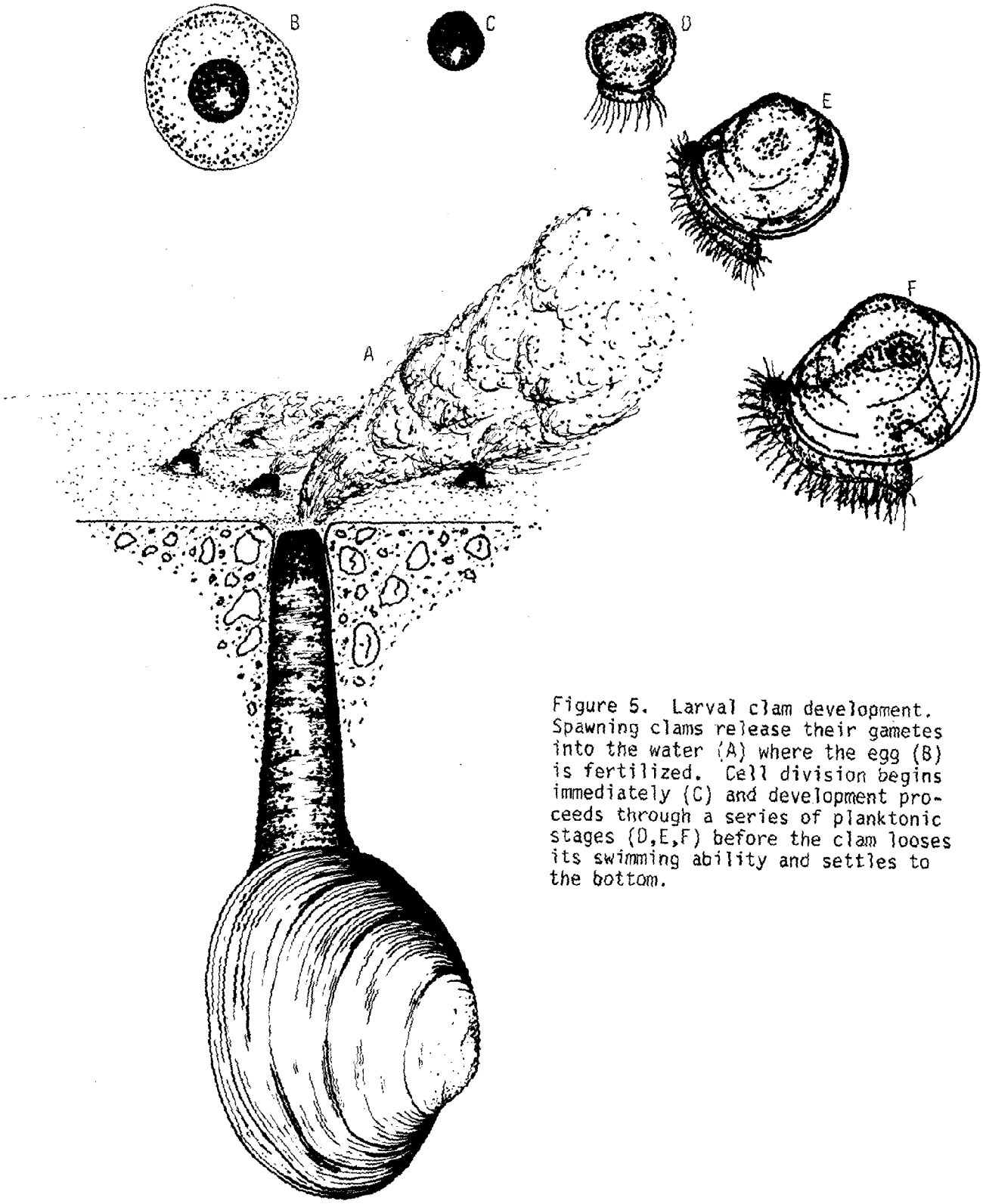


Figure 5. Larval clam development. Spawning clams release their gametes into the water (A) where the egg (B) is fertilized. Cell division begins immediately (C) and development proceeds through a series of planktonic stages (D,E,F) before the clam looses its swimming ability and settles to the bottom.

Mortality

Upon burrowing, the clam passes out of the most dangerous stage in its existance. As larvae the clams are highly susceptable to predation by small fish, crustaceans and even other filter feeders (including clams). They may also be carried by currents into deep water or other areas which are not suitable for settlement. The chance of survival to settlement for these larvae is probably less than one in a thousand.

Upon settlement, the clam's chance of survival improves but it is still vulnerable to predation, damage from shifting substrates, etc. Even adult clams, are not entirely safe. Siphon tips may be eaten by bottomfish or crabs. Crabs may dig into substrate to attack clams - especially the red rock crab (*Cancer productus*) which will carefully break away the thin edge of the shell to reach the meat. Another major predator of hardshell clams are starfish, which wrap around the clam and exert a constant pressure to open the shell until the clam's adductor muscles tire. Once the clam is open slightly the starfish everts its stomach into the shell and begins initial digestion. Final digestion occurs in the internal stomach.

Perhaps the most specialized predator on clams is the large moon snail *Pollinices lewisii*. The moon snail moves randomly through the substrate until a clam is found. The snail then drills a neat, counter-sunk hole in the clam shell with its rasp-like tongue. This hole is almost always near the apex of the shell (umbonal region), usually on the left shell. The clam is then killed or immobilized with a toxic injection before it is eaten. Littleneck and butter clams are the most common food of the moon snail with horse clams only rarely attacked - perhaps because of their depth in the substrate.

Horse clams frequently host commensal pea crabs (*Pinnotharid sp.*). These clams live in the mantle cavity and may reach sizes up to one inch long, but do not harm the clam. Pea crab sometimes inhabit butter clams also. Clams are also occasionally hosts to parasitic worms. The incidence of infection appears to be rare and poses no danger to human consumption.

Pollution and Toxicity

Because clams are such highly efficient filter feeders, human pathogens, in the water can be concentrated to dangerous levels by the clam can and pose a threat to those who eat the clams. Of particular concern is pollution by bacteria and viruses from improperly treated sewage, leaking septic systems, agricultural run-off, etc. These pathogens may include Salmonella, infectious hepatitis and other bacteria and viruses. Another concern which has recently become a major problem in Puget Sound is the planktonic dinoflagellage Gonyaulax cantenella, the causitive organism of paralytic shellfish posioning (PSP) or "Red Tide". Although "red tide" may be caused by a variety of planktonic red algae, only those caused by blooms of Gonyaulax, which contain a powerful neural toxin, are dangerous. Clams usually feed on Gonyaulax without effect, concentrating the toxin. If these clams are eaten and sufficient toxin ingested, they can be lethal. PSP is generally a problem only during the summer or warm weather.

Because of the health hazards, all commercially harvested clams are carefully monitored by the Department of Social and Health Services. Before any harvest is allowed the area must first be certified as free from pollution by DSHS on the basis of strict federal standards for shellfish sanitation. Fecal coliform levels above 230 per 100 g of clam tissue or 14 per 100 ml of water will result in decertification, as will close proximity of the beds to potential sources of pollution - e.g., sewage outfalls, marinas, etc.

DSHS also monitors for PSP. The occurrence of dangerous levels of Gonyaulax are quite sporatic and unpredictable. DSHS, following federal guidelines, regularly monitors beaches around Puget Sound. If the paralytic shellfish toxin exceeds 80 mg/g of tissue commercial harvest is stopped by the DSHS and the general area around that beach is closed to recreation shellfish harvest by the local health department. Since 1942 the Washington Coast and Strait of Juan de Fuca have been routinely closed to all recreational clam and oyster harvest, except razor clams, between April 1 and October 31. In recent years major portions of Puget Sound have also been closed. Samples of commercially harvested clams are also routinely monitored to ensure that clams reaching the market place are safe for human consumption.

The Subtidal Hardshell Clam Fishery

History

Butter clams and littleneck clams have long supported commercial intertidal harvest in Washington and British Columbia, with production in Washington ranging from one million to over 3-million pounds per year since 1935. These clams have also supported a major sport clam fishery. Contributing to the popularity of these clams was their abundance, relative ease of digging, and their ability to close tightly - giving them relatively long shelf lives. Littlenecks, which if kept cool and moist have shelf lives of 5-7 days, have generally been sold in the shell as steamer clams while butter clams, with a shorter shelf life, have traditionally been canned.

The horse clam, has not received commercial interest until recently. It is difficult to dig the deeply burrowed clam without breaking the shell and the clam is perishable because the shell cannot be tightly closed. The proportion of meat is relatively low and the clams are difficult to process but the neck meat is of high quality.

The hardshell fishery was limited to intertidal beaches, until 1956 when a mechanical clam harvester, was introduced to Puget Sound. After considerable modifications to allow its use in the deep, rocky waters of Puget Sound, an experimental commerial fishery began in 1959.

Harvest Tracts

WDF has made extensive inventories of potential commercial subtidal clam beds in Puget Sound. These inventories were made by SCUBA divers using a hand-held venturi suction dredge. This sampling is adequate for assessing the abundance of clams but not to assess the economic feasibility of harvest. Such determinations necessitate test harvest with commercial gear.

Forty-seven major beds have been identified ranging in size from 1 to 847 acres. Of these, 14 are classified as commercial beds based upon past harvests. These 14 beds represent 494 acres and have produced 8,807,609 pounds of clams since 1962. At present, 292 acres are under lease for harvest, but only three tracts, 194 acres, are under harvest pending final resolution of legal challenges to harvest in Agate Pass, Kitsap County. Harvest is also

being conducted on Semiahmoo Spit in Whatcom County in an attempt to utilize a major clam bed before it is destroyed by construction of a marina. The commercial beds are shown in Appendix A.

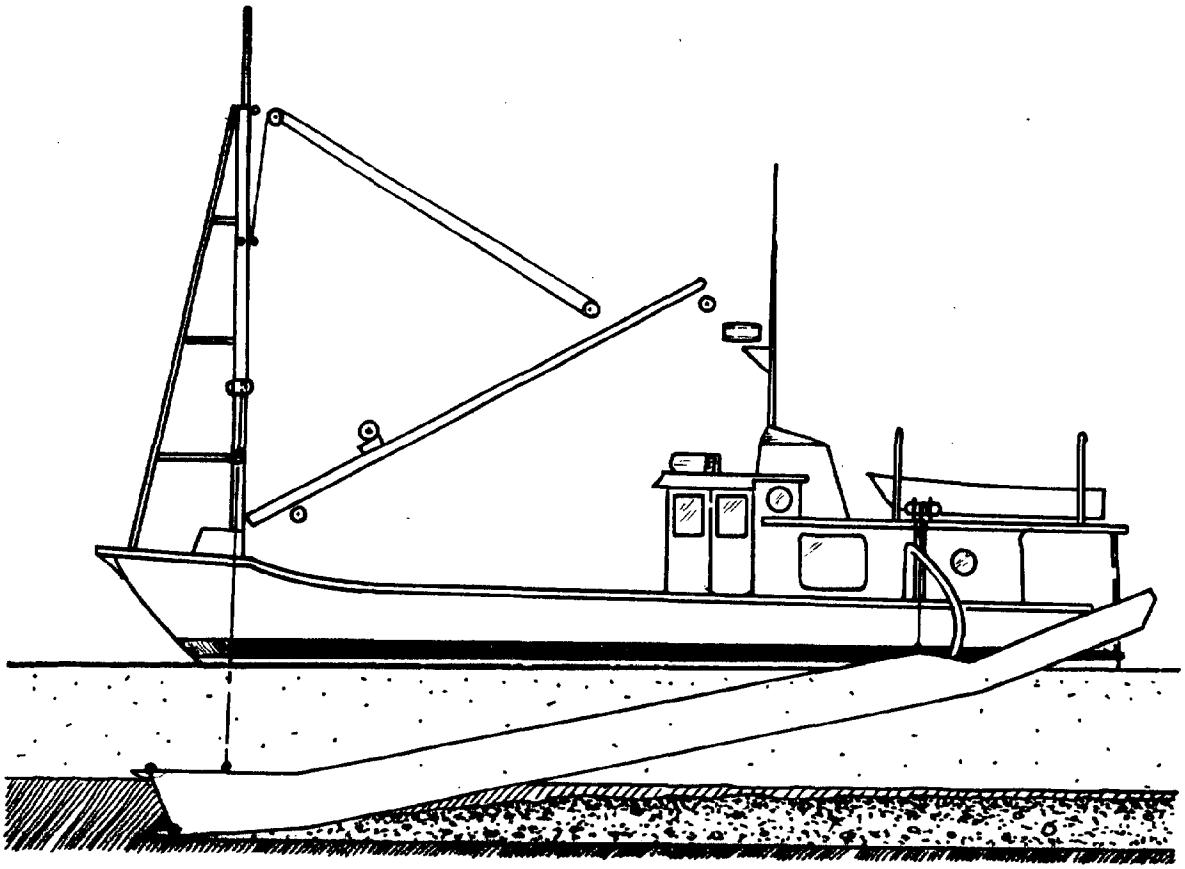
Harvest Gear and Methods

The mechanical clam harvester, or hydraulic escalator harvester, introduced to Puget Sound in 1956 was designed by Fletcher Hanks in 1951 for the harvest of the eastern soft-shell clam (*Mya arenaria*). These clams are harvested from shallow mud bays along the Atlantic Coast of the U.S. and Canada. The Hanks' harvester is used extensively for this harvest and hundreds of these boats are currently in operation. Only one operator is using a mechanical harvester in Puget Sound although a new boat is presently undergoing testing.

The mechanical harvester (Figure 6) uses water jets to loosen the substrate and allow removal of the lighter clams. As the harvester moves forward (at up to 10 ft/min), water jets at the front of the harvester loosen the substrate material which is then washed back towards a one inch mesh screen conveyor belt which carries the clams to the surface. Large, heavy particles such as rocks and gravel settle to the bottom of the trench before reaching the conveyor. Small material, including small clams, fall through the conveyor belt into the trench. Larger, light objects and larger clams are retained and carried to the surface where the harvestable size clams are removed by hand. The remaining material then falls back into the water in the approximate location of the trench.

Limited harvest has also been conducted using a hand-held venturi suction dredge. This permits harvest in rocky areas and among obstructions where a hydraulic harvester could not operate. A bed near Point Roberts is under lease for venturi harvest but the method is proving only marginally successful. No environment evaluation of the method has been made.

Presently one hydraulic escalator harvester is operating in Puget Sound on three subtidal tracts of 192 total acres. Harvest operations are rotated around these tracts based upon the following criteria:



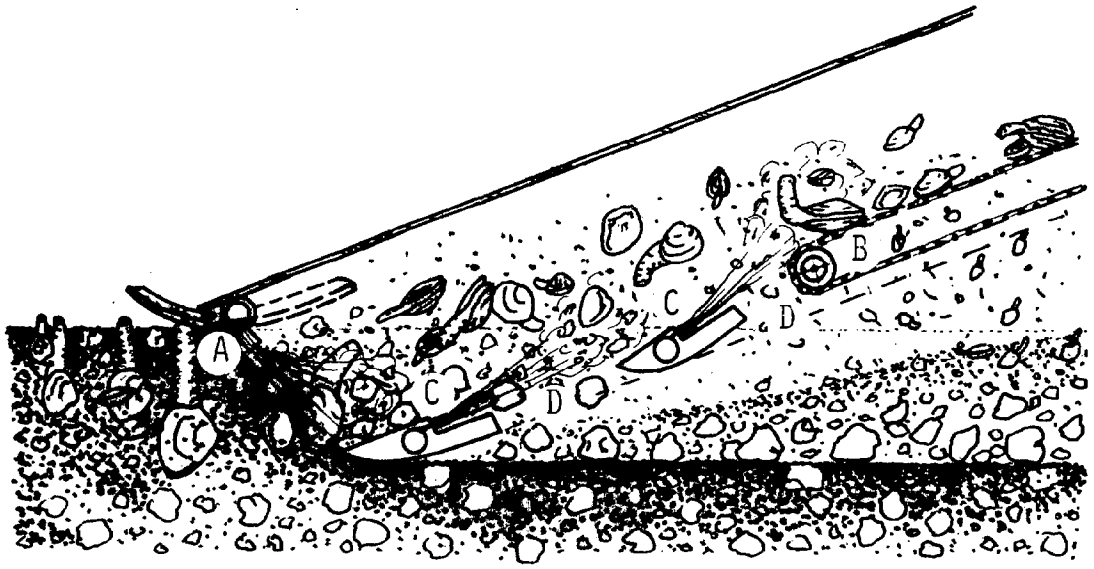


Figure 6. A hydraulic escalator harvester showing the relation of the gear to the harvest vessel (upper) and the operation of the harvest head (lower). The harvester loosens the substrate with jets of water (A). The lighter material is directed back towards a wire mesh conveyor belt (B) by additional jets of water (C). Heavy particles fall through the harvest head (D) and back into the trench. Small particles fall through the conveyor belt while the harvestable clams and other large, light material is carried up the conveyor belt to the surface where the clams are removed by hand. The remaining material falls off the belt and back into the water.

a. Exposure. Some tracts are exposed to wind, waves and current and can only be harvested under favorable conditions.

b. Red Tide. Recently red tide has prevented harvest of some tracts during the summer forcing the operator to work in other areas.

c. Clam Stock Recovery. After harvest the operator leaves an area to recover, allowing clam density and size to return to economically harvestable levels. The harvester will routinely check tracts to determine suitability for reharvest and when possible, will allow an area to lay fallow 3-4 years.

d. Species Desired. The species mix of the three clams varies from tract to tract. By selecting which tract to harvest, the operator can control to some degree the species harvested.

The harvester works on state owned subtidal beds between extreme low water (4.5 ft. below MLLW), and about -25 feet, which is the maximum depth that the conveyor can reach. The boat moves forward, into the current, as fast as the substrate can be loosened. By observing the material on the conveyor belt, the harvester can judge the type of substrate, the presence of eelgrass, and the suitability of an area for harvest. A tract is usually harvested systematically with a portion of the tract being harvested repeatedly until harvest production drops to a level which the operator considers uneconomical.

Harvest Production

Over the last decade, subtidal hardshell clams have accounted for about a third of the state's hardshell clam production. Between 1969 and 1978 the industry reached its peak production averaging over 700,000 pounds per year and reaching 1,008,906 pounds in 1977 (Figure 7). Since the start of the fishery in 1959, almost 10-million pounds of clams have been harvested.

Total production is closely related to the acres of clam beds available for harvest. Table 1 shows the tracts which were actively harvested, the date of issue and termination, and their acreage. Acreage under harvest reached 386 acres in 1974 and declined following the closure of Agate Pass

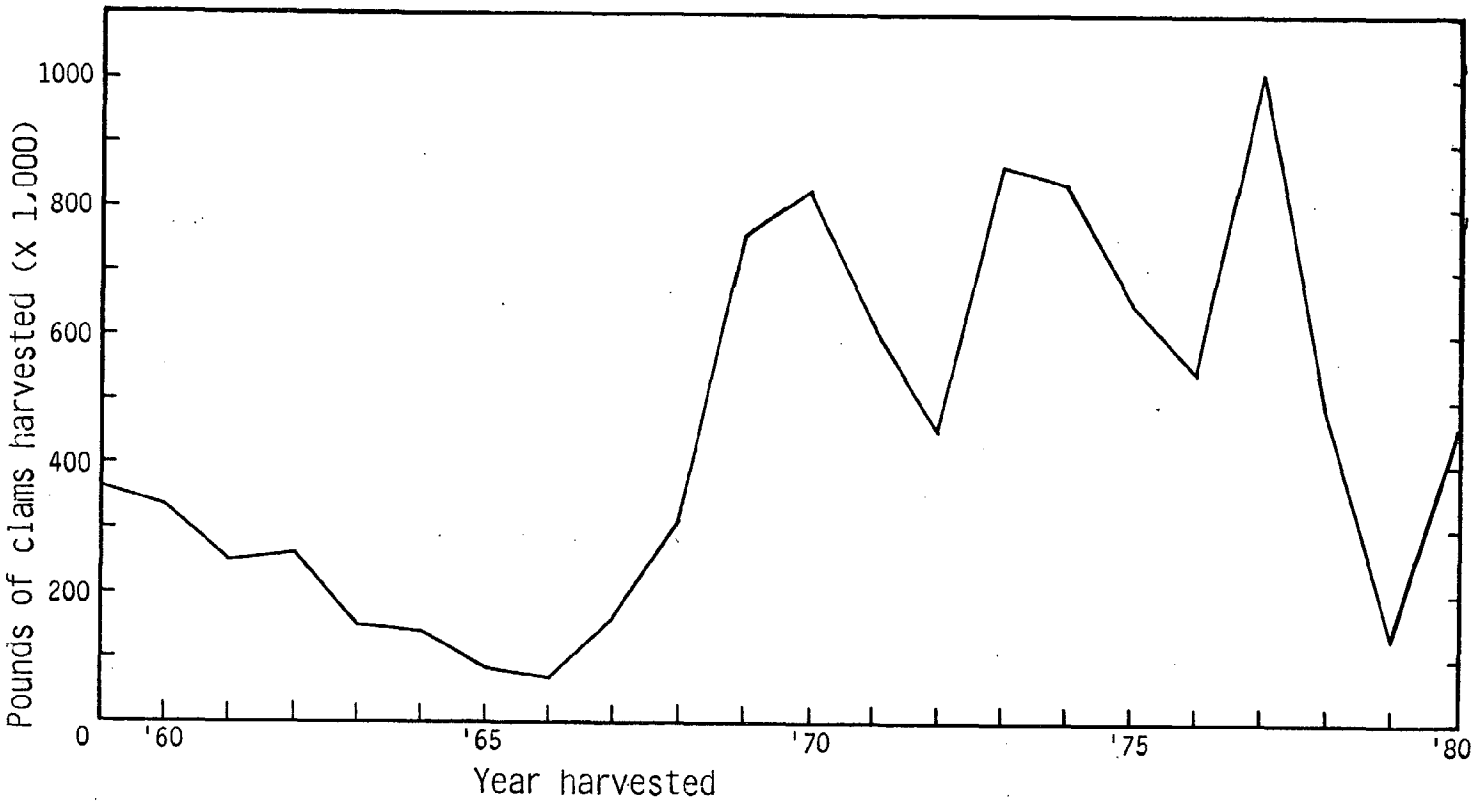


Figure 7. Commercial harvest of subtidal hardshell clams in Puget Sound.

Table 1. Subtidal hardshell clam tracts which have been, or are being, actively harvested.

Tract name	Acres	Year issued	Status of tract
Case Shoal	40	1962	Returned 1973
Brown Point	37	1966	Returned 1976
Kilisut Harbor	132	1968	Active
Colvos Rocks	27	1969	Active
Pt. Townsend Canal	35	1969	Active
Boys' Camp Pt.	8	1970	Returned 1975
South Point	6	1970	Inactive
Agate Pass (E)	13	1972	Inactive*
" " (SW)	43	1972	"
" " (W)	14	1973	"
" " (NW)	43	1974	"
" " (NE)	28	1974	"

* Pending final court decision on Shoreline permit requirements.

in 1978 to 192 acres, with a subsequent decline in clam production to 136,000 pounds in 1979. Production in 1980 increased with the opening 8 acres of clam beds on Semiahmoo Spit in Blaine where 300,000 pounds were harvested, between October 1980 and January 1981.

Production by species has varied depending upon market conditions and the areas harvested (Figure 8). Butter clams have generally predominated in the catches (52% average) and subtidal harvest has provided 80-90 percent of the state's butter clam production. Subtidal harvest has provided about a quarter of the state's native littleneck clam production since 1959 but their proportion in the catch has declined. Over the last 5 years only 15 percent of the landed littleneck clams were harvested subtidally.

Perhaps the most significant change in catch composition is the proportion of horse clams. Initially, the horse clam had no market value and areas of horse clams were either avoided or the horse clams were not retained. During the 1970's horse clam harvest increased as markets were developed and the value of the clam increased to equal that of butter clams. Over the past 5 years, horse clams have made up over 1/3 of the catch and, just prior to the closure of Agate Pass to harvesting, horse clams were the dominant species caught.

Harvest Potential

Over 170 million pounds of subtidal hardshell clams have been identified. It is conservatively estimated that the maximum sustainable yield for hardshell clams in Puget Sound would be around 10 percent of the standing crop per year or as much as 17 million pounds per year. However, only a small portion of the resource in shallow water is in suitable substrate for harvest, is protected from wind and waves, and is unpolluted. Allowing for these factors, it is estimated that only 2-2.5 million pounds could be harvested annually on a sustained basis with present technology.

Cost of Production

Only one harvester is presently in operation directly employing 2-3 people. The total investment including the machine and modifications to reduce noise and

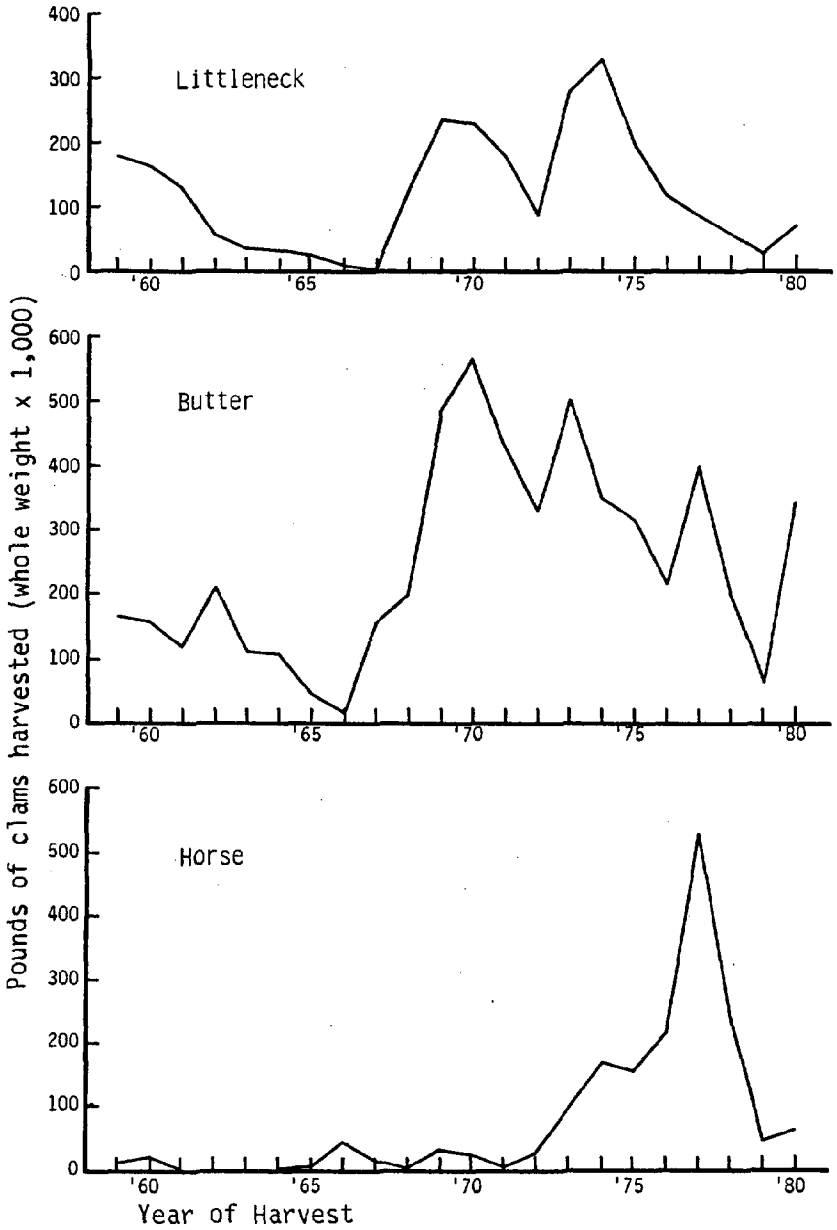


Figure 8. Puget Sound subtidal hardshell clam production by species.

improve efficiency is near $150,000 while operating costs are around $30-40 per day for fuel alone. Presently production varies between 2,000-5,000 pounds per day with a maximum capacity of around 10,000 pounds per day depending upon the substrate, clam density, operating limitations, etc. About 2,000 pounds per day is necessary to cover operating costs and wages (Doug Lyle, pers. com.). Total production is limited by the availability of harvestable tracts. Current harvest is limited by the availability of clams to only about 3 days a week (5 or 6 hours per day). Between September 1980 and September 1981 there were only 137 days of harvest (about 7,000 hours). Harvest was limited partly by the availability of clams but also by equipment breakdowns and by tract closures due to PSP and sewage pollution. Harvest in 1979 was only 135,000 pounds and increase to over 400,000 pounds in 1980 as a result of 300,000 pounds taken from the Semihaimoo Spit marina site near Blaine. The harvested value of the hardshell clams ranges from $0.25 to $0.85 depending upon the species. Most of the catch, however, is butter and horse clams and the average landed value is only around $.032 per pound. Production from his operation has resulted in up to 30 people being employed to process the harvested clams. A new harvester is now being tested which is estimated to be worth around $800,000. This harvester will reduce the impacts of the fishery while allowing access to clam beds in deeper water (to about 30 feet).

Other costs include the harvest tract lease and royalty payments to DNR. Royalties are now 5 cents per pound on harvested littleneck clams and 3 cents per pound on butter and horse clams. Table 2 shows the income generated to DNR from these leases. The operator must also pay a $300 annual WDF license fee for the harvester, $15 for a WDF clam farm license, and a 2% privilege tax on the landed value of the catch to the Department of Revenue, in addition to regular business taxes.

Table 2. Revenue generated to State through DNR leases for subtidal clam harvest.

Year	Dollars
1973	12,028
1974	14,504
1975	18,352
1976	11,467
1977	12,431
1978	18,570
1979	6,826
1980	12,086

Catch Value and Markets

Presently all subtidal hardshell clams are being harvested for a local seafood restaurant chain which pays a price of 25 cents per pound for butter and horse clams and 50-90 cents per pound for littlenecks - the higher price being for small, steamer-size clams. This one buyer is apparently able to utilize all of the clams harvested and is seeking more. Additional markets exist also. Steamer size littleneck clams sell for .85-$1.00 to the harvester on the local market and strong demand exists in and out of the state. Butter clams have been canned for many years but local processors must now rely on imports from Canada and would utilize local clams if available. Horse clams, which until recently were not considered a desirable species, are now proving to be very good clams for chowder having a large proportion of white meat. There are also possible markets for horse clams in the Orient which may further increase the clam's value. It, therefore, appears that the market could readily accept significant increases in clam production. At maximum sustainable yield, the value of the catch could increase from about $150,000 presently to close to $1,000,000 annually.

Impacts of the Fishery on the Marine Environment

Effect on Clam Stocks

Clam harvest, whether manual or mechanical, removes adult clams, disturbs small clams, causes some incidental clam mortality (due to shell breakage, smothering, or increased exposure to predation), and alters the substrate which may affect future sets. Studies both in Puget Sound and on the East Coast have demonstrated that the hydraulic clam harvester is the most benign method which is practically and economically feasible for subtidal clam harvest.

Two important factors in evaluating a harvest method are its efficiency (ability to harvest all of the adult clams in its path) and the breakage rate (percent of clams which are broken or damaged by the harvester). In tests by WDF, the Hank's type harvester was much more efficient and less wasteful in the coarse substrates of Puget Sound then other gear tested (Goodwin 1973). The EIS on subtidal clam harvest specifies a harvest efficiency of better than 90 percent and a breakage rate of less than 15 percent. Studies on the East

Coast show harvest efficiencies of 95-100 percent with less than 5 percent breakage of soft shell clams. This was compared to hand harvest where efficiency averaged only 60 percent and mortality due to breakage and burial averaged 48 percent of the unharvested clams (Medcof and MacPhail, 1957).

The small clams which fall through the conveyor belt are lighter than the substrate material and land on the surface of the trench. Thus mortalities due to burial and smothering are minimal. Medcof (1961) found that 90 percent of the small soft shell clams in Nova Scotia were returned to the surface of the trench and reburrowed within two hours, although large adult clams had great difficulty reburrowing. Reburrowing is facilitated by the softness of the substrate in the trench; however, while the clams are on the surface they are subject to predation by fish, crab, starfish and moonsnails.

Observations at a number of harvest sites in Puget Sound have demonstrated that the clam populations rapidly recover from harvest although the rates of recovery will vary depending upon area, the percent of the population removed by harvest and the occurrence of successful clam sets. Generally harvest is terminated by the harvester before clam densities drop to less than about 0.4 lb/sq. ft. (and bed over 0.25 lb/sq. ft. is considered a major bed). Recovery of the beds to preharvest levels, even when intensely harvested, usually requires less than 5 years. A harvester normally will allow a tract to lie fallow for 3-5 years between harvest and will not harvest until the clam density returns to levels which will support profitable harvest.

The ability of the clam population to support harvest is demonstrated by the continued yield of clams over many years from tracts such as Kilisut Harbor. Specific studies have been conducted to assess the rate of recovery at two harvest sites in Puget Sound - Buggy Spit at the entrance to Kilisut Harbor (Goodwin and Shaul, 1980), and South Point on Hood Canal (Goodwin, 1973). In 1959, 238,000 pounds of clams were harvested from 40 acres of Navy-owned intertidal beach on Buggy Spit. Between October 1970 and January 1972 another 565,630 pounds were harvested. Eighteen months after the second harvest the abundance of harvestable butter and littleneck clams approached or exceeded preharvest levels. Littleneck clams, however, attained only about a third of their preharvest density after 3-1/2 years.

At South Point extensive harvest occurred between 1971 and 1972, removing 94,000 pounds of butter clams. After harvest ceased the population had dropped from 159,000 to only 40,000 pounds. By January 1975 the population had recovered to 153,000 pounds, and in December, 1977 was 165,000. Similar recoveries had also been observed in Kilisut Harbor, Colvos Rocks, and Agate Pass.

The suitability of the harvested tracts for settlement and growth of small clams to replace those harvested has also been demonstrated repeatedly. In Agate Pass on one harvest tract butter clam and littleneck seed clams increased from 0.71 and 0.86 per sq. ft. before harvest to 1.33 and 1.17 per sq. ft. 3 months after harvest. On a nearby tract the seed clam densities were 1.07 and 2.64 respectively before harvest and 1.00 and 3.00 per sq. ft. after harvest (Goodwin 1980, before Shorelines Hearing Board). At South Point the preharvest butter clam seed density was 0.8 per sq. ft. Twenty eight months after harvest ceased the density of seed clams had almost doubled at 1.55 per sq. ft. Similar results have been observed on the East Coast showing that harvest does not reduce the settlement and survival of seed clams (Pfitzenmeyer, 1972). Kyte, et al. (1975) observed a significant increase in the abundance of seed clams in the harvest tracks one season after harvest. In some areas tilling the clam beds may increase the success of a clam set. Intertidal clam farmers will sometimes dig less productive areas specifically to enhance the beds for clam settlement and growth.

One effect of repeated harvest on some tracts is that the relative proportions of the three clam species may change, indicating that one species may reproduce, set, survive and grow more aggressively than the others. This appears to be the case in Agate Pass and some other areas where horse clams numbers have increased relative to butter and littleneck clams. There has been concern that eventually horse clams would dominate the clam population on the tract and eventually alter the species composition of the area.

This does not appear to be the general case. While horse clams appear to be the dominant clam in Agate Pass, other clams dominate other areas. Many beds are almost exclusively one species, as South Point which is almost exclusively butter clams, or Kilisut Harbor where the population is dominated by butter and littleneck clams with few horse clams.

Concern has been expressed that the harvest of subtidal clams stocks are important to the seeding and repopulation or intertidal beaches. The planktonic clam larvae are mixed and widely dispersed by currents and may set many miles from their parental stocks. Thus it is very unlikely that any intertidal beach would be dependant upon a specific local spawning population. South Puget Sound illustrates this point because a major intertidal commercial clam industry exists despite the absence of major subtidal clam beds. It should also be noted that even immediately after harvest a spawning population remains on the tract. Harvested tracts generally still have clam densities over 0.4 lb/sq. ft. and thus still constitute major beds. In addition to these remaining mature clams, clams which are less than harvestable size, yet are sexually mature will remain to contribute to the spawning reserve.

Effect on Other Animals

Except for sessile organisms and animals living in the substrate, no effect has been demonstrated on other fish from harvesting by hydraulic equipment. Although an occasional crab comes up the harvester's conveyor belt (usually unharmed), most crab and fish are able to move out of the harvester's path. In Agate Pass (harvested 1972-1978) it was suggested that cod fishing declined as the result of harvesting. Studies by marine fisheries biologist demonstrated no significant effect from clam harvesting. In fact, fishing effort around Bainbridge Island had doubled between 1974 and 1978. The number of cod caught during the same period tripled, and the catch of cod in inner Puget Sound increased almost four times (Bargmann, 1980). Manning (1957) compared fishing in Chesapeake Bay during four years of harvest with the four years prior to clam harvest and found no effect. Manning did note that fishing and crabbing temporarily declined downstream from the harvester. This was attributed to either adverse effects of the harvester or, more likely, the attraction of fish and crab upstream to the harvest area to feed on exposed clams, worms and other organisms.

It is recognized that harvesting can have some effect on other fish especially if their habitats are disrupted. In harvest site selection WDF eliminates from consideration tracts which are significant to important species.

For instance, tracts in Dungeness Bay and around Guemes Island were eliminated to protect Dungeness crab, while parts of Agate Pass were eliminated from harvest to protect lingcod spawning areas. Seasonal and operational limitations have also been imposed to protect herring spawning and to protect migrating salmon.

While fish and crab can generally escape a slow moving harvester, animals attached to or living in the substrate are often killed or exposed to predation. Goodwin (1978) demonstrated that the number and biomass of these organisms were reduced in the harvest tract as compared to adjacent unharvested areas, but also noted that recovery of these populations was quite rapid. The species diversity was not reduced by harvest. Similar results have been noted on the East Coast (Kyte, et al., 1975; Godcharles, 1971).

Effect on Eelgrass

Eelgrass (*Zostera marina*) is a perennial vascular plant found throughout the northern hemisphere. Eelgrass occurs from the mid-intertidal zone down to about 100 feet with depth being limited by the penetration of sunlight. In the rich waters of Puget Sound its depth range is limited to about 22 feet below MLLW (Phillips, 1972). Eelgrass is found on mud and sand substrates, in bays and on beaches sheltered from extreme wave action in northern and central Puget Sound and Hood Canal. Eelgrass is only occasionally found south of the Tacoma Narrows. The Coastal Zone Atlas of Washington series (DOE, 1978-80) shows over 40,000 acres of eelgrass beds in Puget Sound (Table 3); however, many subtidal beds are not shown. Thayer and Phillips (1977) estimate that over 125,000 acres of Puget Sound are covered by eelgrass.

The eelgrass plant (Figure 9) consists of a rootlike rhizome from which clumps (turions) of long bladed leaves emerge. Each eelgrass plant may have many turions. Eelgrass may occur in dense patches or bands, in sparse beds, or in extensive dense beds which may cover thousands of acres such as in Grays Harbor and Willapa and Padilla Bays. Phillips (1972) studied two eelgrass beds in Puget Sound, Alki and Bush Points. The combined average densities of these beds was about 420 turions per m^2 with densities ranging from 3-1,743 turions/m^2.

Table 3.
EELGRASS ABUNDANCE IN PUGET SOUND*

COUNTY	ACRES OF EELGRASS
Whatcom	1,449
Skagit	20,228
Snohomish	1.665
King	1,110
Pierce	531
Thurston	40
Mason	697
Kitsap	2,982
Jefferson	3,806
Clallam	2,384
San Juan	2,114
Island	3,494
TOTAL	40,200

*Area of eelgrass beds based upon planimeter measurements of the eelgrass beds shown in the Coastal Zone Atlas of Washington series (1978-80). The Coastal Zone Atlas does not show many subtidal beds and does not give any criteria defining what constitutes a shown bed. Therefore, this estimate of eelgrass abundance is probably less than the actual abundance.

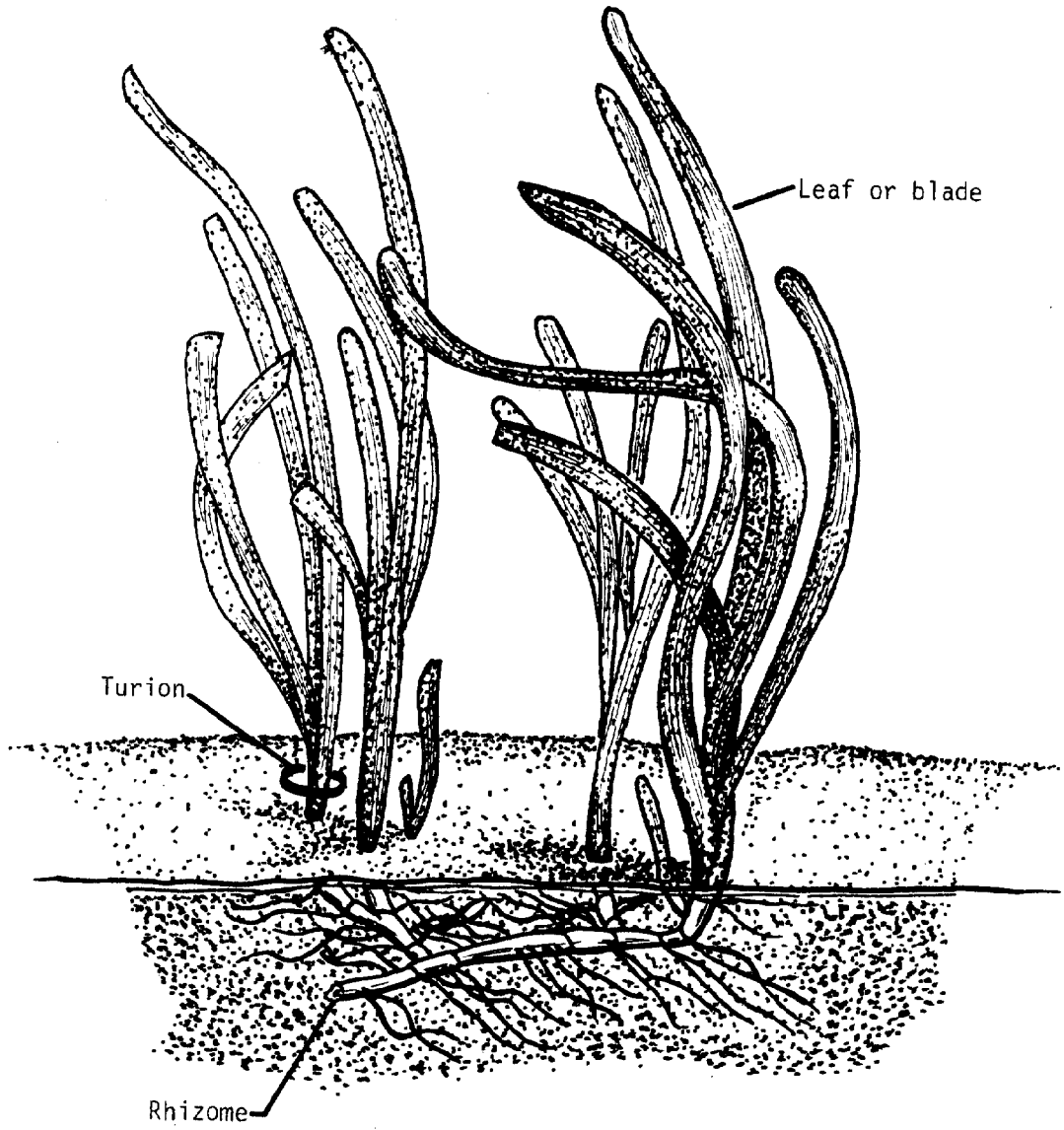


Figure 9. Eelgrass (*Zostera marina*).

Eelgrass is important in the marine environment, stabilizing the soft substrate with a mat of inter-twined rhizomes and providing a habitat for a myriad of organisms. Eelgrass provides protection and food for many other plants, fish, invertebrates, and birds either directly or through the food chain. Eelgrass beds are important or critical areas for many of the species which support the commercial fisheries of the state including herring which spawn onto the eelgrass leaves, juvenile salmon which utilize the beds as nursery areas, and Dungeness crab which dwell in the beds. WDF therefore shares the concern of many agencies and individuals over any activities which may destroy or damage these beds, including clam harvesting.

Mechanical clam harvesting will effectively uproot any eelgrass in the path of the harvester. Recovery may take many years. The possibility of this damage is minimized by the facts that: 1) commercial densities of hard-shell clams do not normally occur in the fine substrate associated with eelgrass, 2) eelgrass clogs the harvester and stalls the machinery, 3) WDF's substrate criteria limit harvest to tracts having less than 15 percent fine materials which would exclude major eelgrass beds; and 4) many tracts with eelgrass would be excluded from harvest to protect other important organisms.

To further minimize the possibility of significant damage to eelgrass habitats the Department of Fisheries with assistance from the U.S. Fish and Wildlife Service and the Environmental Protection Agency has developed an eelgrass density criteria to prevent harvest in areas of significant eelgrass. This criteria was based on the observations of eelgrass density in Puget Sound made by divers from the three agencies. Under this criteria, a clam tract will not be authorized for harvest if:

1) Eelgrass density on the tract exceeds ten turions per 1/4 meter square (equivalent to 40 turions/m^2) if measured November through February or 13 turions per 1/4(m^2) (52/m^2) if measured March through October.
2) No more than 10 percent of the samples shall exceed 20 turions per 1/4(m^2).

3) Eelgrass density shall be determined by at least 20 random samples per tract unless eelgrass is absent.

Criteria (1) limits harvest to only those tracts with very sparse eelgrass coverage or none while (2) prevents harvest in those areas where eelgrass occurs in dense patches and random sampling might not adequately detect it. In practice tract boundaries are adjusted as necessary and as practical to exclude eelgrass from the harvest tracts.

It is recognized that this standard will not protect all eelgrass, but it is felt that the loss of this small amount of eegrass will have little effect on the important role of eelgrass in the marine environment. It is further felt that if all environmental criteria for the protection of other organisms are met that the loss of this limited amount of eelgrass will be acceptable given the benefits of clam harvesting to the state. These criteria only represent guidelines for determining the suitability of a tract for harvest. Tracts meeting these criteria will additionally be evaluated on a case by case basis.

Effect on Other Plants

In addition to eelgrass, attached algae and kelp may also be disturbed or destroyed by mechanical clam harvesting. For the larger attached perennials recovery may take some time, while the annuals may recover quite rapidly.

Dense beds of attached algae are usually limited to coarse or rocky substrates which provide secure attachment for the plants. These beds, especially kelp, are important to many fish which congregate in the beds and invertebrates which live on the plants or the bottom. The rocky substrate may also provide spawning sites for fish such as lingcod. Because of the abundance of organisms, these beds are frequently popular recreational fishing areas.

Generally, a harvester is unable to operate in the rocky substrates associated with kelp beds. Yet some harvestable areas may include dense stands of attached algae. WDF has not proposed specific criteria to protect these areas because the harvester normally stays outside dense kelp beds and

because this has not been raised as a major issue. Criteria for protecting habitats important to other species, such as lingcod and herring spawning, should adequately protect important kelp beds.

Effect on Substrate

The most obvious feature of a recently harvested clam tract is the extensive criss-cross network of shallow trenches marked by an absence of vegetation, and the presence of sand and old shell. These tracts are 6 to 12 inches wider than the harvest head (or about 4 feet) and average about 6 inches deep (Figure 10). The trenches usually refill quickly, especially in the high current, coarse substrate areas typical of hardshell clam beds. On intertidal Buggy Spit the trenches were refilled and indiscernible from the surrounding area within a month after harvest (Goodwin and Shaul, 1980). In Agate Pass, no harvest furrows were obvious in the study area immediately after harvest had ceased on the tract.

The hydraulic harvester basically stirs the substrate to float the clams to the surface and most of the disturbed material never leaves the trench. As the material settles the heavier particles fall faster leaving the lighter, finer material such as sand and old shell on top. This is the reverse of the natural substrate stratification in which currents wash away the finer, lighter particles leaving a coarse surface substrate. Initially, the material in the trench is soft and unconsolidated.

A certain amount of the material is washed out of the trench during harvesting and some of the unconsolidated material is eroded from the trench. This sand and shell may be distributed around the tract and in extreme cases may form temporary dunes which move with the currents across the tract. The most extreme case observed on a Puget Sound clam harvest tract was at Buggy Spit (Goodwin and Shaul, 1980) where a transient dune, as much as 12 inches thick, affected a 2-3 acre portion of the 40 acre tract. The dune probably smothered many clams and other organisms but its effect was temporary and limited only to a small portion of the tract. When the tract was next observed two years later, the dune had disappeared and a new clam population was developing. Observations of other dunes confirm they are quite localized, usually remaining within 50 feet of the harvest tracks.

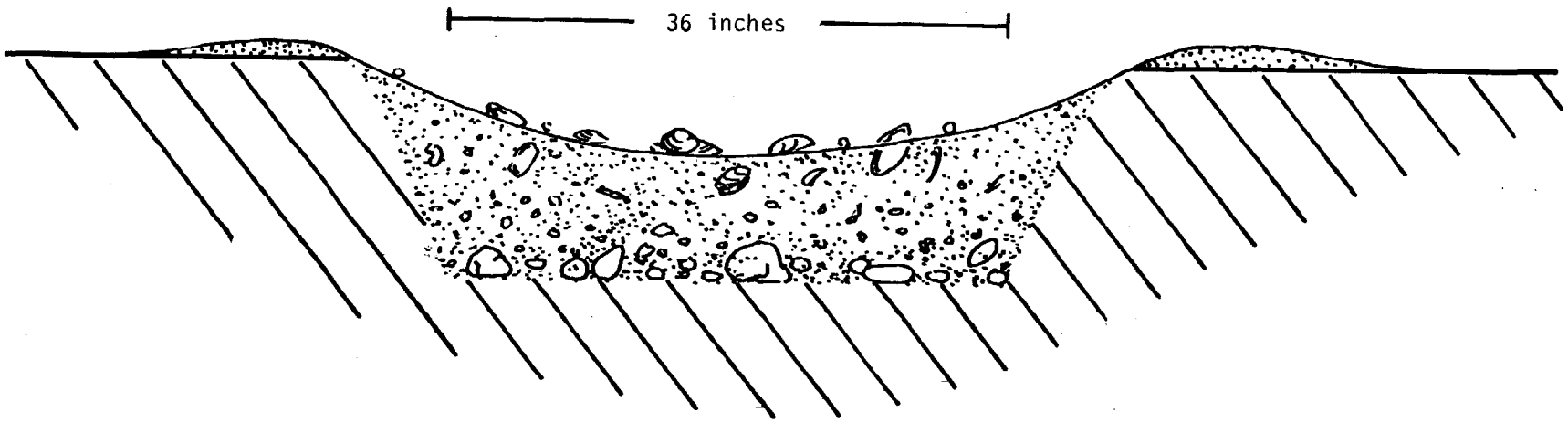


Figure 10. Cross-section of a typical trench left by a hydraulic clam harvesting machine (harvester head width is 36 inches).

Effect on Water Quality

A small proportion of the substrate material becomes suspended in the water during harvest allowing deposition of silt away from the harvest tract, causing turbidity, and allowing chemical changes in the water. Tarr (1977) conducted water quality studies at Agate Pass and Kilisut Harbor. At Kilisut Harbor sediment from the harvester was generally confined to a plume near the bottom and about 50 yards wide and 75 yards long while in Agate Pass the plume was only 50 yards long. While this sediment settles out rapidly, very fine particles may stay suspended for longer periods creating a turbid plume visible from the surface. In strong tidal currents in Kilisut Harbor this turbid plume was detectable as far as 300 yards from the harvester while in Agate Pass a plume of only 40 yards was detected. Generally the plumes are less than 200 yards long and 50 yards wide.

The impact of these plumes and silt are negligible given the small amount of sediment involved. They are temporary in nature, and background turbidity often eclipses that caused by the harvest. Fifty yards behind the harvester Tarr observed suspended solids of 0-4 mg/l above background (average 1 mg/l). (One mg/l equals about 1 ounce of silt in 6,000 gallons). The average background level for suspended solids was 8-25 mg/l and varied greatly due to plankton blooms, wave erosion of beaches, and silt from rivers.

In Kilisut Harbor sediment traps were used to determine if silt was moving off the tract and potentially affecting intertidal beaches (Goodwin, 1973). On beaches near the harvest area sediment levels did not exceed those of background. On the east coast, where the substrate is predominately fine material, Manning (1957) observed that virtually all silt remained within 75 feet of the harvest tract. While extremely large amounts of suspended silt could affect organisms by smothering and reducing light penetration, observed levels of silt are well within the range normally encountered by marine organisms and should cause no adverse impact on them.

Tarr (1977) also observed the effects of harvest on water quality. The most probable effect of harvest would be a reduction in dissolved oxygen caused by the suspension of organic and anoxic substrate material. No significant changes in water chemistry were observed, however, to prevent harvest in areas of unsuitable substrates WDF has established chemical criteria for the substrate (See Page 53).

Effect Onshore - Noise

Noise levels onshore must meet DOE regulatory standards of less than 55dBA (45 dBA at night) (WAC 173-60). This may be 5-15 dBA above background. Even at these levels the prolonged harvest in one location close to shore may disturb nearby residents. Although DNR is generally responsible for onshore effects of harvesting, including noise, WDF encourages harvesters to operate at the lowest noise level possible. The one harvester currently in operation has significantly improved its engine muffling and has just modified its conveyor belt system to reduce mechanical noise (Doug Lyle - pers. com.). A new harvester is undergoing test and should be considerably quieter than existing vessels and should create minimal onshore disturbance.

Jurisdiction Over the Fishery

A major source of conflict in the hardshell clam fishery, as well as other shoreline activities, has arisen from the many facetted, jurisdictional environment in which numerous state, federal, and local agencies exert some form of control over management and operation of the fishery. This jurisdictional environment has resulted in a complex, confusing, and time-consuming permit process in which each major agency can effectively veto the proposal and which is open to abuse through delay by anyone opposed to the proposal. WDF cannot unilaterally change this system, but in cooperation with DNR and DOE, is attempting to resolve some of the local and state jursidictional problems.

Perhaps the greatest cause of interagency conflict is the overlapping jurisdictions of these agencies, each having its own mandate, goals, concerns and constituencies. To better understand their relations the role of each involved agency will be discussed pertinent to subtidal hardshell clam harvesting.

State Agencies

Department of Fisheries - (WDF) is the manager of the foodfish and shellfish of the state. WDF's role is defined through its mandate "...to preserve, protect, perpetuate and manage the foodfish and shellfish in the water of the state and... for the purpose of conservation... maintain the economic well-being and stability of the commercial fishing industry ..." (RCW 78.08.012).

It is, therefore, WDF's responsibility to ensure that the harvest of foodfish and shellfish be on a long-term, sustainable basis. In this management, WDF attempts to accomodate both recreational and commercial use of these resources. WDF also has broad responsibilities to protect the marine environment and specifically shellfish beds (RCW 75.08.060).

To achieve these goals the department has the power to pass rules and regulations controlling when, where and how fish shall be taken (RCW 78.08.060). To enforce these regulations, WDF has its own Fisheries Patrol Division, including officers specifically assigned to the subtidal clam fisheries (hardshell clam and geoducks). Fisheries' regulations may also be enforced by local law enforcement officers.

In practice, WDF surveys and inventories the subtidal clam resources and recommends those tracts suitable for harvest to DNR, limits harvest where significant adverse environmental impacts to other fish or the marine habitat would occur, and also ensures that harvest is conducted so as to minimize damage to the stocks and habitats. WDF also licenses the harvest tract and the harvest gear, and sets performance standards for the gear. A major aspect of this management is the study of the biology, ecology and population dynamics of the clam populations and the effects of clam harvest.

Department of Natural Resources - DNR administers the state's ownership interest in the subtidal bedlands and the clams which dwell in those beds. As the proprietary owner, DNR is also the lead agency in permit application and compliance under SMA and SEPA. DNR is directed to "foster the commercial and recreational use of the aquatic environment for the production of food fiber, income and public enjoyment" (RCW 79.68.080) and has identified five objectives for its aquatic land management. These are: 1) meeting navigational needs, 2) providing space for a variety of uses, 3) assuring compliance with the environmental requirements of other agencies, 4) maintaining the environmental quality of these lands, and 5) assuring that the public is adequately compensated for public and private uses of state lands. DNR has developed a management plan for the subtidal hardshell clam fishery to carry out its authorities according to the above objectives.

DNR is authorized to enter into lease agreements for the cultivation of clams from state-owned bedlands (RCW 79.01.568). Upon receipt of an application for lease, WDF is notified and conducts a survey of the proposed site to determine its suitability for harvest and to assess and recommend a minimum rental price (RCW 79.01.576). DNR presently leases the beds on a per acre basis with an additional per pound royalty fee on the clams harvested.

Department of Ecology - State Environmental Policy Act - DOE was created in 1970 to consolidate the regulatory programs concerned with protection of water and air resources. With the influx of environmental laws during the early 1970's, DOE became the central agency concerned with protection of the environment at the state level and with planning to ensure this protection and to accomodate competing interest in the use of these resources.

Among DOE's responsibilities are setting standards and protecting the waters of the state from pollution (Coastal Waters Act of 1971) setting and enforcing noise standards (Noise Control Act of 1971), and administering the State Environmental Policy Act of 1971 (SEPA), and the Shoreline Management Act of 1971 (SMA).

SEPA (RCW 43.21) was implemented to ensure broad consideration of the environmental, economic and social impacts of a proposed action and possible alternatives to that action - whether it be initiated or authorized by a state or local agency. SEPA requires that the lead agency, generally the agency proposing or authorizing the activity, prepare an Environmental Impact Statement (EIS) on those projects which, when considered cumulatively, significantly affect the quality of the environment. The law requires consultation between the lead agency and "... any public agency which has jurisdiction by law or special expertise with respect to any environmental impact involved." (RCW 43.21c.030 (s)(d)). SEPA has had a significant effect in making public and private projects more responsive to environmental and social concerns and has provided a tool by which a citizen or group can challenge a governmental decision. This power has, on the other hand, also provided minority opponents of a project a major tool for blocking or delaying a project.

Under SEPA, DNR and WDF have prepared a programatic EIS for mechanical subtidal hardshell harvesting (Vining 1978). Much of the material in this plan on the impacts and effects of the fishery are presented in the EIS and it is recommended to anyone interested in this fishery.

Department of Social and Health Services - DSHS under RCW 69.30 is responsible for inspecting and approving shellfish handling facilities to ensure that proper sanitation and health standards are followed and that shellfish growing areas are free from pollution and potential health hazards. Certification of shellfish beds is based upon surveys of fecal coliform abundance in the shellfish, water quality history, and proximity of the area to potential pollution sources (e.g., sewer outfalls, marinas, etc.). No shellfish may be harvested or sold without DSHS certification and certification may be revoked whenever conditions dictate.

DSHS also conducts regular monitoring throughout Puget Sound to detect areas of potentially dangerous levels of Paralytic Shellfish Poison (Red Tide) and checks commercially harvested shellfish. The strict and conservative standards of DSHS ensure that the commercial shellfish harvested in Washington are safe for human consumption.

Other State Agencies - Other agencies, under SEPA, review clam harvest proposals. The most important of these by virtue of its expertise is the Department of Game. Game is concerned primarily with the protection of game birds and animals and their nesting and feeding habitats. Game is extremely concerned about any proposals which may disturb these animals or damage their habitats. The Parks and Recreation Commission would be involved if the harvest activity might impact nearby state park beaches.

Federal Agencies

U.S. Army Corps of Engineers - Through judicial interpretation, mechanical clam harvesting has been classified as "dredging" (Island County vs. English Bay Enterprises, Ltd.), an activity which requires permission of the Corps of Engineers. The basis for the Corps involvement in clam harvesting

is the Harbor and Rivers Act of 1899 (33 USC 403). This Act was intended to regulate actions affecting the navigability of harbors and rivers by limiting unauthorized dredging, filling, and construction. It may be argued that it is a rather generous definition of dredging which includes clam harvesting, but Corps involvement could also be required under the Federal Water Pollution Control Act which governs discharges and water quality alterations with special provisions for shellfish beds. At the moment, only the Seattle District is directed to require such permits for shellfish harvest. No permits are required for the extensive clam harvest operations on the East Coast involving hundreds of boats.

The Corps permit must be renewed every three (3) years and will only be granted after all local issues have been decided. Thus a separate, independent review by the federal government follows the local and state reviews and evaluations.

The Corps decisions are also subject to the National Environmental Policy Act (upon which SEPA was modeled), which requires environmental review of major projects and provides federal agencies, as well as the state agencies and public, again, with an opportunity to evaluate and review a proposal. The Corps, based upon this input, may then deny the permit, approve it as proposed, or approve it with conditions.

U.S. Fish and Wildlife Service - USFWS has responsibilities for protecting freshwater and anadromous fish, marine birds, mammals and their habitats. USFWS shares many of the same concerns of the Department of Game over protection of birds and their habitats and provides important and influential input into the environmental review of Corps permits.

National Marine Fisheries - NMFS is the federal equivalent of WDF concerned with protection and utilization of the marine environment, with particular expertise in marine fish and mammals.

Local Government - Shoreline Management Act

The Shoreline Management Act of 1971 (RCW 90.58) establishes the local government (county, city or town) as a primary agency responsible for management of the shorelines within its jurisdiction. Under the guidance of DOE, each

local government bordering navigable waters established Shoreline Master Plans to regulate the use of these shorelines. Following approval of the Master Plans, the Department of Ecology adopted them into its own regualtions (WAC 173-19).

The SMA requires substantial development permits for major projects falling within the requirements of the Shoreline Master Plan and then requires environmental review of the proposal with opportunity for public input. The county may attach conditions to the permit to limit or modify a project or, through permit denial, prohibit the project. Permit decisions can be appealed through the six member state Shoreline Hearing Board.

The Shoreline Permit process has been a major means used by shoreline residents opposed to mechanical clam harvesting to prevent the activity. The SMA has not provided specific guidance for regulation of mechanical clam harvesting. Each county has thus developed its own policy concerning mechanical clam harvesting, including defacto prohibition of harvest by some counties. DOE's recent amendment of the SMA guidelines pertinent to aquaculture (WAC 173-16-060) (2) Aquaculture) is intended to provide greater consistency between counties in their treatment of clam harvest and provide for case by case evaluation of its suitability. The counties are presently revising this portion of their Master Plans.

Management of the Fishery

Subtidal Hardshell Clam Management Goals

The basic goal of WDF's management of the subtidal clam fishery is to protect the resource and to manage its use to best serve the interests of all the citizens of the state. To achieve this goal the fishery is managed to accomplish the following goals.

1. Protect marine environment.

Through its mandate and its responsibilities under SEPA, WDF has a major responsibility to protect the marine environment. WDF is directly responsible for the food fish and shellfish of the state and will allow clam harvest only where, when and how other organisms and the marine environment will not be significantly or permanently damaged.

WDF also has major concerns in protecting marine waters from pollution and degradation to which shellfish are particularly susceptible. The presence of a viable shellfish industry promotes this protection by providing a strong economic justification for clean water - upon which the industry depends.

2. Protect the clam stocks.

WDF is responsible for managing the clam resource on a state-wide basis for both personal and commercial use so as to ensure the viability of the resource. Harvest will not be allowed which will permanently damage the intertidal or subtidal stocks. Only harvest gear and methods which cause minimal incidental damage to the stocks and which leave the susbstrate suitable for future clam sets and growth will be allowed.

3. Provide maximum production of clams.

It is WDF's goal that those subtidal clam beds which are suitable for harvest (given that objectives 1 an 2 are met) be harvested to provide food, income and jobs for citizens of the state and that harvest from the state's waters be at optimal sustainable yield.

4. Minimize onshore impacts.

DNR is generally responsible for onshore impacts of the clam fishery while WDF is responsible for impacts in the marine environment. WDF does, however, realize that its management of the fishery may affect the degree or nature of onshore impacts and will adopt policies and encourage actions which minimize any disruptive effects of clam harvesting on the shoreline residents and community.

5. Ensure fair compensation to state for clams harvested.

WDF has no direct responsibility or interest in the financial compensation of the state for clam harvest. This is a function of DNR. WDF is responsible for estimating the value of the bed for DNR, and, through its policies, can affect the value of the bed and/or the amount of income derived to DNR. WDF will, therefore, establish management policies which allow for the full and fair compensation of the state for clams harvested.

Present Management

The hardshell clam fishery is managed through WDF regulations and policies governing selection of harvest tracts, harvest gear and operating limitations, and through the monitoring of harvest activities and enforcement of WDF laws and regulations. In some cases, management and enforcement are supplemented by conditions included in the DNR lease contract.

Harvest Tract Selection - Clam harvesting occurs on discrete tracts leased from DNR. WDF is responsible for surveying proposed tracts, evaluating their economic potential and value, and evaluating their environmental suitability for harvest. If approved by WDF, DNR is free to lease the tract following issuance of the necessary permits (Shoreline, Corps, etc.).

Based upon many years of observation of clam harvest and experience with channel dredging, WDF has developed criteria for evaluating the suitability of a proposed tract for mechanical harvest of subtidal hardshell clams as part of the EIS on clam harvest.

To be approved for harvest, a tract must meet the following criteria:

1. Substrate Composition.
   The substrate must average less than 15 percent fine material (fine material is silt and clay with particle size less than 6 microns in diameter).
2. Substrate Chemistry.
   a. Biochemical oxygen demand of substrate material must not exceed 7 mg/g.
   b. Phosphates (PO_4) = must not exceed 1.5 mg/g).

c. Sulfides must not exceed 0.6 mg/g.

d. Volatile solids must not exceed 6 percent.

e. Kjeldahl nitrogen must not exceed 1.0 mg/g.

3. Flora and Fauna

   a. Geoduck abundance shall be less than one (1) per square yard.

   b. Eelgrass (Zostera sp.) abundance shall not exceed 13 turions per 1/4 (m^2) April to October or 10 turions per 1/4 (m^2) November to March.

   c. Other biota of significance will be assessed on a case by case basis.

4. Hardshell Clam Abundance.
   Density of the target clams shall exceed 0.25 pounds per square foot prior to harvest.

Harvest Gear Evaluation - Fisheries regulations (WAC 220-52-018) requires that all mechanical clam harvesting equipment must be licensed by the Director of Fisheries and that subtidal harvest be limited to beds leased from DNR and approved by WDF. To be approved and licensed a harvester must:

1. Have deck read out instrumentation showing:

   a. pump water pressure

   b. a 3/4 inch pipe fitting on the pump to permit Fisheries Patrol personnel to check pump pressure.

2. Have controls allowing immediate cut off to water to harvest head manifold without impairing vessel maneuverability.

3. Submit accurate performance data on the pump and harvest head. Alteration of any of the specified components is illegal without WDF approval.

4. In coarse substrates (more than 10 percent of the substrate particles are greater than 500 microns in diameter) harvest head width shall not exceed four (4) feet overall and pump volume shall not exceed 1,252 gallons per minute at 45 pounds per square inch, measured at pump discharge.

In addition, the programmatic EIS states that at least 90 percent of the adult clams will be retained and clam breakage will not exceed 15 percent, that the substrate will be left in satisfactory condition for future crops, and that juvenile and seed clams will be returned to the trends unharmed.

Permits and Licenses Required - The following licenses and permits are required prior to any subtidal mechanical harvest of hardshell clams.

1. WDF clam farm license (RCW 75.28.280) - $15.00 issued for one year.
2. WDF mechanical harvester license (RCW 75.28.287) - $300.00 issued for one year.
3. Joint Fisheries/Game hydraulics permit (WAC 220.120).
4. DNR clam harvester tract lease (RCW 79.01.568) issued for five years and renewable (see example in Appendix H).
5. DSHS certificate of approval - Shellfish growing area (RCW 69.30.050) no fee - issued for one year.
6. Substantial development permit (RCW 90.58.140). Issued by the local county to DNR as the landowner for five years.
7. Water quality certification (WAC 90.48) and/or modification permit (WAC 173-201) - issued by DOE.
8. Section 10/404 Permit (33U.S.C.403). Issued by Corps of Engineers to DNR for three years - issued after all local permits issued.
9. SEPA compliance. A programatic Environmental Impact Statement has been prepared (Vining 1978). A site specific supplement will be prepared for each new lease.
10. WDF mechanical clam harvest permit (WAC 220-52-018) (see example in Appendix I).

Harvest Tract Management

Virtually all fisheries of the world are based upon a "common property resource" in which the fish belong to the first person to capture them. In a common resource system there is no incentive for the individual fisherman to conserve the resource. Fish not caught by the fisherman who unilaterally practices conservation will be taken by his competitors. It is the common

property nature of most fisheries which necessitates the volumes of laws and regulations of their management and which eliminated any incentive for the individual fisherman to conserve.

In contrast, management of the hardshell clam tracts simulates private ownership as much as possible through the issuance of long term leases (5 year with option to renew) leases and the exclusive right of the leasee to harvest clams from that tract. This encourages the leasee to treat the tract as if it were his own and allows him to reap the rewards of his prudent management. Instead of a single harvest, the farmer manages the tract for repeated harvests over succeeding generations of clams. It is thus to his economic advantage to harvest only that which the population can support, to harvest in a manner that does not damage small clams which will grow to support future harvests, and to protect the beds to ensure that they will support future settlement and growth. This prudent management has a second advantage to the clam farmer in that he is able to provide a steady supply of clams to the market place which generally opens more reliable and profitable markets.

An example of common resource versus private ownership is the intertidal littleneck clam fisheries of Canada and Washington. In British Columbia all the intertidal clam beds are the property of the public and are open to digging. During the winter and spring large numbers of clams are harvested and in some cases beaches have been dug out. The market is thus erratic with an over abundance of clams dug during the winter, which lowers the price, and a shortage during the summer. In Washington, almost all of the littleneck clam production is from privately owned or leased intertidal clam farms. These farms are able to produce a high quality product year round and guarantee a steady supply to their markets. Over the years these farmers have also conscientiously improved their beds by graveling and turning the ground over to loosen it and to remove fine materials. Thus these farms have maintained and/or increased their productivity over fifty years and more - all without governmental regulation or involvement in management.

To allow long term productivity it is necessary for the clam farmer to harvest only on a sustainable yield basis. In an open fishery elaborate statistical procedures are needed to estimate sustainable yield and even more

elaborate means are necessary to ensure that harvest does not exceed this goal. In a private ownership fishery economics limit harvest to less than the maximum yield possible. Figure 11 (Gulland 1968) relates the cost of fishing to the yield that is derived. In a fishery costs are directly proportional to amount of time and effort needed to catch the fish while the yield is the dollar value of the fish caught. The peak of the catch curve is the maximum sustainable yield of the population or the maximum harvest which can be taken year after year. Line OB is the line where the cost of fishing just equals the value of the catch. In an unrestrained open fishery harvest would tend towards point B where income equals cost resulting in over fishing of the stocks and reduced profits to the fisherman. This is the situation in many fisheries today. However, if a single harvester has control of the fishery, he will manage it to provide the greatest profit to himself. Profit is the difference between yield curve and the line OB and is greatest at point A. This point of maximum net economic return is always less than the maximum sustainable yield and in a private property enterprise economic considerations will limit harvest.

Monitoring and Evaluation of Harvest

WDF is confident that given proper incentives, economics will necessitate proper management of the harvest tract by the operator. To ensure proper management, WDF monitors the harvest tracts and harvest operations using both divers and with enforcement personnel. In addition to regular Fisheries Patrol Officers, two officers are now assigned fulltime to the geoduck and subtidal clam fisheries. These officers operate from car, boat, and airplane. On a regular basis, Patrol Officers inspect the harvester and confirm that harvest complies with WDF regulations and DNR contract conditions, that operations are within the designated boundaries, and that appropriate marker buoys are in place. They also measure samples of the harvested clam.

The harvester is required to fill out daily a harvest log recording the hours of operation, the pounds landed by species the area harvested. This provides WDF with a continuous record of the clam production and the pounds harvested per hour (catch per unit effort). By monitoring the average clam

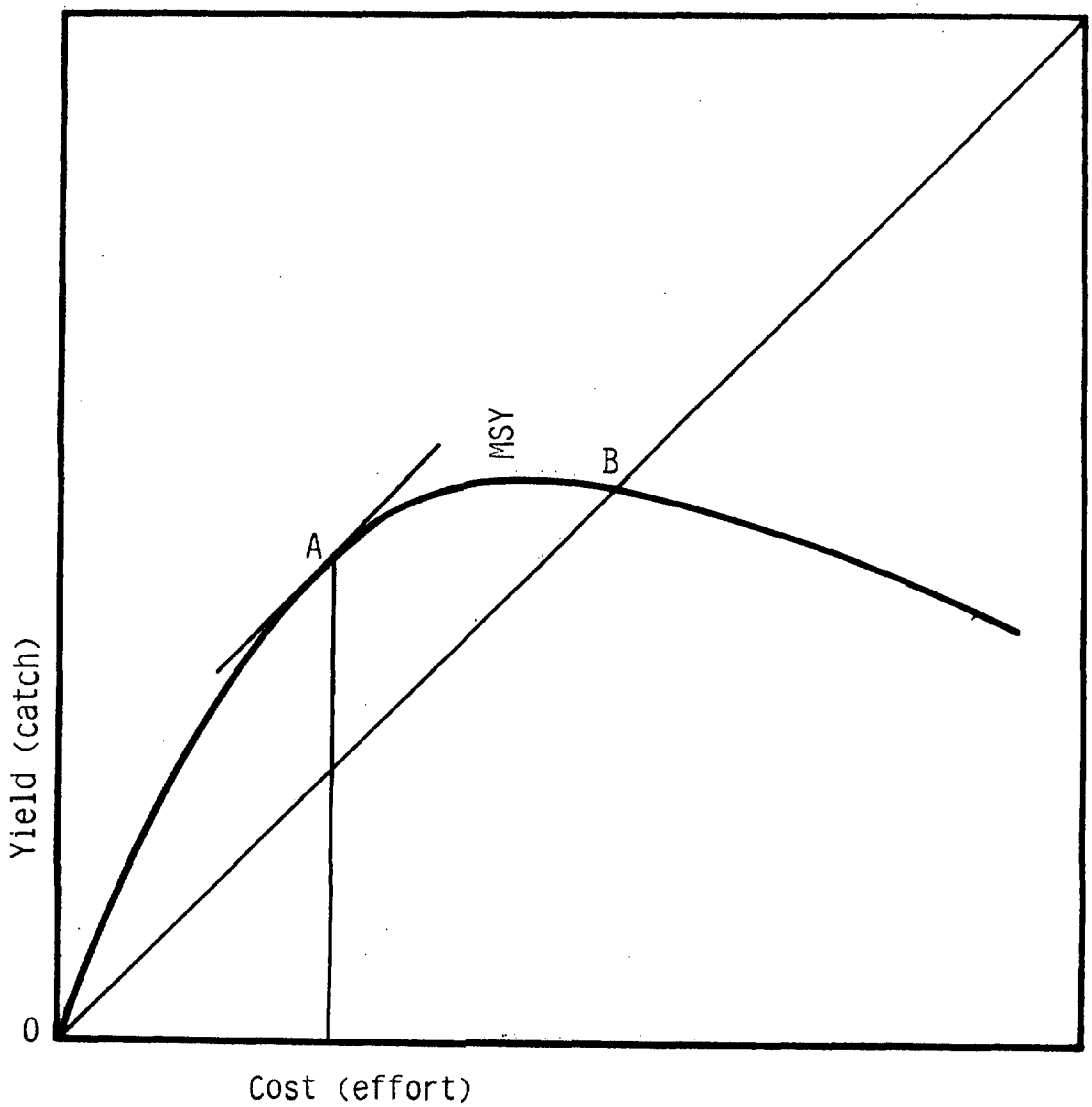


Figure 11. The relation of fishing costs (proportional to fishing effort) to the economic yield to the fisherman (equal to the value of the catch). A privately owned fishery is managed to provide the greatest profit (difference between the value of the catch, line OAB, and the cost of harvest, line OB). The greatest profit is attained at point A which is less than the maximum sustainable yield (MSY). In a common property fishery competition drives the harvest towards point B where profits to the individual fishermen are minimal and where the resource may be overfished. (After Gulland, 1968).

size as measured by enforcement personnel, the average weight per bushel of clams landed, and the catch per unit effort, WDF is able to monitor the harvest activities and ensure that harvest will not exceed appropriate levels. Over-harvest would be indicated by declines in these measurements.

In addition to specific tract monitoring, WDF monitors previously harvested tracts, and various experimental plots to develop additional information on the effects on harvest of clam populations and the marine environment.

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SECTION III - DNR MANAGEMENT OBJECTIVES

The Department of Natural Resources has management responsibility for a vast area of state-owned marine tidelands, bedlands, and harbor areas, and freshwater shorelands and bedlands. The Department exercises its control over land use of state-owned lands through leases, use easements, permits, deeds, interagency coordination and applied research. Unlike state-owned uplands which are managed for economic return, aquatic lands are managed as a public trust for a variety of economic, recreational and natural process activities. To guide its management programs, the Department has identified five objectives:

1. Provide space for a variety of recreational and economic activities;
2. Provide for navigational needs which are of benefit to the general public;
3. Insure adherence to the environmental standards of other agencies;
4. Maintain the productivity and environmental quality of the aquatic lands while continuing to provide for the needs of the public; and
5. Compensate the public for withdrawal of lands by private and public activities which reduce the use options of the general public.

In addition to these, the legislature has authorized the Department to "foster" certain uses of the aquatic lands and this directive is taken here as a sixth aquatic land management objective:

6. The Department of Natural Resources shall foster the commercial and recreational use of the aquatic environment for production of food, fibre, income, and public enjoyment from state-owned lands under its jurisdiction and from associated waters.

The test of whether this subtidal hardshell clam management plan is successful is in how well these objectives are achieved. The Department has defined these objectives in a report titled "The Department of Natural Resources' Marine Land Planning Program", February 10, 1981. The following outline explains what actions are required to achieve these objectives in management of subtidal hardshell clam harvest. Most of these actions have been incorporated into the procedures outlined in Section I of this plan.

Objective 1. Provide space for a variety of recreational and economic activities.

A. DNR has adopted the following administrative policies in regard to use of space for renewable resources:
   1. Utilization of renewable resources is a preferred use of aquatic lands. (WAC 332-30-160(1))
   2. Tidelands, shorelands and beds of navigable waters, especially valuable now and in the foreseeable future for renewable resource activities . . . . shall be so designated and protected from conflicting human uses which limit their utility for this purpose. (WAC 332-30-160(5))
   3. Harvesting must be conducted in such a manner as to . . . minimize insofar as possible conflicts with other users of the water area . . . . (WAC 332-30-160(7))

B. The Department of Fisheries has identified 5,350 acres of marine bedlands in Washington where subtidal hardshell clams occur in commercial abundance. Of this area only about 1,432 acres meet basic commercial harvest criteria. These criteria cover substrate type, water depth, water quality, harvest technology and environmental protection.

C. The Department of Fisheries' recommended management scheme for this fishery is to lease all tracts for simultaneous, continuous harvest. The timing and duration of harvest are left to the judgment of individual harvesters. No more than 10 boats are expected to operate on presently known tracts.

D. Harvest under this scheme is a low intensity use of the waters and will not usually conflict with other navigational activity.

E. Subtidal hardshell clam beds extend into shallow subtidal waters. Erection of structures or dredging in these areas would conflict with use and maintenance of the clam resource.

F. Local conflicts over use of marine land space will be identified and resolved through the procedures contained in Section I.

Objective 2. Provide for navigational needs which are of benefit to the general public.

A. Some subtidal hardshell clam beds are found in narrow channels such as Agate Pass, Portage Canal and the entrance to Kilisut Harbor.

B. Some subtidal hardshell clam beds occur in historical high use sport and commercial fishing areas. Some concern has been raised about potential interference with sport fishing.

C. Subtidal hardshell clam harvest boats move slowly while harvesting. They can easily avoid and be avoided by other navigational uses. Historically, there have not been any conflicts between harvesters and other navigational uses.

D. The procedure stated in Section I will identify and resolve local conflicts over navigation.

Objective 3. Insure adherence to the environmental standards of other agencies.

A. DNR has adopted the following administrative policies in regard to coordinating with the environmental standards of other agencies:

1. Other governmental agencies, local, state and federal, administer laws and regulations which also govern activities on aquatic lands. In order to benefit from the expertise and experience of these agencies, the

Commissioner of Public Lands seeks the advice of the Marine Resources Advisory Committee. (WAC 332-30-100(1))

2. The Department will insure that its allocations, leases, uses and activities are consistent with local [shoreline] programs. (WAC 332-30-100(1))
3. Harvesters must comply with all applicable federal, state, and local rules and regulations. Noncompliance may result in lease suspension or cancellation upon notification. (WAC 332-30-157(6))
4. The Department will work with other agencies through development and implementation of management plans to insure that . . . as much as possible of the resource base is available for harvesting. (WAC 332-30-160(11)).

B. The following permits are required for commercial subtidal hardshell clam harvest:
   1. Shoreline management substantial development permit
   2. Corps of Engineers section 10 permit
   3. Department of Fisheries clam farm license and permit to operate clam harvesting machine.

C. Four counties have shoreline management master program regulations which would effectively prohibit subtidal hardshell clam harvest. These counties are Clallam, Skagit, Kitsap and King. Commercial subtidal hardshell clam beds have been found in Kitsap and Clallam but not in King or Skagit. The Kitsap and Clallam master programs require that harvest trenches be refilled to within three inches of the original substrate surface. The Department of Fisheries believes that artificial refilling of the trench is unnecessary and present equipment is not designed for this. A harvester now being tested may refill trenches better than older models but the effectiveness is still not known. The Department of Ecology has adopted revised aquaculture guidelines which require that counties with potential commercial subtidal hardshell clam tracts re-evaluate their master program standards. DNR will

participate in that process and encourage adoption of standards which have a sound scientific basis.

D. The Corps of Engineers issued a three-year permit for harvest at Portage Canal on May 1, 1980. The permit was not conditioned but the attached environmental assessment requested that pre- and post-harvest data be collected. The Department of Fisheries will work with the Corps to supply it.

E. Some agencies have expressed concern that the eelgrass criteria developed in the EIS will be difficult to apply in the different types of eelgrass beds. All agencies agree that each site needs to be evaluated individually. This will be done through the procedure contained in Section I.

Objective 4. Maintain the productivity and environmental quality of the aquatic lands while continuing to provide for the needs of the public.

A. The Department has adopted the following administrative policy in regard to protection of the environment from and for commercial geoduck harvesting:

1. Harvesting must be conducted in such a manner as to have . . . insofar as possible a minimal impact upon the environment. (WAC 332-30-160(7))
2. The Department will work with other agencies through development and implementation of management plans to insure that commercial shellfish beds are kept free of pollution . . . . (WAC 332-30-160(11))
3. The boundaries of clam tracts offered for lease shall be established and identified to avoid detrimental impacts upon significant beds of aquatic vegetation or areas of critical biological significance . . . . (WAC 332-30-157(2))
4. Commercial clam beds on aquatic lands shall be managed to produce an optimum yield. (WAC 332-30-157(1))

5. The methods of harvest may only be those as established by law and certified by the department of fisheries. (WAC 332-30-157(3))

B. DNR and WDF have prepared an EIS for subtidal hardshell clam harvest. The EIS contains environmental standards for site selection and harvester operation.

C. The EIS was intended to cover general operating characteristics of the harvester. There is still a need for

D. While the WDF and DNR are satisfied that the harvest scheme will not cause significant adverse environmental impacts, some other agencies and citizens are not convinced. This skepticism is at least partly due to the fact that much of the harvest and tract data collected by the WDF has either not been prepared for public distribution or has been written up in technical reports which are difficult for others to understand.

There is also concern that once a lease is granted, the state may not do adequate monitoring to assure that the harvest is at a sustained yield rate and that eelgrass beds will be protected.

E. Trespass has been a major concern of adjacent homeowners and aquaculturists although WDF has never been able to document any actual trespass cases. Buoys have been set to mark corners but these have occasionally been stolen, leaving no reference for upland owners or harvest operators.

F. The Department of Fisheries is legally responsible for assuring that harvest maintains a sustained yield of clams and does not injure other aquatic flora and fauna.

G. Harvest equipment must as a minimum meet the noise limits set by the State Department of Ecology in WAC 173-60. The Shorelines Hearings Board found in the Agate Pass case that special noise limits lower than the state maximum should be applied due to the residential character of the site.

H. The Department of Social and Health Services has identified several clam beds where a potential for water pollution exists.

I. DNR considers that an optimum yield will be achieved in this fishery by carefully limiting harvest areas and by allowing harvesters, under supervision, to regulate harvest within those areas. Limitations on the area available for harvest will be imposed through allocation procedures and individual site reviews. Within areas suitable for harvest, harvesters will be allowed to set their own harvest rate according to market conditions and their own judgment of the best rate of harvest. Lower and upper limits will be set by a minimum yearly harvest quota and periodic monitoring by WDF of the harvested population to prevent over harvest.

Objective 5. Compensate the public for withdrawal of lands by private and public activities which reduce the use options of the general public.

A. DNR has adopted the following administrative procedures in regard to insuring adequate compensation from commercial subtidal hardshell clam harvest:

1. Surveillance methods will be employed to insure that trespass as well as off-tract harvesting is prevented. (WAC 332-30-157(4))
2. Harvesters must comply with all lease provisions. Noncompliance may result in lease suspension or cancellation upon notification. (WAC 332-30-157(5))
3. The boundaries of clam tracts offered for lease shall be established and identified to . . . prevent unauthorized harvesting. (WAC 332-30-157(2))

B. The Department of Fisheries recommends that subtidal hardshell clam tracts be offered for long-term leases and that the harvester be allowed to determine the timing and amount of harvest.

C. In the past, lessees have been charged a fixed royalty for clams harvested. This royalty has not provided a fair return to the state, as the value of clams has increased and a new higher royalty might be unfair if market prices were to drop.

Objective 6. The Department of Natural Resources shall foster the commercial and recreational use of the aquatic environment for production of food, fibre, income and public enjoyment from state-owned lands under its jurisdiction and from associated waters.

A. DNR has adopted the following administrative regulations in regard to fostering commercial subtidal hardshell clam harvest:

1. The Department will foster renewable resource utilization through research and development work, public education, land use allocation and resource inventory. (WAC 332-30-160(2))
2. Commercial harvesting of wild stocks of shellfish shall be encouraged on aquatic lands. (WAC 332-30-160(7))

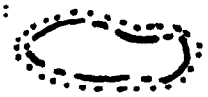
B. The Department allocates marine lands for subtidal hardshell clam harvest in accordance with the procedures stated in Section I.

APPENDIX A

DNR Marine Land Allocations for Commercial Subtidal Hardshell Clam Harvest

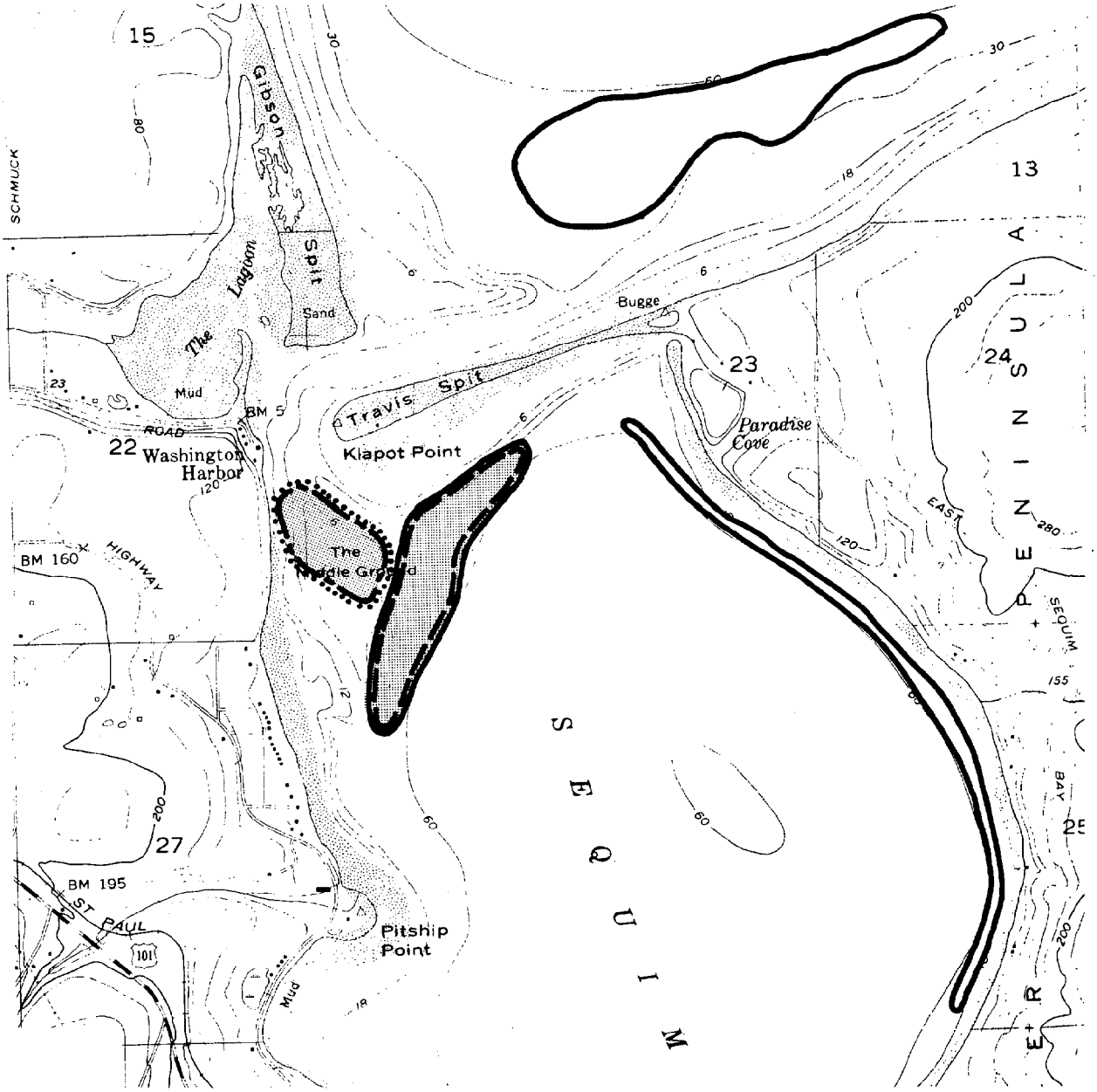
DNR marine land allocations are made to reserve and protect certain marine areas for designated uses. Areas are allocated on the basis of general surveys which consider environmental, social and economic suitability. Allocations are made for regional planning purposes only. Site specific conditions or information found during specific project evaluations may restrict or even prevent use of any particular site for the allocated use.

This appendix consists of a series of detailed site maps. The maps show the general locations of all subtidal hardshell clam beds allocated for commercial harvest. General area maps of Puget Sound which serve as keys to these maps are contained in Figure 2 of the report in Section II. These allocation maps will be revised as needed to include new areas found suitable for harvest or to delete areas which have been found to be unsuitable. Areas allocated for commercial subtidal hardshell clam harvest are shown on the maps by this symbol:



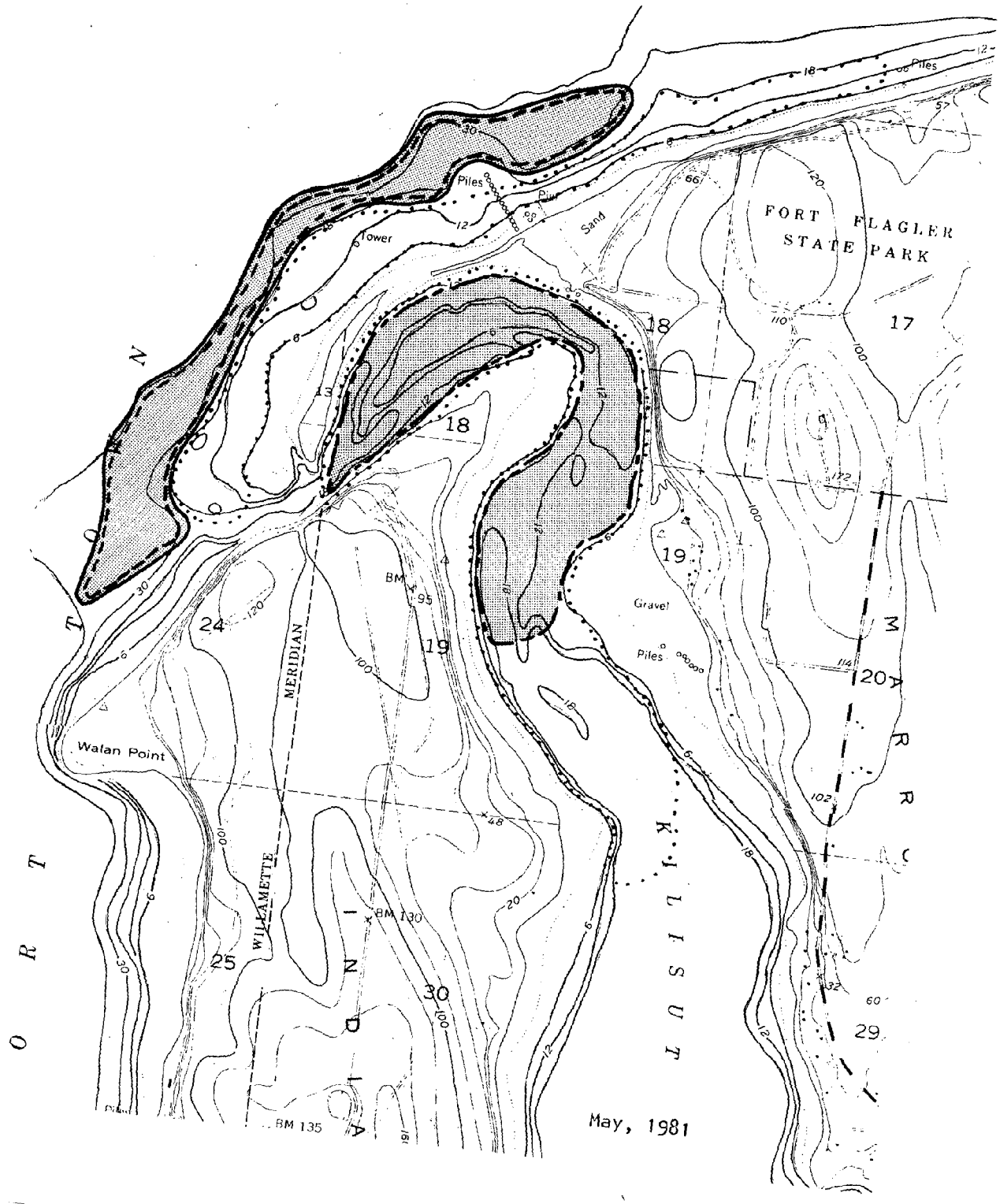
Some of these maps contain a slightly different symbol used to designate another type of marine land allocation. The reader should be careful to only use the above symbol in reference to this plan.

DNR Marine Land Allocations
Commercial Geoduck and Subtidal Clam Harvest
Clallam County 3

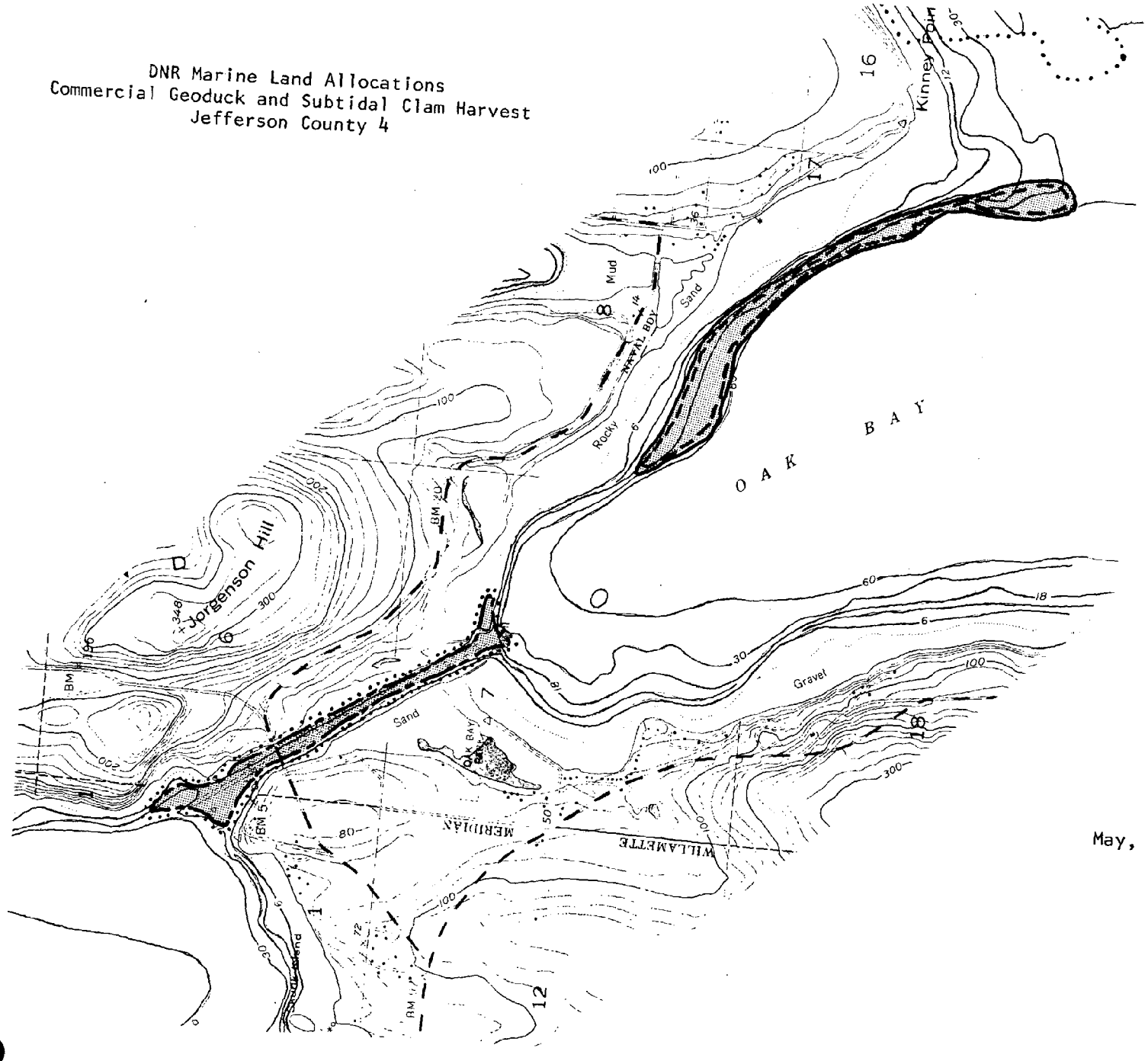


May, 1981

DNR Marine Land Allocations
Commercial Geoduck and Subtidal Clam Harvest
Jefferson County 3

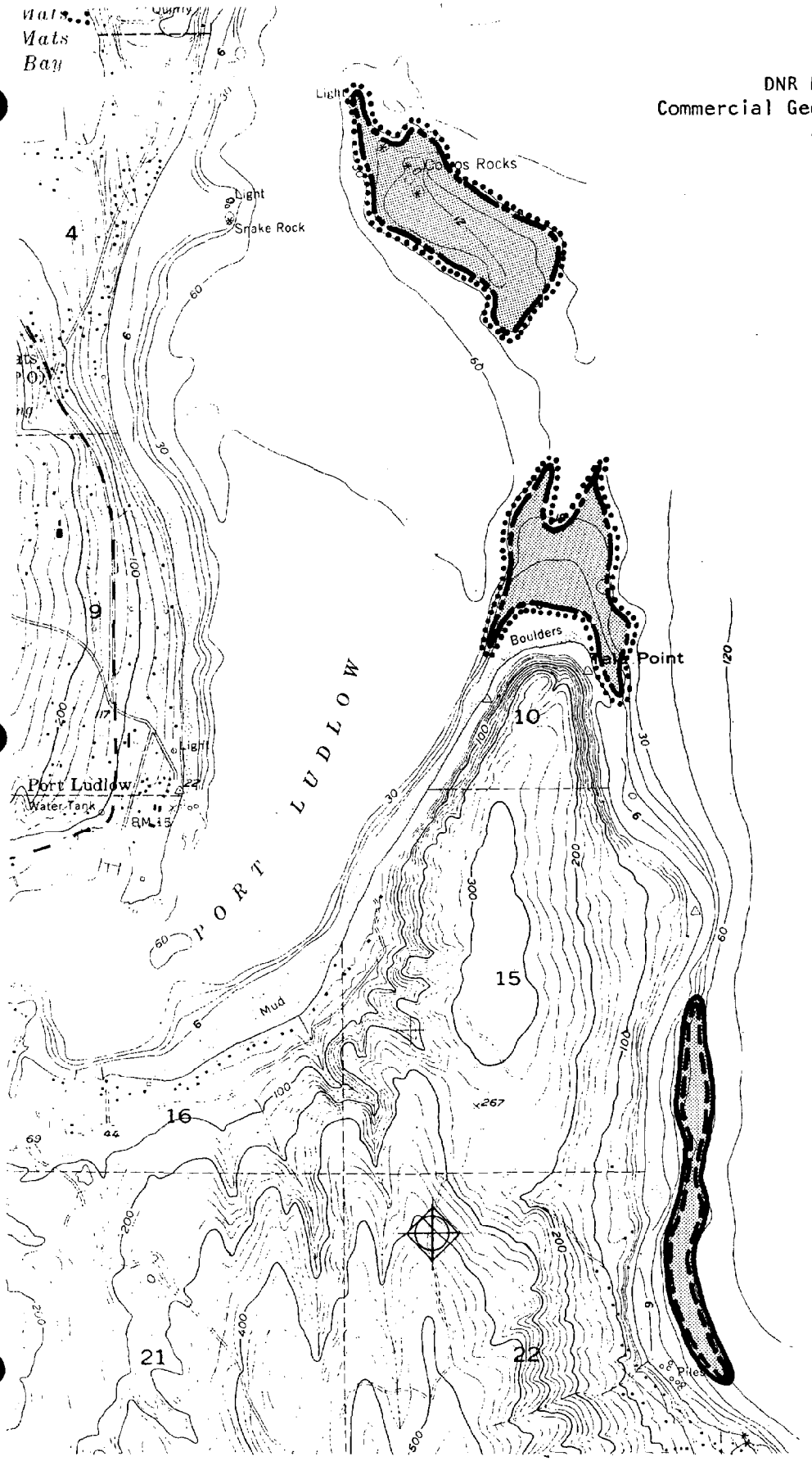


DNR Marine Land Allocations
Commercial Geoduck and Subtidal Clam Harvest
Jefferson County 4

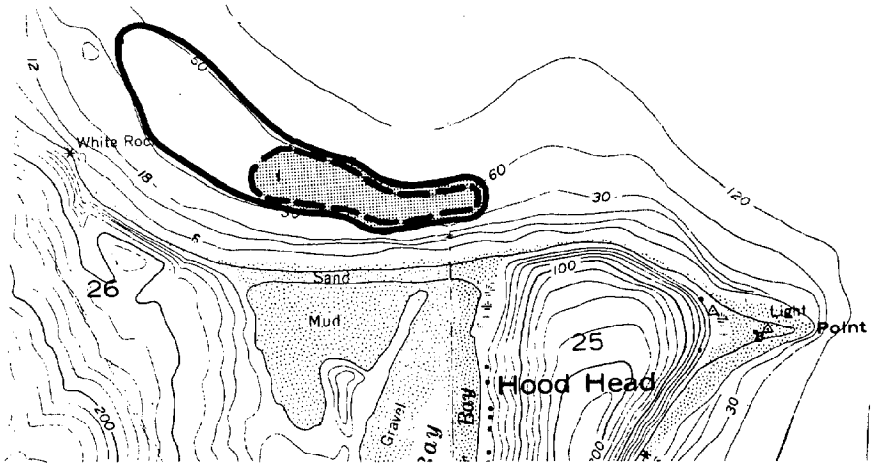


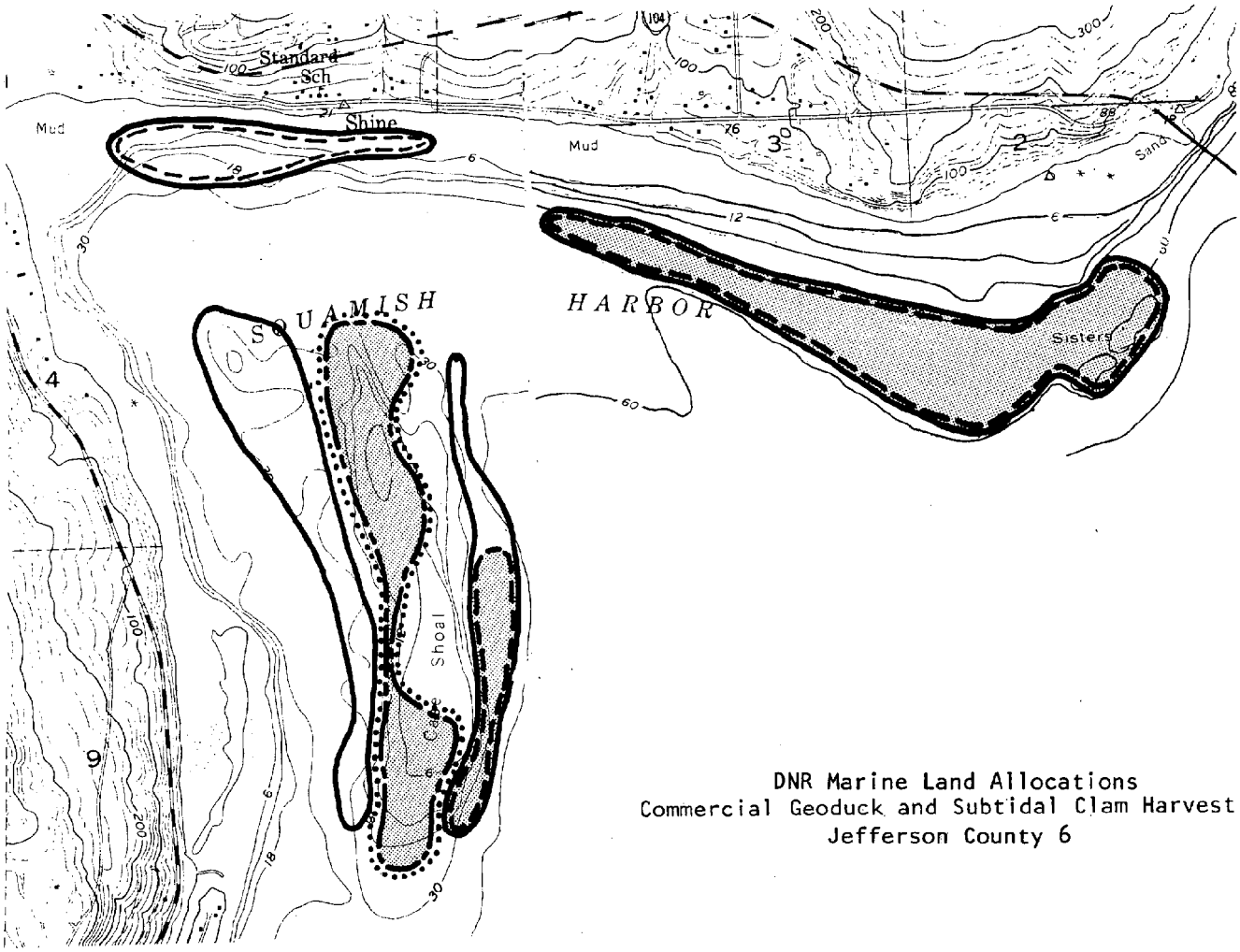
May, 1981

DNR Marine Land Allocations
Commercial Geoduck & Subtidal Clam Harvest
Jefferson County 5



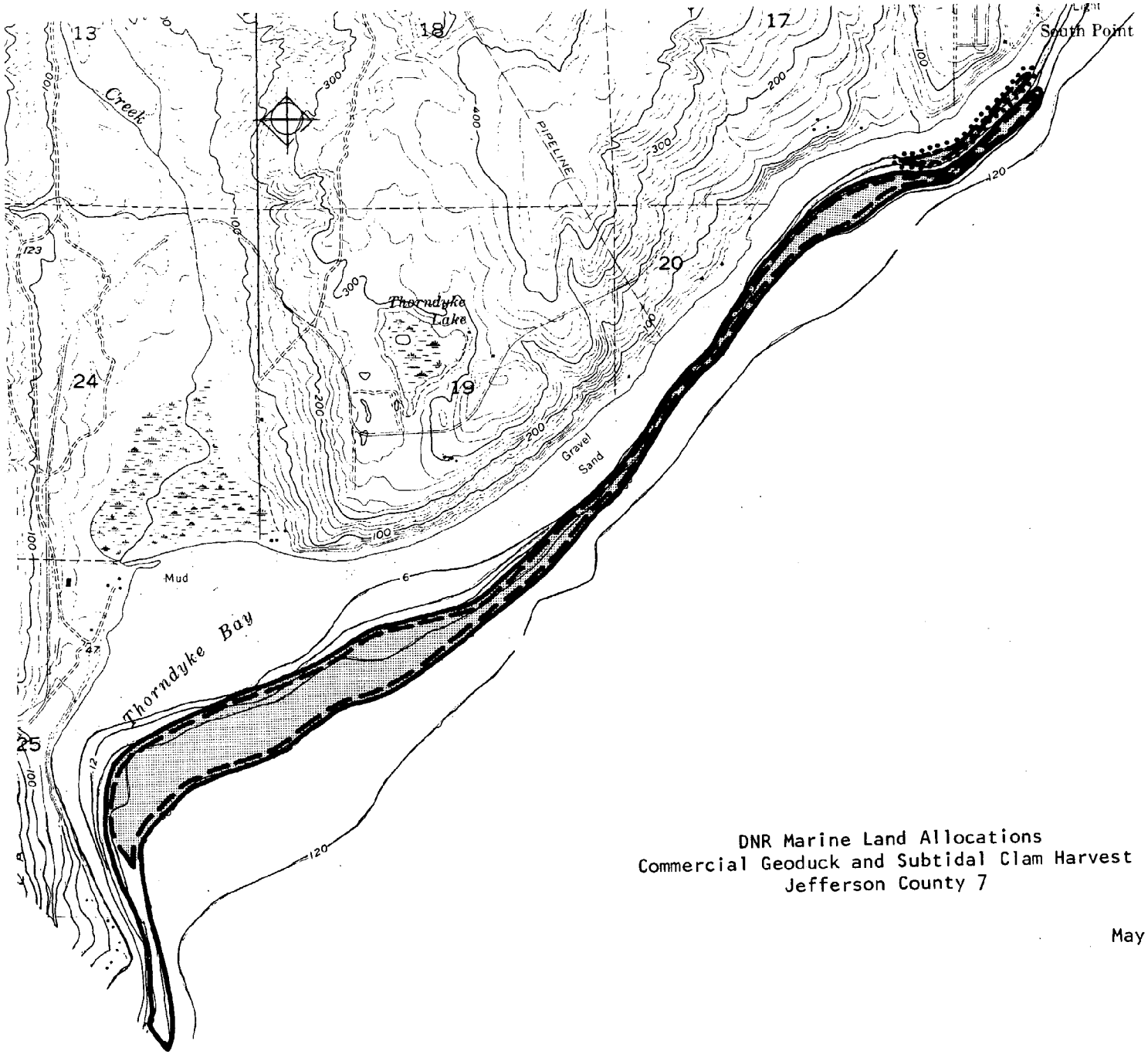
May, 1981





DNR Marine Land Allocations
Commercial Geoduck and Subtidal Clam Harvest
Jefferson County 6

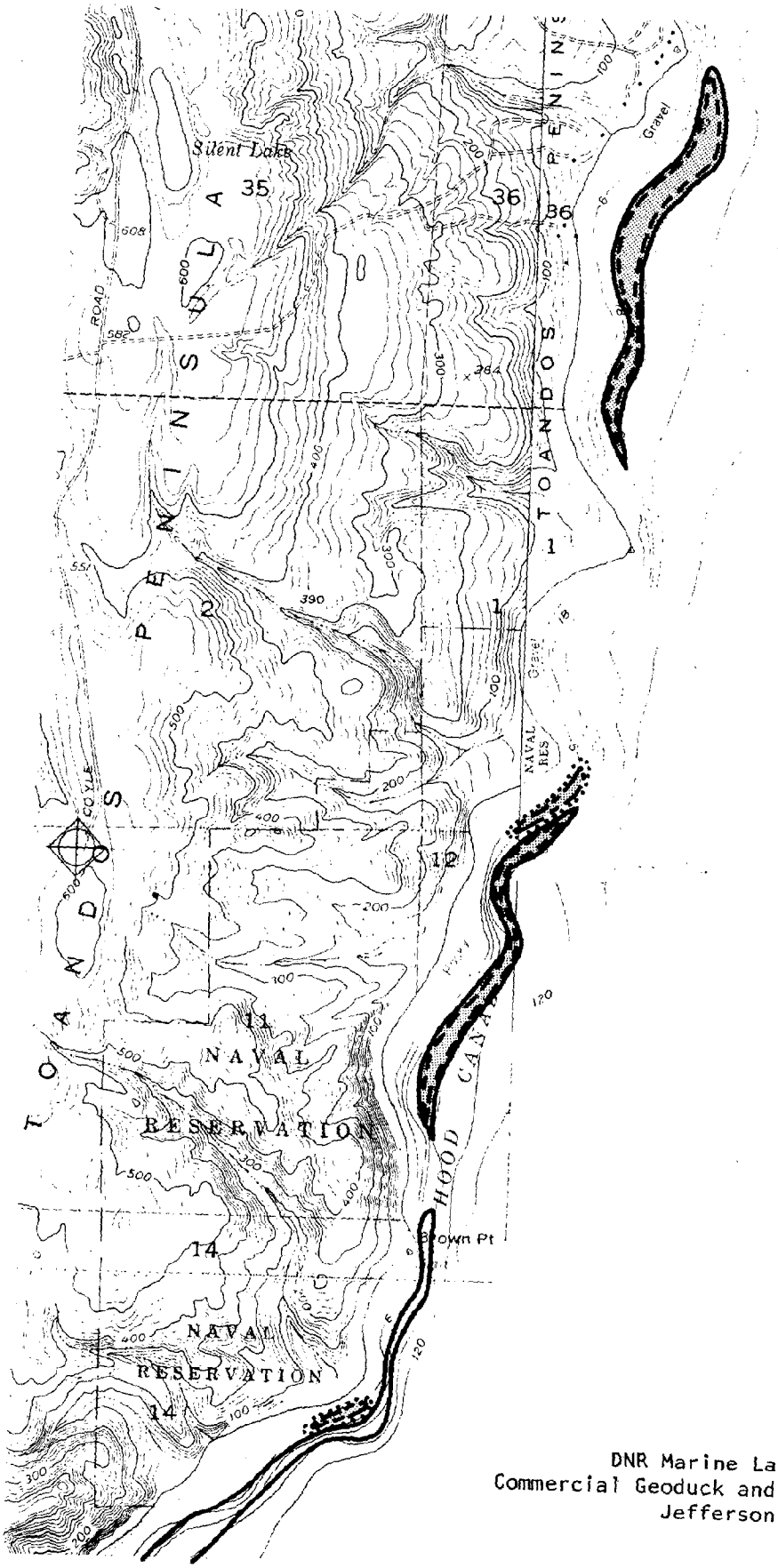
May, 1981



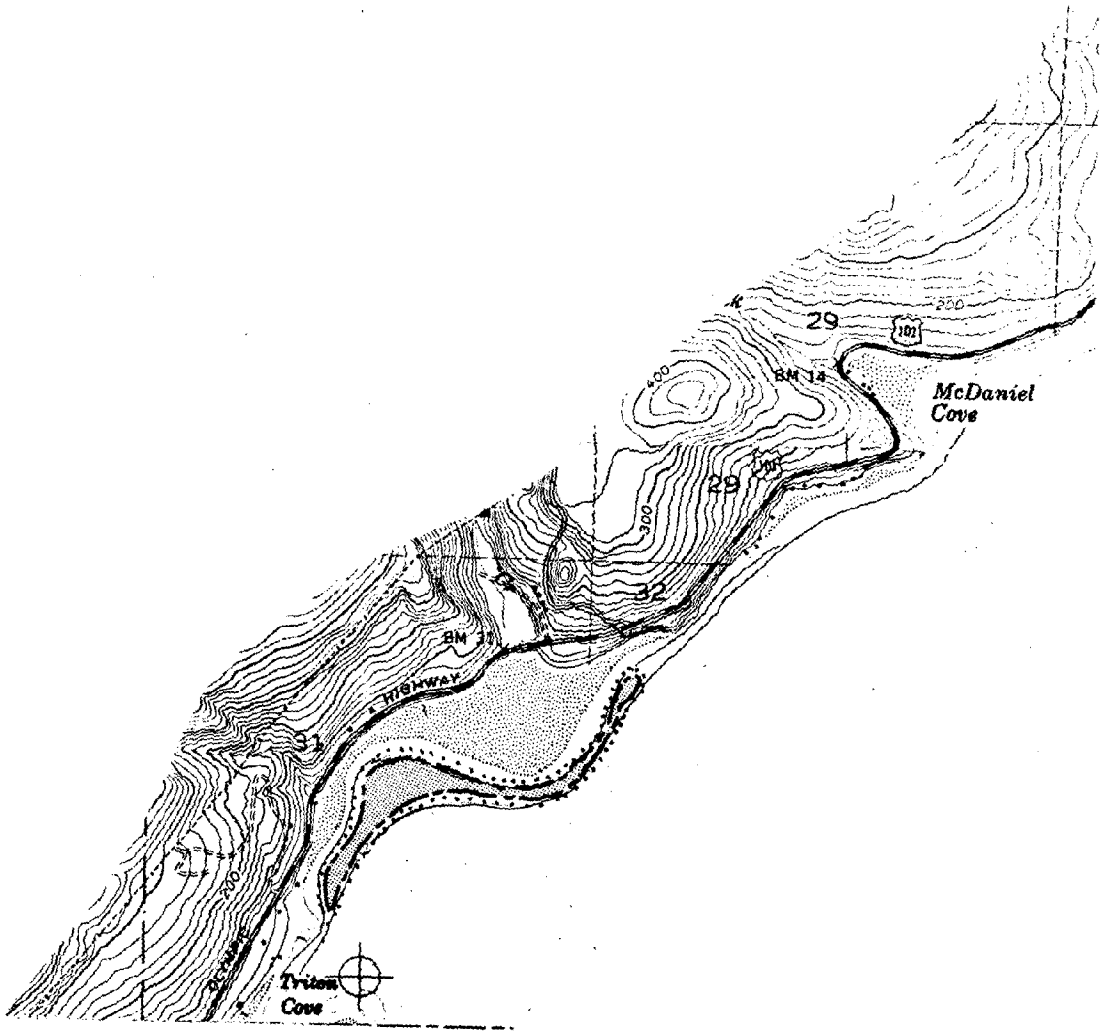
DNR Marine Land Allocations
Commercial Geoduck and Subtidal Clam Harvest
Jefferson County 7

May, 1981

May, 1981



DNR Marine Land Allocations
Commercial Geoduck and Subtidal Clam Harvest
Jefferson County 8

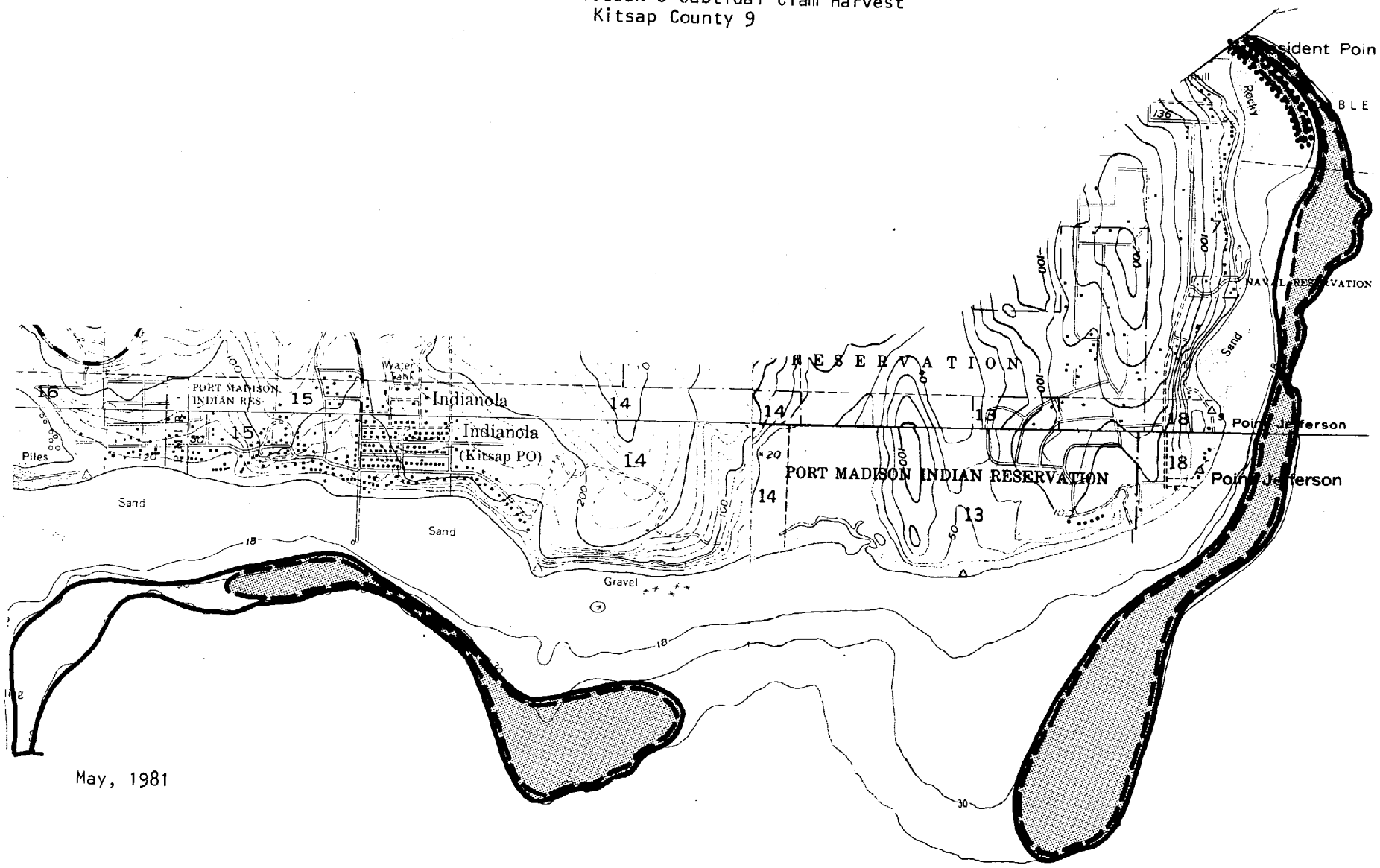


DNR Marine Land Allocations
COMMERCIAL SUBTIDAL HARDSHELL CLAM HARVEST

Jefferson County 9

May, 1981

DNR Marine Land Allocations
Commercial Geoduck & Subtidal Clam Harvest
Kitsap County 9



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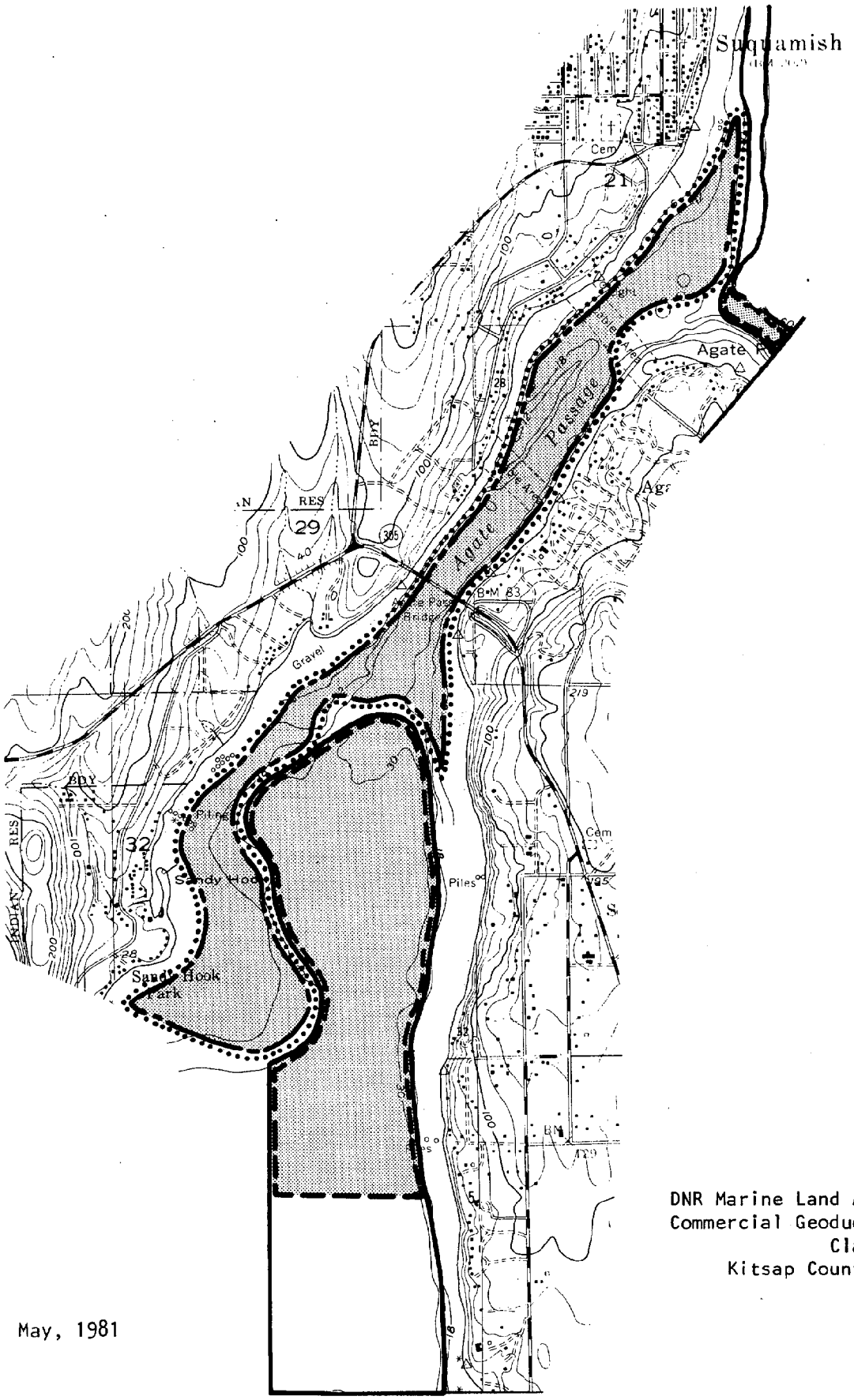
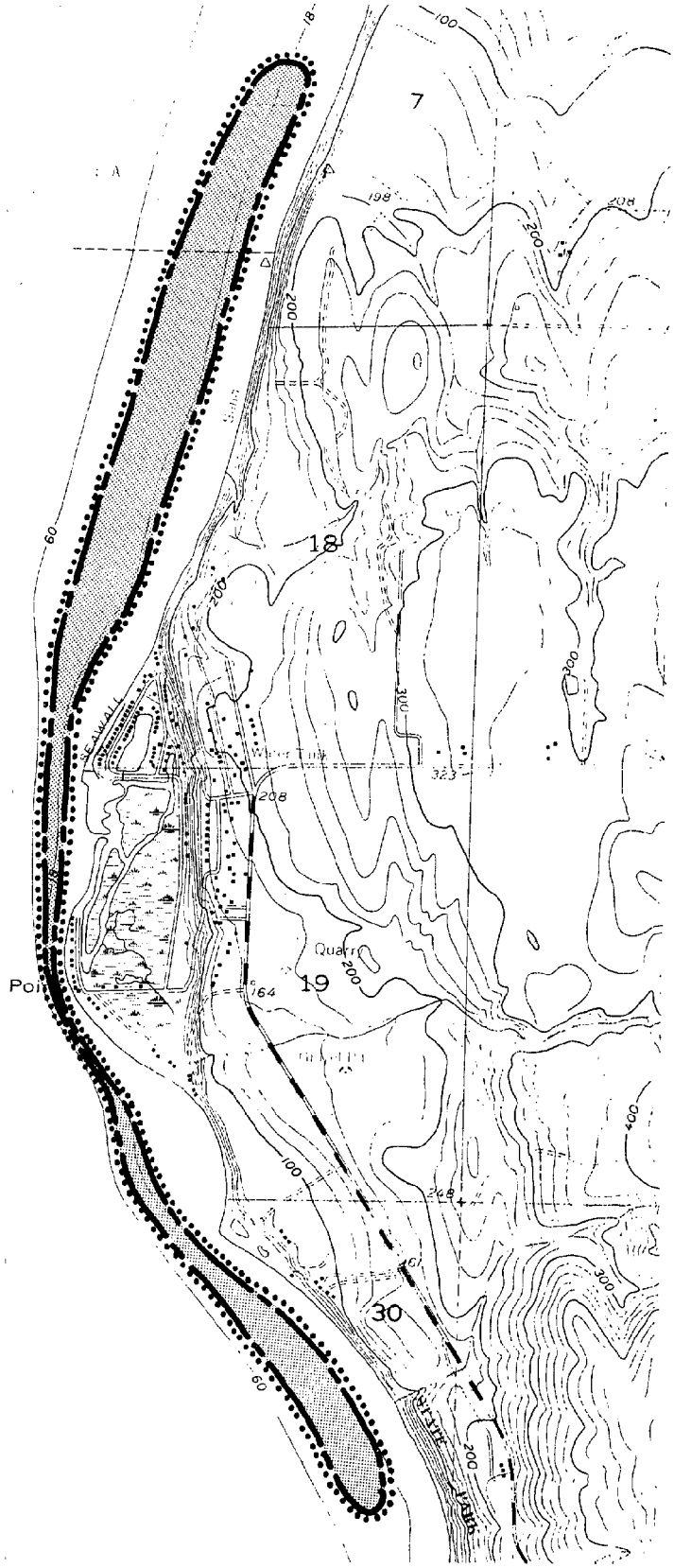


DNR Marine Land Allocations
Commercial Geoduck & Subtidal
Clam Harvest
Kitsap County 10

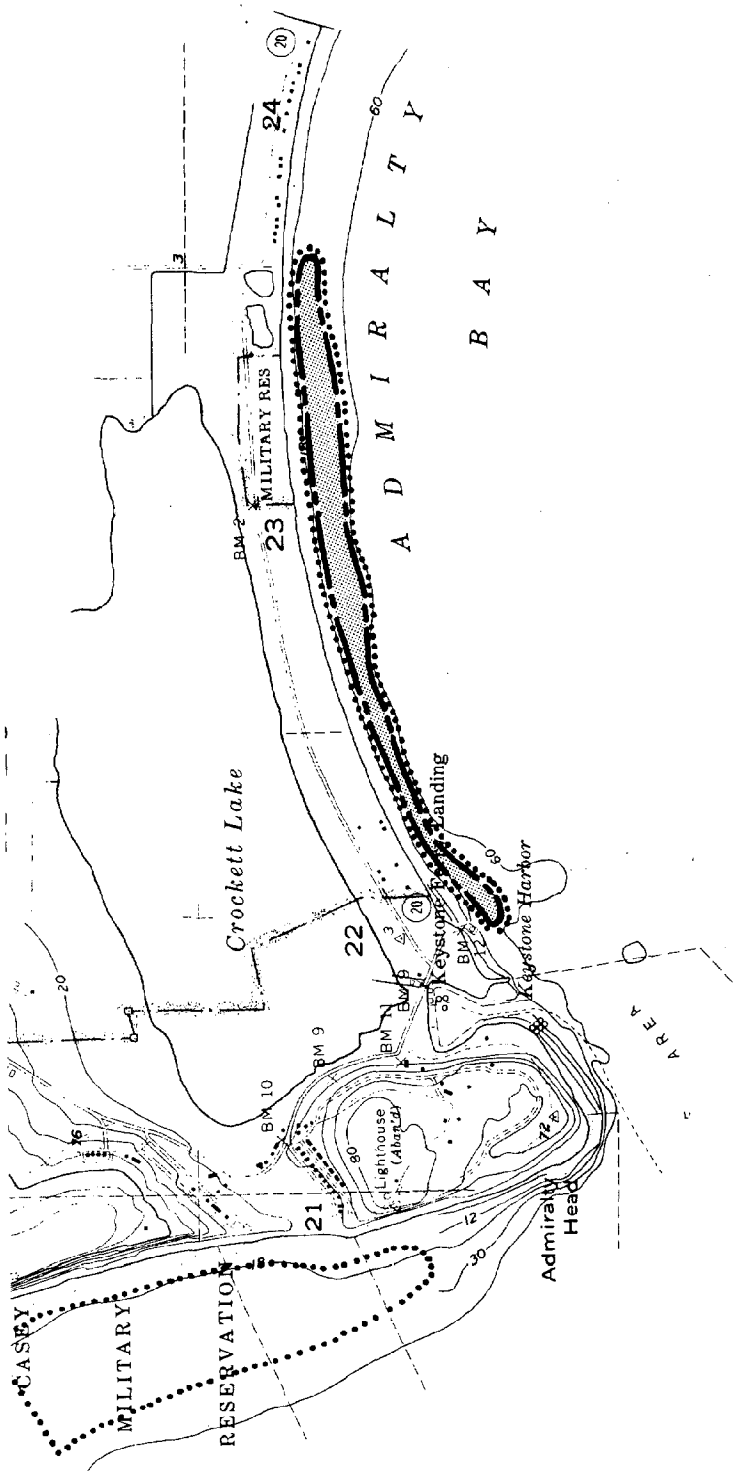
May, 1981

May, 1981



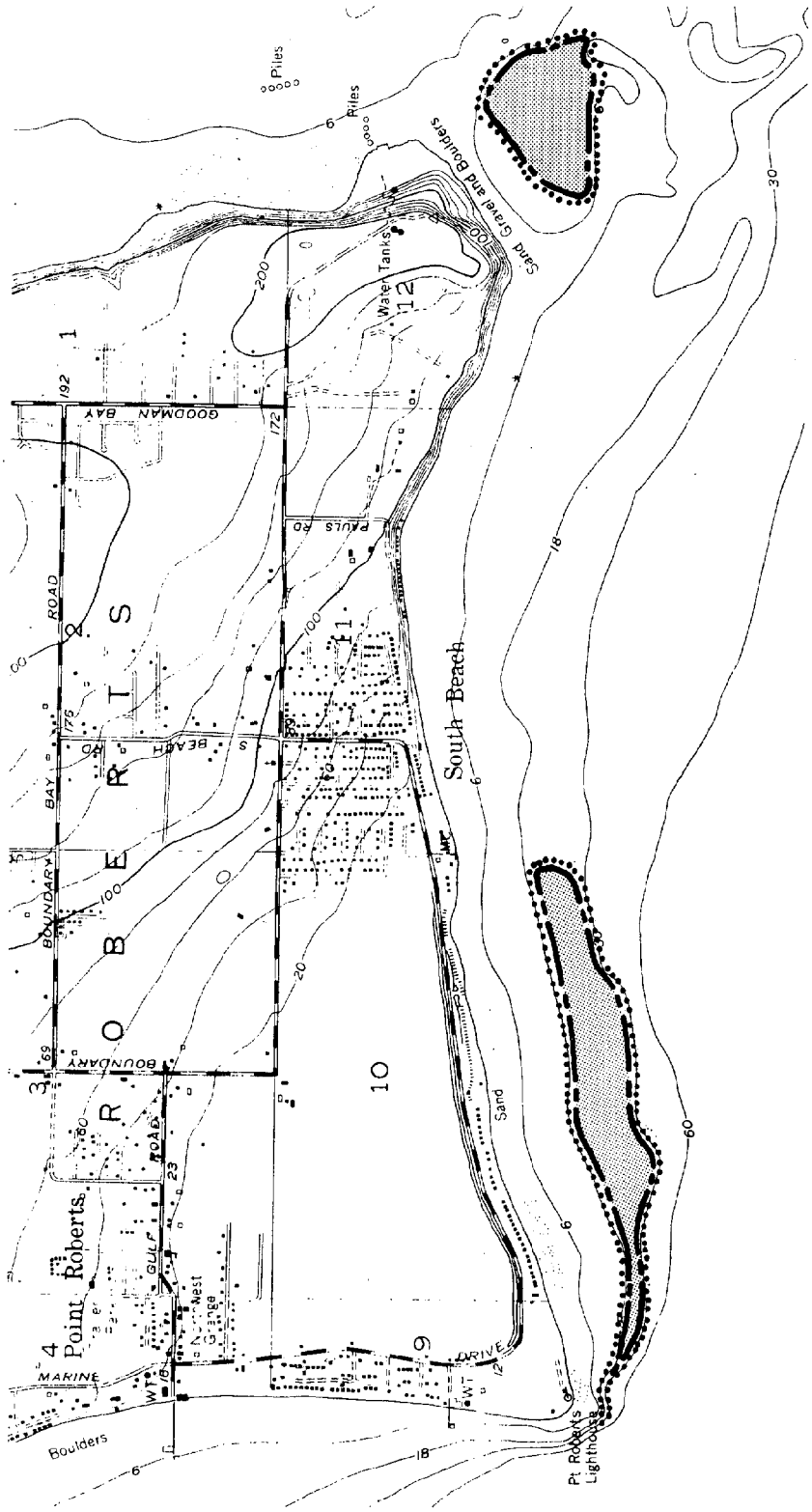
DNR Marine Land Allocations
COMMERCIAL SUBTIDAL HARDSHELL CLAM HARVEST
Island County 3

May, 1981



DNR Marine Land Allocations
COMMERCIAL SUBTIDAL HARDSHELL CLAM HARVEST
Island County 4

May, 1981



DNR Marine Land Allocations
COMMERCIAL SUBTIDAL HARDSHELL CLAM HARVEST
Whatcom County 1

APPENDIX B.

Commercial Subtidal Hardshell Clam Bed
Environmental Data Summary

DNR Map	Tract Name	Acreage	Flora & Fauna Species	Season	Comments
Clallam 3	Sequim Bay		F 78 F 66 33	F? W Sp	Nearby beds certified. Marina under consideration nearby. Intensive development would cause pollution problems.
Jefferson 3	Kilisut Harbor	132	B 21 B 24 B 28 B 26 B 29 B 50 F 19 F 66 F 75 B 30 36	W W W W W F Sp S F W S F W S F W Sp W F	Water line to Ft. Flagler State Park may cross clam bed.
Jefferson 4	Portage Canal	35			
Jefferson 5	Colvos Rocks Tala Point	27 60			
Jefferson 6	Case Shoal	40	I 14 M 8	W Sp S F W Sp S F	
Jefferson 7	South Point	6			
Jefferson 8	Brown Point (N) Brown Point (S)	37 8	B 76 B 76	S S	
Jefferson 9					
Kitsap 9	President Point				
Kitsap 10	Agate Pass	98	F 2 F 66 F 75		Shorelines are residential areas. Noise is a major concern.
Island 3	Lagoon Point		P 1 B 21 B 24 B 25 B 26 B 27 B 29 B 30 B 50 B 2 B 5 36	W Sp S F W W W W W W F W F Sp S F W F	Proposed withdrawal of marine bedlands for South Whidbey State Park may overlap clam bed. Some residences nearby. Noise and navigational access to shore should be considered.
Island 4	Admiralty Bay		I 35 P 1	W Sp S F W Sp S F	Underwater park near east jetty of Keystone Harbor. Marine lands abutting park have been withdrawn for recreational use.
Whatcom 1	Pt. Roberts		B 2 I 14 F 22 F 66	W Sp S F W Sp S F W Sp W Sp	

KEY TO FLORA AND FAUNA *

Birds

B-1	Common Loon
B-2	Arctic Loon
B-3	Red-throated Loon
B-5	Horned Grebe
B-6	Eared Grebe
B-7	Western Grebe
B-8	Double-crested Cormorant
B-12	Western Canada Goose
B-13	Black Brant
B-14	White-fronted Goose
B-15	Snow Goose
B-16	Mallard
B-17	Pintail
B-18	Green-winged Teal
B-19	American Wigeon
B-20	Northern Shoveler
B-21	Canvasback
B-22	Greater Scaup
B-23	Lesser Scaup
B-24	Common Goldeneye
B-25	Barrow's Goldeneye
B-26	Bufflehead
B-27	Oldsquaw
B-28	Harlequin Duck
B-29	White-winged Scoter
B-30	Surf Scoter
B-31	Black Scoter
B-35	Parasitic Jaeger
B-36	Glaucous-winged Gull
B-37	Western Gull
B-47	Pigeon Guillemot
B-48	Marbled Murrelet
B-50	Rhinoceros Auklet
B-51	Tufted Puffin
B-53	Northern Phalarope
B-54	Great Blue Heron
B-55	Whimbrel
B-62	Least Sandpiper
B-63	Dunlin
B-64	Short-billed Dowitcher
B-66	Western Sandpiper
B-67	Sanderling
B-68	Black Oystercatcher
B-69	Semipalmated Plover
B-70	Killdeer
B-71	Black-bellied Plover
B-72	Surfbird
B-75	Belted Kingfisher
B-76	Northern Bald Eagle

Fish

F-2	Lingcod
F-7	Pacific Halibut
F-9	Rock Sole
F-10	Dover Sole
F-19	Pacific Cod
F-20	Pacific Hake
F-22	Walleye Pollock
F-23	Wolf-Eel
F-24	Pacific Ocean Perch
F-41	Longnose Skate
F-66	Pacific Herring
F-75	Surf Smelt
F-76	Longfin Smelt
F-78	Capelin

Invertebrates

I-3	Red Sea Urchin
I-5	Ocean Pink Shrimp
I-6	Northern Pink Shrimp
I-8	Spot Shrimp
I-11	Coonstripe Shrimp
I-14	Dungeness Crab
I-30	Octopus
I-34	Sea Scallop
I-35	Rock Scallop
I-38	Oysters

Mammals

M-2	Harbor Seal
M-3	Northern Fur Seal
M-8	River Otter
M-9	Dall Porpoise

Marine Plants

P-1	Sea Grasses
P-2	Green Algae
P-3	Brown Algae
P-4	Red Algae

△ Important multispecies areas. **

* Information on flora and fauna was obtained from data collected for the report, Washington Coastal Areas of Major Biological Significance, June, 1981 update.

**Numbers in triangles refer to descriptions in Table 2 in above referenced report.

APPENDIX C.

Agencies to be Notified of Harvest Plans.

The following agencies and groups will be notified of all commercial subtidal hardshell clams harvest proposals, and of any revisions and updates of the subtidal hardshell clam management plan.

Supervisor
Shorelands Division
Department of Ecology PV-11
Olympia, WA 98504

Inter-Agency Coordinator
Department of Game
Olympia, WA 98504

Supervisor, Shellfish Program
Food and Housing Section
Dept. of Social and Health Services
LD-11
Olympia, WA 98504

Chief, Research & Long-Range Planning
Wash. St. Parks and Recreation Comm.
KY-11
Olympia, WA 98504

Coastal Zone Coordinator
National Marine Fisheries Service
847 NE 19th Avenue
Portland, OR 97232

Division of Ecological Services
U.S. Fish and Wildlife Service
2625 Parkmont Land, Bldg. B-3
Olympia, WA 98502

Chief, Regulatory Functions
Seattle District
U.S. Army Corps of Engineers
P.O. Box C-3755
Seattle, WA 98124

Dredge and Fill Permits Section
U.S. Environmental Protection Agency
Mail Stop 521
1200 6th Avenue
Seattle, WA 98101

All counties having identified commercial subtidal hardshell clam beds.

All current holders of DNR tract leases for subtidal hardshell clam harvest.

Other agencies and groups upon request.

Other agencies will be notified as necessary. These would include the following agencies which own property adjacent to the harvest tracts or which operate in the waters adjacent to and over the tracts:

U.S. Coast Guard

U.S. Navy

U.S. Army

Native American Tribes

APPENDIX D.

Pertinent WDF Laws and Regulations

Title 75 RCW: Food Fish and Shellfish

75.08.012 Duties of the department. It shall be the duty and purpose of the department of fisheries to preserve, protect, perpetuate and manage the food fish and shellfish in the waters of the state and the offshore waters thereof to the end that such food fish and shellfish shall not be taken, possessed, sold or disposed of at such times and in such manner as will impair the supply thereof. For the purpose of conservation, and in a manner consistent therewith, the department shall seek to maintain the economic well-being and stability of the commercial fishing industry in the state of Washington. [1975 1st ex.s. c 183 § 1; 1949 c 112 § 3, part; Rem. Supp. 1949 § 5780-201, part. Formerly RCW 43.25.020. Redesignated as RCW 75.08.012 and added to chapter 12, Laws of 1955 and Title 75 RCW by 1965 c 8 § 43.25.020.]

75.28.280 Clam farm license——Exception, geoducks. A license is required for each and every clam farm of one or more tracts of land being operated for commercial purposes on privately owned or leased tidelands and on leased beds of navigable waters in the state, except that a license under this section is not required for subtidal geoduck harvest tracts for which the required harvest rights and licenses have been obtained pursuant to other provisions of law. The fee for said license is fifteen dollars per annum, and shall be paid for each and every year in which clams are removed from the clam farm for purposes of sale. A separate license is required for each clam farm being operated within each of the following clam districts; northern Puget Sound district, southern Puget Sound district, Grays Harbor district, and Willapa Harbor district; said districts are to include the waters, beds, shores, beaches, and tidelands of, northern Puget Sound, southern Puget Sound, Grays Harbor, and Willapa Harbor, respectively, as geographically defined by the director of fisheries under appropriate regulations. [1979 1st ex.s. c 141 § 3; 1969 ex.s. c 253 § 3; 1955 c 212 § 8; 1955 c 12 § 75.28.280. Prior: 1951 c 271 § 26; 1949 c 112 § 70; Rem. Supp. 1949 § 5780-508.]

75.28.282 Clam farm license, oyster farm license——Who must obtain. A clam farm license or an oyster farm license or both as provided in RCW 75.28-.280 and 75.28.281 shall be required of:

(1) Any person or company owning and operating an oyster farm or clam farm or both;

(2) Any lessee operating an oyster farm or clam farm or both, except when the owner thereof comes within the provisions of subsection (3) of this section;

(3) Any person or company owning an oyster farm or a clam farm or both, operated by a lessee or another, which owner handles, processes, sells, or otherwise deals in the oysters or clams or both produced thereon, which are received by the owner as total or partial consideration for the use of the oyster or clam farm or both. [1955 c 212 § 10.]

75.28.287 Tract license for harvesting geoducks——Diver's license——License for mechanical and/or hydraulic device used taking clams——Displaying licenses. (1) A geoduck tract license is required for each subtidal geoduck tract for which harvest rights have been granted by the department of natural resources for the commercial harvest of geoducks. The fee is one hundred dollars per annum.

(2) Every diver engaged in the commercial harvest of geoduck or other clams shall obtain a nonassignable personal commercial fishing license. The fee is fifty dollars per annum.

(3) A license is required for each and every mechanical and/or hydraulic device operated for the purpose of taking clams other than geoduck clams for commercial purposes from tidelands and beds of navigable waters of the state of Washington, the fee for which license shall be three hundred dollars per annum.

Evidence of issuance of the licenses required by this section shall be prominently displayed by numbers, codes, or symbols upon the vessel used in geoduck or clam harvesting activities before engaging in the harvesting activities in a manner prescribed by the director of fisheries in rules promulgated under chapter 34.04 RCW. [1979 1st ex.s. c 141 § 4; 1969 ex.s. c 253 § 4.]

Chapter 220-52 WAC
SHELLFISH

WAC 220-52-018 Clams——Gear. It shall be unlawful to take, dig for or possess clams or mussels taken for commercial purposes from any of the tidelands in the state of Washington except with a pick, mattock, fork or shovel operated by hand; provided, that permits for the use of mechanical clam digging devices may be obtained from the director of fisheries subject to the following conditions:

(1) Any or all types of mechanical devices used in the taking or harvesting of shellfish must be approved by the director of fisheries.

(2) A separate permit shall be required for each and every device and the permit shall be attached to the specific unit at all times.

(3) All types of clams to be taken for commercial use must be of legal size and in season during the proposed operations unless otherwise provided in specially authorized permits for the transplanting of seed to growing areas or for research purposes.

(4) The holder of a permit to take shellfish from tidelands by mechanical means shall limit operations to privately owned or leased land.

(5) The taking of clams from bottoms under navigable water below the level of mean lower low water by any mechanical device shall be prohibited except as authorized by the director of fisheries. Within the enclosed bays and channels of Puget Sound, Strait of Juan de Fuca, Grays Harbor and Willapa Harbor, the operators of all mechanical devices shall confine their operations to bottoms leased from the Washington Department of Natural Resources, subject to the approval of the director of fisheries. The harvesting of shellfish from bottoms of the Pacific Ocean westward from the western shores of the state shall not be carried out in waters less than two fathoms deep at mean lower low water. In said waters more than two fathoms deep the director of fisheries may reserve all or certain areas thereof and prevent the taking of shellfish in any quantity from such reserves established on the ocean bottoms.

(6) The operator shall keep an accurate log of operations indicating location, time of digging, species and quantities of clams, and other pertinent data in regard to production and operations as requested by the department of fisheries. This log shall be available to agents of the department of fisheries at all times.

(7) Noncompliance with any part of these regulations or with special requirements of individual permits will result in immediate cancellation of and/or subsequent nonrenewal of all permits held by the operator.

(8) Applications must be made on the forms provided by the department of fisheries and permits must be in the possession of the operator before digging commences.

(9) All permits to take or harvest shellfish by mechanical means shall expire on December 31 of the year of issue.

(10) All mechanical clam harvesting machines must have approved instrumentation that will provide deck readout of water pressure.

(11) Effective July 1, 1977, all mechanical clam harvest machines must have approved instrumentation that will provide deck readout of:

(a) Depth of cut.

(b) Harvest head angle with bottom.

(12) All clam harvest machines operating on intertidal grounds where less than 10% of the substrate material is above 500 microns in size must be equipped with a propeller guard suitable for reducing the average propeller wash velocity at the end of the guard to approximately 25% of the average propeller wash velocity at the propeller. The propeller guard must also be positioned to provide an upward deflection to propeller wash.

(13) Clam harvest machines operating in fine substrate material where less than 10% of the substrate material is above 500 microns in size, shall have a maximum harvest head width of 3 feet (overall) and the maximum pump volume as specified by the department of fisheries commensurate with the basic hydraulic relationship of 828 gpm at 30 pounds per square inch, pressure to be measured at the pump discharge.

(14) Clam harvest machines operating in coarser substrate material where more than 10% of the substrate material is above 500 microns in size, shall have a maximum harvest head width of 4 feet (overall) and a maximum pump volume as specified by the department of fisheries commensurate with a basic hydraulic relationship of 1,252 gpm at 45 pounds per square inch, pressure to be measured at the pump discharge.

(15) All clam harvest machine operators must submit accurate performance data showing revolutions per minute, gallons per minute, and output pressure for the water pump on their machine. In addition, they shall furnish the number and sizes of the hydraulic jets on the machines. If needed, the operator shall thereafter modify the machine (install a sealed pressure relief valve) as specified by the department of fisheries to conform with values set forth in either WAC 220-52-018(12) or WAC 220-52-018(13). Thereafter, it shall be illegal to make unauthorized changes to the clam harvester water pump or the hydraulic jets. Exact description of the pump volume, maximum pressure and number and size of the hydraulic jet for each harvester machine shall be included in the department of fisheries' clam harvest permit. All existing clam harvest machines must complete the needed steps to comply with the provisions of this regulation no later than July 1, 1976.

(16) All clam harvest machines shall be equipped with a 3/4-inch pipe thread tap and valve that will allow rapid coupling of a pressure gauge for periodic testing by enforcement personnel.

(17) Each mechanical clam harvester must have controls so arranged and situated near the operator which will allow the operator to immediately cut off the flow of water to the jet manifold without affecting the capability of the vessel to maneuver. [Order 76-152, § 220-52-018, filed 12/17/76; Order 1258, § 220-52-018, filed 8/25/75; Order 807, § 220-52-018, filed 1/2/69, effective 2/1/69. Formerly WAC 220-52-010(2).]

79.01.568 Leasing beds of tidal waters for shellfish cultivation or other aquaculture use. The beds of all navigable tidal waters in this state lying below extreme low tide, except as prohibited by Article XV, section 1 of the Washington state Constitution, shall be subject to lease for the purpose of planting and cultivating thereon oyster beds, or for the purpose of cultivating clams or other edible shellfish, or for other aquaculture use, for periods not to exceed ten years.

Where the lands are used for the cultivation of oysters, the parcels leased shall not exceed forty acres.

Where the lands are used for the cultivation of clams or other aquaculture use, the department of natural resources may, in its discretion, grant leases for larger parcels.

Nothing in chapter 228, Laws of 1967, shall prevent any person from leasing more than one parcel, as offered by the department. [1979 1st ex.s. c 123 § 1; 1967 c 228 § 1; 1963 c 79 § 1; 1961 c 73 § 9; 1951 c 271 § 39; 1927 c 255 § 142; RRS § 7797-142. Prior: 1899 c 136 § 1. Formerly RCW 79.20.010.]

79.01.572 Leasing for oyster beds, cultivating clams or other shellfish——Who may lease——Application——Deposit. Any person desiring to lease lands for the purpose of planting and cultivating thereon oyster beds or for the purpose of cultivating clams and other edible shellfish, shall file with the commissioner of public lands, on a proper form an application in writing signed by the applicant and accompanied by a map of the land desired to be leased, describing the lands by metes and bounds tied to at least two United States government corners, and by such reference to local geography as shall suffice to convey a knowledge of the location of the lands with reasonable accuracy to persons acquainted with the vicinity, and accompanied by a deposit of ten dollars which deposit shall be returned to the applicant in case a lease is not granted. [1967 c 163 § 5; 1927 c 255 § 143; RRS § 7797-143. Prior: 1899 c 136 §§ 3, 5. Formerly RCW 79.20.020.]

1967 Act adopted to implement Amendment 42——Severability——1967 c 163: See notes following RCW 64.16.005.

79.01.576 Leasing for oyster beds, cultivating clams or other shellfish——Inspection and report by director of fisheries——Rental and term. The commissioner, upon the receipt of an application for a lease for the purpose of planting and cultivating oyster beds or for the purpose of cultivating clams or other edible shellfish, shall notify the director of fisheries of the filing of the application, describing the lands applied for. The director of fisheries shall cause an inspection of the lands applied for to be made and shall make a full report to the commissioner of his findings as to whether it is necessary, in order to protect existing natural oyster beds, and to secure adequate seeding thereof, to retain the lands described in the application for lease or any part thereof, and in the event the director deems it advisable to retain the lands or any part thereof for the protection of existing natural oyster beds or to guarantee the continuance of an adequate seed stock for existing natural oyster beds, the same shall not be subject to lease. However, if the director determines that the land applied for or any part thereof may be leased, he shall so notify the commissioner of public lands and the director shall cause an examination of the lands to be made to determine the presence, if any, of natural oysters, clams or other edible shellfish on said lands, and to fix the rental value of the land for use for oyster, clam, or other edible shellfish, cultivation. In his report to the commissioner, the director shall recommend a minimum rental price for said land and an estimation of the value of the oysters, clams, or other edible shellfish, if any, then present on the lands applied for. The lands approved by the director for lease may then be leased to the applicant for a period of not less than five years nor more than ten years at a rental not less than the minimum rental recommended by the director of fisheries. In addition, before entering upon possession of the land, the applicant shall pay the value of the oysters, clams, or other edible shellfish, if any, then present on the land as determined by the director, plus the expense incurred by the director in investigating the quantity of oysters, clams, or other edible shellfish, present on the land applied for. [1967 c 228 § 3; 1951 c 271 § 40; 1927 c 255 § 144. Prior: 1927 c 255 §§ 145, 147; 1923 c 59 § 1; 1899 c 136 §§ 3, 4. Formerly RCW 79.20.030.]

79.01.580 Leasing for oyster beds, cultivating clams or other shellfish——Survey and boundary markers. Before entering into possession of the leased lands the applicant shall cause the same to be surveyed by a registered land surveyor, and he shall furnish to the commissioner of public lands and to the director of fisheries a map of the leased premises signed and certified by the registered land survey. The lessee shall also cause the boundaries of the leased premises to be marked by piling monuments or other markers of a permanent nature as the director of fisheries may direct. [1951 c 271 § 41 (adding a new section to 1927 c 255). Formerly RCW 79.20.035.]

Registered land surveyors: Chapter 18.43 RCW.

79.01.584 Leasing for oyster beds, cultivating clams or other shellfish——Renewal lease. The commissioner of public lands may, upon the filing of an application for a renewal lease, cause the lands to be inspected, and if he deem it for the best interests of the state to re-lease said lands, he shall issue to the applicant a renewal lease for such further period not exceeding ten years and under such terms and conditions as may be determined by the commissioner. In case of an application for a renewal lease it shall not be necessary for the lands to be inspected and reported upon by the *director of fisheries and game. [1967 c 228 § 4; 1927 c 255 § 146; RRS § 7797-146. Prior: 1923 c 59 § 1. Formerly RCW 79.20.050.]

79.01.588 Leasing for oyster beds, cultivating clams or other shellfish——Reversion for use other than cultivation of shellfish. All leases of lands for the purpose of planting and cultivating oyster beds, clam beds, or other edible shellfish beds, shall expressly provide that if at any time after the granting of said lease, the lands described therein shall cease to be used for the purpose of oyster beds, clam beds, or other edible shellfish beds, they shall thereupon revert to and become the property of the state and that the same are leased only for the purpose of cultivating oysters, clams, or other edible shellfish thereon, and that the state reserves the right to enter upon and take possession of said lands if at any time the same are used for any other purpose than the cultivation of oysters, clams, or other edible shellfish. [1967 c 228 § 5; 1927 c 255 § 148; RRS § 7797-148. Prior: 1899 c 136 § 7. Formerly RCW 79.20.070.]

79.01.592 Leasing for oyster beds, cultivating clams or other shellfish——Abandonment——Application for other lands. If from any cause any lands leased for the purpose of planting and cultivating oyster beds, clam beds, or other edible shellfish beds, shall become unfit and valueless for any such purposes, the lessee or his assigns, upon certifying such fact under oath to the commissioner of public lands, together with the fact that he has abandoned such land, shall be entitled to make application for other lands for such purposes. [1967 c 228 § 6; 1927 c 255 § 149; RRS § 7797-149. Prior: 1899 c 136 § 10. Formerly RCW 79.20.080.]

WAC 332-30-157 Commercial clam harvesting.

(1) Commercial clam beds on aquatic lands shall be managed to produce an optimum yield.

(2) The boundaries of clam tracts offered for lease shall be established and identified to avoid detrimental impacts upon significant beds of aquatic vegetation or areas of critical biological significance as well as prevent unauthorized harvesting.

(3) The methods of harvest may only be those as established by law and certified by the Department of Fisheries.

(4) Surveillance methods will be employed to insure that trespass as well as off-tract harvesting is prevented.

(5) Harvesters must comply with all lease provisions. Noncompliance may result in lease suspension or cancellation upon notification.

(6) Harvesters must comply with all applicable federal, state and local rules and regulations. Noncompliance may result in lease suspension or cancellation upon notification.

(7) If appropriate, the Department may secure all necessary permits prior to leasing.

WAC 332-30-160 Renewable resources.

(1) Utilization of renewable resources is a preferred use of aquatic lands.

(2) The Department will foster renewable resource utilization through research and development work, public education, land use allocation and resource inventory.

(3) Depending on the activity involved and the stage of commercial development, all necessary permits may be secured by the Department for specific sites and activities before the sites are offered for lease.

(5) Tidelands, shorelands and beds of navigable waters, especially valuable now and in the foreseeable future for renewable resource activities (such as aquaculture, natural resource harvesting or electrical energy production), shall be so designated and protected from conflicting human uses which would limit their utility for this purpose.

(7) Commercial harvesting of wild stocks of shellfish shall be encouraged on aquatic lands. Harvesting must be conducted in such a manner as to provide an optimum yield of the crop within the harvestable resource base, to minimize insofar as possible conflicts with other users of the water area and to have insofar as possible a minimal impact upon the environment.

(10) Enhanced productivity of commercially and recreationally important species of aquatic life shall be encouraged on aquatic lands.

(11) The Department will work with other agencies through development and implementation of management plans to insure that commercial shellfish beds are kept free of pollution and that as much as possible of the resource base is available for harvesting.

APPENDIX F

DNR PROCEDURES FOR PREPARATION OF A SUPPLEMENTAL EIS

WAC 332-40-695 Draft and final supplements to a revised EIS. (1) In any case where the department is preparing a supplement to an earlier EIS or to an EIS prepared pursuant to NEPA, it shall prepare a draft supplemental EIS and comply with WAC 332-40-450. Copies of both the prior and supplemental EIS shall be maintained at the SEPA public information center, and copies of the prior EIS, as well as the supplement, shall be transmitted to the consulted agencies which had not previously received it.

(2) Upon preparation of the draft supplemental EIS, the department shall comply with WAC 332-40-550 through 332-40-580 and the final supplemental EIS, together with the earlier EIS, shall be regarded as a final EIS for all purposes of these guidelines. [Order 259, § 332-40-695, filed 6/10/76; Order 257, § 332-40-695, filed 5/21/76.]

WAC 332-40-450 Public awareness of availability of draft EIS. Upon publication of the draft EIS, the responsible official shall list the proposal in the lead agency's "EIS Available Register" maintained at the department's SEPA public information center. [Order 259, § 332-40-450, filed 6/10/76; Order 257, § 332-40-450, filed 5/21/76.]

WAC 332-40-480 Public hearing on a proposal—— When required. (1) If a public hearing on the proposal is held pursuant to some other requirement of law, such hearing shall be open to consideration of the environmental impact of the proposal, together with any available environmental document.

(2) In all other cases a public hearing on the environmental impact of a proposal shall be held whenever one or more of the following situations occur:

(a) The department determines, in its sole discretion, that a public hearing would assist the department in meeting its responsibility to implement the purposes and goals of SEPA and these guidelines; or,

(b) When fifty or more persons residing within the jurisdiction of the department, or who would be adversely affected by the environmental impact of the proposal, make written request to the department within thirty-five days of the listing of the proposal in the "EIS Available Register"; or,

(c) When two or more agencies with jurisdiction over a proposal make written request to the department within thirty-five days of the listing of the proposal in the "EIS Available Register."

(3) Whenever a public hearing is held under subsection (2) of this section, it shall occur no later than fifty-one days from the listing of the proposal in the "EIS Available Register" and no earlier than fifteen days from such date of listing. [Order 259, § 332-40-480, filed 6/10/76; Order 257, § 332-40-480, filed 5/21/76.]

WAC 332-40-485 Notice of public hearing on environmental impact of the proposal. (1) Notice of all public hearings to be held pursuant to WAC 332-40-480(2) shall be published in a newspaper of general circulation in the area where the project will be implemented. For nonproject actions the notice shall be published in the general area where the department has its principal office. The notice shall be published no later than five days preceding the hearing. For nonproject proposals having regional or state-wide applicability, copies of the notice shall be transmitted to the Olympia bureaus of the associated press and united press international.

(2) A notation of the hearing date and location shall be entered in the "EIS Available Register" maintained at the department's SEPA public information center. [Order 259, § 332-40-485, filed 6/10/76; Order 257, § 332-40-485, filed 5/21/76.]

WAC 332-40-460 Specific agencies to which draft EIS shall be sent. (1) A copy of each draft EIS shall be mailed no later than the day that it is listed in the "EIS Available Register" to the following:

(a) The department of ecology.

(b) Each federal agency having jurisdiction by law over a proposed action.

(c) Each agency having jurisdiction by law over, or environmental expertise pertaining to a proposed action, as defined by WAC 332-40-040 and 332-40-465 (required by RCW 43.21C.030(2)(d)).

(d) Each city/county in which adverse environmental effects identified in the draft EIS may occur if the proposed action is implemented. (This subsection does not apply to draft EISs for nonproject actions.)

(e) Each local agency or political subdivision which will be required to furnish additional public services as a result of implementation of the proposed action.

(f) The applicable regional planning commission, regional clearinghouse, state-wide clearinghouse, or area-wide council of government which has been designated to review and coordinate local governmental planning under the A-95 review process and other federal regulations and programs [See RCW 36.64.080, RCW 35.63-.070 and RCW 36.70.070].

(g) The department's SEPA public information center.

(h) [Optional] Any person, organization or governmental agency that has expressed an interest in the proposal, is known by the department to have an interest in the type of proposal being considered, or receives governmental documents (e.g., local and regional libraries) may be sent a copy of the draft EIS.

(2) An agency that receives a copy of the draft EIS does not become a "consulted agency" under these guidelines due to that factor alone. [See WAC 332-40-040, 332-40-465, 332-40-510 and 332-40-520 for those provisions that define a consulted agency.] [Order 259, § 332-40-460, filed 6/10/76; Order 257, § 332-40-460, filed 5/21/76.]

WAC 332-40-570 Preparation of the final EIS——Contents——When no critical comments received on the draft EIS. (1) If the department does not receive any comments critical of the scope or content of the draft EIS, the department may prepare a statement to the effect that no critical comments were received and circulate that statement in the manner prescribed in WAC 332-40-600.

(2) The statement prepared and circulated pursuant to subsection (1) above, together with the draft EIS (which is not recirculated with the statement), shall constitute the "final EIS" for the proposal: *Provided*, That when the draft EIS was not circulated to the office of the governor or the ecological commission, then the draft EIS shall be attached only to the statement sent to these agencies. [Order 259, § 332-40-570, filed 6/10/76; Order 257, § 332-40-570, filed 5/21/76.]

WAC 332-40-580 Preparation of the final EIS——Contents——When critical comments received on the draft EIS. (1) When the department receives any comments critical of the scope or content of the draft EIS, whether made in writing or made orally at any public hearing on the environmental impact of the proposal, it shall comply with either subsection (2) or (3) below.

(2) The department may determine that no changes are required in either the draft EIS or the proposal, despite the critical comments that were received during the commenting period. The department must prepare a document containing a general response to the comments that were received, the text or summary of written comments, and a summary of the oral comments made by the public at any hearing held on the proposal or its environmental impacts. The department shall then circulate the document in the manner prescribed in WAC 332-40-600: *Provided*, That when the draft EIS was not circulated to the office of the governor or the ecological commission, then the draft EIS shall be attached only to the statement sent to these agencies.

(3) The department may determine that it is necessary and appropriate to rewrite the contents of the draft EIS in order to respond to critical comments received during the commenting period. In such instances, the department shall circulate the rewritten EIS in the manner specified in WAC 332-40-600. The department shall ensure that the rewritten EIS evidences an affirmative response by the department to the critical comments, or alternatively, contains a summary of those critical comments with which it does not agree.

(4) A document prepared and circulated pursuant to subsection (2) or (3) above shall constitute the "final EIS" for the proposal. [Order 259, § 332-40-580, filed 6/10/76; Order 257, § 332-40-580, filed 5/21/76.]

WAC 332-40-600 Circulation of the final EIS. The final EIS shall be circulated to the department of ecology, office of the governor or the governor's designee, the ecological commission, the department's SEPA public information center, agencies with jurisdiction, and federal agencies with jurisdiction which received the draft EIS. It shall be made available to the public in the same manner and cost as the draft EIS. [Order 259, § 332-40-600, filed 6/10/76; Order 257, § 332-40-600, filed 5/21/76.]

APPENDIX G.

Table of major subtidal hardshell clam beds.

Bed location	Area (acres)	Estimated hardshell clam population (pounds). Butter	Littleneck	Horse	Total
1. Point Roberts	113	7,517,759	98,271	786,171	8,402,201
2. Point Roberts	48	6,893,326	754,286	1,278,094	8,925,706
3. Hale Passage	150	2,487,886	1,505,826	0	3,933,712
4. Hale Passage	166	1,514,843	649,218	0	2,164,061
5. Sinclair Island	280	7,305,012	852,251	0	8,157,263
6. Guemes Island	847	10,698,380	386,910	0	11,085,290
7. Port Angeles Hbr.	100	1,566,592	1,000,878	913,845	3,481,315
8. Green Point	467	10,171,260	1,627,402	1,830,827	13,629,489
9. Dungeness Spit	356	13,162,743	2,447,693	3,251,972	18,862,408
10. Dungeness	20	270,072	174,240	740,520	1,184,832
11. Sequim Bay	44	979,708	288,149	845,238	2,113,095
12. Dallas Bank	375	4,899,193	0	0	4,899,193
13. Port Discovery	39	152,895	509,652	169,884	832,431
14. Port Discovery	21	118,918	155,509	0	274,427
15. Lagoon Pt. North	138	4,087,670	240,451	60,112	4,388,233
16. Laggon Pt. South	164	4,357,742	500,068	142,876	5,000,686
17. Port Townsend Canal	28	1,719,748	414,691	2,097,849	4,232,288
18. Midchannel Bank	46	179,746	199,940	19,994	399,680
19. Marrowstone Island	110	1,054,152	479,160	1,341,648	2,847,960
20. Kilisut Hbr. North	373	3,412,970	6,500,894	5,525,760	15,439,624
21. Kinney Point	156	2,920,132	407,460	67,910	3,395,502
22. Mats Mats Channel	25	713,513	76,480	-	790,353
23. Colvos Rocks	96	2,179,045	377,571	125,714	2,681,901
24. Colvos Rocks	103	1,304,927	269,985	0	1,574,912
25. Hood Head	42	640,332	109,771	0	750,103

APPENDIX G. (Cont.)

Bed location	Area (acres)	Estimated hardshell clam population (pounds). Butter	Littleneck	Horse	Total
26. Port Gamble	85	554,083	36.939	73,633	644,655
27. Squamish Harbor	155	2,222,344	336,828	471,406	3,030,469
28. Squamish Harbor	6	172,498	5,227	91,476	269,201
29. Lofall	117	1,783,782	101,930	305,791	2,191,503
30. Brown Point	4	339,332	1,655	67,866	408,853
31. Bangor Wharf	5	75,751	10,237	24,568	110,556
32. Bangor Wharf	19	401,275	40,946	106,461	548,682
33. Bangor Wharf	7	191,316	6,273	18,818	216,407
34. Kings Spit	10	139,426	8,451	101,408	249,295
35. Dabob Bay	45	1,117,314	39,204	176,418	1,332,936
36. Fulton Creek	54	3,228,537	23,566	329,923	3,582,026
37. South Hood Canal	80	1,498,464	34,848	209,088	1,742,400
38. Indianola	1	59,677	3,049	74,488	137,214
39. Port Madison	31	1,404,157	160,475	0	1,564,632
40. Agate Passage	140	5,072,518	3,116,849	5,500,321	13,689,688
41. Agate Pass	30	1,372,140	692,604	1,267,596	3,332,340
42. Port Orchard	66	742,959	942,987	428,630	2,114,576
43. Port Orchard	27	269,506	515,576	11,718	796,800
44. Port Orchard	7	70,916	83,809	19,341	174,066
45. Liberty Bay	51	1,082,161	1,015,906	331,274	2,429,341
46. Sinclair Inlet	2	13,939	25,265	23,552	62,726
47. Dyes Inlet	101	1,407,859	307,969	0	1,715,828
TOTAL	5,350	113,528,528	27,567,171	28,832,160	169,927,859

APPENDIX H

Example of DNR Agreement

For Subtidal Hardshell Clam Harvest

The DNR harvest agreement if being revised. When available, copies will be sent to those listed in Appendix C.

APPENDIX I. Example of WDF Harvest Permit.

JOHN SPELLMAN
Governor

ROLLAND A. SCHMITTEN
Director

STATE OF WASHINGTON
DEPARTMENT OF FISHERIES
115 General Administration Building • Olympia, Washington 98504 • (206) 753-6600 • (SCAN) 234-6600

EXPERIMENTAL PERMIT TO OPERATE A CLAM HARVESTING MACHINE

PERMIT NO. 81-07

The purpose of this permit is to allow further development and testing of the new clam harvester. Operations are permitted at Colvos Rocks during the first half of the permit period and at Kilisut Harbor during the second half of the permit period. The operator is to notify the Point Whitney Shellfish Laboratory of each day's operation. Additional diver observations of the operating characteristics of the vessel are to be made at a mutually arranged time while the vessel is in Kilisut Harbor.

This permit authorizes Sea Foods, Inc., Pier 54, Seattle, WA 98104, to use a mechanical device known as a hydraulic harvester to harvest clams on an experimental basis for a 40-day time period.

The device, operated under terms of this permit, shall be attached to the motor vessel "KEEP CLAM" and this permit shall be carried on board this vessel at all times when clam harvest operations are in progress.

Prior to harvesting on the following described area, markers shall be erected to clearly designate the limits of the leased grounds. A minimum number of markers shall be one at each corner and angle of the tract boundary lines, and at intervals between corner markers so that the interval between markers shall, in no case exceed 500 feet. A marker shall consist of a pole sunk in the ground or bottom at a sufficient depth to stand upright, tall enough to project above the water at all stages of the tide, and equipped with a flag. Buoy markers may be substituted for pole markers provided they are sufficiently sturdy and well moored to form a permanent-type marker. Said markers shall be of sufficient strength to withstand the weather and remain upright or in position until harvesting operations are concluded under the terms of this permit. Special marking procedures agreed upon between the Department of Natural Resources and Jefferson County shall be used at all times when operation is occurring in Kilisut Harbor.

COLVOS ROCKS, JEFFERSON COUNTY

Described approximately as follows:

A 70-acre tract of the bed of navigable waters lying in front of Section 4, Township 28 North, Range 1 East, W.M., in the vicinity of Colvos Rocks and further described in state of Washington lease No. 10560.

KILISUT HARBOR, JEFFERSON COUNTY

Described approximately as follows:

This tract comprised of approximately 132 acres of the bed of navigable waters

described as follows: Those portions of the bed of Kilisut (Long) Harbor, owned by the state of Washington, situate in front of Government Lots 5 to 8 inclusive and southerly side of Government Lots 1 to 3 inclusive, Section 18; and Government Lots 1, 2 and 6, Section 19, all in Township 30 North, Range 1 East, W.M., included within the limits of the two tracts and as further described in state of Washington lease no. 9112A.

This permit is applicable only to the tracts described above, and is valid only during such time as a valid Southern Puget Sound District clam farm license, a mechanical clam gear license, and a lease or other agreement between the permit holder and owners are in effect.

NOTE: It shall be unlawful for any license to be operated or caused to be operated by any person other than the person listed on the license.

Number of jets: 21 Jet diameter: 1/2 inch

This permit is subject to the attached conditions.

This permit expires: November 29, 1981.

October 19, 1981
Date

Rolland A. Schmitten, Director
Washington Department of Fisheries

bcc: Brennan
Patrol
Licenses
CF
SF - Oly
ANR

Company: Sea Foods, Inc.

Permit No. 81-07

Vessel(s) KEEP CLAM

THIS PERMIT IS SUBJECT TO THE FOLLOWING CONDITIONS:

1. For each week's operation, the harvester must successfully harvest the clams without smashing them, destroying seed clams, or without other damage to the clam habitat. Breakage of clams shall not exceed 15%.

2. The harvester must leave the ground in good condition for future crops of clams, the maximum depth of the harvester cut must not exceed 24 inches, and care shall be exercised to ensure the cut is no deeper than that necessary to effectively harvest the clams.

3. Damage to other important animal and plant populations must be, in the judgement of the Department of Fisheries, at an acceptable minimum.

4. Operation of the harvester does not create problems with water quality, primarily in respect to silt.

5. The harvester will be operated in a manner to minimize blow-out of clams on the bottom and obtain maximum return of the substrate material into the cut.

6. In an effort to minimize wastage of small clams, long single harvest transects will be avoided. Operation will be confined to smaller areas that can be more completely worked before going on to new areas.

7. This permit does not authorize the harvesting or use of the device on public beaches, State lands not under lease, private lands not under lease, or on any of the shellfish reserves.

8. Nothing in this permit shall be construed to mean that the permittee is exempt from compliance with the trespass laws or any other valid law or regulation of any governmental agency.

9. A harvest log, available from the Department of Fisheries, shall be on board the vessel during each time the harvester is in operation and shall be made out at the end of each day of harvest. The record shall include the daily catch in pounds or bushels, by species for the harvest location, and shall be mailed to the Director of Fisheries by the 10th of the following month.

10. It shall be the responsibility of the operator to cease harvest operation at any time it appears that improper operation is occurring, or that the operation is not in compliance with the above listed permit requirements. Prior to resumption of harvest, the operator must complete needed repairs, notify the Department, and receive approval for resumption of activities.

11. This permit is subject to revocation at any time the Director of Fisheries deems such action to be in the best interest of proper management of the fisheries of the state of Washington, for any violation of the terms of this permit, or the Revised Code of Washington.

HUGHES, OCZM 254-7100

DATE DUE

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