# PRELIMINARY

NORTHERN PUGET SOUND

AQUACULTURE STUDY

(ISLAND COUNTY)

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Prepared for:

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# I. INTRODUCTION

## A. STATEMENT OF PROBLEM

### Demand for Aquaculture

It is evident that aquaculture is a rapidly growing industry around the world. In the last five years over 6 million metric tons have been produced annually, which is roughly 10 percent of the world fish production (1). In the United States about 30 percent of the Pacific salmon caught is produced by hatcheries, 40 percent of oysters, catfish and crawfish, and nearly all of the rainbow trout production is produced by private aquaculturists. Unfortunately, United States production has not increased in the last five years although consumption has. Many of the species consumed by Americans have technological and biological problems which remain to be solved. Further constraints are placed on aquaculture developments by the lack of adequate high-quality water or institutional problems such as site availability, financing, and licensing.

As demand in the marketplace for seafood products increases and technology is created for the culture of marine organisms, development of the nation's shorelines and aquatic resources becomes vital to the aquaculture industry.

### Study Area

Washington State's Puget Sound environment has over 1628 miles of shoreline which contains numerous protected areas of high quality saline water. Island County (see figure 1) contains 221 miles of shoreline and a demonstrated potential for aquaculture. This study will evaluate the waters of Island County and the adjacent waters of Snohomish and Skagit Counties from Deception Pass to Priest Point just north of the City of Everett for natural aquaculture potential based upon existing natural conditions. Potential land and water use compatibility problems and analysis will be confined to the waters of Island County only.

Figure 1. Island Co. Vicinity Map

Current Problems Associated with Aquaculture Development

Marine aquaculture is a new industry to the U.S. and the evolutionary process that customarily takes place to form controls and opportunities for business is just beginning. The use of the waters and shorelines are controlled by many local, state, and federal agencies each with specific areas of concern. Demand for the use of these waters is also high and covers a broad spectrum of interests.

The following list of issues facing agencies, citizens and aquaculturists summarizes the major problems that have been faced by these groups in the past as the aquacultural industry begins to take form.

Local Government

- Has policies which encourage aquaculture, but which are unspecific as to the location, scope, and scale of the activity
- Lacks information on aquaculture operating characteristics
- Must represent both local residents and aquaculturists interests in the evaluation of permits
- Must place statewide interests over local interests on "shorelines of statewide significance"
- Burdened with statewide interests that are not well defined
- Is required to make reasonable and knowledgeable trade-offs between aquacultural projects and upland and water uses

Citizen

- Sees aquaculture as an aesthetically objectionable industry
- Unpredictability of where aquaculture development will occur
- Perceives aquaculture projects as reducing their enjoyment of the shoreline
- Is impacted negatively by noise and odors of some types of aquaculture

Aquaculturist

- Requires high quality water
- Requires permits and licenses from many uncoordinated agencies
- Unpredictability in permit process
- Project may conflict with upland owners

- Competes with other water related uses
- Products are most sensitive to environmental impacts from other uses

State Government

- Has many uncoordinated agencies
- Does not interact directly with citizens
- Has insufficient information on impacts of aquaculture on the surrounding environment to arrive at reasonable decisions on permits

Federal Government

- Deals only with certain specific areas of concern
- Certain concerns overlap with state and local jurisdiction

Current Jurisdiction

An understanding of the current jurisdictions and their areas of responsibilities is reviewed to fully perceive the procedural problem of the parties and the local government's need for initiating such a study. Table 1 indicates each agency with regulatory responsibilities, the permits they issue, and the procedure used for the issuance of these permits.

## B. SCOPE AND PURPOSE OF STUDY

Purpose

It is not the intent of this study to overcome jurisdictional problems, solve technological difficulties, open the door for massive industrial development of the shorelines or prevent responsible use of a valuable renewable resource.

The purpose of this study is to provide: (1) more predictability for both aquaculturists and citizens in the shoreline permit process; (2) citizens and local government with information as to what to anticipate in the future from aquaculture proposals; (3) mitigative measures and regulatory controls to alleviate long-term adverse impacts; (4) a methodology whereby aquaculture applications are

| PERMIT | ISSUING AGENCY | COST | REVIEW PERIOD | ISSUED | REQUIRED FOR | REMARKS |
|---|---|---|---|---|---|---|
| Federal | | | | | | |
| Section 10 and/ or Section 404 Permit | Army Corps of Engineers | N/A | 60+ days | Once | Work in navigable waters(section 10) or dredging and disposal of material in navigable waters. | Permit issued only if SMSD permit has been issued. |
| E.I.S.; Corps of Engineers Permit; Shoreline Management S.D.P.; Nat'l Pollution Discharge Elimination System Permit | U.S. Fish & Wildlife Service | N/A | N/A | N/A | Compliance with fish and wildlife protection laws. | Participates in the review process of each document. |
| E.I.S.; Corps of Engineers Permit; Shoreline Management S.D.P.; Nat'l Pollution Discharge Elimination System Permit | U.S. Coast Guard | N/A | N/A | N/A | Review for navigational hazards and identification | Participates in the review process of each permit. |
| E.I.S.; Corps of Engineers Permit; Shoreline Management S.D.P.; Nat'l Pollution Discharge Elimination System Permit | Nat'l Marine Fisheries Service | N/A | N/A | N/A | Compliance with fish and wildlife protection laws | Participates in the review process of each permit. |
| State | | | | | | |
| Salmon Aquaculture Permit | Wash. Dept. of Fisheries(W.D.F.) | No Charge | N/A | Expires 12/31 following date of issue | Demonstrating ability to conduct salmon aquaculture activities | |
| Aquaculture Farm License | W.D.F. | $100.00 | N/A | Expires 12/ 31,following date of issue. | Cultivation of food animals for commercial purposes. | Issued after WDF Salmon Aquaculture Permit is approved. |

| PERMIT | ISSUING AGENCY | COST | REVIEW PERIOD | ISSUED | REQUIRED FOR | REMARKS |
|---|---|---|---|---|---|---|
| Wholesale Fish Dealer License | W.D.F. | $ 37.50 | N/A | Expires Dec 31,Following date of issue | Wholesale operations (sales) | |
| Retail Fish Dealer License | W.D.F. | 5.00 | N/A | Expires Ded 31,Following date of issue | Retail operations (sales) | |
| Geoduck Diver or Tract License | W.D.F. | 50.00 Diver 100.00 Tract | N/A | Expires Dec 31,Following date of issue | For commercial harvest of geoducks | Includes diver and harvest of other clams |
| Clam Farm License | W.D.F. | 15.00 | N/A | Expires Dec 31,Following date of issue | For commercial purposes of privately owned or leased tidelands | |
| Oyster Farm License | W.D.F. | 15.00 | N/A | Expires Dec 31,Following date of issue | For commercial purposes of privately owned or leased tidelands | |
| Commercial Fishing Gear License or Permit | W.D.F. | Varies w/ method of catch | N/A | Expires Dec 31,Following date of issue | For commercial fishing, harvesting of clams or geoducks | |
| Hydraulic Permit | W.D.F. | N/A | N/A | Once | Alteration or Consumption of water resources. | |
| Shucking and Packing Certification | Dept. of Social & Health Services (D.S.H.S.) | N/A | | Annual | Shellfish Processing | |
| Oyster and Shell Transfer Permit | W.D.F. | N/A | N/A | Expires Dec 31,Following date of issue | Claims and/or Oyster transfers | |
| Oyster Reserve License | W.D.F. | 15.00 | N/A | Expires Dec 31,Following date of issue | Taking Oysters from State Reserve | |
| Health Certification | D.S.H.S. | No Cost | N/A | Annually by 1st of October | Rearing Shellfish for human consumption | Clams, oysters, mussels, geoduck tracts |

| PERMIT | ISSUING AGENCY | COST | REVIEW PERIOD | ISSUED | REQUIRED FOR | REMARKS |
|---|---|---|---|---|---|---|
| Shucking and Packing Certification | D.S.H.S. | N.A. | | Annual | Shellfish | |
| Lease | Dept. of Natural Resources | Commensurate w/fair market value | 60-90 Days | Varies w/ activity | Beds of navigable waters and publicly owned tidelands | |
| N.P.D.E.S. Permit | Dept. of Energy | N/A | | Once | Effluent discharge points source | |
| Local | | | | | | |
| Shoreline Management Substantial Development Permit | County or City + D.O.E. | Varies | From 90-270 Days | Once | Commercial/Aquacultural Projects | |

evaluated; (5) citizen recognition of the technological and environmental constraints limiting suitable sites for commercial aquaculture development; and, (6) an awareness and possible direction for state and federal jurisdictions to consider in the development of their regulations.

Scope of Study

The first step required in defining the scope of work is to define the discipline which we are studying. Today's aquatic environment finds many activities which conceivably can be considered under the realm of aquaculture. To identify those activities which are considered in this study, a definition of aquaculture is provided which elucidates the actions which are being evaluated in this study.

AQUACULTURE: The culture and harvest of organisms for profit or social benefit from an environment which is controlled or semi-controlled to increase productivity.

More appropriate would be the use of the term "mariculture" since this study deals only with marine waters; however, the popular term "aquaculture" has been used by agencies and individuals to such an extent that it would be unrealistic to make that change in terminology at this point in time.

The first step undertaken in accomplishing the purpose of the study is to identify the potential for aquaculture based upon natural conditions. Species, rearing methods, and areas suitable for commercial development will be identified given existing knowledge and what can be predicted for the next decade. Economic, market, and legal considerations are not incorporated for determining potential as they are not "natural factors".

The second step is to analyze the problems associated with allowing the various forms of potential aquaculture industries to conduct business given the existing land and water uses in Island County. As conditions change, so can the analysis of problems without the

need to develop a new methodology. The methodology developed is comprehensive so that new conditions will still fit into the evaluation system devised. As new technology or different economic assumptions make new aquacultural techniques more feasible, they can be added directly to the system without the need for major revisions.

The third and final stage of this study is to recommend regulations and policy statements, as well as mitigative measures which will assist local government in dealing with the growth of the aquaculture indistry and the associated problems which result from that growth.

Use of this Report

This report will primarily be utilized by three of the five groups which were identified in Section A of this chapter. First and foremost, this study is intended for the use of Island County, and other local agencies which may adopt its findings and methodology. Island County will use this to evaluate the aquaculture proposals which it receives, to determine more thoroughly what impacts can be expected from the aquaculture use, and what significant environmental impacts can be expected which might not be able to be mitigated. At the stage of the permit process where the decision must be made to issue the permit or not, this study will assist in identifying the specific water and upland uses which are compatible or incompatible with the proposed aquacultural method. This information, and knowing the criteria used to make the determination, will assist the decision-maker in determining the probable results of the issuance of the permit. This information can also be turned around to help the local government guide potential aquaculturists to find areas which will be compatible with adjoining uses.

This study also identifies mitigative measures and use regulations which can be applied to an aquaculture project in order to lessen its negative impacts or make it more compatible with other uses. These

conditions are specific; the study also proposes more general policy statements which lay out the criteria for decision-making, and also propose certain requirements which will ensure that approved projects do not become an onerous burden on the community following their approval.

This study will also be used by citizens concerned about aquacultural projects as well as persons and commercial enterprises involved in aquacultural enterprises. Citizens will be able to use this information to determine to what extent a proposed aquacultural method will negatively impact the area, what possible measures can be taken in order to lessen any problems, and whether there may be any alternative methods of aquaculture to raise the species which will be less harmful to the area. This study will give citizens information so that they will be able to make informed comments on an aquacultural proposal.

The aquaculturist can use the study in two ways - first, it provides guidance as to the most suitable locations around Island County for various species and methods based on natural resource constraints; second, by assessing the proposal against the criteria described in the project evaluation system, the proponent will have certainty as to whether his project has the potential for approval and what the major issues are which will be debated during the permit process. This information will guide the aquaculturist toward a location, aquaculture method, or a different proposal which is more likely to be approved.

## II. SPECIES POTENTIAL FOR ISLAND COUNTY

### Potentially Suitable Species

A tremendous number and variety of finfish, shellfish, zooplankton, and marine alga are potentially suitable for aquaculture. They are too numerous to be individually described in an overview of this length and depth; however, by reviewing species that fall into four different categories a list of major species/groups were identified as worthy of further consideration. The categories were as follows:

1. Currently under local commercial culture e.g., salmon, oysters, clams, and mussels.
2. Currently under commercial culture nationally or internationally e.g., tuna, flatfish, abalone, scallops, and brine shrimp.
3. Experimental culture e.g., lobster, rockfish, and seabass.
4. Potential for commercial culture; however, no significant effort has been attempted, e.g., urchings, barnacles, limpets, and sea perch.

Although somewhat unscientific, species are referred to be a common name which represents a group of phenotypically similar organisms e.g., algae, clams, for ease of understanding by layman.

### Species Literature Review

Over 270 species comprising some 60 species/groups, each fitting into one of the above categories, were identified. These 60 species/groups, were reduced to 22 groups by a review process which used as criteria:

(1) The potential for development within the next decade

(2) If the species/group can be cultured in a marine environment similar to Puget Sound, Washington.

Table 2 lists the 22 species/groups and their member species with scientific and common names.

The 22 species/groups were then further investigated through a comprehensive literature review for specific status on available rearing technology, life cycle requirements, and natural resource requirement.

The literature review included a computerized literature search as well as references from experts contacted throughout the Pacific Northwest. A bibliography of material reviewed is presented as an appendix to this report. A summary for each species/group is presented which outlines current knowledge of the groups under further consideration.

Species Evaluation and Selection

These 22 species/groups were numerically evaluated based upon information generated in the literature and in contact with other experts in the aquaculture field. This evaluation (see table 3) produces a list of 8 species/groups (table 4) which are considered to have the highest potential for development in Island County marine waters. These 8 species/groups will receive further analysis throughout this study. The element descriptions of the species/group evaluation matrix and scoring criteria are presented in table 5. It is not the intent of the species/group evaluation matrix to discard the other 14 species/groups. If major breakthrough in technology and/or information on life history or market conditions change, any of those species have potential for commercial aquaculture development. By changing the ratings on the evaluation matrix one can determine the potential for any given specie. Any species which are ranked higher because of changed conditions can then be incorporated into the analysis in the remainder of the report. It is important that an active species evaluation process be maintained in order to provide Island County with a program responsive to aquaculture and public concerns.

Table 2. Listing of Principal Members Which Were Considered Candidates for Aquaculture Development in Island County, Washington

| Species - Group | Scientific Name | Common Name |
|---|---|---|
| Algae (Marine) | Ahnfeltia gigartinoides | |
| | Alaria | |
| | Callophyllis flabellulata | |
| | Caulacantus ustalatus | |
| | Constantinea subulifera | |
| | Enteromorpha | |
| | Farlowia mollis | |
| | Gelidium purpurascens | |
| | Gigartina exasperata | |
| | Gigartina papillata | |
| | Gracilaria sjoestedtii | |
| | Gymnogongrus linearis | |
| | Iridaea cordata | |
| | Iridaea heterocarpa | |
| | Laminaria | |
| | Monostroma | |
| | Neoagardhiella baileyi | |
| | Nereocystis | |
| | Palmaria palmata | |
| | Plocamium cartilagineum | |
| | Porphyra perforata | |
| | Prionitis lanceolata | |
| | Rhodomela larix | |
| | Schizymenia pacifica | |
| Abalone | Haliotis kamtschatkana | Pinto abalone |
| | Haliotis rufesens | Red abalone |
| | Haliotis walallensis | Flat abalone |
| Baitfish | Ammodytes hexaptreus | Pacific sandlance |
| | Clupea harengus | Pacific herring |
| | Hypomesus pretiosus | Surf smelt |
| Baitworms | Euzonus mucronata | Bloodworms |
| | Neanthes virens | Sandworms |
| | Nereis vexillosa | Pile worm |
| Barnacles | Balanus sp. | Acorn barnacles |
| | Lepas sp. | Gooseneck barnacle |

Table 2. Listing of Principal Members Which Were Considered Candidates for Aquaculture Development (Continued)

| Species - Group | Scientific Name | Common Name |
|---|---|---|
| Brine Shrimp | Artemia salina | Brine shrimp |
| Clams | Mercernaria mercernaria | Quahog (Cherry stone, hard clam) |
| | Mya arenaria | Soft-shell clam (Eastern) |
| | Panopea generosa | Geoduck (King clam) |
| | Protothaca staminea | Native littlenech (Steamer) |
| | Saxidomus giganteus | Butter clam (Washington) |
| | Venerupis japonica | Manila clam (Japanese Little neck steamer) |
| Cod | Anoplopoma fimbria | Black cod |
| | Gadus macrocephalus | Pacific cod |
| | Microgadus proximus | Pacific tomcod |
| | Ophiodon elongatus | Ling cod |
| Crabs | Cancer magister | Dungeness crab |
| | Paralithodes camtschatica | King crab |
| Flatfish | Hippoglossus stenolepis | Pacific halibut |
| | Platichthys stellatus | Starry flounder |
| Lobster | Homarus americanus | Lobster |
| Mussels | Mytilus californianus | Ocean mussel |
| | Mytilus edulis | Blue mussel (Bay mussel) |
| Octopus | Octopus dofleini | Octopus |
| Oysters | Crassostrea gigas | Japanese oyster (Giant Pacific) |
| | Crassostrea virginica | Eastern oyster (Native pop. in Boundary Bay) |
| | Ostrea edulis | European flat oyster |
| | Ostrea luridia | Olympia oyster (Native oyster) |

Table 2. Listing of Principal Members Which Were Considered Candidates for Aquaculture Development (Continued)

| Species - Group | Scinetific Name | Common Name |
|---|---|---|
| Rockfish | Sebastes auriculatus | Brown |
| | Sebastes caurinus | Copper |
| | Sebastes flavidus | Yellowtail |
| | Sebastes maliger | Quillback |
| | Sebastes melanops | Black |
| | Sebastes nebulosus | China |
| | Sebastes nigrocinctus | Tiger |
| | Sebastes pinniger | Canary |
| | Sebastes ruberrimus | Yelloweye rockfish or Red snapper |
| Salmon | Oncorhynchus gorbuscha | Pink |
| | Oncorhynchus keta | Chum |
| | Oncorhynchus kisutch | Coho |
| | Oncorhynchus nerka | Sockeye |
| | Oncorhynchus tshawytscha | Chinook |
| Scallops | Aequipectin irradians | Bay scallop |
| | Hinnites multirugosis | Purple-hinged rock scallop |
| | Patinopectin carinus | Weathervane scallop |
| | Patinopectin yessoeneis | Sea scallop |
| Sea Cucumbers | Parastichopus californicus | Red sea cucumber |
| Sea Perch | Cymatogaster aggregata | Shiner perch |
| | Embiotoca lateralis | Striped perch |
| | Rhacochilus vacca | Pile perch |
| Shrimp | Crago sp. | Bay shrimp |
| | Pandalus danae | Coon-stripe shrimp |
| | Pandalus platyceros | Spot prawn |
| Snails | Polinices lewisii | Moon snails |
| | Tegula funnebralis | Turbon snails |
| Trout | Salmo clarki | Cutthroat trout |
| | Salmo gairdneri | Steelhead trout (Rainbow trout) |
| | Salmo salar | Atlantic salmon |
| Urchins | Strongylocentrotus franciscanus | Giant red sea urchin |

## TABLE 3 - SPECIES/GROUP EVALUATION MATRIX

| | Algae (Marine) | Abalone | Baitfish | Baitworms | Barnacles | Clams | Cod | Crab | Flatfish | Lobster | Mussels | Octopus | Oysters | Rockfish | Salmon | Sea Cucumbers | Sea Perch | Scallops | Shrimp | Snails | Tro/Urc |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Abundancy in Puget Sd | 4 | 4 | 5 | 3 | 5 | 5 | 4 | 4 | 4 | 1 | 5 | 3 | 5 | 5 | 5 | 4 | 4 | 3 | 3 | 2 | 4 | 5 |
| Morphology Understood | 4 | 5 | 4 | 5 | 4 | 5 | 3 | 4 | 4 | 5 | 5 | 3 | 5 | 3 | 5 | 4 | 5 | 4 | 3 | 3 | 5 | 3 |
| Hybridization Poten. | 1 | 5 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 5 | 1 | 1 | 5 | 3 | 5 | 1 | 1 | 1 | 1 | 1 | 5 | 1 |
| Few Devel. Stages | 4 | 1 | 3 | 5 | 4 | 4 | 3 | 1 | 3 | 1 | 4 | 3 | 4 | 3 | 4 | 3 | 5 | 4 | 3 | 4 | 4 | 4 |
| Gregarious in Nature | 4 | 5 | 5 | 3 | 5 | 5 | 4 | 1 | 2 | 1 | 5 | 1 | 5 | 3 | 5 | 2 | 3 | 5 | 3 | 5 | 5 | 5 |
| Mature Early | 5 | 3 | 3 | 4 | 5 | 5 | 2 | 2 | 2 | 2 | 5 | 3 | 5 | 3 | 3 | 3 | 3 | 4 | 3 | 3 | 3 | 3 |
| Rapid Growth | 5 | 1 | 4 | 4 | 2 | 2 | 2 | 1 | 2 | 1 | 5 | 3 | 1 | 3 | 2 | 3 | 3 | 3 | 3 | 2 | 3 | 3 |
| Cannabilistic | 5 | 5 | 4 | 5 | 5 | 5 | 3 | 1 | 4 | 1 | 5 | 1 | 5 | 3 | 3 | 5 | 3 | 5 | 4 | 5 | 3 | 5 |
| Predators(Preyed On) | 2 | 2 | 1 | 1 | 3 | 3 | 4 | 3 | 3 | 3 | 4 | 4 | 4 | 3 | 3 | 4 | 3 | 3 | 3 | 4 | 3 | 4 |
| Diseases & Parasites | 4 | 3 | 3 | 4 | 3 | 4 | 3 | 3 | 3 | 3 | 4 | 4 | 4 | 3 | 3 | 3 | 3 | 3 | 4 | 3 | 3 | 4 |
| Egg/Spat | 5 | 3 | 2 | 1 | 3 | 5 | 3 | 3 | 3 | 3 | 4 | 3 | 5 | 3 | 4 | 3 | 2 | 4 | 3 | 3 | 4 | 3 |
| Juveniles (Easy to Collect) | 5 | 3 | 2 | 2 | 2 | 5 | 3 | 3 | 2 | 2 | 5 | 2 | 5 | 2 | 3 | 3 | 2 | 3 | 3 | 3 | 3 | 3 |
| Adults (Easy to Collect) | 4 | 4 | 4 | 4 | 4 | 5 | 3 | 5 | 3 | 5 | 5 | 4 | 5 | 3 | 4 | 4 | 3 | 3 | 4 | 3 | 4 | 4 |
| High Fecundity | 3 | 5 | 2 | 3 | 4 | 5 | 5 | 5 | 3 | 3 | 5 | 3 | 5 | 3 | 1 | 2 | 1 | 5 | 2 | 2 | 1 | 4 |
| Nutritional Needs Known | 5 | 4 | 3 | 3 | 3 | 4 | 3 | 3 | 3 | 3 | 4 | 4 | 4 | 3 | 4 | 2 | 3 | 3 | 4 | 3 | 4 | 4 |
| Growth Rate Can Be Accelerated | 5 | 3 | 2 | 3 | 5 | 5 | 2 | 3 | 3 | 4 | 4 | 4 | 5 | 3 | 4 | 3 | 3 | 4 | 2 | 3 | 4 | 3 |
| Density High in Captivity | 5 | 4 | 5 | 5 | 5 | 5 | 4 | 1 | 3 | 1 | 5 | 2 | 5 | 3 | 4 | 3 | 4 | 5 | 3 | 5 | 4 | 5 |
| Hatchery Technology | 5 | 5 | 2 | 3 | 3 | 5 | 2 | 3 | 3 | 4 | 4 | 2 | 5 | 2 | 5 | 2 | 2 | 5 | 4 | 1 | 5 | 1 |
| Growout Technology | 5 | 4 | 2 | 3 | 3 | 5 | 2 | 3 | 3 | 3 | 5 | 3 | 5 | 3 | 5 | 2 | 2 | 5 | 4 | 1 | 5 | 1 |

| | Algae (Marine) | Abalone | Baitfish | Baitworms | Barnacles | Clams | Cod | Crab | Flatfish | Lobster | Mussels | Octopus | Oysters | Rockfish | Salmon | Sea Cucumbers | Sea Perch | Scallops | Shrimp | Snails | Trout | Urchin |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Hardiness in Captivity | 4 | 3 | 3 | 4 | 5 | 4 | 3 | 3 | 3 | 3 | 4 | 4 | 5 | 3 | 3 | 2 | 3 | 3 | 3 | 4 | 3 | 2 |
| Broodstock Maint. | 4 | 5 | 3 | 5 | 5 | 5 | 3 | 2 | 3 | 2 | 4 | 3 | 5 | 2 | 5 | 3 | 3 | 4 | 2 | 3 | 5 | 3 |
| Controlled Spawning | 4 | 5 | 3 | 3 | 4 | 5 | 3 | 1 | 3 | 1 | 4 | 1 | 5 | 3 | 2 | 3 | 1 | 3 | 1 | 3 | 2 | 3 |
| Commercial Feeds | 1 | 1 | 1 | 1 | 1 | 2 | 3 | 4 | 3 | 4 | 2 | 3 | 2 | 3 | 5 | 1 | 3 | 2 | 4 | 1 | 5 | 1 |
| Available | | | | | | | | | | | | | | | | | | | | | | |
| Food Conversion | 5 | 1 | 3 | 3 | 3 | 1 | 3 | 1 | 3 | 1 | 1 | 5 | 1 | 3 | 5 | 1 | 3 | 1 | 1 | 1 | 5 | 1 |
| Efficiency | | | | | | | | | | | | | | | | | | | | | | |
| Polyculture Potential | 5 | 4 | 2 | 4 | 5 | 5 | 2 | 1 | 2 | 1 | 5 | 1 | 5 | 2 | 3 | 1 | 3 | 3 | 3 | 3 | 3 | 3 |
| Trophic Level | 5 | 5 | 3 | 4 | 3 | 5 | 1 | 1 | 1 | 1 | 5 | 1 | 5 | 1 | 1 | 4 | 1 | 5 | 2 | 4 | 1 | 4 |
| Existing Local Markt | 2 | 5 | 4 | 2 | 1 | 4 | 4 | 5 | 4 | 5 | 2 | 2 | 4 | 3 | 4 | 1 | 2 | 5 | 5 | 1 | 4 | 1 |
| Existing Nat'l Markt | 3 | 5 | 3 | 4 | 1 | 4 | 4 | 5 | 4 | 5 | 2 | 2 | 4 | 3 | 4 | 1 | 2 | 5 | 5 | 1 | 4 | 1 |
| Recreational Use | 1 | 5 | 5 | 3 | 1 | 5 | 3 | 5 | 3 | 5 | 3 | 2 | 5 | 4 | 5 | 1 | 3 | 3 | 4 | 1 | 5 | 1 |
| Processing Facilities | 1 | 1 | 5 | 1 | 1 | 5 | 5 | 5 | 5 | 5 | 3 | 3 | 5 | 5 | 5 | 1 | 5 | 5 | 5 | 1 | 5 | 1 |
| Local | | | | | | | | | | | | | | | | | | | | | | |
| Processing Facilities | 3 | 4 | 3 | 3 | 1 | 5 | 5 | 5 | 5 | 5 | 2 | 2 | 5 | 5 | 5 | 1 | 5 | 5 | 5 | 1 | 5 | 1 |
| Nationally | | | | | | | | | | | | | | | | | | | | | | |
| Fresh/Frozen Avail. | 3 | 3 | 4 | 2 | 1 | 5 | 5 | 5 | 5 | 5 | 2 | 2 | 5 | 5 | 5 | 1 | 2 | 5 | 5 | 1 | 5 | 1 |
| Island County Water | 4 | 1 | 2 | 3 | 4 | 4 | 2 | 3 | 4 | 2 | 4 | 1 | 4 | 3 | 3 | 1 | 4 | 2 | 3 | 3 | 3 | 1 |
| Sensitivity | | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | | |
| TOTALS | 125 | 117 | 101 | 104 | 105 | 142 | 102 | 96 | 102 | 96 | 128 | 85 | 147 | 102 | 127 | 78 | 95 | 123 | 107 | 105 | 127 | 89 |

## TABLE 4 - SPECIES CANDIDATES RANKING

| | | |
|---|---|---|
| Oysters | 147 | High Potential (3.5 average or better) |
| Clams | 142 | |
| Mussels | 128 | |
| Salmon | 127 | |
| Trout | 127 | |
| Algae | 125 | |
| Scallops | 123 | |
| Abalone | 117 | |
| Shrimp | 017 | Medium Potential (3.0 to 3.5 average) |
| Barnacles | 105 | |
| Snails | 105 | |
| Baitworms | 104 | |
| Cod | 102 | |
| Flatfish | 102 | |
| Rockfish | 102 | |
| Baitfish | 101 | |
| Lobster | 96 | Low Potential (Less than 3.0 average) |
| Crab | 96 | |
| Sea Perch | 95 | |
| Urchins | 89 | |
| Octopus | 85 | |
| Sea Cucumber | 78 | |

Table 5. Evaluation and Scoring Criteria for the Species/Group Evaluation Matrix

The purpose of this evaluation was to provide an objective selection of those species/groups which offer the highest potential for aquaculture development in Island County within the next decade. Difficulties do arise when using common characteristics for species with diverse requirements, e.g., algae, clams, salmon. Additional problems arise when data gaps for particular components exist or the quality of information does not warrant a specific decision. Judgment calls were required for many of the individual ratings where those problems arose decreasing somewhat, the objectivity originally desired. However, the composite scores reflect many criteria which tend to average out individual weak spots in the available information. Experts may argue individual scores, yet the outcome of species with the highest potential remains the same.

Several accomplishments in addition to rating the species/groups was achieved by conducting the evaluation matrix: (1) problem areas within certain species/groups constraining development is clearly illustrated which may assist research development organizations in identifying future activities; (2) a large amount of data was efficiently presented; and, (3) the aquaculture industry is comprised of many complex factors affecting future development which result in a high risk operation.

The higher number indicates that the specie/group is more suitable for commercial aquaculture based upon what is known about that particular criteria. In certain cases, when no information exists but the criteria is not expected to be significant in itself for preventing aquaculture development a rating of three was given. This will prevent extreme bias until more information is obtained.

TABLE 3

LIFE HISTORY CONSIDERATIONS

Abundancy in Puget Sound - Provides aquaculturist with easy access to egg/spat stock.

| Score | Description |
|---|---|
| 5 | Extremely abundant |
| 3 | Abundant only in selected areas |
| 1 | Stock must be imported |

Morphology Understood - Aids in developing appropriate husbandry techniques.

| Score | Description |
|---|---|
| 5 | Complete understanding of morphology |
| 3 | Partial understanding of morphology |
| 1 | No understanding of morphology |

Hybridization Potential - Offers greater genetic manipulation capabilities.

| Score | Description |
|---|---|
| 5 | High degree of hybridization potential |
| 3 | Average or unknown hybridization potential |
| 1 | Low degree of hybridization potential |

Few Developmental Stages - Less husbandry techniques required for fewer developmental stages.

| Score | Description |
|---|---|
| 5 | One or two stages |
| 3 | Several distinct stages |
| 1 | many stages |

Gregarious in Nature - gregarious behaviour is more suitable to dense conditions of commercial aquaculture.

| Score | Description |
|---|---|
| 5 | Found in high numbers in a given area |
| 3 | Found in average numbers in a given area |
| 1 | Found in low numbers in a given area |

TABLE 5 (cont.)

Mature Early - Early maturation provides more reproductive cycles for a given period of time which affects the feasibility of various production stratagies.

| Score | Description |
|---|---|
| 5 | Reaches sexual maturity at market size |
| 3 | Reaches sexual maturity somewhat after market size |
| 1 | Reaches sexual maturity long after market siz |

Rapid Growth - Time required to grow from ititial stocking to market size.

| Score | Description |
|---|---|
| 5 | less than six months |
| 3 | nine and twelve months |
| 1 | longer than fifteen months |

Cannabalistic - Cannabalism prevents high density culture

| Score | Description |
|---|---|
| 5 | No cannibalism |
| 3 | Periodic cannibalism with size disparity |
| 1 | Highly cannibalistic |

Predators (Preyed on)- Few predators reduces problem for non-captive culture.

| Score | Description |
|---|---|
| 5 | Little or no predators |
| 3 | Some predation especially during certain stages of development |
| 1 | Many predators |

Diseases and Parasites - Suceptibility of species to diseases and parasites increases mortality and controls required.

| Score | Description |
|---|---|
| 5 | Little or no problem with diseases and parasites |
| 3 | Average suceptibility but some treatment available |
| 1 | Many diseases with no treatment available |

Easy to Collect(eggs/spat, juvenile, adults) - The ease of collection in natural or articifial environments reduces the cost to the aquaculturist.

| Score | Description |
|---|---|
| 5 | Large and sessile |
| 3 | Smaller and/or some mobility |
| 1 | Small and mobile |

High Fecundity - Requires few adults to supply required egg/spat - reduces costs of broodstock capture/maintenance.

| Score | Description |
|---|---|
| 5 | 100,000 + |
| 3 | 10,000 - 50,000 |
| 1 | Less than 5,000 |

Nutritional Needs Known - Nutritional information is an asset to most species cultured.

| Score | Description |
|---|---|
| 5 | Most basic nutritional needs are known |
| 3 | Some basic nutritional needs are known |
| 1 | None of basic nutritional needs are known |

REARING TECHNOLOGY CONSIDERATIONS

Growth Rates Can Be Accelerated - Accelerating growth rates decreases rearing times and greatly enhances the commercial prospects.

| Score | Description |
|---|---|
| 5 | Demonstrated acceleration of growth rate to a high degree |

| Score | Description |
|---|---|
| 3 | No demonstration of growth rate or demonstrated to an average degree |
| 1 | No acceleration of growth rate demonstrated |

Density High in Captivity - High densities reduce required rearing space.

| Score | Description |
|---|---|
| 5 | Extremely high densities w/little problem |
| 3 | Average densities w/some problems |
| 1 | Extremely low densities |

Hatchery Technology - The more hatchery technology that has been developed, the less unknowns to the aquaculturist and reliance on wild stocks.

| Score | Description |
|---|---|
| 5 | Hatchery technology completely developed |
| 3 | Some unknowns in the hatchery technology |
| 1 | Hatchery technology undeveloped |

Growout Technology - Aquaculture development can proceed to a commercial scale when growout technology is comprehensive.

| Score | Description |
|---|---|
| 5 | Highly developed technology |
| 3 | Basics understood w/some unknowns |
| 1 | Undeveloped technology |

Hardiness in Captivity - Capable of withstanding variations in environmental parameters e.g., salinity, temperature, which may cause stress.

| Score | Description |
|---|---|
| 5 | Very tolerant of large variations |
| 3 | Somewhat tolerant of reasonable variations |
| 1 | No tolerance of variation |

Broodstock Maintenance - The ability to maintain broodstock will reduce dependency of eggs/spat/juveniles from other sources.

| Score | Description |
|---|---|
| 5 | Easy to maintain |
| 3 | Some difficulties encountered or unknown |
| 1 | Extremely difficult |

Controlled Spawning - Achieving controlled reproduction in captivity greatly affects the avilability of stock for culture.

| Score | Description |
|---|---|
| 5 | Controlled spawning demonstrated and presents no problem |
| 3 | Controlled spawning demonstrated with certain difficulties |
| 1 | Controlled spawning undemonstrated |

Commercial Feeds Available - Greatly affects aquaculture potential where supplemental feeding is required.

| Score | Description |
|---|---|
| 5 | Demonstrated complete commercial diet available |
| 3 | Some nutritional problems/commercial availability uncertain |
| 1 | No commercial diet known |

Food Conversion Efficiency - Reduces cost to operation where supplemental feeding is required.

| Score | Description |
|---|---|
| 5 | High feed conversions |
| 3 | Average conversion or unknown |
| 1 | Low feed conversions |

Polyculture Potential - Species adaptability to the presence of other species provides the aquaculturist with greater potential.

| Score | Description |
|---|---|
| 5 | Highly adaptable with most species |
| 3 | Adaptable with certain species |
| 1 | Unadaptable |

Trophic Level - A high score is given for ability to convert materials low on the food chain which occur naturally and reduce cost to an aquaculturist.

| Score | Description |
|---|---|
| 5 | Herbivore-primary producer feeds on plankton |
| 3 | Mixed/Herbivore/Carnivore feeds on zoo-plankton and invertebrates |
| 1 | Carnivore feeds on other carnivores |

ECONOMIC CONSIDERATIONS

Existing Local Market - If an identifiable local market exists it increases opportunity for commercial development.

| Score | Description |
|---|---|
| 5 | High demand over supply |
| 3 | Market exists-demand meets supply |
| 1 | No local market |

Existing National Market - If an identifiable national market exists, it increases opportunities for commercial development.

| Score | Description |
|---|---|
| 5 | High demand over supply |
| 3 | Demand meets supply |
| 1 | No national market |

Recreational Use - Species with potential for recreational fishing/diving increase the feasibility of commercial aquaculture.

| Score | Description |
|---|---|
| 5 | Potential for recreational fishery high |
| 3 | Moderate |
| 1 | Not foreseen |

Local Processing Facilities - Local processing facilities increases the feasibility of commercial aquaculture.

| Score | Description |
|---|---|
| 5 | Species specific facilities in operation |
| 3 | Some facilities w/adaption for species |
| 1 | None available |

National Processing Facilities - If product is easy to transport, processing facilities increase feasibility of commercial aquaculture.

| Score | Description |
|---|---|
| 5 | Many facilities in operation |
| 3 | Some facilities available |
| 1 | No facilities in operation |

Fresh/Frozen Availability - If the product is available year round, expecially in the fresh state, the commercial prospects increase.

| Score | Description |
|---|---|
| 5 | Available on a year round basis |
| 3 | Available seasonally |
| 1 | Restricted Availability |

ENVIRONMENTAL CONDITIONS

Island Co. Water Sensitivity - More sensitive species increase risk of stress and mortality and limit suitable site availability.

| Score | Description |
|---|---|
| 5 | Very tolerant of environmental changes |
| 3 | Somewhat tolerant of moderate changes |
| 1 | Strict requirements w/little tolerance |

## III. REARING METHODS POTENTIAL FOR ISLAND COUNTY

### Selection of Potential Rearing Methods

Many methods are in use for rearing marine organisms in the world today. These methods vary from small scale projects to massive enterprises covering hundreds of acres. The degree of technology employed appears to be dependant upon two basic factors: (1) the controls imposed by applicable jurisdictions; and (2) the severity of the aquatic environment.

Assessing which methods may be proposed in future years is almost limitless although the same two factors will continue to influence the methodology for commercial aquaculture. An analogy between agriculture and aquaculture is drawn for many issues that arise over development of the industry. However, determining methods of rearing for aquaculture is much more complex, in terms of farming, because of that third dimension imposed by water - depth.

Aquaculture activities can occur in five major zones: (1) shore-based; (2) intertidal (from high water to extreme low water); (3) sub-tidal (from extreme low water to about 10 meters); (4) surface (located in 10 meters to 90 meters of water); and, (5) submerged from water surface to sea bottom (in depths of 10-190 meters). (See Figure 2.)

FIGURE 2. ZONES OF REARING

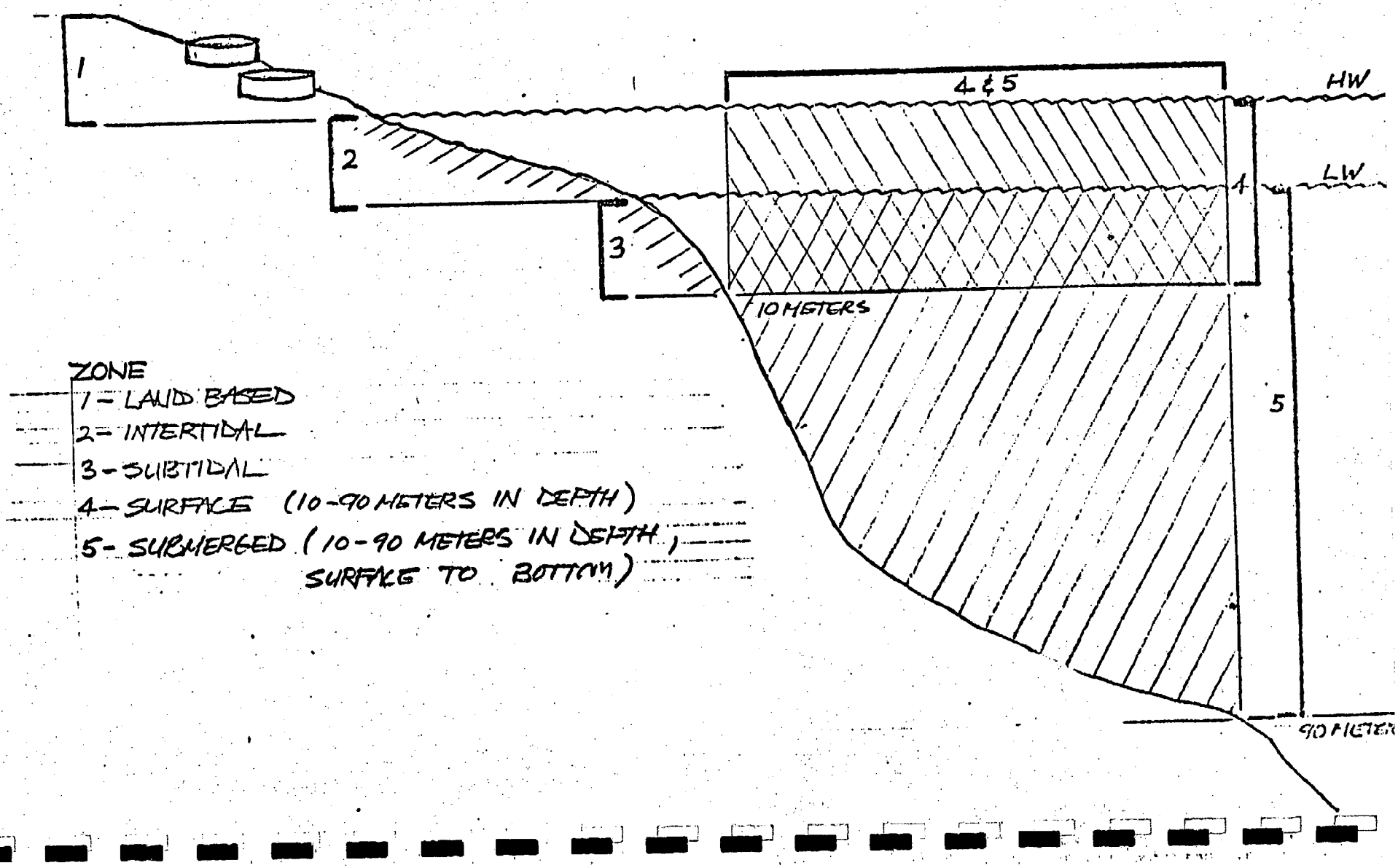
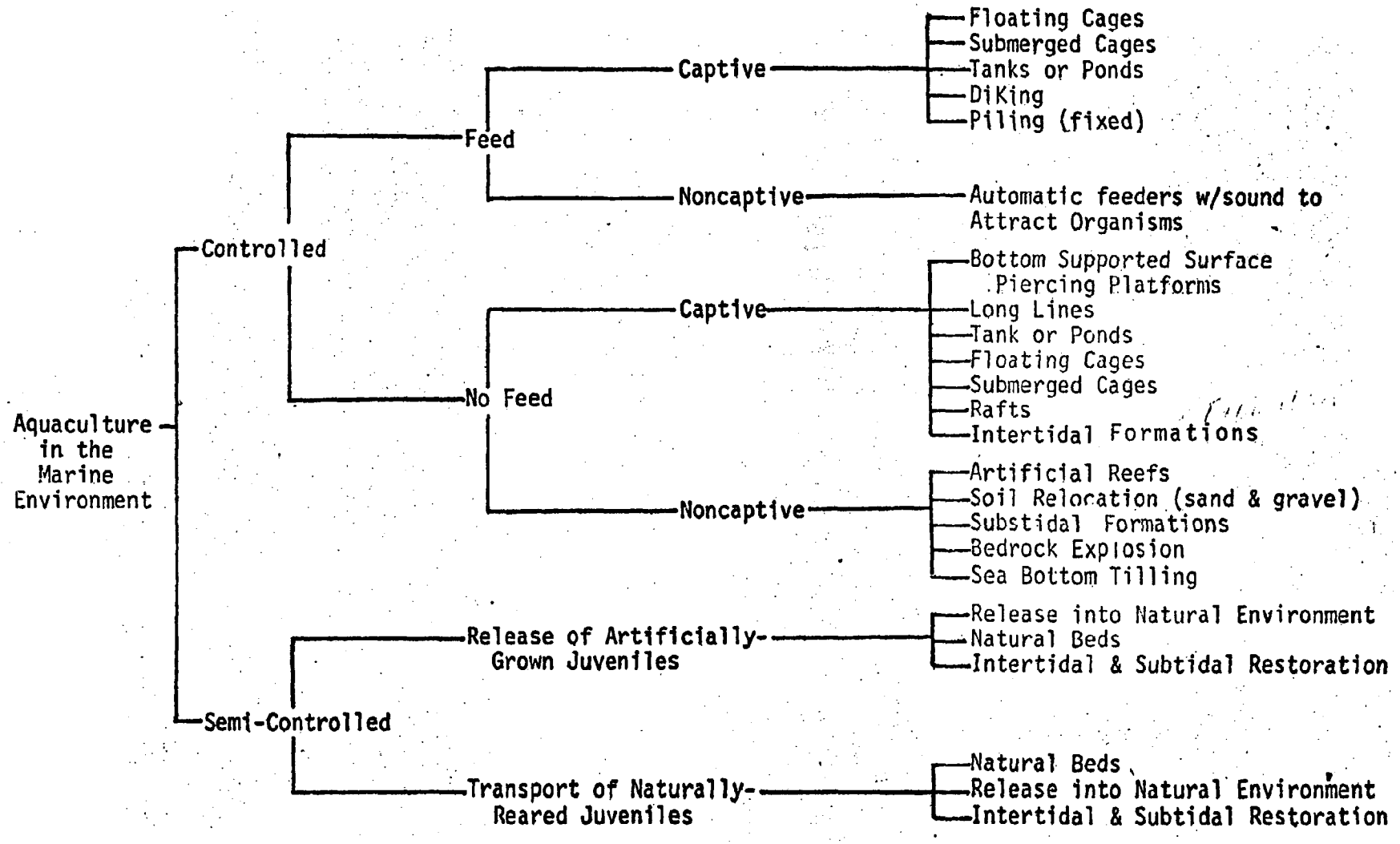


Table 6 . Potential Methods of Rearing in Puget Sound in a Controlled or Semi-Controlled Environment



Certain methods are applicable to each zone for a particular species. All zones end in 90 meters of water as beyond those depths it is extremely difficult to have access because of diver and equipment limitations for hardware inspection, servicing, and harvesting. Methods of rearing for those five zones was developed by reviewing the technology employed in the U.S. and other foreign countries e.g., France, Japan, Norway, where aquaculture is a significant industry. It was determined that rearing methods can be classified as either controlled or semi-controlled. A controlled method is defined as manipulating the substrate, creating captive environments, and/or supplying feed on a regular basis. A semi-controlled method would involve the release or transport of juveniles to a natural environment. A summary of those methods for the various combinations is presented in Table 6.

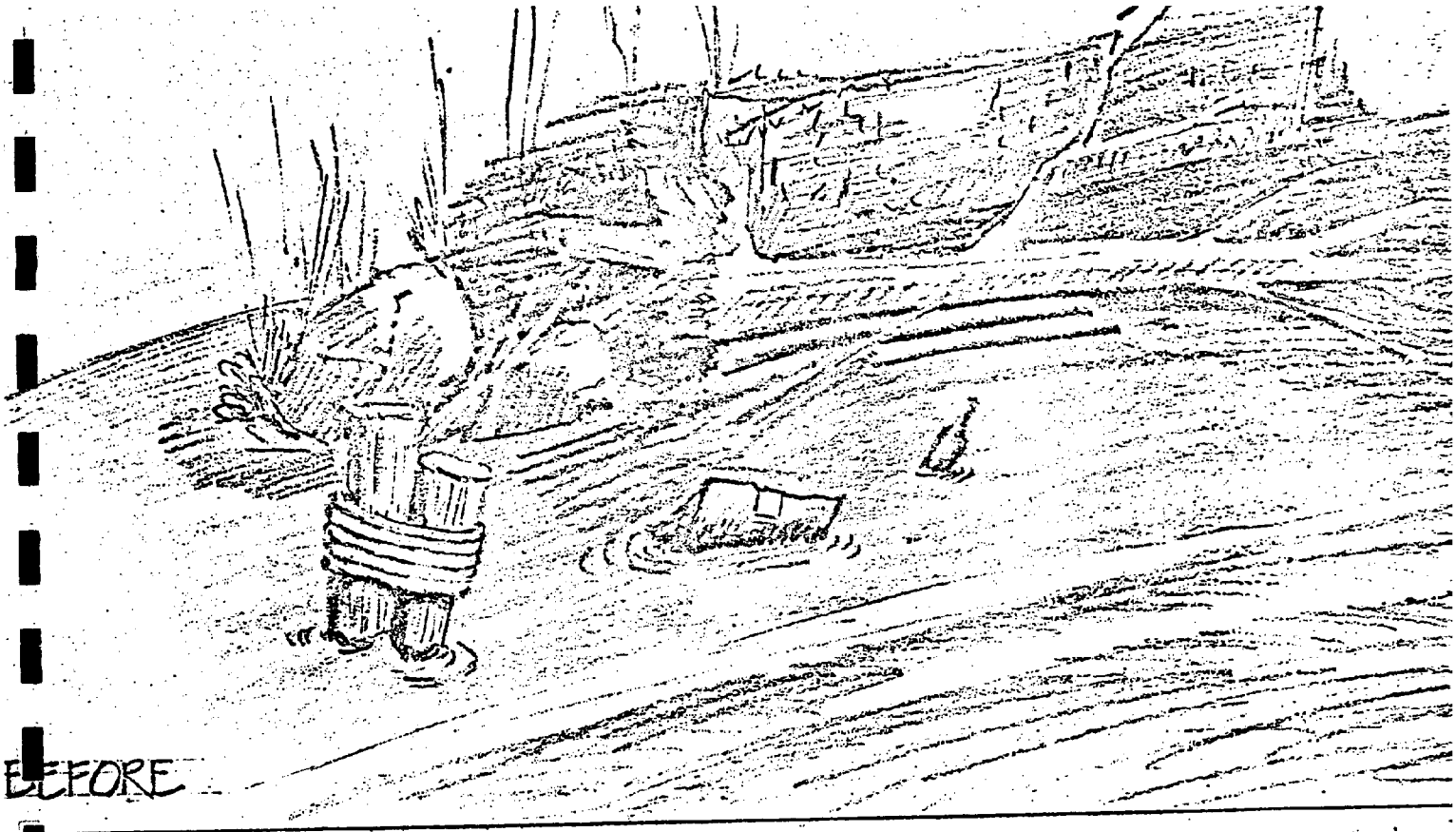
Description of Rearing Methods

Of the eighteen methods of rearing, many variations exist. For example, surface cages may include, but are not limited to five-sided net-pens, hexagonal net-pens, horizontal nets, and impermeable cages. Major components and physical characteristics of each method of rearing is given, in some cases with an illustration, in the following descriptions.

1. INTERTIDAL AND SUBTIDAL RESTORATION

   Species: Abalone, Algae, Clams, Mussels, Oysters, Scallops

   The cleaning and removal of debris from intertiday and subtidal areas can classify as an aquaculture method when this activity is designed to return an area to a natural state as a prelude to natural or artificial seeding. The scale of restoration can vary greatly but usually includes both manual shore labor and mechanical systems such as cranes and barges when large debris such as logs or old bulkheads must be removed. This method is conducted in rearing method zones 2 and 3. Harvesting is conducted by manual methods or with floating mechanical harvesters.



BEFORE

AFTER

INTERTIDAL & SUBTIDAL RESTORATION

2. RELEASE INTO THE NATURAL ENVIRONMENT

Species: Abalone, Clams, Oysters, Salmon, Scallops, and Trout

This method is similar to natural bed seeding except that natural beds may not currently exist, or be unapplicable to the specie released such as salmon and trout. The future harvest of an area is improved by simply increasing the number of eggs, spat, or juvenile organisms without enhancing their environment. This method is usually done in conjunction with a juvenile rearing program at a land based hatchery. Boats (12'-20') or barges can be used to release the juveniles, or release can be done from the shoreline, creeks edge, or hatchery facility. This method is conducted in zones 2, 3, and 4. Harvesting is accomplished by manual methods or floating mechanical harvesters in the case of shellfish and with typical commercial fishing techniques or traps and weirs for salmon and trout.

3. NATURAL BEDS

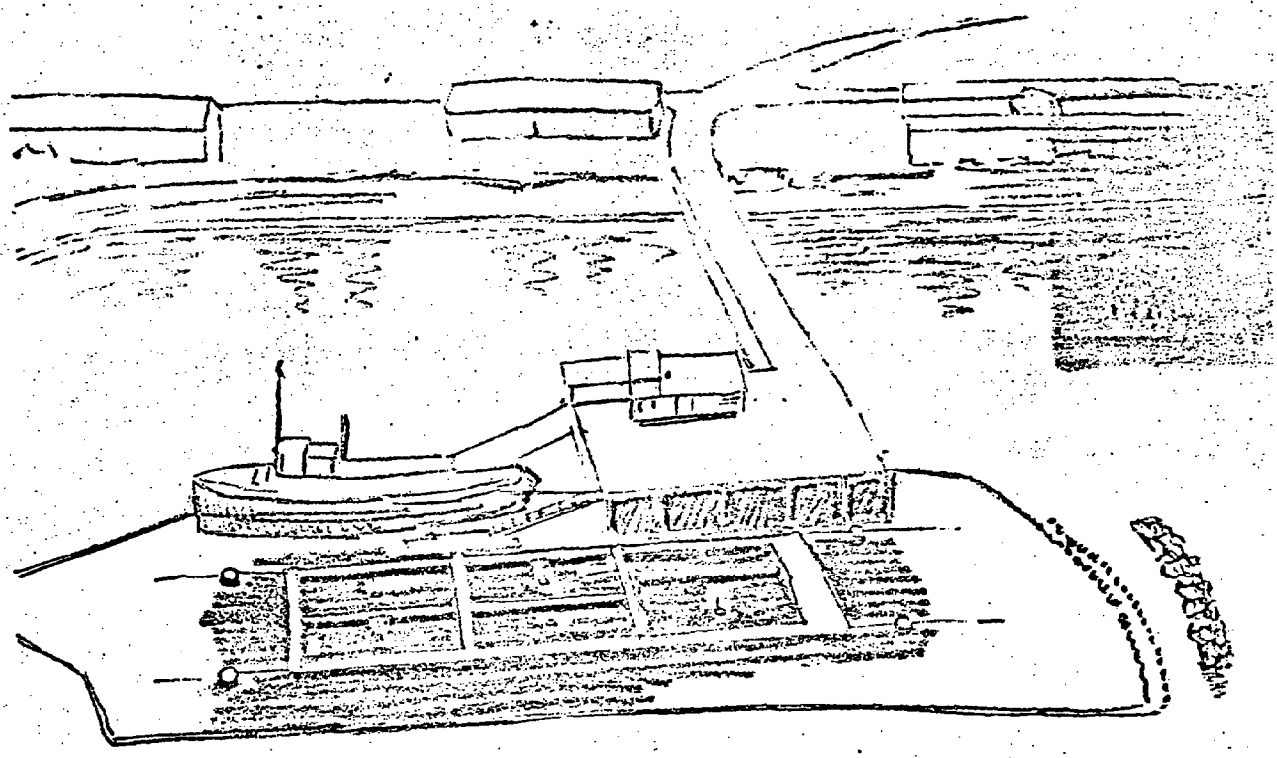
Species: Abalone, Clams, Mussels, Oysters, Scallops

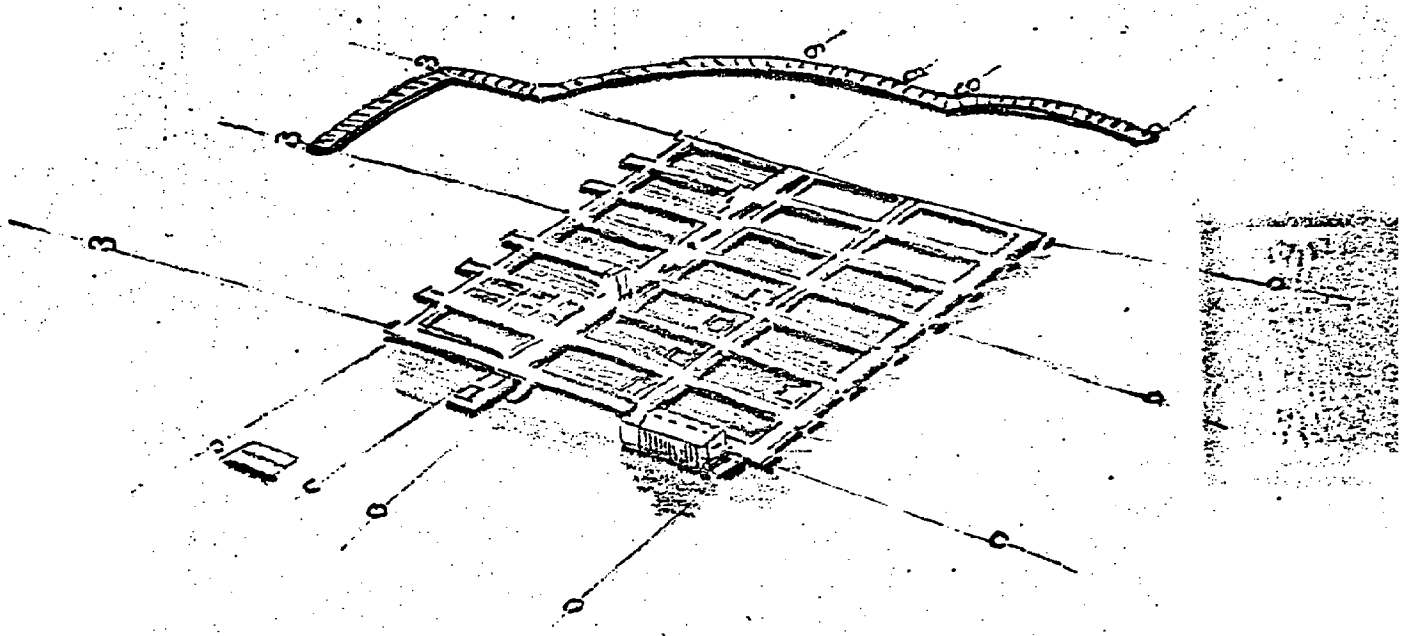
This method entails enhancing existing natural beds of aquatic organisms through seeding of artificially-grown juveniles, or the transport of naturally-grown juveniles. Seeding of natural beds can be done in zones 2 and 3. In intertidal zones seeding is usually done by hand at low and extreme low tides. In subtidal zones, boats from 12' to 40' are typically used. Importation or land based hatcheries are the source for artificially grown juveniles. Harvesting is accomplished by manual methods or with the use of a floating mechanical harvester.

4. FLOATING CAGES

Species: All Species

This method consists of enclosed cages usually made of plastic, nylon, or plastic covered wire mesh with solid or perforated sides and bottom that is suspended by flotation material at the surface of the water. There can be a platform around each cage,





FLOATING CAGES

or group of cages, for access. The entire assembly is anchored in place by a cable, rope or chain system and weights. Under certain conditions, a cage system can also be attached to pilings. The size of each cage varies, depending upon the species to be reared, from 4 ft. x 8 ft. up to 60 ft. x 60 ft. with the average being approximately 20 ft. x 40 ft. for commercial uses. Units of cages can range from 4 to several hundred cages depending upon the species and intensity of the operation. Some systems are large enough to incorporate floating living quarters for operations personnel. Depending upon the species and if supplemental feeding is used, a relatively close shore facility for processing and administration may be required. Servicing, harvesting, and general maintenance usually require daily boat activities in and around a floating cage system. Motorized skiffs (12 to 20 feet) are most often used.

Night operations are usually not included in this system. Odors associated with supplemental feeding of salmon or trout are sometimes detected in the immediate area of the cages. Critical to odor control is the cleanliness of the operation. Rearing other species via this method yields no unusual odors.

The range and duration of equipment noises is directly dependent on the scale of the operation. The service skiffs can generate noise levels up to 50 DBA. Site characteristics and operations will determine the effect. Visually, a floating cage system can be almost totally obscure (under dock system) or cover several acres of water surface. Although the nets themselves are submerged, work platforms and auxiliary facilities are visible. Navigational safety lights are also visible at night when incorporated into larger deep water facilities. If supplemental feeding is done in an area with weak flushing characteristics, some water quality problems may occur directly below the cage system. This method is conducted in zone 4. Harvesting is conducted at the cage site with the use of barge type vessels and, in the case

of salmon or trout, chill tanks which kill the fish efficiently. Some species such as clams will be reared to the juvenile stage and then transported to other locations.

5. SUBMERGED CAGES - All Species

This method consists of placing cages or traps below the surface of water secured by cable, ropes, and/or chanins to anchors and surface or subsurface flotation devices. The cages or traps can be made of rope, steel, plastic covered wire mesh, or nylon and may be completely enclosed or open on top. Some species may receive daily feeding, requiring substantial boating activity around the area. A system of cages can cover up to several acres and may employ supplemental working platforms or barges depending upon the species reared and intensity of the operation. This method is conducted in zone 5 except for algae which may be conducted in zone 3 to utilize the photic zone.

6. RAFTS

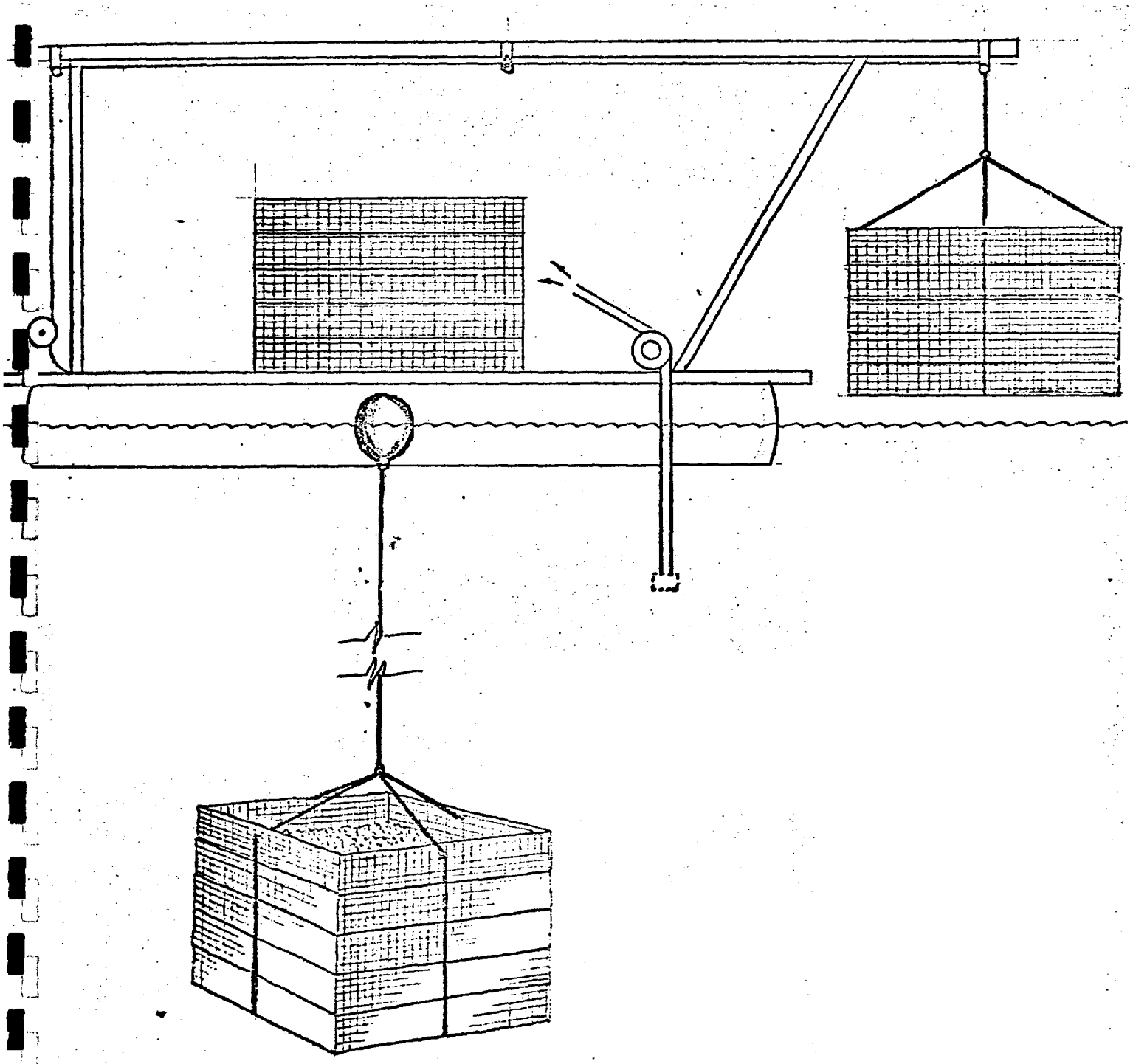
Species: Mussels, Oysters, Scallops

This method includes the rearing of organisms suspended from surface located structures, usually made of wood with additional flotation material. Ropes and other material can be suspended from the raft depending upon which species is being reared. The rafts are pre-assembled and floated into place in zone 4. Once in place, the structures rise 1-3 feet above the water line. No supplemental feeding is done during the rearing so daily boating activity is restricted to maintenance of the structures. Because they protrude from the water, navigational markers and lights may be incorporated in the larger systems. Operations can range from 1 to 50 acres of water surface area. Harvesting is conducted with boats that pull the suspended organisms from the water and deposit them in the boat for transport to a processing area.

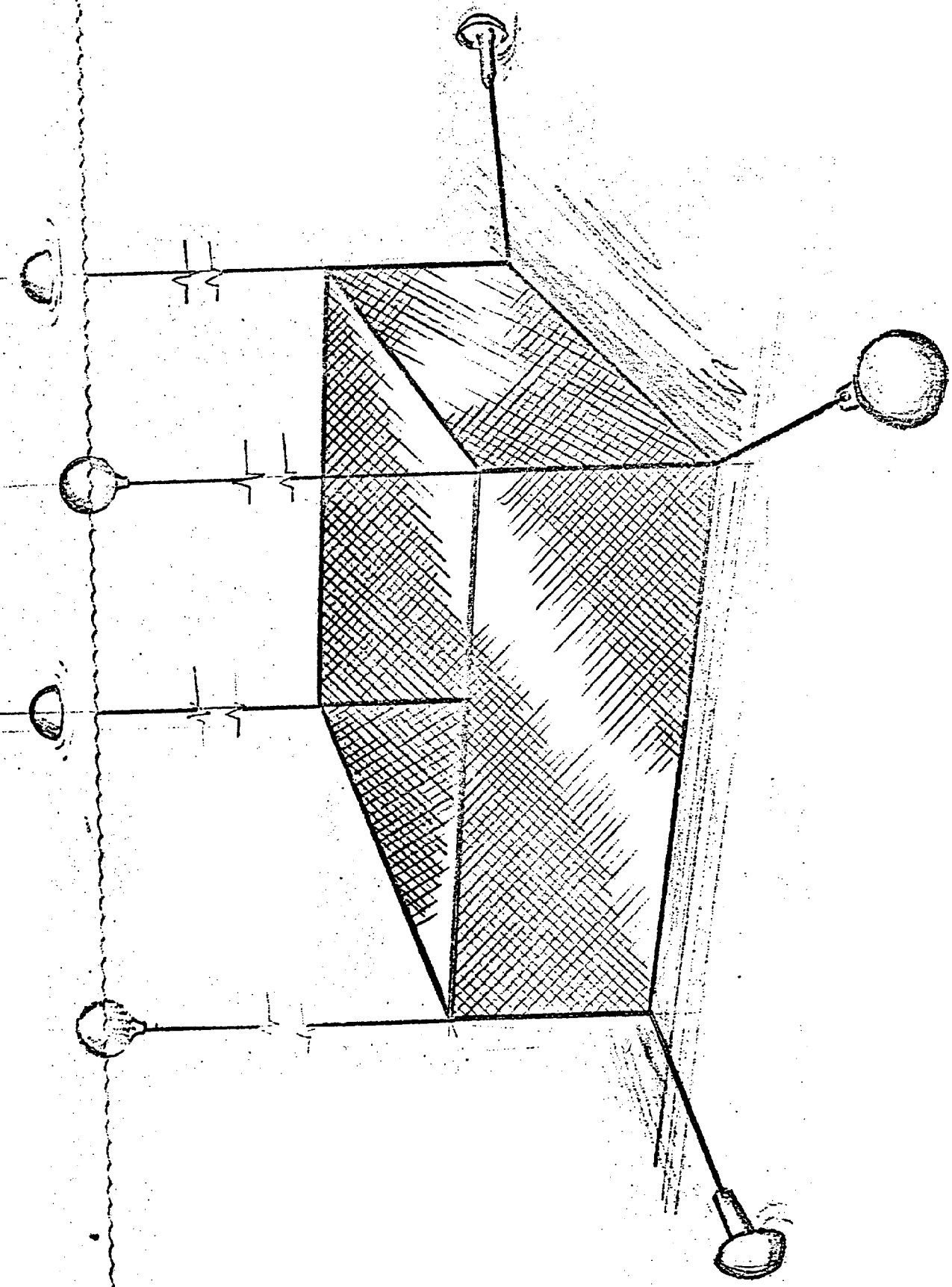
7. PILING

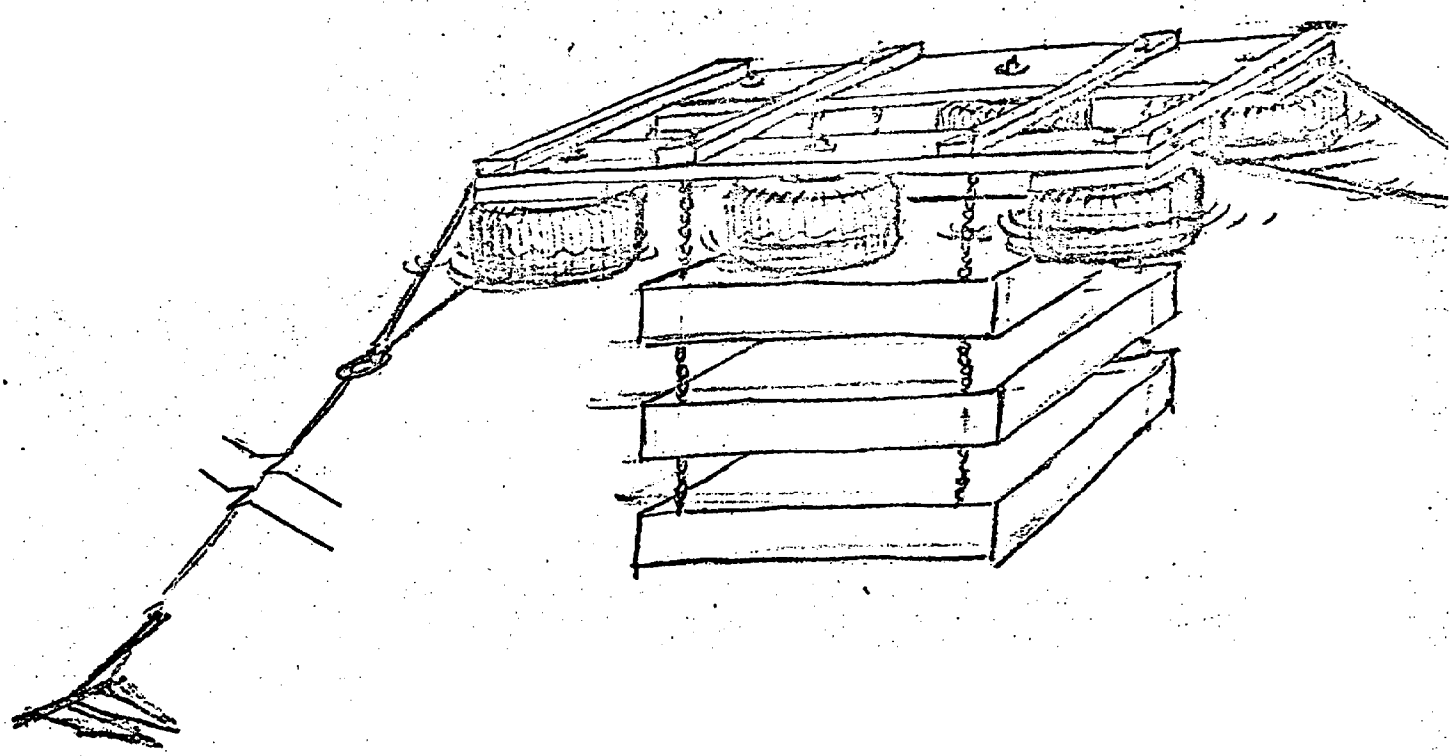
Species: Mussels, Oysters, Scallops (Bay)

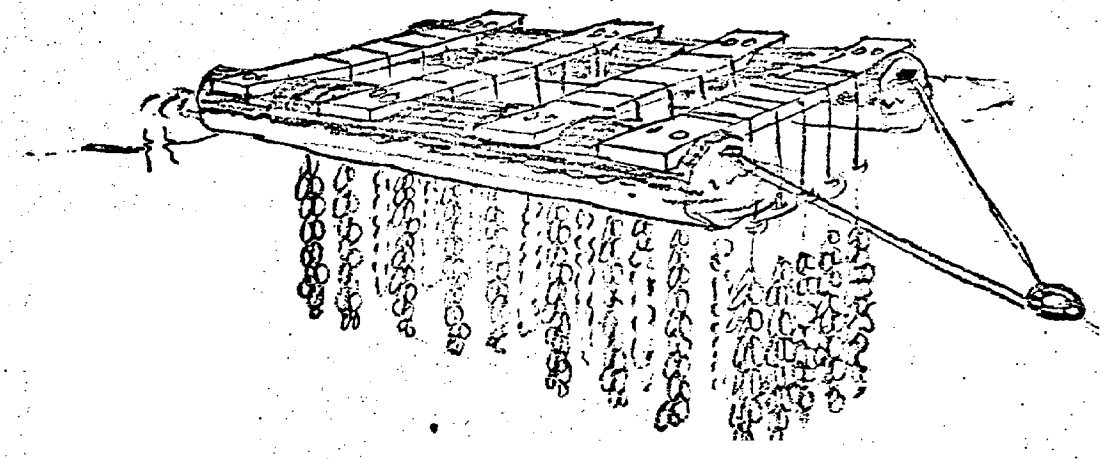
This method entails the driving of sticks, stakes, or poles into



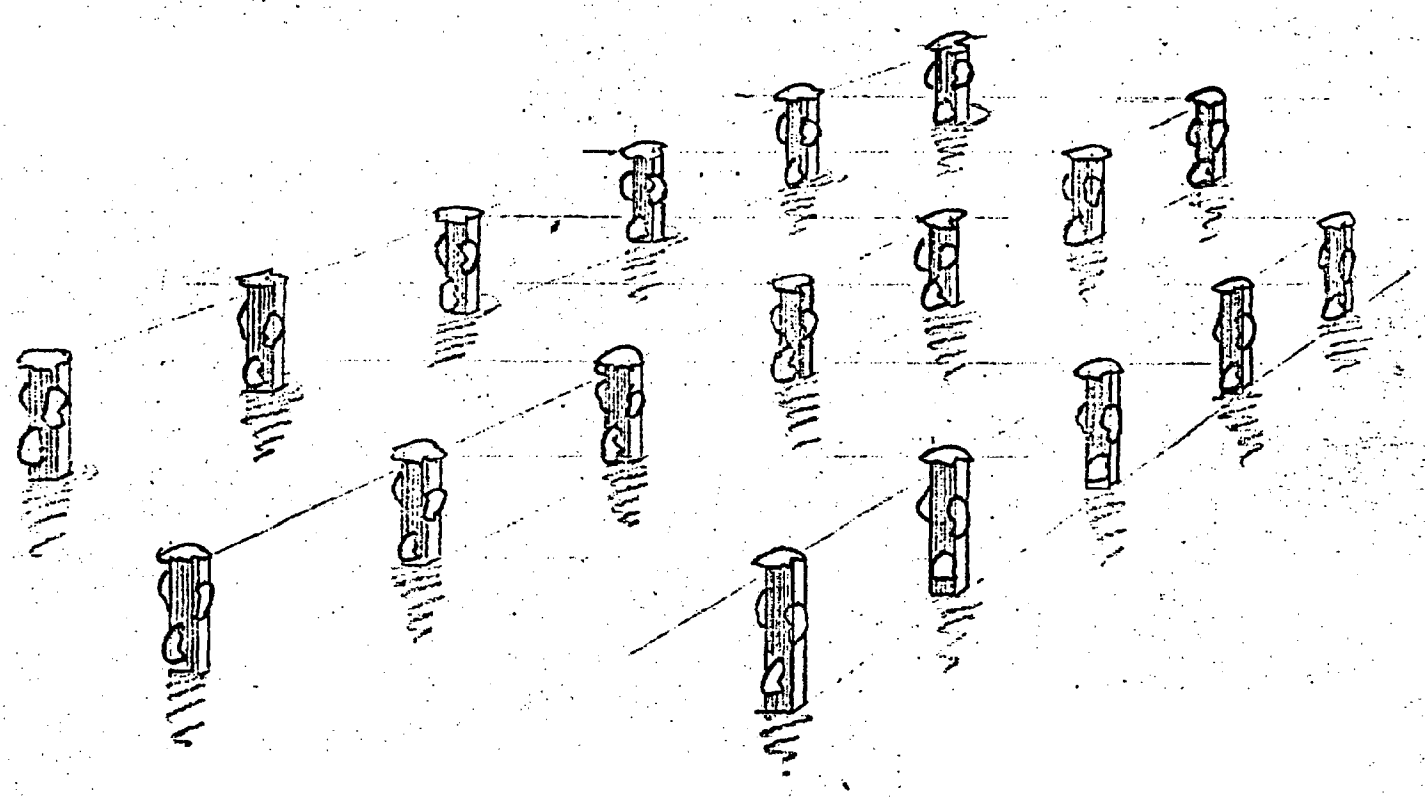
SUBMERGED CAGES

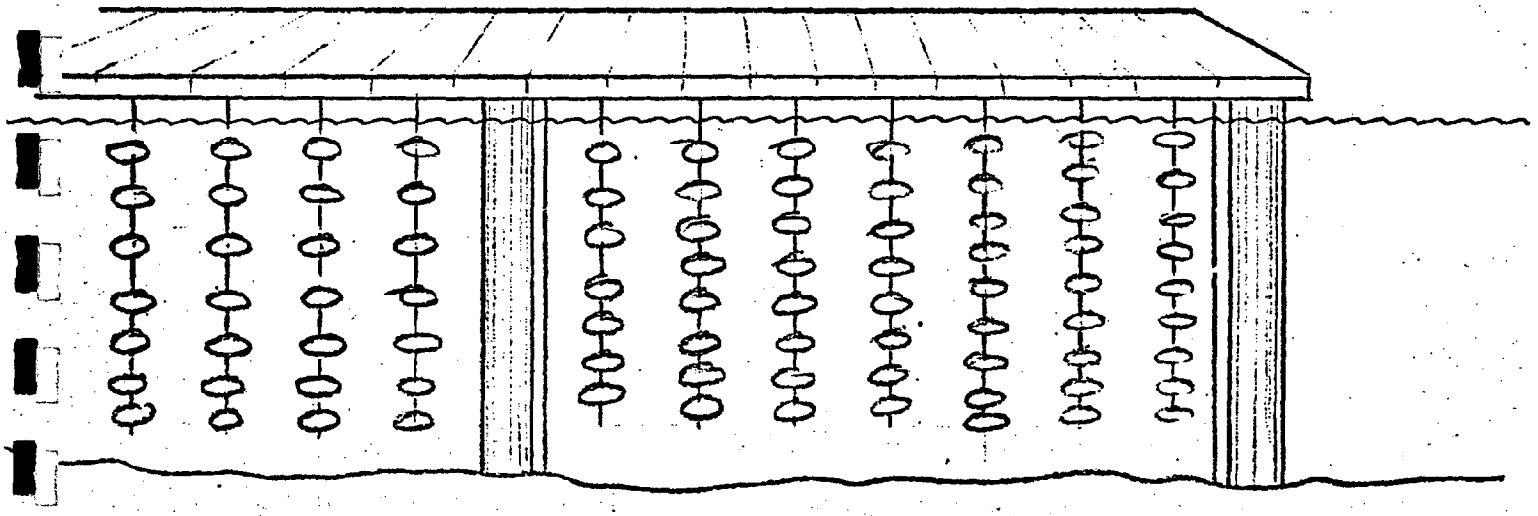


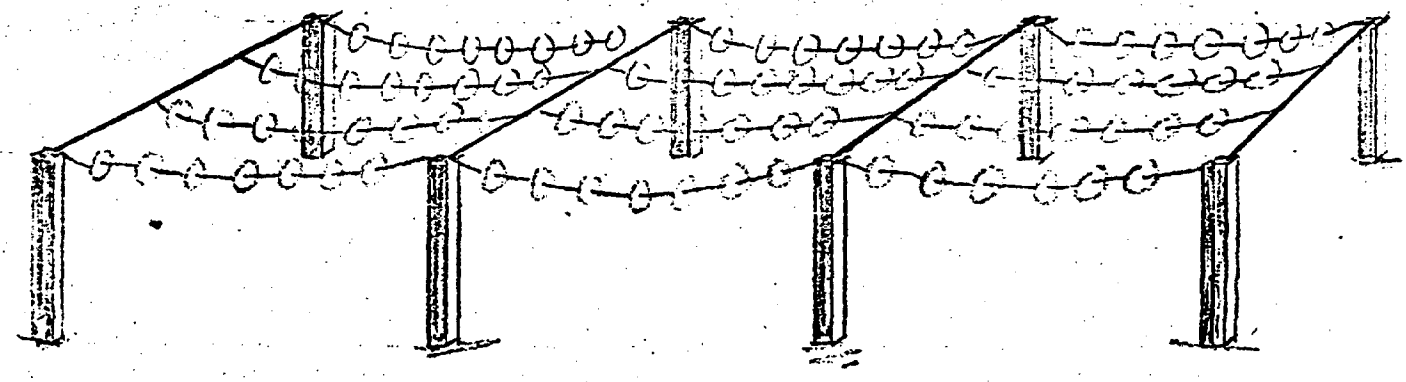




RAFTS







PILING: STAKES; SUSPENDED FROM DOCK; SUSPENDED FROM STAKES

the sea bottom with the top of the pole protruding from the surface of the water. The poles may be connected by rope, nets, wires, or ridged material or may themselves be individual units. Spacing and intensity of the operation depends upon the species and economic considerations. This method is usually done in 0 to 10 meters of water and requires no upland support area. No daily servicing, feeding or maintenance is required and harvesting is usually done via a small skiff from 10' to 20' in length or can be accomplished with manual methods during low tides.

8. LONG LINES

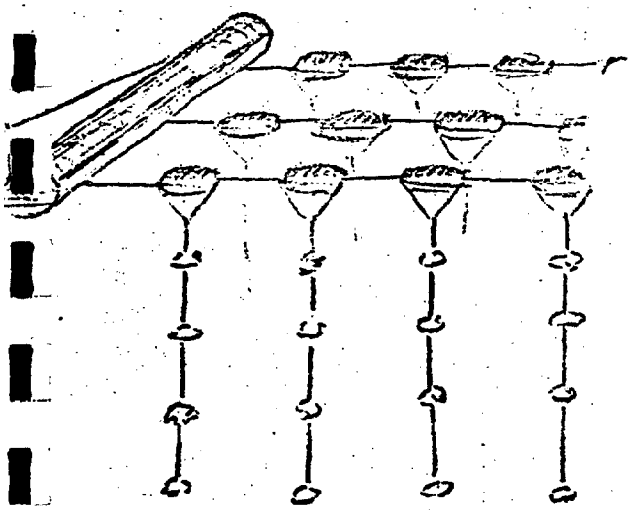
Species: Mussels, Oysters, Scallops (Bay and Sea)

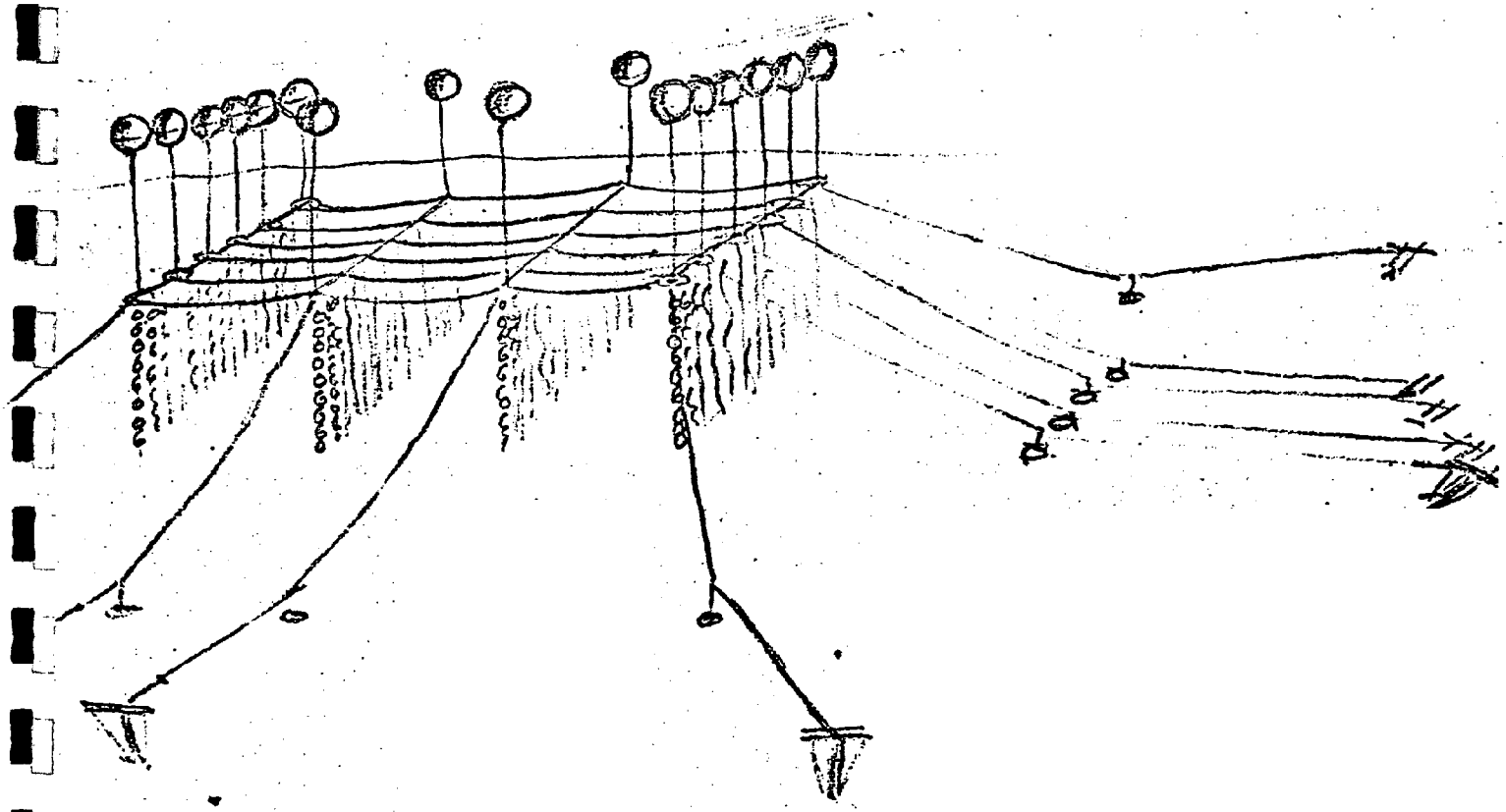
This method consists of using rope or wire to suspend cultures in open water. The long line system includes flotation devices and anchors to secure the assembly. The design of the system is very flexible and can be suspended below the surface, from surface buoys, or used in conjunction with rafts. No supplemental feeding is done with this system; however, occasional service and maintenance trips via a boat is required. A barge may also be used for installation and harvesting activities. A long line system can range from a few hundred linear feet to miles when done for commercial purposes. Long lines can be set up in many configurations in parallel or in series.

9. BOTTOM-SUPPORTED SURFACE PIERCING PLATFORMS - All Species

This method consists of a structure of metal, wood, or concrete that rests on the sea bottom and supports a working platform above the water's surface. Typically, three or four legs are used for support which can be used for aquaculture activities such as submerged cage supports, hanging lines, tray supports, or racks. The system can be located in waters up to 90 meters in depth. The method is highly visible and because the capital investment costs are high it is usually associated with a large scale operatio Enclosed power plant and working quarters are possible with the larger systems. Depending upon the species to be reared, associate

# TONG-LINES





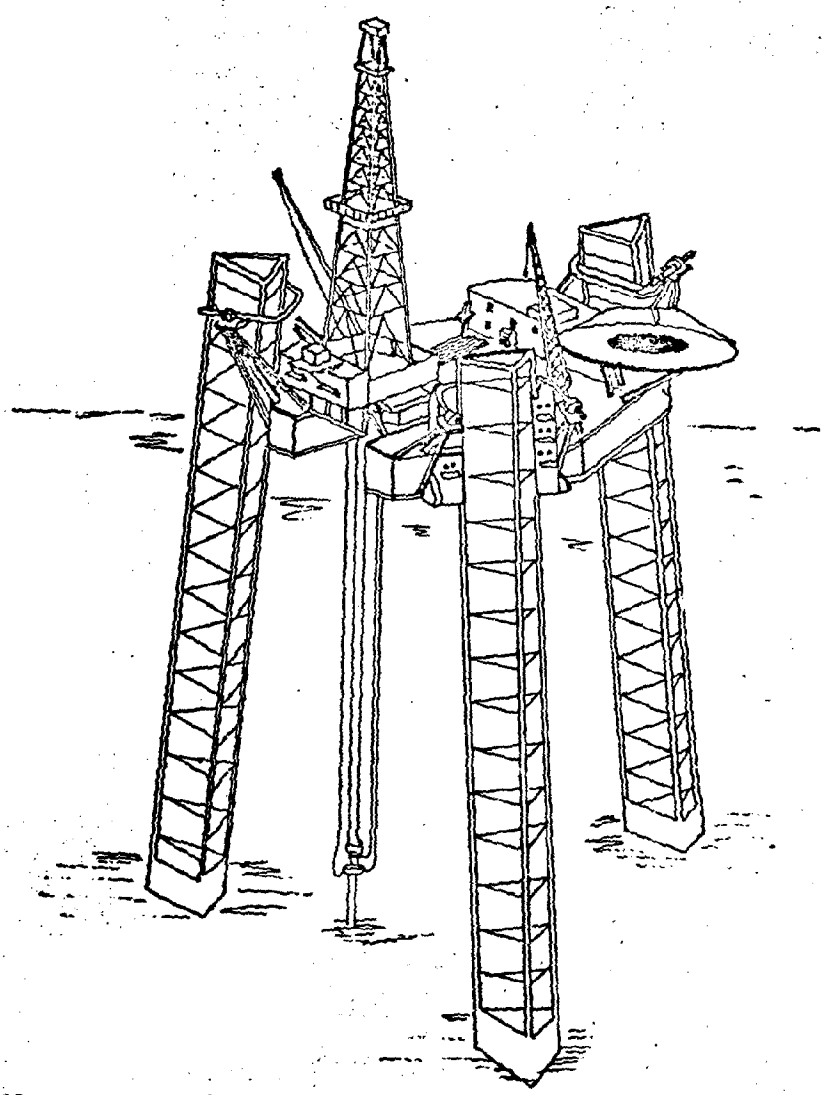


**FIGURE 12.7** *Jack-up type oil-drilling platform. (Adapted from Marks and Kim [7].)*

## BOTTOM SUPPORTED SURFACE-PIERCING PLATFORMS

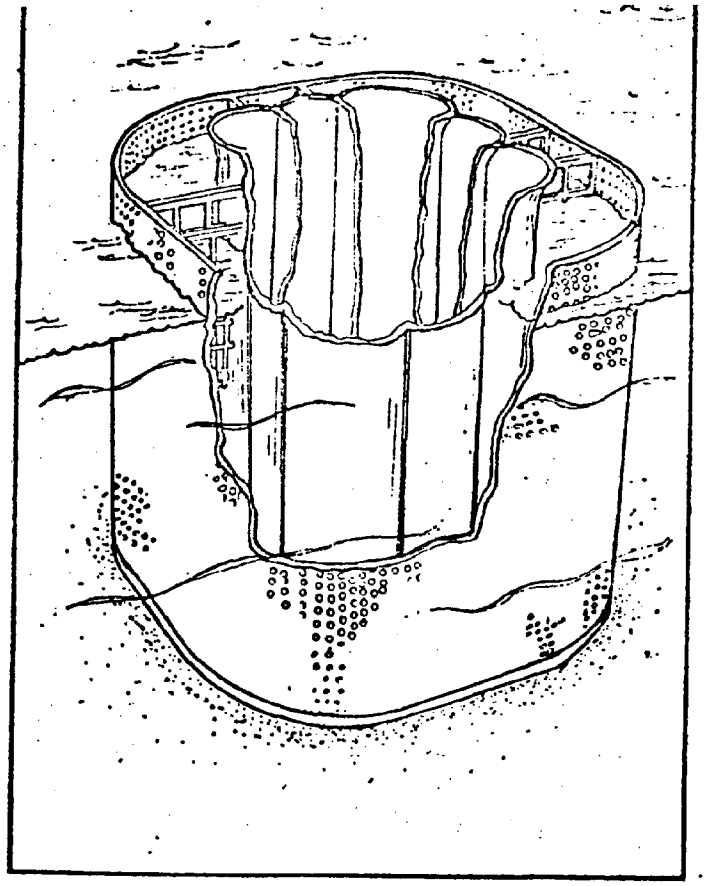


**FIGURE 12.10** *Ekofisk offshore oil storage facility. (Courtesy of the Phillips Petroleum Co.)*

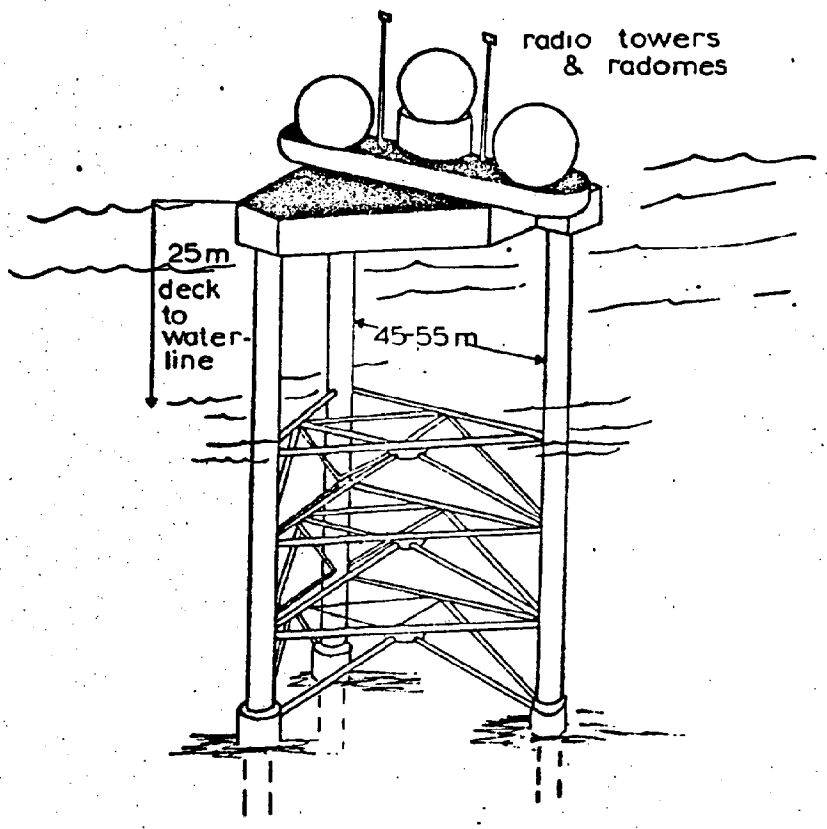



**FIGURE 12.6** *Texas-tower type radar platform.*

boating activity and a land based support operation, may also be included. Navigational lights are required around the structure.

10. AUTOMATIC FEEDERS WITH SOUND

Species: Salmon, Trout

This method consists of feeders placed on piers, rafts, floating cages, or surface platforms with ultrasonic sound devices which attract fish for sport or commercial use. As the sound permeates the water, it keys the fish to associated feed which is dispersed from a hopper controlled by timers. External power is required, therefore these operations are associated with piers or large floating operations. Once fish attain harvestable size, they can be harvested by commercial fishing methods.

11. SOIL RELOCATION

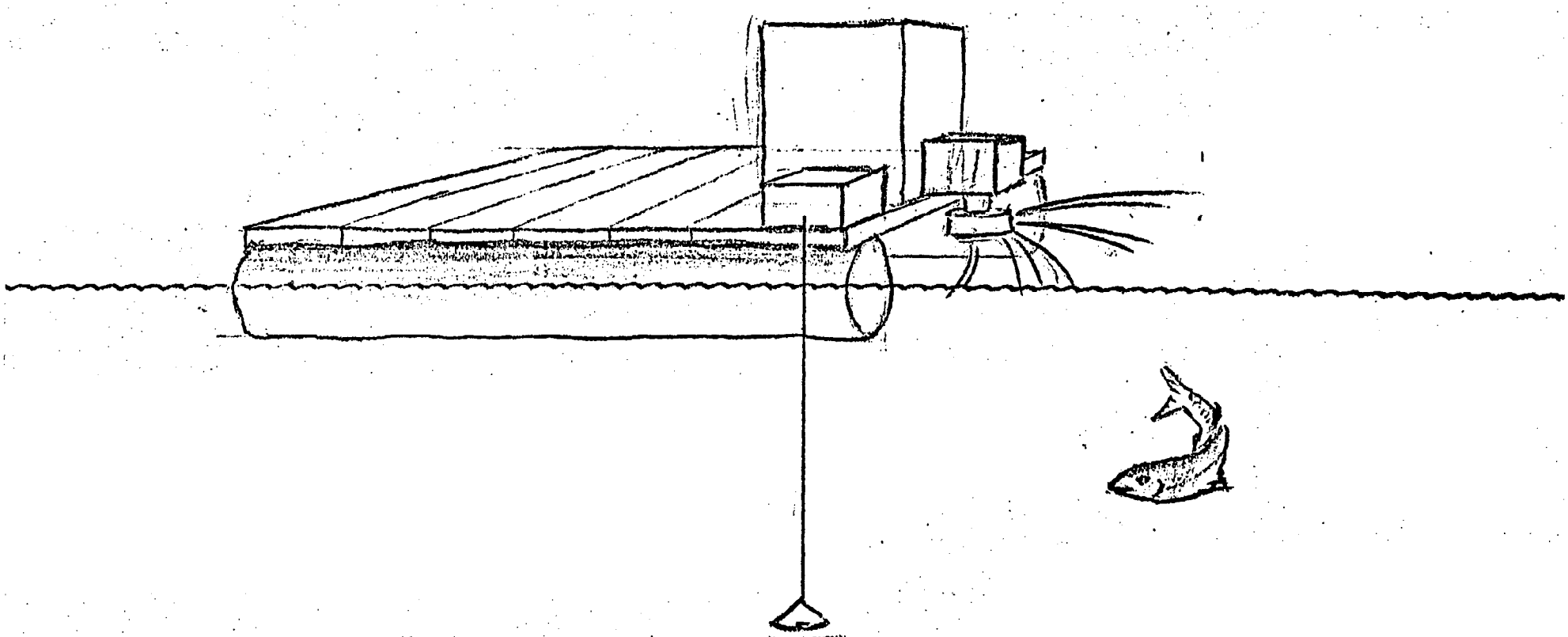
Species: Clams, Lysters, Scallops

This method consists of the placement of sand or gravel in areas whose bottom type was previously unsuitable for productive rearing of subsurface commercially valuable organisms. Artificial or natural seeding is conducted after the surface is prepared. The extent of this method for commercial purposes can be from a few acres to several miles of shoreline. Harvesting in these areas can be done via mechanical harvestors or manual methods such as hand digging or diving. This method can be conducted in zones 2 and 3.

12. INTERTIDAL FORMATIONS

Species: Clams, Mussels, Oysters

This method entails the placement of materials such as concrete rubble, tires, rock, etc. in the intertidal zone for increasing the productivity and/or for providing a habit for the specie to be reared. This method usually requires no supplemental feeding and harvesting is done via manual methods at low tide. The intensity of this operation can range from a few hundred feet to miles of shoreline. Offshore barges or trucks are used to install the material. Daily servicing and maintenance is not typically needed



AUTO-FEEDER
W/ SOUND

for the species utilizing this method, therefore, associated boating activities are minimal. During low tide conditions the material placed in the intertidal zone is visible from the shoreline. This method is conducted in zone 2.

13. SUBTIDAL FORMATIONS

Species: Algae, Abalone

This method consists of placing materisl such as concrete rubble, tiles, rocks, etc. in the subtidal zone. This enhances the habitat for these species and increases productivity. The extent of this method for commercial purposes can be from a few acres to several aquare miles. A barge type vessel from 20' to 25' is used for placement of the material. A tender vessel can be used in conjunction with divers for harvesting activities or mechanical algae harvesters can be employed. Marker buoys are often used to mark the boundaries of the rearing area. The material selected should be non-toxic and non-corrosive. This method is conducted in zone 3.

14. ARTIFICIAL REEFS

Species: Abalone, Salmon, Trout

This method entails improving habitat conditions by placing non-corrosive materials such as rocks, concrete, and tires in clusters in subtidal zones. Artificial reefs improve production at all levels of the entire food chain and is usually followed by seeding with the species to be later harvested. Barges and divers are used to install the system. Artificial reefs are marked with a marking buoy and specified as to which user group has exclusive use.

15. DIKING - All Species

This method consists of the segregation of an area of shoreline by placement of a berm, sheet piling or other material to contain water. The enclosed area may be dredged for proper slope and depth. Tidal gates can be installed for diurnal flushing with sea water. Pumps may also be installed for continuous water exchange. A variety of rearing methods can take place within a dike

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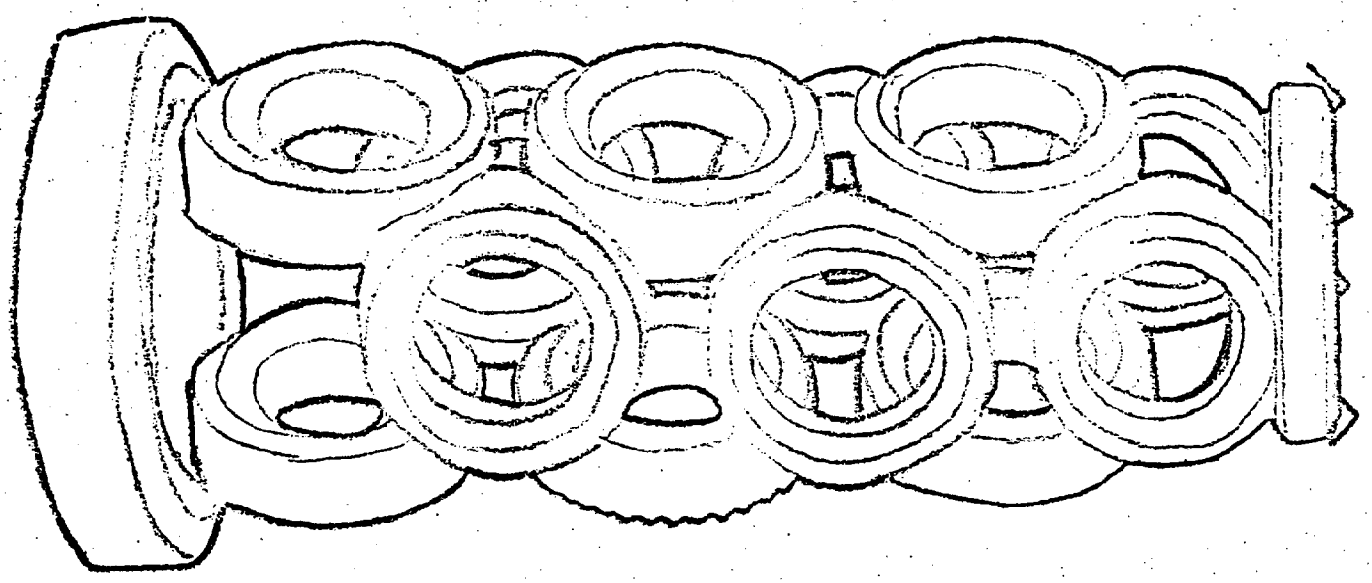

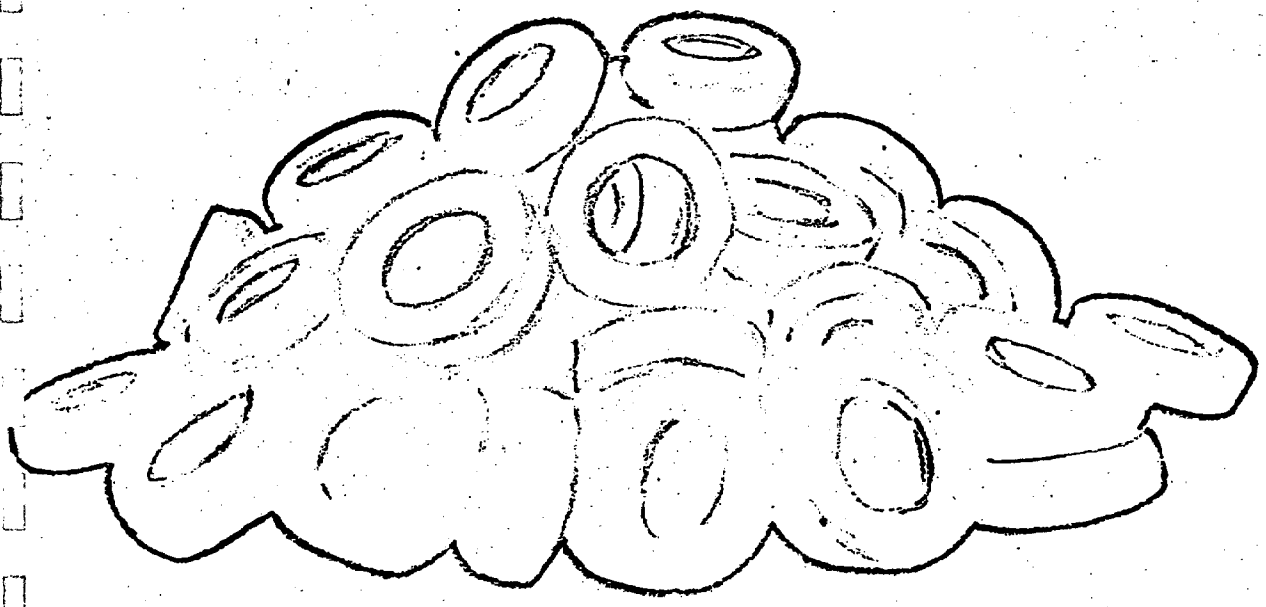

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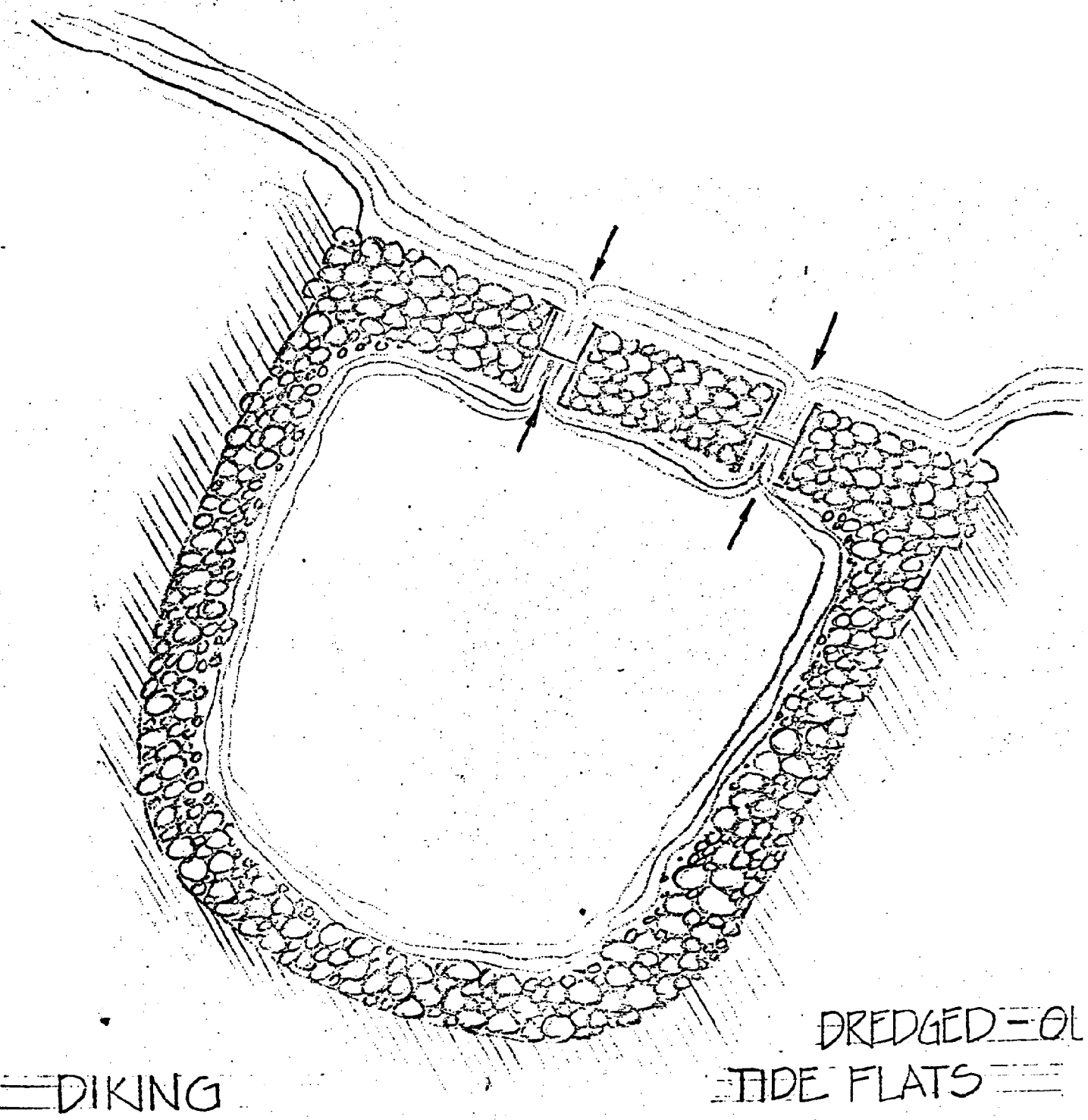
ARTIFICIAL REEFS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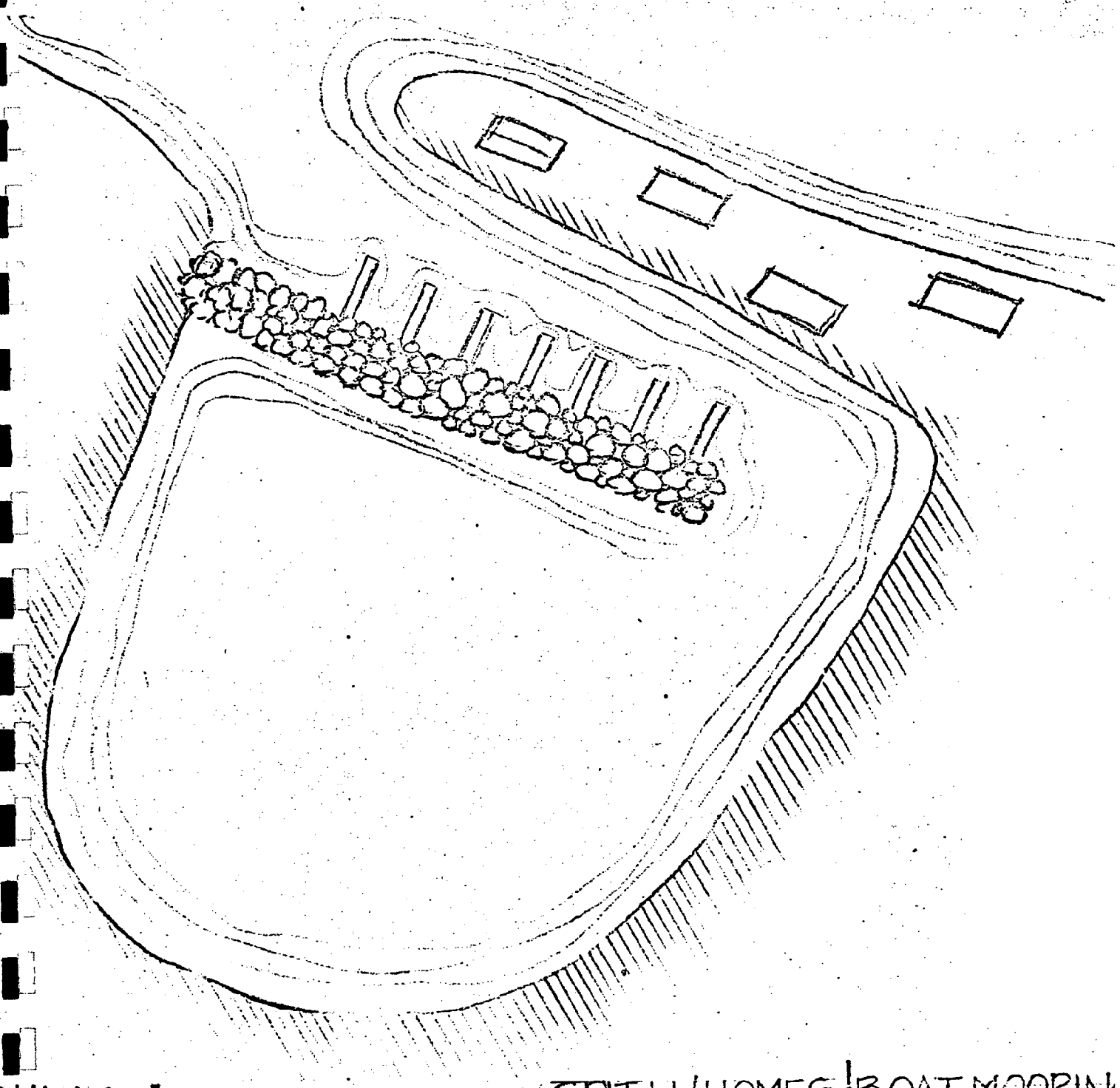

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SPIT W/HOMES & BOAT MOORIN

depending upon the goals, water quality conditions, etc. The size of an area impounded by a dike can cover from several to hundreds of acres. The enclosed area is usually several feet below mean high water with the dike containing seawater at low tide. Tidal gates are usually made of steel or concrete and sheet piling is usually constructed of interlocking steel sections. Dredging and filling or the placement of rip-rap is the standard method of forming the dike. Partial diking is also feasible for aquaculture. This includes the partial enclosure of an area. Associated boating activities include skiffs from 12' to 20' in length and/or barges. This method is conducted in zones 1 and 2. Harvesting can be accomplished with manual methods or with the use of mechanical harvesters depending upon the species and intensity of operations. The other rearing methods are used in conjunction with diking.

16. SEA BOTTOM TILLING

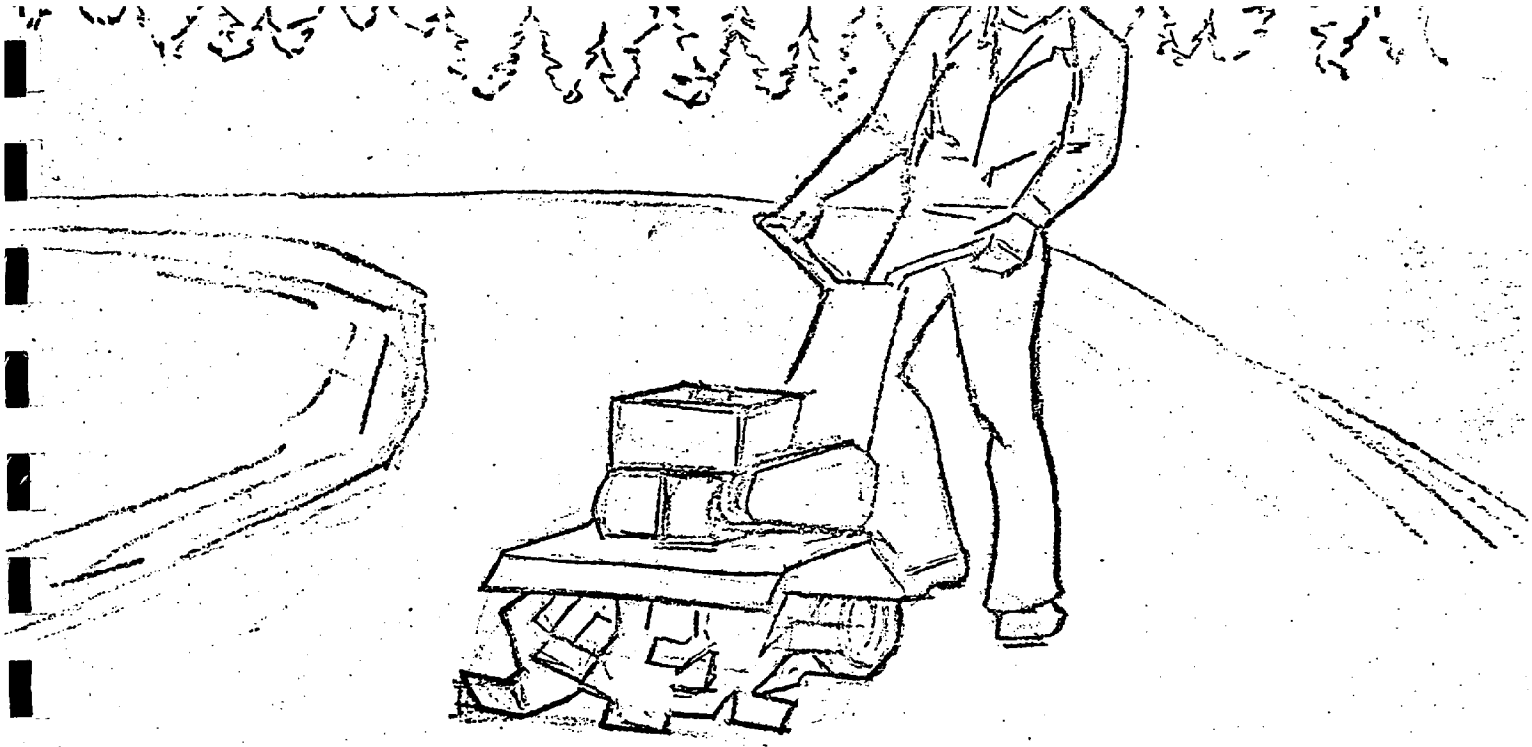
Species: Clams, Mussels, Oysters

As in upland agriculture methods, sea bottom tilling is the tilling of intertidal or subtidal areas (zones 2 and 3) to improve habitat conditions. Tilling can be simply a turning of the soil prior to seeding, or done in conjunction with a harvesting and/or reseeding activity. Mechanical clam harvesters currently used in various areas of Puget Sound fall into this category. Boats used in this method range from 30' to 80'. Sea bottom tilling in the intertidal areas can be accomplished with conventional tractor type tillers adapted to soft bottom conditions. In most cases, artificial seeding follows tilling operations.

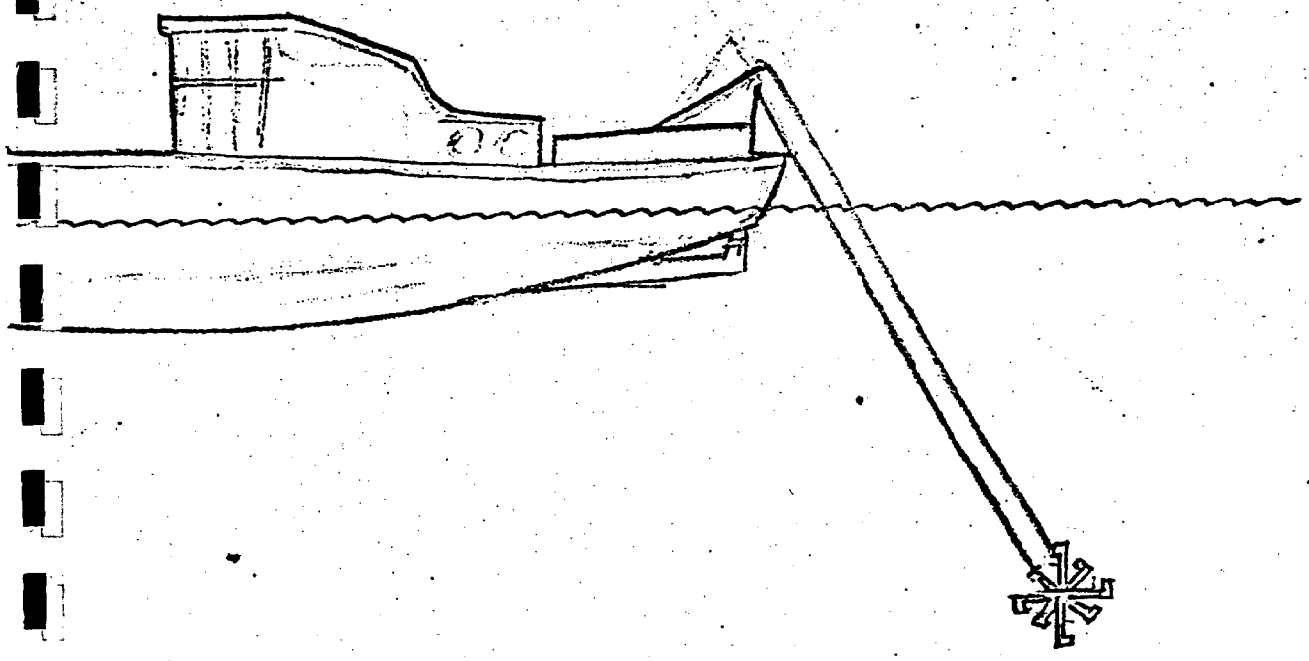
17. BEDROCK EXPLOSION

Species: Abalone, Algae, Scallops

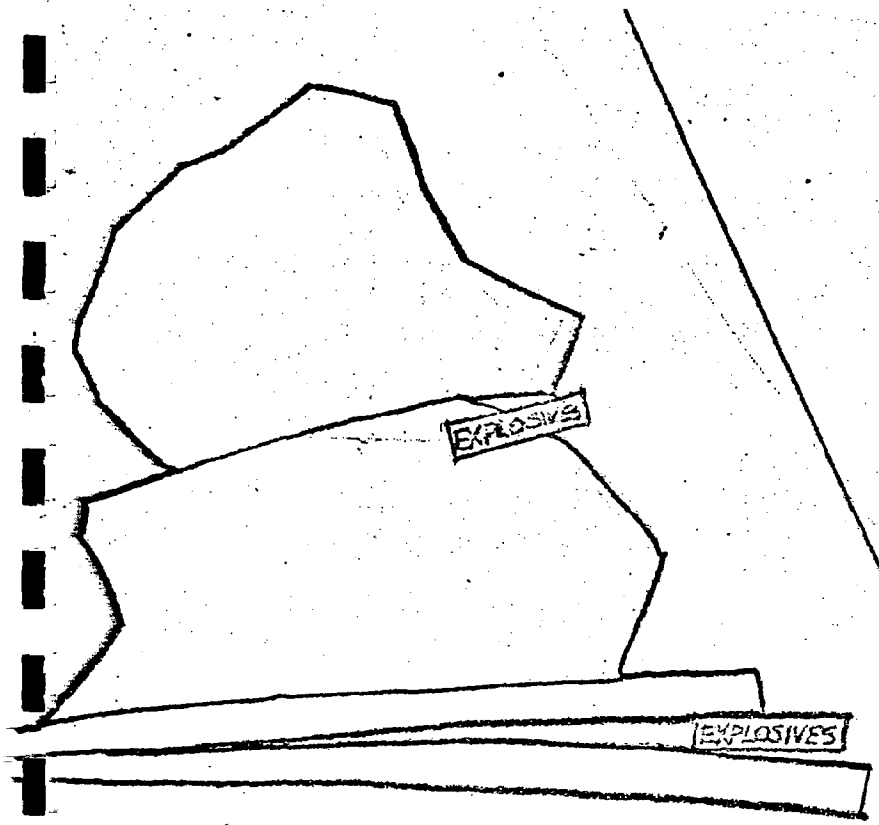
This method entails the fracturing of large masses of solid rock by explosive devices. Although somewhat extreme this technique yields a bottom surface similar to artificial reefs and subtidal formations. By breaking up large masses of rock into smaller fragments, the surface area is greatly increased for attachment,



INTERTIDAL SEA-BOTTOM TILLING



SUBTIDAL SEA-BOTTOM TILLING

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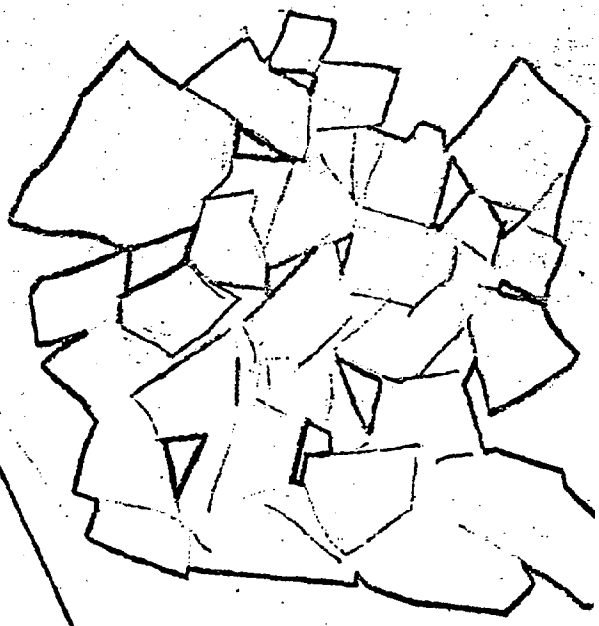

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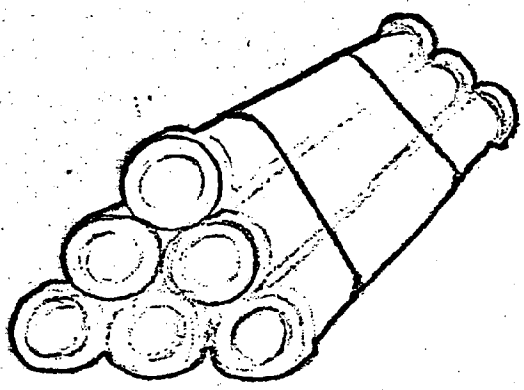
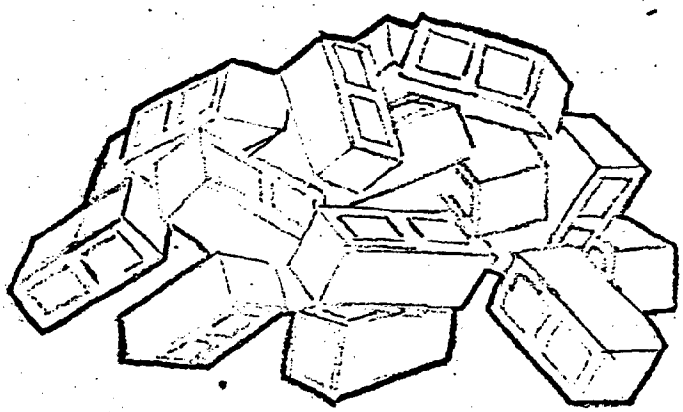




SUB-TIDAL & INTERTIDAL FORMATION

CLAY PIPES & CEMENT BLOCKS

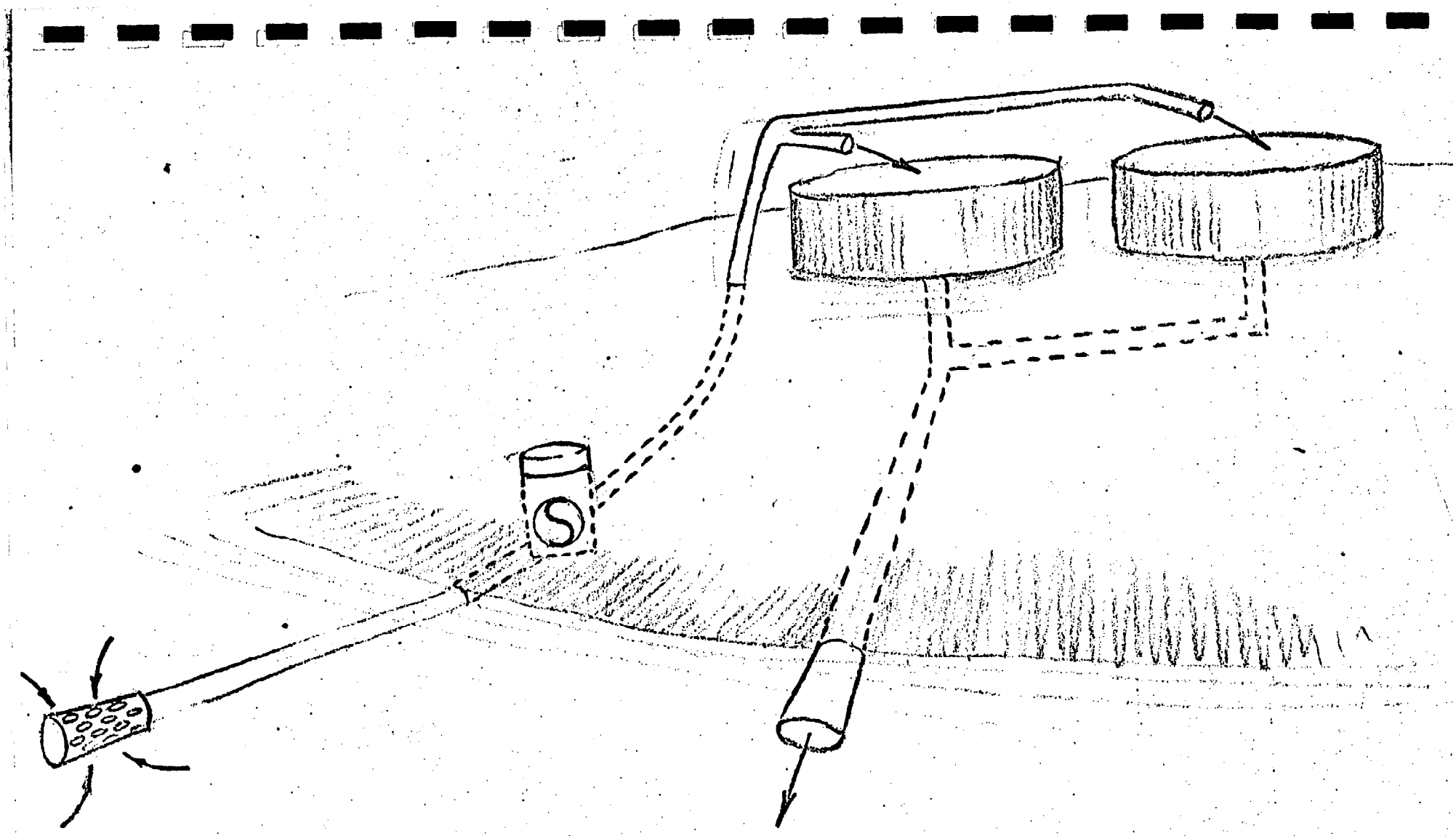
protective areas, and/or increasing productivity of the area. Rock from adjacent cliffs or underwater can be utilized (zones 1, 2, or 3.)

18. TANKS OR PONDS - All Species

Tanks or ponds are land-based operations, requiring their water supply to be pumped from the marine environment. The tank may range from several feet in diameter to more than sixty feet. They can be constructed of concrete, fiberglass, steel, wood, or plastic. They range from less than a foot high to more than forty feet. Ponds are either dug out, or created by placement of berms. Ponds are often lined with an impervious material made of rubber, plastic, or lined with clay. Water supply lines in the marine environment are oversized because of fouling problems, and are oftennconstructed of concrete-lined steel, asbestos, or plastic. The intake structure is located in water depths of suitable quality, temperature, and salinity. Location of tanks or ponds should be close to the shoreline with elevations above man high water not exceeding fifty feet; otherwise, pumping costs become prohibitive. This method is conducted in zone 1.

Species Applicable to Rearing Methods

The species/groups identified in section 2 are compatible with a variety of rearing methods (see Table 7). The method selected by an aquaculturist will be determined from a variety of criteria that is based upon economics, jurisdictional controls, geographical, and water quality conditions. One of the criteria for choosing a particular method of rearing will be the compatibility of one rearing method to another in a given body of water whether it be adjacent to, on top of, or below an existing aquaculture site. A matrix is provided in Table 8 which indicates the degree of compatibility of any given combination of rearing methods. The degree of compatibility is considered for an existing method and a proposed method as distinguished from two methods that may be combined to rear a particular species on one proposa Many of the rearing methods may be employed simultaneously as the best approach for a particular application, e.g. intertidal and subtidal restoration and subtidal formation and release into the natural environ-




TANKS OR PONDS

ment for the species/group abalone.

TABLE 7. SPECIES APPLICABLE TO REARING METHODS

| | Algae (Marine) | Abalone | Baitfish | Baitworms | Barnacles | Clams | Cod | Crab | Flatfish | Lobster | Mussels | Octopus | Oysters | Rockfish | Salmon | Sea Cucumbers | Sea Perch | Scallops | Shrimp | Snails | Trout | Urchins |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| INTERITDAL & SUB- | | | | | | | | | | | | | | | | | | | | | | |
| TIDAL RESTORATION | X | X | | | X | X | | | | | X | | X | | | | | X | | X | | X |
| RELEASE INTO NAT- | | | | | | | | | | | | | | | | | | | | | | |
| URAL ENVIRONMENT | | X | | X | X | X | X | X | X | X | | X | X | X | X | | | X | X | | X | X |
| NATURAL BEDS | | X | | X | | X | | | | | X | | X | | | | | X | | X | | |
| FLOATING CAGES | X | X | X | | X | X | X | X | X | X | | X | X | X | X | | X | X | X | X | X | X |
| SUBMERGED CAGES | X | X | X | | X | X | X | X | X | X | | X | X | X | X | X | X | X | X | X | X | X |
| RAFTS | X | | | | X | | | | | | X | | X | | | | | X | | | | |
| PILING | | | | | | | | | | | X | | X | | | | | X | | | | |
| LONG LINE | | | | | X | | | | | | X | | X | | | | | X | | | | |
| BOTTOM SUPPORTED | | | | | | | | | | | | | | | | | | | | | | |
| SURFACE PLATFORM | X | X | X | | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X |
| AUTOMATIC FEEDERS | | | | | | | | | | | | | | | | | | | | | | |
| WITH SOUND | | | | | | | X | | | | | | | X | X | | X | | | | X | |
| SOIL RELOCATION | | | | X | | X | | | | | | | X | | | | | X | | | | |
| INTERTIDAL FORMATIONS | | | | | X | X | | | | | X | | X | | | | | | | X | | |
| SUBTIDAL FORMATIONS | X | X | | | X | | | | | | | X | | | | | | | | X | | X |
| ARTIFICIAL REEFS | | X | | | X | | X | X | | X | | X | | X | X | | X | X | | X | X | X |
| DIKING | X | X | X | X | X | X | X | X | X | X | X | | X | X | X | X | X | X | X | X | X | |
| SEA BOTTOM TILLING | | | | X | | X | | | | | X | | X | | | | | | | | | |
| BEDROCK EXPLOSION | X | X | | | X | | | | | | | X | | | | | X | | | X | | X |
| TANKS AND PONDS | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X |

## IV. NATURAL RESOURCE CHARACTERISTICS

Determination of suitable sites for aquaculture is conducted by locating a body of water that fits within the ranges acceptable to the species of concern for a variety of key parameters. Some species can withstand being exposed to environmental extremes for short periods of time without apparent stress. The risk of crop damage is increased when environmental stress is encountered. Each aquaculture farmer must assess these risks when choosing a site with a given set of parameters. The following set of maps of key parameters are crucial to the success of a commercial venture. There are other biological and physical constituents of the marine environment that can only be obtained through sampling at the site under consideration. Evey the key parameters that have been mapped out are based upon review of existing data bases and must be verified for each specific site. Temperature, salinity, dissolved oxygen, water currents, bottom type, and wind fetch are mapped for determination of those sites with potential for commercial aquaculture based upon natural conditions.

Information was obtained from the Washington Marine Atlas by DNR, the Atlas of Physical and Chemical Properties of Puget Sound and its Approaches by Sea Grant, Tide Prints by Sea Grant, a Marine Water Quality Compendium for Washington State by WDF, the Tidal Current Charts of Puget Sound by NOAA and the USCGS Nautical Charts.

## V. AQUACULTURE POTENTIAL FOR SELECTED SPECIES

The development of potential aquaculture sites based upon natural factors followed a process which incorporated the information developed in Sections II - IV. It was determined that one map for each of the species selected as having high potential would be prepared with the exception of salmon and trout which have essentially the same requirements. All methods of rearing applicable for that species-group are indicated on the map which corresponds to Table . The specific requirements of each species as mapped in Section IV were applied to the natural conditions of Island County and adjacent waters from which the following set of maps were developed. These maps provide the potential aquaculture sites from a broad overview based upon existing sites and do not take into account specific peculiarities that must be determined by field inspections from the aquaculture applicant. It may be argued that some areas not considered as good potential for commercial aquaculture could be developed as such. This is a debate that is based upon economic principles such as the aforementioned risks assumed by the aquaculturist. For example, an applicant may request to locate rafts in an area that is not mapped as having good potential because of the extreme wind conditions expected. However, if the raft design demonstrates the capability to withstand these conditions then the probability of a successful operation is high from the technological standpoint. Whether or not it is economically feasible, is for the aquaculture applicant to determine.

As new species are identified as having commercial aquaculture potential maps indicating the areas of rearing can be developed which incorporates the existing natural conditions and the requirements of the species for successful rearing.

## VI. ENVIRONMENTAL ASSESSMENT

The environmental analysis contained in this section discusses the effects of each aquaculture method described in Chapter III. The "List of Elements of the Environment" is from W.A.C. 197-10-444 in the State Environmental Policy Act (SEPA) Guidelines in order to assure comprehensiveness and facilitate review consistent with State procedures.

Because locational factors and the specific design of each proposal are so important in determining the degree of impact, it is impossible to assess in detail the ramifications of a specific aquaculture operation in this report. This analysis is not intended to replace the SEPA environmental review process required for all non-exempt aquaculture projects at time of application. It is intended to be used later in this report as part of the basis for determining the degree of compatibility of aquaculture activities with various land uses in Island County. The analysis is applicable to those areas identified in the study as having the potential, based on natural environmental conditions, for commercial aquaculture activities. It is also to be a guide for local decision makers in reviewing project applications and as an aid in making "threshold determinations" to determine the need for a full Environmental Impact Statement (E.I.S.).

The analysis is geared to potential effects on the upland areas and does not detail the impacts to the technically complex marine microbiotic ecosystem which is both site and project specific. These impacts are discussed generally; however, in the specific instances where this general discussion indicates that substantial impacts will occur, it is recommended that an expanded "checklist" or an Environmental Statement be produced by the applicant in order to detail these ecosystem impacts.

The matrix groups the various aquacultural methods by the general level of sea bottom disturbance. The matrix not only assists in the

comparative analysis of similar methods, but also allows for comparison of dissimilar methods. Mitigative measures are given for each potentially significant impact. These are intended to be a guide for conditioning aquaculture permit applications, as well as part of the rationale used for policy formation by Island County in their Shoreline Master Program.

# KEY TO MATRIX

Eth 1. Construction activities dislodge bottom substrate and cause limited erosion of soils. The effects are short term with the degree of erosion dependant upon the intensity of the operation (number of disturbances per specified period of time in a given area).

Eth 2. The placement of foreign material will overcover the existing soil. This will compact soil layers and disrput bottom sediments. The effect will be ong-term but may or may not change stability characteristics. If done in intertidal zones the washing action of winds and waves may disperse and erode this material more rapidly than in a subtidal area.

Eth 3. This method displaces and churns up the existing soil up to 3 feet deep. The soil is loosened and made less dense by this action. Depending upon the method of tilling utilized and the specifics of the area the soil composition (% of the sediments) may be altered. The extent of soil disruption can be limited to a pattern of trenches or cover contiguous acres. The effect of the latter will be more far reaching in terms of changes to the areas overall soil characteristics.

Eth 4. This method will effect the land form of the sea bottom but will not be visible. The change is usually minor with little adverse effect.

Eth 5. This method will effect the land form of the sea bottom but may not be visible. The degree of change can be quite dramatic but usually over a limited area.

Eth 6. This method will effect the land form of a limited area to a significant degree. Berms visible at high tide will alter the landscape. The form is usually linear and can vary greatly in length and width.

Eth 7. If any unique geological or physical features do exist this method could completely destroy or overcover it. Depending upon the nature of the feature, secondary effects could result in terms of increased instability or erosion.

Eth 8. Increased erosion of the earth modification will result immediately after installation. Wind and weather conditions as well as specific locational factors will pay an important role in determining the extent and severity of this impact.

Eth 9. This method may cause changes in the deposition or corosion of surface material on adjacent beaches but usually to a minor extent. Effects will be most notable immediately after installation and would soon diminish. Wind, ewather and locational criteria will be the determining factors.

Eth 10. This method has been known to cause significant changes in the deposition or corosion of surface material on adjacent beaches. When done in littoral drift zones and exposed to extensive wave action the effect can cause the loss or gain of shoreline and increased accretion and avulsion. Wind, wave, weather and locational factors are critical in determining the extent of the effect

Eth 11. Some potential disruption in geologic substructure due to foundatio and footing installation of buildings. The amount of disruption will depend upon the scale of the facility. No significant effect to the geologic structural system of an area would result.

Eth 12. Soil excavations for facilities installation will be required. The amount of material moved could be substantial. Soil modification could effect stability and bearing capacity however, on-site charateristics will be different from area to area.

Eth 13. Pond installation will cause greater disruption to both soils and geology. Again a site by site evaulation will be required to detail the extent of the change.

Eth 14. Land form changes to upland areas can be substantial depending upon the extent of the operation. Pond construction will create depressions and possibly earth mounds. The height and depth of these will vary and be critical in evaluating the degree of topographical impact on the surrounding area.

Eth 15. Minor topographical changes will result from the installation of this method.

Eth 16. The potential for increased accretion or avulsion will be present especially if situated in areas of steep bluffs or with unsuitable soil characteristics.

AQ 1. Potential for objectionable odors during the rearing period if supplemental feeding is done. The duration and intensity of the odor depends upon amount of feeding to be done and weather conditic at the site. The scent is that of decaying fish.

AQ 2. Related boating activity releases petrochemical fume odors mainly in the immediate vicinity of the operation.

AQ 3. Some degradation in air quality can be expected during installatio Increased dust and debris will be evident as the material is installed. The effect is short-term and affects a limited area.

AQ 4. If clean-up operation includes heavy machinery for log or boulder removal some additional petrochemicals will be released into the air. Additional dust may also be noticable in intertidal zones.

AQ 5. Significant short-term air quality degradation can be expected. Smoke, ash and debris can be expected if done in upland zones. The duration of the affect is usually short.

WQ 1. Installation may result in floating debris and minor petrochemical residues caused by necessary boat activities. This minor effect is visual and results in no long term degradation of water quality.

WQ 2. If supplemental feeding is done, organic material will be concentrated in the immediate surrounding area. In enclosed areas with minimal flusing activities the build up of this material will degrade water quality to where odor and chemical content, and control of culture rearing parameters could present problems.

WQ 3. Since minimal substrate disturbance occurs with this method, no turbidity is caused during the seeding or harvesting periods.

WQ 4. Required soil disruption during installation will result in increased turbidity. In zones where the bottom substrate consists of a soft silty bottom the amount of turbidity could be substantia The effect is however temporary and is not the direct result of either seeding or harvesting activities.

WQ 5. Some alternation in water movement will result. The immediate effect will be over a limited area, however wave action and currer flow could cause secondary effects (see Eth 10).

WQ 6. Depending upon the material used to enhance the sea bottom ecology for rearing, some leaching may occur for a period of time. Certa materials can give off petrochemicals, asbestos and other potentia toxic chemicals. Oxygen content may be effect but only to a limited extent. No effect on water temperature is predicted.

WQ 7. Mechanical harvesting activities can cause silt plumes in the immediate vicinity. The width of these plumes can be 10 to 25 yards wide and run up to 75 yards in length at the surface. Determining factors will be wave and current action as well as substrate composition.

WQ 8. Empounded areas could differ in the amount of water they previously contained. Dredging, filling or pumping could cause the deviation.

WQ 9. In some instances portions of creek flows and bays are used in this method. This diversion may present some flow problems for up channel water users. The quantity of water required in relationshop to the entire flow of creek or inlet will be critical areas for further evaluation.

WQ 10. Water used for washing, etc. and then released back into the adjacent water body could contain different suspended elements. In most cases these substances are non-toxic and quickly reabsorbed by the ecosystem.

WQ 11. This facility will require some impervious surfaces which will alter the absorption and runoff rates on the site. Little effect will be felt on adjacent properties if installed and engineered properly.

WQ 12. In some instances this facility utilizes groundwater as its primary water supply. The quantity of water required in relationship to the entire supply in the water table as well as the requirements of other property owners in the drainage basin will be critical areas for further evaulation.

Fl 1. Flora on the sea bottom is disturbed to a minor extent because of anchor or footing placement. Vegetation will be able to re-assert itself in a short time. No long-term effects will result.

Fl 2. The potential for significant disruption of any unique flora species which may be present is minimal.

Fl 3. Flora on the sea bottom is significantly disturbed by this method. In most cases it is lost for a period of time until new plants are able to revegetate the covered zone. It is necessary to keep the vegetation content at a low level or avoid heavily vegetated zones for most harvesting techniques.

Fl 4. Certain unique species, or species of special concern, could be affected by this method. Eelgrass, marine algae and kelp provide habitats for many sea organisms. Disruption of these environments, if done to extensively, could affect the larger ecosystem. These flora species, themselves, thrive within a certain range of water quality parameters and in special zones. This aquaculture technique could alter those parameters. Confirmation of the presence and extent of these plants is necessary for a complete analysis.

Fl 5. These structures can provide a barrier or corridor. The size and extent of the structure as well as the species affected are critical factors in evaluating the degree and significance of the impact

Fl 6. A number of terrestrial species will be reduced during the construction period. The significance of this loss is related to site characteristics and the presence of any unique species. The effec is generally minimal.

Fn 1. A significant increase in the cultured specie will result if the method is successful. In certain instances the specie will be newly introduced into an area. Because the specie is restricted to a confined area no diminishment of other organisms will result.

Fn 2. Supplemental feeding could attract other organisms to the aquaculture zone. No adverse effects from this has been documented.

Fn 3. No reduction of the numbers of any unique, rare or endangered specie will result from this method even if present in the aquaculture zone.

Fn 4. Potential effects on other species of subtidal marine life are difficult to quantify. Many benthic organisms will be overcovered or destroyed during the installation phases of this method, however, many should reestablish themselves as the area is made suitable for aquaculture. Harvesting mechanically dislodges and displaces those organisms which attach themselves to the substrate. Some less mobile species will perish as a result of being buried too deep or exposed to predators on the surface. Some larger organisms (crab, sea urchins, shrimp, etc.) can survive harvesting, but must adapt to the modified habitat.

Fn 5. This method could potentially reduce the numbers of rare or endangered species. The presence of these species and the degree of impact can only be determined by a site by site evaluation.

Fn 6. A number of terrestrial species will be reduced during the construction period. The significance of this loss is related to site characteristics and the presence of any unique species. The effect is generally minimal.

Fn 7. Some disruption of terrestrial habitats will be altered due to

construction activities. The effects could be significant depending upon site location and extent of the operation.

Ns 1. Installation noise will be evident mainly consisting of boat noises and assembly of elements. If substantial construction is done on-site (as opposed to floating pre-constructed elements into place) noise levels can range up to 65-70 dba. These effects will be short term and unrelated to actual rearing or harvesting activities.

Ns 2. Operational noises will be those of boat traffic as monitoring, rearing, and harvesting is done. Levels up to 60 dba can be expected.

Ns 3. Pile driving noises will be present during the construction period. Levels up to 105 dba for short periods of time could result if left unmitigated.

Ns 4. Installation noises will be evident mainly consisting of boat noises and dumping/stockpiling equipment. Levels can range up to 90 dba. These effects will be short term and unrelated to actual rearing or harvesting activities.

Ns 5. Bottom dredging equipment could also be used in this method. Levels can range up to 55 dba if done completely under water. Noise levels will rise if uplands or shoreland dredging is done.

Ns 6. Significant short-term noise levels could result from this technique. Levels up to 140 dba for brief periods are possible. Muffling devices are however usually standard with this method.

Ns 7. Construction activities will cause short term levels of up to 70 dba.

Ns 8. Operational noise levels will be caused by occasional light-duty

trucks supplying material to the facility. Shore based pumping can also emit a low level noise.

LG 1. Navigational lights may be required if the system is spread over a large area and near navigable water ways.

LG 2. If night operations are anticipated, running lights from service craft and spot lights will produce uncharacteristic light and glare

LG 3. Standard security lights may also be required for facility operatic

NR 1. The species being cultured can be considered a renewable natural resource. This aquaculture method will increase its rate of use. The purpose of aquaculture is, however, to replenish the stocks depleted by sea farming.

Tr 1. Waterborne traffic could be affected is this system is extensive and done in navigable waters. The operational boat requirements will add to the number of boats in the area. Waterborne circulation patterns of other boats, not related to the aquaculture syste could be altered. Critical factors include the width and depth of the total navigable area as well as the extent of the existing boating activity and aquaculture activity.

Tr 2. Truck traffic to haul the substrate materials could be used in intertidal zones. The number of trips generated will depend upon the extent of the substrate enhancement project.

Tr 3. Road access to certain beach areas could present potential hazards especially in high bank areas.

Tr 4. Additional truck and car traffic will be generated by this facilit

The trips will be limited to employees and service deliveries. The extent of the effect will be dependant upon the scale of the operation.

TR 5. New employee parking will be required.

As 1. Structures will be visible protruding up to 3 ft out of the water. This could change the visual character of an area that is relatively enclosed, such as a small bay or inlet, if the activity is extensive (over 10 structures). The visual effect will be diminished as the waterbody becomes larger and the activity is reduced in scale. The concentration of these structures and proximity to the shoreline are also factors in a causing a noticable change in character.

As 2. With this system only marker bouys are visible. No significant change in visual character will result.

As 3. Service boats will be seen trolling the area. In large systems this activity can become extensive expecially if supplemental feeding is required on a regular basis. The average size of these boats will be between 12 to 20 feet although some could be as large as 60'. The frequency and duration of stay of these boats in any one area will also cause perceived visual effects from the adjacent shoreline.

As 4. Structures will be visible protruding from 3 to 30 feet out of the water. This will change the visual character of most zones except those areas with extensive existing manmade structures. Pilings without other elements attached to them will resemble old abandoned pier supports if weathered material is used and the activity

is not overly extensive. The degree of the perceived visual impact will depend upon the character of the adjacent shoreline and intensity of the operation.

As 5. Very little visual evidence of change will occur after the installation phase. The area should reassume a "natural" character.

As 6. Earth structures will be visible which could be considered out of character with the surrounding area. Height and scale of these structures will determine the overall visual impact.

As 7. If done in subtidal waters the visual effect of the operation will vary depending upon the depth.

Rc 1. Recreational boating activities could be affected by this system depending upon the location of the aquaculture site and its intensity. Bays and inlets are most sensitive especially in the vicinity of marinas and recrational public boat launching ramps.

ArH 1. This system does not significantly disturb the sea bottom, therefore even if there are significant archeological or historical resources present no effects will result.

ArH 2. There is very little documentation identifying potential resources in submerged marine lands in Washington State. This particular method requires very little disruption of the sea bottom so the possibility of disrupting a significant find is minimal.

ArH 3. There is very little documentation identifying potential resources in submerged marine lands in Washington State. This method requires a great deal of sea bottom disturbance so the possibility

of disrupting a significant find is present. A careful survey on a case by case basis can provide more information on the effect of disturbing a critical zone.

ArH 4. There is a potential for disruption of an upland site of significance. Appropriate state agencies should be contacted to check documented finds.

Ec 1. Economic gains from aquaculture systems include:

1. Economic gains to Washington's shellfish industry.
2. Generation of revenues to the State from licenses, leases and royalties.
3. Local and State employment for individuals involved in the industry.

The extent of the cost vs. benefit to local jurisdictions can only be made on a case by case evaluation of a specific proposal.

Ps 1. Some additional services will be required but not enough to significantly affect existing systems in most cases.

## MITIGATIVE MEASURES KEY

M 1. Reduce the aquaculture operation to a smaller scale.

M 2. In areas containing a very fine silty sea bottom substrate, restrict or severely limit the scale of operation.

M 3. Spread out construction/installation phase to reduce its effects at any one time. (Reduce the amount of disturbance in a given period of time.)

M 4. Conduct a survey of the proposed site prior to beginning the aquaculture activity. If unique features are discovered and deemed worth preserving either limit or prohibit the operation in this area.

M 5. Restrict the construction of any "groin-like" structures in littoral drift zones. The possibility for any potential secondary effects, such as increased instability or erosion either on-site or in adjacent areas, should be considered.

M 6. Allow this oepration only where the required soil disturbance will not significantly alter the earth's stability or bearing capacity.

M 7. Restrict the amount of supplemental feeding.

M 8. Change to an alternate feed type with less offensive odor characteristics.

M 9. Limit boat operations to staying a lesser amount of time in the area around the aquaculture project.

M 10. Reduce or limit potentially odorous operations which occur close in to "lee" shores.

M 11. A maintenance schedule shall be made a part of the project which will prescribe frequent cleaning of the project area in order to create a neat operation and reduce objectionable odors.

M 12. Require dust control by wetting and/or the use of chemical suppressants. If necessary, require the daily cleaning of mud and dust from impermeable surfaces.

M 13. Require use of steel or fiber nets in conjunction with this operation to reduce the amount of suspended particulates and objectionable fumes.

M 14. Restrict this operation to areas with good flushing characteristics.

M 15. Analyze how the wind and wave action in the specific area could spread any adverse effects to adjacent areas; alter project elements to minimize the effect. (M 1. and M 2.)

M 16. Utilize non-toxic materials with this method.

M 17. If fresh water is to be utilized, a determination of the water utilization requirements of upland property owners should be made based on land use designations and intensities. Water requirements of the operation should also be specified, and the two balanced to provide an equitable distribution and utilization.

M 18. Storm water control systems with oil separators and catch basins should be designed into this system. Also, every effort should be made to reduce the amount of paved surfaces.

M 19. Concentrate the major elements of the operation and space the rearing structures. If cultivating the sea bed is proposed, provide a non-disruption buffer zone (25-100') between each bed.

M 20. Conduct a survey of the proposed site prior to beginning the aquaculture activity. If species of special concern are discovered in significant quantities either limit or prohibit the operation in this area.

M 21. Evaluate alternative rearing or harvesting method to cultivate the proposed species. Other methods may accomodate the intent of the proposal with less environmental disruption.

M 22. Leave buffers and some undisturbed areas on the site. Keep vegetation loss to a minimum.

M 23. Require all equipment to be muffled to the maximum extent possible. Limit all activities to certain hours (dawn to dusk or working hours of 7 AM - 6 PM).

M 24. Restrict operations on the weekends.

M 25. Prohibit night operations.

M 26. Prohibit rotating high intensity beacons or strobe lights.

M 27. Require a special storage area to incorporate additional protective measures.

M 28. Prohibit this method from established shipping lanes.

M 29. Limit the number of service craft associated with this method.

M 30. Prohibit land vehicles from intertidal zones.

M 31. Improve the roads and access system to accomodate projected increases.

M 32. Use natural materials and colors for structural elements of this method.

M 33. Restrict the number of structures per acre and cluster in small zones.

M 34. Severely restrict or prohibit this method in narrow inland areas with local views.

M 35. Keep the number of marker buoys to a minimum which would also be safe for navigational purposes.

M 36. Restrict the intensity of this system off shores with developed low banks. High bank areas can provide some visual barriers from upland uses.

M 37. The visual offensiveness of these boats is a subjective judgment and will very with the individual. Factors which enter into this judgment can include associated odor, noise duration in an area, field of vision, and environmental setting as well as boat size, style, color, and state of repair. Because of their functional aspects, modifications to the boats themselves to make them more aesthetically pleasing to more people is somewhat limited. The aquaculture industry should, however, further investigate to determine any positive changes. The fact that very few objections by upland property owners are raised over pleasure boats and the state ferries indicate that a greater degree of acceptability can be reached.

M 38. The height of these structures should be kept to a minimum. Landscape and hydroseed the new earth berm.

## VII LAND/MARINE USE COMPATIBILITY WITH AQUACULTURAL REARING METHODS

Conflicts between activities in the coastal zone areas of our state are increasing as additional uses are proposed for the shoreline areas. Island County, with its 221 miles of shoreline, was somewhat insulated from this problem in the past because of its ample shoreline and small population. Commitments of the aquatic resources for the marine-based uses of aquaculture, shipping, log-rafting, sport and commercial fishing, and other water oriented economic uses are being demanded increasingly. At the same time, shoreline residents are also placing increasing demands for recreational and aesthetic uses, which often preclude other uses. These issues have erupted into public debates over the proper use for shorelines, and have made the issuance of any permits for water-oriented use controversial and lengthy.

Marine-oriented uses generally fall in three categories: water-dependent uses, e.g. moorage facilities, aquaculture, aquatic ecological reserves; water-oriented uses, e.g. fish processing, warehouse/storage for bulk products; and, non-water oriented uses, i.e. all other uses that can operate in other locations besides the waterfront. Conflicts can arise based on requirements for natural resources, on factors rising from various uses, or on perceived impacts because of aesthetic or recreational uses. Although aquaculture is a "water-dependent" use, it must not be automatically assumed that it has a guaranteed priority over other types of land and marine uses. Island County has emphasized throughout its planning processes a commitment to balanced, orderly growth which preserves the existing rural and open character, maximizes the productivity of its natural resources, and ensures the maintenance of a high level of environmental quality. Goals and Policies in both the Shoreline Management Master Program and the Comprehensive Plan -- Planning Policy (Phase II) implicitly direct development in order to create a multiple-use situation throughout Island County. Through the Plan and Program development actions are guided to certain areas; however, as in all planning processes

the mix and intensity of uses cannot be specified in detail. This allows both for diversity of uses as well as for freedom of choice in pursuing locations for land uses.

However, this freedom of choice also causes conflicts. Although many uses of property are compatible, or at least are perceived as being compatible by the property owners, other types of activities cause conflicts. Many owners have expectations that the "ambience" that they acquired when they purchased the land will always remain as it was; any change to this environment causes the issue of compatibility to be raised.

Since compatibility is a subjective term, what one person feels is compatible will cause a different reaction from others. In many cases, issues of compatibility are resolved privately and easily. However, there are other instances where these issues cannot be resolved between the parties involved; much of the time these conflicts must be resolved through the governmental approval process. Answers to the questions raised regarding impacts must be provided within the framework of the process; this study will combine the analysis of these issues with recommendations for resolving those problems through conditions placed on allowable uses.

Compatibility is a reflection of the changes wrought by an adjacent use. The most common way to address the issue of compatibility is to determine the impacts of the new use on the existing use, determine the real meaning of those impacts (in objective terms if possible), and assess how they affect the neighboring property. Many impacts are able to be measured objectively, e.g. change in noise level, additional amounts of traffic, change in power usage, amount of soil covered with impervious surface; other impacts are more subjective, or are "perceived impacts". View, retention of vegetation, recreational potential, and other non-quantifiable subjects fall into this category. Although the objective impacts are more easily measured, in many cases the "perceived impacts" are the more important to a resident.

This chapter will discuss in detail the issue of compatibility between aquaculture uses and other upland uses. Since a large variety of factors provide the answer to whether uses are compatible or not, and since there are varying degrees of compatibility, the approach taken is to place the factors in a matrix. This allows comparisons between aquaculture types and a variety of other uses, activities and areas which are nearby.

There are two types of factors to be used in determining compatibility. The objective factors (generally quantifiable ones) have been addressed in the previous chapter dealing with the Environmental Assessment. This chapter will address those issues which are "qualitative" issues; is a proposed aquacultural use "in character" with a neighborhood or community? Is a proposed aquacultural project a "blight" on the area? Can the "amenities" that were purchased with a lot or parcel of land still be "enjoyed" if an aquacultural project is carried out nearby? These are the types of questions that are raised by the issue of compatibility.

In the process of resolving these very difficult issues, the Planning Commission and County Commissioners often hear conflicting testimony, study a sometimes unclear fact pattern, and rely on the Planning Staff to provide them with a recommendation for action. The methodology proposed assists both the technical staff and the decision-makers in identifying the most important factors to evaluate. The information which is referenced in this study identifies the major environmental impacts in the Environmental Assessment, the compatibility between certain types of aquaculture and water and land uses, and the relationship that aquacultural methods have to each other.

Each of the steps in the evaluation system fit into their proper place in the application approval process. The natural resource based maps which indicate the locations that are most suited to different aquacultural species and methods. This will enable Island County to advise applicants and potential applicants where different

aquaculture species can occur with the best results based on natural resource factors. The next step entails an environmental analysis of the aquacultural method. The environmental assessment can be used in the pre-application phase to enable the potential aquaculturist to compare the impacts of various methods, and learn which of the potential impacts are most serious. Following submittal, the environmental assessment can be used by the staff to determine any significant impacts, ascertain the mitigative measures which can be used to lessen the impacts, and determine which are major negative impacts which cannot be mitigated. Already at this stage, the applicant should be aware of whether his/her proposal has a realistic chance of success.

The "Land/Marine Use Compatibility Matrix" provides the next review. This also can be used prior to application submission to inform the aquaculturist what conflicts might be expected in a specific location. Island County will utilize this information to identify the major issues and actors, to determine which conditions will apply to the project to lessen its negative features, and to advise the applicant what he/she can expect through the hearing process. At an early stage in the review process this information can be used to revise the application or to indicate to the aquaculturist what the likelihood is of receiving an approval. At this time, the staff can also advise the applicant of the conditions which may likely be placed on the project.

The final stage is to recommend the approval or denial of the project. This will be based on the information generated through all of the above steps. If the project is found to have significant environmental impacts which cannot be mitigated, to be incompatible with water or land uses, incompatible with existing aquacultural uses, or to not be compatible with the goals, policies, or designations of the Shoreline Management Program, it is likely a denial will result. If this evaluation shows that there are problems in one or more of these areas, but that these can be resolved through conditions imposed on the project or through a revision of the project, approval based on these conditions is likely. In instances where no significant environmental

problems result, where the proposal is compatible with aquacultural, water, and land uses, and meets the intent of the Shoreline Management Program, the applicant can be assured of a very high probability of approval.

What factors were analyzed to determine the compatibility of aquaculture with marine and land uses? The first step is to list the various alternative methods of doing aquaculture around Island County. These were arrived at and described in Chapter 3 - Rearing Methods for Aquaculture in Island County. This will refer the reader to that portion of the study to gain an understanding of how the 18 methods which are being analyzed were arrived, what species are raised using each method, and a description of each method.

In order to arrive at a compatibility rating in an orderly and meaningful fashion, a matrix system is utilized. This system has two variables which are being compared - the above-mentioned aquacultural methods, and the water and upland uses and ownership factors which comprise the "compatibility factors". The aquacultural methods form the rows, and the compatibility elements form the columns -- this enables the reader to read across the matrix to determine the varying levels of compatibility for any given aquacultural method. Additionally by reading down the columns, a comparison of different aquaculture methods can be arrived at. As potential aquaculturist with a specific location in mind can evaluate the different methods for their compatibility with that location. This location analysis will allow a basic understanding of what issues might be involved during the approval process; however, this will only function as a general guide. The applicant will need to work with land owners, the business community, shipping and boating interests, and general citizens in order to determine the best solutions fo the siting of aquaculture projects.

Any variable along the list of aquacultural methods can be compared with any of the compatibility factors. Compatibility has been measured

ranging from totally Compatible to totally Incompatible. In addition to the two extremes, a Somewhat Compatible and Somewhat Incompatible are also used to provide an intermediate step between the aquaculture method between harmony and conflict. Factors that are judged compatible are where, after analyzing the environmental impacts and the general functional relationship between the two uses, little conflict would generally be expected. Compatibility usually is associated with non-developed areas where aquaculture will not effect large numbers of people who either reside in or use that area. Where aquaculture is compatible with these upland and other water uses, consideration may be given to protect the aquaculture potential by preserving the lands and waters as they now exist. This situation may be particularly true where the natural factors in a specific location provide an excellent base for aquaculture.

Incompatible ratings would occur when the proposed aquaculture method and the upland or water use cause major conflicts. Controversy usually results, and opposition to an aquacultural proposal by upland and other water users will likely occur. An example of incompatibility would be to place an aquaculture operation in the middle of a productive commercial fishing ground; this would not only interfere with the fish habitat, but would also interfere with the fishermen's ability to make their catch. Petroleum pipelines and sewage outfalls are incompatible because of the health hazards resulting from their proximity.

The ratings are designed to be a guide to the decision-maker. They can assist in determining the most important impacts, and leading the decision-maker to the measures which might ameliorate those. The following ratings are used:

Compatible -- These two factors generally function well together. Although minor negative impacts could occur, very few mitigative measures should be necessary to reduce them. Based on this factor, approval of the proposal is likely.

Somewhat Compatible -- The two factors generally function with only a minor amount of conflict. Some minor negative impacts

are expected; conditions of the approval should be expected in order to reduce the impacts. Approval of the proposal is possible.

Somewhat Incompatible -- These two factors generally cause conflicts when they occur in the same area. Negative impacts to one or both would be expected to occur; major mitigative measures are likely to be needed to minimize the impacts. The proposal could be revised, or conditions could be applied prior to approval being granted.

Incompatible -- These two factors normally cannot occur together in the same area because of the resulting conflicts. Either functional conflicts or major negative impacts occur; these impacts are difficult to reduce by applying mitigative measures. It is most likely that the project will be revised based on this factor, or that major conditions will be applied to alter the situation before any approval could be expected.

## Compatibility Factors

These factors are divided into three general categories -- Water Related Uses, Upland Uses, and Ownership. Each of these general categories is broken down into specific uses and situations which occur. Only those factors which are actually occurring in the same location of the aquacultural proposal are used; particularly in the case of Upland Uses, it would be expected that only those uses in close proximity or having a directly affected view would be analyzed.

There are 13 Water Related Uses which have been identified. These are uses which typically occur or can be expected to occur at various intensity and frequency around Island County. Different characteristics, as well as requirements for their continued enjoyment, exist for each one. Some of these uses are very compatible with certain types of aquaculture; others cannot exist in the same waters. Trade-offs must be made between these uses and aquaculture; in some instances guidance can be derived from natural factors; sometimes the natural resource

factors favor aquaculture, other times other water uses.

Upland Uses are generally thought of as the existing activities that are on-going. However, the potential long-range land uses as indicated by the Comprehensive Plan, and the allowed uses under the Zoning Code and Shoreline Master Program must also be considered. These land uses are divided into 7 categories, with one of them "Residential", being further subdivided into 6 more categories. These uses generally fit the existing and expected uses in the County.

The third area is Ownership -- this factor describes the owner of the uplands and the tidelands above the project. Ownership falls into three categories -- the applicant, some other private party, or the public.

Each of these 31 categories has been rated on the scale from Compatible to Incompatible. There are specific criteria which are used to make these evaluations. In the following section, the criteria for each of the compatibility factors is listed. The criteria are listed in order of their importance.

Water Related Uses

Naval Operations

These are areas where the U.S. Navy conducts on-going activities or uses the area for periodic exercises. A high level of marine and/or air-based operations would be expected.

Criteria:

1. Areas where Navy ship activities occur are incompatible with any methods which restrict navigation in any way.
2. Where bomb-run practice occurs and the placing of targets is necessary, aquaculture techniques which interfere with any navigation is incompatible.

Navigation/Anchor Buoys

This factor encompasses the commercial navigation that occurs around

Island County. This includes shipping lanes, tugboat hauling of bulk cargoes, and public transportation in the form of ferry service. Docking, loading, and unloading facilities are an important aspect of this use.

Criteria:

1. Aquaculture is incompatible with those areas which are regularly used for handling, loading, and unloading of industrial and commercial cargo.
2. Shipping and tugboat lanes as defined in the Washington Marine Atlas are incompatible with many of the various forms of aquaculture.

Commercial Fishing

Commercial fishing falls into three categories -- salmon, bottom-fishing, and herring fishing. All three of these classes utilize net fishing as the primary means of collection.

Criteria:

1. Aquacultural methods which do not interfere with boat movements and the use of nets in fishing are compatible with commercial fishing.
2. Any aquacultural project which alters the natural characteristics of the waters so that fish species (of commercial importance) would be driven away is incompatible with the commercial fishing industry.

Sport Fishing

Both salmon and other species are heavily fished for by sport fisherman. The season, time of day, and stage of the tide all have an effect on sport fishing; however, there are locations which are heavily utilized by fisherman.

Criteria:

1. Maps indicating heavy sport fishing areas (both in the Shoreline Management Program and in the Washington Marine Atlas) should be analyzed to determine the possible conflicts with aquaculture methods. Boat access to these areas should not be restricted by aquaculture. Aquaculture methods which restrict

trolling and interfere with fishing lines are not compatible with sport fishing locations.

Recreational Boating

This activity consists of sport, power and sail boating activities. these activities may be concentrated around a particular recreational area, or may be a result of nearby boat launches or marinas.

Criteria:

1. In areas of heavy recreational boat usage, aquaculture methods which interfere with surface navigation and cannot be conditioned to not interfere are classified incompatible.

Moorages/Marinas

A number of moorages/marinas currently exist throughout Island County, most of which are private for the use of residents or club members. These range from small piers and docks with a few spaces to marinas which have upwards of a hundred berths. It can be expected that a great amount of recreational boating will take place in areas surrounding moorages and marinas.

Criteria:

1. Aquacultural methods which interfere with large scale boating by restricting the use of the surface waters should not be allowed.
2. Aquacultural methods which require a large number of tender vessels to be in an area for long periods of time would be deemed to be somewhat incompatible or incompatible with moorages and marinas.

Nearby Boat Launch Facilities

These sites are generally publicly owned and maintained facilities which are used to launch trailered boats. Depending upon their location, the number of boats launched ranges from very few to scores on the highest use day. Many of the same characteristics of recreational boating and moorages and marinas apply to these facilities also.

Criteria:

1. Aquacultural activities which restrict surface navigation are incompatible with boat launch facilities if they restrict access directly in front of the boat launch.

2. Aquacultural methods which cause a hazard to low draft recreational boats which would use public boat launch facilities should be rated incompatible or should be conditioned so that any danger to recreational boaters is minimized.

Recreational Scuba Diving

Recreational scuba diving normally occurs in areas of significant historical interest (locations where shipwrecks or other incidents have occurred), or in areas where there are natural caves or other natural areas which create significant interest. This use is normally indicated by boats and diver marker buoys.

Criteria:

1. Aquacultural methods are incompatible if they interfere with scuba divers access to historical locations.
2. Aquacultural methods which rely on diving for their harvest are incompatible with areas which are heavily used by recreational scuba divers. At the same time, areas which are being used for aquaculture which rely on diving as a harvesting method should be restricted from recreational scuba diving use.

Public Beaches

Public beaches are normally associated with State and/or County Parks. These beaches can be either sand beaches for swimming or rocky/gravelly beaches which are used for the enjoyment of the environment and walking.

Criteria:

1. Any aquacultural method which interferes with swimming or the use of shallow waters off public beaches is incompatible with the public beach use.
2. Aquacultural methods which require placement of soils or other formations within the intertidal areas along public beaches should be restricted.
3. Aquacultural methods which create a high visibility type of structure near the shore of intensely used public beaches are somewhat incompatible or incompatible. Conditions on the aquacultural method which reduce their visibilty may make these methods more compatible.

Environmental Monitoring/Test Areas

These areas are used for educational and research projects. Information gained from these areas is used in order to ensure that the knowledge will be there to determine the best use of the State of Washington's marine lands and waters. The data which is acquired is normally based on a study of a completely natural area.

Criteria:

1. Aquacultural activities should be allowed which do not upset the balance of the natural resources of this area, all other aquacultural activities which cause a change in the local ecosystem are incompatible.

Log Rafting

Log rafting areas are utilized by the timber industry for making rafts, sorting logs for transportation to mills, and overnight storage where the log is not transported to its final destination in one day. Water areas utilized for log storage are usually near mills, in ports or at dumping sites and normally involve short-term storage areas only.

Criteria:

1. Because of their bulk, log rafting and any surface aquacultural methods are incompatible.
2. Because certain areas have the natural resources to support specific aquacultural methods, log rafting may be prohibited in those areas in order to protect the aquacultural industry.

Sewage Outfalls

There are many sewage outfalls, some of which are from municipal treatment plants and generally output a great deal of treated material into the waters; others of which are very small outfalls with a very low output. Discharge in any substantial volumes is generally felt to be a limiting factor to the water quality of the area.

Criteria:

1. Aquacultural methods are incompatible in any waters within 1/4 mile of substantial sewage outfall.

Pipelines and Underwater Utilities

These utilities connect Island County with the mainland to either the east or the west. These utilities could be power or phone connections, or could be one of the proposed oil pipelines. As was stated in the Environmental Impact Statement for the oil pipelines, it is expected that with oil pipelines there will be chronic minor spills and would be some probability of a major oil spill.

Criteria:

1. Aquacultural methods are incompatible in areas surrounding the proposed oil pipelines. Conversely, areas designated as having a high aquacultural potential should not have oil pipelines built in those areas.
2. Aquacultural methods which use mechanical means or which affect the substrata to any large extent are incompatible with underwater pipelines or utilities. Aquacultural methods which do not affect the substrata are generally compatible or somewhat compatible with underwater utilities.

UPLAND USES

Residential Uses

Residential uses are broken into three densities categories and two bank height categories in order to more specifically address the compatibility of aquacultural methods with the residential development that currently exists in Island County. The three density categories are Low, Medium, and High. Low density is defined as one unit per 2½ acres (.4 units per acre) or less. Low density areas are characterized by single-family dwellings on large parcels of land. Medium density in Island County is defined as residential dwelling between one unit per 2½ acres and up to 2 units per acre. This comprises many older plats which were subdivided into 1 acre lots and some of the newer plats which are approximately 2 units per acre. High density is any development over 2 units per acre. These are primarily the newer plats along the shoreline and any shoreline developments which are in the

incorporated areas with sewers. The other category examined is the height of the bank. High bank is defined as any bank over 20 feet high; low bank is any bank lower than 20 feet. Bank height has two characteristics which are examined for this study. The first is the issue of access to the shoreline and to the waters. Low bank generally is characterized by better access and by development which utilizes that access as an amenity; high bank may have access although it is not generally as convenient and is not generally utilized as an amenity to the same extent as a low bank. The second characteristic of bank height is the view/visibility aspect. High bank will generally decrease the impact of the visibility of any aquacultural use because of the larger scale of view. With a low bank situation, the visibility of an aquacultural method is somewhat higher because of the scale of the view as well as the perspective of the view, is somewhat more closely related to the location and height of the aquacultural method.

There are six specific categories of residential use. These are:

Low Density, Low Bank

This land use is characterized by a great deal of open space which may be forested, a meadow, or even used for agricultural or grazing purposes. The use of the land may be linked with the water because of the existing low bank. Undeveloped land usually falls into this category.

Criteria:

1. Areas developed at this level are normally compatible with most forms of aquaculture. These areas may need to be protected if special natural areas highly suitable for aquaculture are seaward of them.
2. Since little development is normally occurring in these areas, the impacts of view, noise, and odor are generally not large; these lands would generally be compatible with aquaculture.

Low Density, High Bank

The land uses of this category are very similar to the low density, low bank. The difference is that the interface between land and water

is characterized by limited access from the land to the water.

Criteria:

1. Areas developed at this level are normally compatible with most forms of aquaculture. These areas may need to be protected if special natural areas highly suitable for aquaculture are seaward of them.
2. Views, noise, and odor would generally affect very few people in this residential category; therefore, these lands are normally compatible with most aquaculture uses.

Medium Density, Low Bank

This land use is comprised of many of the shoreline subdivisions which rim Island County. Many of these subdivision, because of the low bank associated with them, use recreational marine activities an an amenity. These uses are normally characterized by a cleared area providing residential units with views of the water.

Criteria:

1. Because of the views usually associated with this area, aquaculture uses tend to be somewhat incompatible if they can be seen from the upland area.
2. Because of the large number of people upland of the aquaculture use, aquaculture methods which require a large amount of servicing or other activity, or create odors because of concentrations of species or artificial feeding, would be incompatible with this use category.

Medium Density, High Bank

This category describes shoreline developments which cannot have ready access to the water. Most of these developments use as their main amenity the views created by being atop a high bank. These developments usually create a relatively large concentration of people.

Criteria:

1. Large scale aquacultural methods which are highly visible from the bank above would be incompatible or somewhat incompatible.
2. Aquacultural methods which would cause major environmental impacts or cause changes to the marine environment which would create an erosion potential along the high bank area would generally

be incompatible in this area.

High Density, Low Bank

This residential use is characterized by 2 units to the acre development or more along the shoreline. The most recent plats which are developed at 12,500 square feet or older plats which are developed at that level or smaller lots would fit into this high density category. With the low bank providing easy access to the marine environment, it can be expected that these developments will cause a great deal of activity on the beaches and tidelands in front of them.

Criteria:

1. Because of the high intensity of activity expected with this development, aquacultural uses which use tidelands or are close in to shore will be incompatible.
2. Views, noise, and other perceptions of upland residents which make aquaculture distasteful cause most aquacultural methods to be incompatible or somewhat incompatible with this category.

High Density, High Bank

This use category has the same density as the previous one; however, because it sits on a high bank view is somewhat more important than access and use of the tidelands and the beach.

Criteria:

1. Aquacultural methods which are highly visible to large numbers of people in these developments will be incompatible.
2. Aquacultural methods which create a large amount of activity, noise, and have high service requirements for artificial feeding associated with them will be incompatible.

Commercial

This category usually describes retail business or small retail shopping areas. It also would be the classification that community business centers and central business districts would fall. The intensity of use can range from very intense to a very low level of commercial use. Wholesale and other commercial uses also fit into this category.

Criteria:

1. Commercial spaces which are dependent upon view will have visible aquacultural methods classified as somewhat incompatible or incompatible.
2. Other commercial spaces will be rated as incompatible only with those aquacultural uses which directly affect, through either noise or odors, the level of activity that goes on in the commercial space.

Industrial

Industrial areas are those areas where light manufacturing and heavy commercial development will exist in areas which are designed to harmonize with natural surroundings of the local community. In Island County these areas have typically been created in light industrial parks in several locations around the County.

Criteria:

1. Industrial areas which do not create a large amount of run-off or waste which goes directly into the water will be compatible with aquacultural uses.
2. Aquacultural methods which have the least amount of natural system impacts will be deemed compatible; all other aquacultural methods will be somewhat compatible.

Agriculture

Agricultural use areas are those areas which have productive soil and which are currently being used for the raising of crops, grazing, or other agricultural uses.

Criteria:

1. Since aquaculture and agriculture are very similar uses, aquaculture will be compatible with all agricultural land. Areas which are extremely well suited by virtue of natural resources for aquacultural production may be protected from upland encroachment by leaving uplands in the agricultural land use.

Forestry

Forest uses are those areas in the County which are under forest

management in order to create a long term return from logging.

Criteria:

1. Because forestry uses are a sustained yield type of land use activity, aquacultural uses will have minimal impact on the forest use. Therefore, aquacultural uses are compatible with forestry uses.

Parks/Recreation

Park and recreation areas are defined as open spaces and parks dedicated for recreational purposes which may be currently maintained as public or private facilities. The activities at these parks may be upland related or may be focused on the marine environment.

Criteria:

1. Parks which have activities that are focused on the upland area with little focus toward the marine environment will be very compatible with aquacultural uses.
2. Parks which are "view parks" will be compatible with those aquacultural methods which are not highly visible, and incompatible with those aquacultural methods which are highly visible.
3. Parks which have activities which are focused upon the tidelands and/or marine environment will be incompatible with those aquacultural methods which create a great deal of development or view blockage near the shoreline.

Federal

Federal lands are largely military properties which are currently located within Island County.

Criteria:

1. Aquacultural methods are normally compatible with all Federal lands; however, the Federal Government will have the final determination as to the use of waters off these Federal lands for aquacultural purposes.

OWNERSHIP

The ownership of the uplands and the tidelands is normally a very critical factor in determining the compatibility of the aquacultural method. Ownership has been divided into three categories for both the uplands and the tidelands; either the applicant proposing the aquaculture owns them, another private individual or group, or they are held in public ownership by either the city, county, state, or federal government. Obviously, the most desirable situation is when the applicant owns both the uplands and the tidelands. Other situations have various levels of compatibility for different methods of aquaculture.

Uplands

The ownership of the uplands refers primarily to those lands directly above the location of aquaculture. However, in some cases because of view orientation or other miscellaneous factors other portions of the uplands must also be examined in order to determine the overall compatibility rating.

Criteria:

1. For those methods which have little or no environmental impact and/or are not visible from the shoreline, on a case-by-case basis they may be found compatible with any of the uplands ownership categories.
2. Those aquacultural methods which cause major negative environmental impacts or which cause views to be disrupted from upland properties will be incompatible or somewhat incompatible with other private ownership, and will be somewhat incompatible or somewhat compatible with public upland ownership depending upon the use of the public lands.
3. Those aquacultural methods which utilize intertidal waters will be somewhat incompatible or incompatible with private ownerships other than the applicants.

Tidelands

Tideland ownership should most desirably be in the hands of the applicant. However, it is recognized that other private parties as well as

the State of Washington will also own tidelands. Aquacultural methods may be utilized in these tidelands or in the waters off these tidelands depending upon impact that the aquacultural use has on the tidelands.

Criteria:

1. Aquacultural methods which are off tidelands owned by the applicant will be compatible.
2. Aquacultural methods which utilize intertidal waters will be incompatible when a private party other than the applicant owns these tidelands. When the State of Washington owns these tidelands, they may lease to the applicant these tidelands for aquacultural uses, in which case the use will be compatible. When these publicly owned tidelands are utilized for parks or recreational purposes aquacultural methods which use intertidal waters or are close into shore and are highly visible will be incompatible.

## USE OF THE COMPATIBILITY MATRIX

The compatibility matrix is intended as a guide in assisting decision-makers in determing whether a proposed aquacultural project should be approved, approved with conditions or revisions, or whether it should be rejected. The compatibility matrix will also allow the decision-makers to determine which, if any, of the compatibility factors are most important or are most incompatible with the aquacultural method, and will then assist the decision-maker in clarifying in his own mind what type of conditions or mitigative measures might be imposed upon the aquaculturist in order to make that project more compatible with the surrounding community. Although general guidance can be derived from this matrix, scoring cannot be done using this method. Even though a given project may be found to be compatible in a number of the 21 factors, it does not necessarily follow that it will be approved. The factors whichhave been designated as incompatible may in a particular instance be the more important factors; therefore, the aquaculture proposal may be rejected or may be heavily conditioned before it is allowed.

For any specific project the compatibility matrix may be used to arrive at four ratings. Although there are 21 actual compatibility factors, many of these factors will not apply to every project. Each project must be rated only on the factors that do apply, i.e. each of the aquacultural proposals will only be seaward of one upland use. Many of the aquacultural uses will be found to have both compatible and incompatible characteristics with the uplands and water surrounding it. This matrix will allow the decision-maker to objectively determine which of those factors the aquacultural method is compatible and and which of those factors it is incompatible with. Through the use of this matrix and further use of the proposed regulations as outlined in this study, the decision maker will then be able to determine whether the aquacultural use is acceptable and what conditions can and should be applied.

As is very obvious, the compatibility matrix will change in the future. Not only will the compatibility factors expand because of additional land use designations and additional water related uses that may begin to occur in Island County which had previously not occurred, but the number of aquacultural methods may also change in the future. It is also possible that a different judgment of the compatibility between any given use and any given aquacultural method may be made after actual experience. As a wider variety of aquacultural methods are put into effect in Island County and as more aquacultural locations are utilized around Island County, County staff as well as the citizens of Island County will begin to realize the true ramifications of aquacultural uses. As this occurs, ongoing input should be taken by the ataff in order to continually re-evaluate the compatibility of various aquacultural methods with various upland and water uses. It may be found that compatibility ratings change to become more compatible as aquacultural methods are carried out and found to be not very damaging to the environment both physically and socially to the human environment. However, in other instances it may be found that aquacultural methods, particularly if they proliferate, will become much less compatible with areas because the impacts were not able to be known until a full scale aquacultural experience was known.

It may be that there is an upper limit to the amount of aquaculture which is acceptable to the public, as well as an upper limit to the amount that any body of water can handle without upsetting the local ecosystem. It is recommended that every two years the Island County Planning Department review the compatibility matrix, review the number of aquaculture proposals which have been evaluated using this compatibility matrix, and make a report to the County Commissioners in order to determine the feasibility of maintaining or changing the compatibility matrix and the evaluation system which it results in.

## VIII. POLICY RECOMMENDATIONS AND USE REQUIREMENTS

The application of the evaluation system which is being set up will assist the decision-maker in determining whether an aquaculture proposal falls in the most desirable natural locations, what the general environmental impacts of the project will be, and how this project will harmonize with the existing land and water uses and characteristics. These are only a part of the objectives of this study; recommendations to the Shoreline Master Program's Goals and Policies are also to result from this project. This chapter addresses these issues by recommending certain policy changes and additions and use requirements which Island County may wish to amend to their Shoreline Master Program.

The eight elements of the Shoreline Master Program are all-encompassing; they define the parameters of the shoreline uses succinctly and directly Each element has a goal which represents the long-term direction that Island County's citizens wish to see carried out by this program. These goals adequately reflect the multipurpose approach that Island County has adopted in dealing with shoreline development. This document will rather deal with policies. Policies are more reflective of situations which arise than a general objective statement, such as a goal.

The policies proposed are those that have been arrived at based on a thorough analysis of the issues which have been raised in the past (cause of this study) and those which were determined during this project (result of this study). These policies reflect Island County's attitude toward the emerging industry of aquaculture - how, where, and why it should be approved or disapproved, and what conditions should be imposed if it is approved.

The following policies could be amended to the Shoreline Master Program in a variety of places. Rather than reduce flexibility by recommending a specific location within the program, the policies are listed in this document to be used by the County in a manner as they see fit.

The locations in the existing documents (Comprehensive Plan - Planning Policy and Shoreline Master Program) where aquaculture is mentioned are listed in Appendix B - reference to Island County Plan and Program. These policies could be placed at any of these spots as appropriate.

Aquaculture Policies

1) To provide an evaluation and decision-making system for approval-disapproval of aquaculture proposals which:
   A) Implements the intent of aquaculture related goals and policies of the Island County Comprehensive Plan;
   B) Implements the intent of aquaculture related policies of the Island County Shoreline Master Program;
   C) Establishes predictability, consistency, and equity in the approval process;
   D) Protects both public and private interest in the utilization of natural resources, including the maintenance of quantities of existing species and diversity of species within the marine ecosystem.
2) Aquaculture projects will be encouraged in those areas and sites deemed compatible with existing and planned adjacent uses with existing and planned adjacent uses.
3) Aquaculture projects will be discouraged in thise areas and sites deemed incompatible with existing and planned adjacent uses.
4) Aquaculture projects which exist will be encouraged to continue by discouraging changes in upland uses which would cause either human intrusion on or environmental degradation of the area where aquaculture is on-going.
5) The State Noise Ordinance (RCW ) and all other pertinent existing codes and ordinances will be utilized in the evaluation of each aquacultural project proposal.
6) Any approval of an aquaculture project may be conditioned by requirements deemed necessary to mitigate adverse environmental impacts.
7) Disapproval of aquaculture projects may result if it is determined

that adverse environmental impacts cannot be sufficiently mitigated in the judgment of the Island County Board of Commissioners.

8) Disapproval of a project may result if the environmental review process indicates that the aquacultural method clearly diminishes the natural productivity of a marine area.

9) Aquaculture applicants will be required to submit an operations plan with their application which specifies:
   - specie(s) to be reared
   - aquaculture method(s)
   - site plan (depicting all physical improvements pertinent to the proposal)
   - schedule, method, and type of feeding (if applicable)
   - manpower/employment
   - harvest method and timing
   - other pertinent information from seabed lease application (specified by Planning Dept. at pre-application conference)
   - listing of all permits required by other state, local, or federal agencies.

10) Aquaculture project approval will be based upon compliance with the project operations plan as submitted.

11) If, in the opinion of the Planning Director, changes in the operations plan alter the character, impact, or compatibility of the project, the Director may require the applicant to re-apply for an amendment to the original operations plan. Operation plan amendments will be processed in the same manner as the original proposal.

12) The Planning Director, or his agent, is empowered to periodically inspect aquaculture operations to assess compliance with their operations plan and the conditions of permit approval.

PROPOSED USE REGULATIONS

In addition to policies, the study has also identified a number of use regulations which seem relevant to add to those which already exist. The following additional use regulations are proposed:

1) Aquacultural activities shall be spaced approximately 450'-500' apart in situations where the scale of aquacultural activities could be a major visual intrusion on an area.
2) Aquacultural methods shall not be allowed which cause an undue amount of siltation , substrate displacement, or dredging in areas which have high concentrations of residential development.
3) Aquacultural activities which require large amounts of construction with resulting environmental impacts shall be phased.
4) Aquaculture development shall not be such to cause erosion along adjacent shorelines.
5) Addition to existing Use Requirement (2): In instances where submerged systems are used, a draft of 10' minimum shall be provided in areas of recreational boating. In areas where commercial or naval shipping occurs, systems should be submerged to a depth of 10' past the maximum draft of any vessel expected to use this shipping lane.

PROJECT APPLICANT:
LOCATION OF PROJECT:
SPECIES TO BE RAISED:
METHOD OF RAISING:

| CRITERIA FOR APPROVAL | | RATING OF PROPOSAL | CONDITIONS TO MAKE PROJECT MORE COMPATIBLE |
|---|---|---|---|
| COMPATIBLE WITH NEARBY EXISTING AQUACULTURAL USES | | | |
| COMPATIBLE WITH OTHER WATER USES | BOATING/NAV.:<br>FISHING:<br>OTHER: | | |
| COMPATIBLE WITH UPLAND USES | | | |
| COMPATIBLE WITH UPLANDS AND TIDELANDS OWNERSHIP | | | |
| COMMENTS: | | | |
| SIGNIFICANT ENVIRONMENTAL IMPACTS WHICH CANNOT BE EASILY MITIGATED | | | |
| COMPATIBLE WITH DESIGNATION GOAL & POLICIES OF SHORELINE MANAGEMENT PROGRAM | | | |

PROJECT EVALUATION RATING: _____ X _____ PC
STAFF RECOMMENDATION: _____
CONDITIONS OF PERMIT (if approved): _____

LEGEND:

X- PROJECT IS INCOMPATIBLE OR EXHIBITS SUBSTANTIAL NEGATIVE IMPACTS. PROJECT CANNOT BE APPROVED UNTIL REVISED OR UNTIL MAJOR CONDITIONS ARE IMPOSED WHICH WILL ALLEVIATE THE NEGATIVE IMPACTS.

PC- POTENTIALLY COMPATIBLE- PROJECT HAS A MAJOR NEGATIVE IMPACT ON ONE OR MORE EXISTING NEARBY USES, PROJECT CAN BE REVISED TO MAKE IT MORE COMPATIBLE OR CONDITIONS CAN BE IMPOSED WHICH WILL MITIGATE THE MAJOR NEGATIVE IMPACTS.

# APPENDIX C

## AQUACULTURE PROPOSAL EVALUATION MATRIX

Species descriptions

illustrations reduced

maps on 8½ × 11

Bibliography List of References

Large matrices will be photographically reduced.

Summary