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Fisheries and Fishery Policy in the State of Maine:

An Overview

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1.0 INTRODUCTION

Maine has a long, indented coastline bordering a highly productive marine habitat. Its people are independent, self-sufficient and have traditionally obtained their livelihood from available natural resources. It is not surprising that in such a climate a complex, free enterprise fishery system developed in Maine. It is also understandable that institutions of state government have attempted to develop the fisheries, protect the environment and conserve the resource for the common good. This is not always a harmonious mix. In order to minimize unnecessary restrictions and maximize the benefits of institutional activities, state government must establish policies that are reasonable and are based on a clear understanding of the nature of the resource and its fishery.

At present there is no clear summary of how Maine's laws and regulations relate to state policy or how state policy relates to resource and fisheries problems. The rules under which Maine's fisheries operate originate from many sources; the state legislature, state agencies, and local governments all engage in rule making. In some cases policy is clearly stated, in others it is implied through the laws and regulations themselves. Nowhere are they found collectively where policy can be related to problems and to resulting regulations.

This document presents an overview of Maine's marine fisheries system and the state's policy framework which interacts with it. We have attempted to present the essence of the physical habitat which contains the resource, the main biological features of the resource and the economic characteristics of the fisheries. These elements have

been summarized from a large body of knowledge that resides in numerous research documents and in the experience of the people who have contributed to the overview. We have also incorporated the laws and regulations that exist for each habitat and resource component. Finally we have identified state policy where clear policy exists. The overview describes fishery laws, regulations and policies as they exist today. It does not attempt to recommend or predict future policy changes.

This document is the result of the knowledge and efforts of a great many people in the Department of Marine Resources. Those that have contributed are identified below:

Editors: Stanley Chenoweth
Alden Stickney

Contributors: Spencer Apollonio
Jean Chenoweth
Edwin Creaser
Robert Dow
Penn Estabrook
Lewis Flagg
Walter Foster
Joseph Graham
Kenneth Honey
John Hurst
Jay Krouse
Robert Lewis
Michael Moser
Herbert Perkins
Dan Schick
Stuart Sherburne
Tom Squires
Brad Sterl
David Stevenson
Lorraine Stubbs
James Thomas
Ralph Townsend
Dana Wallace
Clement Walton
Walter Welch

2.0 HABITATS

2.1 Tidal rivers

2.1.1 Physical characteristics

For the purposes of this overview, the major emphasis for discussion on tidal rivers will be their relationship to anadromous and catadromous fish resources. Because most of Maine's tidal river habitat could also be defined as estuarine habitat, the importance of the tidal river habitat as it concerns marine finfish and shellfish will be discussed under the section on estuaries (see sec. 2.4.1).

There are 36 Maine rivers with a drainage area of 25 square miles or greater, which discharge into Maine tidal waters. Five of these exceed 1400 square miles of fresh water drainage areas, four exceed 300 square miles, six exceed 200 square miles, four exceed 100 square miles and the remaining seventeen range from 25 to 92 square miles. All of these rivers contain one or more of the 12 diadromous fish species found in Maine (See Sec. 3.1)

2.1.2 Biota

Tidal rivers are particularly significant to diadromous (anadromous and catadromous) fish resources for the following reasons:

1. They are important spawning, nursery, and feeding grounds for most diadromous fish species.

2. They are a transitional zone for physiological acclimation as diadromous species move between the fresh water and marine environment.

3. They are the prime areas where diadromous fish are normally intercepted by commercial/recreational harvesters on their return to and from spawning grounds.

The magnitude of anadromous fish resources is governed by the quantity and quality of tidal and nontidal freshwater habitat available to the spawning components. Historically, nontidal freshwater spawning habitat available to anadromous fish resources in Maine consisted of 13,800 square miles of watershed for all species. Because of their ability to leap over large natural falls, Atlantic salmon habitat encompassed an additional 6700 square miles of watershed. These areas represent 39% and 60% respectively of the entire drainage area of the State of Maine. Although availability of nontidal freshwater habitat has been reduced to about 1/10 of historical size, tidal freshwater habitat (notably the Kennebec-Androscoggin estuary) and tidal saltwater habitat available to diadromous fish resources has not changed significantly since Colonial times. However, the reduction in nontidal freshwater habitat has reduced most anadromous fish stocks to about 1/10 or less of their former abundance.

2.1.3 Commercial importance

The importance of tidal rivers for navigation, food production and a number of other human uses is reflected in the concentration of human settlements and activities within these areas. The production of diadromous fish and their seasonal concentrations in tidal rivers were particularly attractive food sources for early colonists and greatly influenced settlements in these areas.

A major impact on tidal rivers has been degradation of water quality caused by heavy pollution from industrial and municipal sources,

both in inland and coastal areas. The most significant single problem has been oxygen depletion caused by pulp and paper mill discharges. Additional impacts on tidal river productivity has occurred from dredging and filling of wetlands which provided food and cover to early life stages of diadromous fish. The construction of hydroelectric dams at or near head of tide on major rivers has severely depressed anadromous fish runs which depend on freshwater spawning areas.

2.1.4 Laws and regulations

Habitat management laws, programs, and objectives are outlined in the following laws (See also Section 2.5 on laws):

1. MRSA 38: 361-372; 411-454 - Water Quality Laws of the State of Maine - establish water quality classification of all Maine waters and a timetable for mandatory reduction of discharges to meet established classifications.

2. MRSA 38: 471-478 - Alteration of Coastal Wetlands Act. These laws regulate dredge and fill and other activities in all tidally influenced areas.

3. MRSA 12: 6121, 6122, 6123 - These laws govern requirements for fish passage facilities in certain dams obstructing fish migration

4. MRSA 12: 7776-7780 - These laws regulate dredging, filling or construction affecting rivers and streams including contiguous wetlands.

2.2 Emergent wetlands

2.2.1 Physical characteristics

Emergent wetlands, comprising largely the salt marshes of Maine, total about 77,000 acres (Ricker 1977). Most of this habitat occurs

west of Cape Elizabeth; several extensive salt marshes are to be found in the towns of Scarboro, Wells, Ogunquit and Kittery. East of Cape Elizabeth the habitat is less extensive, bordering the seaward ends of tidal rivers and streams. The largest salt marshes form behind barrier beaches, few of which occur along the strongly dissected middle and eastern coast.

A common substrate for the development of salt marshes is accumulating silt, in which cord grass (Spartina alterniflora) gains a foothold and flourishes, creating hydrological conditions conductive to the further deposition of silt. The foundations of salt marsh vegetation are thus successive layers of silt and grass roots as each year's growth is added. These old deposits are often called "peat."

The marshes are drained with each tidal cycle by a complex series of often serpentine creeks of varying sizes. The major drainage creeks may frequently be fed by coastal fresh water streams as well. At the lowest tidal level the borders of the marsh are usually banks or flats of silt or fine sand. From about the mid-tide level to the level of mean high water the principal grass is Spartina alterniflora, but in the higher parts of the marsh, between mean high water and spring tide levels, the predominant vegetation is salt hay, Spartina patens, which is still harvested in some places.

The structure and condition of Maine salt marshes is affected very strongly in the winter by ice, great sheets of which may cover the marsh and blocks several feet thick may lift off and raft away substantial portions of the marsh surface.

2.2.2 Biota

The dominant vegetation profile of the marsh consists of various attached seaweeds and occasionally eel grass (Zostera) below low tide, Spartina alterniflora from 7 to 10 feet above mean low water, Spartina patens from 9 to 10.3 feet above MLW, and at the extreme upper levels (9.75 to 12.6 feet above MLW, Juncus and various other halophytic plants such as sea lavender (Limonium), glasswort (Salicornia), and reed (Phragmites). Where salt marshes border on fresh water marshes, bull rushes (Scirpus) and cattails (Typha) may occur.

The aquatic fauna in a salt marsh habitat, although less varied than in the truly marine environment, is abundant. Some of the more important or abundant species are the ubiquitous mummichog (Fundulus heteroclitus), juvenile winter flounder (Pseudopleuronectes americanus), green crabs (Carcinides moeras) and mud shrimp (Crago septemspinosus, numerous species of amphipods and isopods, mud snails (Nassarius obsoletus), ribbed mussels (Modiolus demissus), the clams Mya arenaria and Macoma balthica, and numerous polychaetous worms, chiefly Nereis diversicolor.

2.2.3 Commercial importance

The salt marsh habitat is of less commercial importance for the resources harvested from it than it is for its importance in the life cycles of resources harvested elsewhere. The creeks and lagoons are the nursery areas for several commercial species (although perhaps not to the extent that they are in more southern latitudes). The vegetation contributes substantially to the productivity of the continuous waters. The annual productivity of a salt marsh in Maine has been estimated

(U.S. Fish and Wildlife Service 1980) at about 396 g/m^2 or about 2 tons per acre, much of which, from 60.5 to 242 pounds per acre (Ricker 1977) is decomposed and leaches into the tidal water, providing nutrients for the growth of phytoplankton, and the beginning of the food chain. The salt marshes are the habitat for waterfowl and other wildlife which provide a recreational resource of consideralbe value.

In the past, salt marsh type wetlands have been the victims of commercial exploitation merely as a source of cheap land for industrial or residential purposes. It has been only recently that their value as a resource habitat and their intimate association with other ecosystems have been recognized. Maine is fortunate that, unlike other Atlantic seaboard states which have lost as much as 30% of their wetlands to industrialization, it has lost only about 1%. Still, development in some areas has led to pollution by industrial and sanitary wastes and pesticides.

2.2.4 Laws and regulations

Applicable laws and regulations are covered in Section 2.5.

2.2.5 Policy.

Ricker (1977) has stated aptly:

"Biologically, wetlands are many things to numerous species of fish and wildlife. They are not dumps, have no need to be filled, do not need to be dredged, but are in fact areas needing no assistance from man to provide the services for which they are best adapted. The best service man can render them is to preserve them, upon realization of the important function they perform."

2.3 Intertidal flats

2.3.1 Physical characteristics

Intertidal flats are the nearly level areas of sediments deposited between high and low tide, their extent being dependent on their slope and the range of tides, which varies from about 9 feet in the west to 20 feet in the far eastern part of the coast.

Approximately 50% of the estuarine system is considered to be intertidal: an area of approximately 66,382 acres (26,875 ha) and including a wide variety of habitat types and geological features: mud flats (clay, silt, sand and mixtures); sand flats and beaches, pebble, cobble, and boulder beaches, protected and exposed rocky shores, emergent wetlands; streambeds; and reefs. The intertidal flats occupy about 66% of the intertidal zone and are mixtures of different size sand particles and (so-called) mud with a composition of silt, clay and sand.

With Maine's deeply-indented and irregular coastline and thousands of islands, there are many protected coves and sheltered embayments. Sediments in such areas originate from offshore, coastal rivers, other flats or local sand erosion. They are carried by the water and may settle out of slack waters to develop flats dominated by silt and clay.

Mud flats are derived from the subtidal glacial marine clays and silts containing small amounts of organic detritus, with the organic contents of the sediments a factor in controlling the distribution of the sediments. When transported in suspension, the smaller particles settle landward with erosion materials being redistributed. It is believed that about 1.9 to 2.8 cm/year is being added to some Maine flats.

The silt-clay flats are being affected by many natural processes including wave action, tidal currents, alternate freezing and thawing and ice formation and movements. Different sediments may influence the burrowing activities of invertebrates and their presence in the flats can effect sediment mixtures.

Sand flats may occur from the deposition of sand in locations where there is relatively more exposure to tides, waves and currents than where mud flats are located, and where the regional geology makes a source of sand available.

Sand can be eroded and carried seaward from sand beaches. Currents may deposit sand along tidal channels or build bars. The composition of the flats range primarily from medium sand to silty sand. With Maine's rising sea level, sand flats are responding by migrating shoreward; beaches recede and silt, clay, fine sand deposition covers the seaward margins of the sand flat. However, there are only a few large sand flats in Maine. A good example would be Sagadahoc Bay in Georgetown.

Among the physical factors affecting the distribution of organisms are the areas of the intertidal zone, period of submergence, the temperature regime thoughout the year, the height of the tide, waves, speed of currents, nature and slope of substratum, moisture and the sediments, available sunlight, cloud and fog cover.

Most commercial clam (Mya arenaria) producing flats are usually sediment mixtures with dominant type depending on the geology and source of sediments in the area, exposure and degree of protection from transporting currents, and wave action.

Sediment transport mechanisms have effects on invertebrate survival. Among the many natural influences in the near shore

environment are water circulation, velocity and turbulance, wave action, wind, algal holdfasts, animals, freezing, erosion, compaction and redistribution. Important to the alteration of productive habitat have been climatic cycles and changes associated with man's intervention, primarily engineering structures and operation.

2.3.2 Biota

Although intertidal flats are found in our tidal rivers to the head of the tide, these areas are not all productive of commercially valuable species of shellfish, worms, and plants, because of the adaption of the latter to different salinities. The nature of the sediments is also important in modifying the effects of salinity fluctuations as some water remains in the sediment between tides.

There are various differences between silt and clay flats and sandy areas. Mud is more anaerobic than sand because of the growth, collection and decomposition of organic materials. Even diatoms, bacteria and fungi may aid in aggregating particles in silt-clay flats so that the stability of bottom sediments is affected. When organic material is bound up with the sediments the chemical composition and associated biological activity is complex. This environment may be important to the natural setting and survival of larvae of species of commercially valuable shellfish and marine worms.

It is important to continue research on these associations because of the possibility of modifying or creating conditions in the flats that will enhance commercial productivity.

A rich and varied fauna is supported by the flats. Of particular commercial interest are species of shellfish, primarily soft shell

clams, Mya arenaria, and marine worms, Nereis virens, and Glycera dibranchiata. During periods of relatively high annual water temperatures, quahogs, or hard shell clams, Mercenaria mercenaria, were abundant in upper Casco Bay. Various species of juvenile and adult fish feed on submerged flats, and waterbirds and fowl feed during exposed periods.

Of the many animals found in the flats, some are scattered with other species and some congregated into groups with a gregariousness that may be important in commercial species, particularly when larvae settle near the adult animals. Distribution of the invertebrates is influenced by varying levels of biological competition and predation. Competition for space and food, and predation as a part of the food chain continue to need research attention in relation to the development of management programs: for example, the building of specially designed low fences to protect clams from green crab predation or removing small poor quality mussels from intertidal flats to good growing subtidal habitats and thereby enhancing the growth and survival of both transplanted mussels and remaining soft shell clam populations.

Although large algal plants such as Fucus may grow near the shore, or around ledges, they do not develop on the flats because fine sediments do not provide suitable substrate for their holdfasts. The short-lived, seasonal plants such as Ulva, the sea lettuce, and Enteromorpha, do bloom on the flats adding to organic material in the surface sediment. Marine plants are poorly supported on flats of pure sand, and faunal density is also generally low.

Nearly all mud flats will contain worms, gastropods, periwinkles, bivalves, clams, mussels, crustaceans, barnacles. One study indicated

that about 12 species accounted for about 95% of the invertebrate individuals on Maine mud flats. Seventy-five species were identified on one flat.

Mussel beds are frequently found on intertidal flats where they may compete for space with clams; however, mussels of commercial quantity or quality are usually below the mean low tide line. When mussels become established, other mussels set on them and beds develop. Worms and crustacea can generally be found associated with the pseudofeces and silt collected around the mussel beds.

Sand flats are generally indicators of good water current, which is associated with good growth in soft shell clams. Some of the best growth along the coast occurs in predominantly sandy flats in western Maine. Adverse conditions for hard and soft shell clams include sediment transport and environmental alterations associated with climatic cycles, predation, ice cover, salinity reduction, sediment erosion or compaction, burial and exposure.

The environment or sediment composition of the flats was found to be important when the flats are turned over in the process of harvesting soft shell clams with a clam hoe. Experiments evaluated the effects of sediments on the survival rates of clams buried at different depths. In general, survival of soft shell clams was inversely proportional to the depth of burial. It was found that a greater percentage of clams survived in silty sand than in sand, and in silt their survival was poorest.

2.3.3 Commercial importance

The economic value of this zone to the state and nation is great. Commercial value, not including nutrients supplied to the waters and

available to finfish, crustacea, and other animals in the food chain, is in the order of $34 million. Considered in the estimate are the direct harvested values of commercial landings of shellfish and worms along with indices and indirect value-added in the channels of trade within the State of Maine. It is estimated that 6-7,000 people earn part or all of their incomes in activities based on intertidal fauna and flora harvests.

Recreational and aesthetic values are not equated here in economic terms, but the zone is highly valued by natives and tourists probably annually attracting untold thousands of people to the coast.

2.3.4 Laws and regulations

The laws and regulations applicable to the intertidal flats are essentially the same as those applicable to other wetlands and coastal waters, discussed in Section 2.5.

2.4 Estuaries , bays and coastal waters.

The habitat described in this section is the subtidal, open water habitat and includes coastal waters and estuaries.

2.4.1 Physical characteristics

Estuaries.

Numerous streams and rivers, twelve of which exceed an average discharge of 200 cubic feet per second, empty into Maine's coastal waters. There are about as many smaller ones which are important for reasons other than size. The estuaries of these rivers, together with certain other coastal waters associated with them, constitute a distinctive and important habitat.

Estuaries can be classified in three categories: highly stratified ("salt wedge"), partially-mixed, and fully-mixed. All three types occur in Maine, but the most common is the partially-mixed estuary with decreasing salinity towards the river end at all depths. Mixing is chiefly the result of tidal action, which is strong on the Maine coast. The flushing rate, one of the important parameters of estuarine hydrology, depends on the volume of river flow and the tidal exchange as related to the volume of the estuarine basin. Estuaries such as the Sheepscot, Damariscotta and Penobscot are flushed slowly because of their large volumes relative to the fresh water input. Other estuaries with high river discharges but relatively small volumes, such as the Kennebec and Presumpscot are flushed more rapidly. Estuaries with low flushing rates are potentially more productive since nutrients are retained for longer periods, allowing sufficient time for recycling and regeneration.

Sources of primary productivity in estuaries are macroalgae, phytoplankton and emergent wetlands (e.g. salt-marshes). Phytoplankton contribute the largest share of the estuarine productivity in Maine at an annual average rate of about 150 grams of carbon per square meter per year. Rates are extremely variable between estuaries, however.

Estuaries per se represent but a small fraction of the coastal waters of Maine. The estuarine habitat, however, comprises a much larger portion, extending from the heads of tide of the streams for an indeterminate distance towards the headlands. Because of its degree of protection, its more variable temperature and somewhat reduced salinity, this zone can be distinguished from the coastal waters. The intertidal shorelines of this region include large areas of sand or mud flats and

salt marsh; its subtidal bottoms are mud (silt) where tidal action is weak, and sandy or rocky where water movement is strong. Surface temperatures in some of these estuarine areas can become quite warm in summer - perhaps 25°C as contrasted with the 13°C of the coastal water - and permit the existence of relict populations of species usually associated with more southern waters.

Nitrogen is the limiting nutrient to primary production in Maine estuaries during the summer. The input of nitrogen from land and sewage represents a very small percentage of the total required to maintain the production rates observed in Maine estuaries. The principal nitrogen source is the offshore coastal water, and its input to estuaries depends on the sill depth at the mouth of the estuary. Estuaries with low sills have unrestricted access to nutrient rich coastal intermediate water, hence higher production rates. There is no bathymetric boundary between the inner bays and sounds and the coastal waters. Coastal estuarine embayments therefore have an unrestricted input of nutrients from offshore.

Bays and Coastal waters.

These are open marine waters over either rocky or unconsolidated bottom extending along the coast from the shoreline to depths averaging less than 40 fathoms. Since the coast is characterized by many deep water indentations, the lower reaches of such large embayments as Cobscook Bay, Penobscot Bay and Casco Bay, as well as many smaller ones, are more typically marine than estuarine. The natural outer boundary of the habitat extends out at least 10 to 12 miles to a point where the mainland shelf gives way to the deeper water of the Gulf.

The mainland shelf is a glaciated and drowned coast with features largely controlled by bedrock. These features are irregular, consisting of submerged rocky reefs and ledges that run in a general north/south direction. East of Cape Elizabeth pronounced rocky headlands of many estuaries and embayments intrude upon the coastal water. West of Cape Elizabeth the coast is relatively open with margins of sand beach. Along the shelf, areas of sediment are interspersed with bedrock. Bottom sediments consist of mud, sand, gravel or shell, usually in combination.

The circulation of coastal surface waters is strongly influenced by the tide and, to a lesser degree, by river discharge and wind. Residual, non-tidal flow is generally east to west along the coast, but during periods of extreme freshwater runoff, eddies frequently develop. Westward surface flow is more pronounced west of the Mt. Desert region and more variable to the east (Graham, 1970). Nontidal flow along the bottom is inshore, indicating that upwelling is an important feature of the coastal circulation, bringing nutrient rich bottom water shoreward. Predominant winds in coastal Maine are from the southwest in summer and northwest in winter. Sometimes a strong thermocline forms in the spring and summer as warm air temperatures and freshwater runoff reduce the surface water density. The thermocline breaks down in the fall and winter as a result of cooling, reduced runoff and strong northwest winds. A factor which causes turbulent vertical mixing during the entire year is the interaction between tidal currents and bottom friction.

Three distinct water masses have been described in the Gulf of Maine (Hopkins, Garfield, 1979). Maine intermediate water (MIW) is

characterized by low salinity and temperature and is formed by the cooling of coastal water in the winter when it is indistinguishable from Maine surface water (MSW). The two water masses diverge in the spring when MSW is diluted and warmed. MIW is not destroyed during summer heating because the mixing processes associated with cooling extend deeper than do those associated with warming. Maine bottom water (MBW) is denser than either MIW or MSW and is unaffected by air-sea interaction.

Coastal surface waters exhibit a large seasonal variation in temperature. Variations in temperature decrease with depth and from west to east along the coast. Lower surface temperatures and higher salinities in the east are associated with greater tidal mixing. Autumn surface temperatures are highest in the west whereas bottom temperatures are highest in the east.

2.4.2 Biota

The coastal and estuarine habitat is the source of considerable secondary production. Phytoplankton and zooplankton grow richly and provide the direct source of nourishment for most larval and some adult fish, and for both the larvae and adults of many species of invertebrates. These organisms in turn are fed upon by others higher on the trophic scale such as lobsters, crabs, shrimp, carnivorous fish, birds, seals and whales.

The biota is typical of shallow water, boreal latitudes - relatively low in species diversity, high in abundance and productivity, and characterized by marked seasonal variations in distribution and standing crop. The waters over the mainland shelf are characterized by

a combination of the physical and biological attributes of open Gulf and estuarine waters.

Larval and juvenile stages of several important commercial species are transported into the estuaries and embayments through the inshore movement of shelf water and retained there. Anadromous species move through the shelf waters on the way to their upstream migrations, and the waters are rich feeding grounds in the warm parts of the year for diverse and commercially important fishes.

Pronounced environmental differences between eastern and western portions of the mainland shelf are sometime reflected in the distributions of organisms. Standing crops of zooplankton are higher in the west than the east. Shrimp and several species of commercially important fish are more abundant in the west than the east.

2.4.3. Commercial Importance

The coastal waters, bays and estuaries of Maine are the permanent habitat of many commercially valuable fish and shellfish and provide the nursery ground for the larvae and juveniles of these and other species. All of the clam and worm harvest, most of the lobster and herring harvest and at least half of the scallops landed are from these inshore waters. During the summer, transient schools of menhaden provide an additional fishery.

The landed value in dollars of the resources from this habitat can be estimated from the total landings multiplied by the approximate percentage of the total landings taken there. These estimates for nine most valuable categories of fish and shellfish are shown in Table 2-1. The actual value to the economy of the state for these resources is much

higher; how much higher depends on what factors are taken into account in calculating the multiplier, such as retailing, additional processing, ancillary businesses created, etc. (See Section 5.2.1).

The resources harvested from natural populations in the habitat undoubtedly contribute the greatest share of its commercial value, but the potential for aquacultural development should not be overlooked. At the present time there are 18 sites leased for aquacultural enterprises involving approximately 155 acres in state waters.

Nearly all of the support facilities for the fishing industry of Maine are located in the estuaries and protected coastal waters of the state, including 47 ports with fish handling facilities, 130 boatyards, and 54 equipment dealers and suppliers. (C.E. MacGuire, Inc. 1978).

Table 2-1. Approximate landed value of principal living marine resources harvested from coastal waters, 1979.

	Total landed value (Millions of dollars)	Fraction taken in coastal waters	Proportionate value (Millions of dollars)
Lobsters	39.5	99%	39.2
Soft-shell clams	7.8	100%	7.8
Herring	4.6	99%	4.5
Marine worms	2.5	100%	2.5
Scallops	3.6	50%	1.8
Groundfish	18.8	10%	1.9
Mussels	.8	100%	0.8
Menhaden	.8	100%	0.8
Crabs	.2	100%	0.2
Total	78.6	(Average) 75%	59.5

2.4.4 Laws

The laws relating to the estuaries, bays and territorial waters are for the most part the same as those governing any of the shoreline habitats described in this report. Very few of them apply to the territorial waters uniquely. Therefore, the laws discussed in Part 2.5 also relate to the intertidal habitats and tidal rivers.

2.5 Laws and Policies Relative to Habitats

2.5.1 Laws

The concern of the public for the environment is a fairly recent development, a fact which must be recognized in any evaluation of environmental laws. Because the marine habitat is particularly vulnerable to man's activities, the need to protect it and its valuable resources has been recognized in several federal and state laws, most of which are of relatively recent origin. In general, these laws are equally applicable to all coastal waters and wetlands, be they tidal rivers, salt marshes, estuaries or intertidal flats, and are therefore discussed under a single heading.

Three major federal laws are pertinent. The Rivers and Harbors Act of 1899 required the Army Corps of Engineers (C.O.E.) to review, grant or deny permits for alterations and obstruction to navigable waters of the United States. This law was designed primarily to prevent obstructions to navigation and had little concern as to how these alterations affected the environment. Under the general provisions of this act, President Nixon issued Executive Order 11574, December 23, 1970 providing that the C.O.E. require permits for all discharges into navigable waters. Thus, for the first time, there was some knowledge as

to what types of pollutants were being discharged. This act has accomplished little in the way of protecting the marine habitat, however.

The Clean Water Act of 1972, with it's 1977 amendments under Sections 401, 402 and 403, set up the guidelines for the issuing of discharge permits and the provisions for the elimination and/or control of pollutants; it sets effluent limitations to these discharges with the avowed purpose of habitat improvement and protection. Section 404 deals with permits for dredged materials and stipulates the responsibilities of the C.O.E., Environmental Protection Agency (E.P.A.), and the states in this matter.

The Marine Protection, Research, and Sanctuaries Act of 1972 under Section 102 requires that criteria for the issuance of ocean disposal permits be promulgated after consideration of the environmental effect of the proposed dumping operation, the need for ocean dumping, alternatives to ocean dumping, and the effect of the proposed action on esthetic, recreational and economic values, and/or other used of the ocean.

State laws date back to colonial times, and early colonial ordinances provide the legal basis for many contemporary habitat protection and management practices. Some of these early laws are discussed in Section 4.2. Recent laws which Maine has enacted for water pollution abatement and habitat protection are listed below:

Under Maine Revised Statutes Annotated (MRSA) 38, Sections 361-372 and 411-454, standards for the classification of surface waters, both fresh and tidal, are defined by law. All surface waters of the state have been classified either by the Department of Environmental

Protection or the legislature. Classification of a particular body of water reflects the current use as well as the desired condition. Under state law, no untreated wastes are supposed to be discharged into water. No activity is allowed which will lower the present classification of any body of water.

MRSA 38: 541-560 prohibits the discharge of oil and provides for damages resulting from accidental oil spills.

Wetlands are protected under MRSA 38: 471-478, which states in part:

> "No person shall dredge or cause to be dredged, drain or cause to be filled or erect or cause to be erected a causeway, bridge, marina, wharf, dock or other permanent structure in, on or over any coastal wetland; or bulldoze, remove, add or displace sand, or build any permanent structure in, on or over any coastal sand dune without first obtaining a permit therefor from the Board of Environmental Protection or a municipality acting under the provisions of sections 473 and 474; nor shall any action be taken in violation of the conditions of such permit, once obtained."

Permits to alter wetlands are subject to the following requirements.

> "If the applicant for the wetlands permit demonstrates to the satisfaction of the board or municipality as appropriate, that the proposed activity will not unreasonably interfere with existing recreational and navigational uses; nor cause unreasonable soil erosion; nor unreasonably interfere with the natural flow of any waters; nor unreasonably harm wildlife or

freshwater, estuarine or marine fisheries; nor lower the quality of any waters, the board or municipality shall grant the permit upon such terms as are necessary to insure that the proposed activity will comply with the foregoing standards."

The Site Location and Development Act, MRSA 38: 481 et seq. regulates the location of developments which might adversely affect the coastal environment. The purpose of this subchapter is to provide a flexible and practical means by which the State, acting through the Environmental Improvement Commission, in consultation with appropriate state agencies may exercise the police power of the State to control the location of those developments substantially affecting local environment in order to insure that such developments will be located in a manner which will have a minimal adverse impact on the natural environment of their surroundings.

The Mandatory Shoreland Zoning Act, MRSA 12: 4811-4814, provides specific standards of protection over all shore lands. Under this law, the first 250 feet of all land above high tide in the State of Maine have been zoned. This law, again, prevents unreasonable environmental changes.

Research and aquaculture leases (MRSA 12: 605, 6072) provides for the leasing of tidal or subtidal lands for aquaculture by the Department of Marine Resources if certain conditions are met with respect to other compatible uses of the area in question.

In addition to regulatory laws governing activities that may cause adverse effects on coastal wetlands, other federal and state laws enacted during the past ten years provide for the acquisition of wetlands for preservation.

Rachel Carson National Wildlife Refuge using migratory water fowl funds has acquired 2,139 acres of coastal marsh and buffer zones between Kittery and Cape Elizabeth. When completed, the Refuge will accumulate a total of 4,450 acres.

The State Department of Inland Fisheries and Wildlife, with the aid of a ten million dollar bond has acquired approximately 3,000 acres of coastal marsh in the Scarboro area along with several coastal islands.

2.5.2 Policy

Maine's policy concerning the marine environment has been stated very well in the preamble to the Oil Discharge Prevention and Pollution Control Act:

> "The Legislature finds and declares that the highest and best uses of the seacoast of the State are as a source of public and private recreation and solace from the pressures of an industrialized society, and as a source of public use and private commerce in fishing, lobstering and gathering other marine life used and useful in food production and other commercial activities.
>
> The Legislature further finds and declares that the preservation of these uses is a matter of the highest urgency and priority and that such uses can only be served effectively by maintaining the coastal waters, estuaries, tidal flats, beaches, and public lands adjoining the seacast in as close to pristine condition as possible taking into account multiple use accommodations necessary to provide the broadest possible promotion of public and private interests with the least possible conflicts in such diverse uses."

While this policy cannot always be achieved, these goals demonstrate a positive attitude toward maintaining and improving the marine environment.

3.0 MARINE RESOURCES

3.1 Diadromous fish

3.1.1 Commercial characteristics

Historically, diadromous (anadromous and catadromous) fish resources were esteemed as a very valuable branch of the Maine fishing industry. Unfortunately, the construction of dams without fish passage facilities and the pollution of our rivers has reduced most diadromous fish stocks and associated fisheries to a remmant of their former level.

There are 11 anadromous fish species native to the State of Maine as follows:

Atlantic salmon (Salmo salar), American shad (Alosa sapidissima), Alewife (Alosa pseudoharengus), Blueback herring (Alosa aestivalis), Rainbow smelt (Osmerus mordax), Sea run brook trout (Salvelinus fontinalis), Striped bass (Morone saxatilis), White perch (Morone americana), Atlantic sturgeon (Acipenser oxyrhynehus), Shortnose sturgeon (Acipenser brevirostrum), Sea lamprey (Petromyzon marinus).

In addition, the brown trout (Salmo trutta) was introduced from Europe in the early 1880's and anadromous strains have evolved in some Maine rivers. The only catadromous fish species represented in Maine is the American eel (Anguilla rostrata).

Thirty-six coastal rivers and 29 minor coastal streams contain one or more of the diadromous fish species listed above. Marine distribution and traditional river fisheries for these species are summarized in Table 3-1. The volume and value of commercial fishery harvests may be obtained from monthly landings compiled by the Maine Department of

Table 3-1. Distribution and traditional fisheries for diadromous fish species in Maine.

Species	Fishery			Distribution			
	Commercial	Incidental Commercial	Recreational	State Territorial	Interstate	FCZ	Outside
Alewife	X			X	X	X	
Blueback	X			X			
Shad	X		X	X	X		
Smelt	X		X	X			
Striped bass		X	X	X	X		
White perch			X	X			
Atlantic sturgeon		X		X	X		
Short nose sturgeon*	X		X	X			
Atlantic salmon		X	X	X		X	X
Eel	X			X	X		
Brook trout			X	X			
Brown trout			X	X			
Lamprey	X			X			

*Endangered species

Marine Resources and the National Marine Fisheries Service. Recreational fishery statistics for rainbow smelt and American shad in selected watersheds may also be obtained from the Maine Department of Marine Resources. Recreational fishery statistics on Atlantic salmon may be obtained from the Maine Atlantic Sea-run Salmon Commission.

3.1.2 Biology

The fresh water phases of the life cycles of diadromous fish species are well known. Although limited information is available on harvest rates and total harvest of certain species in selected watersheds, information is presently inadequate to manage all species in all watersheds. For adequate management of these resources in territorial and FCZ waters, an expanded data base would be essential. Specific areas requiring further information and research include the following:

(a) Diadromous fish stock sizes and exploitation rates by species and watershed.

(b) Pathological studies of diadromous fish with attention to impacts on resident fresh water species.

(c) Competition between fresh water and diadromous species.

(d) Optimum escapement levels for diadromous species.

(e) Marine and estuarine ecology of diadromous species.

(f) Commercial exploitation in the marine environment.

(g) Inventory of spawning and nursery habitat.

(h) Impact of mans water use (e.g. hydropower development, instream flow requirements, water diversions, pumped storage, irrigation, etc.).

3.1.3 Laws and regulations

Tidewater fisheries within the jurisdiction of the State of Maine are subject to the rules and regulations of the Commissioner of Marine Resources. The Commissioner's rule making authority is limited to the time, method, number, weight, length, and location from which a species may be taken. This authority is established under MRSA 12: 6171, 6191, 6192 and MRSA 5:8053.

Atlantic salmon are regulated by the Maine Atlantic Sea Run Salmon Commission by authority of MRSA 12:6253. All other diadromous fish species wherever found that migrate from the ocean to fresh water are under the joint jurisdiction of the Commissioner of Marine Resources and Commissioner of Inland Fisheries and Wildlife and management coordination is effected under Section 6022.

Harvesting regulations for diadromous fish resources focus on control of river and estuarial commercial/recreational fisheries. Regulations are designed to assure adequate adult spawning escapement, to protect juveniles in nursery areas, and to provide for mitigation measures (fishways, minimum flow provisions, etc.) involving developments of rivers with diadromous fish runs (Sections 6121, 6122, and 6123). Anadromous alewife resources managed by coastal municipalities which conform to state conservation practices outlined in Section 6131. Other statutes which relate to diadromous fish are as follows:

Section	Species	Remarks
6552	Rainbow smelt	Establishes a statewide creel limit during the spawning run to prevent overfishing of the spawning components;

6553	Atlantic salmon	Establishes a closed season on commercial harvest and a minimum length of 14 inches to conserve adult spawners returning to the home rivers and prevents taking of small juveniles going to sea;
6555	Striped bass	Prohibits netting of striped bass and relegates fishery to hook and line and spear gun only in order to prevent overharvesting of the resource.

Regulations of the Commissioner that relate to diadromous fish resources may be found in the Maine Marine Resources Laws and Regulations, Sections 8, 9, 33, 38, 40, 42, 43, 54, 64, 68A, 68B, 73, 80, 81, 82, 83, 89, 106, 108B, 109, 114, 116, 117, 130A, Chaper B, Sections 2, 3A and 4. These regulations deal with specific river systems and address local problems of interception of fish returning to home rivers and protection of juvenile diadromous fish in nursery areas.

Major stock management problems are harvesting of diadromous fish outside home rivers, conflicts between recreational and commercial fishermen for use of limited resources and the need to develop integrated river management programs involving diadromous fish and fresh water fisheries.

3.1.4 Policy

Achievement of the 1967 Maine Legislative Mandate for clean water by October 1, 1976, has greatly improved the outlook for restoration of diadromous fish resources. Recent interest in expanded hydropower development on Maine rivers could result in serious setbacks in the restoration effort unless developers are required to provide appropriate safeguards for the river fisheries. The Department of Marine Resources has developed a policy statement on hydropower development that reflects a commitment to protect and preserve the river fisheries of Maine (Maine

Department of Marine Resources Policy Statement on Hydropower Expansion in Maine, January, 1981).

Under the Maine Statewide Comprehensive Fish, Wildlife, and Marine Management Plan (1971) species management plans have been prepared by the Department of Marine Resources for the following species: American shad, rainbow smelt, alewife, striped bass, and American eel. In addition, river management plans for Atlantic salmon have been prepared by the Maine Atlantic Sea Run Salmon Commission. Detailed information concerning life histories, historical records, commercial.recreational fisheries, volumes harvested, harvesting regulations, stock management problems and recommended management goals can be found in these reports. Limited life history data and abundance estimates for shortnose and Atlantic sturgeon have also been compiled by the Department of Marine Resources.

3.2 Sea Herring

3.2.1 Commercial characteristics

The sea herring, Clupea harengus, has supported an important commercial fishery in Maine's territorial waters since 1887. Herring has ranked first in number of pounds landed and third or fourth in ex-vessel dollar value in recent years (see Maine Landings, NMFS). In 1980, 48,912 metric tons (107.8 million lbs.) were landed in Maine at an ex-vessel value of $5.98 million. The juvenile fish, age 1 through 3, support an industry which packs sardines and steaks. The adult herring, age 4+, support the filleting, smoking and pickling industry. The volume of herring landed in Maine per year has varied from a high of 90,000 metric tons to a low of 13,000 metric tons. Average annual

catches in the 1950s, 1960s and 1970s were 65,000, 39,000 and 23,000 metric tons respectively.

Three gear types account for most of the catch: the stop seine, weir and purse seine. Fixed gear (stop seines and weirs) capture primarily age 1-3 juveniles, with incidental catches of adults. Mobile gear (purse seines) capture age 3 and older fish. Other gear types such as floating traps, trawls and gill nets account for less than 1% of the catch. Most of the fishery is conducted between Cape Elizabeth and the Canadian boundary.

3.2.2 Biology

The discreteness of herring stocks in the western North Atlantic continues to be an unanswered question. Spawning congregations are known to occur in southwest Nova Scotian waters, off Grand Manan, in several locations along the coast of Maine, and in the vicinity of Jeffreys Ledge and Nantucket shoals. The Georges Bank stock has collapsed. Juveniles along the coast of Maine may come wholly from local spawning groups or may be a mixture of fish spawned on Jeffreys, along coastal Maine, and in Canadian waters. Recent analysis of tag return data by the Department of Marine Resources indicates that as Maine juveniles mature, they go east to spawn, not west to Jeffreys (Chenoweth, Hunter and Speirs, 1980).

The herring fishery along the Maine coast exists almost entirely within the state's territorial waters. The western Gulf of Maine fishery (usually called the Jeffreys Ledge fishery) ranges through Massachusetts, New Hampshire and Maine (NEFMC subarea 5Y south) territorial waters and into the Fisheries Conservation Zone (FCZ). A

migration of fish from Canadian and Maine waters takes place after the spawning season, as the fish move south into the Massachusetts Bay winter-spring fishery. A reverse migration takes place in the spring when the fish return up the coast of Maine. The degree of intermixing is not known.

The basic biology of the herring is well known but their ecology and behavior need more study. Research is needed in state waters and the FCZ to determine the source (or sources) of the juveniles. Stock-recruitment relationships, if any, are not known, nor is the minimum stock size needed to prevent collapse. The degree of intermixing between stocks by area and season is not known. Tagging studies are the best hope for defining stock migration patterns, although these data are not quantitative enough to give actual degree of intermixing. Areas requiring further information and research are outlined extensively by Sindermann (1979).

The information which exists is adequate for managing the Maine coastal fishery. Additional information needs include a precise assessment of the age 3+ stock size within Maine's waters and its relationship to other 3+ stocks, especially to that on Jeffreys Ledge; better indices of larval and pre-recruit juvenile abundance along the Maine coast, indices of larval and juvenile abundance in New Hampshire and Massachusetts waters, and a better understanding of the relationships and intermixing between stocks.

3.2.3 Laws and regulations

Harvesting regulations in force include both state laws and a Maine Herring Management Plan which is revised yearly. Laws which have the

most impact for conservation include MRSA 12:6542 which makes it unlawful to catch herring less than 4 1/2 inches in length; 6571, which prohibits purse seining in Washington County waters from April 10 to October 15; and 4159, a law which restricts the use of herring between 4 1/2 and 9 inches in length to human consumption or bait only. Thus herring under 4 1/2 inches are protected from fishing pressure and those from 4 1/2 to 9 inches are channelled directly into food or bait use only.

Several other laws dealing with harvesting herring are included in MRSA 12:6541-6544. These restrict use of artificial lights, establish standard units of herring measure, and require sealing of boats transporting herring.

3.2.4 Policy

The Maine Herring Management Plan is designed to protect the traditional seasons and nature of the fishery and at the same time conform as closely as possible to the regional plan. The Maine Plan allows the fixed gear (stop seines and weirs) to operate without quota restrictions on the assumption that their catch is directly related to abundance. Mobile gear such as purse seines and gill nets are restricted in 1981 by a quota of 8,000 metric tons of herring 9 inches and larger per year. Trawling for herring is not permitted. Mobile gear usually does not capture herring much less than 9 inches as the quality of the small herring is poorer than that taken by fixed gear, due to problems in holding the fish long enough for the intestinal tract to clear itself of food. The collapse of most herring stocks around the world has been associated with an increased use of mobile gear and more efficient harvesting methods, not with fixed gear fisheries.

An important part of Maine's plan is the prohibition of the taking by mobile gear of herring containing spawn from September 1 through November 30. It is felt that harassment of herring during spawning may cause dispersal and decrease spawning success. There is evidence that the collapse of the Georges Bank stock may have been related to over-fishing on spawning congregations from east to west. The enhancement of spawning activity is hoped to result in better year class production.

The Maine management plan is intended to complement the regional plan which seeks to control the harvest of adult herring through quotas. Maine has therefore placed a quota on its mobile gear fishery, which seeks the older fish. Maine hopes to increase the abundance of fish through spawning enhancement and adult quotas to permit expansion of the herring food processing industry, to allow for decreased dependence on Canadian imports of the raw product, and to allow industry product diversification. For further discussion of the relationship between the Maine plan and the New England Council (NEFMC) plan, see the section on the FCMA (6.2).

3.3 Groundfish

3.3.1 Commercial characteristics

Excluding ocean perch (redfish) and some incidental species, there are some 17 species of groundfish landed annually in Maine ports. Landings in 1980 were 62.6 million pounds and were valued at 17.0 million dollars.

Groundfish are caught primarily with otter trawls and gill nets, but some are also caught by longline or in fish traps. Most of the

groundfish fleet consists of small draggers or gill netters less than 70 feet and most boats fish from ports in the western part of the state. A trip catch is characteristically a mixture of several groundfish species.

3.3.2 Biology

The groundfish resources with Maine's territorial waters are a part of the ecologically interrelated groups of fishes that inhabit the broad areas of the Gulf of Maine and Georges Bank. The life histories of some of these species is well known, - cod and haddock for example. However, for most species a great deal more information is needed. In particular, the interrelationships between the various groundfish populations are poorly understood.

Many of the groundfish species are only abundant within Maine's waters during the spring and summer. The bulk of the adult populations is apparently offshore during fall and winter. During spring the fish move shoreward and many enter embayments to spawn.

Several questions concerning the groundfish resources within Maine's waters remain unanswered. Two, for example, are what percentage of the Gulf of Maine groundfish stocks move shoreward into Maine's waters each spring, and to what extent do the Gulf of Maine groundfish stocks depend on Maine waters for spawning and nursery areas. The Maine Department of Marine Resources has collected preliminary information on groundfish movements from its groundfish tagging program. An expansion of this program would add to an understanding of the seasonal movement of fish and the intermixing of stocks.

3.3.3 Laws and regulations

There presently is no groundfish management plan or policy for the state of Maine. Three of the groundfish species commonly taken in the Gulf of Maine - cod, haddock, and yellowtail flounder -are under management ouside of Maine's territorial waters. There are specific Maine laws and regulations that address licensing and reporting procedures for commercial fishermen (12 MRSA:651 and regulations promulgated by the commissioner Chapter I), the taking of lobster by otter trawl (12 MRSA:6952), and the use of groundfish gear in specific areas of the Maine coast (12 MRSA:6571 and regulations promulgated by the commissioner Sections 9, 32, 33, 34, 56-A, 72, and 73-A)

3.4 Redfish

3.4.1 Commercial characteristics

The redfish (Sebastes marinus) is a commercial groundfish important to the state of Maine. Landings from 1970 to 1977 averaged about 33 million pounds. In 1979, the landed weight was 18 million pounds and the value was 3.5 million dollars, which ranked 6th and 4th, respectively, in the 1979 landings and values of all commercial species in Maine.

Redfish are harvested with otter trawls that are adapted to this particular fishery. They are heavy built with large rollers to withstand rocky bottom and they employ small mesh cod ends. Most of the harvesting and virtually all of the processing within the state is conducted by two companies, one in Portland and the other in Rockland (C.E. MaGuire, 1978). Each is vertically integrated, controlling the harvesting, processing, and wholesaling within the company. Each has a

fleet of large trawlers capable of extended trips to distant waters. The recent exclusion of U.S. fishing vessels from Canadian waters has limited the range of the Maine redfish boats to the Gulf of Maine, with the effect of reducing the supply of redfish to Maine processors, increasing the fishing pressure on the Gulf of Maine stock and forcing the companies to diversify into other species of groundfish.

3.4.2 Biology

The redfish, or ocean perch, is a slow growing, cold water fish found in deep waters of the Gulf of Maine and Canadian maritimes. Redfish give birth to live young, are long-lived and are very territorial. It is not clear how a resource with these qualities responds to heavy fishing pressure. A general review of redfish biology can be found in Kelly, Earl, Kaylor, Lux, McAvoy and McRae, (1972). A detailed review can be found in the ICNAF Special Publication No. 3, Redfish Symposium, (1961).

Redfish in the Gulf of Maine and on Georges Bank are assessed as a single stock, but the actual stock structure is not known. At the present time the stock is approaching depletion as a result of poor recruitment and increased fishing pressure. Because the species is slow growing, productivity and surplus yield are low and recovery of stock may be slow once it is depleted.

Most of the present research on redfish is of a monitoring nature and the results are used to assess the condition of the stock. There is a need for further biological research to improve our understanding of the dynamics of the stock in relation to fishing mortality.

3.4.3 Laws and regulations

Redfish are harvested outside state waters. There are no state statutes that regulate this fishery.

3.5 Northern Shrimp

3.5.1 Commercial characteristics

The northern shrimp, Pandalus borealis, is commercially harvested in the Gulf of Maine primarily by Maine and Massachusetts fishermen. The fishery has historically been a Maine inshore winter fishery with recorded landings starting in 1938. Two periods of increased landings indicate a wide fluctuation in abundance with a peak in 1945 of 264 metric tons and a peak in 1969 of 10,993 metric tons compared to no landings at all in the mid 1950s, and low landings in the late 1970s. Landings have remained at a low level to the present time.

Two methods of harvest have been employed. The otter trawl is by far the most common with both the semi-balloon and 4 seam trawls used. In 1970 wire mesh shrimp traps were introduced in Maine and saw gaining popularity until the stocks started falling rapidly in 1974. Traps accounted for only 3% of the Maine catch in their peak year, but still see limited use. The vessels employed in the winter territorial fishery were modified lobster boats from 28 to 40 feet and small draggers from 40 to 55 feet. The fishery in the Fisheries Conservation Zone (FCZ) tended towards larger vessels 45 to 75 feet in length. The winter fishery is predominantly within territorial waters and harvests almost exclusively female shrimp, while the fishery in other seasons is in the FCZ and harvests males and transitional shrimp as well as female shrimp.

3.5.2 Biology

The location and timing of the fishery is dependent upon the migratory behavior of the shrimp. The ovigerous females migrate inshore and congregate in the territorial waters in winter to release their larvae. They then migrate back offshore. The young shrimp remain inshore until they start maturing as males at which time they migrate offshore to function as males at 2 1/2 years of age. They then remain offshore and go through transitional forms to become functioning females at 3 1/2 years of age. At 4 years of age the females will return inshore to complete the cycle.

A considerable volume of work has been done on the biology and behavior of E. borealis in the Gulf of Maine as summarized in the FMP-EIS for northern shrimp (Northern Shrimp Scientific Committee, 1979). A review of this work has indicated several areas of investigation that remain to be explored. These include but are not limited to migration, juvenile behavior, mesh selection for smaller shrimp, age structure, and abundance estimates. Scientists and representatives from Maine, New Hampshire, Massachusetts and the NMFS met in the spring of 1981 to establish directions for future research .

Current research includes collection of landings data and catch/effort and length (age) structure data from biological sampling of the commercial catch, collection of location and length (age) structure information from three separate NMFS cruises, collection of catch per tow and length (age) structure from an August cruise with a fine mesh net, and recruitment and survival studies of larvae. Data from these sources have been used for an annual assessment of the population since 1974. The reliability and usefulness of these assessments have been the

subject of controversy, and were one of the main reasons for holding the spring 1981 meeting. Current information being gathered is considered by some to be inadequate and an attempt is being made to resolve the differences of opinion.

3.5.3 Laws and regulations

The fishery was unregulated until 1972 when a State-Federal conservation program was begun under the auspices of the Atlantic States Marine Fisheries Commission. In October 1973 a minimum mesh size of 1.5 inches stretched mesh was instituted pending completion of a mesh selection study. The study resulted in a 1.75 inch stretched mesh minimum which was adopted in 1975. Closed seasons have been instituted from time to time as well. Despite these regulations, the shrimp stock continued to decline and has remained at low levels since 1977. The management of northern shrimp in the FCZ and in Maine's territorial waters is complicated by disagreement among professionals as to causes of fluctuations in abundance, incomplete enforcement of the mesh regulations and failure to protect the spawning females.

3.6 American Lobsters

3.6.1 Commercial characteristics

The commercial fishery for the American lobster (Homarus americanus) ranks first in landed value among the fisheries of the Northwest Atlantic and usually fifth nationally. In Maine during 1980, the lobster fishery was ranked first in landed value ($41.7 million) and second in total pounds landed (21.9 million pounds or 9,932 metric tons) of all the harvested commercial species. The lobster landings in Maine

over the last 40 years have fluctuated from a low of 7.6 million pounds (3,467 metric tons) in 1940 to a high of 24.4 million pounds (11,068 metric tons) in 1957. About 81% of the 8,460 licensed lobstermen in Maine reported that they fished less than 500 traps per boat in 1979. During that same year, the lobster fishing vessels usually varied in length from 16 feet (4.9 meters) to 45 feet (13.7 meters) with most vessels in the 30 to 40 foot (9.1 to 12.2 meters) class.

There are approximately 56 lobster "pounds" (natural enclosures for holding live lobsters for limited periods) in the State of Maine. These storage facilities can hold approximately 4.2 million pounds of lobsters. The basic operational procedure is to buy commercially caught lobsters (from Maine and Canada) at lower prices during the usually high catch months of August through November (supply exceeds demand), then sell these impounded lobsters at higher prices during January through March when the commercial catch is low (demand exceeds supply). An economic study would be desirable to evaluate the net economic effect of this procedure on the lobster industry (fishermen, dealers, "pound" owners, and consumers)

3.6.2 Biology

A recent tagging study on lobsters revealed that over 90% of the tagged lobsters in the legal size range (3-3/16 to 5 inches, 81 to 127 millimeters, carapace length) displayed a shoalward movement in late spring and summer with a return to deeper water in the late fall and winter; this movement pattern occured mostly within the territorial waters of Maine. However, other tagging studies on larger lobsters (>5 inches, 127 millimeters, carapace length) revealed that some of these lobsters move considerable distances. This movement pattern traversed

the territorial waters of several states and the Fishery Conservation Zone.

The shoalward movement of lobsters makes it possible to study them more readily to determine molt frequency and increment of growth by size. This information can then be used in yield per recruit models in order to aid in management decisions. The total mortality and its two components of natural and fishing mortality also need to be known. In conjunction with this work, studies are necessary on hydrographic and ecological conditions in so-called "nursery areas" for lobsters. This information will help in determining why juvenile lobsters are relatively abundant in some areas and not in others. If these studies are successful, they will eventually lead to understanding the stock-recruitment relationship for lobsters in the Gulf of Maine. Another major item of importance is the continuing collection of catch-effort information in order to establish past and present abundance indices of the natural population of lobsters. At present, the Maine Department of Marine Resources has the only continuing field collections of detailed catch and effort statistics on its commercial lobster fishery when compared with any other state, federal, or Canadian agency. These statistics provide the information necessary to evaluate the possible cause and effect relationships of most lobster management techniques that might be contemplated or enacted.

The New England Fisheries Management Council and the National Marine Fisheries Service are responsible for the development of lobster management plans in the Fisheries Conservation Zone. In view of the findings from past tagging studies on larger lobsters (>5 inches, 127 millimeters, carapace length), these agencies should evaluate the

complete movement pattern of these lobsters. Concurrently, because these larger lobsters are all sexually mature, their importance to the stock-progeny-recruitment relationship, not only in the Gulf of Maine but also in other areas within the geographic range of the American lobster should be determined.

3.6.3 Laws and regulations

MRSA 12, sections 6421 through 6463 cover most of the pertinent laws on the lobster resource in Maine. These laws cover such things as type and quantity of gear, minimum and maximum legal sizes, closed areas or seasons for certain locales.

Because the legal minimum and maximum sizes are important biological and socio-economic considerations, a knowledge of the history of these regulations is essential (Table 3-2).

Table 3-2. History of Legal Minimum and Maximum Size Regulations on Lobsters in Maine

	Year Enacted	Minimum (inches)	Maximum (inches)	Period of Measurement	Method of Measurement
1.	1874	10 1/2	-	all year	one extreme of body to other
2.	1883	9	-	April 1 to August 1	head to tail exclusive of claws or feelers
		10 1/2	-	rest of year	
3.	1885	10 1/2	-	October 1 to August 15	head to tail extended
		9	-	April 1 to July 15	
4.	1895	10 1/2	-	all year	bone of nose to end of bone of middle tail flipper
5.	1907	4 3/4	-	all year	bone of nose to center of rear of body shell
6.	1919	3 1/2	-	all year	rear of eye socket to the rear end of body shell (carapace length)
7.	1933	3 1/16	4 3/4	all year	as above (1919)
8.	1935	3 1/16	5	all year	as above (1919)
9.	1942	3 1/8	5	all year	as above (1919)
10.	1958	3 3/16	5 3/16	all year	as above (1919)
11.	1960	3 3/16	5	all year	as above (1919)

3.6.3 Policy

Based upon the history of the legal minimum and maximum size laws, it appears that the canning of lobsters during the latter part of the 19th century caused the regulations for seasonal legal minimum sizes in the same year. Because of the profitability in the live lobster trade and an improved transportation system, the single legal minimum size by year started in 1895, which effectively eliminated the cannery operation. The subsequent legal minimum and eventually the maximum sizes changed seven times from 1907 to 1958; reflecting poor catch years and the influence of the depression in the 30's. This brief description indicates that economics was the major consideration in these regulations, although the term "conservation" was evoked time after time for most of the size changes.

Nevertheless, a lobster hatchery was established by the Maine legislature in the early 1900's to supplement the "conservation" measures being proposed and enacted. It would appear that recruitment failure was a concern also (influenced certainly by the diminished catches of the 20's and 30's). It is unfortunate that the economic (conservation) and recruitment (hatcheries) concepts were not merged at their inception because these separate courses have evolved into lack of acceptance by the lobster industry of current management proposals that incorporate biological and socio-economic conditions.

The New England Fishery Management Council is reviewing and revising the 1978 State-Federal Lobster Management Plan. After completion, the new plan will be used to manage the lobster resource <u>beyond</u> the three mile territorial (State) waters. Each state has the prerogative to develop its separate lobster management plan <u>within</u> the

three mile zone provided this plan does not adversely affect the management objectives set forth by the New England Fishery Management Council.

The Maine Department of Marine Resources is in the process of collecting biological and socio-economic information, along with continuing discussions of members of the lobster industry to determine the feasibility of developing a lobster management plan for the State of Maine.

3.7 Edible Crab

3.7.1 Commercial characteristics

The commercial crab fishery in Maine exploits the rock crab (Cancer irroratus) and Jonah crab (C. borealis). These two cancrid crabs, which are primarily harvested as an incidental catch in the inshore American lobster (Homarus americanus) fishery, support a small but increasingly important fishery which in 1979 had landings of 1,344,179 pounds valued at $213,616 (ex-vessel price). Compared to the value (ex-vessel) of other commercial species in Maine, crabs were ranked 20th in 1979. Because as high as a third of Maine's total crabmeat production may result from "home picking" operations which is not reported, the true economic value of the crabmeat industry cannot be determined (Cowger 1978).

Seasonal variations in crab landings may be explained primarily by the activities of man and temporal alterations in crab behavior. Catches generally increase in early spring when fishermen begin to set their traps, peak in May-June as the result of prerecruit male rock crabs attaining marketable size after the winter-spring molting season,

and then diminish through the summer and fall due to fishing mortality and the crabs' behavioral changes.

3.7.2 Biology

Although both cancrid crabs occur coastwide, variations in the spatial and temporal distribution and abundance of each species is related to substrate type in association with depth and water temperature. Rock crabs are extremely abundant at inshore areas (estuaries and embayments) characterized by soft mud-sand bottoms, whereas Jonah crabs show preference for more seaward coastal areas having hard bottoms of rock, sand, and clay. In fact, Jonah crab catches apparently increase during late fall-winter when lobstermen move their traps to deeper water.

Based on limited data, the annual variations in crab landings may be attributed to natural population cycles and, possibly, to overfishing in some areas. Two factors tend to self-regulate the industry: one is that it is not economical to pick meat from crabs smaller than about 90 mm (carapace width) in size, so there is a self-imposed minimum size limit in the industry; the other factor is that female rock crabs become sexually mature at a small size (nearly all mature between 70-80 mm CW) and seldom attain CW >95 mm (most females are too small to be of commercial value), thus resulting in a sufficiently large brood stock. This situation may now be changing as the high price and, at times, lack of lobster bait has led some lobstermen to use small crabs as bait. Continued expansion of this practice may have serious consequences on the crab fishery and should be watched closely. Also, if machine processing of crabs is developed it is likely that the smaller females would then be harvested, possibly causing a significant reduction in brood stock.

Considering the paucity of information on Maine's two species of crab (particularly the Jonah crab), it is evident that it is not possible at this time to manage the Maine crab fishery on a sound scientific basis, until such parameters as growth, mortality, stock abundance, and possibly movement are defined.

3.7.3 Laws and regulations

According to Maine Marine Resources Laws and Regulations (revised to September 1979) a lobster and crab fishing license is required for taking crabs unless either bare hands or hook and line are used (method of recreational fisherman). Because most crabs are harvested by lobstermen, the majority of crabs are caught in either the traditional wooden lobster traps or the increasingly common wire trap. Since 1979 all crab (unless exempted by Commissioner) and lobster traps fished in Maine waters are required to have escape vents of prescribed dimensions within the parlor section. Fishermen who wish to retain crabs are encouraged to use the circular vents (57.2 mm diameter) as commercial-sized crabs (>90 mm carapace width) of either species cannot egress through this size opening.

Aside from the incidental crab catch of Maine lobstermen, there is also a small directed crab fishery. Two areas with crab fisheries are the Damariscotta and Sheepscot Rivers, which now, at the request of local fishermen, are closed to crab fishing during the winter months when male rock crabs molt and subsequently yield less meat.

3.8 Sea Scallop

3.8.1 Commercial characteristics

The sea scallop Placopecten magellanicus is harvested by both commercial and recreational fisheries in Maine. The commercial fishery is divided between territorial and Fishery Conservation Zone (FCZ) waters while the recreational fishery is entirely in territorial waters. Recorded commercial landings may not represent the entire catch due to the variety of marketing methods employed in the fishery. No estimate of the recreational landings is available. Landings show roughly a ten year cycle with strong peaks in 1910, 1933, 1953 and 1961 and range from less than 100,000 pounds to more than 2,700,000 pounds. Recent years show the effects of an increased offshore year round fishery. Commercial harvesting methods include dragging and SCUBA diving while the recreational fishery is limited to diving. Steel drags three to four feet wide, either singly or in multiples, and with 3 inch ring mesh bags are commonly used in the fishery but beam trawls and otter trawls have also been employed on appropriate bottom. Wilson and Peters (1978) found that vessels employed in the fishery are typically lobster boats and small draggers in territorital seas and larger draggers in the FCZ .

3.8.2 Biology

There is no biological evidence that different stocks occur within the territorial sea and the FCZ. Scallop larvae are free swimming for approximately 4 weeks and will settle out wherever currents take them. Local scallop abundance appears sporadic and variable and may well be controlled by environmental conditions during their larval stages or at the time and site of spatfall. Once scallops have settled on bottom there appears to be no concerted directional movement, although juvenile

scallops are active swimmers. The existing body of knowledge concerning scallop biology and behavior is substantial but incomplete. Areas requiring further research and information include the scallops distributional relationship to currents, food and bottom type; conditions affecting larval survival and successful spatfall; juvenile life history; parent-progeny relationship; spatial effects on growth, natural mortality, and size at first sexual maturity.

3.8.3 Laws and regulations

At present, the scallop fishery is regulated on the basis of other than biological considerations. No data except landings are gathered and, since a sizeable but unknown percentage of the catch is unrecorded due to sale directly to local markets or consumers, the landings data underestimate the catch. Some socio-economic information has been summarized by Wilson and Peters (1978) and Walton (1980) concerning vessels involved in the fishery and the annual capital and operating cost allocation. Gear types in use are known but percentage by type is not known. In general, existing information is inadequate to manage the Maine scallop stock other than the way it is presently managed: as an off-season inshore convenience fishery for lobstermen and small draggermen in territorial waters.

Laws pertinent to the scallop fishery in territorial waters are covered by MRSA 12:6701-6725 providing for a closed season from 16 April through 31 October, a three inch diameter minimum ring size in the gear and a three inch shell height minimum.

Fishing in the FCZ outside the 3 mile limit is presently unregulated except for the 3 inch shell size if the shells are brought ashore in Maine.

A $25.00 license is required to take more than 2 bushel unshucked scallops, or 4 quarts shucked scallop meats per day. Local restrictions more closely control gear type and size and fishing season in various areas of the territorial waters. These are primarily efforts aimed at restricting harvest rate, eliminating competition from larger vessels and reducing gear conflict with one lobster fishery. The closed season appears to conserve the resource; that it encompasses the spawning season is probably coincidental. The extent of conservation is minimal since the majority of the vessels switch to more profitable fisheries during the spring, summer and fall. With the recent rapid rise in price per pound for scallops the closed season and gear restrictions may better serve to conserve the resource.

3.9 Soft-Shell Clam

3.9.1 Commercial characteristics

The soft-shell clam ,Mya arenaria, landings in Maine for 1979 were 5,193,313 lbs. valued at $7,525,500 to the fishermen. There were 4,142 commercial diggers licensed by the state for digging clams in 1979. The species also supports a sizable recreational fishery of unknown volume and value.

3.9.2 Biology

The basic biology and life history of the soft-shell clam are fairly well known and documented. Such characteristics as the reproductive cycle, larval stages, planktonic period, setting, growth, predator mortality, and fishing mortality have been described in their typical forms.

Physiological reactions in terms of survival or growth in response to salinity, oxygen, and temperature changes have been investigated sufficiently to define critical limits and optimum levels.

The ecological associates of the soft-shell clam are known, but the various interrelationships and their relative importance to clam well-being are not well understood but are under study in Universtiy of Maine, Orono, Sea Grant Projects.

The effects of the fishery on the clam population remaining in the sediment after removal of the harvested clams under conditions of a 2-inch minimum size is fairly well understood. These effects include breakage and burial by the clam fork and the interruption of growth because of repeated digging. There is not enough information on digging efficiency in the absence of a legal minimum size, nor on typical size-distributions of commercial catches.

Many clams are withheld from the market each year in areas closed because of domestic pollution (coliform bacteria) or because of paralytic shellfish poisoning (PSP). In 1979, an estimated standing crop of 1,028,752 bushels of clams were located in areas closed because of domestic pollution. In the past 1980 season, an estimated $8 million loss was sustained by the clam industry because of coast-wide closures due to PSP.

The safety and wholesomeness of harvested clams in regard to domestic pollution and PSP are assured by a monitoring, testing, and enforcement system which conforms to the requirements of the National Shellfish Sanitation Program (NSSP), a tripartite, cooperative program among industry, the producing or receiving state, and the U.S. Food and Drug Administration.

Among the other areas where more information is needed are: determination of natural mortality rates; up-to-date determination of digging mortality rates in the absence of a minimum size limit; development of set and growth enhancement methods; development of refinements in transplanting methods; development of methods of predicting PSP outbreaks and the detoxification of affected clams; and the determination of the physiological effects of such contaminants as oils, heavy metals, pesticides, and PSP toxin.

3.9.3 Laws and regulations

The statutes and laws of the State of Maine dealing specifically with soft-shell clams are included under MRSA 12:6601, 6621-6623, 6651, 6671-6673 and also MRSA 12:6851-6852, 6855-6856. The former cover digging licenses, permitted harvesting methods, closed areas and provision for local management by municipalities. The latter cover wholesale and retail marketing licenses, transportation and sanitation.

Regulations promulgated by the Commissioner define the areas closed for pollution or conservation areas. It has otherwise been the policy of the State to leave management to the individual municipalities.

3.9.4 Policy

DMR's policy toward the soft-shell clam fishery is to: 1) take a strong lead in ensuring the safety and wholesomeness of the clams that go to market; 2) support, advise, and oversee the municipalities of the state in their primary roles as managers of the clam resource according to local priorities and conditions; and 3) continue to seek ways and means of increasing the level of production through such methods as set

and growth enhancement, reduction of natural and fishing mortalities, improvement of transplanting methods, restoration of non-productive or contaminated flats, evolvement of improved and less destructive harvesting methods such as the hydraulic rake, utilization of clams from moderately contaminated areas through supervised depuration plants, and intense PSP monitoring to keep uncontaminated areas open.

DMR's intent to encourage maximum utilization of the resource through the most efficient means practicable has been to some extent overruled by the legislative mandate requiring hand digging only (12 M.R.S.A., Ch. 623, Subch. 1, Art. 2, Sect. 6623).

The options, powers, and obligations of any municipality in regulating its clam resources are outlined in 12 M.R.S.A., Ch. 623, Subch. 1, Art. 4, Sects. 6671, 6672, 6673 and 6674.

3.10 Blue Mussel

3.10.1 Commercial characteristics

The blue mussel (Mytilis edulis) can be found along the entire Maine coast. Commercial harvesting of mussels occurs from Casco Bay to the Machias River. South of Casco Bay mussels are primarily limited to rocky shores with relatively few commercially harvestable beds. Most of this area (York and Cumberland counties) is closed for fecal pollution. Few mussels occur, at least intertidally, between Eastport and the Machias River.

Mussel landings were very high during the period of World War II, reaching a peak production of 2.5 million pounds (173,000 bu.) in 1944. Annual mussel landings since that time have averaged as follows:

Year	Landings (bushels per year)
1947-1956	13,000
1957-1965	2,000
1966-1974	20,000
1975	40,000
1976	80,000
1977	180,000
1978	200,000
1979	200,000

There is no evidence that availability of mussels has been responsible for the historical variations in mussel landings; instead, consumer demand seems to have been the source of this variability.

Maine mussel harvesting methods have evolved as the market demand increased. One of the earliest harvesting techniques was used for intertidal mussel beds and involved beaching a dory on the mussel bed at ebb tide, filling it with mussels during low tide and then floating it off on the flood tide. Harvesting was thus limited by the number of low tides during daylight hours and the height of those tides. A measure of independence from the tidal cycles was gained when harvesters employed long handled rakes and, subsequently, tongs to harvest subtidal mussels. As market demand increased, the harvesting and selling of larger quantities of mussels attracted more sophisticated gear and small day trip vessels began dredging mussels. This was the first significant advance in Maine's mussel harvesting technology and it has induced some problems for the industry. Dredging has provided an ample supply of mussels for the market but they sell at a relatively low price and quality control is negligible. Advances in mussel production technology

will probably occur in the aquacultural field rather than in harvesting and culling technology.

Mussels continue to be a fairly inexpensive food and with other shellfish in short supply they apparently have taken part of this market. Maine fishermen receive a low price for their mussels ($3.00/bu.) and this means that quantity takes precedence over quality. This does not imply that Maine is shipping only poor quality mussels, but the market apparently does not pay for quality and does not expect it.

Mussel aquaculture shows a great potential for a high quality product. Lutz (1979) has discussed the perspective of mussel mariculture. He states in his abstract that, "Mussel cultivation presents an effective means of expanding the resource base, and the accelerated growth and superior quality of cultured mussels makes this product an attractive addition to the industry. Experimental and pilot commercial mussel culture systems have been successful in various areas of the United States (including Maine) and continued expansion of mariculture operations offers the potential for a dependable commercial supply of high quality mussels. To enable production at a competitive cost, labor-intensive processes should be mechanized. Considerable research is required in order to obtain an adequate understanding of the manner in which biological and physical parameters will affect production efficiency of large-scale commercial operations."

While there remain many unresolved biological and production problems in mussel aquaculture, the most serious problems to be resolved are probably social. The conflicting uses of the growing area waters such as boating, recreational and commercial fishing, while not always real, are definite deterrents to developing the full potential of

shellfish aquaculture. These conflicts are currently resolved through the public hearing process involved in the Department of Marine Resources' aquaculture permit system.

3.10.2 Biology

Mytilus edulis is circumpolar in its distribution in boreal and temperate waters of both northern and southern hemispheres. The factor most limiting in its distribution appears to be temperature, coinciding more or less with a maximum surface isotherm of 27°C. Spawning in Maine occurs from June to mid-September.

3.10.3 Laws and regulations

There are no laws regulating the harvesting of mussels per se. Mussels are, however, included in shellfish closures for pollution or paralytic shellfish poison.

3.11 Marine Worms

3.11.1 Commercial characteristics

Two species of marine worms, the sandworm or clam worm Nereis virens and the bloodworm or beak-thrower Glycera dibranchiata are dug in commercial quantities along the Maine coast. These worms are used as bait for recreational fishing on the Atlantic coast, in California, and to a very limited extent in France. The numbers of diggers, the numbers of bloodworms and sandworms harvested, and the value of marine worms dug from and landed in the State of Maine between 1946-1979, are recorded in Table 5. Harvesting is done by hand with a tined hoe, or fork.

3.11.2 Biology

Both species of marine worms inhabit the intertidal sand-silt-clay environment. Generally, sandworms are found in close proximity to the low water mark and bloodworms are found higher in the intertidal zone.

Information on catch per unit effort (catch in numbers per hour) and worm size has been collected for the marine worm industry for the period 1973-1976. However, the present status of Maine's marine worm stocks is unknown, since information on these vital parameters has not been obtained since 1976 .

In addition to a continuous need for monitoring catch/effort and worm size further research is needed to establish (1) the age and growth rates for both species, (2) natural and digging mortality estimates on both species, and (3) the reason for the nearly complete lack of bloodworm spawners east of Sullivan Harbor, Maine. With respect to (1) it is recommended that growth be investigated in situ in various growing areas using tagged worms. The results of age and growth studies could then be applied in deriving natural and digging mortality estimates from open and closed digging areas situated side by side. Further investigation into bloodworm feeding habits and the sediment characteristics of growing areas would also be of value.

3.11.3 Laws and regulations

In view of the fact that commercial marine worm populations are within within the 3 mile limit, the provisions of the Fisheries Conservation and Management Act of 1976 do not apply to these 2 species and only the State of Maine can impose management regulations on the fishery.

Between 1937-1955, nearly 40 local laws were passed in Cumberland, Sagadahoc and Lincoln Counties which prohibited nonresidents from digging worms within the political boundaries of numerous Maine municipalities. These laws were repealed in 1955 when it became apparent that many of these exclusions were motivated by property owners who were trying to prevent trespass rather than conserve marine worm stocks.

Marine worm regulations presently in effect which supposedly reflect management considerations include (1) requirement to take marine worms solely by devices or instruments operated by hand power (MRSA 12:6771), (2) restrictions on the amount of digging effort (no Sunday digging: Marine Resources Laws and Regulations, Chapter F, no. 1) and (3) a very limited restriction on digging area: one closed conservation area at Wiscasset (Marine Resources Regulations, Conservation Areas, Lincoln Co., Wiscasset, Conservation Area 1).

3.12 Seaweeds

3.12.1 Commercial characteristics

The seaweed resources of Maine are considered here in three groups, the commercial, biological and legal aspects being somewhat different for each group. These groups are (1) the brown intertidal seaweeds (rockweeds) chiefly species of Fucus and Ascophyllum, (2) the red lower intertidal and subtidal seaweeds, primarily Chondrus crispus (sea moss) and (3) other types known to have some commercial value, but less abundant than the first two groups and not exploited appreciably in Maine.

Seaweeds of the first group are processed for liquid fertilizer and for cattle and poultry feed supplements as a source of trace elements. The annual harvest reached 1500 metric tons in 1980, and the principal harvester anticipated doubling this in each of the next three years. The landed value is approximately $22.00 a metric ton. This group of seaweeds could be utilized for alginates as is done in Nova Scotia.

Seaweeds in the second group are harvested for carrageenin, an alginate widely used in food manufacture. The nation's largest processor, Marine Colloids, Inc., is located in Maine. Representatives of the company estimate that Maine could produce 7,000 to 13,000 tons of seaweed annually, or about 3 to 4% of the company's requirements. Reported actual landings in metric tons and harvester licenses issued for the past six years are as follows:

Year:	1975	1976	1977	1978	1979	1980
Landings:	1165	2000	1000	607	445	505
Licenses:	285	_	140	104	75	-

The decreasing landings and harvest effort are due in part to the price paid to the harvesters which has increased very little since 1976 in comparison to the returns for effort in other fisheries, such as clams or lobsters.

Several mechanical harvesting devices have been developed but in Maine the industry still remains dependent on hand harvesting. Artificial culture methods have also been developed in Canada, but after five years they have not proven cost effective in comparison with the wild harvest.

No major Maine industry processes the various seaweeds in the third group, although small quantities may be harvested for sale in health and ethnic food stores. The kelps (Laminaria spp.) can be used as a source for alginates in the phycocolloid industry, but none are now so utilized in Maine at the present time.

3.12.2 Biology

Seaweeds in group 1 are largely intertidal, those in groups 2 and 3 largely subtidal. All require clean hard substrate such as rock or shell on which to fasten. Growth is relatively fast and two harvests are often possible in a single summer. In some areas grazing by sea urchins (Strongylocentrotus droehbachiensis) has severely reduced subtidal seaweed stocks. Epiphytic and competing species of undesirable seaweeds sometimes lower the quality of commercial beds.

The sizes of standing crops in various parts of the coast have been estimated for Irish moss (Foster 1953; 1954 a, b; 1955 a, b; 1956), and also for fucoid species (Topinka, Tucker and Korjeff, 1981). Kelps (Laminaria spp. and Alaria) contribute the major seaweed biomass on the coast, and may contribute significantly to the benthic ecosystem as a lobster habitat.

3.12.3 Laws and regulations

A license is required to harvest sea moss (MRSA 12:6801).

3.13 Other species

There were four species that had individual exvessel value of over $50,000 in 1979, but collectively they constituted only about two percent of the total value of Maine landings. These species were: Atlantic menhaden, Atlantic mackerel, swordfish and blue fin tuna.

Menhaden and mackerel are pelagic, schooling fish that support fisheries in the Gulf of Maine during the summer months. Menhaden are taken with purse seines and they are sold for industrial reduction. The fishery is cyclical, fluctuating widely over the years as a result of changing migration patterns of the species. During the past few years menhaden have been very abundant along the Maine Coast and the fishery has been active. Landings in Maine were about 30 million pounds in 1979. Mackerel are popular sport fish and have a limited commercial market. Commercial landings in 1979 were about 300,000 pounds. They are taken by sportsmen with rod and reel and commercially with purse seines.

Swordfish and blue fin tuna are large pelagics that occur seasonally in the Gulf of Maine. They are both sport and commercial species. Swordfish are usually taken commercially with longline gear. Landings in 1979 were approximately 400,000 pounds. The transport and sale of swordfish is restricted by the Food and Drug Administration because of mercury levels found in the fish. Blue fin tuna are primarily a sport fish but there are some commercial catches with harpoons. Approximately 40,000 pounds were landed in 1979.

4.0 CULTURAL FRAMEWORK

4.1 Historical and Sociological Importance of Fisheries to Coastal Communities

The Maine coast is an extensive and complex natural environment. Approximately 2800 miles of coastline and hundreds of snug harbors provide ready access to the sea and have stimulated the development of fishing communities and traditions. Some of these traditions have persisted since the Europeans began fishing the Gulf of Maine in the 15th and 16th centuries.

Aboriginal inhabitants exploited the marine resources of the Maine coast for centuries prior to the arrival of the Europeans. Mounds of oyster, clam and quahog shells, bones of sturgeon, swordfish and cod and remains of brush weirs are remnants of these activities and give evidence of ancient fisheries.

European fishermen, nearly 400 years ago, sought groundfish from the Gulf of Maine. They established fishing stations where they could repair their boats, dry and salt their catch, and live for a portion of the year. These grew into small fishing villages, and by 1636 Kittery Point, Winter Harbor, Damariscove, Pemaquid, New Harbor, Monhegan, Saint George, Matinicus and others were well established. In these towns a fisherman could process his catch, sell it to others and obtain gear and supplies needed to continue fishing.

The early settlers found both the rivers and the ocean rich in fish. Each year the anadromous fish returned to spawn, providing an abundant supply of food, bait and fertilizer. Alewives, smelts, shad, sturgeon, blue back herring and salmon were easily caught and utilized

as they migrated from the coast up to one hundred miles inland, thus providing a fishery to the developing inland settlements. Gradually, as industrial development put dams on the rivers, sawdust and soil silted the spawning areas and sewage contaminated the waters, the anadromous fishery all but disappeared. Only recently under the Anadromous Fisheries Act has restoration of this fishery begun and now provides some coastal communities with a sport fishery and bait industry.

The historic development of Maine's commercial fisheries and how it relates to the coastal communities has been summarized by Acheson, Acheson, Bort and Lello (1980) and Acheson and Reidman (1980). Many of Maine's coastal towns were established because of the fishing industry. Up until 1775 Maine's principal export was salt cod, but during the 18th century, the fishing industry broadened rapidly. Lobsters, herring, mackerel, menhaden, scallops and clams were harvested in addition to groundfish. Most of these fisheries developed within coastal communities, and family and kinship groups were the participants. The harvesting was done largely with small sailing vessels within relatively local waters and shore based processing facilities such as sardine factories, menhaden factories, salt fish processing plants and lobster pounds were established within the coastal communities.

Today there are 144 coastal communities in actual contact with the sea. They are scattered along a corridor bounded by the head-of-tide and the sea. Over one-half of the state's population lives in this area, which makes up less than twelve percent of the state's land mass. There are sixty eight ports along the coast from which some kind of fishing is conducted. Two of these, Portland and Rockland, are major fishing ports where substantial landings are made by larger, offshore

vessels. The remainder are small communities with a heavy dependence on inshore fisheries; lobster, herring, scallops, clams/ mussels, worms and to some extend, groundfish. Most of the boats from these ports are small, fished from by one to three persons, and rarely spend more than three days at sea. During the year, as different species of fish are sought, gear is constantly being shifted, thus, permitting these fishermen to switch between lobster trap, gill net, scallop dredge, long-line
or trawl. These towns are inhabited by persons of Maine origin who are proud and independent. Most of the inhabitants can trace their ancestry back to the town's founding fathers and a strong feeling of ownership prevails. Fishing rights, activities and positions are closely tied to family and kin. Fathers, sons and grandsons often are involved and carry out the fishing while women maintain the homes and operate the businesses. The vast majority of these fishermen begin as lobster fishermen, move into finfishing during their prime fishing years and then return to lobstering in their old age.

Formal education varies widely among fishermen. The amount of formal education has little bearing on success in the fishing industry. Fishing is a highly skilled activity that requires actual experience as part of the learning process. Few schools provide such activities. Age, not schooling, seems to be the major factor in innovation. Persons between the ages of 35 and 50 are most likely to adopt larger boats, newer navigational equipment and new fishing gear.

The actual economic value of fisheries to Maine's social structure is difficult to determine. Home, land and fishing rights are often kept

within the family. These three factors often influence who fishes, where they do it, and to what extent they are involved. Outsiders must meet rigorous social standards before they may participate freely in these activities. Interestingly, with these strong ties to the fisheries, the people are far more committed to the area than the occupation itself remaining where they are and accepting new occupations when fisheries fail.

4.2 Common law origins of fisheries policy

The marine and estuarine fisheries of Maine are predicated on the Free Fishing and Fowling Colonial Ordinances of 1641-47. In 1672 they were amended to become a part of our common and statute law and are so recognized and enforced today. After amendment the new version became:

> "Every inhabitant who is an House Holder, shall have free Fishing and Fowling in any great ponds, Bayes, Coves and Rivers, so far as the Sea Ebbes and Flows within the precints of the Town where they dwell, unless the Freemen of the same Town or the General Court have otherwise appropriated them.
>
> Provided that no Town shall appropriate to any particular person or persons, any great Pond, containing more than ten acres of Land, and that no man shall come upon another's propriety without their leave, otherwise than as hereafter expressed.
>
> The which clearly to determine:
>
> It is Declared, That in all Creeks, Coves and other places about and upon Saltwater, where the Sea Ebbs and Flows, the Proprietor, of the Land adjoyning, shall have

> Propriety to the Low-water mark, where the Sea doth not Ebbe above a hundred Rods, and not more wheresoever it Ebbs further.
>
> Provided that such Proprietor, shall not by this liberty have power to stop or hinder the passage of Boats and other Vessels, in or through any Sea, Creeks, or Coves, to other mens Houses or Lands.
>
> And for great Ponds lying in Common, though within the Bounds of some Town, it shall be free for any man to fish and fowle there, and may pass and repass on foot through any man's propriety for that end, so they trespass not upon any man's Corn or Meadow."

This states in effect that anyone and everyone has access to the marine resources. While the riparian owner apparently owns the land of the intertidal zone, the owner cannot restrict the public's use of this zone.

These common laws established the concepts of a common property resource and free-enterprising fisheries in Maine. Their purpose was to protect the right of the public to the resource, but not to protect or conserve the resource itself. Over the years, as the fisheries increased and fishing technology improved, the need for some restrictions on the exploitation of the common resource was necessary for the common good. These types of restrictions have been enacted either by legislative statute or regulatory authority of the Department of Marine Resources (12 MRSA). Thus, laws and regulations that restrict access to the resource in some way have been enacted from

time to time. They usually have included restrictions on the time, method or location of fishing or on the amount of fish that could be caught.

We can consider that historically two fundamental fisheries policies have developed in Maine. One is that the marine resources are in the public domain and that everyone has access to them, and the other is that the resources must be conserved. The former is socio-economically oriented and the latter is resource oriented. Obviously, at times, these policies may be diametrically opposed. Thus, in our current problems of fisheries management, the desire to increase harvesting capacity and flexibility, to improve processing capacity and to create new markets are at times pitted against the desire to perpetuate the resource. Free enterprising fishermen and processors have in many cases developed the traditional adversary relationship that has existed between commercial fishermen and government agency which might curtail their activities. One of the greatest tasks in the management of Maine's marine fisheries is to reach an accommodation between these two policies.

5.0 ECONOMICS AND DEVELOPMENT

5.1 The Harvesting Sector

5.1.1 Commercial fisheries

Maine landings in 1979 included 53 species of finfish, shellfish, marine worms and seaweed. The catch totaled more than 232 million pounds and was valued at more than 82 million dollars. Shellfish accounted for 65 percent of the value and 14 percent of the total weight, while finfish accounted for 32 percent of the value and 85 percent of the total weight.

Although the total marine harvest is comprised of a large number of species, much of the value and volume is accounted for by a relatively few species. Ninety percent of the 1979 total value and 77% of the poundage was derived from 10 species (Table 5-1). The lobster fishery contributes a large portion of Maine's total landed value, while the finfish catch, principally herring and redfish, contributes a large portion of the landed weight. Since 1947 the lobster fishery has accounted for 40 to 65 percent of the landed value, but less than 12 percent of the landed weight. The herring and redfish fisheries have contributed 43 to 76 percent of the landed weight since 1948, but no more than 30 percent of the landed value.

Gear types used in the Maine fishery are almost as numerous as the number of species harvested. Statistics collected for 1976 indicate that 17 types of gear were used to harvest the catch. Otter trawls, purse seines and gill nets accounted for 90% of the volume and value of finfish, while traps, dredges and hoes accounted for 85% of the volume and 98% of the value for shellfish.

Table 5-1 1979 Maine Landings with Ex-vessel Value of More Than $50,000

Species	Rank	Thousand of Dollars	Percent of Total[b]	Rank	Thousands of Pounds*	Percent of Total[b]	Rank	Dollars per Pound
Lobsters	1	39,901	50	3	22,133	10	4	1.80
Clams, Soft	2	7,508	9	10	5,193	2	7	1.45
Herring	3	4,584	6	1	89,375	38	24	.051
Dab	4	4,171	5	6	11,641	5	15	.36
Scallop, Sea	5	3,878	5	17	1,164	-c	2	3.33
Ocean Perch	6	3,534	4	4	17,837	8	20	.20
Haddock	7	2,591	3	8	6,247	3	13	.41
Cod	8	2,598	3	7	10,366	4	17	.25
Pollock	9	2,305	3	5	13,139	6	22	.18
Gray Sole	10	1,525	2	12	2,657	1	11	.57
Bloodworms	11	1,434	2	26	113**	-c	1	12.69
Sandworms	12	1,109	1	24	363	-	3	3.06
Menhaden	13	760	1	2	30,005	13	30	.025
White Hake	14	719	1	9	5,299	2	25	.14
Mussels	15	716	1	11	3,000	1	19	.24
Swordfish	16	631	1	23	392	-c	6	1.61
Anglefish	17	339	-	20	730	-	12	.46
Blackback	18	312	-	18	986	-	16	.32
Cusk	19	298	-	15	1,467	1	21	.20
Crabs, Rock	20	214	-	16	1,344	1	23	.16
Yellowtail	21	168	-	21	430	-c	14	.39
Crayfish	22	151	-	14	2,314	1	26	.065
Halibut	23	146	3	28	89	-	5	1.65
Alewives	24	131	-	13	2,476	1	28	.053
Eels	25	89	-	27	111	-	9	.80
Mackerel	26	84	-	25	334	-c	18	.25
Skates	27	64	-	22	399	-	24	.16
Tuna, Bluefin	28	58	-	30	43	-	8	1.33
Shrimp	29	51	-	29	72	-	10	.71
Seaweed	30	51	-	19	890	-	27	.057
Total		80,108			230,609			.347
Total for all Maine Landings		80,271			232,283			.346
Percent a contributes to b		99.8			99.3			

c All species contributing less than .05% were left blank. All 14 of these account for about 3% of the total landed weight.

* All weights are for whole organisms except clams, mussels (whole meats), and scallops (adductor muscle).

** Calculated from DMR estimates of 172 bloodworms or 82 sandworms per pound. (Maine Landing use estimates of 44 bloodworms or 40 sandworms per pound).

The precise number of vessels operating in the commercial fisheries at present is not known. However, estimates for the years 1976 through 1978 are available from several sources. The U.S. Dept. of Commerce, 1980, listed 217 "vessels" (over 5 gross tons) and 7,508 "motor boats" (under 5 tons) as operating units in the Marine Fisheries. This comprised 25% of the New England "vessel" fleet and 49% of the "motor boat" fleet. The U.S. Coast Guard documentation records show that there were 300 commercial fishing vessels (over 5 gross tons) that claimed home port in Maine in 1975 and that this number had grown to 600 in 1978. During this three year period, 54 new vessels were added annually. Finally, Acheson, Acheson, Bort and Lello (1980) provide a tally of fishing craft operating from each of 69 Maine ports during 1978. The number of vessels over 25 feet that were engaged in each major fishery were: lobster, 1899; groundfish, 269; herring, 82; scallops, 212; and redfish, 11. These counts cannot be totaled because many vessels are engaged in more than one fishery and therefore may have been tallied several times. This publication also indicates the numbers of fishermen engaged in each fishery and the types of gear used.

The DMR has begun to process more thoroughly the information obtained on license applications. A more precise tally of the vessels used in the 1981 fishery will be available at the end of November when all license applications are tabulated.

There were 6 types of commercial fishing licenses issued by the State of Maine in 1979, including lobster and crab (55%), commercial fishing (7.5%), scallop (4%) and sea moss (0.5%). In 1979 there were 15,220 commercial fishing (harvester) licenses issued. Between 1952 and 1967 the number remained fairly constant, ranging from a high of 9,603

in 1954 to a low of 8,345 in 1952. After 1967, total license sales increased to a high of 18,915, then declined to 15,220 in 1979. Total license sales are not the best measure of employment in the harvesting sector but they do indicate trends. The three references discussed in relation to vessel numbers provide a more detailed analysis of employment by fishery, gear types, vessel size, and by location. Since a large proportion of the licenses issued are obtained either by persons harvesting for their own use or persons fishing for seaweed species (i.e. some fishermen hold as many as 4 different license types) it is difficult to acertain just how many people earn a significant (50%) portion of their living fishing.

The strategy that prevails in the Maine fishery is aptly described in Maguire, (1978) as follows:

> "The Gulf of Maine, unlike the waters of southern New England, contains an abundance of commercial species relatively close to shore. Most Maine fishermen have adapted to this situation by shifting between species as the seasons change rather than learning to chase one species throughout its range. As a result, with a few notable exceptions, Maine's has been a day or at most an overnight fishery. Through the years of successfully doing this, making a living close to home has become a primary objective for the Maine fishermen."

Important seasonal rhythms are: (1) the inshore movement or aggregation of juvenile herring in late spring and summer, (2) the decrease in lobster activity in the fall (a result of cooling water temperatures), (3) the opening of the inshore scallop season (Nov. 1 - April 15), (4) the decreasing frequency of good weather in fall and

winter, (5) the shrimp season in late winter and early spring, and (6) the movement of groundfish into the coastal waters during the spring.

In addition to the seasonal and biological rhythms, there are "economic" and "regulatory" factors that weigh heavily in the present switching strategies. The economic factors are: (1) personal indebtedness (the fleet size doubled between 1975 and 1978 adding about 54 new vessels annually); (2) sudden and dramatic price increases or decreases (resulting from new markets, loss of old ones, increased demand, scarcity of competing products, etc.); (3) availability of alternate employment in the homeport; and (4) cost of fuel and competition from foreign imports.

Management regulations have exerted an increasing influence upon the switching strategy in recent years. State regulations that have considerable impact are: the closed season for shrimp, the minimum size limit and closed season for scallops, and the adult herring quota and seasonal closures. Federal regulations include quotas and closures of the adult herring and groundfish fisheries outside Maine territorial waters.

In Maine the predominance of the small boat - day trip - fishery switching strategy has been viewed as hindering the industry's ability to realize the full potential of the so called "200 mile limit" legislation (Maine DOT,1979). While extended jurisdiction provides some opportunity to increase the catch in the Gulf of Maine waters, the most promising fishing area is Georges Bank. It is here that most of the fish harvested by the foreign fleets were taken. Fishing in the offshore waters requires larger vessels than are utilized by the traditional Maine inshore fisheries. (less than 5% of Maine

Vessels exceeded 70 feet in 1980). Not only are larger vessels needed to fish the offshore area safely but they are needed to fish economically for the "underutilized" or low value species that were caught by the foreign fleets. In 1979, Georges Bank landings comprised only 3% of Maines total landed value, and most were high value species such as swordfish, scallops, haddock and flounder.

Even on the inshore fishing grounds the days fished are reduced for the small vessels. Less than 1/3 of the vessels fishing for groundfish report any activity for a given month between October and March (Fisheries consulting Group 1980).

Small vessels that are more vulnerable to the vagaries of weather, and a high percentage of vessels that switch from fishery to fishery are also viewed as an impediment to developing consistent supplies of high quality groundfish. Many of the small vessels do not have fish holds and a high percentage of those that do have no facilities for refrigeration.

5.1.2 Recreational Fisheries

There are 63 marine species associated with recreational fisheries in Maine and there are directed fisheries of some magnitude involving 26 of the species. Some of these are mixed species fisheries such as the mackerel-harbor pollock fishery and the groundfishery for cod, pollock, cusk, haddock and hakes. The majority of these fisheries have no significant effect on the abundance of the resources and management to control fishing mortality is not necessary at this time. Atlantic salmon, rainbow smelt, brook trout, brown trout and shad require management because their particular life cycle requirements make them more vulnerable to overfishing. Except for salmon, management regulations and policies for these species are jointly handled by DMR and the Maine Department of Inland Fisheries and Wildlife. Atlantic salmon are managed by the Atlantic Salmon Commission. Striped bass and bluefin tuna may also require regional state/federal management because of excessive fishing mortality.

There are no explicit statutory responsibilities for oversight of the marine recreational fisheries vested in any state agency. The Department of Marine Resources has implicit management responsibility by virtue of its authority to manage marine species and should be involved in the development of a definitive state policy for the management of these recreational fisheries. The Fisheries Conservation and Management Act of 1976 (MFCMA) requires that recreational fishing be considered in the computation of optimum yields and that allowable catches be divided between commercial and recreational fisheries. These provisions may ultimately result in the development of recreational fishery management policies at the state and state/federal levels of government. State

management policies could encompass a number of species and fisheries that are not managed under the MFCMA and the state may, as necessary, plan for the management of all marine anadromous and estuarine species which support a recreational fishery within the territorial waters of the state.

There are four major user groups in the Marine recreational fisheries: party boat fisheries, charter boat fisheries, private boat fisheries, and the shore based fishery. Data on these fisheries are extremely sparse although the state-wide annual economic impact of the Maine recreational fisheries may exceed 50 million dollars; i.e., roughly one sixth the economic impact of the commercial fisheries.

Associated support industries include marinas, bait and tackle shops, charter and party boats, fish wholesalers and retailers who purchase sport catches and the usual array of tourist industries such as motels and restaurants. The diversity of the fisheries and the complexity of the support industry linkages complicate economic evaluations and thus impact estimates are, at best, approximations. The estimated economic impacts, excluding landed value and induced multiplier effects, for the fishery groups are: party boat fishery, $2.4 million; charter boat fishery, $1.7 million; private boat fishery, $24.2 million. Data are totally inadequate for the shore based fisheries but their combined economic impact probably matches that of the private boat fisheries; perhaps $24 million.

Statutory regulations and licensing requirements for most of these support industries are administered by authority of federal and state agencies. Fish dealers who buy sport catches and fishermen who sell their catch must be licensed by DMR. Charter and party boats have federal (Coast Guard) licensing requirements concerning passenger safety while at sea.

5.1.3 Aquaculture

Commercial characteristics

There are more than 50 aquaculture ventures in Maine; two-thirds of these have reported commercial sales to date. Nearly 60% of Maine's aquaculturists have been in business for three years or less. Total gross sales in 1979 were about $450,000; a minimum of $3 million in total gross sales is envisioned by 1985 if adequate financial investments are made in the industry. (Fisheries consulting group and Maine aquaculture plan steering committee, 1980). Primary species cultured are European oysters, Ostrea edulis, and American oysters, Crassostrea virginica. Other commercial scale ventures involve rainbow trout, Salmo gairdneri, blue mussels, Mytilus edulis, and a single lobster-culture operation. Hard clam, Mercenaria mercenaria aquaculture is in its early development stages. All aquaculture operations are within state waters, primarily utilizing shallow water areas in coves and estuaries.

Culture Methods

Oysters: Seed oysters are raised in hatcheries in the spring and take approximately 10 weeks to reach 2-3 mm in size. At this size they are ready for sale to growers, although some growers prefer larger (12 mm) seed. The growers then hold the seed oysters in large tanks or suspend tham from rafts in bay water until they reach about 25 cm. Oysters are then placed on the bottom in flats or trays or hung by lantern nets for growing.

Mussels: Wild seed mussels are obtained by scraping stock from the rocks. They are usually suspended from rafts in mesh bags and grown to marketable size.

Rainbow trout: Rainbow trout (Salmo gairdneri) are native to the Pacific coast drainages of North America to Baja, California. Fingerlings (2.5 to 16.5 cm) are sold to trout farmers and raised in raceways, ponds, etc. Depending on water temperature and diet, marketable sized trout (20 to 35 cm in the U.S.) can be produced in 7-14 months after eggs are fertilized.

Constraints to Development of Aquaculture

Expansion of aquaculture activity is impeded by a variety of biotechnical, economic, legal and socio-cultural factors. Hatchery systems capable of delivering adequate supplies of seed shellfish and smolts are lacking, requiring their importation from other states. Also needed are improved spawning processes and juvenile nursery systems. Inconsistent product supply, the lack of well coordinated market development efforts and insufficient leverage in the market place due to low overall supply are among the marketing-related obstacles faced by the industry. An additional economic obstacle is the scarcity of capital for financing local aquaculture ventures. Problems related to the leasing of water and bottom rights, conflict with other water and land uses, inappropriate or unclear institutional responsibilities for research, technical assistance, and regulatory matters, and other legal issues must be resolved if the industry is to prosper.

Environmental factors constitute an additional constraint to the development of aquaculture. For example, European oysters are sensitive to low temperatures and can die when subjected to water temperature very much below -1.5°C, particularly for a prolonged period of time. Since an oyster grower must wait two and a half to three years for his first harvest, he is at the mercy of Maine's winters with mortalities which may exceed 90%.

Disease control and prevention is one of the most pressing needs facing aquaculture development in Maine. The dangers of introducing disease into the state and subsequently transferring disease from one area to another within the state are severe. Since Maine's three oyster hatcheries are unable to supply enough spat for our growers, approximately 5 million oysters (primarily O. edulis) per year has been imported from the West Coast, mainly from California hatcheries.

Massive mortalities of Ostrea edulis have recently occurred in Europe, apparently originating from introduction of shellfish with microcell disease from the West Coast of the U.S. or Canada. In addition, Mytilicola orientalis (red worm disease), a relatively non-specific parasite endemic to the West Coast, is capable of infecting shellfish on our East Coast, including American and European oysters, soft-shell clams and blue mussels. Therefore, to protect endemic shellfish stocks, Maine has banned further imports of live shellfish from the West Coast.

Research and Development Priorities

Research and development needs currently faced by the industry are beyond the financial ability of Maine's current aquaculturists. These include improved hatchery, spawning and nursery systems which will provide adequate supplies of seed stock and result in more energy-efficient production, genetic research aimed at the development of improved broodstock and seed production which will provide large seed early in the season. Since imports of live shellfish from the West Coast have been prohibited, Maine hatcheries require increased financial support in their development of a hardier, faster-growing Maine oyster stock. Furthermore, the state needs additional funds to support the

costs of pathological examination which are performed as a service to the industry.

Laws and regulations

Maine has several regulations which protect its waters from the introduction of harmful marine organisms and which promote the development of the aquaculture industry. MRSA 12:6071 states that it is unlawful to introduce or import for introduction into any coastal waters any live marine organism or to possess any of those introduced or imported organisms without a permit issued by the Commissioner. In addition, the Commissioner may take what steps he deems necessary to assure that live marine organisms imported into Maine are free of pests/predators/diseases that may be dangerous to indigenous marine life or its environment.

MRSA 12:6072 gives the Commissioner exclusive power to lease areas in, on and under the coastal waters including the public lands beneath those waters and portions of the intertidal zone for scientific research or for aquaculture of marine organisms. This section gives limitations of the lease, need for municipal approval, application requirements, review, hearing procedures, rents, lessee's actions, and conditions for revocation and renewal requirements.

MRSA 12:6073 states that each lease for aquaculture shall be exclusive for the species and to the extent provided by the Commissioner in the lease.

MRSA 12:6074 states that the Commissioner may issue a special license for research or aquaculture which exempts the holder from one or more marine resouces' laws relating to the time, place, length, condition, amount and manner of taking or possessing any marine organism.

5.2 Economic status of the fisheries

5.2.1 Importance of the fisheries to Maine's economy

There can be no doubt that with an annual exvessel value approximating 100 million dollars Maine's marine fisheries contribute significantly to the state's economy, but the actual economic value of the fisheries is difficult to define. The exvessel value is not a good indicator of total contribution because economic activity is a complicated web of interdependent behavior and to evaluate that activity requires that the changes occurring throughout the economy as a result of fishing be considered.

The most comprehensive study of the economic relationship of Maine's fisheries to the rest of the economy was conducted by researchers at the University of Maine at Orono in 1979-80. The study was supported by the DMR and funded by Maine's coastal zone program. The results are given in Wilson, Duchesneau, Briggs, Rollins, Burlingame and Williams (1980) and updated in Briggs, Townsend and Wilson (In press). The study featured an input-output analysis of the harvestor and processing sectors from nine fisheries within a thirty-seven sector model of Maine's economy. The most important products of the analysis were "income multipliers" which estimated the income generated per dollar of fisheries output, that is, they estimated the value added throughout the economy as a result of a given transaction. These multipliers are presented in Table 5-2. As a result, it was determined that maine's fisheries generated $239 million within the state in 1980, or 3.1% of Maine's personal income of $7.7 billion.

The estimated in-state income of the harvesting and processing sectors for each fishery component is given in Table 5-3 and demon-

Table 5-2. In-State Income Multipliers For Nine Fishing Industries

Industry	Income Multiplier
Harvesting Sectors	
Clam	1.54
Worm	1.65
Herring and Menhaden	1.47
Lobster, crab and scallop	1.38
Groundfish	1.32
Processing Sectors	
Clam and worm	.64
Groundfish	.54
Herring and Menhaden	1.03
Lobster, crab and scallop	.48

Note: Processing figures do not include income generated in fish harvesting sectors.

strates that the unique characteristics of each fishery is reflected in its particular contribution to the total economy. The lobster/ crab/scallop fisheries are dominant in terms of income to the economy when the combined sectors are considered. Of particular interest, however, is the relative value of different fisheries within sectors. For instance, in the harvesting sector the low value of herring relative to lobster/ crab/scallop and groundfish reflects differences in exvessel price and the way in which the fisheries are conducted. In the processing sector, herring is the biggest income generator because of the complex and labor intensive methods of processing. The total contribution of the herring fishery to the total economy, therefore, is not clearly indicated by its landed value.

Table 5-3. Estimated in-state income from the harvesting and processing sectors of nine fishing industries, 1980. (Briggs, Townsend and Wilson, In press).

Industry	Gross Output	Estimated Income
Harvesting sector		
Groundfish	$19,697,000	$ 26,000,040
Herring and menhaden	6,427,000	9,447,690
Lobster, crab, and scallop	52,670,000	72,684,600
Clams	8,554,000	13,173,160
Worms	2,499,000	4,123,350
Total	$89,847,000	$125,428,840
Processing sector		
Groundfish	$18,021,000	$ 9,731,340
Herring and menhaden	56,509,000	58,204,270
Lobster, crab, and scallop	70,872,000	34,018,560
Clam and worm	17,507,000	11,240,480
Total	$162,909,000	$113,194,650
Combined sectors		
Groundfish	$ 37,718,000	$ 35,731,380
Herring and menhaden	62,936,000	67,651,960
Lobster, crab and scallop	123,542,000	106,703,160
Clam and worm	38,560,000	$ 28,536,990
Grant total	$252,756,000	$238,623,490

Economic status of principal fisheries

Maine's primary commercial fisheries include groundfish, herring and shellfish. Each of these fisheries function as an integral unit, with its own harvesting, processing and market supply characteristics; each makes its own unique contribution to the economy as previously shown, and each has its unique problems of production logistics, and marketing. For these reasons it is necessary to examine component fisheries separately to determine their economic characteristics and status.

The Groundfish. Landings for these finfish species are generally dispersed along the coast but show major concentrations in Portland, Rockland, and other southern and mid-coastal locations. To a large extent, the location of processing plants reflects the location of landings. Despite recent trends toward larger vessels and increased operating ranges, the groundfish fleet is dominated by short trip boats. Therefore the availability of Maine-landed groundfish supplies is seasonal and inconsistent, depending as it does upon migrations of prime species close to shore as opposed to the pursuit of the resources over their entire migratory range. Larger vessels capable of more extended and directed fishing activities are forced by high operation costs, current management quotas and Maine market limitations to divert from groundfishing to higher value species such as scallops, thereby accentuating inconsistencies of supply.

The decentralized nature of Maine landings together with difficulties in obtaining market supplies on a regular and predictable

basis, deprive Maine processors of the volume thresholds necessary to compete effectively in profitable, high volume markets for finfish products. Difficulties in aggregating significant volumes of product in one location frustrate standardization of product handling procedures necessary for effective quality control. It is primarily these factors which often force Maine processors into opportunistic, spot trading market situations as opposed to establishing longer term market commitments which would eventually result in "demand pull" from the marketplace and would tend to stabilize supply. As a result of its spot market position and generally poor market leverage, Maine ships much of its valuable raw product to Massachusetts and New York markets for further value-added processing. In addition, large amounts of whole, Maine-landed groundfish flow northward into the Canadian-controlled salt fish market.

Thus the groundfishery is fragmented horizontally, with respect to geography and market cohesiveness, and vertically, with respect to the useful integration of production, operational and marketing functions.

Reversal of these circumstances calls for a new, commonly held market development strategy. This need raises two fundamental questions: 1) what is the optimum market use for the Maine groundfish resource, considering the particular capabilities of the industry and 2) how could the industry organize itself to consolidate market control and compete against large scale producers outside Maine for access to high volume, high profit markets. In response to the first of these questions, a state-sponsored industry development process has resulted in a clear set of market choices based upon a thorough analysis of the volume thresholds, costs of access, profit potentials, and risks

associated with various market categories. These choices indicate a fresh, premium quality, high volume, distant, domestic, retail market for a Maine source identified product as having the most potential for Maine groundfish.

Answers to the organizational question were less clear. This question is complicated by problems such as 1) the degree of market control any organization representing industry would exert between individual groundfish producers and the marketplace (i.e.: ability to own fish, take profits, act as broker, or to commit private processors to sell their products) and 2) how such an organization would raise money to accomplish its purpose. Answers to these questions continue to reflect long-standing economic divisions between harvesting and processing interests within the industry.

In November, 1979, Maine voters approved a $12 million bond issue to finance improvements for public fish piers. The state investment was to be supplemented by a major commitment of grants and loan guarantees by EDA to complete several pier development projects located along the coast. Since the federal government appears now to be withdrawing its current funding commitments, it is possible that only the Portland project will proceed on the scale originally planned. The Portland fish pier will function to modernize the fishing operations at the State's major landing location. It could even be a major factor for Maine interests in consolidating their market control over the Maine landed resource. But the potential economic value of the Portland pier could be offset to some extent by the failure of companion pier projects to proceed as planned.

Herring. Most of the herring processing industry on the East Coast of the United States is located in Maine. There are 19 major herring processing plants in the state which employ roughly 1500 people in the processing sector alone. An estimated 2900 people were employed in the entire industry in 1977 (C.E. Maguire Co., 1978 and New England Fisheries Management Council, 1978). The herring processing industry generates the most income of any fishery processing sector in the state (Table 5-3).

The herring industry produces sardines and steaks as a canned product for primarily a domestic market and frozen fillets, smoked and pickled herring primarily for export. The sardine segment of the industry is the oldest, dating from late 1800s, and probably the most stable. Production is seasonal because it is based on juvenile herring caught in inshore waters during the summer and fall. The adult processing segment of the industry developed during the 1970s with the opening of European markets for herring fillets. It depends on supplies of highly migratory adult herring. It is less seasonal than the sardine processing segment because of the availability of raw materials from a variety of times and locations, but it suffers from considerable market instability.

One of the chief characteristics of the herring processing industry is the extreme variability on both the supply and demand sides. On the supply side, the abundance and availability of herring can vary considerably between years, particularly in the juvenile fishery which depends each year on the abundance of single, recruiting year classes. On the demand side, there is market instability, particularly in the adult segment, because of a lack of stable domestic markets. Foreign

markets develop and then soften within a few years, as is the case of the European frozen fillet market.

The herring resource in the Gulf of Maine is probably being fully utilized today and major increases in output from one processing segment will probably be at the expense of the other if the long term supply of raw material is not to be depleted. The return of the massive stocks of herring on Georges Bank, which were depleted during the early 1970s, would substantially increase potential supplies of raw materials to the U.S. herring industry.

Shellfish. Lobsters, clams and scallops are being harvested very nearly to the constraints of resource abundance. Several towns are setting hatchery-reared clams on their flats. Although these clams will add only nominal amounts to the total supply, similar experiments elsewhere have demonstrated improved natural sets apparently drawn by the hatchery reared stock. Offshore fisheries for scallops and lobsters are growing. Both of these species are harvested inshore and landed at many ports along the Maine Coast; the larger, offshore scallop boats require better port facilities than their inshore counterparts.

Because lobsters are usually sold whole and may be held live, success in marketing lobsters hinges to a large degree on overcoming inventory problems such as shrinkage and the timing of sales. Although no hard data exists, probably more than 70% of the lobsters harvested in Maine are consumed elsewhere. Typically, lobsters are trucked to Boston and flown from Boston to cities across the U.S. Clams, and to some extent scallops, are hand shucked onshore. Although many small firms are shucking clams in Maine, about half of the total harvest is sold to wholesalers and retailers in other New England states and New York by a

few large firms. These firms often handle scallops as well. Consumption of lobsters and clams in Maine is considerably augmented by summer tourism.

At the state level, DMR monitors clam flats for the appearance of Paralytic Shellfish Poison; this program is a critical garantee that clams are free of toxins. Finally, the Maine Department of Environmental Protection, using Federal grants, has undertaken a vigorous program of establishing human waste treatment facilities. Goggins (1975) estimated that one-fifth of the productive clam flats in the state were closed due to excessive pollution. The benefits of cleaner waterways are not limited to clams, however, but extend to all species that, during some stage of their life, dwell in estuarine waters.

5.2.2. Market and price factors

A quite simple and reasonable economic argument can be constructed that, other things being equal, higher prices for a species will attract more fishing effort and lead to larger catches. Unfortunately, meeting the Ceteris parabus conditions in empirical work in fisheries is quite difficult. When actually looking at the relation between price and output, we must consider demand as well as supply. In technical terms, exogenous shifts in demand are required to "identify" the supply function. In fisheries work, one generally finds that supply is subject to substantial exogenous shift (because of changes in stock availability), so demand functions are relatively easy to identify. Demand estimation for New England species, has been recently reviewed by Bockstael (1977). Corresponding exogenous changes in demand which identify supply equations are difficult to isolate. This is reflected in a virtual absence of estimated supply functions for multi-species fisheries in the economic literature.

How fishermen respond to price fluctuations is obviously an interesting question for any management authority. Unfortunately, no one seems to have developed an adequate methodology to deal with the underlying econometric problems. Consequently, the Department of Marine Resources does not have quantitive estimates of this relationship. and the Department is not currently spending research money in this area. This reflects the Department's feeling that the limited services of economists which are available to it would not be well utiluzed on highly speculative basic research. The Department remains interested in the research being performed elsewhere, and may well be interested in following up methodological advances discovered elsewhere.

A considerable amount of work is underway in New England to estimate supply functions, especially for groundfish. The New England Fisheries Management Council has funded researchers at the University of New Hampshire and the Charles River Associates of Boston to estimate supply functions of the New England ports for groundfish. Researchers at the University of New Hampshire and the University of Maine/Orono are involved in on-going projects that attempt to understand the institutions which underly supply functions.

5.2.3 Major barriers to development of more prosperous fisheries

The barriers to fishery development may be important singly or in combinations and are frequently species-specific. The general categories of such barriers (with examples of specific characteristics included) are as follows:

1) harvester access to the resource

- legal barriers to entry to the fishery
- harvesting technology insufficient for the resource
- gear conflicts precluding effective harvest of the resource

2) biology of the resource

- limited abundance
- inadequate quality
- instability of biomass or yield

3) research needs

- exploratory fishing
- gear development
- dynamics of populations
- predator or disease control

4) inefficiency of harvesting gear

- inappropriate selectivity for pre-and post-spawning organisms - gear damage to resource - excessive by-catches
- fuel and cost inefficiencies

5) inadequate harvesting and processing capabilities

6) excessive harvesting and processing capabilities ("over capitalization")

- excessive removals from the resource
- wasteful use of capital

7) lack of markets

8) lack of access to markets

- impractical transportation
- quality or product form not acceptable to markets
- seasonal unavailability of resource in relation to market demand
- lack of consolidation of product and reliability of supply to meet market demand

9) inter-jurisdictional restraints

- discriminatory fishing restraints
- incompatible management objectives
- fragmentation of or insufficient management resources

The matrix in Table 5-4 identifies the major barriers to optimum development of important Maine fisheries by species. It identifies those fisheries which are now fully exploited and it indicates possible improvements in the use of those fully-exploited resources. It indicates whether the state has identified or implemented policy or remedial action. Footnotes provide explanation.

It must be kept in mind that implementation of biologically or economically more efficient harvesting techniques of fully-exploited species may be contrary to over-riding social objectives for resource use. The best example in Maine is the statute prohibiting the inter-tidal use of hydraulic clam dredges: The implementation of formal state management policy in such fisheries will, therefore, entail thoughtful and informed political decisions if the overall best use of the resources are to be realized.

TOB65-4

Figure Major barriers to development of more prosperous fisheries and state policy towards those fisheries. Footnotes provide explanation.

	Barriers to development										Management Policy		
	Access to Resource	Biology of Resource	Research Needs	Inefficiency of Gear	Harvesting or Processing Capability	Overcapitalization	Markets	Access to Markets	Inter-jurisdictional Restraint	Resource Fully Exploited	Possible Improvement of Use	State or DMR Policy Identified	State or DMR Policy Implemented
Clams	1/		2/	3/					4/	X	5/	X	
Crabs					X		6/						
Lobsters			7/			X				X	8/	X	9/
Mussels										X	10/	X	X
Scallops		11/	12/							X		13/	
Shrimp		11/	12/							X		13/	
Worms			14/							X		13/	
Anadromous Fish		15/										X	16/
Groundfish	1/						17/		X		18/	X	19/
Herring		X	12/						X	X		13/	20/
Ocean Perch	21/	22/								X			
Aquaculture			23/		23/		17/				23/	23/	23/

1/ harvesters partially restricted by regional or local legal restraints
2/ conditions affecting recruitment; green crab predation control
3/ breakage by clam hoes
4/ regional management limited by multiple jurisdictions
5/ hydraulic dredges rakes improve yield and harvesting efficiency
6/ market insufficient to stimulate full utilization
7/ conditions controlling year class strength and recruitment
8/ "ghost traps" reduce biomass harvest; trap vents reduce percentage of cull lobsters
9/ regulatory hearings proposed on "ghost traps"
10/ reseeding for improved growth
11/ recruitment or biomass apparently highly variable
12/ conditions affecting recruitment and year class strength
13/ research in progress
14/ reseeding of depleted flats; factory producing productive flats; conditions affecting spawning and recruitment
15/ resources significantly below historic levels of abundance
16/ environmental quality control and fish passage construction in progress
17/ substantial improvement is possible
18/ more fuel-efficient harvesting is possible; gear type affects quality control
19/ industry-state market development program in progress
20/ Maine Herring Plan
21/ industry prohibited from traditional supply in Canadian waters
22/ Gulf of Maine resource is small and slow growing
23/ identified in A Development Plan for Maine's Aquaculture Industry. June 1980.

5.2.4 Prospects for future change

When projecting the future expansion of Maine's fisheries, it is useful to distinguish between those fisheries whose expansion is biologically constrained, and those where expanded landings are biologically feasible. For most of the resources which have dominated Maine's fishing industry -- lobsters, clams, scallops, and herring -- expansion is pretty closely tied to biological availability. Unless stocks increase for environmental reasons, these sectors will not expand. The only potential for increasing economic value from these sectors rests upon increasing price. For example, the recently developed market for herring fillets has substantially increased the market value of adult herring. Other such fundamental marketing changes are not anticipated in these "mature" fisheries.

There have always been a number of small fisheries which undergo cyclical expansion and contraction. For example, market prices are currently supporting an expansion of crab landings and processing. Basically, crabs are a by-product of the lobster fishery and are marketed when price is sufficiently high. Processing is done by lobstermen's families or by clam shucking operations. Some shellfish, such as periwinkles and mussels, are attracting harvesting effort at this time. Overall, it does not seem realistic to expect dramatic expansion of these fisheries.

There are several potential fisheries that could expand but presently lack market development, processing capability or knowledge of the size of the potential resource. For instance, ocean quahogs have no market in the state and their potential harvest is unknown, or squid could be a viable fishery if either a domestic or foreign market was developed. None of these fisheries,

however, are seen to have the potential to become a major fishery within the state.

Of the major fisheries, only groundfish seems to have the potential for substantial expansion. This fishery has increased dramatically since the enactment of the MFCMA, and some further expansion is almost inevitable. The present barriers to expansion - horizontally with respect to geography and market cohesiveness, and vertically with respect to the integration of production, and marketing - have been identified in 5.2.3 and 5.2.2. Whether this fishery will expand to become the mainstay of the Maine fishery economy remains to be seen.

In addition to the stated economic barriers, several additional factors are beyond Maine's direct control, but are oriented to significant expansion. They include: 1) management policies of the New England Fisheries Management Council, 2) condition of the stocks in the Georges Bank and the Gulf of Maine, 3) cost competitiveness of Maine's fleet and 4) growth of the groundfish market in general.

6.0 INSTITUTIONAL STRUCTURES AND MANAGEMENT

6.1 Functional relationships among public entities

The Department of Marine Resources deals with many state agencies in carrying out its responsibilities as specified under - 12 M.R.S.A. Section 6022 (11):

> 11. Interagency cooperation. The Commissioner shall consult with, offer advice to and cooperate with the State Planning Office, the Department of Environmental Protection, the Department of Inland Fisheries and Wildlife and the Department of Conservation in carrying out his duties, and these agencies shall do the same in carrying out their duties. Cooperation shall include the exchange of information and the filing of copies of any application, petition, request report or similar document which may bear upon the responsibilities of any of these departments. Details of those exchanges shall be worked out by the heads of the departments.

and Section 6051:

> §6051. General department activities
>
> The department, under the direction of the Commissioner, may conduct or sponsor programs for research and development of commercial fishery resources and other marine resources of the State which may include biological, chemical, technological, hydrological, processing, depuration, marketing, financial, economic and promotional research and development. The department may carry out these programs within the department, in cooperation with other state agencies, and federal, regional and local governmental institutions, or with private intitutions or persons.

The following institutions are described as to purpose, what they do in the marine area; and how they interact with Department of Marine Resources.

6.1.1 Intra-state agency relationships

The Department of Environmental Protection (DEP) was established to protect and improve the quality of the natural environment and the resources that constitute it, and to enhance public opportunity to enjoy the environment. It is authorized to direct growth and development.

The department, through authority vested in the Board of Environmental Protection, is empowered to control, abate and prevent the pollution of air, water and coastal flats so as to prevent diminution of the highest and best use of natural environment of the state. Three subdivisions of the department are involved in marine areas.

Land Quality Control. This bureau administers nine environmental laws, including the Coastal Wetlands Act. Proposed alterations of wetlands are investigated by DMR area biologists who evaluate possible impacts on marine resources and fisheries. DEP staff and/or Board either approve, approve with qualifications, or reject proposed alterations. Marine Patrol Officers take enforcement action on wetlands violations in cooperation with DEP enforcement personnel.

Water Quality Control. This bureau is responsible for reviewing the quality of Maine's waterways and its Division of Licensing and Enforcement is accountable for issuing waste discharge licenses. DMR area biologists and Resource Services Personnel evaluate applications for possible effects on the bacteriological quality of shellfish producing waters and flats. DMR supplies the Attorney General's Department and DEP with data on water quality and shellfish to enforce the water quality laws. Assistance is also given to Sanitary Engineers in locating treatment facilities and discharges in order to minimize harmful effects on marine species.

Oil Conveyance Services. This division administers the requirements of the Coastal Conveyance Act and the Oil Discharge Prevention and Pollution Control Regulations. It is responsible for oil spill prevention

programs out to 12 miles and the supervision of oil spill cleanup activities. The discharge and transfer of oil are licensed. A coastal protection fund of $6,000,000 was established from license fees.

DMR Personnel conduct research work on oil pollution; they investigate oil spills, evaluate impacts on marine species and assist with attendant problems. DMR biologists are under contract to DEP to inventory valuable inshore commercial marine species in specified areas. In the event of oil spills, such information can be used to plan protection for marine species, and settle claims for damages to the resources.

Department Inland Fisheries and Wildlife.

The Department of Inland Fisheries and Wildlife (DIFW) was established to ensure that all species of wildlife and inland aquatic resources are maintained and perpetuated for their intrinsic and ecological values, for their economic contributions and for their recreational, scientific and educational use by the people of the state. The jurisdiction of the Inland Fisheries and Wildlife is above the head of tide, and that of the Department of Marine Resources is below in each coastal river system. DMR and DIFW are most closely allied in the following activities:

Anadromous fish. These resources are a shared responsibility. Both departments have concurrent jurisdiction over sea run salmon, shad, alewives, and smelts wherever found. The Commissioner of DMR serves on the Atlantic Salmon Commission and staff biologists serve on the Atlantic Salmon Research Committee.

Recreation safety and registration. This division was established to register boats and to promote safe boating in both coastal and inland waters. DMR and DIFW Commissioners act jointly in making rules.

State Planning Office (SPO)

This office was established to strengthen the planning and management capabilities at all levels of government. One of the main responsibilities of SPO is to coordinate the development and conservation goals of the State.

DMR has worked closely with the Coastal Program since its inception in 1970. Under this program, DMR has received contracts funded by the Coastal Zone Management Act of 1972 and administered through SPO by the Office of Coastal Zone Management, NOAA, Dept. of Commerce. With this financial assistance, DMR programs were developed such as trawl surveys, economic planning, a landings data management system and a state aquaculture plan. Help was also given to programs that documented the location and nature of waste discharges into coastal waters and shellfish management activities. CZM funds were also used to assist towns with shellfish and anadromous fish mangement and pier development.

The Governor's Committee on Coastal Development and Conservation, administered by SPO, met from 1975 to 1979. The Commissioner of the Department of Marine Resources served on the Committee, and staff aided in public meetings and evaluations of recommendations for expanded marine oriented programs in the state. A bond issue was successfully voted by Maine citizens to earmark matching funds for pier development and other associated assistance to the fishing industry.

Federal Consistency. As a part of the CZM Act this provision allows the state to review all federal action taking place in the coastal zone. The SPO coordinates the review by state and local agencies. DMR examines federal activities and actions to determine if they are consistent with the laws that it administers. As an example of the use of this provision, DMR gathered information and presented biological, ecological, and economic data and evaluations at formal hearings on the proposed exploration for oil on Georges Bank. The bank is important to Maine as a spawning, nursery area, and migratory route for fish important to Maine's economy.

Shoreline Zoning Law. This is administered by the SPO in conjunction with the Board of Environmental Protection and Land Use Regulatory Commission, and provides for State Shoreland Zoning Ordinances where a local ordinance does not comply with the mandatory Shoreland Zoning Act. Municipalities are advised on matters relating to shoreland zoning. DMR Area Biologists and Research Personnel aid local communities and regional planning commissions in supplying information regarding marine resources and fisheries.

State Development Office

The two major statutory functions of this office are industry and tourism development. DMR Commissioner and staff work with this agency in furnishing fisheries data, and cooperating primarily in Industrial Development and World Trade.

Department of Human Services

The purpose of this department is to protect and preverve the health and welfare of Maine citizens. Many Bureaus, Divisions and

Programs address these needs and functions. DMR is most closely associated with the following activities:

Division of Health Engineering. Community Environmental Health Program. The surveillance of food services in restaurants and other establishments involving licensing and sanitation inspection by the division is significant to DMR because they serve clams, quahogs, mussels and oysters that have been harvested and processed under the department's shellfish sanitation program. A cooperative agreement details the responsibilities of the Department of Human Services whenever it becomes necessary to embargo or destroy shellfish being held or served in eating places, because of a public health emergency caused by paralytic shellfish poisoning.

Waste Water and Plumbing Control Program. This program governs the quality of potable water, the land sub-surface disposal of home waste products. The program is important for the protection of shellfish producing flats and the installation and function of plumbing in shellfish processing plants that are under DMR shellfish certification program.

Department of Agriculture, Food and Rural Resources

Part of this agencies function is to protect the consuming public against harmful and unsanitary products and practices. The department, established in 1901, has the authority to establish and promulgate standards; to inspect facilities, products and conveyors; to enforce these standards; and to issue licenses and certificates.

The Commissioner and staff of DMR work closely with this agency in accomplishing common tasks related to health concerns in the areas of

seafood and especially shellfish (clams, mussels, quahogs, oysters). A Memorandum of Understanding, signed jointly by DMR with Departments of Human Services and Agriculture, specifically sets forth the duties of each at the time of a paralytic shellfish poisoning.

Department of Conservation.

Land Use Regulation Commission (LURC). This unit of the Department of Conservation is concerned with planning for the proper use of resources and guiding land use activities in order to preserve ecological values by preventing inappropriate development and pollution. Policies are implemented through zoning and a permit system. The agency also has responsibility for all state owned marine lands below high water, coastal wetlands of more than 10 acres, coastal areas containing townships, plantations and 116 coastal islands. Under the Site Location of Development Act, projects in excess of 20 acres or more than 60,000 square feet are evaluated for environmental impacts. Municipalities may grant permits for subdivisions of between 20 and 100 acres if they meet certain criteria.

The DMR has worked with this agency in considering problems in the use of marine flats and waters in the unorganized areas of the state. DMR staff present data at hearings, and for Board and DEP staff review and evaluate proposals in light of possible adverse impacts on the marine environment or neighboring municipalities.

DMR has worked with the Division of Municipal Services, Sanitary Engineers in the Construction Grants Program by supplying resource information for locating waste discharges of municipal waste water treatment facilities. Information supplied about shellfish productivity is also considered on a priority basis for financial assistance to the towns.

The Bureau of Public Lands. Was established to bring more attentive rational and businesslike management to the public lands of the State. The Bureau is authorized to lease the right to dredge, fill or erect permanent causeways, bridges, marinas, wharves, docks, or other permanent structures on state-owned submerged or intertidal lands. The Bureau manages the submerged lands in order to secure an economic return to the public from large-scale commercial use but exempts small or noncommercial users from fees. The DMR has worked with this agency in evaluating the effects of development on marine resources and the fee structure on different types of projects.

Attorney General Department

The Attornery General's primary responsibility is to protect public rights, and preserve order through serving as the State's Chief Law Officer and legal representative of the State. An Assistant Attorney General serves as counsel to advise the Commissioner of DMR in legal matters involving his responsibilities for the marine resources and fisheries and also represents the State in boundary litigations and in dealing with the Federal Government regarding fisheries and Outer Continental Shelf matters.

6.1.2 Intra-State Commissions and Councils

Soil and Water Conservation Commission

This commission was established to provide for the protection, proper use, maintenance, and improvement of soil, waters, and related natural resources of the state of Maine. The Commissioner of Marine Resources serves on the commission and department staff furnish infor-

mation on marine resources and fisheries for planning studies and programs in coastal areas.

Maine Marine Resources Commission

This Commission was established to advise the Governor and several departments, bureaus and offices of the State problems associated with the marine resources of the state. The primary activity of the Commission has been in the matter of the marine boundary determination between Maine and the provinces of New Brunswick and Nova Scotia. The Commissioner of Marine Resources serves as an Ex Officio member as does the State Geologist. The other three members are appointed by the Governor.

Maine Land and Water Resources Council

The purpose of the council, which is composed of the heads of public institutions is to advise the Governor, Legislature and state agencies on the development of a comprehensive, integrated land and water resources planning and management program for Maine. The state planning office administers the program. DMR has actively participated on issues impacting on the marine environment, particularly the effects of hydropower development on fisheries; the Half Moon Cove Tidal Project in Cobscook Bay; and the development of fee schedules for the use of all public lands, including intertidal and subtidal areas.

Maine Sardine Council

This organization was established to promote, develop, and stabilize the Sardine Industry. A tax on each case of sardines provides funds for the program. The Council consists of seven industry members appointed by the Commissioner of Marine Resources.

The Commissioner and staff of DMR work with this organization in areas of biological research and fisheries management.

Maine Development Foundation

The Development Foundation is a quase-public entity which works with private industry to create economic activity. In carrying out this role with the fishing industry the emphasis has been issues relating to industry, marketing, quality control and organization.

Coastal energy impact programs

This program was established to help communities and the state accommodate new energy facilities and assist the Governor in his allocation of discretionary federal economic funds. The DMR worked on this program to gather, evaluate and present data on the fisheries of the Georges Bank area and possible impacts of offshore-oil oil explorations and production.

6.1.3 Inter State Commissions and Councils

Atlantic States Marine Fisheries Commission

The Commission's purpose is to promote better utilization of the fisheries in state waters through a compact between the 15 Atlantic coastal states. The Commission consists of 3 representatives from each state, one of which is the executive officer of the agency charged with the conservation of the fisheries. The Commission's duties are to determine the condition and circumstances of the fisheries and recommend to state administrators and legislatures procedures that will prevent depletion and physical waste of the resourcs. By authority of amendment number one and upon agreement of two or more of the consenting states, the Commission may be designated as a joint regulatory agnecy for a specific fishery within the consenting states' jurisdiction.

The authority by which Maine enters into this campact is stated in 12 MRSA, Sections 4651-4656. The Commissioner of the DMR is granted all the powers provided for in the compact and all the powers necessary to carry out the compact in every particular,

> "it being declared to be the policy of the state of Maine to perform and carry out the said compact and to accomplish the purposes there of." (12 MRSA: 4653)

The Commissioner of DMR and staff have been active in the Commission's business since World War II. The Commission, through its amendment number one authority, regulates the northern shrimp fishery in the Gulf of Maine. The northers shrimp section of the Commission, comprised of the Commissioners from Maine, New Hampshire and Massachusetts, promulgate regulations for the management of this fishery.

New England Fisheries Management Council

The New England Fisheries Council is a quasi-federal agency established under the Magnuson Fisheries Conservation and Management Act (MFCMA). The Council develops and recommends management policies for marine fisheries in waters that extend from the outer boundaries of the state's territorial waters to the 200 mile limit. The state of Maine is represented on the Council by the Commissioner of the DMR, who is one of 17 voting members. The Commissioner and his staff are therefore involved in the development of fisheries policies for the New England region and the coordination of regional policies with those of the State of Maine.

6.1.4 State/federal relationships

U.S. Environmental Protection Agency (EPA)

EPA was established to protect the environment from pollution and to assist states in developing pollution abatement facilities. Funds are channeled through the Maine Department of Environmental Protection (DEP). A program was completed by Department of Marine Resources, in cooperation with DEP and EPA, that identified sewage outfalls from houses along the entire coast.

Federal Food and Drug Administration

This agency and its federal predecessors in cooperation with the states and the shellfish industries extablished a National Shellfish Sanitation Program in 1925. Maine and other shellfish producing states follow guidelines and have passed laws and regulations to implement certification programs. DMR is wholly responsible for this program in Maine. Coastal flats and waters are classified as closed or open for shellfish harvesting on the basis of the bacteriological quality of the waters and the absence or presence of waste discharge. The certification program requires that all Maine wholesale shellfish dealers and transporters conform to specific standards of facilities and operations. A sophisticated monitoring program has been established to detect and evaluate the levels of marine toxins (paralytic shellfish poison) in filter feeding shellfish. Flats and waters can also be closed under standards set by the National Program.

National Marine Fisheries Service (NMFS)

NMFS is responsible for marine fisheries research and the implementation of fishery policy in federal waters. The DMR interacts with NMFS in many areas.

Enforcement. DMR and NMFS enforcement officers work cooperatively to ensure that both federal and state laws and regulations are observed.

Statistics. The collection of fisheries statistics is a joint federal/state effort in Maine. Federal port agents in Portland, Rockland and Eastport are assisted by state statistics personnel in collecting landings data and scientific samples for processing and analysis.

Research. Much of the fisheries research activity conducted by DMR's Bureau of Marine Research is funded by NMFS through state-federal grant programs. There is considerable cooperative fisheries research being conducted between the Northeast Fisheries Center in Woods Hole and the DMR Marine Research Laboratory at Boothbay Harbor.

Seafood Quality Inspection. This service was established to perform inspectional and quality control work. The Department of Marine Resources has a contract with the federal government to carry on the service. The DMR is designated by statutes as "The State Agency which shall be responsible for coordinating with the federal government in developing and administrating a voluntary fish product inspection program." State inspectors are trained and cross licensed by the federal government to carry out the requirements of this activity.

6.2. Effect of MFCMA on management and development of state fisheries

The regulations promulgated under the Magnuson Fisheries Conservation and Management Act (MFCMA) apply to an area from the outer boundary of the state's territorial waters to a point 197 nautical miles seaward. These regulations influence the management and development of Maine's fisheries in different ways, depending on the nature of the

resource. Some of Maine's fisheries are conducted exclusively within the state's territorial and inland waters on resources that are essentially non-migratory. The soft-shell clam, mussel and marine worm resources are examples. The management and development of these resources are unlikely to be influenced by actions under the authority of the MFCMA. Another type of fishery is conducted extensively within the state's waters, but the resource is transboundary in nature. The stocks, or management units, occur within both state and federal jurisdiction, as is the case with the Atlantic herring and sea scallop. In this instance the regulations developed for the fishery Conservation Zone (FCZ) will affect the management and development of the fisheries within state waters. A third type of fishery is conducted primarily outside state waters on a resource that is trans-boundary, but is relatively unavailable within state waters. The redfish resource is an example. In this case, management within state waters may not be greatly affected by MFCMA regulations, but the development of the fisheries, which depend almost entirely on catches within the FCZ, will be.

In New England there are presently two fishery management plans in place under the MFCMA. One of these is the Atlantic Herring Plan. The Herring Plan has two objectives; one is to achieve spawning stock biomass levels of herring in the Gulf of Maine and on Georges Bank at which relatively stable recruitment is likely to be sustained over time, the other is to stabilize and rebuild the sardine industry by appropriate managment of the Gulf of Maine juvenile herring stock. The plan identifies the state of Maine as having primary responsibility for the management of the juvenile herring stock because most juvenile herring are found in Maine's territorial waters.

The Herring Plan establishes an allowable catch level of herring age 3 and older north of Cape Elizabeth. The catch allocation applies to Maine's territorial waters as well as federal waters and is divided into two periods: July to November and December to June. The herring fishery north of Cape Elizabeth is conducted from June to November and almost entirely within Maine's territorial waters, therefore the allowable catch of age 3 and older herring north of Cape Elizabeth, as established under the MFCMA, has been the basis for allocation to the herring fisheries in Maine's waters by means of the State of Maine's herring management plan. The state's plan is an attempt to adapt the catch level desired on a regional scale to the realities inherent in the state of Maine's herring fisheries. These adaptations and the reasons for them are discussed under the herring resource section (3.2).

The other management plan under the MFCMA is for groundfish (cod, haddock and yellowtail flounder). The groundfish plan is essentially a collection of management measures that was carried over from pre-MFCMA days (prior to 1977) and implemented under emergency regulations in order to protect these three species until a more formal and studied plan could be devised. The plan has no explicit objectives, although the rebuilding of once depleted stocks is implied. The plan has not been a success for many reasons and patchwork measures designed to improve it have only added to the complexity and ineffectiveness of groundfish management in New England waters.

The groundfish plan calls for quarterly catch allocations for each species in the Gulf of Maine (5Y). It also specifies weekly trip limits by vessel class and a minimum mesh size for otter trawls and gill nets. The catch of cod, haddock and yellowtail within the state's waters is a

small percentage of the total Maine landings of those species and even less of the present allowable catch in 5Y (Gulf of Maine). The State of Maine, therefore, has no catch allocation system within its jurisdiction, although it does regulate catch reporting.

The development of Maine's groundfish industry is very directly effected by MFCMA regulations, since most of the state's landings come from the FCZ. The groundfish fleet is comprised primarily of small draggers or gill netters (up to 70'). Most fish out of ports in the western part of the state. A trip catch is characteristically a mixture of cod, haddock, several flounder species, hake, whiting and redfish, depending on availability and market price. The present MFCMA regulations, which limit the catch of cod, haddock and yellowtail flounder and restrict the mesh size employed to catch them, has been difficult, if not impossible, to enforce within the FCZ and when complied with, the regulations have caused disruptions in the normal practices of the fishery. The future development of Maine's groundfish industry will, among other things, depend on a reasonable access to the groundfish resource in the Gulf of Maine.

One of the difficulties in successfully applying more or less uniform regional regulations to fisheries throughout New England and Mid-Atlantic waters is that fisheries differ in many aspects between areas. Regional regulation, therefore, may have very different consequences within a state's waters from what the intent was within the FCZ, depending on species and local circumstances. The problem from the regional perspective is that loopholes created by uncoordinated regulations in state waters can lead to ineffective enforcement of regulations in the FCZ. The problem from the state perspective is how to

maintain the unique and successfully established qualities of their territorial fisheries with managment measures that often are not suitable to them.

Maine has experienced these problems in attempting to coordinate its policied with those established within the FCZ for herring and groundfish, and quite likely will experience problems after the proposed Atlantic Sea Scallop Plan is implemented.

For herring, the problem has been the unique characteristics of Maine's inshore juvenile fishery which at times can take substantial quantities of age 3 herring which are under quota in the FCZ.

For groundfish the problem has been that the cod, haddock and yellowtail that are caught in Maine's waters are usually only part of a mixed trip catch. The small Maine draggers fish for about 14 groundfish species in the same areas and with the same gear. It is very difficult to apply a quota management system for only three species on this type of a fishery.

For scallops the problem will be the minimum shell size. Maine has an active inshore scallop fishery which is regulated in part by a legislative statute specifying a minimum shell size of 3 inches. This law has been in effect for years and is widely accepted by the industry. The industry uses dredges and culling equipment and has adapted its shore based shucking operations to be compatible with this minimum size. The Federal Management Plan is directed at the offshore scallop fishery and will probably be implemented with a larger minimum size which, from a regional perspective, is most suitable to obtain the plans objectives.

These are difficult issues to resolve and in some cases the viability of certain segments of Maine's Territorial fisheries could be effected by the outcome

6.3 The role of local Government in fisheries management and development

Local governments are authorized by statute to manage or control, within their municipal boundaries; shellfish in the intertidal zone and coastal waters, alewives in riverine areas, and weir fishing. A bill to allow municipalities control over the taking of marine worms in a shellfish growing area, was defeated in the 110th Legislature.

Forty one coastal towns practice some form of shellfish conservation under the provisions of 12 MRSA:6671, which states:

> "Shellfish conservation ordinance. Within any area in the intertidal §one or coastal waters in the municipality, a shellfish conservation ordinance may regulate or prohibit the taking of shellfish; may fix the amount of shellfish that may be taken; may limit the size of soft-shell clams; may fix the qualifications for a license, including municipal residency; may fix license fees; and may authorize the municipal officers to open and close flats under specified conditions. No program or ordinance shall regulate areas closed by regulation of the Commissioner. An ordinance may also provide for enforcement, protection and evaluation of a green crab fencing program."

The concept of local government managing the shellfish resources using monies raised by taxation is not new. Special laws originated from Colonial Ordinances allowing towns to take care of their resources and to implement management based on conservation policies. Currently this is being accomplished by adopting various management methods such as rotating the growing areas, evaluating predator control and surveying the resource to determine growth rates, size distribution, standing crops.

This resource is best regulated at the municipal level with technical assistance provided by state marine resource agencies. Various municipalities have different management goals based on socio-economic circumstances. Physical and biological differences occur between areas and towns and must be managed accordingly.

While local knowledge of the industry is important, professional advice in surveys, data collection and evaluation, and management techniques are available by trained biologists.

In recent years there has been increased interest by local governments in soft-shelled clam management for several reasons. Green crab predation increased in 1972 which threatened to decimat clam populations in many of the most productive flats. Also in 1972 a hurricane destroyed a substantial portion of the Maryland clam populations, thus placing a heavy demand on Maine stocks. Finally, the State Supreme Court ruled that digging requirements, such as residency, could only be imposed by the towns if they were justified by adequate resource data and proper conservation methods.

The alewife fishery within a municipality may, upon authorization by the Commissioner of the DMR, be managed by the town. These rights must be renewed periodically and must be accompanied by a harvesting plan which specifies harvesting conditions and include proper conservation practices.

The authorization for the location and operation of fish weirs is also the responsibility of local municipalities. Except in the case of unorganized townships where the Commissioner is the regulating authority. This authority is applied most commonly to herring weir operators where application is made to local town officials to establish a weir.

In the future the expansion of the local municipalities involvement is the management of the clam resource will depend on the resolution of some key legal issues which are currently being refined by the judicial process. The Municipalities serve an important mechanism for optimizing production for a significant resource which is now under great harvesting pressure and natural loss due to green crab predation.

6.4 Contributions made by non-government groups

Fishery cooperatives and associations make important contributions to the economic welfare of each Maine community in which they are located. These organizations exist to meet the wide variety of fishery needs of the fishing community they serve.

The United States Fishery Cooperatives Act of 1934 provides that "persons engaged in the fishery industry, as fishermen, catching, collecting, or cultivating aquatic products, or as planters of aquatic products on public or private beds, may act together in associations, corporate or otherwise, with or withoug capital stock, in collectively catching, producing, preparing for market, processing, handling and marketing in interstate anf foreign commerce, such products of said persons so engaged." Any gourp of fish and shellfish producers, organized and operating in compliance with its provisions, is considered a fishery cooperative within the meaning of the act.

In Maine, fishery cooperatives may be organized under the Fishery Marketing Act of 1959 (Revised Statues of Maine, Ch. 56-A) or the special cooperation law (Revised Statutes of Maine, Ch. 49, Sec. 3, et Seg.) and general corporation law (Revised Statutes of Maine, Ch. 49,

Sec. 8, et Seg.) under the former, the certificate of incorporation is recorded in the Registry of Deeds in the county where the principal office is to be located and a copy of the certificate is filed with the Secretary of State. Under the latter, the certificate of incorporation is recorded in the county where the corporation is located. A copy is filed with the Secretary of State.

In 1980, there were 862 members of fisherman's cooperatives organized into 17 cooperatives. In addition, 811 lobstermen belonged to one of four lobstermen's associations (Maine Lobstermen's Association, Western Casco Bay Lobstermen's Association, Eastern Casco Bay Lobstermen's Association and Southern Maine Lobstermen's Association). The Maine Fishermen's Cooperative Association composed mostly of draggers and seiners had a membership of 140 fishermen. In the Portland area a group of draggers formed Vessels Services, Inc. a type of cooperative effort to obtain fuel and ice at reduced rates.

These organizations provide a great deal of political pressure on local, state and federal governments and speak out loudly for their own interests. Since the enactment of the fishery Conservation and Management Act of 1976, these organizations have been extremely vocal on a wide range of topics that effect their livelihood.

The educational community impacts the fisheies through a wide range of formal and informal activities. Three coastal Maine school regions (Region 10 - Eastern Cumberland-Sagadahoc County, Region 8 - Knox County and East Machias) recognize the importance of the fisheries to the community and their students. They have developed regional vocational high school programs emphasizing boat maintenance and repair, engine mechanics, deck hand skills, fishing techniques and net mending. These

same programs offer similar adult educational programs for active fishermen.

The greatest impact of these programs lies in the introductions of newer and/or a wider variety of practical skills and ideas to participating fishermen in a semi-formal situation. Another result of such a program is the improvement of school-community relationships.

Two post-secondary vocational school programs are impacting upon fisheries and other marine activities. Washington County Vocational-Technical Institute has a commercial fisheries school and boat building school. The fisheries school stresses skills involved in the large boat fisheries and should have an impact on the future crews of larger commercial vessels. Less resistance to change because of a familiarity with a variety of techniques and theories should help improve the fleet. The boat school is impacting on both the commercial and the recreational fisheries through design and quality construction. Southern Maine Vocational-Technical Institute provides instruction in deckhand skills, technical equipment design and maintenance, and basic fisheries biolgoy. The graduates of these programs are finding positions in fisheries research and development programs.

The University of Maine offers programs involving fisheries in several areas. Their scientific-research staff, working in cooperation with the Department of Marine Resources staff are involved in biological research, aquacultural development, foods and nutrition and marine technology. Also recognizing the importance of marine education in Maine schools, they have developed a marine science education graduate teacher program.

The Sea Grant program maintains the Marine Advisory Service with field agents working directly with fishermen. These people are helping fishermen utilize the program's research and development information. Working with DMR's-Fisheries Technology Service, the two groups improve fisheries skills, devise new equipment and harvesting methods, marketing skills and help the fishermen understand and develop management activities that are beneficial to the fisheries.

Most of the other colleges have research staff involved in marine research. These activities augument other research activities conducted by DMR and/or University of Maine and ultimately reach the fishermen through management activities.

In 1977 the State Legislature passed L.D. 1552 charging DMR with the task of increasing marine literacy of the people of Maine through both formal and informal educational activities. The goal is to get scientific data, management information and techniques out to the people in a language they understand and can use. In addition, the hope is to make the people of Maine more aware of the economic importance of the fisheries, to break down old stereotypes and to improve the sociological conditions surrounding the fisheries.

Several other private organizations are interacting with the fisheries and the fishing communities through information generation, political pressure and economic development. The Audubon groups, League of Women Voters, Natural Resources Council, Maine Coast Heritage Trust, Nature Conservancy and the Gulf of Maine Marine Education Association are a few active groups. Interested in land use, public access, coastal development and other social, economic and conservation topics, these groups influence the political climate and physical restraints that the

fisheries must consider. These groups lobby the legislature, involve other management agencies and involve citizens in a wide variety of activities using all possible techniques, hence, the importance of maintaining a citizenry well educated about marine matters.

7.0 References

(Reserved)