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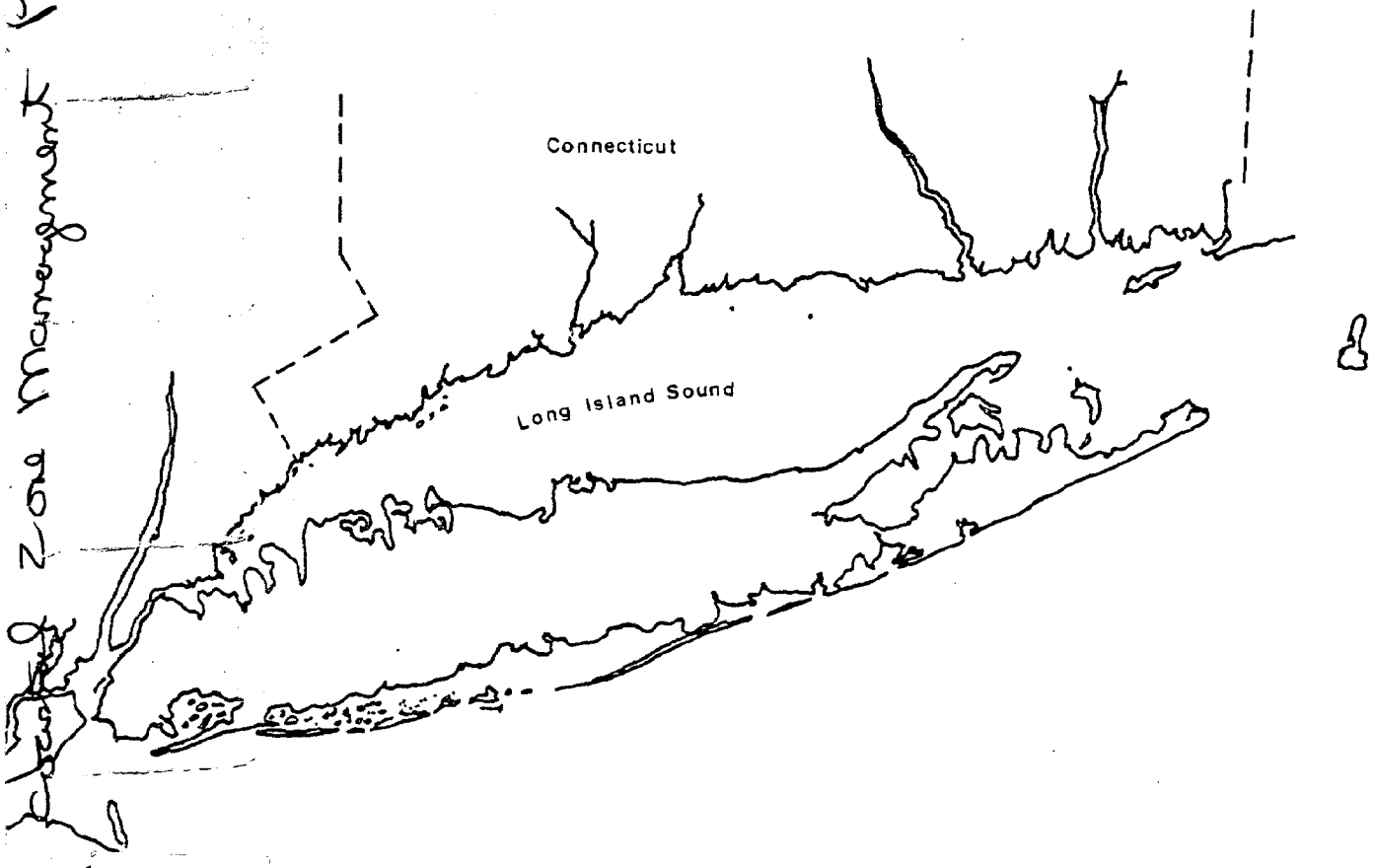
State of Connecticut
Marine Resources Management Plan

Part One: A description of marine resources and their users



Department of Environmental Protection
Bureau of Fisheries
Marine Fisheries Office

October 31, 1982

State of Connecticut

Marine Resources Management Plan

Part One

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1.0 INTRODUCTION

The marine fishery resources of Connecticut exist in a diverse and unique assemblage of finfish, shellfish, and crustacea. The location of Long Island Sound in mid-temperate latitudes, its protected, relatively shallow geomorphology, and its high nutrient load, seasonally mild temperature, and low salinity make it unique both as spawning and nursery habitat and as a location in which many coastal species pause to feed during seasonal migrations.

Management of coastal resources in Connecticut by a variety of state agencies has been increasingly active in recent years. The earliest activities required implementation of legislation by the Connecticut General Assembly while initial agency activities began with the development of a marine fisheries program in 1954 under the auspices of the former Connecticut Board of Fisheries and Game. Subsequent program developments included the acquisition of a marine research vessel and employment of a marine fisheries biologist.

More recent evolution of coastal resource management has included passage of the Connecticut Coastal Area Management Act in 1979, the institution of a Division of Aquaculture in the Department of Agriculture for the administration and management of state-owned shellfish beds, a reorganization providing for a Marine Fisheries Program within the Bureau of Fisheries of the Department of Environmental Protection (the former Board of Fisheries and Game), and the development of both a Sea Grant Program with a Marine Advisory Service and a Department of Marine Sciences within the University of Connecticut at its Avery Point, Groton campus.

While there has been much attention given to marine resources during the past twenty-five years, actions relating to the central issue of this document - management of marine resources - have often been fragmented. In many cases, the importance of Connecticut's marine resources, the characteristics of their users, and a description of the ever-changing management community has eluded efforts to be documented in one volume.

The purpose of the present effort is to prepare a Marine Resources Management Plan for Connecticut which will serve as a comprehensive strategy for intelligent planning of coastal resource use. It is intended to provide planners with a single source of information about Connecticut's valuable marine resources, to indicate which of its citizens have an interest in those resources, and to illustrate who in the management community are responsible for ensuring the wise use of our resources. More importantly, however, the plan will become a policy document for use by managers in

planning for future development and use of Connecticut's coastal resources.

The plan will be developed in two parts. Part One is a description of Long Island Sound (LIS), its resources and users, the economics of marine resource use, and the resource management community at the state, local and federal levels. It is intended that Part One provide an informative documentation of fact to assist citizens and planners in their management efforts.

Part Two will present goals and objectives for marine resource use and will detail policies for management that evolve through review by other agencies and the general public. Policies will relate principally to the use of resources by recreational and commercial fishermen, as well as to the philosophies and intentions of the management agencies in providing stable, productive and valuable resources for the public good.

Nothing in Part Two will be considered as a final product, that is, incapable of being changed. Resources as well as management strategies are dynamic in their performance; inflexibility in management planning will cause a failure in the process and we hope to avoid such pitfalls by avoiding inflexible approaches to management problems.

Development of the Connecticut Marine Resources Management Plan is being funded for a two-year period by the Connecticut Coastal Area Management Program. Responsibility for development of Part One rests with the DEP-Bureau of Fisheries, Marine Fisheries Program. Development of Part Two will be a joint effort of the DEP-Bureau of Fisheries, the DEP-Planning & Coastal Management Unit, and the Department of Agriculture, Division of Aquaculture.

2.0 The Resource Management Community

2.1 State Government

There are two principle agencies responsible for the mangement of Connecticut's marine resources. Within the Department of Environmental Protection (DEP), the Planning and Coastal Management Unit, based in Hartford, excercises broad authority over the use and development of the shoreline and man's activities there which may affect marine resources. This authority is excercised in cooperation with coastal communities upon development of community coastal area use plans.

The DEP Bureau of Fisheries is responsible for the management of finfish, lobster, squid, and crab resources living within the waters of the State. The Bureau's main office is located in Hartford, CT and functions as the administrative and federal aid office for the inland and marine fisheries programs. The Marine Fisheries Headquarters of the Bureau is located in Waterford, CT. This site supports field marine fisheries research and management activities of the Department and the marine conservation law enforcement program, and serves as the operations and maintenance facility for marine program activities. The headquarters houses seven fisheries biologists, seven conservation officers, clerical and support staff, and several technical assistants employed on various field projects.

The second agency involved in marine resource management is the Department of Agriculture, Division of Aquaculture located in Milford, CT. The Division manages all molluscan shellfish resources (except squid) in State waters outside of town jurisdictions other than those in the towns of Milford, West Haven, New Haven, and Westport.

A third agency with some responsibilities similar to those of DEP and Agriculture is the Connecticut Department of Health Services in Hartford which excercises certain controls over the harvesting, processing, and distribution of oysters and clam species to assure that they do not present a health hazard to consumers.

The three management agencies, Environmental Protection, Agriculture, and Health Services are responsible for licensing and the collection of fishery statistics where such activities are mandated. In addition, DEP and Agriculture are responsible for the regulation of coastal fishing activities when such regulation is necessary for the conservation, preservation and management of resources or for the well-being of participants in the fisheries; Health Services may regulate aspects of the shellfish industry when the health of citizens may be jeopordized.

Licensing of fishing activities in Connecticut is authorized by the Connecticut General Statutes (CGS). All commercial fishing activities are covered by license, permit or registration. The DEP issues 11 types of commercial fishing licenses and registrations, a lobster dealer license, and a party and charter vessel registration with fees ranging from $5 to $500 (Sec. 26-142a).

In contrast, virtually all recreational fishing activities are unlicensed. The exception to this generality is the "personal use" (non-commercial) lobster license issued by the DEP for a fee of ten dollars, and many of the municipal shellfish harvest programs for oyster, bay scallop, and softshell or hardshell clams. Programs administered by municipalities will be addressed in Section 2.3.

The Division of Aquaculture leases waters under the jurisdiction of the State to private persons or firms, for periods up to ten years at a time, for the purpose of planting and cultivating shellfish (Sec. 26-194). In addition, three licenses are issued which govern use of oyster vessels (Sec. 26-212), taking oysters from natural beds (Sec. 26-213), and taking conch (Sec. 26-219). Licensing requirements for harvesting from waters under municipal jurisdiction will be discussed in Section 2.3.

The Department of Health Services issues two types of commercial shellfishing licenses; permits for harvesting in closed areas (Sec. 19-59), and certificates for harvesting from open waters, and for processing and distribution (Sec. 19-53).

The DEP requires submission of catch and effort statistics from all holders of marine fishing licenses, permits, and registrations. Depending on the type of license, however, this requirement can be extensive or almost non-existant. Resident and non-resident commercial lobstermen and trawler operators, non-resident lobstermen who only land in Connecticut, lobster dealers, purse seine vessel operators, commercial shad fishermen, party and charter vessel operators, and personal use lobster license holders are required to record information on catch and fishing effort, or receipts of lobsters, on a daily basis, on forms provided for this purpose.

Commercial lobster and trawl fishing reports, lobster dealer reports, and lobster landing reports are submitted monthly. Personal use lobster, purse seine, and party and charter vessel reports are submitted at the end of the year, while shad reports are returned in July at the end of the eight week shad fishing season. All other commercial license holders (finfish, marine and inland bait,

pound net, and blue crab licenses) submit annual summary totals of their activities.

The Division of Aquaculture does not require submission of catch and effort statistics for shellfishing, however, accurate records are maintained which document the extent and location of State-owned shellfish beds leased by private parties for cultivation and harvest of oysters. The Department of Health Services requires that natural growth seed oyster harvesters, who harvest in areas closed due to pollution, submit monthly reports which document quantities taken, their source, to whom they are sold, and where they will be transplanted.

Management authority over marine resources is broadly vested in Title 26 of the Connecticut General Statutes. However, amendments to the statutes in 1980 (P.A. 80-164; Sec. 26-159a CGS) granted the Department of Environmental Protection regulatory authority over a broad range of fishing activities in the coastal area. Activities which are now managed by regulation are season and area closures, limitations on species sizes and the gear by which they may be taken, mesh size and other gear restrictions. However, certain other management responsibilities continue to be authorized by statute. Chief among these are authority over the lobster resource (Sec. 26-157a) and several site-specific area closures implemented during past years for a variety of social as well as conservation reasons (Sec. 26-154, 26-154a, 26-169 through 26-185).

The regulatory process requires a maximum of four months to complete and consists of drafting and Departmental review, public hearing, redrafting if appropriate, and submission for approval to both the Regulations Review Committee of the General Assembly and the Office of the Attorney General. The process is similar to that required of any Unit or Bureau of the Department of Environmental Protection with one notable exception: the legislation implementing regulatory authority over marine fishing required that public hearings be held in coastal communities which might be impacted by the proposed changes.

Management authority over shellfisheries also is vested in Title 26 of the general statutes. Sections 26-192 through 26-237 govern leasing of shellfish grounds, permissable gear to be used, and other required activities such as the marking of boundaries and dumping of mud and other substances on shellfish beds. Regulatory authority granted to the Commissioner of Agriculture is restricted to designating shellfish spawning beds (Sec. 26-220), taking oysters from the Housatonic River (Sec. 26-233a), and setting daily limits on the take of oysters (Sec. 26-234a).

Enforcement of fisheries statutes and regulations by

the DEP is implemented through the DEP - Bureau of Law Enforcement. The marine staff of this bureau has a variety of responsibilities which include conservation law enforcement activities such as checking for species less than some prescribed minimum size, or for violations of season, area, and gear restrictions. Ancillary but important duties include boating safety patrols, investigation of boating violations, and cooperative law enforcement activities with the National Marine Fisheries Service, the U.S. Fish and Wildlife Service, and municipal and state police forces within Connecticut and from adjoining states.

The Commissioner of Agriculture may appoint shellfish wardens in coastal towns (Sec. 26-205) and shellfish policemen upon application of commercial shellfishing interests (Sec. 26-206). These officers may assist in detecting and prosecuting offenses against state shellfish harvesting laws. Enforcement of provisions of shellfish harvesting and distribution pertaining to public health is the responsibility of local directors of health, police departments, and shellfish policemen.

2.2 Federal Government

Federal management responsibilities are vested in the National Marine Fisheries Service (NMFS) for marine species including marine mammals and endangered species and, in cooperation with the NMFS, the US Fish & Wildlife Service for anadromous fisheries such as Atlantic salmon.

Implementation of the Magnuson Fishery Conservation and Management Act of 1976 (MFCMA as amended) introduced an entirely new concept for management of fisheries resources in the Fishery Conservation Zone, that is, the area of the contiguous oceans and continental shelf seaward of the States' territorial seas and to a point 200 miles from the baseline used to define the territorial sea.

The Act called for cooperative fisheries management to be implemented by the NMFS based on fishery management plans developed by one or more of the eight Fishery Management Councils authorized by the Act. Connecticut is a member of the New England Fishery's Management Council. Appointed memberships on the Councils of persons qualified in fisheries matters are determined by the NMFS from lists submitted by each of the coastal state governors. Standing members of the New England Council include the state agency directors with principle fisheries management responsibility, the Regional Director of the National Marine Fisheries Service, and, as non-voting members, the Regional Director of the U.S. Fish & Wildlife Service, and representatives of the Atlantic States Marine Fisheries Commission, and the U.S. Coast Guard. To date, the New England Council has prepared fishery management plans for Atlantic groundfish, sea scallop, American lobster, and Atlantic herring.

The federal regulatory process for implementation of FMPs developed under the MFCMA is rather complex. Typically, plans are prepared by the Councils and submitted to the NMFS along with an environmental impact statement (mandatory) and a draft of proposed regulatory language. Plan review under the National Environmental Policy Act and NOAA/NMFS guidelines, and implementation of regulations by NMFS have often taken in excess of a year; however, recent efforts to improve the process will hopefully shorten this interval.

The interactions of the federal regulatory process with those of the state government agencies potentially can be in conflict but ideally, and usually, they are compatible. For example, in many of the more recent cases of federal fishery regulation under MFCMA, Connecticut has acted immediately to implement identical or compatible regulations in order to present a unified fisheries management position to all users. This is not surprising when one considers that

Connecticut, as a member of the New England Council, has had an active role throughout the process in the development of FMP's and the promulgation of regulations. The Act, therefore, stimulates cooperative state/federal fishery management programs and, in Connecticut, this philosophy is embodied in the state's regulatory process.

Another example of a cooperative, interjurisdictional management effort is the Connecticut River Anadromous Fish Restoration Program. The program is a joint effort of the U.S. Fish and Wildlife Service, the National Marine Fisheries Service, and each of the Connecticut River basin states (Connecticut, Massachusetts, New Hampshire, and Vermont). Program participants are structured into a Technical Committee and a Policy Committee and have responsibility for development of projects and activities to enhance the American shad resource in the system and to restore Atlantic salmon to the basin. Further discussion regarding this program is contained in Section 2.4.

2.3 Local Government

Resource management by municipalities is exercised exclusively over shellfish in beds under town jurisdiction with the exception of some areas in the towns of West Haven, New Haven, Milford, and Westport (Sec. 26-238 and 26-257 CGS). Municipalities are granted broad authority by Sec. 26-257a(b) of the statutes to regulate shellfisheries and shellfish grounds when such authority is not granted to other parties and when such grounds are not under the jurisdiction of the Commissioner of Agriculture. However, Sections 26-238 through 26-294 of the statutes do provide statutory authority by which area-specific management measures are enforced in waters under local jurisdiction. Principal species of interest are the fall bay scallop fisheries and predominantly summer fisheries for softshell and hardshell clams.

Due to the degraded quality of much of Connecticut's inshore tidal waters, many areas supporting shellfish populations are, unfortunately, closed to shellfishing. Exceptions are in the more eastern, non-urban communities such as Waterford, East Lyme, Groton, Stonington, Madison, Clinton, and Westbrook. All coastal towns including those farther to the west have some clean water areas offshore which are capable of supporting populations of the American oyster.

Management by the towns is through appointed shellfish commissions empowered to enact regulations on seasons, quantities to be taken, sizes of shellfish and the methods of harvest. In this manner, local control is exercised over local resources. The towns of Madison and Old Saybrook have developed shellfish management plans through which commercial harvesting of shellfish in closed areas is allowed provided that the commercial harvesters transplant an agreed upon amount of their harvest to a certified clean water area for recreational shellfishing. The town of Branford also operates a similar program.

The process for enacting or amending town shellfish regulations varies between communities. Generally, proposals may be made by the Commission, or to the commission by interested citizens. Also, most commissions retain shellfish wardens who have law enforcement responsibilities. These individuals often become the most knowledgeable persons regarding the status of the town's resources and the activites of their users. As a result, proposals many times emanate from the shellfish wardens. After due process which includes review and public hearing, regulations are enacted for the coming fishing season. Generally, the process is repeated each year.

2.4 Relationships within the Marine Resource Management Community in Connecticut

Cooperative, interjurisdictional management is an essential element of any marine resource management program since virtually all species of interest to one state migrate through the waters of another or through the Fishery Conservation Zone. The inability to participate in cooperative management planning activities reduces the ability of each individual state to protect its resources and precludes regional efforts which are of benefit to all states.

Two examples of successful, interjurisdictional management programs are the Connecticut River Anadromous Fisheries Program, and the Interstate Fisheries Management Program (ISFMP) administered by the Atlantic States Marine Fisheries Commission.

Anadromous fisheries management in the Connecticut River basin is accomplished largely through a cooperative effort between the basin states and both the U.S. Fish and Wildlife Service and the National Marine Fisheries Service. Since the mid 1960's, enhancement activities for American shad have been conducted in the form of fishway and fish lift construction, and fishery investigations. More recent efforts of the program have been in the restoration of Atlantic salmon to the river system. Again, through construction of fishway traps on mainstem tributaries, as well as selective breeding and rearing of smolts for release as sea-run fish, the cooperative, interstate, interagency program has shown remarkable success in restoring a previously extirpated species to the Connecticut river.

Connecticut is a member state of the Atlantic States Marine Fisheries Commission. A state's delegation to the Commission is composed of a member of the state legislature, a gubernatorial appointee, and the director of the state agency with principle marine fisheries management responsibility.

Under the auspices of the Interstate Fisheries Management Program, the Commission is responsible for the preparation of fishery management plans for inshore species meeting five criteria. These are:

1) That the fishery is in need of management,
2) That the fishery is of considerable value to the states and the nation,

3) That the fishery is not scheduled for management under the Magnuson Fishery Conservation and Management Act in the near future or that the harvest does not occur predominantly in the Fishery Conservation Zone,
4) That there is a reasonable expectation of plan implementation, and
5) That management is expected to be cost-effective.

To date, the ISFMP and its predecessor program (the NMFS State/Federal Fisheries Management Program) have developed FMP's for American lobster, Atlantic menhaden, summer flounder, striped bass, and northern shrimp. Additional program activites include the coordination of regional, interstate activities in the collection, processing, and dissemination of coastal fisheries statistics. With one exception, plans developed under the interstate program have then been presented to each of the ASMFC member states for implementation under that state's regulatory authority. Inherent in this statement lies both the weakness of the ISFMP and its strength in promoting cooperative management efforts between the states.

The interstate program, in itself, has no authority to implement a plan. However, member states with a similar interest in a regional fishery can elect to designate ASMFC as the management body for that plan. By exercising Amendment One of the Atlantic States Marine Fisheries Compact, regulations may be enacted by the Commission which become force of law for each of the designating member states. At the present time, the northern shrimp in the Gulf of Maine is managed under Amendment One.

Regardless of the applicability of Amendment One, it is assumed that each member state will make a legitimate attempt to implement those parts of a plan pertinent to its fisheries when such plan is approved by the Commission. In practice, this does not always occur since the pressures brought to bear within a state during the public hearing process often overcome the initial inclinations of state representatives to the Commission during development and initial approval of the plan. The advantage to the interstate management process is that it requires negotiation and compromise during development and approval of a plan. This is considered desirable since most state legislatures have been unwilling to relegate management responsibilities to a central fisheries management authority which would then have authority over those fisheries and resources within a state's territorial sea.

Cooperative town shellfish management programs include those where a water body may represent the boundary between

two towns such as the Niantic River between Waterford and East Lyme. Also, coastal towns with similar management philosophies often cooperate to manage beds in each of the towns. An example of this type of program is in the towns of Clinton, Madison and Guilford which annually sponser a joint shellfish commission meeting.

The Division of Aquaculture has recently worked closely with the New York Department of Environmental Conservation on shellfish management issues. The situation in Connecticut is an interesting one in that much of the oyster harvest from Connecticut is transported to New York for depuration. As a result, there is perhaps a greater motivation for cooperative discussions between the two states regarding shellfish management. Finally, the Division is looking forward to an increase in cooperative management efforts with Rhode Island in nearshore eastern Connecticut areas.

Within related state and federal jurisdictions, potential for conflict exists in the cooperative anadromous fisheries management programs however, in reality, such conflicts do not occur. The Connecticut River program serves as the model for a successful, long-term, cooperative management effort.

3.0 Scientific Information

The major scientific studies on the physical and chemical oceanography of the Long Island Sound ecosystem were performed in the 1950's and 1960's by G. A. Riley and his associates at the Bingham Oceanographic Laboratory of Yale University (Riley 1952, 1956, 1959, 1961, 1967; Riley and Conover 1956; Riley and Schurr 1959; Larkin and Riley 1967). More recent information can be found in the Technical Report Series of the Marine Science Research Center of the State University of New York (Hardy 1970, 1972 a,b; Hardy and Weyl 1971; Jay and Bowman 1975).

Studies of Long Island Sound sediments include: McCrone et al. (1961); Sanders (1956); Donohue and Tucker (1970); Krebs (1963); Yingst and Rhoads (1978); Bokuniewicz et al. (1976); Ellis (1962); Michael (1976); McCall (1977); and Rhoades et al. (1978 a,b).

Environmental baselines in Long Island Sound are reported in Reid et al. (1979). Investigations designed to measure levels of pollutants in Long Island Sound, and to determine their origins, distribution, and fate in the environment (Dehlinger et al. 1973, 1974), and to monitor dredged material disposal sites (Serafy et al. 1977; Valenti and Peters 1977; Cobb et al. 1977; DAMOS 1979; Stewart 1980) also provide baseline scientific information on the Long Island Sound ecosystem. Transcripts of the proceedings of a major conference on the pollution of the Sound and its tributaries contain a large volume of information on this subject (EPA 1971).

Scientific information on biota that are of commercial, recreational, and ecological resource importance is available in Thomson et al. (1978); Bigelow and Shroeder (1953); Technical Series Reports of the NMFS Sandy Hook Laboratory; FAO Fisheries Synopses; final and draft Fishery Management Plans prepared by regional Fishery Management Councils, and reports of investigations conducted by the Connecticut Department of Environmental Protection, New York Department of Environmental Conservation, and Northeast Utilities Service Company's environmental laboratory at the Millstone Nuclear Power Station in Waterford, CT. In addition, the most useful scientific journals, in which results of recent investigations on the population dynamics, migratory habits, and other information vital to the management of marine species are reported include: Fishery Bulletin, Marine Fisheries Review, Canadian Journal of Fisheries and Aquatic Sciences, Ecology, Transactions of the American Fisheries Society, Copeia, and Estuaries.

The Connecticut DEP Marine Fisheries Information System provides valuable data on commercial catches and fishing effort. Presently, the relative stock abundance of the

lobster resource and finfish species most effectively caught by otter trawl can be monitored by relating catches and associated fishing effort derived from the system.

4.0 Marine Resources of Connecticut

4.1 Description of Long Island Sound

4.1.1 Geomorphology

Long Island Sound (LIS) is an approximately 928 square nautical mile embayment, 113 miles long with a maximum width of about 21 miles, bounded on the south by Long Island, New York and on the north by the Connecticut and New York shore. Fisher's Island, Great Gull Island, Little Gull Island, and Plum Island delimit the eastern end from the more open coastal waters of Block Island Sound (Figure 1). Maximum depths of about 328 ft occur in the eastern end, which decrease to about 115 ft (maximum) in the central and western basins. The mean depth of LIS as a whole is 65 ft (Riley 1961). A volume of approximately 16,800 billion gallons or 15.4 cubic miles of water is contained in LIS (OCZM and CAM 1980; USGS & NOAA 1973).

The Connecticut coast has an irregular geography with many headlands and embayments. Total shoreline frontage, including tidal rivers and embayments, is 583 miles (OCZM and CAM 1980). Of 278 miles of shoreline that directly fronts on LIS, 14.2% consists of sandy beach, 11.3% is glacial drift, 8.2% is artificial fill, 7.2% is bedrock, and 59.1% exists as combined tidal wetland and undifferentiated tidal shores (CAM 1979).

Irregularity is the dominant characteristic of the coastline of Westchester County, N.Y. and the western half of the northern Long Island coast. Eastward, the coast becomes exceptionally regular with no significant indentations. Along the entire north shore of Long Island, the beaches are generally narrow and rocky or pebbly, except where beaches have been nourished with sand, or groins have been constructed. Beaches usually front high bluffs or small marshes and embayments. Large wetlands are uncommon except at the heads of a few embayments (NERBC 1975).

There are 129 islands in LIS, 3 in the East River, New York, and 126 along the Connecticut coast. They range from small outcroppings to wooded and settled islands with dwellings. Large shoals lie off Stratford and Old Saybrook (NERBC 1975).

4.1.2 Sources of Fresh Water

Three major drainage basins provide LIS with fresh water. In order of importance they are:

1) The Connecticut River basin with a drainage area of 11,250 sq mi.

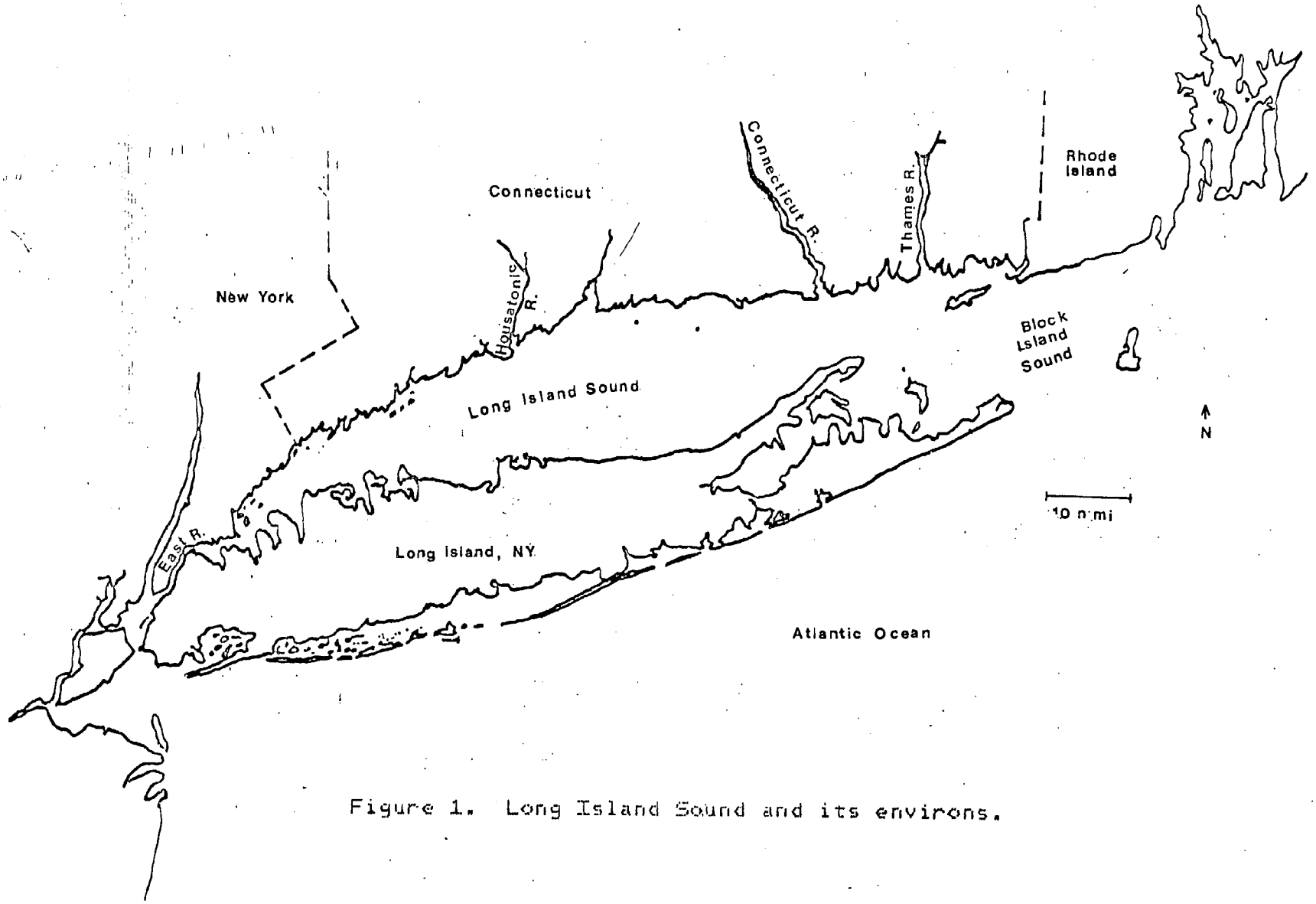


Figure 1. Long Island Sound and its environs.

2) The Housatonic River basin (1,950 sq mi).
3) The Thames River basin (1,470 sq mi).

In addition to these three, 66 mainland coastal streams flow directly into LIS with a combined drainage area of 1,467 sq mi. Of these, the three largest are the Pawcatuck River (304 sq mi), the Quinnipiac River (166 sq mi), and the Saugatuck River (93.2 sq mi) (USGS & NOAA 1973).

The average annual freshwater inflow is approximately 6,200 billion gallons, equal to 37 percent of total volume. Most of this inflow (80% or more) is into the eastern end of LIS from the Connecticut and Thames Rivers. Considering that the average annual precipitation in Connecticut is 36 inches, an additional 800 billion gallons a year of fresh water falls directly on LIS (USGS & NOAA 1973). Maximum river runoff generally occurs during April and May, preceeded by secondary peaks from December to February. Minimum flow rates usually occur in early autumn (Riley 1967).

4.1.3 Physicochemical Characteristics

Long Island Sound displays estuarine characteristics in the western and central parts and embayment characteristics in the eastern third. Estuarine properties are repeated on a smaller scale in the mouths of rivers flowing into the Sound.

Minimum tidal range and maximum tidal currents occur at the eastern end, while the maximum tidal range and minimum tidal currents occur at the western end. Circulation or movement of water within LIS and the adjacent estuarine streams is controlled principally by tidal currents modified by freshwater inflow, winds and other weather conditions, and bottom topography (NERBC 1975).

The circulation pattern of surface and near-surface waters is fairly well defined (Larkin and Riley 1967; Riley 1952), but relatively little is known about deep current circulation. Surface tidal current patterns in the central and eastern Sound are elliptical and counter-clockwise in direction. At the eastern end, surface water flows out of LIS into Block Island Sound, and oceanic bottom water flows into LIS through a channel commonly known as the "Race". At the western end, surface water from the East River flows into the Sound and bottom waters move into the East River. Quantified information on inflow and outflow in the western end of the Sound is unavailable (NERBC 1975).

Long Island Sound has been classified as a moderately stratified estuary (Bumpus et al. 1973) because ocean and fresh waters do not mix completely. The well-oxygenated,

cold, dense, marine waters remain unmixed below the surface throughout a large area of the eastern Sound. The less oxygenated, warmer, lower density fresh water enters mostly in the eastern end from the Connecticut and Thames Rivers, remains near the surface, and is flushed out to sea rather rapidly. Thus, dilution of marine waters is minimal. This physical two-layer movement system influences the chemical regime of the Sound and its estuaries. Lighter suspended inorganic and organic materials, including pollutants, from inland sources tend to be flushed out to sea while nutrient-rich bottom waters circulate to surface layers. The sediment distribution within the Sound is also affected by circulation patterns (NERBC 1975; USGS and NOAA 1973).

Vertical and horizontal variation of the Sound's chemical parameters are influenced by its bathymetry and interaction with the adjacent inshore waters of Block Island Sound and freshwater tributaries. Freshwater drainage and the two layer transport system described above tend to develop and maintain a vertical salinity gradient throughout the Sound (Riley 1959) although fall and winter mixing destroys these vertical gradients (Kester and Courant 1973). A general east-west gradient in salinity occurs whereby the salinity of the western end is 3-5%. lower than the eastern end in which the surface salinity ranges from 31-32%. except during periodic flooding of the Connecticut and Thames Rivers (Riley 1959).

East-west temperature gradients vary seasonally with the western part being lower in temperature during winter and higher in summer. Surface water temperature ranges from about 34-66°F in the eastern end, and 32-73°F in the western end. A slight vertical temperature gradient occurs during the summer with surface temperatures ranging from 68 °F in the western part and 64 °F in the eastern part of the Sound to bottom temperatures of 63 °F and 61 °F, respectively. Maximum differences between surface and bottom temperatures are about 9 °F in central LIS (Riley 1959).

Supersaturation of oxygen in surface waters occurs during the spring bloom of phytoplankton, while the oxygen content of bottom water declines during the spring bloom and early summer, with minimum saturation values of 50%. This type of vertical distribution indicates that production of oxygen in the surface layer by phytoplankton exceeds utilization. During fall and winter, the Sound's waters are generally undersaturated with respect to oxygen. Three factors are probably involved:

1) a slight lag between surface cooling and oxygen uptake;
2) acceleration of vertical mixing and convection;

3) excess oxidation over production in most of the water column, which is indicated by an increase in nutrients in fall and winter (Riley and Conover 1956).

The saturation of oxygen in surface waters is spatially uniform within the Sound, except for increases caused by occasional phytoplankton blooms at river mouths due to the influx of a limiting nutrient such as nitrate. Greater variability occurs at depth after the summer season with reduced saturation near New York City and the Connecticut River (Kester and Courant 1973).

Long Island Sound is a moderately turbid body of water in which most Secchi disk transparency readings generally range from 3-15 ft. During rare heavy plankton blooms or river flooding, values of as little as eight inches have been recorded. The maximum recorded value is slightly more than 30 ft. Usually the highest readings are taken in the early spring in the eastern end of the Sound, which is relatively deep and subject to rapid interchange with open coastal waters. Phytoplankton is responsible for about one third of the total light extinction. The remainder is due to a conglomeration of other factors: the water itself, dissolved and particulate organic matter, and silt and bottom sediment in suspension. The latter appears particularly important since significant correlations were found between transparency and such variables as depth, stability, wind, and tidal speed, all of which might be expected to influence the rate of suspension of bottom materials (Riley and Schurr 1959).

4.1.4 Sedimentary Characteristics

In sedimentary environments such as beaches, tidal marshes, estuaries, and offshore bottom areas, the distribution of most sediments, although complex, follows a simple rule: the more an area is protected from wave action, the finer is the grain size of its sediment. Protection can be found in deep water, the shelter of islands, in estuaries, or tidal marshes. The waves of LIS, which govern sediment grain size distribution, are small but steep, and are capable of moving large amounts of material.

Areas of deposition (estuaries, tidal marshes, protected offshore areas) are characterized by fine sediments, while areas of erosion (some parts of beaches and exposed offshore areas) are characterized by coarse sediments (Ellis 1962).

In general, the eastern part of the Sound is characterized by predominantly medium to coarse grained sediments with relatively local and intermittent occurrences

of poorly sorted, fine grained sediments. Sediments of western LIS are predominantly fine grained and, with the exception of the relatively thin surface layer, exhibit poor sediment sorting and high silt and/or clay compositions from top to bottom of core profiles. This indicates little or no reworking of the sediment mass subsequent to initial deposition (Donahue and Tucker 1970).

Estuarine currents superimposed on tidal currents produce a net westward transport of sand out of the eastern Sound into the central muddy basin. A large amount of silt has accumulated in the central and western basins. Fine sediment is introduced by rivers and is carried by estuarine circulation into the inner Sound. The accumulation of silt is aided by the feeding activity of animals inhabiting the muddy bottom. Fine grains of silt are bound into much larger fecal pellets by bottom-dwelling animals. The muddy central basin is covered with a layer of fecal pellets approximately 0.2 in. thick (CAM 1977).

During every tidal cycle, a layer of sediment approximately 1/16 in. thick is eroded and redistributed within the central basin. Throughout LIS, tidal streams re-suspend and re-deposit more than 7 million tons of sediment daily. Because of this activity, fine silt is accumulating in the central and western basins at a rate of slightly less than 1/16 in. per year (CAM 1977).

4.2 Habitats Supporting Marine Species

4.2.1 Pelagic

The pelagic habitat, or the water column, is utilized by nektonic (swimming) and planktonic (drifting) organisms. The physical and chemical characteristics of this habitat, such as currents and water circulation, temperature, depth, salinity, and dissolved oxygen and nutrient concentrations differ spatially and temporally within LIS and its adjacent estuaries. This influences the distribution and seasonal occurrence of pelagic organisms.

4.2.2 Estuaries

Generally, many habitats which support marine species in LIS can be broadly classified as estuarine due to the significant dilution of the Sound by its freshwater tributaries. However, especially in the eastern part of the Sound, pelagic and benthic habitats are more representative of those oceanic habitats occurring on the continental shelf of New England. The estuarine classification becomes more specific and accurate for areas near the mouths and in

estuarine reaches of rivers tributary to the Sound.

The confinement of estuaries provides shelter from wave action, permits the retention of plankton, and enables plants to root and shellfish larvae to settle. Shallow depths permit light to penetrate through the entire water column (except in areas of high turbidity), thus stimulating the growth of bottom plants. These depths also allow the growth of marsh plants and tideflat biota, and allow for flushing of the system. Freshwater flow dilutes salt water and fosters an especially rich and varied biota; it also deters oceanic predators which cannot tolerate low salinity and encourages estuarine forms which can. Freshwater flow, tidal energy, and salinity together create a two-layer water movement system, beneficial to suspended life for transport, and useful for diluting and flushing wastes. Estuaries have a high capacity for energy storage; marsh grass and submerged grasses convert and store energy for later use, and physical conditions promote the retention and rapid cycling of nutrients and the conversion of available nutrients to animal tissue (Clark 1977).

4.2.3 Eelgrass Beds

In LIS, submerged marine eelgrass (Zostera marina) beds grow in shallow waters where turbidity is low enough for sufficient light penetration, currents are not too swift, wave action is low, and bottom sediments are favorable. They prosper in quiet, protected waters of healthy estuaries and are essential elements of the estuarine ecosystem, particularly where marshes are reduced or absent. They often provide a substantial amount of primary productivity and nursery habitat in estuaries. They supply food to herbivorous animals and detrital nutrient to the water, add oxygen (during daylight hours), and stabilize bottom sediments by collecting and holding suspended particles that settle from the water column as tidal currents slow (Clark 1974).

4.2.4 Rocky Shore

The shallow depths of subtidal rocky shorelines (30 ft or less) permit light penetration sufficient for algal primary productivity and an associated food chain. The rocky shore provides a stable substrate for the attachment of algae, and in many areas, dense kelp (Laminaria) beds cover the rock substrate. Barnacles and mussels also utilize the hard substrate for attachment. Crevices, caves and attached kelp provide protective shelter from predators for crabs, lobsters, and fish.

The rocky intertidal shore is a habitat of high stress resulting from wave action, alternating exposure and

inundation from tidal action, and temperature and salinity extremes in tidepools which have formed at low tide. Larval and juvenile stages of crustaceans and fish receive some protection from large predators under and among rocks in this habitat; snails such as Littorina littorea are usually abundant. Generally, the rocky intertidal zone is not a habitat from which species are commercially or recreationally harvested, although some bait species may be available.

4.2.5 Reefs

Subtidal rocky reefs offer habitat characteristics similar to those of subtidal rocky shore areas. Nearshore rocky reefs such as Bartlett (Waterford), and Penfield (Bridgeport) and offshore reefs such as Stratford Shoal in the middle of the Sound are productive sportfishing and/or lobstering areas. The same shallow rocky habitat characteristics are found at man-made breakwaters such as the Stonington and Duck Island breakwaters which make them productive lobstering and fishing areas.

4.2.6 Sand and Mud Bottom

Subtidally, a flat bottom composed of sand or mud, or a combination of both, is the predominant benthic habitat in LIS and its estuaries. Burrowing deposit feeders such as polychaete worms and small crustaceans (i.e. amphipods, isopods) feed on detritus, bacteria, and unicellular algae at the base of the food chain. Bivalve molluscs filter feed on phytoplankton suspended in the water near the bottom. Epifaunal animals such as crabs, lobsters, and snails feed on the infaunal species. Bottom-feeding fish of resource importance such as flounder and scup feed on the infauna and epifauna of this habitat.

Dredged material disposal sites in LIS become quickly colonized by infaunal species which are followed by epifaunal species in search of food and potential shelter. Disposal sites were originally chosen in areas considered to be of low habitat value. Species such as lobster and finfish are attracted by the "feature" aspect of the mound on an otherwise featureless bottom in addition to the food source provided by the initial colonizing infauna. Fine grained silts and clays are manipulated by crabs and lobsters and, due to their cohesiveness, easily formed into protective burrows.

Tidal marshes usually extend into unvegetated expanses of mud or sand. These flats may extend above the low-tide mark and thus create a tideflat shoreline, where the tidelands area is unfavorable to the growth of grasses because of heavy tidal scouring or other factors. Mud and sand flats are often rich sources of basic nutrients for the

ecosystem and feeding areas for fish at high tide or birds at low tide. In many estuaries they support large populations of polychaete worms and shellfish. Mudflats are important energy storage elements of the estuarine ecosystem. If they were not present, vital dissolved chemical nutrients (such as phosphates, nitrates, and nitrites) would be swept out of the marshes with ebbing tides, eventually depleting the energy supply to the marsh food chain. The mudflat serves to catch the departing nutrients and hold them until the returning tide can sweep them back into the marsh. There appears to be an optimum balance between the proportion of marsh to mudflat area which is vital to the stability and the continued existence of both systems (Clark 1977).

4.2.7 Tidal Marshes

The tidal marshes of Connecticut represent a very limited but valuable resource totalling some 15,500 acres (Niering et al. 1977). Marshes of the northeastern United States are dominated by a small number of plant species. Along the intertidal zone, saltwater cordgrass (Spartina alterniflora) usually forms a conspicuous belt of varying width. On the adjacent higher marsh, a finer and shorter saltmeadow cordgrass (Spartina patens) forms a matrix within which occur "islands" of short S. alterniflora, blackgrass (Juncus gerardi), spikegrass (Distichlis spicata) and forbs (flowering plants usually with broad leaves; i.e., sea lavender, seaside goldenrod), or a mixture of these species. At the upland/marsh interface, Juncus often forms a belt along with the marsh elder (Iva frutescens). Here, reed-grass (Phragimites communis) and switchgrass (Panicum virgatum) also may be conspicuous (Niering et al. 1977).

Three major tidal marsh types (salt, brackish, and fresh) are recognized in Connecticut, each of which exhibits different vegetation patterns. Brackish and fresh tidal marshes attain their optimal development on large, slowly flowing river systems characterized by gentle gradients and tidal influence over considerable distances. They are a relatively rare class of tidal wetlands in Connecticut. The combined acreage of brackish and fresh marshes of the Connecticut and Housatonic Rivers represents only 6.3% and 8.0%, respectively, of the total acreage of Connecticut tidal wetlands.

Tidal inundation is the main feature shared by salt, brackish, and fresh marshes, with dissimilarities in aquatic vegetation correlated to variations in salinity. Generally, areas with salinities greater than 15%. and less than 0.5%. will support salt and fresh marshes, respectively. Brackish marshes occupy the salinity zone between the fresh and salt marsh zones (Metzler and Rosza 1982).

Tidal marshlands serve as a vehicle for the storage and transfer of nutrients from upland sources which are partially used and recycled within the marsh system, but ultimately transported into coastal waters to provide basic nutrient for the food web system. Vegetation plays a key role in converting inorganic compounds (nutrients) and sunlight into the stored energy of plant tissue. When dead leaves and stems of plants enter the water and are broken down by bacteria, they leave the storage component of the energy cycle and, as small particles of organic detritus, they become the food of fiddler crabs, worms, snails, mussels, and larval stages of fish and shellfish in estuarine waters. About one half of the plant tissue created in tidal salt marshes is flushed out into the estuary to suppport life there (Clark 1974).

Tidal creeks that transect salt marshes provide a way for various fishes and invertebrates to move into marshes to feed, to spawn, or to seek sanctuary. Some species, such as the blue crab and various fishes, actively move in and out of these tide marshes while others, such as copepods and larvae of fish and invertebrates, are passively carried in and out with the tide.

Tidal marsh systems perform a valuable function in pollution filtration by oxidizing organic waste and by serving as a nutrient "sink", thus reducing the pollution load entering the Sound and the resulting algal blooms and entrophication (NERBC 1974). As sediment accretors, tidal marshes also act as depositories for sediments, therefore reducing the frequency of dredging needed for navigation. This, in turn, reduces the potential for smothering shellfish and other bottom estuarine invertebrates. Marshes also are important in erosion control. During severe storms, extensive mats of marsh peat exhibit great resiliency, and thereby serve to buffer the shoreline and provide the upland with an added degree of protection (Niering and Warren 1974).

Thus, tidal marshlands serve as essential habitat, nutrient producer, water purifier, sediment trap, aesthetic attraction, storm barrier, shore stabilizer, and, perhaps most importantly, as an energy storage unit for the ecosystem (Clark 1974).

4.2.8 Beachfront

The beachfront is a harsh, unstable environment and not a permanent habitat for species of major resource importance. It can provide productive sportfishing for gamefish as they prey upon schools of baitfish such as sand launce which often occur there.

4.3 Living Marine Resources

4.3.1 Introduction

The amount of information available that pertains to Connecticut's living marine resources varies considerably among the individual species. Some life history information such as geographic range, migratory habits, preferred habitat, food habits, and reproduction has been established and is briefly summarized in this section based on the existing literature. Occurence and distribution in Long Island Sound is known for major commercial and recreational species, but is unclear for others which may be less important to fishermen but of considerable ecological importance.

Information in Section 4.3 is presented based on available literature, commercial and recreational fishery statistics, and the knowledge of biologists and fishermen familiar with the species. Life history information for finfish has been extracted from Bigelow and Schroeder (1953), Thomson et al. (1978), and Olsen and Stevenson (1975). Sources of similar information on molluscan and crustacean shellfish are referenced individually for each species.

Trends in the commercial landings of each species are indicated for the period for which records are available. The methods of collection of landing statistics have varied widely over time and may in fact present serious biases in the time series of data. The reader is cautioned in making decisions based only on the commercial landings data contained herein.

Prior to 1981, Connecticut commercial landings statistics were compiled by the National Marine Fisheries Service in part from the total catches recorded for certain species by DEP Marine Fisheries staff and their predecessors from commercial fishing reports. Landings of species were published annually in "Fisheries Statistics of the United States" from 1939 to 1976 although, in 1941, no data were collected in Connecticut. For the years 1977-79, preliminary data were obtained from NMFS, which will eventually be published in the same publication. Data compiled by NMFS for 1980 were not completed at the time of this writing.

In 1981, DEP Marine Fisheries staff, through a contract with NMFS, assumed full responsibility for the collection and compilation of commercial landings statistics. The Connecticut landings of species caught by offshore trawlers that do not fish in Connecticut waters -- and thus are not required to obtain a Connecticut license or to submit a report of catch and landings to Connecticut -- were derived

from dealer interviews and integrated into the total annual landings of each species. Because the 1981 landings of species trawled from offshore grounds such as yellowtail flounder, butterfish, haddock, hakes, bluefish, and cod show dramatic increases over those from 1976-79, and because of differences used to collect these statistics, landings obtained by NMFS prior to 1981 are not directly comparable to 1981 landings. It is widely believed that the figures reported prior to 1981 are underestimates of the true performance of the southern New England fleet landing in eastern Connecticut. Since there is such a disparity in the the magnitude of some landings as well as both the method and collection agency used to derive the figures, dotted lines have been utilized to illustrate the differences and to continually remind the reader of those differences.

Certain restrictions such as minimum legal size limits, creel limits, and prohibition on the taking of egg bearing females, that were designed to protect species from detrimental harvesting practices have been imposed on commercial and recreational harvesters. These restrictions are presented in Table 1.

Table 1. Conservation measures regulating the commercial and recreational harvest of marine species in Connecticut.

Finfish - taken commercially

	minimum legal lengths (inches, total length)		minimum legal lengths (inches, total length)
blackfish	12	winter flounder	8*
black sea bass	8	fluke	14*
bluefish	9	mackerel	9
butterfish	6	scup	7*
cod	17	tomcod	7
weakfish	12	striped bass	16**

* for fish taken recreationally as well as commercially.

** creel limit - 4 fish per day between 16-24 inches fork length, no limit on fish > 24 inches fork length.

Crustacean shellfish - taken commercially and recreationally.

Lobster	3-3/16 inches minimum carapace length; no egg-bearing females may be taken; no lobster parts other than those for immediate personal consumption may be possessed or brought ashore.
Blue crab	5 inches minimum length from tip to tip of shell spikes for hard shell crabs, 3 1/2 inches for soft shell crabs; no egg-bearing females may be taken.

Molluscan shellfish - taken from public grounds.

Hard clam	Those taken from public grounds must be no less than 1 inch in thickness and must not be able to pass through a ring of 1 1/2 inches internal diameter; creel limits differ among towns.
Bay scallop	Only adult scallops with a definite growth ring may be taken. Those taken from the Niantic River must not be able to pass through a ring of 2 inches internal diameter; creel limits differ among towns.
Oyster, soft clam	Creel limits differ among towns.

4.3.2 Finfish

4.3.2.1 Blackfish (Tautoga onitis), tautog

Description: Blackfish are stout-bodied with thick lips, blunt nose, stout conical teeth, and are enlarged anteriorly. They are a dark mottled color with adults bearing a prominent white spot on the chin. Blackfish caught in Connecticut usually weigh from two to nine pounds. They range along the Atlantic coast of North America from Nova Scotia to South Carolina and are most abundant from Cape Ann to the Delaware capes. Blackfish are a year-round inhabitant in LIS. No extensive migration occurs. During the colder months blackfish move into deeper water and lay dormant, returning to shallower waters as they warm in the spring. They are found mostly inshore around breakwaters, ledges, piers and docks, over boulder strewn bottoms and on mussel beds predominately in salt, and sometimes brackish water. They are sensitive to sudden cooling of the water. Blackfish feed mainly on molluscs, predominantly mussels, crushing them with their large, stout teeth. Their diet also includes crabs, sand dollars, amphipods, shrimps, isopods, and lobsters. Spawning occurs in late spring and early summer in LIS.

Fishery and Condition of Stocks:

Year	Commercial landings (Lbs)	Percent of total commercial finfish landings (includes squid)	Percent of total commercial landings of all species (includes shellfish)
1977	10,000	0.3	0.2
1978	12,000	0.3	0.2
1979	12,900	0.4	0.2
1981	21,335	0.4	0.3

Blackfish contribute a low percentage to total commercial finfish landings and landings of all species including shellfish in Connecticut. They are harvested primarily by trawl (82% and 48% of annual blackfish landings in 1979 and 1981, respectively) and hand line (40% in 1981). Smaller amounts of the annual blackfish landings are taken by gill net (9% and 4% in 1979 and 1981, respectively). Commercial landings have generally ranged from 10,000-40,000 pounds since 1939, except for 1948 when a record 150,000 pounds was landed (Figure 2).

From 1977-1981, Connecticut-licensed trawlers reported catching blackfish mostly in central LIS (60-80% of annual

blackfish catches). Small percentages were caught in eastern (5-20%) and western (6-17%) LIS. Essentially none were caught in Block Island Sound and waters farther offshore. It should not be inferred that blackfish are more abundant in Central LIS than the eastern and western ends because they are a by-catch species of trawlers seeking scup or flounder and those vessels concentrate their effort in central LIS.

In 1979, 423,000 blackfish were reported caught by recreational anglers (NMFS 1980), ranking this species sixth by number caught and third by estimated total pounds caught (Table 2). This catch was 49 times greater than the reported catch of Connecticut-licensed commercial fishermen that year (Table 2). In 1981, 24,500 pounds of blackfish were reported caught by Connecticut party and charter boats. Blackfish are a very desirable sportfish susceptible to angling and spearfishing by skin and scuba divers. In 1979, the peak of seasonal angling effort occurred during June when 15% of the overall effort was directed towards the species. However, blackfish are most susceptible to sportfishing during spring and fall by both shore and boat based anglers. They are also vulnerable to angling during October when they congregate in large numbers around deep water reefs and in shoal areas (Sampson 1981).

Relative abundance of blackfish as indicated by catch per commercial trawl hour increased 91% from 1978 to 1979 and has remained at the higher level since then (Figure 3).

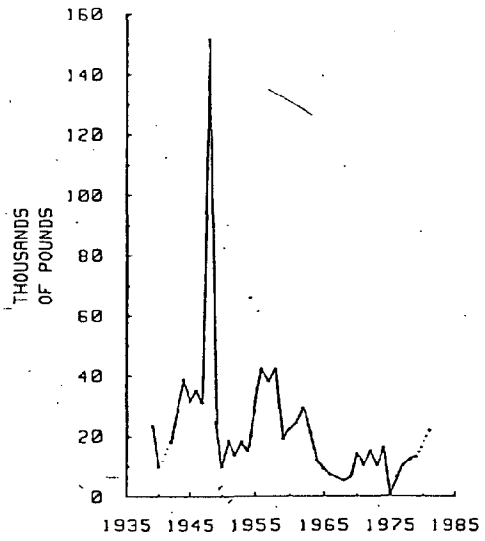


Figure 2. Connecticut commercial blackfish landings, 1933-1981.

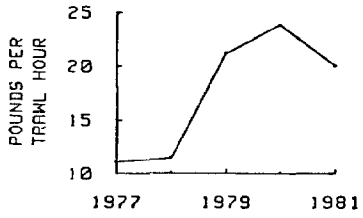


Figure 3. Catch per effort of blackfish caught by Connecticut licensed trawlers, 1977-1981.

4.3.2.2 Bluefish (Pomatomus saltatrix), snapper (young)

Description: Bluefish are an elongate, powerfully built fish, with a somewhat compressed body, a large head with projecting lower jaw and a single row of large teeth on both jaws. They are blue-green on the dorsal surface and silvery below. Most adults caught in Connecticut waters are 2-8 pounds, and sometimes weigh up to 15 pounds. Bluefish are a world-wide species, found in the coastal margins of the Atlantic, Indian, and western Pacific Oceans and the Mediterranean Sea. They range along the east coast of North and South America occurring regularly from Cape Cod, sometimes straying to Nova Scotia, to Brazil and Argentina. They appear in Connecticut waters during May and June remaining into the fall. Bluefish migrate seasonally in response to warmer temperatures. Small bluefish move southward along the coast during late fall while adults exhibit an inshore-offshore movement. Bluefish are pelagic, preferring warmer waters, and are seldom found in waters below 58-60°F. Young are seen close inshore inhabiting the bays and estuaries during summer and early fall. They are voracious predators traveling in large schools feeding primarily on fish, although a large variety of organisms are preyed upon including squid, crabs, worms, lobsters and shrimp. Spawning in the western Atlantic Ocean occurs in two major areas: 1) offshore near the Gulf Stream between southern Florida to North Carolina in spring; 2) mid-Atlantic bight over the Continental shelf in summer. Preferred spawning temperatures range from 64 to 79°F.

Fishery and Condition of Stocks:

Year	Commercial landings (Lbs)	Percent of total commercial finfish landings (includes squid)	Percent of total commercial landings of all species (includes shellfish)
1977	12,800	0.4	0.2
1978	54,800	1.3	0.8
1979	52,500	1.4	1.0
1981	311,969*	5.6	3.8

*See 4.3.1

Landings of bluefish from 1977-79 indicate that this species contributed a low percentage to total commercial finfish landings as well as landings of all species including shellfish. However, the 1981 figure suggests that bluefish contribute a significant percentage to total landings.

Landings are divided about equally between the otter trawl and commercial angler fisheries. An insignificant amount per year is also taken by gill net. Bluefish are the mainstay of the hook and line fishery and constitute approximately 50% of all commercial angler landings. Historical peak landings of about 90,000 lbs. occurred in 1952 and from 1969-1974. Recent landings have increased during 1977-79. The 1981 landings of 312,000 lbs is a record, however, because of the new statistics collection method, it is uncertain whether this value represents a true increase in landings or, more likely, whether previous values were underestimates (Figure 4).

Resident commercial trawlers report catching bluefish mostly in central LIS (60-70% of annual bluefish catches), a small amount in western LIS (10-20%) and Block Island Sound (2-8%), and essesntialy none in eastern LIS. Commercial anglers probably catch most bluefish in major bluefish sportfishing areas such as the Race, and similar areas in western and central LIS.

The 1979 recreational catch of bluefish in Connecticut (NMFS 1980) ranked the species first for total number caught (2,015,000). Because an estimated 75% of all bluefish reported from Connecticut are snappers (1,511,000 in 1979) (Sampson 1981), snapper bluefish are ranked second, and adults fifth, by number caught. By weight, adult bluefish are ranked first in importance to the recreational fishery because an estimated 3,500,000 lbs. of adult bluefish were caught by recreational anglers in 1979. This figure is approximately 70 times greater than the number of pounds landed commercially in 1979 (Table 2).

In 1981, 1,074,200 pounds of bluefish were caught from Connecticut's party and charter boats, accounting for 81% of their catch of all species that year. This catch exceeded the 1981 Connecticut-licensed commercial catch of bluefish for all gear types combined (178,000 pounds) by a factor of six. It also exceeded the 1981 commercial landings of bluefish, which includes landings of vessels not licensed by Connecticut (312,000 pounds) by a factor of three.

The relative abundance of bluefish in LIS and adjacent nearshore waters, as indicated by catch per commercial trawl hour, has steadily increased approximately 90% from 1977-1981 (Figure 5).

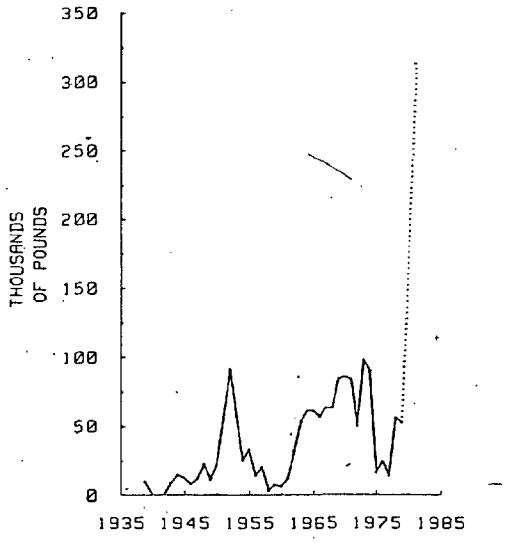


Figure 4. Connecticut commercial bluefish landings, 1939-1981.

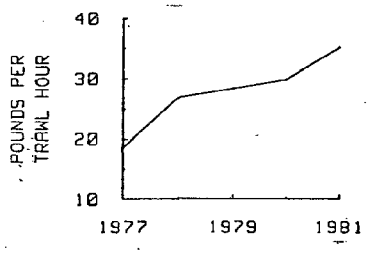


Figure 5. Catch per effort of bluefish caught by Connecticut licensed trawlers, 1977-1981.

4.3.2.3 Butterfish (Peprilus triacanthus)

Description: Butterfish have a very thin deep body, are bluish on top, with light sides and a silver belly. They are usually 6 to 9 inches long and range to 1 pound in weight. Butterfish are most common from South Carolina to Nova Scotia and Cape Breton, occasionally straying northward to the Gulf of St. Lawrence and southward to Florida in deep water. Seasonally migrating, loosely formed schools appear in LIS in late spring and remain until late fall when they return to the edge of the continental shelf. While inshore during the warmer months, butterfish are most abundant over sandy bottom, swimming near the surface in water usually not exceeding 30 fathoms. They are pelagic feeders, concentrating on nektonic or planktonic organisms. Their diet includes small fish, squid, amphipods, copepods, shrimps and annelid worms. Spawning occurs in spring and summer (June to August in New England) a few miles out to sea. Post-spawning individuals return to coastal waters.

Fishery and Condition of Stocks:

Year	Commercial landings (Lbs)	Percent of total commercial finfish landings (includes squid)	Percent of total commercial landings of all species (includes shellfish)
1977	28,200	0.8	0.5
1978	66,000	1.0	1.6
1979	25,900	0.7	0.5
1981	510,435*	9.1	6.2

* See 4.3.1

Landings of butterfish from 1977-79 indicate that this species contributed a low percentage to total commercial finfish landings and landings of all species including shellfish. However, the 1981 landings, which include previously unreported offshore landings, suggest that butterfish contribute a significant percentage to those categories. They are harvested primarily by trawl (greater than 80% of annual butterfish landings) with small amounts taken by hook and line (about 10%) and gill net (less than 5%).

Historical landings increased from less than 100,000 pounds prior to the 1940's to a record 1 million pounds in 1947, after which they dropped to less than 20,000 pounds in the early 1970's. Landings have since increased to over 20,000 pounds (Figure 6).

From 1977-79, Connecticut-licensed trawlers reported catching butterfish mostly in central LIS (47-84% of annual butterfish catches), Block Island Sound (10-20%), and waters further offshore (17-54%). Very little is reported caught by trawl in eastern (2-3%) and western (2-6%) LIS.

No butterfish were reported caught by recreational anglers in 1979 (NMFS 1980). Thus, they are not an important sportfish, although available to anglers, since 1-3 thousand pounds are taken by commercial anglers each year. They are highly regarded as a food fish.

Relative abundance of butterfish as indicated by catch per commercial trawl hour decreased 69% from 1978 to 1979 and has remained at the lower level since then (Figure 7).

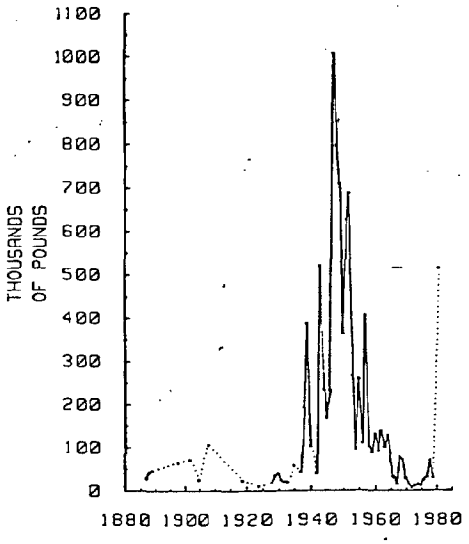


Figure 6. Connecticut commercial butterfish landings, 1887-1981.

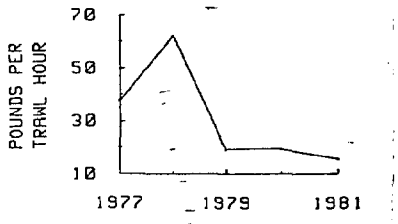


Figure 7. Catch per effort of butterfish caught by Connecticut licensed trawlers, 1977-1981.

4.3.2.4 Cod (Gadus morhua), scrod (juvenile)

Description: Cod are heavy-bodied fish with three dorsal fins, two ventral fins and a nearly square tail. Color varies widely from gray-green to reddish. Near LIS, weight ranges from 6-12 pounds, and length, up to 20 inches. They are found in the northwest Atlantic from West Greenland south to Cape Hatteras with the continental slope marking the offshore boundary. Cod rarely enter LIS, instead remaining outside its eastern edge. Migrations are associated with temperature, food and spawning. Seasonally, cod move into deeper water in winter and spring. They occur most frequently on rocky and pebbly bottom, on gravel or sand, and on a substrate of clay and broken shell. They are found at temperatures between 32 and 55°F, and to depths of at least 250 fathoms. Typically a bottom fish, cod consume a variety of invertebrates and fish. Spawning grounds are generally small and well defined. Peak spawning occurs from January to mid-September, depending upon location, in temperatures ranging from 30 to 54°F, usually at depths between 5-25 fathoms.

Fishery and Condition of Stocks:

Year	Commercial landings (Lbs)	Percent of total commercial finfish landings (includes squid)	Percent of total commercial landings of all species (includes shellfish)
1977	49,400	1.4	0.9
1978	55,200	1.3	0.8
1979	19,200	0.5	0.4
1981	504,800*	9.0	6.1

* See 4.3.1

Landings of cod from 1977-79 indicate that this species contributed a low percentage to total commercial finfish landings as well as to landings of all species including shellfish. However, the 1981 landings suggest that cod contributes a significant percentage to those categories. They are harvested primarily by trawl (90-98% of annual cod landings), with a few thousand pounds (2-8%) taken by hook and line. Historical landings peaked in the late 1920's to almost 9 million pounds in 1930. They have remained near, or less than 400,000 pounds since then (Figure 8). Resident commercial trawlers report catching cod mostly in Block Island Sound (78-94% of annual cod catches) and offshore grounds (2-20%). Essentially none are reported from LIS except for about 100 pounds per year from eastern LIS.

Less than 30,000 cod were reported caught by recreational fishermen in 1979 (NMFS 1980). A rough conversion of 15,000 cod to 90,000 pounds ranks cod thirteenth in recreational importance by weight of landings. Recreational landings exceed the 1977-79 commercial landings approximately two-fold; again however, commercial cod landings figures for these years are probably underestimates. In 1981, 58,500 pounds of cod were reported caught by Connecticut party and charter boats.

Relative abundance of cod as indicated by catch per commercial trawl hour decreased 75% from 1978-1980 and remained low in 1981 (Figure 9).

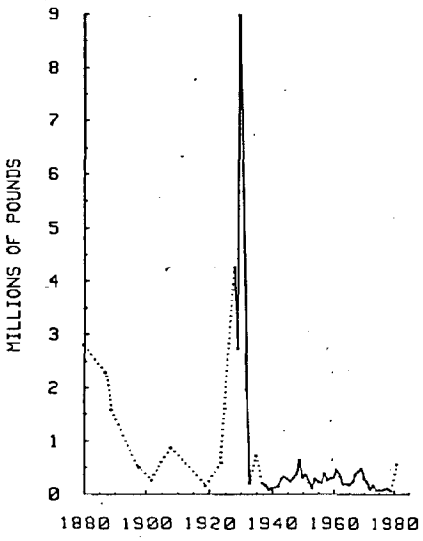


Figure 8. Connecticut commercial cod landings, 1880-1981.

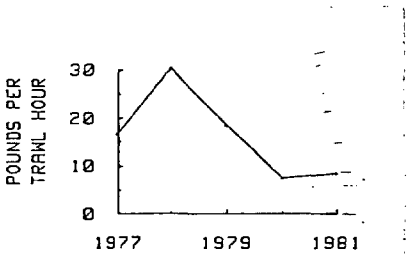


Figure 9. Catch per effort of cod caught by Connecticut licensed trawlers, 1977-1981.

4.3.2.5 American eel (Anguilla rostrata)

Description: Eels have an elongate, snake-like appearance. The dorsal fin originates far behind the pectorals. They are brown to olive green in color, silvery when migrating. Males are generally smaller than females which average 2 to 3 1/2 feet. They range from West Greenland to Central America and the West Indies. The eel is a common species in Long Island Sound inhabiting estuaries and streams along the entire coastline. It matures in fresh water, then migrates downstream to salt water and out to open ocean breeding grounds in the Sargasso Sea. Adult eels are assumed to die at sea following reproduction during mid-winter. The elvers (young eels) then migrate back to fresh water. Eels are not particular about the type of bottom they inhabit, and can tolerate wide ranges of environmental variables such as temperature, salinity, dissolved oxygen, and levels of pollutants. They are principally a nocturnal feeder, consuming all types of animal matter both living and dead, including small fish, crabs, lobsters, worms, shrimp and small crustacea.

Fishery and Condition of Stocks:

Year	Commercial landings (Lbs)	Percent of total commercial finfish landings (includes squid)	Percent of total commercial landings of all species (includes shellfish)
1977	34,200	0.1	0.6
1978	26,400	0.6	0.4
1979	27,600	0.8	0.5
1981	27,335	0.5	0.3

Eels contribute a low percentage to total commercial finfish landings and landings of all species including shellfish in Connecticut. They are harvested primarily with eel pots (85-97% of annual eel landings) with small amounts taken by trawl (0.1-4%), gill net (0.1-10%), and hand lines (less than 1%). Commercial landings have generally ranged from 10,000-50,000 pounds since 1939. The 1950's and 1960's were a period of consistently low landings between 10,000 and 25,000 pounds (Figure 10).

In 1979, less than 30,000 eels were reported caught by recreational anglers (NMFS 1980), ranking this species, along with four others, last by number caught. Eels are considered a desirable food fish by many people. In Japan they are a delicacy.

The condition of Connecticut eel stocks is thought to be stable. However, some commercial eel fishermen believe that catches are declining while fishing effort is increasing (Shen 1982). No scientific data is available to determine the condition of stocks.

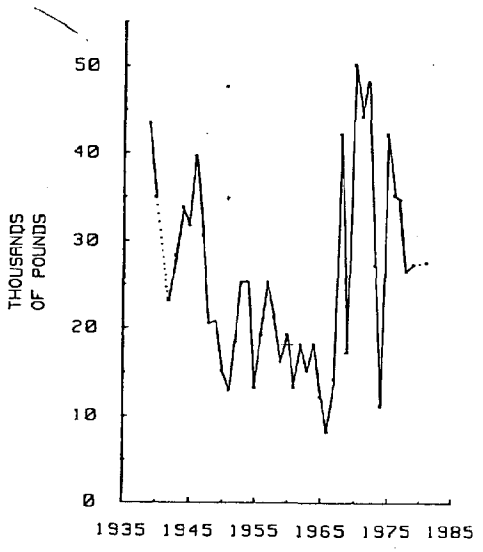


Figure 10. Connecticut commercial eel landings, 1939-1981.

4.3.2.6 Winter flounder (Pseudopleuronectes americanus), blackback flounder, lemon sole

Description: The eyes of the winter flounder are on the right side of its body, it is small mouthed, and thick bodied; color is variable but generally this is the darkest of the flatfish. Adults are commonly 12 to 15 inches long and weigh 1.5 to 2.0 pounds. The winter flounder ranges from Labrador to Georgia, but is most common from the Gulf of St. Lawrence to Chesapeake Bay. It is a permanent resident of LIS, completing its life cycle here. Adults migrate seasonally, moving into deeper water in the summer and then back to shallow water and estuaries in the winter. Juveniles spend their first year in estuarine waters. Soft, muddy bottom (commonly where there are patches of eelgrass) is preferred over a moderately hard one. Winter flounder tolerate a wide range of temperatures but are most abundant at about 53-60 °F, and are found between 1-20 fathoms. Winter flounder are sight feeders and are active during daylight hours. They eat a wide variety of isopods, copepods, amphipods, crabs, shrimp, worms, molluscs, snail eggs, and some seaweed. Spawning occurs at night in winter and early spring (between January and May in New England) on sandy bottoms, often in water as shallow as 6-18 feet.

Fishery and Condition of Stocks:

Year	Commercial landings (Lbs)	Percent of total commercial finfish landings (includes squid)	Percent of total commercial landings of all species (includes shellfish)
1977	609,000	17.7	11.6
1978	804,000	19.5	12.4
1979	529,400	14.4	10.2
1981	1,161,000*	20.8	14.1

*See 4.3.1

Among Connecticut commercial finfish landings, only unclassified baitfish landings exceed those of winter flounder, which can be classified as Connecticut's most important commercial foodfish species. Essentially all (99% of annual landings) of the winter flounder landed by commercial vessels in Connecticut are caught by otter trawl. Small quantities are also commercially taken by haul seine, gill net, and angling.

The greatest commercial winter flounder landings, between 3-5 million pounds, were recorded annually from 1940-1950. Landings have remained less than or near 1 million pounds since then, although very low landings (less

than 200,000 pounds) occurred in 1972, 1973, and 1975 (Figure 11).

Resident trawlers report catching winter flounder mostly in Block Island Sound (50-60% of annual winter flounder catches). Eastern LIS yield is low (5-20%), and the catch in western LIS is insignificant.

The 1979 recreational catch of winter flounder (1,377,000 fish; NMFS 1980) ranked this species third by number and fifth by weight in recreational importance (Table 2). In 1981, 34,000 pounds of winter flounder were reported caught by Connecticut party and charter boats. It is the most highly-sought species in Connecticut waters due to its high quality flesh and the ease with which it may be caught (Sampson 1981). In 1979, the recreational catch exceeded the commercial catch from all gear types by 17% (Table 2).

Although abundance, as indicated by catch per commercial trawl hour, decreased 28% from 1979-80, it increased 19% from 1980-81 and appears to have remained relatively steady over the entire period (Figure 12).

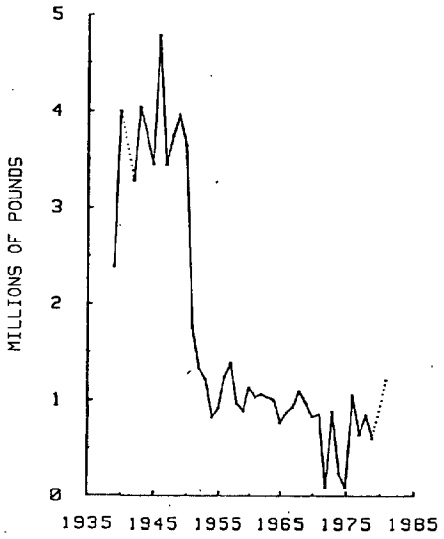


Figure 11. Connecticut commercial winter flounder landings, 1939-1981.

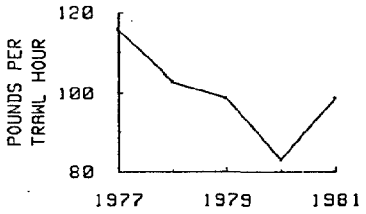


Figure 12. Catch per effort of winter flounder caught by Connecticut licensed trawlers, 1977-1981.

4.3.2.7 Fluke: (Paralichthys dentatus), summer flounder

Description: The eyes of the fluke are on the left side of its body. Its mouth is large with sharp teeth, color is variable depending upon background, from shades of brown and gray to almost black, with several prominent spots. The average size of fluke in LIS is 17-22 inches weighing 2-5 pounds, although larger ones up to 10-15 pounds are often caught. Fluke occur on the continental shelf from Maine to South Carolina. They occur seasonally in LIS during summer months in bays, harbors, and mouths of estuaries. Fluke move inshore to shallow coastal water in the early summer, and migrate offshore in the fall to overwinter. Medium sized and larger fluke occur between the 25 to 30 fathom contour and the 80 fathom contour during winter and early spring. They spend most of their lives on the bottom preferring sand or mud, but will rise into the water column when chasing prey. Fluke consume primarily small fish, squid, crabs, shrimp, molluscs, worms, and sand dollars. They spawn in offshore waters during fall, winter, and spring.

Fishery and Condition of Stocks:

Year	Commercial landings (Lbs)	Percent of total commercial finfish landings (includes squid)	Percent of total commercial landings of all species (includes shellfish)
1977	63,500	1.8	1.2
1978	110,800	2.7	1.7
1979	30,700	0.8	0.6
1981	81,343*	1.4	1.0

*See 4.3.1

Fluke contribute a low percentage to total commercial finfish landings and landings of all species including shellfish in Connecticut as indicated by reported catch and landings. They are harvested primarily by trawl (greater than 95% of annual fluke landings) with several hundred pounds (1-2%) taken by hook and line. Historical landings fluctuating between 200,000 and 800,000 pounds occurred from 1944-1959. Landings dropped to less than 100,000 pounds from 1965-1977, but increased from less than 25,000 to 111,000 pounds during 1972-78 (Figure 13).

From 1977-1981, Connecticut-licensed trawlers reported the greatest catches of fluke in Block Island Sound and offshore grounds, and central LIS. The combined catch from

these areas amounted to about 90% of annual fluke catches. No finer definition of consistant trends in catch by area is apparent except that low fluke catches were reported from eastern (5-9%) and western (1-4%) LIS.

In 1979, 33,000 fluke were reported caught by recreational anglers (NMFS 1980), ranking this species fourteenth by number caught and sixteenth by estimated total pounds caught (Table 2). This ranking is not an indication of the species' appeal to recreational fishermen. It is the seventh most sought after species by Connecticut recreational anglers (Sampson 1981). Low recreational catches in 1979 may represent an extreme low in abundance or availability that year since the same depressed figure is represented in Connecticut commercial catches as well. Fluke are of high quality as a food fish, and catching larger fluke may provide an exciting angling experience. The 1979 recreational fluke catch was 13% greater than the 1979 reported catch of Connecticut licensed commercial fishermen (Table 2). In 1981, 7,600 pounds of fluke were caught from Connecticut party and charter boats.

Although the relative abundance of fluke as indicated by catch per commercial trawl hour fluctuated between 20-35 pounds from 1977-1981 this difference is not believed to represent a large variation in abundance (Figure 14).

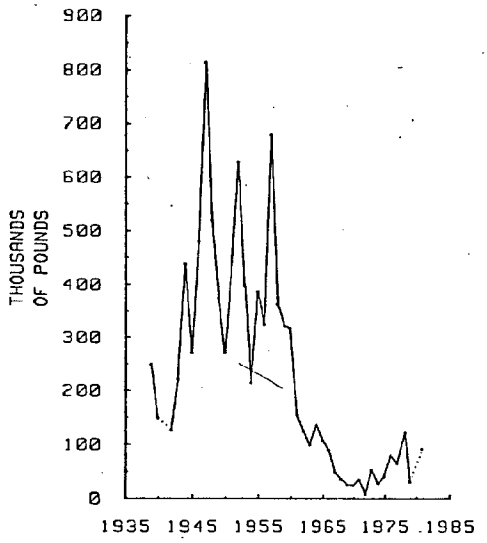


Figure 13. Connecticut commercial fluke landings, 1939-1981.

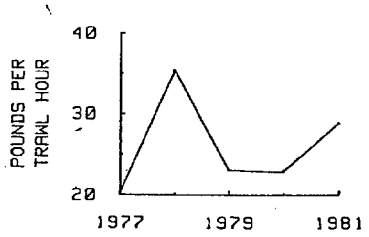


Figure 14. Catch per effort of fluke caught by Connecticut licensed trawlers, 1977-1981.

4.3.2.8 Yellowtail flounder (Limanda ferruginea)

Description: The yellowtail flounder is small-mouthed, with its eyes on the right side of its body. It is brownish with reddish spots, with a distinct yellow spot on the underside at the base of the tail. They average 15 to 18 inches in length, weighing 1 to 2 pounds. Yellowtail range from the Gulf of St. Lawrence to the lower part of Chesapeake bay, and are especially abundant off southern New England and on Georges Bank. They are not known to enter LIS. Yellowtail do not make significant migrations although they may undertake local movements of probably not more than 50 miles. Yellowtail inhabit sand or sand-mud bottoms and avoid rocky and very soft, muddy areas. They are found in moderate depths from 7 to 40 fathoms and are tolerant of water temperatures ranging from 33 to 54°F. A demersal fish with a small mouth, yellowtail feed mainly on amphipods, shrimps, mysids and small shellfish as well as on worms. Small fish are consumed when available. Spawning takes place from mid-March to September with peaks in April to June in New England.

Fishery and Condition of Stocks:

Year	Commercial landings (Lbs)	Percent of total commercial finfish landings (includes squid)	Percent of total commercial landings of all species (includes shellfish)
1977	384,300	11.2	7.3
1978	307,600	7.4	4.8
1979	346,300	9.4	6.6
1981	1,502,416*	26.8	17.8

* See 4.3.1

Landings of yellowtail flounder from 1977-79 indicate that this species contributed a substantial percentage to total commercial finfish landings and landings of all species including shellfish. In 1977 and 1979 it was second only to winter flounder in importance as a commercial finfish. In 1978 it was third in commercial importance as a finfish; in that year, scup was second to winter flounder. However, the 1981 landings, which include unreported offshore landings, indicate that yellowtail flounder is the most important commercial finfish, winter flounder being second.

Yellowtail are harvested entirely by trawl. Landings near 6 million pounds in 1942 decreased steadily to less than 200,000 pounds in the 1950's and 1960's. In 1974 and 1975, landings peaked dramatically at 9 million pounds. The

increased level of landings in 1981 over that recorded for 1977-79 is believed to be a result of an improvement in the method of collecting statistics. Therefore, landings from the late 1970's are likely to be underestimated. However, the 1981 landings are still low compared to those of 1974 and 1975 (Figure 15).

From 1977-79, Connecticut licensed trawlers reported catching yellowtail mostly offshore of Block Island Sound (37-68% of annual yellowtail catches) and in Block Island Sound (37-58%). Reports of catches made at the extreme eastern end of Long Island Sound occasionally account for about 2% of landings.

No yellowtail flounder were reported caught by recreational anglers in 1979 (NMFS 1980). The species may be caught incidentally by anglers fishing for cod, but is not a target species itself.

The relative abundance of yellowtail flounder as indicated by catch per commercial trawl hour decreased 59% from 1977 to 1981 (Figure 16). Individuals of two yellowtail stocks -- the southern New England and Georges Bank stocks -- are landed in Connecticut, probably more of the former than the latter. Research survey data on the southern New England stock indicated a pronounced decline in abundance between the late 1960's and mid 1970's, which has leveled off since then (NEFMC 1981). It is unknown whether the Connecticut commercial catch/effort data reflects a further decline in stock abundance.

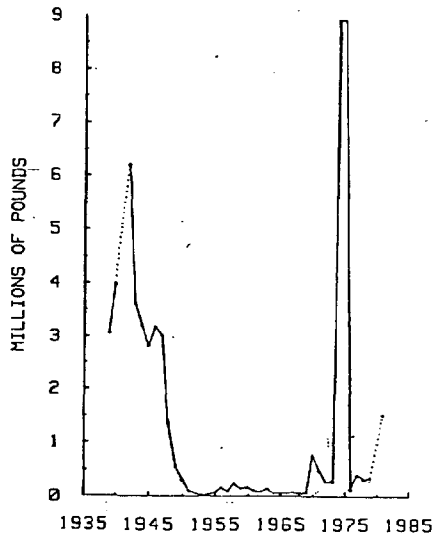


Figure 15. Connecticut commercial yellowtail flounder landings, 1939-1981.

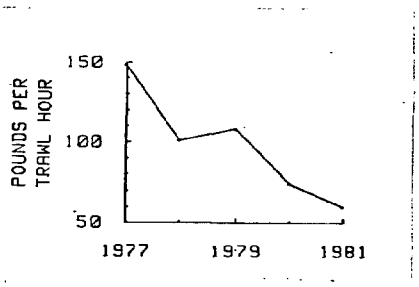


Figure 16. Catch per effort of yellowtail flounder caught by Connecticut licensed trawlers, 1977-1981.

4.3.2.9 Mackerel (Scomber scombrus)

Description: Mackerel have a streamlined body with a narrow caudal peduncle, and are blue-green above with dark, wavy tranverse bars, whitish sides and belly. Adults are usually 14 to 18 inches long weighing approximately 1-3 pounds. They range from the Gulf of St. Lawrence to Cape Hatteras out to the edge of the continental shelf. The mackerel is an early summer visitor to LIS, leaving in the fall. LIS may be an important nursery area for young mackerel. Each fall, mackerel move out of LIS and overwinter off the southern New England coast near the edge of the continental shelf. They return each spring as part of a general northerly and inshore migration. Mackerel swim in dense schools, and are occasionally seen in harbors and estuaries, but adults are more commonly found in open water, down to 100 fathoms. They are mainly a pelagic feeder with the diet consisting of copepods, crustaceans and small fish. Spawning occurs during the spring and summer over the entire continental shelf (June in southern New England). The most productive spawning occurs south of Cape Cod, but there are no specific spawning grounds.

Fishery and Condition of Stocks:

Year	Commercial landings (Lbs)	Percent of total commercial finfish landings (includes squid)	Percent of total commercial landings of all species (includes shellfish)
1977	32,800	1.0	0.6
1978	15,600	0.4	0.2
1979	12,200	0.3	0.2
1981	86,228*	1.5	1.0

* See 4.3.1

Landings of mackerel from 1977-1981 indicate that this species contributes a low percentage to total commercial finfish landings and landings of all species including shellfish. Mackerel are commercially harvested mostly by gill net (32-65% of annual mackerel landings) and trawl (19-58%). Small quantities (6-9%) are taken by commercial anglers.

Landings of 1.3 million pounds in 1880 decreased to less than 300,000 pounds until the late 1920's - early 1930's when a record 2 million pounds was landed in 1929. Landings declined dramatically in the 1930's. Small peaks near 300,000 pounds occurred in the 1940's, after which landings have remained less than 100,000 pounds (Figure 17).

In 1979, 254,000 mackerel were reported caught by recreational anglers (NMFS 1980), ranking this species eighth by number caught and seventh by estimated total pounds caught (Table 2). Mackerel are important to the recreational boat fishery during a three to six week period from May to mid-June and sporadically throughout the summer and fall. On days during their peak availability (one or two weekends per year), 50% or more of the boat-based fishing effort may be targeted towards mackerel. Shore based anglers seek this species 19% of the time during that same period of peak abundance, however the species seldom ventures within casting range of shore (Sampson 1981). In 1981, 19,400 pounds of mackerel were reported caught by Connecticut party and charter boats.

The spawning stock of mackerel declined steadily from about 2.4 million metric tons in 1969 to 525,000 metric tons in 1977. NMFS bottom trawl catch-per-tow data indicated a decline in overall mackerel abundance during this period (MAFMC 1978).

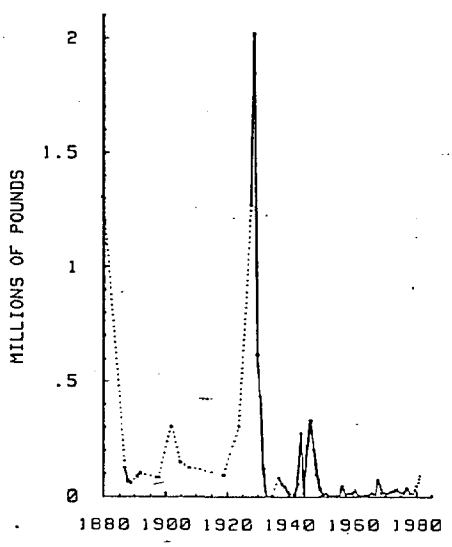


Figure 17. Connecticut commercial mackerel landings, 1880-1981.

4.3.2.10 Menhaden (Brevoortia tyrannus), bunker

Description: Menhaden are deep-bodied with a deeply forked tail, dark blue to blue gray above, with silvery sides. Adults average 12 to 15 inches in length and up to one pound in weight. They range from Nova Scotia to eastern Florida. A seasonal migrant in LIS, menhaden first appear in Connecticut waters in April and remain until late fall. Both adult and immature menhaden make long northern migrations during the summer and then move south in the fall. It is suspected that they migrate into the deep offshore waters of the continental shelf during winter. During summer, they concentrate near large estuarine drainage systems where food is most abundant. They are rarely found in water below 50 °F. Menhaden are efficient planktivores, swimming with their mouths open using layers of comb-like gill rakers to capture minute crustacea, decapod larvae, rotifers and vast quantities of unicellular algae. Spawning of menhaden north of New Jersey occurs from April to October in the ocean over the continental shelf and in some of the larger more saline bays and sounds. In LIS, Wheatland (1956) found menhaden eggs between June and October.

Fishery and Condition of Stocks:

Year	Commercial landings (Lbs)	Percent of total commercial finfish landings (includes squid)	Percent of total commercial landings of all species (includes shellfish)
1977	106,600	3.1	2.0
1978	85,100	2.1	1.3
1979	100,200	2.7	1.9
1981	151,349	2.7	1.8

Menhaden contribute a moderately low percentage to total commercial finfish landings and landings of all species including shellfish in Connecticut. They probably contribute a much larger percentage to these categories because an unknown quantity of menhaden is reported in the commercial landings statistics as unclassified baitfish, of which over 1 million pounds were landed from 1977-79. Menhaden landed in Connecticut are commercially harvested primarily by gill net (90-97% of annual menhaden landings) with small amounts taken by trawl (2-8%) and angling using snag hooks (1-2%).

Record historical landings exceeding 40 million pounds occurred in the 1880's. They declined to less than 200,000 pounds in the 1930's and 1940's. From 1954-1969

record low landings less than 50,000 pounds occurred. From 1970 to the present, landings have generally ranged between 100,000-600,000 pounds (Figure 18). The early landings from 1880-1930 reflect the magnitude of Connecticut's former menhaden industry.

Processing plants serving purse seine boats fishing in Long Island Sound operated in Connecticut from about 1870 to 1930 (General Dynamics 1968). Purse seining is the most efficient method of harvesting menhaden to be used for reduction to fish oil and fertilizer. Since the closing of the Connecticut menhaden processing plants, purse seine boats have continued to operate in LIS. However, they land their catches in New Jersey where a processing plant currently operates (see Section 5.1.11). Thus, the actual catch of menhaden from LIS is much greater than landings statistics since 1930 indicate. From 1974-1981, one company operating several purse seine boats in LIS reportedly caught greater than 2 million pounds per year to be processed as industrial fish. The Connecticut landings statistics only represent that menhaden which is used for bait by Connecticut lobstermen and anglers.

No menhaden were reported caught by Connecticut recreational anglers in 1979 (NMFS 1980). However, anglers probably did take considerable numbers using snag hooks to use as bait for bluefish and striped bass.

All menhaden along the Atlantic coast belong to a single stock. Abundance has declined since the last century. Heavy fishing pressure on the stock as a whole may have caused the size of the spawning stock to drop below an optimum level which may have caused poor recruitment in the 1960's. Few menhaden were landed in southern New England between 1963 and 1968 (Henry 1971; Olsen and Stevenson 1975). This is reflected by low Connecticut landings during this period (Figure 18). During the 1970's and at present, catches of menhaden entering LIS have been relatively large, indicating that the condition of the stock may be stable. However, no scientific data is available on the population dynamics of that portion of the Atlantic menhaden stock entering Long Island Sound.

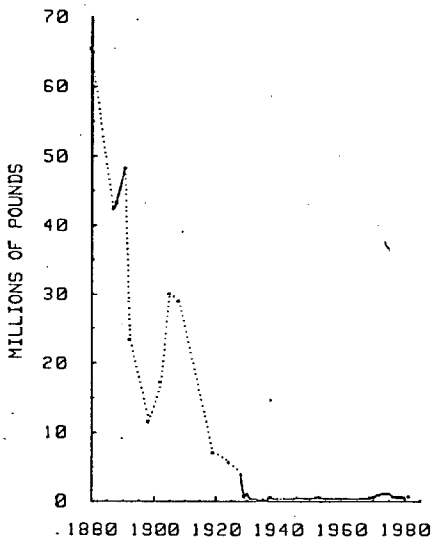


Figure 18. Connecticut commercial menhaden landings, 1880-1981.

4.3.2.11 River herring: alewife (Alosa pseudoharengus), blueback herring (Alosa aestivalis), glut herring.

Description: The bodies of river herring arestrongly compressed laterally and are deeper than in sea herring (about 1 1/3 times as long as deep). They have one short dorsal fin and a deeply forked tail. Color is blueish above for the blueback, grayish green above for the alewife, and both have silvery sides. Adults of both species are commonly less than 12 inches in length and 1/2 pound or less in weight. Alewives range from Labrador to Cape Hatteras, and are less abundant south of Cape Cod. Bluebacks are more southern species, most abundant from southern New England to Florida but occurring north to Nova Scotia. Pre-and post-spawning anadromous river herring pass through Long Island Sound on their migration to and from the rivers in which they spawn, especially the Connecticut and Thames Rivers. Little is known about migrations in the ocean where most growth occurs. There is evidence that both species are schooling fish in the ocean. The blueback may move out far from land (more than 100 miles) and may pass the winter near the bottom. The spawning migration of the alewife occurs in the early spring in Connecticut rivers and streams, before the blueback's spawning migration in the late spring and early summer. Both are mainly planktivores, feeding on copepods, other crustacean zooplankton, and fish eggs. They also eat small fish. The alewife does not feed when swimming upriver to spawn; when they return to saline waters they feed ravenously. This is probably true for bluebacks but not known with certainty. River herring are broadcast spawners; alewives prefer areas of relatively slow flow and temperatures of 55-60 °F; bluebacks prefer areas of relatively fast flow and later spring temperatures of 70-75° F.

Fishery and Condition of Stocks:

Because no distinction is made between the blueback and alewife by commercial harvesters, both species are included under "alewives" in commercial landings statistics.

Year	Commercial landings (Lbs)	Percent of total commercial finfish landings (includes squid)	Percent of total commercial landings of all species (includes shellfish)
1977	61,300	1.8	1.2
1978	39,900	1.0	0.6
1979	62,700	1.7	1.2
1981	52,816	0.9	0.6

"Alewives" contribute a low percentage to total commercial finfish landings and landings of all species including shellfish in Connecticut. They are harvested primarily by haul seine (90-95% of annual "alewife" landings) with 2-6% taken by gill net. Commercial fishing for river herring occurs mainly in the Connecticut River, during their spring spawning migrations. They are currently used primarily as lobster bait and bait for game fishing. During the 1950's they were used as industrial fish, being reduced to fish meal. Actual commercial landings may be much greater than those reported under the "alewives" category because a large percentage of the landings reported under "unclassified baitfish" may consist of river herring. These "unclassified" landings exceeded 1 million pounds from 1977-79.

Two peak periods in the recorded historical landings occurred from 1892-1908 and 1950-55. During these periods, annual landings exceeded 500,000 pounds. A record landing of 1.94 million pounds occurred in 1950. Landings have generally remained at less than 100,000 pounds since 1960 (Figure 19).

River herring are a productive bait for recreational anglers fishing for striped bass and bluefish. They are not a target of recreational fishing effort.

From annual surveys of juvenile shad abundance in the Connecticut River conducted by the DEP since 1979, it is known that the blueback herring stock of this river is quite abundant. In fact, juvenile blueback herring are the most numerous species taken in haul seine samples from August to October. Juvenile alewives are seldom taken in samples; thus little is known of the size or condition of the Connecticut River alewife stock. No scientific information is available on the present condition of the river herring stocks of other Connecticut rivers and streams.

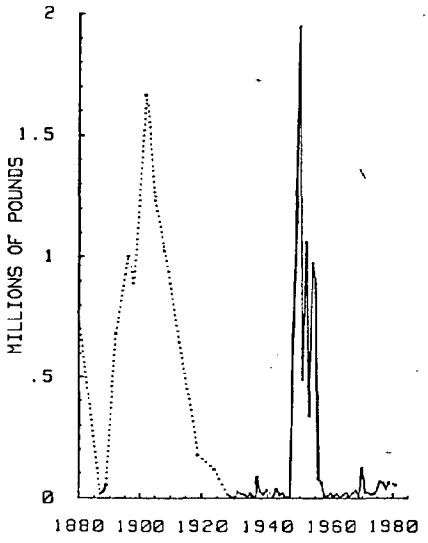


Figure 19. Connecticut commercial river herring landings, 1880-1981.

4.3.2.12 Scup (Stenotomus chrysops), porgy

Description: Scup are half as deep as they are long, very thin, with large scales. They are silvery and irridescent, darker above, with a white belly. Adults are usually 8 to 14 inches long weighing 1/2 to 2 1/2 pounds. Scup range from Cape Cod to Cape Hatteras. They occur in LIS from June to mid-October. Juveniles were found to overwinter in LIS during 1971-75 (Thomson et al. 1978). Scup migrate to inshore regions along the New England coast, including LIS, to spawn during June, leave the New England coast around mid-October, and migrate southward and offshore of the New Jersey and North Carolina coast. In the following spring, they again undertake their spawning migration northward into nearshore areas of southern New England and New York. Scup prefer smooth to rocky bottom and stay in fairly deep (30-100 feet) waters during the summer in LIS. They are very sensitive to temperature; apparently the need for an environment of about 45°F determines how far offshore they move in winter. Scup are bottom and near-bottom feeders. Their prey includes small crustacea, worms, molluscs, squid, vegetable debris, hydroids and sand dollars. They apparently cease feeding during spawning. Spawning occurs in late spring apparently over sandy and weed covered grounds.

Fishery and Condition of Stocks:

Year	Commercial landings (Lbs)	Percent of total commercial finfish landings (includes squid)	Percent of total commercial landings of all species (includes shellfish)
1977	256,200	7.4	4.9
1978	379,700	9.2	5.9
1979	174,600	4.8	3.4
1981	97,999	1.8	1.2

Scup contribute a moderate percentage to total commercial finfish landings and landings of all species including shellfish in Connecticut. They are commercially harvested primarily by trawl (87-98% of annual scup landings) with small amounts taken by angling (0.2-9%) and gill net (0.5-2%). The period of major scup landings was from 1940 to the mid 1960's when they ranged from 1-2.5 million pounds with a record of 3.4 million pounds in 1955. Landings declined in the 1960's and have remained at less than 500,000 pounds since (Figure 20).

From 1977-1981, Connecticut-licensed trawlers reported the greatest catches of scup in central LIS (48-69% of annual scup catches), lesser amounts in western LIS

(15-24%), Block Island Sound and further offshore (5-33%), and small catches in eastern LIS (2-6%).

In 1979, 1,984,000 scup were reported caught by recreational anglers (NMFS 1980), ranking this species first by number caught and second by estimated total pounds caught (Table 2). Scup are the sixth most popular recreational finfish species in terms of targeted angling effort. This effort occurs from May through October for the species. In 1979, scup catch rates were less than 10 fish per 100 hours of angling from shore, since the species is relatively unavailable to shore based anglers. However, from July-September, catch per effort was higher for scup than any other species caught in the boat fishery. A peak of 180 scup per 100 hours occurred during September for the boat fishery (Sampson 1981).

In 1981, 16,500 pounds of scup were caught by party and charter boats. The recreational catch of scup in 1979, which includes the party and charter boat mode, was two times greater than the catch of Connecticut-licensed commercial fishermen that year (Table 2).

The relative abundance of scup as indicated by catch per commercial trawl hour decreased 68% from 1978 to 1980 and remained at the lower level in 1981 (Figure 21).

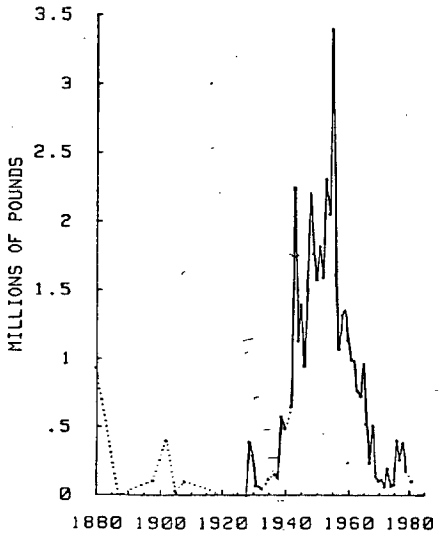


Figure 20. Connecticut commercial scup landings, 1880-1981.

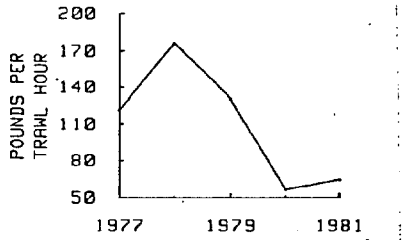


Figure 21. Catch per effort of scup caught by Connecticut licensed trawlers, 1977-1981.

4.3.2.13 American shad (Alosa sapidissima)

Description: Shad are the largest of the herrings. Their body is deep, with a sharply serrated belly, deeply forked tail, and large scales. They are bluish or greenish above which gradually shades into bright silver sides. Adult males weigh up to 6 pounds and females up to pounds. Shad range from the St. Lawrence River and Nova Scotian banks south to the St. Johns River in Florida. They enter the Connecticut River to spawn from early April through mid-June. They are present in eastern LIS as they migrate from the ocean to the Connectiut River and back again after spawning. Juveniles migrate through LIS from the Connecticut River to the ocean in October. After migrating as far as Turners Falls, Massachusetts in the Connecticut River to spawn, post-spawners move back downstream to the sea and then swim north to spend the summer and early fall in the Gulf of Maine. With declining fall water temperatures, most shad move out of the Gulf of Maine and congregate offshore, between southern Long Island and Nantucket shoals. Adults enter coastal waters in a broad front toward the middle Atlantic coast, as far south as North Carolina during the winter and spring. North Atlantic populations proceed north up the coast to their natal rivers in spring with the warming of coastal waters, while south Atlantic populations migrate southward to their natal rivers (Neves and Depres 1979). During their adult life in the sea, shad are pelagic schooling fish, and they never re-enter fresh water until they return to their natal river to spawn, though they sometimes do appear in brackish estuaries. In the ocean, schools of shad are often seen at the surface in spring, summer and autumn, but are seldom seen during the winter. They have been trawled from depths of 50 fathoms off Nova Scotia in March, and at 26 to 68 fathoms off southern New England in May. Shad are primarily plankton feeders, like other herrings. In the sea, adult shad feed on copepods and mysid shrimp. They take little or no food in fresh water during the spawning migration. Most spawning in the Connecticut River presently occurs between the Enfield Dam, Connecticut and the base of the Turners Falls Dam, Massachusetts from mid-May through mid-July at water temperatures between 14-23 ° C. Broadcast spawning begins about an hour after dark in open water over sandy or pebbly bottom, during which groups of 5-10 male and female shad swim close together in small circles near the surface. Adults experience considerable energy and weight loss during migration and spawning; therefore, post-spawning mortality is believed to be high. Surviving shad will leave the river shortly after spawning, endure an unknown rate of oceanic mortality, and return to the river in the following year as repeat spawners. Due to the high rate of post-spawning mortality, shad will rarely spawn more than twice in their lifetime.

Fishery and Condition of Stocks:

Year	Commercial landings (Lbs)	Percent of total commercial finfish landings (includes squid)	Percent of total commercial landing of all species (includes shellfish)
1977	332,400	9.7	6.3
1978	306,300	7.4	4.7
1979	206,800	5.6	4.0
1981	324,600	5.8	4.0

Shad are one of Connecticut's five most important commercial finfish species in terms of annual landings. Only winter flounder and yellowtail flounder consistently contributed higher percentages to total annual landings than shad during 1977-81. Since 1975 shad have been commercially harvested entirely by drift gill net in the Connecticut River from its mouth north to Portland, Connecticut. Except for the period 1942-49, during which landings peaked at 1 million pounds in 1946, annual landings have generally fluctuated between 200,000-400,000 pounds (Figure 22).

Shad that swim upriver past the commercial gill netting areas in the lower Connecticut River, are then subject to being caught in a substantial sportfishery located mainly in areas near Windsor locks and Enfield, Connecticut and Holyoke, Massachusetts. A 1982 creel census of the shad sport fishery in Connecticut conducted by the DEP, revealed that an estimated 118,900 pounds of shad were taken, and an additional 42,600 pounds were caught but then released. The American shad is acclaimed by many anglers for its trophy size (3-8 pounds), and its fighting quality on light tackle. Recent tag-recapture studies by the DEP indicate that recreational anglers annually harvest between 8-13% of the shad run.

The DEP is currently conducting an early life history study of the Connecticut River shad population in which the strength of each year class is estimated by annually monitoring the survival of larvae and relative abundance of juvenile shad. With this information the condition of the stock is closely monitored and measures can be taken, if necessary, to maintain the stock at a stable level of abundance.

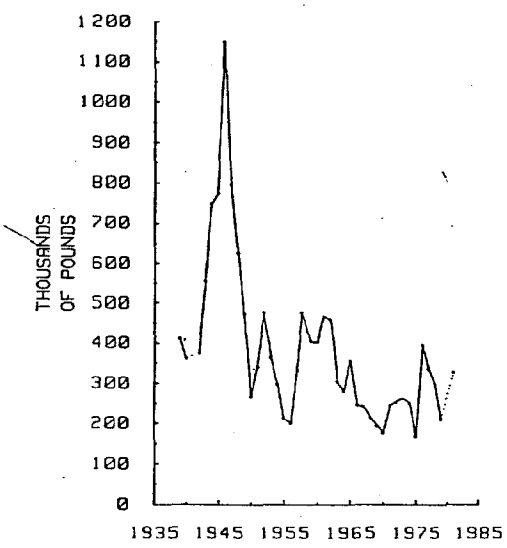


Figure 22. Connecticut commercial shad landings, 1939-1981.

4.3.2.14 Striped bass (Morone saxatilis)

Description: Striped bass have a deep body with a broad tail, and are dark olive green to bluish above, with silver sides, that have narrow dark stripes. Bass over 40 pounds are quite rare in Connecticut waters, 5-20 pounds being the usual range. They range along the Atlantic coast from the St. Lawrence River to Florida, into the Gulf of Mexico to Louisiana. Although small groups may overwinter in LIS, the majority of fish are seasonal migrants. They appear in early spring traveling northward and return in fall on their way to overwinter in the Hudson River and Chesapeake Bay. Striped bass rarely occur more than 5 miles from the coast. They prefer surf-swept beaches, shallow estuaries and bays, and rocky stretches. Water temperatures between 46-70 °F are preferred. They are a voracious predator feeding primarily on fish but also worms, squid, clams, lobsters and crabs. The first two years appear to be spent in the rivers in which they were spawned. Bass three years and older undergo extensive northern migrations in early spring, returning to large rivers and bays, principly the Hudson River and Chesapeake Bay in late fall. An anadromous species, striped bass enter brackish and fresh water to spawn. Along the Atlantic coast, spawning usually occurs from April to June, governed largely by water temperatures (55-73 °F). The most prolific spawning area is Chesapeake Bay. Spawning occurs in moving water which serves to keep the semiboyant eggs from settling to the bottom and smothering.

Fishery and Condition of Stocks:

Year	Commercial landings (Lbs)	Percent of total commercial finfish landings (includes squid)	Percent of total commercial landings of all species (includes shellfish)
1977	57,700	1.7	1.1
1978	25,600	0.6	0.4
1979	44,600	1.2	0.9
1981	4,900	0.1	0.1

Since the early 1950's under the Connecticut General Statutes, striped bass taken from Connecticut waters cannot be sold; they are considered a recreational gamefish. Therefore, legal Connecticut striped bass landings are of fish taken mainly from New York and Rhode Island waters. Striped bass contribute a low percentage to total commercial finfish landings and landings of all species including shellfish in Connecticut. They are commercially harvested

entirely by angling. Generally, landings were less than 30,000 pounds from 1939-1968. From 1965-1975 no landings were reported; then in 1973, a record 63,000 pounds were landed. Landings have generally decreased since 1973 (Figure 23).

In 1979, 65,000 striped bass were reported caught by recreational anglers (NMFS 1980), ranking this species thirteenth by number caught and fourth by estimated total pounds caught (Table 2). Striped bass were sought by about 5% of all shore based anglers interviewed during June, October, and November, 1979. In the Thames River estuary, shore based striper fishing is particularly popular from November through May. Striped bass are ranked fourth in order of directed recreational angling effort in Connecticut (Sampson 1981).

From 1979-1981, over 1,500 striped bass were reported caught by Connecticut recreational anglers participating in a Volunteer Angler Survey conducted by the Connecticut DEP. Most were taken from western LIS as a result of angler, rather than fish, distribution. For both 1979 and 1980, over 90% of the stripers caught were under 24 inches, and over 90% of these small bass were released unharmed. Of successful anglers, 66% caught bass between 20-30 inches long, and 87% of these fishermen caught bass over 30 inches (Sampson and Macleod 1982).

The 1979 catch of striped bass by recreational anglers, including those fishing from party and charter boats, exceeded the catch of Connecticut licensed commercial anglers that year by a factor of 21. In 1981, the party and charter boat catch was 9,400 pounds, almost twice the commercial catch.

The abundance of striped bass fluctuates widely depending on the success of year classes. Three major stocks constitute the striped bass population of the Atlantic coast. They originate from the Hudson River, Chesapeake Bay, and Roanoke River. In 1975, estimates of the relative contributions of these stocks to the coastal population were calculated to be 6.5%, 90.8%, and 2.7% respectively (Berggren and Lieberman 1978). The Atlantic coast fishery is no longer dominated by the especially strong 1970 Chesapeake year class, and it is probable that the Hudson's contribution to the Atlantic coast migratory stock is now higher than 7 percent (Kumar and Van Winkle 1978 -- cited in ASMFC 1981). For LIS fishermen, at least, striped bass from the Hudson may partially compensate for the declining abundance of Chesapeake fish until another dominant year class is produced (ASMFC 1981). The striped bass catch of western LIS anglers who voluntarily participated in the 1981 DEP survey is believed to be primarily of Hudson River origin. The estimated total

fishing mortality on that stock is 27% and it is estimated that Connecticut anglers account for about 9% of that 27% (Florence 1980; Sampson and Macleod 1981).

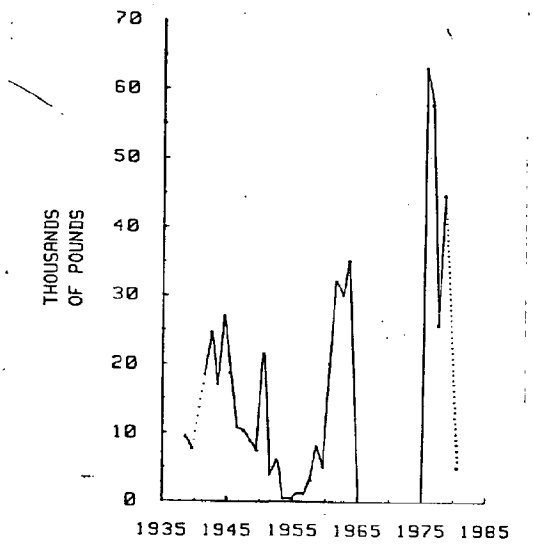


Figure 23. Connecticut commercial striped bass landings, 1939-1981.

4.3.2.15 Weakfish (Cynoscion regalis), seatrout, squeteague

Description: Weakfish are slim-bodied with a relatively deep caudal peduncle, two large canine teeth in the upper jaw and two separate dorsal fins. They are greenish above with purple and bronze metallic reflections, and silvery below. Weakfish weighing up to 12 pounds are commonly caught in LIS. They range from Cape Cod to Florida, being most common off the middle Atlantic states. A seasonal migrant, weakfish appear in Connecticut waters in late spring and leave in the fall. With the onset of colder water, larger fish, greater than 4 years old, move south and offshore, probably no farther south than North Carolina. The younger fish move south along the coast, some as far as Florida. During the summer, weakfish stay close inshore in bays, estuaries, and frequently in the surf, usually staying near the surface, and often traveling in schools. They prefer warmer waters and are sensitive to sudden cooling. Weakfish feed on a variety of organisms which include crabs, amphipods, shrimp, molluscs, worms and fish. The larger fish tend to concentrate on small fish while the young depend more on shrimp and other small crustaceans. Spawning usually takes place at night from May to October throughout most of their range, usually in or near large estuaries, at temperatures ranging from 60 to 70 °F.

Fishery and Condition of Stocks:

Year	Commercial landings (Lbs)	Percent of total commercial finfish landings (includes squid)	Percent of total commercial landings of all species (includes shellfish)
1977	7,300	0.2	0.1
1978	17,700	0.4	0.3
1979	33,800	0.9	0.6
1981	28,500	0.5	0.4

Weakfish contribute a low percentage to total commercial finfish landings and landings of all species including shellfish in Connecticut. They are commercially harvested primarily by trawl (57-89% of annual weakfish landings) with lesser amounts taken by angling (5-26%) and gill net (6-12%). Commercial landings were highest in the 1940's, during which a record 150,000 pounds were landed in 1946. Landings dropped to less than 25,000 pounds in the 1950's and 1960's. Landings have fluctuated between 0-20,000 pounds from 1970 to 1978 with an increase to 34,000 pounds in 1979, decreasing slightly to 28,000 pounds in 1981 (Figure 24).

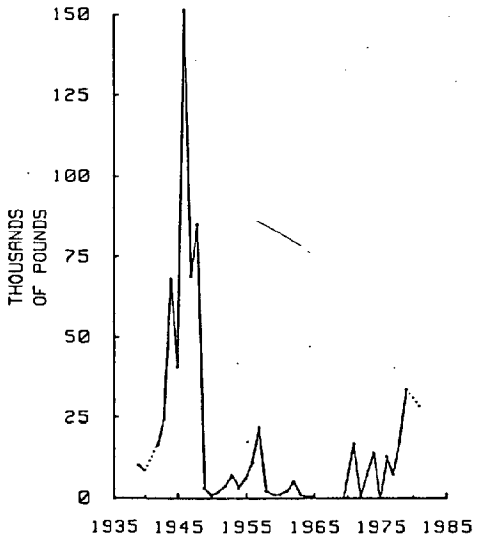
From 1977-1981, Connecticut-licensed trawlers reported catching weakfish mostly in central LIS (65-90% of annual weakfish catches) with lesser amounts taken in western LIS (7-12%) and waters outside of LIS (3-19%). Essentially none were caught in eastern LIS.

In 1979, less than 30,000 weakfish were reported caught by Connecticut recreational anglers (NMFS 1980). This is believed to be an underestimate because field sampling was insufficient during June when weakfish were most abundant (Sampson 1981). In this report, a catch of 30,000 was assigned to weakfish to compensate for the underestimation of the 1979 angler catch (Table 2). It is unknown how much greater the actual weakfish catch may have been that year. In 1981, 7,400 pounds of weakfish were caught by party and charter boats.

In 1979, weakfish were sought by only 5% of interviewed Connecticut anglers, all fishing modes combined. Weakfish were ranked eleventh in order of directed fishing effort for target species. However, there is some evidence that interest in weakfish angling is increasing (Sampson 1981).

Relative abundance of weakfish as indicated by catch per commercial trawl hour appears to have declined slightly (40%) over the entire period 1977-1981; except for 1979, when a peak occurred (Figure 25).

Weakfish were of significant historical importance to the sport fishery of the North Atlantic. However, about forty years ago their numbers rapidly declined. Since 1975 the species has apparently made a resurgence in Connecticut waters. Anglers actively seek weakfish with marked success in areas that ten years ago only produced striped bass and bluefish (Sampson 1981).



Figures 24. Connecticut commercial weakfish landings, 1939-1981.

Figure 25. Catch per effort of weakfish caught by Connecticut licensed trawlers, 1977-1981.

4.3.2.16 White perch (Morone americana)

Description: The white perch is similar to its larger relative, the striped bass, although it is a deeper-bodied fish, more flattened laterally, and has no longitudinal stripes. They average 8 to 10 inches long, weighing 1 pound or less. White perch range from the Gulf of St. Lawrence and Nova Scotia to South Carolina. The species is a year round resident in Connecticut waters, completing its life cycle there. White perch exhibit seasonal movements, migrating into deeper water in winter, returning to brackish waters to spawn in the spring. They prefer brackish and nearshore salt water and are also found far up in rivers, and in lakes and ponds. White perch feed on a variety of organisms including small fish fry, squid, shrimp, worms, crabs and the spawn of various fish. Spawning in southern New England takes place in spring in fresh or slightly brackish water.

Fishery and Condition of Stocks:

Year	Commercial landings (Lbs)	Percent of total commercial finfish landings (includes squid)	Percent of total commercial landings of all species (includes shellfish)
1977	12,600	0.4	0.2
1978	6,000	0.2	0.1
1979	24,600	0.7	0.5
1981	14,860	0.3	0.2

White perch contribute a low percentage to total commercial finfish landings and landings of all species including shellfish in Connecticut. They are commercially harvested primarily by gill net (54-86% of annual white perch landings) and trawl (3-32%). Small amounts are taken annually by seine (0-12%), angling (0-2%), and fyke net (0-2%). White perch were not commercially landed in significant quantity until the 1970's when record landings of 68,000 pounds occurred in 1973 and 1974, after which they dropped to between 5,000 and 30,000 pounds (Figure 26).

White perch are commercially harvested mainly from the Connecticut River with gill nets; reported trawl catches of white perch probably occur near the mouths of the Connecticut and Thames Rivers in LIS.

In 1979, 31,000 white perch were reported caught by Connecticut recreational anglers (NMFS 1980), ranking this species eighteenth by number caught and twenty-first by

estimated total pounds caught (Table 2).

The condition of Connecticut white perch stocks is thought to be stable. The Connecticut River population is commercially underutilized, and any increase in fishing effort should yield an increase in catch. The Connecticut River white perch fishery is highly selective, with most of the catch consisting of fish 9 1/2 inches and over, thus allowing for the species to reproduce at least once and usually twice prior to being harvested (Maltezos et al. 1976).

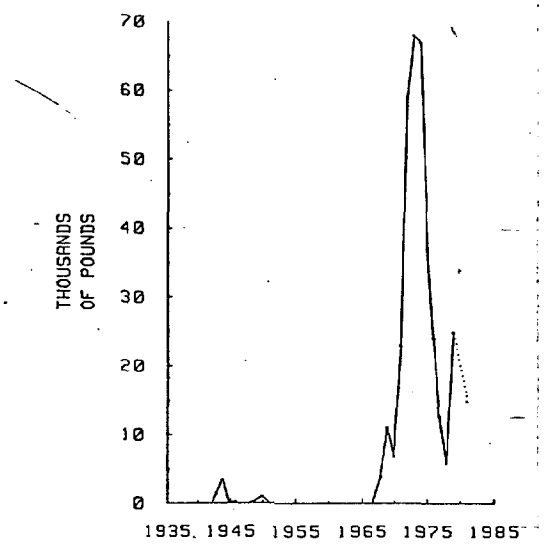


Figure 26. Connecticut commercial white perch landings, 1939-1981.

4.3.2.17 Whiting (Merluccius bilinearis), silver hake

Description: The whiting is a slender fish with two separate dorsal fins, a projecting lower jaw, and numerous rows of sharp recurved teeth. They are dark grey above with silvery sides and belly, usually about 14 inches long, reaching a maximum of 2 1/2 feet and 5 pounds. Whiting range from the Newfoundland Banks to South Carolina. In general, whiting are an offshore species, with some individuals migrating into LIS in the summer. Very small catches have been reported from all areas of LIS by Connecticut-licensed trawlers. It is believed that whiting move offshore and southward during the winter, temperature being the major factor influencing their movement. They are found over all types of bottom except rocks, in depths ranging from the tide line down to 400 fathoms. Whiting prefer temperatures ranging from 40 to 64 °F. They are extremely voracious predators on the young of any species of fish as well as a variety of invertebrates. Whiting reproduce throughout their range at water temperatures from 45 to 55 °F or warmer, predominantly in July and August.

Fishery and Condition of Stocks:

Year	Commercial landings (Lbs)	Percent of total commercial finfish landings (includes squid)	Percent of total commercial landings of all species (includes shellfish)
1977	97,900	2.8	1.9
1978	168,400	4.1	2.6
1979	147,500	4.0	2.8
1981	103,112	1.8	1.3

Whiting contribute a moderate percentage to total commercial finfish landings and landings of all species including shellfish in Connecticut. They are one of the five most important foodfish species in terms of annual weight landed. Whiting are harvested entirely by trawl. Peak historical landings greater than 800,000 pounds per year occurred in the 1940's, with a record 1.65 million pounds landed in 1944. A smaller peak of 500,000 - 800,000 pounds occurred in the early 1960's. Since then, annual landings have been less than 300,000 pounds (Figure 27).

From 1977-1981, Connecticut-licensed trawlers reported catching essentially all of their whiting in Block Island Sound and waters farther offshore.

No whiting were reported caught by recreational

fishermen in 1979 (NMFS 1980). They are not considered to be a sport fish although they will readily take a baited hook.

Relative abundance of whiting as indicated by catch per commercial trawl hour increased 153% from 1977-78 and decreased 61% over the period 1978-81 (Figure 28).

Edwards (1968) estimated that whiting comprised the largest standing crop of any species in the offshore area between the Nova Scotian shelf and the New York Bight during 1963-65. Based on current assessments of the status of the stocks in this area, whiting still maintains that supremacy at the present time. By virtue of the available biomass and the currently low level of landings, whiting must be classified as an underutilized species (Anderson et al 1980).

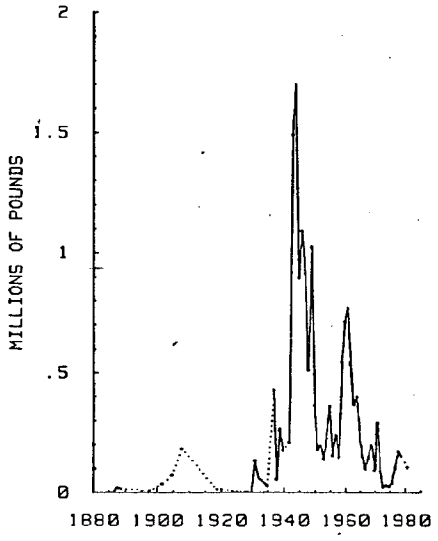


Figure 27. Connecticut commercial whiting landings, 1887-1981.

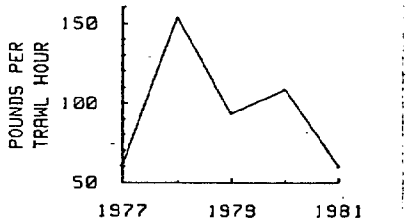


Figure 28. Catch per effort of whiting caught by Connecticut licensed trawlers, 1977-1981.

4.3.2.18 Other [illegible]h

A number of finfish species that are commercially harvested by trawlers fishing on offshore grounds contribute small or inconsistent percentages to annual Connecticut landings. These species are not considered to be major living marine resources of Connecticut, although they are sometimes found in Long Island Sound. Some, such as haddock, pollock, and Atlantic herring, are important and traditional New England finfish species, but are exploited most heavily by the Massachusetts, Maine, and Rhode Island offshore trawler fleets and landed at major ports in these states.

The American plaice (Hippoglossoides platessoides), or dab, is a right-handed flounder (eyes on the right side of the body) distributed on both sides of the Atlantic from Greenland south to Rhode Island. The most consistent Connecticut landings occurred from 1943-1954 and peaked at 252,000 pounds in 1951. Intermittent landings generally less than 3,000 pounds per year have occurred since, except for 1977 when 33,000 pounds were landed.

The haddock (Melanogrammus aeglefinus) is a member of the cod family that prefers cold, deep water. They are most abundant north of Cape Cod, although they range from the Grand Banks to New Jersey along the Atlantic coast. Substantial Connecticut haddock landings of 200,000-300,000 pounds occurred in the late 1800's and early 1900's and, in 1932, a record 4 million pounds were landed. Haddock was landed consistently from 1940-1985, after which no landings were reported until 1978. In 1981, 50,000 pounds were landed in Connecticut.

Adults of the red hake (Urophycis chuss), or squirrel hake, are migratory, coming inshore and into LIS in the spring, although they generally prefer deep, cold waters. Juveniles may reside in LIS throughout the year. They range from the Gulf of St. Lawrence to Virginia. Red hake have been landed relatively consistently in Connecticut since 1939, although landings have generally decreased since the 1950's. A record landing of 1.7 million pounds occurred in 1956. In 1981, 17,500 pounds were landed.

The white hake (Urophycis tenuis) is similar in appearance and habits to the red hake. A record 1.1 million pounds were landed in Connecticut in 1980. Annual landings have generally remained at less than 10,000 pounds since the late 1940's.

The black sea bass (Centropristes striatus) ranges from southern Florida to Cape Cod and occasionally to Maine. It is usually found on rocky bottoms and around pilings or wrecks in water from a few feet deep to 70 fathoms. It

occurs in LIS and several thousand pounds were reported caught mainly in the central Sound by Connecticut-licensed trawlers from 1977-1981. The peak period of commercial landings in Connecticut occurred from 1939-1966. A record 215,000 pounds were landed in 1957. Since 1967, less than 6,000 pounds have been landed annually. The black sea bass is valuable as a food and game fish in its center of abundance which is from the southern shore of Long Island to North Carolina.

Adult Atlantic herring (Clupea harengus) appear to be winter migrants to LIS. They range from northern Labrador and the west coast of Greenland to Cape Cod and Block Island, occasionally straying as far south as Cape Hatteras. Herring have been consistently landed in Connecticut annually from 1943-1967, with two peaks of 3.3 million pounds occurring in 1948 and 1953. Landings since 1970 have been intermittent and generally less than 4,000 pounds except for 1978 and 1981 when 65,000 pounds and 26,000 pounds were landed, respectively.

The kingfish (Menticirrhus saxatilus), or king whiting, is related to and resembles the weakfish in several characteristics. It is a more southern fish, distributed from Florida to Cape Cod, being most common from Chesapeake Bay to New York. It is an excellent food fish and supports recreational and commercial fisheries south of LIS. Connecticut landings of generally less than 1,000 pounds occurred from 1939-1950. A record 5,400 pounds were landed in 1948. There have been no commercial landings in Connecticut since 1969, when less than 500 pounds were landed.

The pollock, (Pollachius virens) is a member of the cod family that ranges from Hudson's Bay to North Carolina on the Atlantic coast, and is most common from the Gulf of St. Lawrence to the Gulf of Maine. The peak period of commercial landings in Connecticut occurred from 1920 through 1940 with a record of 300,000 pounds in 1931. Since 1940, landings have been intermittent and generally less than 20,000 pounds per year. In 1979, less than 30,000 individual pollock were reported caught by Connecticut recreational anglers (NMFS 1980). In 1981, 24,000 pounds of pollock were caught by Connecticut party and charter boats. Pollock are a firmer-fleshed fish than either haddock or cod. They yield high quality fillets, and put up a good fight for anglers.

The swordfish (Xiphias gladius) ranges along the entire eastern American coast as far north as the St. Lawrence. It is an oceanic fish that prefers temperatures of 61°F or higher. They are traditionally harvested with harpoons. From 1880-1933, Connecticut landings generally ranged from 100,000-400,000 pounds per year with a record 451,000 pounds

landed in 1905. Annual landings were generally consistent from the late 1930's to the early 1960's at usually less than 10,000 pounds per year. Since then, landings have been intermittent and less than 5,000 pounds annually, except for 1981, when 10,000 pounds were landed.

The tilefish (Lopholatilus chamaeleonticeps) is an offshore, deepwater fish ranging along the outer continental shelf and upper slope from northern Nova Scotia to southern Florida and the Gulf of Mexico. Its chief center of abundance is between Nantucket and Delaware Bay in a belt only 15 to 25 miles wide on the outer part of the Continental shelf and upper part of the slope. The peak period of commercial landings in Connecticut occurred from 1946-1956. A record 218,000 pounds were landed in 1952. Since 1956, tilefish have been landed very infrequently; none were landed from 1967-1977. In 1981, 2,000 pounds were landed.

The bluefin tuna (Thunnus thynnus) is a large, oceanic fish occurring throughout the Atlantic and Pacific Oceans in warm waters. Those commercially landed in Connecticut are caught by trolling lines. The peak period of bluefin landings in Connecticut occurred from 1946-1958. A record of 36,000 pounds were landed in 1949. Otherwise, landings during this period were less than 10,000 pounds per year. Since 1958, there have been essentially no tuna commercially landed in Connecticut, although in 1981, 1,000 pounds were landed. Tuna are a popular recreational species sought by Connecticut anglers; in 1979, 39,000 individual mackerel and tuna were reported caught (NMFS 1980). In 1981, 26,000 pounds of bluefin, 7,400 pounds of other tuna species, and 3,000 pounds of bonito (Sarda sarda) were reported caught by Connecticut party and charter boats.

Two other finfish that occur in estuarine Connecticut waters, the smelt and tomcod, are worthy of mention as living marine resources of Connecticut that are of minor commercial and recreational importance. The rainbow smelt (Osmerus mordax) is a small (7-9 inches in length), anadromous, shoal-water species, remaining very close to the coast, often in an estuarine environment. They range from the Gulf of St. Lawrence to New Jersey along the Atlantic coast and support commercial fisheries especially in Maine and Canada, but not to a large extent south of the Gulf of Maine. They spawn in fresh or brackish water in the late winter or early spring. The most well known population in Connecticut occurs in the Thames River, and is presently the seasonal target of a small recreational fishery. The species' population in Connecticut has been classified by Dowhan and Craig (1976) as being of indeterminate status, indicating that further investigation and additional information is necessary to determine the condition of stocks. A small commercial smelt fishery existed in

Connecticut from 1880 to 1946 and again from 1960-69. A record 27,000 pounds were landed in 1880. Since 1931, landings have been less than 5,000 pounds per year. During the 1970's, the only commercial landings reported were 300 pounds in 1979.

The Atlantic tomcod (Microgadus tomcod), or frostfish, is a small (9-12 inches in length) member of the cod family that ranges from southern Labrador to Virginia and is largely restricted to coastal waters and estuaries, close to shore, occasionally entering fresh water. They spawn between November and February in shoal water. They are of no commercial importance, but are the most important winter species to Connecticut shore-based recreational anglers, and are exploited by over 25% of those fishermen (Sampson 1981).

The following group of relatively abundant finfish species available to Connecticut commercial and recreational fishermen have been traditionally considered trash fish and have been commercially used for fish meal, as bait, or discarded. These species may be more properly termed underutilized species and are potentially valuable as food fish if proper preparation techniques are used and they are promoted through innovative marketing campaigns.

The anglerfish (Lophius americanus), goosefish, or monkfish, ranges from the Gulf of St. Lawrence to North Carolina. It occurs in LIS, although it is more abundant in Block Island Sound and waters further offshore, as evidenced by catches of Connecticut-licensed trawlers from 1978-81. It is a grotesque-looking demersal fish which attracts prey fishes with its fleshy modified first dorsal spine that serves as a "fishing lure". It has an enormous mouth with many long, sharp teeth with which it devours prey species coming within reach. Connecticut commercial landings from 1940-1950 peaked at 120,000 pounds in 1944. Little or no landings were recorded annually from 1950-1973, after which landings increased to 100,000 pounds in 1981. In recent years, the tailmeat of monkfish has been marketed as a "substitute" for lobster meat because of its sweet flavor.

The conger eel (Conger oceanicus) is found from the edge of the continental shelf to the coast and even within tidal rivers, from Cape Cod to Brazil in the western Atlantic. It was commercially landed in Connecticut from 1939-1958 with a record of 570,000 pounds landed in 1944. With the exception of 1976, when 12,000 pounds were landed, none have been landed since 1958.

The cunner, (Tautogolabrus adspersus) is closely related to the blackfish, similar in habits and appearance but smaller, and is abundant in LIS, ranging from Labrador to Chesapeake Bay. It was commercially landed in Connecticut from 1939-1961, with annual landings generally

less than 10,000 pounds. None have been commercially landed since 1961. In 1979, 705,000 individual cunners were reported caught by Connecticut recreational anglers (NMFS 1980). This figure is believed to be an underestimate because they are not a target species, and some anglers fail to report catching them to angling survey interviewers. Most fishermen consider cunners to be either a trash fish or a nuisance species since they frequently steal bait (Sampson 1981).

The ocean pout (Macrozoarces americanus), or eelpout, is a demersal fish living in shallow water to 100 fathoms, ranging from North Carolina to Labrador. It is a permanent resident of LIS. Ocean pout were first landed in Connecticut in 1976, and annual landings since then have ranged from 2,000-65,000 pounds.

The northern sea robin (Prionotus carolinus) and striped sea robin (P. evolans) are permanent residents of LIS. Their geographic ranges are from South Carolina northward to Massachusetts Bay for the striped sea robin, and further north to the Bay of Fundy for the northern sea robin. They are demersal species and have been reported caught throughout LIS by Connecticut-licensed trawlers from 1977-1981. Sea robins have been commercially landed in Connecticut consistantly since 1939. A record 245,000 pounds were landed in 1951. From 1953-1967 landings were less than 30,000 pounds, increasing to near 100,000 pounds in 1968 and 1971, after which landings have generally remained at less than 3,000 pounds per year.

The spiny dogfish (Squalus acanthias) and smooth dogfish (Mustelus canis) are small sharks occurring seasonally from June to September in LIS, migrating back to southern, offshore waters in the fall. Commercial landings in Connecticut have fluctuated from near 30,000 pounds in the 1940's, to generally less than 10,000 pounds until 1968, when a record 50,000 pounds were landed, after which landings declined to less than 10,000 pounds. Dogfish are widely used as lobster bait, but have value as a foodfish if properly prepared.

Other species of sharks have been commercially landed in Connecticut since 1939, generally less than 10,000 pounds per year, except for 1953, when 130,000 pounds were landed. The mako (Isurus oxyrinchus) and blue (Prionace glauca) sharks have been known to enter Connecticut waters, and are valuable as food fishes if prepared properly. They also provide an exciting recreational angling experience for Connecticut sportfishermen. In 1981, 8,700 pounds of sharks were caught from Connecticut party and charter boats.

Four species of skates (Raja sp.) are permanent residents of LIS. Record commercial landings of 400,000

pounds in 1928 declined to less than 100,000 pounds until 1947-1953 when landings ranged to 270,000 pounds. They have since remained at generally less than 20,000 pounds, except for 1979, when 65,000 pounds were landed.

In 1979, 39,000 individual skates were reported caught by Connecticut recreational anglers (NMFS 1980). Skates are widely used as lobster bait by Connecticut lobstermen. As food, the meat of the "wings", or modified pectoral fins, is considered to be of good quality by some people.

The windowpane flounder (Scopthalmus aquosus), or brill, ranges from the Gulf of St. Lawrence to South Carolina, being more common south of Cape Cod. It is a permanent resident of LIS, abundant, and prefers sandy bottom areas. From 1977-1981, Connecticut-licensed trawlers caught 3,000-19,000 pounds annually, mostly in Block Island Sound. Windowpane is commonly used for lobster bait in Connecticut. In 1979, 86,000 individual windowpane were reported caught by Connecticut recreational anglers (NMFS 1980). Although it is edible, most fishermen discard the species because it is very thin, with little meat.

The following finfish species are of ecological importance as Connecticut living marine resources for the role they play as forage species for larger commercially and recreationally important finfish in Long Island Sound. They are the most common resident species. A number of other less common species that may serve as forage also occur in LIS.

The bay anchovy (Anchoa mitchilli) is a schooling species, found mostly along sandy shores and the mouths of rivers, but sometimes in muddy coves and into freshwater rivers.

Four species of killifish (Fundulus sp.) and the related sheepshead minnow (Cyprinodon variegatus) are schooling forage species found in protected waters of all salinities.

The American sandlance (Ammodytes americanus) travels in large schools over sandy bottoms, both inshore in LIS and on the offshore banks. They avoid rocky bottoms and can burrow several inches into the sand if trying to escape predators.

The Atlantic silverside (Menidia menidia) congregates in schools along sandy or gravelly shores and also are found in brackish water.

4.3.3 Crustacean shellfish

4.3.3.1 American lobster (Homarus americanus)

Description: The lobster's body is divided into a combined head and thorax (cephalorthorax), and a segmented tail. The claws, usually one crusher and one pincher, are outstanding anatomical characteristics. Adult coloration is usually dark green with darker spots on the dorsal and lateral surfaces while the ventral side is yellowish or reddish brown. Marketable lobsters vary considerably in size from the minimum legal size (3-3/16 carapace length) which weighs slightly less than one pound to giant specimens weighing 25-35 pounds. Lobsters range offshore from Labrador to North Carolina and inshore from the Canadian maritimes to Delaware. Tagging studies show that lobsters in western LIS generally remain there, while lobsters in eastern LIS may undergo extensive migrations, some as far as the continental shelf (Briggs 1980, Lund et al 1973). Moreover, circular surface current patterns in western LIS have been shown to retain larvae hatched in this area (Lund and Stewart 1970). Thus, a relatively closed lobster population exists in western LIS, while eastern LIS lobsters may mix with offshore and Rhode Island inshore stocks through migration. A seasonal movement to nearshore waters which occurs in the spring, and to deeper mid-Sound waters in late summer is related to seasonal changes in water temperatures. Lobsters prefer habitats that provide shelter or in which they can construct shelters. Burrows are constructed by sediment excavation under rocks or ledge outcroppings, and constitute approximately 90% of the lobster shelters in eastern LIS. Less utilized crevice and rock interspace shelters appear to provide temporary cover. Mud burrows dug into substrates with a high silt fraction were the only shelter noted in the deep water areas of mid-western LIS. Mud borrows excavated directly under mussel (Mytilus edulis) beds and the sulfur sponge (Cliona) occur to some degree in eastern LIS (Stewart 1972). Lobsters occupy depths from the low tide mark to the continental slope, as great as 400 fathoms. Their temperature range is 29-75 F. They are generally inactive below 40 F and are seldom found where salinities are lower than 25%. Adults feed mainly on crabs (especially Cancer irroratus) and molluscs. The amount and composition of the stomach contents varies significantly depending on the season, stage of the molting cycle, and the relative abundance of food organisms. They are primarily active predators, ingesting living prey, but obtain food by scavenging whenever dead organisms are available (Weiss 1970). Female lobsters in western LIS mature at a smaller size than has been recorded elsewhere in the range of the species. Many appear to be mature at a carapace length of 3-3/16 inches which is the present minimum legal length limit in Connecticut and New York. Males mature at a smaller size than females with essentially all over 3-3/16

inches being mature (Briggs and Mushacke 1979). The disparity in size between the sexes at maturity appears to offer no problem with mating, since small males can mate with much larger females (Hughes and Matthiessen 1962). Females also molt about a month later than males, which may assist mating since copulation can be achieved only when the female is soft-shelled and the male hard-shelled. A progressive decrease in mean size of ovigerous females from the eastern (coldest) end of LIS toward the western (warmest) end (Smith 1977), supports the hypothesis that small size at maturity is associated with relatively high summer temperature (Aiken and Waddy 1980). Females are impregnated immediately after molting and retain the sperm within their seminal receptacle for at least 9 months, after which the eggs are extruded and fertilized simultaneously. The eggs remain attached to the swimmerets on the underside of the tail for an incubation period of 10 to 11 months.

Fishery and Condition of Stocks:

Year	Commercial landings (Lbs)	Percent of total commercial shellfish landings (excludes squid)	Percent of total commercial landings of all species (includes finfish)
1977	638,400	35.14	12.14
1978	798,500	34.27	12.36
1979	807,700	52.09	15.49
1981	1,010,800	35.54	11.97

In 1977, 1978, and 1981, lobster ranked from second to fourth in terms of weight contributed to total annual landings of all species in Connecticut. During 1977 and 1978, lobster contributed the second highest percentage to annual landings of crustacean and molluscan (excluding squid) shellfish in Connecticut, oysters being first. However, in 1981, due to the inclusion of previously unreported offshore catches, lobster was first in shellfish landings. Historical landings are presented in Figure 29. The history of Connecticut's lobster landings and fishery as well as its present characteristics are described in detail in Section 5.1.3.

The relative abundance of the lobster population in LIS, as indicated by the number of pounds of legal sized lobsters (> 3-3/16 inches carapace length) caught per trap haul and per trap haul set-over day from 1978-1981, appears

to be stable after an apparent increase from 1975-78 (Figure 30).

The effect of future increases in fishing effort on the apparently stable population abundance is uncertain. There is relatively widespread concern that the coastwide lobster population is presently being fished to its limit. However, as yet there is no evidence that fishing is depleting the population below a level that is necessary to adequately support recruitment.

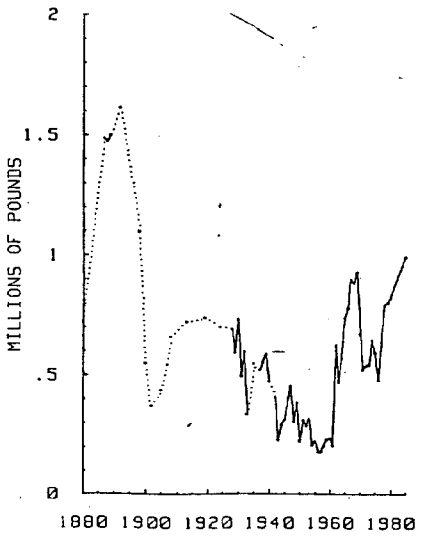


Figure 29. Connecticut commercial lobster landings, 1880-1981.

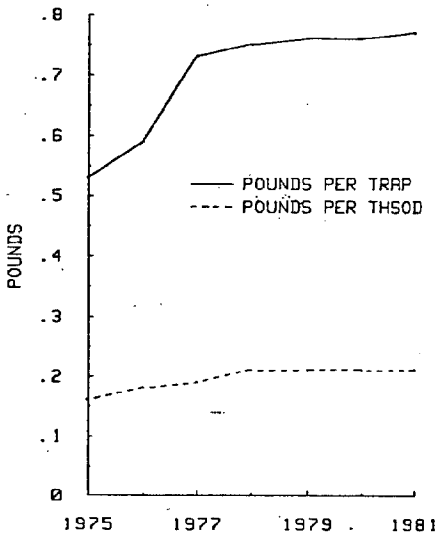


Figure 30. Catch per effort -- pounds per trap and pounds per trap haul set-over day (THSOD) -- of lobster caught by Connecticut-licensed lobstermen, 1975-1981.

4.3.3.2 Blue crab (Callinectes sapidus)

Description: Blue crabs have a carapace up to 7 inches wide with two sharp lateral spines, and are dark green with bright blue and sometimes scarlet legs. They range from Nova Scotia to the Gulf Coast. Blue crabs are present in many river mouths, shallow bays, and salt marsh creeks in Connecticut. Tagging studies in South Carolina and Delaware have shown that most crabs do not migrate between estuaries. Their movements are limited to lower estuaries and adjacent coastal zones (Fischler and Walburg 1962; Porter 1956). Males display only limited movement in North Carolina (Judy and Dudley 1970). However, in Rhode Island both sexes migrate into deeper water in the fall (Jeffries 1966). The blue crab's ability to osmoregulate over a wide salinity range (Ballard and Abbott 1969) allows it to inhabit waters ranging from ocean salinity to almost freshwater in upstream reaches of tidal rivers. The blue crab is a scavenger and a predator eating live or dead fish, crabs, shrimp, whelks, snails, mussels, roots of marsh vegetation, and sets of young oysters and clams (CAM 1977). In Connecticut, mating occurs between June and October (CAM 1977) in less saline waters, frequently in tidal rivers. Females mate while in the soft-shell state and males may mate several times with several females (Van Engel 1958). Egg laying may occur two months after mating but is frequently deferred for as long as 9 or 10 months if mating occurred late in the season. About 2 million eggs are extruded in early spring or summer. The fertilized eggs are attached to the underside of the female in a "spong-like" egg mass.

Fishery and Condition of Stocks: Blue crabs have not been commercially landed in Connecticut since 1971. They have never been landed in large quantities; 5,800 pounds in 1945 is the record annual landing. Landings generally ranged from 2,000-5,000 pounds from 1946-1961, after which they declined dramatically to intermittent landings of 400 pounds in the 1960's and early 1970's (Figure 31). The blue crab is an important recreational species.

Little is known about the condition of Connecticut blue crab stocks. Abundance fluctuates widely from year to year; recently there have been years when blue crabs were so scarce that it was not worthwhile for recreational crabbers to look for them. Other years have been productive. It is apparent that the abundance of blue crabs has declined since the 1940's and 1950's when they were abundant enough to support a small commercial fishery. Many basic aspects of the life history of blue crabs in Connecticut waters are unknown, which emphasizes the need for biological studies.

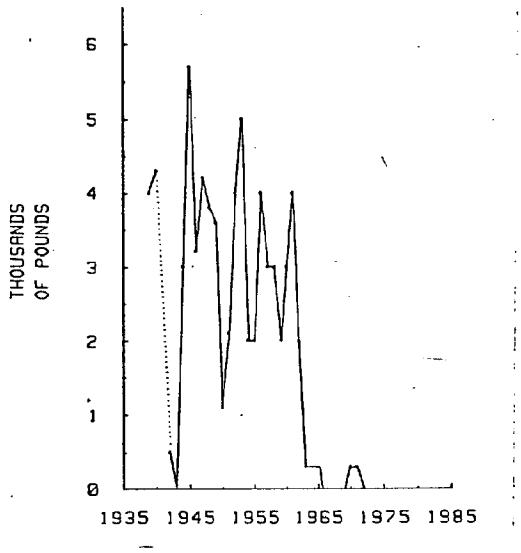


Figure 31. Connecticut commercial blue crab landings, 1939-1981.

4.3.3.3 Other crustacean shellfish

The rock crab (Cancer irroratus) ranges from Labrador to South Carolina; the Jonah crab (C. borealis) ranges from Nova Scotia to just south of the Dry Tortugas in Florida. They are both common in LIS and are permanent residents. The crabs are edible and are considered to be underutilized species. A number of feasibility studies have been conducted in recent years to develop harvesting, processing, and marketing techniques and strategies for Cancer crabs in Rhode Island and Connecticut (Marchant and Holmsen 1975; Stewart L., pers. comm.).

The green crab (Carcinus maenas) is the most common crab inhabiting rocky shorelines, tidal mudflats, salt marshes, and estuaries in Connecticut. Not native to the United States, it was accidentally brought to North America on the bottoms of ships from European waters (CAM 1977). Green crabs are extensively used and sold as bait for blackfish angling. In 1969 and 1970, 4,000 and 3,000 pounds, respectively, of green crabs were reported in annual landings statistics. Green crabs are not reported separately in the present DEP statistics collection system, but are included under "other crabs", of which 3,000-6,000 pounds were landed annually from 1977-1981.

The horseshoe crab (Limulus polyphemus) is not a true crab or a crustacean. It belongs to the same taxonomic group as the spiders and mites. They are common on sandy or muddy bottoms in shallow, brackish water. They are used as bait for eels and conchs in Connecticut. From 1969-1971, 7,000-16,000 pounds of horseshoe crabs were reported in annual Connecticut landings of fish and shellfish.

4.3.4 Molluscan shellfish

4.3.4.1 Hard clam (*Mercenaria mercenaria*) round clam, quahog, littleneck, cherrystone

Description: The shell of the hard clam is solid and oval, the outside is dingy white to brown with concentric growth lines, and the inside is porcellanus white, with deep violet blotches near the muscle scars. Hard clams range from the Gulf of St. Lawrence to the Gulf of Mexico (Miner 1950). They are wide-spread throughout LIS in nearshore areas. Localized beds of high abundance can be found in nearly all areas from east to west along the Connecticut shore. The distribution of dense assemblages is extremely patchy, however (Pratt 1953; Saila et al.1967). No population migration occurs except for the dispersal of pelagic larvae by currents. Hard clams prefer sandy or muddy bottom from the intertidal zone to depths of about 18 meters (Gosner 1979). They are principally estuarine, and populations flourish best in bays at salinities of 18-26‰ (Merrill and Ropes 1967). *Mercenaria* feed on suspended particulate matter consisting of detritus, bacteria, and plankton by means of ciliary mechanisms on the gills and labial palps which sort the particles according to size. In Connecticut, spawning occurs mostly during June through August depending on the temperature in a particular river, bay, or LIS proper, which must exceed 68 °F (Loosanoff 1937a, 1937b). Sperm and eggs are released into the water through the excurrent siphon. *Mercenaria* become sexually mature in their second summer and continue to produce gametes every summer until they die. Sexes are distinct, and although about half those that produce sperm in their first year later develop into females in a given stock, no sex reversals take place after their second summer (Loosanoff 1937b).

Fishery and Condition of Stocks:

Year	Commercial landings (Lbs of meats)	Percent of total commercial shellfish landings (excludes squid)	Percent of total commercial Landings of all species (includes finfish)
1977	180,000	9.91	3.42
1978	180,000	7.73	2.79
1979	300,000	19.35	5.75
1981	360,000	12.66	4.26

Hard clams contribute a moderate percentage to total annual commercial landings of all species in Connecticut. Among Connecticut's landings of molluscan (excluding squid) and crustacean shellfish, they ranked from second to fourth in terms of pounds landed from 1977-81. Historical landings are presented in Figure 32. The history of Connecticut's hard clam landings and industry, as well as their present characteristics, are described in detail in Section 5.1.2.

The condition of hard clam stocks on private commercial beds is enhanced by the seeding and predator control activities of the shellfish companies that own them. The hard clam is a productive species for aquacultural efforts and Connecticut waters are capable of sustaining much larger populations than they currently do. A major drawback to increased production of marketable clams is the limited amount of productive ground located in unpolluted water. The hard clam is probably the most abundant species available for recreational shellfishing in Connecticut at the present time.

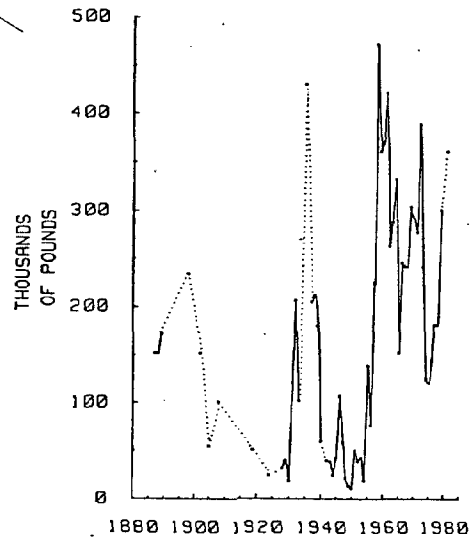


Figure 32. Connecticut commercial hard clam landings, 1880-1981.

4.3.4.2 Soft clam (Mya arenaria) steamer

Description: Soft clams are thin-shelled, usually whitish with dark markings, have gaping valves, and are commonly one to three inches long. They range from the Arctic Ocean to Cape Hatteras. Historically, soft clams were abundant all along the Connecticut coast wherever there was favorable habitat. Presently, however, populations are small and of patchy distribution. In New England, soft clams burrow predominantly in intertidal mud flats, and are frequently found subtidally in estuaries. They are mainly found subtidally in Chesapeake Bay (Saila and Pratt 1973). Soft clams can tolerate salinities as low as 4% (Green 1968). A suspension filter feeding bivalve, soft clams utilize several species of unicellular algae in laboratory culture; they may derive nourishment from non-living particulate organic matter in their natural environment. Sexual maturity is reached at one year of age when the clams are 1/2 to 1 inch in length (Merrill and Tubiash 1970). Spawning, which depends mainly upon temperature, may occur twice in the same year south of Cape Cod (Ropes and Stickney 1965). In New England, spawning principally occurs from June to mid-August and progressively later in the summer for the more southern populations (Hanks 1963). Spawning and fertilization takes place in the water above or near the clam beds.

Fishery and Condition of Stocks:

No commercial fishery presently exists for soft clams in Connecticut. Historically they were commercially harvested from public beds with clam hoes. A record 750,000 pounds was commercially landed in 1880 after which annual landings declined to less than 50,000 pounds in the 1940's. From 1952-1974 annual landings were intermittent and usually less than 500 pounds per year. The last year that commercial landings were reported was 1974 (Figure 33). Recreational harvesting of soft clams from several small beds is controlled by the few towns where such beds exist. Attempts are made to prevent overharvesting of the resource by implementing closed seasons and bag limits. The decline of Connecticut's soft clam populations and fishery may be attributed to the destruction of productive beds by land development activities such as filling and dredging, and to the closing of existing beds to shellfishing due to poor water quality.

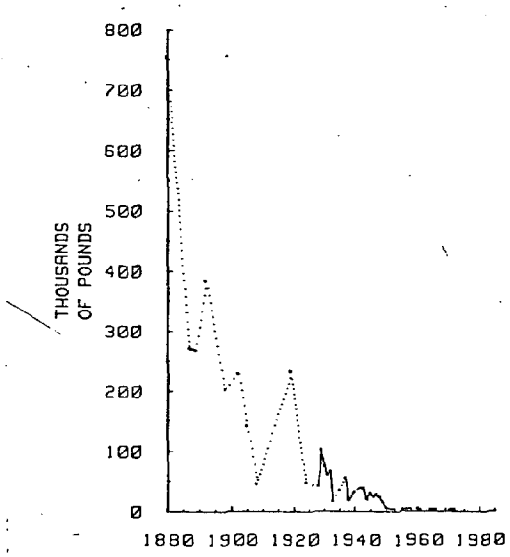


Figure 33. Connecticut commercial soft clam landings, 1880-1981.

4.3.4.3 Conch (Busycon canaliculatum), channeled whelk

Description: The channeled whelk is a gastropod mollusc (snail) with a heavy whorled shell reaching a length of 6 to 9 inches and distinguished by having a deep channel-like groove following each whorl at the suture. They are yellowish-gray and the interior of the shell is lined with yellow (Miner 1950). Conch range from Cape Cod to Florida. The highest concentrations of conch in LIS appear to be in nearshore areas of central LIS, where the commerical fishery is concentrated. Movement appears to be random, with no evidence of seasonal inshore or offshore migration. In Narragansett Bay, RI, the mean daily movement of tagged conchs was 14 meters (Sisson 1972). Conch prefer shallow sandy and mud bottoms. According to one Connecticut conch fisherman, in spring and summer they are caught near rocks and islands with ledges dropping to soft bottom. In fall, they are caught over open, muddy bottom. Busycon prey on bivalve moluscs by inserting the outer lip of their shell between the bivalves' shells and prying them apart. They also feed on dead fish, annelids, and other soft living or dead animals (Magalhaes 1948). Fresh horseshoe crab is the superior bait for catching conch in pots (Sisson 1972). Fertilization in Busycon occurs internally through copulation. Eggs are enclosed within capsules that are laid in strings anchored in the mud. Apparently, reproduction occurs in spring and fall as freshly laid egg case strings have been observed in March and April, and September and November in southern New England (Magalhaes 1948).

Fishery and Condition of Stocks:

Year	Commercial landings (Lbs of meats)	Percent of total commercial shellfish landings (excludes squid)	Percent of total commercial landings of all species (includes finfish)
1977	52,700	2.90	1.00
1978	88,000	3.78	1.36
1979	163,600	10.55	3.14
1981	472,500	16.61	5.60

Conch contribute a moderate percentage to total annual commercial landings of all species in Connecticut. Among Connecticut's landings of molluscan (excluding squid) and crustacean shellfish, they ranked from third to fifth in terms of pounds landed from 1977-1981. Recent landings show an increasing trend, especially from 1979-1981. However, in

1981, commercial landings were estimated by asking dealers how much conch they purchased that year from Connecticut fishermen. It is unknown how previous landings figures were obtained. Historical landings are presented in Figure 34. The history of Connecticut's conch landings and fishery, as well as their present characteristics, are described in detail in Section 5.1.7).

The condition of the conch population in LIS is unknown but it is thought to be abundant enough to sustain present levels of fishing. If the exploitation rate continues to increase, however, it is uncertain what effect it would have on the population, because knowledge of the species' biology and population dynamics in LIS are unknown.

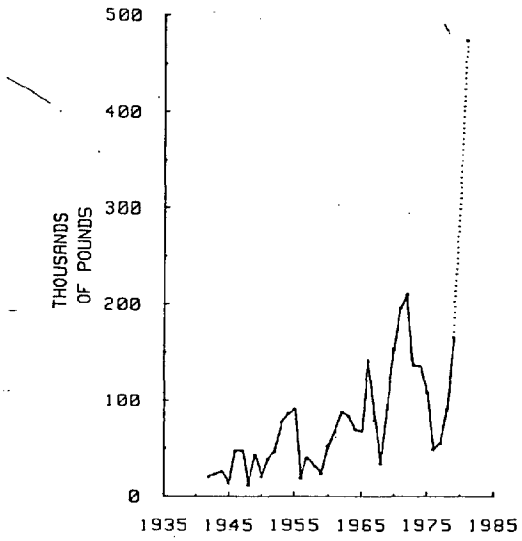


Figure 34. Connecticut commercial conch landings, 1939-1981.

4.3.4.4 American oyster (Crassostrea virginica)

Description: The two valves of the oyster's shell are attached by the left valve which is convex; the upper valve is nearly flat. The shell is irregular and variable, and is often folded in layers and very thick. Oysters are usually 3 to 4 inches at market size but may grow variably in shape and size up to 17 inches in length. They range from the Gulf of St. Lawrence to Mexico. In Connecticut waters, most natural and nearly all commercial oyster beds are located in estuarine river mouths and harbors west of the Connecticut River. High concentration areas, due mainly to the efforts of commercial operations on beds leased from the state, are located in New Haven Harbor, off Milford, and in the Bridgeport and Norwalk areas. On these privately managed beds, densities of over 3,000 bushels per acre have been reported (MacKenzie 1970). Oysters prefer hard rock bottom or semi-hard mud, normally setting on areas already inhabited by other oysters (Galtsoff 1964). Shifting sand and soft mud are unsuitable substrates. Oysters are euryhaline, and can survive salinities from 3‰ to almost 40‰ as adults. Their temperature range is from 34-86 °F over their entire geographic distribution (Saila and Pratt 1973). The oyster filters a mixture of suspended particles from the water and sorts them according to size by passing water through its gills. Several species of phytoplankton, bacteria, and detrital particles provide nutrition. In LIS, the spawning season is generally from late June to late August (Loosanoff 1965) at temperatures above 68 °F (Galtsoff 1964). Oysters can change sex throughout their lives. Under natural conditions a large female is surrounded by several small males. When the female dies, one of the males changes sex. Gametes are released directly into the water column where fertilization occurs.

Fishery and Condition of Stocks:

Year	Commercial landings (Lbs of meats)	Percent of total commercial shellfish landings (excludes squid)	Percent of total commercial landings of all species (includes finfish)
1977	852,000	46.89	16.20
1978	1,058,300	45.43	16.38
1979	174,800	11.27	3.35
1981	947,100	33.30	11.22

In 1977 and 1978, oysters contributed a higher percentage to total annual commercial landings of all species in Connecticut than any other individual species. Unclassified baitfish landings were greater, but are comprised of several species. Apparently 1979 was not a good year for oysters, and their landings represented only a small percentage of total landings of all species. In 1981, because landings from offshore fisheries were accounted for, oysters ranked fourth in terms of pounds of all species landed, yellowtail, winter flounder and lobster being first, second, and third, respectively. It is obvious that a great volume of oysters are commercially landed in Connecticut each year. When it is considered that only the weight of the meats exclusive of the shells constitute the landings figures, the actual number of pounds of oysters, including shells, harvested from LIS becomes enormous compared to other individual species. Given this fact, oysters clearly rank first in landed weight of all species landed in Connecticut by commercial fishermen. Historical landings are presented in Figure 35. Record landings of 10-15 million pounds which occurred from 1890-1900 may reflect an overexploitation of the resource, and may not be a realistic indicator of its potential (Folsom 1979). The history of Connecticut's oyster landings and industry, as well as their present characteristics, are described in detail in Section 5.1.2.

The condition of oyster stocks in LIS, as is the case for hard clams, is enhanced by the aquacultural activities of the private shellfish companies. The oyster is a most productive species for aquacultural efforts and is presently artificially propagated to a greater extent than any other species in Connecticut. A limiting factor in expanding the overall Connecticut production of oysters is the availability of productive grounds that are not presently held under lease or franchise by the existing shellfish companies.

Several towns have oyster resources that are subject to recreational shellfishing. Programs to enhance recreational oystering are presently being conducted by these towns and are described in Section 6.2.2.

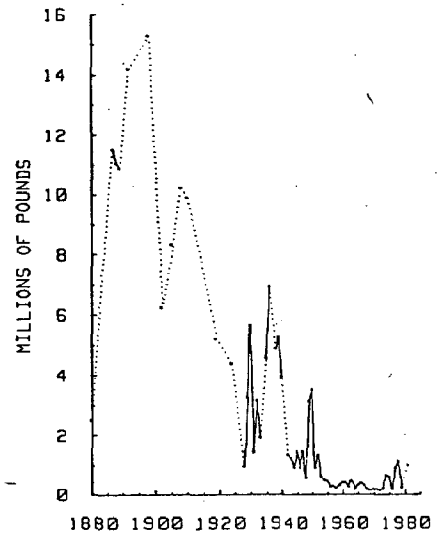


Figure 35. Connecticut commercial oyster landings, 1880-1981.

4.3.4.5 Bay scallop (Aquipecten (Argopecten) irradians)

Description: Bay scallops are two to three inches in diameter, with 17 to 20 radiating ribs, the shell being evenly scalloped around the margin. Their shell color is drab brown or gray, sometimes with yellow. Bay scallops are abundant from Cape Cod to Cape Hatteras, more so in the northern part of their range. They also occur locally farther north (Miner 1950). In Connecticut, bay scallops are most abundant in the Niantic River and in bays and rivers further east where eelgrass beds occur. They are capable of localized movements but don't migrate extensively. They move by crawling and "swimming" by clapping their valves together. Bay scallops prefer subtidal, shallow eelgrass beds of estuaries, but are occasionally found in water as deep as 60 feet (Belding 1910; Gutsell 1931). Scallops feed by filtering suspended material, much of it of benthic origin, from the water (Davis and Marshall 1961). Niantic River scallops spawn from mid-June through July. The great majority of bay scallops spawn only once during their 20-26 month life span. They are hermaphroditic; the same individual can produce both sperm and eggs, though never concurrently (Belding 1931).

Fishery and Condition of Stocks:

A small seasonal fishery for bay scallops presently exists in the Niantic River from October through March each year. It is primarily a recreational fishery, however, the Waterford-East Lyme Shellfish Commission issues permits to harvest up to three bushels per day for the entire season and those that obtain such a permit could be considered small time commercial harvesters when they sell their catch. A number of retail seafood markets in New London County purchase Niantic River bay scallops from these harvesters. An estimated total of 12,000 bushels of bay scallops per year are taken from the Niantic River by recreational and commercial harvesters (Porter, R., pers. comm.). It is unknown what percentage is actually sold. Because each bushel contains approximately 6 pounds of meats (NMFS, Fishery Statistics of the U.S.), approximately 72,000 pounds of meats have been annually harvested in recent years from the Niantic River. Commercial bay scallop landings statistics for Connecticut have not been reported since 1965, when 12,000 pounds of meats were landed. A record of 420,000 pounds were landed in 1953. The 1950's and early 1960's was the peak period of landings, when they were usually greater than 100,000 pounds per year (Figure 36).

The condition of bay scallop stocks in Connecticut is enhanced by seeding conducted by the NMFS shellfish

laboratory in Milford, Connecticut, the UCONN Marine Advisory Service, and the towns with scallop resources such as Waterford, East Lyme, Groton, and Stonington.

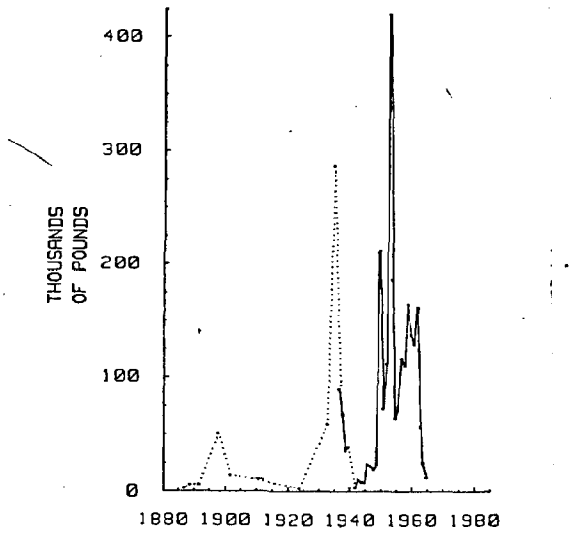


Figure 36. Connecticut commercial bay scallop landings, 1887-1981.

4.3.4.6 Sea scallop (Placopecten magellanicus)

Description: Sea scallops are similar to bay scallops but without ribs in the shell. The upper valve is brown, the lower, white. They grow up to 7 inches long. Sea scallops rangs from the Gulf of St. Lawrence to Cape Hatteras (Posgay 1957). An oceanic bivalve, sea scallops do not occur in LIS. Those landed in Connecticut are harvested from Nantucket Shoals and the waters around Block Island. Sea scallops are capable of localized movements, and swim by clapping their valves together. No evidence exists of long distance movements or seasonal population migrations (Mackenzie 1979). They occur at depths from mean low water to several hundred feet on bottom types ranging from rocks to a mixture of sand and mud (Merrill and Posgay 1967). They are filter feeders utilizing plankton and perhaps some organic detritus as food (Mackenzie 1979). Sea scallops spawn from early summer to early fall (Merrill and Tubiash 1970).

Fishery and Condition of Stocks:

Year	Commercial landings (Lbs of meats)	Percent of total commercial shellfish landings (excludes squid)	Percent of total commercial landings of all species (includes finfish)
1977	93,800	5.16	1.78
1978	198,000	8.50	3.06
1979	98,300	6.34	1.89
1981	50,000	1.76	0.59

Sea scallops contribute a moderately low percentage to annual commercial landings of all species in Connecticut. Among crustacean and molluscan (excluding squid) shellfish, annual sea scallop landings are the lowest. The history of Connecticut's sea scallop landings and fishery, as well as their present characteristics, are presented in Section 5.1.5.

Abrupt yearly fluctuations occur in the density of sea scallop populations. These variations do not appear to be the result of migrations. Overexploitation may be an important factor in these fluctuations, especially for the Georges Bank beds (Saila and Pratt 1973).

4.3.4.7 Long-finned squid (Loligo pealei),

Description: The body of Loligo is a flattened cylinder with fins more than half the length of the trunk. They are commonly 8 inches long and their color is dark grey with reddish spots. Loligo are reported as far north as New Brunswick (Summers 1969) but are primarily distributed from Cape Hatteras to Georges Bank (Tibbetts 1977). They are a seasonal visitor to LIS, entering the Sound during late spring and summer. Loligo migrate on and offshore as much as 125 miles seasonally, generally remaining in waters where the temperature is 46 F (Lange and Sissenwine 1980). They overwinter offshore along the upper continental slope from western Georges Bank to Cape Hatteras (Summers 1969). From late spring to early autumn they disperse from the shelf edge into shallow coastal waters and during summer, may possibly occur anywhere on the continental shelf. This dispersion is part of a spring inshore spawning migration which begins in the southern areas, and as water temperatures rise, proceeds northward along the coast. By April or May, mature squid arrive in Massachusetts waters with smaller immature individuals arriving in May and June. During late spring and summer, they may be found in harbors and estuaries, particularly in southern New England (MAFMC 1978b). Squid are a pelagic species. A strong correlation exists between abundance and bottom temperatures over 46° F (Summers 1968). The largest biomass occurs at depths between 55-92 fathoms (Summers 1969). They are active, voracious predators. Young squid feed heavily on euphausid shrimp and other small crustaceans. As they grow, the diet gradually changes to young fish such as cod, haddock, redfish, capelin and mailed sculpin (Squires 1957). L. pealei usually spawn in shallow waters between Delaware and eastern Cape Cod.

A six-month spawning season extends through the warmer half of the year. Two overlapping reproductive cycles occur. Those squid spawned in spring hatch in June, mature during their first winter, and spawn during late summer of the following year (at about 14 months). Their progency, those spawned in late summer, hatch in September, are too young to mature over the first winter, and spend the next spring and summer feeding and growing. This group matures during their second winter to spawn, as large individuals, early in the spring (Mesnil 1977). During spawning, male squid deposit sperm cells in the mantle cavity of the female with a modified arm. The female then extrudes eggs into its mantle cavity which upon contact with sperm cells become fertilized. Between 150 and 200 fertilized eggs are contained in individual gelatinous capsules which are passed through the siphon into the water (McMahon and Summers 1971). The demersal capsules are attached to bottom debris or often to clusters of previously spawned egg capsules (MAFMC 1978b).

Fishery and Condition of Stocks:

Year	Commercial landings (Lbs)	Percent of total commercial finfish landings (includes squid)	Percent of total commercial landings of all species (includes shellfish)
1977	37,600	1.09	0.72
1978	37,000	0.90	0.57
1979	23,200	0.63	0.44
1981	24,900	0.45	0.30

Squid contribute a low percentage to Connecticut commercial finfish (including squid) landings and landings of all species. In this report, they are grouped with finfish because they are pelagic and harvested by trawl in Connecticut. The peak period of historical landings occurred in the 1940's. A record 622,000 pounds were landed in 1948. Landings since 1950 have been less than 150,000 pounds except for 1969 when 269,000 pounds were landed (Figure 37).

From 1978-81, Connecticut licensed trawlers reported catching squid mostly in Block Island Sound and waters further offshore (44-60% of annual squid catches). Smaller amounts were taken in central LIS (7-32%), and eastern (0.1-7%) and western (1-7%) LIS.

Relative abundance of squid as indicated by reported catch per commercial trawl hour increased 44% from 1979-81 (Figure 38).

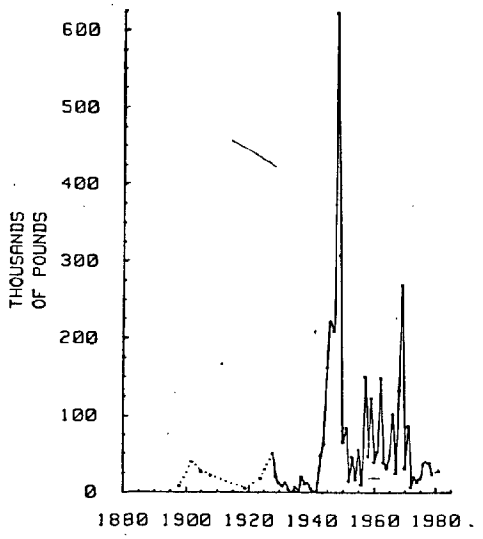


Figure 37. Connecticut commercial squid landings, 1898-1981.

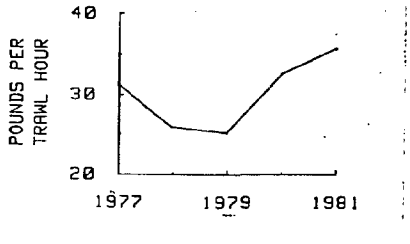


Figure 38. Catch per effort of squid caught by Connecticut licensed trawlers, 1977-1981.

4.3.4.8 Other molluscan shellfish

The blue mussel (Mytilus edulis) is an abundant intertidal bivalve ranging from the Arctic Ocean to South Carolina. It is very abundant along the Connecticut shoreline and may almost cover the rock substrate to which it attaches by its byssus threads. Mussels are edible, however, despite their abundance, they have never been consistently harvested in large amounts in Connecticut. In 1949, a record 96,000 pounds of meats were landed. Landings from 1953-58 were less than 500 pounds per year, after which mussels were landed only in 1971 (< 500 pounds) and 1974 (1,000 pounds). The potential for commercial and recreational harvests of mussels exists in Connecticut, although the limited amount of productive beds in unpolluted waters could be a limiting factor in such activities. Mussels in most existing beds are of small size due to overcrowding. If beds in unpolluted waters were thinned out, mussels there could grow to a desirable, marketable size.

The ocean quahog (Arctica islandica) is an oceanic species most common at depths between 60 and 90 feet. It is not found in Long Island Sound but does occur in large concentrations in the Rhode Island and Block Island Sounds where it supports a substantial fishery in Rhode Island. This species was commercially landed in Connecticut from 1969-1972 and in 1976. Annual landings ranged from 7,000 pounds to a record 532,000 pounds in 1971.

4.3.5 Species that are endangered or being restored

The only Connecticut marine resource species classified as "Endangered" is the shortnose sturgeon (Acipenser brevirostrum), an anadromous fish that formerly spawned in large numbers during the spring in the Connecticut River. It is a bottom dwelling fish which feeds on small, infaunal plants and animals. It is highly susceptible to water pollution, and only limited spawning areas are available in Connecticut (Dowhan and Craig 1976).

The Atlantic sturgeon (Acipenser oxyrhynchus) is classified as "Threatened". It is an anadromous species along the Atlantic coast, and small numbers are reported each year in the Connecticut River and occasionally in other major rivers in the state. Only limited areas for spawning, which occurs in June and July, are available in Connecticut for this species. The young are found in estuaries and around the mouths of rivers. Formerly more common in historical times, the decline of the Atlantic sturgeon in Connecticut has been largely attributed to dams, although water pollution has also been implicated (Dowhan and Craig 1976). Commercial landings of sturgeon, usually less than 10,000 pounds per year, were recorded from 1939-1975. A record 11,000 pounds was landed in 1962, after which landings declined to less than 500 pounds per year in the early 1970's. No distinction was made between Acipenser species in the commercial landings statistics. Sturgeon were harvested by trawl, probably in LIS as they traveled to and from spawning grounds in the Connecticut and other large rivers. The taking of sturgeon in Connecticut is now illegal and no person may sell sturgeon taken from the waters of the state (Sec. 26-159a CGS).

The Atlantic salmon (Salmo salar) is an anadromous species which spawned in large numbers in the Connecticut River prior to 1800. The construction of dams obstructed migration and caused the extinction of the population. The salmon has been re-introduced into the Connecticut River through the cooperative efforts of the resource management agencies of Connecticut, Massachusetts, Vermont, and New Hampshire, the U.S. Fish and Wildlife Service, and the National Marine Fisheries Service. Hatchery reared juveniles have been stocked since 1967 in the Connecticut River and its tributaries. Since 1974, when one adult returned, the number of returning adults has increased to a record of 529 in 1981. Eventual goals of the program are to produce slightly over 200,000 wild Atlantic salmon smolts per year within the river basin, and to insure that 2,000 adult salmon in excess of spawning needs are available for an annual sport harvest (Minta et al 1982).

4.3.6 Marine mammals

As a group, marine mammals are a relative rarity in Long Island Sound because it is largely cut off from the open sea in which they normally occur. However, observations of marine mammals along the Connecticut shore are reported from time to time. The harbor seal (Phoca vitulina) sometimes frequents the rocks off Stonington and Groton during the winter months, and on rarer occasions species such as the harbor porpoise (Phocoena phocoena) may be sighted in LIS or in one of the major rivers. On extremely rare occasions whales have become beached on the Connecticut shore, as in 1975 when a finback whale (Balaenoptera physalus physalus) beached itself in Groton (CAM 1977).

5.0 Marine Resource Users in Connecticut

5.1 The Commercial Fisheries

5.1.1 Introduction

Of the five coastal New England states (Maine, New Hampshire, Massachusetts, Rhode Island, and Connecticut), Connecticut ranks fourth behind Rhode Island and ahead of New Hampshire in terms of annual commercial landings and value of finfish and shellfish (Fishery Statistics of the U.S.). The following subsections describe fisheries and their respective ex-vessel values to Connecticut. Figures respresenting landings are in solid lines with dotted lines used to indicate periods for which no data are available. Values of fishery landings are represented by dashed lines.

From 1939 to the present, the period of greatest finfish and squid landings of all Connecticut finfish fisheries combined occurred from 1942-1957. These landings, from 10-20 million pounds per year, were largely comprised of flounder species. Since then, annual finfish landings have remained at 2-5 million pounds. The value of Connecticut's finfish landings peaked at 1.3 million dollars in 1948, and has generally ranged from $500,000 to $1 million since then (Figure 39).

Connecticut landings of molluscan and crustacean shellfish are dominated by the landings of the oyster mariculture industry and the lobster fishery. Combined molluscan and crustacean shellfish landings decreased from 6 million pounds in 1939 to between 1 and 2 million pounds in the 1940's. Landings rose to near 4 million pounds in 1949 and 1950, then dropped to levels near 1 million pounds until 1966. Molluscan and crustacean shellfish landings have fluctuated between 1 and 2 million pounds since then (Figure 40). The reason for these fluctuations in landings may be found in the history of both the oyster industry and lobster fishery.

From 1939-1960, molluscan and crustacean shellfish landings were dominated by oysters. The peak that occurred during 1949-1950 was due to a peak in oyster landings, after which they subsequently declined. In 1961, lobster landings began to increase and dominated the landings of molluscan and crustacean shellfish until the late 1970's, when oyster landings increased again to a level about equal to those of lobster.

From 1939 to the present, the value of the landings of Connecticut's molluscan and crustacean shellfish industries has increased dramatically, from less than $1 million during

1940-1960, to a record $7.5 million in 1981 (Figure 40). Relative to finfish, molluscan and crustacean shellfish are high value products, often bringing greater than $2.00 per pound to the fisherman. In recent years 78-85% of the total value generated by the harvest of all marine resources in Connecticut has been earned by the industries involved in harvesting molluscan and crustacean shellfish.

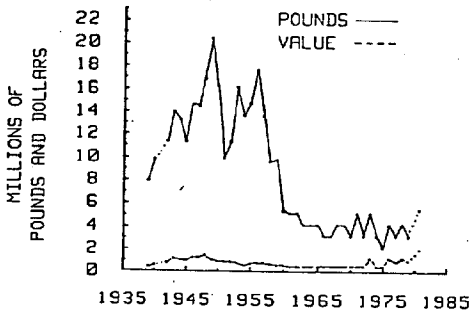


Figure 39. Connecticut landings and value of finfish and squid, 1939-1981.

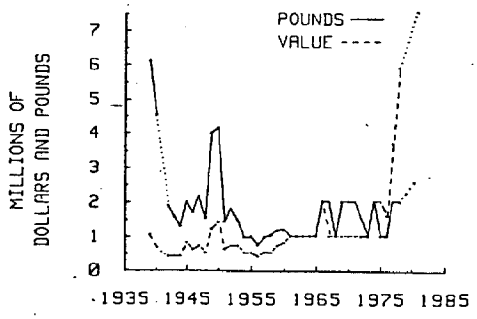


Figure 40. Connecticut landings and value of crustacean and molluscan (excluding squid) shellfish, 1939-1981.

5.1.2 The Oyster and Hard Clam Industry

A small number of private companies grow, tend, and harvest oysters and, to a lesser extent, hard clams in Long Island Sound. These companies lease bottom acreage in the Sound from both state and town governments for seeding and growing the species to marketable size. The industry is Connecticut's most economically valuable one of those based on the harvest of living marine resources. In 1977, 1978, and 1981, it was responsible for 48% of the total annual revenue generated from such harvests. Oyster dredge landings accounted for 35-45%, and clam dredge landings, 3-13% of the revenue generated during each of the three years. In 1979, the harvest of oyster dredges was small and only earned 12%. That same year, the harvest of clam dredges earned a larger percentage (16%), relative to other recent years.

Historical oyster dredge landings declined from a record 5.2 million pounds in 1939 to between 500,000 pounds and 1.4 million pounds in the 1940's. In 1949 and 1950, landings jumped to 3 and 3.6 million pounds, respectively; then dropped and remained at between 100,000 and 500,000 pounds through the 1950's and 1960's. In the 1970's landings fluctuated between a high of 1 million pounds in 1978 and lows of less than 200,000 pounds (Figure 41). From 1939 to 1957, oyster dredges operated on public grounds as well as private grounds, however, the greatest percentage of oyster landings were taken from private grounds. A record of 103,000 pounds were taken by oyster dredge from public grounds in 1943, after which annual landings fluctuated between zero and 31,000 pounds until 1957 when landings from public grounds ceased. Connecticut oyster landings have been entirely from privately leased or franchised grounds since 1958.

The principal hard clam dredge fishery began in 1951 although occasionally intermittant landings of low magnitude were made in prior years. Clam dredge landings increased to 460,000 pounds in 1958, decreased to 151,000 pounds in 1965, increased dramatically to a record 810,000 pounds in 1971, decreased to 120,000 pounds in 1975, and have since been increasing to 360,000 pounds in 1981 (Figure 42). Prior to 1960, essentially all of the hard clams landed were harvested from public grounds. After 1960, developments by the private shellfish companies in seeding and tending private hard clam beds changed the dredging of hard clams into more of a mariculture industry such as that for oysters.

Oysters and hard clams were commercially harvested from public beds by hand tong until 1974. Annual hand tong landings of oysters decreased from 43,000 pounds in 1944 to 12,000 pounds in 1948, increased to a record 50,000 pounds

in 1951, then decreased to between 1,000 and 8,000 pounds from 1957 to 1967, and decreased further to less than 500 pounds until 1974, after which these landings ceased (Figure 43).

Prior to 1951, essentially all hard clams were harvested from public beds by hand tong. A record of 105,000 pounds of hard clams were commercially landed with hand tongs in 1939; however, none were landed in 1940. Hand tong landings increased to 50,000 pounds in 1946, fluctuated between 4,000 and 30,000 pounds in the 1950's and remained at less than 2,000 pounds until 1974, after which they ceased (Figure 44). Hard clams were also commercially harvested with clam rakes from public beds from 1939 to 1956. A record 64,000 pounds were landed in 1939, after which rake landings decreased and then ceased in 1956.

The decline of the commercial hand tong and clam rake fisheries for oysters and hard clams may reflect the closing due to pollution of nearshore public shellfish beds in shallow waters where these gear types are most efficiently used, as well as a decline of natural oyster and hard clam populations. The former harvesting of shellfish from public beds using hand tongs and rakes can be considered a true fishery because a "wild" natural resource was being harvested, in contrast to the maricultural strategies of seeding and predator control employed on private beds.

The operation of one of the two major oyster companies working in Long Island Sound was described in detail by Korringa (1976) for the period 1971-72. At that time the company owned 4,788 acres of ground held under perpetual franchise under the jurisdiction of the Shellfish Commission of the State of Connecticut (now the Department of Agriculture, Division of Aquaculture), and in addition, 357 acres under lease, partly from towns and partly from the State. The total acreage of the company was spread over 94 plots of which only a small number were greater than 100 acres (Korringa 1976). The company has since increased its acreage of franchised and leased shellfish grounds.

Seed oysters to be planted on growing beds are purchased by the company from natural growth seed oyster harvesters (See Section 5.1.8). Seed oysters are also produced on certain beds by scattering oyster shells (cultch) to collect settling larvae (spat). The company keeps a huge pile of cultch on its premises, partly derived from the shucking procedure and partly composed of shells of dead oysters collected when dredging for marketable oysters. When the oysters spawn and conditions are favorable for the settlement of the pelagic larvae, 1,500-2,000 bushels of cultch per acre are quickly spread on the grounds on which the larvae will settle. Usually the best time for larval settlement is the second half of July, but occasionally a

set of commercial importance may come as late as September, as was the case in 1971 (Korringa 1976).

About 6 to 8 weeks after the settling season, a regular system of inspection of the spat is conducted every few weeks. This not only allows for timely action to be taken if predators are discovered, but also indicates whether spat is being shifted by storms, therefore requiring transplantation to a safer ground in October (Korringa 1976).

Seed oysters are transplanted from the settling grounds to the growing grounds, which are categorized by fast water currents rich in food. Transplantation begins in September and October for those seed oysters that are in danger of being washed away from unprotected shoal grounds. Those seed oysters in protected areas are transplanted the following spring. From 300 to 800 bushels of seed per acre are evenly planted, depending on the size of the individuals (Korringa 1976). Seed oysters purchased from natural growth harvesters are planted on the growing grounds as they are received.

Seed oysters remain on the growing grounds for 1-3 years, at which time they are transplanted to special fattening grounds during the final year before marketing. These are shoal grounds, well protected from storms, and in unpolluted waters. Oysters are spread here at a rate of no more than 500 bushels per acre, to assure maximum fattening. Oysters are harvested for market mainly in the fall and spring (Korringa 1976). To assure that the oysters do not contain disease causing organisms when they are marketed, the Connecticut Department of Health Services stipulates that they must remain in an area where the water has been certified as unpolluted for a minimum of two weeks during which the water temperature is 50 F or above.

Predator control is an important part of oyster farming in Long Island Sound. The major predator of oysters is the starfish (Asterias forbesi). When they are not excessively abundant, starfish are removed from the oyster beds by weekly and sometimes daily starfish "mopping". Starfish become entangled in strings of cotton attached to an iron frame that is dragged over the oyster bed by boat. The mop is hoisted aboard the boat and the starfish are killed by dipping the mop into a tank of boiling water. When mopping is ineffective for eliminating severe infestations, the spreading of quicklime (about 2,000 pounds per acre) is an efficient alternative method of control (Korringa 1976).

Other predators causing substantial mortality of LIS oysters are the Atlantic oyster drill (Urosalpinx cinerea) and the thick-lipped drill (Eupleura caudata). A mixture of polychlorinated benzenes known as "Polystream" was formerly

used to successfully control oyster drills, but is no longer in use. Drills are presently removed from the beds when the oysters are dredged during the transplanting process. Other minor oyster predators are the mud crab (Neopanope texana), and the rock crab (Cancer irroratus). No efforts are made to control these predators.

The peak season for harvesting hard clams is during the months of June, July, and August, which is exactly opposite to that for oysters. Therefore, the harvesting of oysters and hard clams are complementary aspects of the shellfishing business. In 1971-72, one company operating in LIS earned approximately 66% of its annual income from sales of hard clams, the rest being from oysters (Korringa 1976).

Because hard clams bury themselves in the sediment with only their siphons protruding, a standard oyster dredge is not effective for harvesting them. A special hydraulic clam dredge is used which has a narrow blade, 6 inch teeth, and water jets through which water is forced by a pump on board the vessel to soften the sediment in front of the teeth. The chain-link bag of the clam dredge can hold from 10 to 15 bushels of material.

Hard clams are dredged by the shellfish companies from public natural beds and private beds leased from the State for the purpose of hard clam farming. Seed clams have been dredged from public grounds which are closed to the harvest of shellfish for direct marketing, and then transplanted to leased beds in clean water for further growth and depuration, or just depuration depending on the size of the clams. As is the case for oysters, hard clams must also remain in certified unpolluted water for at least two weeks during which the water temperature is 50 F or above, before they can be marketed.

The other of the two major shellfish companies operating in LIS leases natural oyster setting grounds in New Haven Harbor from the State of Connecticut to produce seed oysters. Most of the growth of this company's oysters takes place on leased beds in Connecticut waters. However, all oysters are transplanted to fattening and depuration beds leased in unpolluted New York waters on the northern Long Island coast. This company operates a processing plant in Northport, Long Island, where the oysters are landed. A small amount of hard clams are harvested annually by this company and landed in Connecticut. Korringa (1976) estimated that approximately 5% of their annual income was earned from sales of hard clams in 1971-72.

Two other companies harvest and land oysters and hard clams in Connecticut, although in small quantity compared to the two major shellfish companies previously mentioned. In 1981, the shellfish companies that harvest market oysters

and hard clams from Connecticut waters and land them in Connecticut, collectively employed approximately 23 full-time and 13 part-time workers. A total of 11 boats were operated by the shellfish companies landing their harvest in Connecticut in 1981. Approximately 8 were used for oyster dredging and tending of oyster grounds and 3 for hard clam dredging and tending of clam grounds.

No major conflicts are apparent between the commercial shellfishing industry and recreational shellfisheries. Most shellfish grounds owned by the commercial harvesters that are accessible to recreational shellfishing are in polluted waters and not open to harvest for direct consumption. Private beds located in unpolluted waters are usually also in deep water (15-20 feet) not accessible to traditional recreational shellfishing gear such as rakes and tongs.

Potential gear conflicts between private shellfish companies and otter trawlers are avoided by a law prohibiting dragging across any buoyed, actively worked shellfish ground.

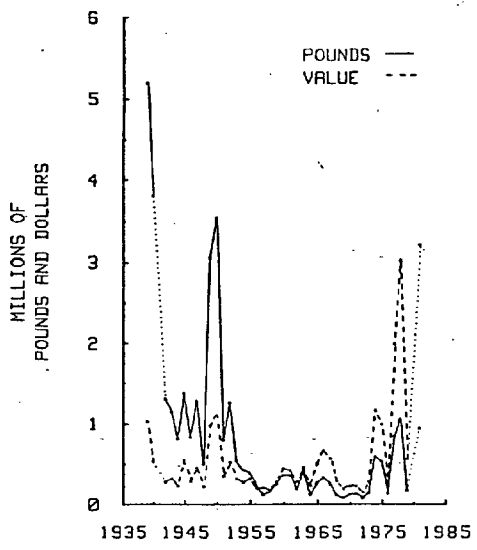


Figure 41. Connecticut oyster dredge landings and value, 1939-1981.

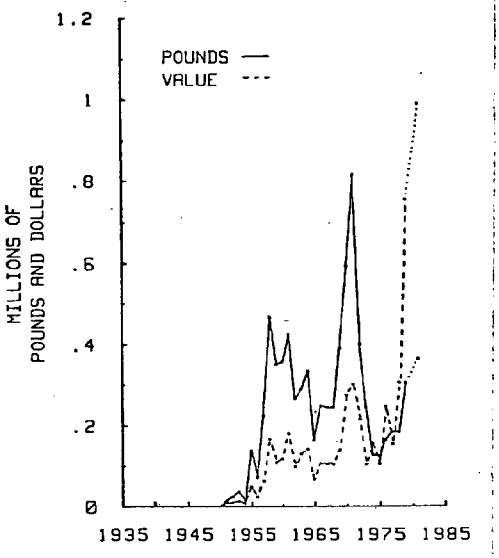


Figure 42. Connecticut clam dredge landings and value, 1939-1981.

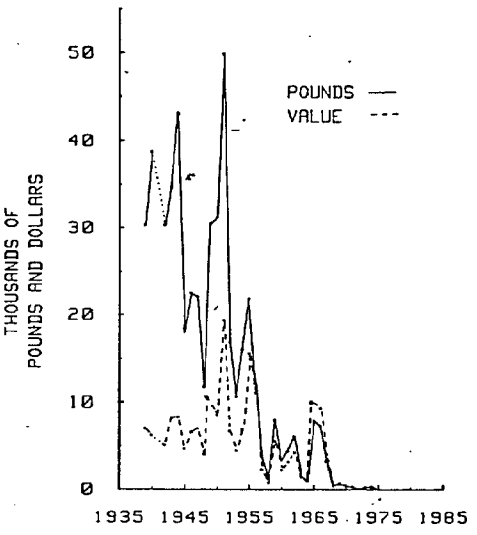


Figure 43. Connecticut hand tong landings and value of oysters, 1939-1981.

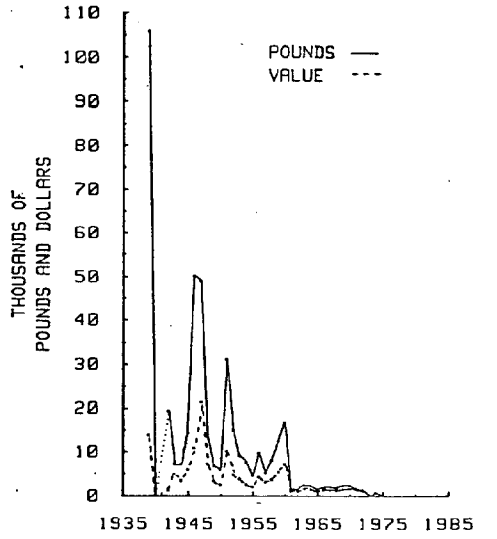


Figure 44. Connecticut hand tong landings value of hard clams, 1939-1981.

5.1.3 The Lobster Fishery

The lobster fishery is second to the oyster industry in economic value, earning 29-44% of the total annual revenue generated by the harvest of all living marine resources from 1977-1981. However, as a true fishery, relying strictly on the harvest of a "wild" resource, it is the most valuable of Connecticut's commercial fisheries.

From 1880-1892, 1.4-1.6 million pounds of lobster were landed annually and represented the greatest landings in the history of Connecticut's lobster fishery. Landings declined from about 700,000 pounds in the early 1900's to 100,000 - 300,000 pounds in the late 1950's (Figure 29). Landings began to increase in the 1960's due to the otter trawl fishery for lobster caught mainly on offshore grounds rather than in LIS (General Dynamics 1968). As trawler landings began to decline in the late 1960's, trap landings increased, and combined trap and trawl landings of about 900,000 pounds were reported. Annual trap landings of 500,000 - 600,000 pounds in the early 1970's increased to 800,000 - 1,000,000 pounds in recent years (Figure 45) now accounting for 10-15% of Connecticut's total annual landings of all fish and shellfish.

The catch of Connecticut-licensed lobstermen from 1976-1981 was 14-17% higher than the amount of lobster landed in Connecticut due to the landing of the balance at out-of-state ports (Figure 45).

The traditional wooden lobster trap is the main gear currently employed, however, lobster were also commercially taken with otter trawls from 1951-1972 with substantial landings between 200,000 - 400,000 pounds during 1962-68, when landings were divided about equally between these two gear types. In 1962, trawl landings exceeded trap landings by 52%. Significant trawl landings ended in 1970 (Figure 45) and lobster for commercial purposes has since been taken almost entirely by trap.

Landings appear to be roughly correlated with the number of traps reportedly fished each year (Figure 45). However, the best indicator available of the effort expended by the lobster trap fishery is the trap haul set over day (THSOD), which has been recorded since 1975 in the Connecticut DEP Marine Fisheries Information System. Lobster fishing effort based on the THSOD has been increasing in recent years, 48% from 1975-1980, with a slight decrease (4%) from 1980-81 (Figure 45).

The number of commercial lobster fishermen in recent years has increased from 390 in 1976 to 567 and 517 in 1980 and 1981, respectively. An estimated 14% of all commercial lobstermen (72 in 1981) derive 50% or more of their income

from lobstering and are considered full-timers, while the remaining 86% are considered part-timers (Smith 1977). An additional component of the part-time category of lobstermen is the personal use or recreational fisherman. Over 3,000 such licenses are issued each year (Sec. 5.2.3).

From 1977-79, about 60% of Connecticut's landings of lobster were divided about equally between New London (28-36%) and Fairfield (23-33%) Counties. In 1980 and 1981, however, New London County reported a higher percentage of these landings, 45% in 1981; while 21% was landed in Fairfield County that year. About 14-16% was landed in New Haven County, and less than 6% in Middlesex County during 1977-1981. The distribution of landings among counties is reflected by the distribution of the number of lobster boats among the counties. From 1977-79 New London and Fairfield Counties each harbored from 35-40% of Connecticut's lobster boats. However, from 1979-1981, Fairfield County's percentage decreased from 36 to 21%. New Haven County harbored 16-26%, and Middlesex, 7-12% of Connecticut's total lobster boats during 1977-1981.

Smith (1977) examined the vessel characteristics of Connecticut's lobster fleet in 1976. The mean length of the boats used by full-time lobstermen in Connecticut was 31 feet and mean horsepower was 142. Eighty-five percent of all full-time lobstermen owned wood boats and 15% owned fiberglass boats. Sixty percent of the boats owned by full-timers were powered by diesel fuel and 40% by gasoline. In contrast, the mean length of all part-time commercial lobstermen's boats was 22 feet and mean horsepower was 81. The distribution of hull material and type of fuel among part-time lobstermens' boats was 65% wood and 35% fiberglass, and 21% diesel and 79% gasoline. Fifty-five percent of the part-time lobstermen used their boats for sportfishing and pleasure as opposed to 13% for full-timers. This is reflected by the differences in vessel characteristics noted above.

A conflict occurs between the commercial lobster fishery and the personal use loster fishery that has to do with experience in the fishery and simple gear competition. An unlimited number of personal use license holders are allowed to each use 10 or less traps to catch lobsters for their own consumption but not for sale. Inexperienced personal use lobstermen may set their traps in the same areas as commercial fishermen, in effect simply following the commercial lobsterman and setting where he sets. This causes pot saturation in productive areas, and the resultant decline in catch per pot thereby reduces the catch of each fishermen.

Commercial fishermen are also plagued by unscrupulous boaters and some scuba divers who illegally steal lobsters

from their traps. The extent of this theft is unknown, but arrests by conservation officers are made each year for this activity and a large number of complaints which do not result in arrests are received annually.

Gear conflicts occur between the lobster trap and otter trawl fisheries. When traps are set in desirable trawling areas, they are subject to physical damage and loss due to trawling activity. Gear conflicts also occur among commercial lobstermen themselves, who are often "territorial" in personally claiming desirable lobster fishing areas.

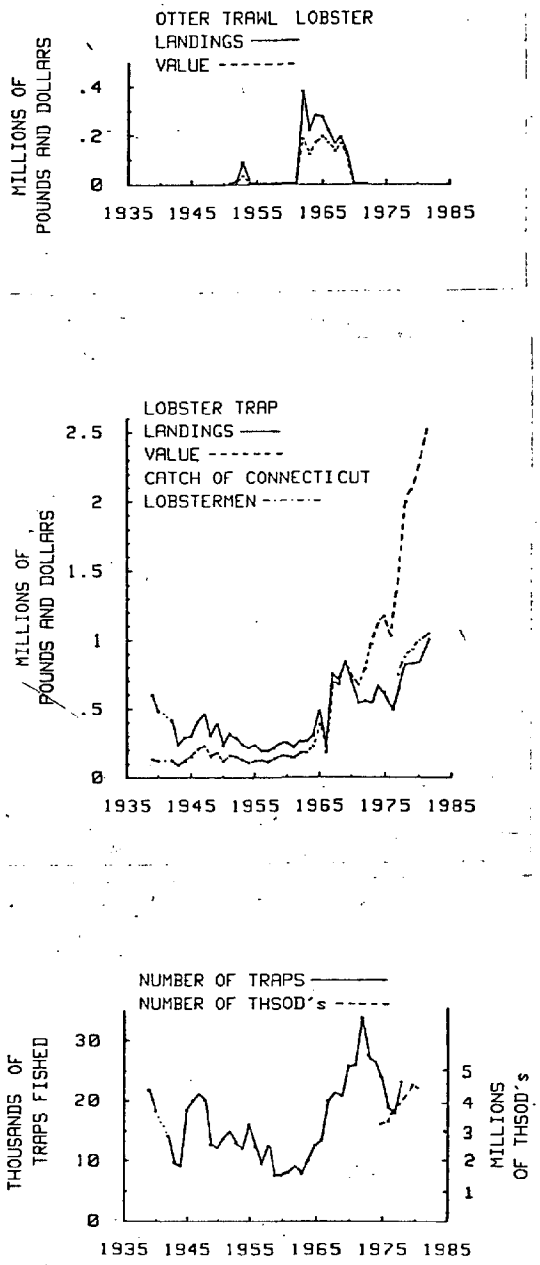


Figure 45. Connecticut otter trawl lobster landings and value 1939-1981; lobster trap landings and value 1939-1981, and catch of Connecticut lobstermen 1977-1981; number of traps fished 1939-1981, and trap haul set-over days (THSOD's) 1975-1981. Sources: NMFS, Fishery Statistics of the U.S. and Connecticut DEP Marine Fisheries Information System.

5.1.4 The Otter Trawl Fishery

The otter trawl fishery is Connecticut's third most economically valuable commercial fishing industry. From 1979-1981, it earned 11-21% of the total revenue generated by all such industries each year. Because more finfish are harvested by otter trawl (79-86% of annual finfish landings) than any other gear, the otter trawl fishery is Connecticut's number one finfish fishery in quantity and value of annual landings.

From 1940 to 1959, over 8 million pounds of demersal and pelagic species were landed annually by trawl, with a peak of 18.5 million pounds in 1949. Landings since 1960 have fluctuated between 2 and 5 million pounds (Figure 46). Otter trawl catch statistics are not accurate indicators of the activity of the otter trawl fleet landing in Connecticut because vessels not licensed by the state may contribute large percentages to Connecticut landings. From 1977-79, Connecticut-licensed otter trawlers landed only 43-56% of the total Connecticut otter trawl landings. In 1981, they landed only 10%. The remainder of the total otter trawl landings are believed to be those of offshore trawlers that are registered in other states, do not fish in Connecticut waters, and thus are not required to possess a Connecticut commercial fishing license or to report their catch and landings to the Connecticut DEP Marine Fisheries Office.

From 1977-1981, annual Connecticut landings of otter trawlers licensed by Connecticut have decreased from near 1.5 million pounds during 1977-79 to 0.5 million pounds during 1980-81. This is not only because the catch of the Connecticut licensed fleet has decreased from 1978 to 1981, but also because much of their catch is not landed in Connecticut. From 1977-1981, the percentage of the Connecticut licensed trawler catch annually landed at out of state ports increased from 30-67%. Point Judith, R.I., New York City, Northport and Oyster Bay, Long Island and, to a small extent, Fisher's Island, N.Y., receive some landings of Connecticut licensed trawlers. The price received for the catch as well as travel time from fishing grounds to a landing port largely determines where the catch will be landed.

Winter flounder and scup are the two principle species taken by Connecticut-licensed commercial otter trawlers, together accounting for 42-52% of their annual catch from 1977-1981. The importance of winter flounder to the otter trawl fishery has been increasing over this period, from 24% of the catch in 1977, to 37% in 1981. Conversely, the percentage of scup in annual catches has decreased from 30% in 1978 to 15% in 1981. Species classified as lobster bait are third in importance, making up 2-11% of annual catches from 1977-1981. Other species which individually do not

usually account for more than 5% of annual Connecticut licensed trawl catches include weakfish, squid, fluke, bluefish, butterfish, herring, dogfish, blackfish, and skate. In combination, however, these species accounted for 17-29% of the annual trawl catches from 1978-1981.

In 1981, a total of 79 otter trawlers operated in Connecticut. Of these, 41 were less than 5 gross registered (GRT) tons (classified as "boats"), ranging from 13-27 feet, and 38 were greater than 5 GRT ("vessels"), ranging from 28-81 feet. Forty-two of the total trawlers (53%) were used for lobstering as well as trawling -- 26 (33%) of the boats, and 16 (20%) of the vessels. The number of Connecticut's otter trawlers has increased since 1976 when there were only 18 boats and 12 vessels.

In 1981, 40 trawlers (51%) reported their home county to be New London County; 19 (24%), New Haven County; 9 (11%), Fairfield County; 6 (8%), Middlesex County. The home port of the remaining 5% were undetermined.

At least 155 fishermen were involved in Connecticut's otter trawl fishery in 1981, assuming that one man operates each boat (< 5 GRT) and 3 men operate each vessel (> 5 GRT). Practically all otter trawl fishermen are full-time fishermen, earning 50% or more of their income from fishing. However, only about half the fishermen earn their living solely from trawling. The other half may trawl mainly to catch lobster bait, or earn money by trawling and lobstering in combination.

All of the Connecticut trawlers that fish in LIS are day boats which leave before dawn and return to port in the afternoon of the same day. Most of the trawlers that fish in Block Island Sound are also day boats. A few of the largest trawlers may make trips to offshore grounds that last several days.

Otter trawling is not permitted in Connecticut estuaries. A special line that is generally not more than 1/4 mile from shore has been designated, north of which trawling is illegal (Sec. 26-154). This law aids in the conservation of the young of many species that utilize estuaries as nursery habitat. Gear conflicts occur between the otter trawl and lobster trap fisheries when traps are set in productive traditional trawling areas.

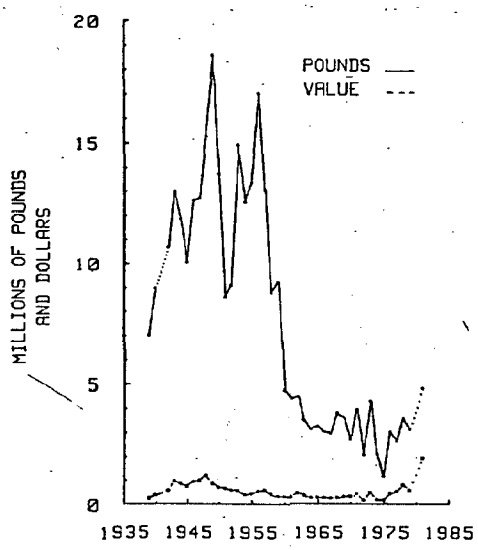


Figure 46. Connecticut otter trawl landings and value for finfish and squid, 1939-1981.

5.1.5 The Sea Scallop Fishery

Connecticut's recent offshore sea scallop dredge fishery began in 1976 and annually produced landings ranging from 12,000 pounds in 1976 to 198,000 pounds in 1978. Landings have since decreased to less than 70,000 pounds in 1981. Although only a small fishery, it is ranked fourth in economic value among all Connecticut commercial fishing industries, earning 2-7% of the total annual revenue generated by these industries from 1977-1981. This ranking is due to the generally high (>$2.00 per pound) ex-vessel value of the product.

Prior to 1976, sea scallops harvested by otter trawl were intermittently landed in Connecticut usually in amounts less than 10,000 pounds per year except for 1919, 1932, and 1933 when landings ranged from 38,000-94,000 pounds.

Nantucket Shoals and the waters around Block Island produce most of the current Connecticut landings. After being caught with a large dredge, the scallops are shucked, washed, weighed, packaged in plastic bags, and frozen on board the fishing vessel. Catches are usually landed at Stonington.

No gear conflicts are known to be related to the sea scallop fishery.

5.1.6 The Connecticut River Shad Fishery

The Connecticut River shad fishery is Connecticut's fifth most economically valuable commercial fishery earning 2-3% of the total annual revenue generated from 1977-1981. It is the second most valuable commercial finfish fishery in Connecticut, the otter trawl fishery being first. Drift gill nets are the major gear used and have been used exclusively since 1975. Landings of shad taken by this gear have generally fluctuated between 100,000 and 500,000 pounds per year except for peak landings of about 550,000 pounds occurring in the 1940's. Peak haul seine shad landings of 220,000 pounds occurred in the late 1940's after which they declined and ceased in the 1960's. Stationary gill nets classified as anchor, set, or stake nets have also been used intermittently with shad landings over 50,000 pounds occurring in 1944, 1958, and 1967, after which they no longer accounted for significant quantities. The 1967 stationary gill net shad landings of 145,000 pounds were a record. Shad were also caught by pound net in the 1940's and 50's during which peak pound net shad landings of 50,000 pounds occurred (Figure 47).

From 1977-1981, the number of drift gill nets employed decreased slightly from 59 to 45. The same is true of the number of boats used in the fishery since each boat uses one gill net. However, the number of licensed fishermen has increased from 109 to 153 during the same period, indicating that the size of the crew working each boat is increasing. All shad fisherman including assistants are required to be licensed. Commonly, a crew of 2-4 men operate in each boat which, typically, are small (less than 20 ft) outboard powered, open workboats. Most (63-75%) commercial shad fishermen report their home port as Middlesex County. Hartford and New London Counties each account for 10-26% of the fishermen. The same distribution applies to boats in the fishery. Middlesex County receives most of the shad landed (59-75%), while New London County receives 15-28%, and Hartford County receives 10-30%.

There is an open season for shad fishing which extends from April 1 to June 15 each year. Shad fishermen are prohibited from using monofilament gill nets. This results in the fishery being conducted principally at night with multifilament nets which are visible to the shad during daylight hours. The exception to this rule is during periods of turbid water when fishermen are able to use the multifilament nets during daylight hours. Shad fishing is also prohibited from sundown Friday to sundown Sunday in an effort to allow a certain proportion of the population to reach upriver spawning grounds.

Gear conflicts often occur between shad fishermen. Certain sections of the river are "claimed" by one or more

groups of fishermen. In these areas, other fishermen may be harrassed if they attempt to fish for shad. In certain areas where only one net can effectively fish at a time, the fishermen must agree on a time schedule or an order of rotation in order to set and tend their nets with a minimum of conflict.

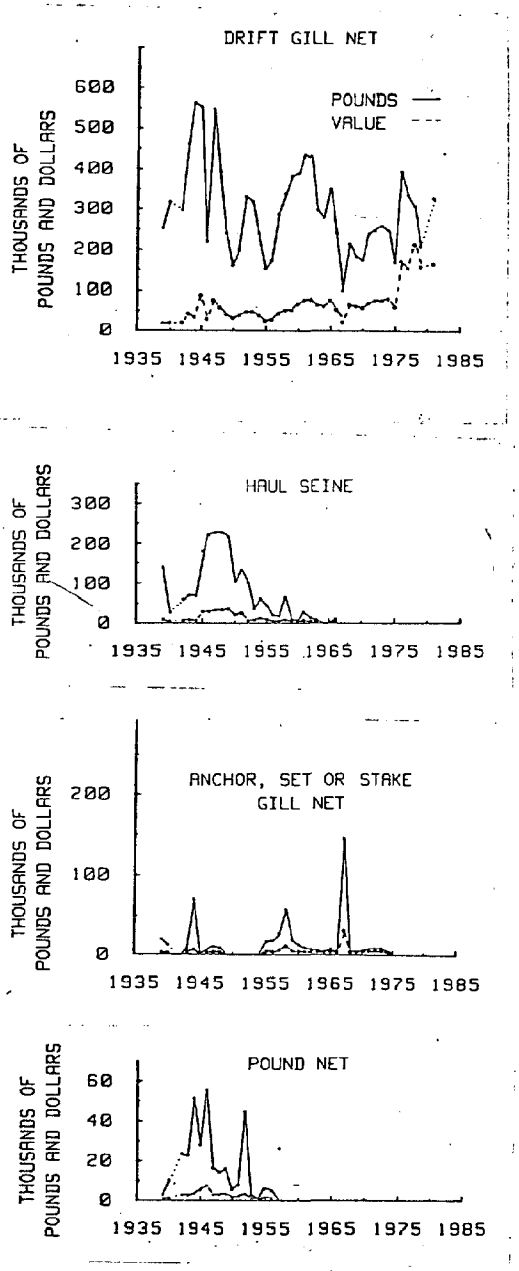


Figure 47. Connecticut commercial shad landings and value by gear type, 1939-1981.

5.1.7 The Conch Fishery

Connecticut's conch fishery is small but rapidly growing. It is the sixth most valuable commercial fishing industry in the state. From 1977-1981, its earnings increased from 1% to 5% of the total annual revenue generated by these industries. The 1981 landings were estimated to be 472,000 pounds of meats and appear to be the highest on record, however, the method of estimating these landings may differ from that used in the past by NMFS. Conch buyers, all in Rhode Island, were asked to recall how much they purchased from Connecticut conch fishermen in 1981. It is unknown how the information was obtained in previous years.

Conch pot landings have increased with fluctuations from < 50,000 lbs in the 1940's to progressively higher peaks of 75,000, 150,000, and 200,000 lbs in 1955, 1967, and 1972, respectively. From 1976-1981, landings have increased ten fold (Figure 48).

Conch pots (or winkle traps) baited with horseshoe crab or shark (usually dogfish) are the gear used. They resemble square wooden lobster traps with a completely open top and a line tied around the inside margin of the top approximately 1 inch from the inside edge. Conch climb up the side, fall in, and are prevented from climbing back out since, "having only one foot, they can't step over the line" (Anonymous recollection of an old-time winkle fisherman).

As the best indicator of fishing effort available, the number of pots used each year appears to be correlated with the size of annual landings (Figure 48), however it is unknown how the number of pots was derived by NMFS prior to 1981. In 1981, based on a conversation with an experienced commercial conch fisherman, 100 traps per licensed fisherman was estimated for calculating the number of pots used. This probably yielded an underestimate of the total number. It was learned that at least 100 pots are needed to make a reasonable living from full-time conch fishing, which is seasonal from June to October. Part-time fishermen use 20 or 30 pots.

The number of commercial conch licenses issued from 1977-1981 has fluctuated between 6 and 22. Thirteen licenses were issued in 1982. It is assumed that all licensed conchmen are full-timers. It is thought that a large number of unlicensed part-timers tend conch pots and take more than 5 bushels per day although this level of activity requires a license. Thus, the landings figures may be gross underestimates of the amount of conch taken annually.

Boats used by conch fishermen are small, usually 25

feet or less, outboard powered open work boats or sportfishing boats. Conch fishing does not require much equipment, the traps are relatively small and can be hauled by hand, thus one man alone can operate efficiently. Each licensed fisherman operates his own boat, therefore the number of boats involved in the fishery is the same as the number of fishermen.

All licensed conch fishermen operate nearshore in central LIS. In 1981, seven fishermen docked their boats and landed their catch in New Haven Co., and four in Middlesex Co.

The only gear conflict identified was between experienced conchmen and inexperienced part-timers who set their pots in the same area as experienced men, thus competing for the resource in a limited area by not taking time to find their own productive fishing grounds. Conch pots are usually set near to shore and over muddy bottom, which avoids conflicts with the lobster fishery.

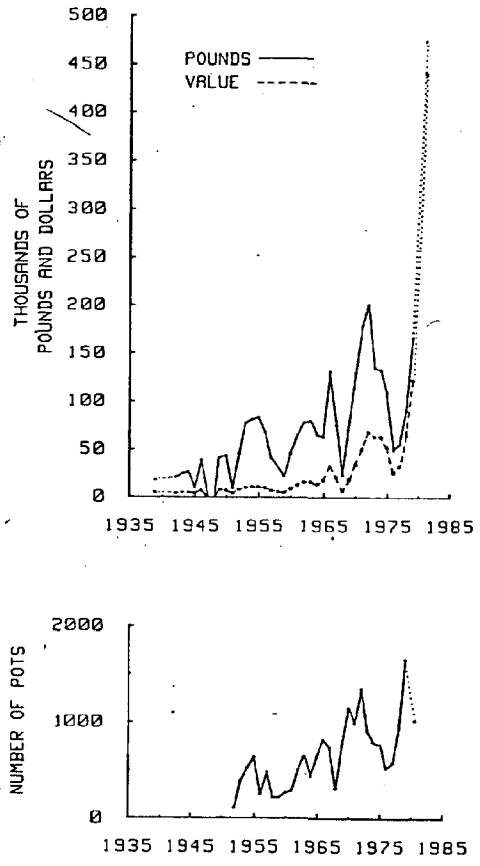


Figure 48. Connecticut conch pot landings, value, and number of pots fished, 1939-1981.

5.1.8 Natural Growth Seed Oyster Harvesting

Seed oysters are defined as those oysters taken from natural beds in areas closed to market harvesting because of pollution and which are then transplanted to clean water for depuration. The harvesting of seed oysters is Connecticut's seventh most valuable industry based on the harvest of living marine resources. From 1979 to 1981, it earned 0.8-3% of the total annual revenue generated by all such industries. It is a unique fishing industry because the catch is not landed for marketing. Instead, seed oysters are sold to Connecticut's private shellfish companies, who then transplant them to their leased grounds before marketing, either for depuration, or for depuration and further growth depending on the size of the oysters.

The harvest of seed oysters in recent years from September through the following August is as follows:

1976-77	34,985 bushels
1978-79	20,000 bushels
1980-81	8,847 bushels

For 1980-81 this information was derived from catch reports of the seed oyster harvesters submitted to the Department of Health Services, otherwise the information was provided by NMFS. If the methods of data collection were at all similar, it appears that the annual seed oyster harvest has decreased in the last five years.

The gear used is an oyster dredge weighing 30 pounds or less with a chain bag having rings of greater than 3/4 inch in diameter, which is hauled by hand into the boat used for towing (Sec. 26-215, 26-217 CGS). Tongs may also be used. However, because of their inefficiency compared to hand-hauled dredges, very few are used each year. In 1981, only one seed oysterman used tongs.

In 1977, 64 fishermen were licensed to harvest seed oysters. In 1979 and 1981, there were 42 and 49 fishermen, respectively. In 1977, 42 dredges were used, 34 were used in 1979, and 41 in 1981. Because one dredge is used per boat, the number of boats in the fishery are the same for those years. The boats used are small (less than 20 feet in length) outboard-powered skiffs and scows.

Natural oyster beds under state jurisdiction from which seed oysters are harvested are located in Darien, Norwalk, Westport, Fairfield, Bridgeport, and Stratford including the Housatonic River. In addition to these traditional natural beds, productive natural oyster beds under town jurisdictions have recently been opened to commercial seed

oystering as regulated by town shellfish management plans (See Section 6.5.2).

To assure the continued productivity of the state's natural oyster beds, the Aquaculture Division of the Department of Agriculture, the natural growth harvesters, and the private shellfish company to whom most seed oysters are sold have participated in a variety of cooperative programs. These include the planting of cultch to provide habitat for settling larvae, cultivation of the bottom to remove silt from shells (thereby making them more suitable for collecting spat), and predator control (Folsom 1979).

Because only hand power may be used to haul dredges on natural beds, conflicts are avoided between the natural growth harvesters and private shellfish companies using large dredges and hydraulic haulers. If this more efficient gear were allowed, those using it would, in effect, be able to monopolize the resource. The law permits a traditional small scale fishery to exist in which a number of individuals can enter and participate at a relatively low expense.

5.1.9 The Hook and Line Fishery

The hook and line (or handline) fishery is a fairly small fishery which, from 1977-1981, earned not more than 2% each year of the total annual revenue generated by Connecticut's commercial fishing industries. Therefore, it ranked eighth among all such industries. However, it is the third most economically valuable finfish fishery, the otter trawl and Connecticut River shad fisheries being first and second, respectively.

Record handline landings of 250,000 - 300,000 pounds were reported during 1946-47. Landings were generally below 100,000 pounds in the 1950's and 1960's. In the early 1970's, between 150,000 and 200,000 pounds were landed which decreased to less than 100,000 pounds from 1976-79. In 1981, 150,000 pounds were landed (Figure 49).

Bluefish is the principal species taken in the fishery, generally constituting half of the total annual catch from 1977-1981. Mackerel, blackfish, and weakfish are other notable species taken in significant quantities. Small quantities of flounder, fluke, scup, and cod are also taken.

From 1943-1953 and 1961-68, multiple hooks were used on handlines. After 1970, the number of hooks fished was no longer reported in "Fisheries Statistics of the U.S." The number of lines and hooks fished generally appears to be related to the size of annual landings and serves as a rough indicator of the amount of fishing effort expended (Figure 49). If the time that each unit of gear fished was known, a more precise indicator of fishing effort could be obtained. Effort and landings increased in the 1970's from the low values of the 1960's.

From 1977-1981, between 84-141 fishermen participated annually in this fishery. Less than 10 were full-time fishermen, who earned over 50% of their livelihood from fishing. Most of these men fished out of Middlesex County ports. The rest were casual participants.

From 1977-79, New London County harbored most hook fishermen (74-83%), Middlesex County harbored 9-16%, and New Haven and Fairfield Counties each harbored 3-6%. However, the 1981 catch reports for this fishery indicate that increasing numbers of fishermen fished out of New Haven and Fairfield Counties, 14% and 20% respectively. Also, the number of New London County hook fishermen decreased from 116 to 32 from 1979-1981.

Almost every commercial hook fisherman operates his own boat although a few boats may be shared. Most of the boats are small (< 25 feet) sportfishing boats or other open work boats powered by outboard motors. It is likely that many

hook fishermen are extremely avid recreational anglers who sell their catch mainly to pay for or defray the operating expenses of their fishing trips.

There are conflicting viewpoints about when an angler who sells his catch should be considered a commercial fisherman. It is not known what number of anglers who sell their catch do so "under the table" without possessing a Connecticut Commercial Finfish License. However, the General Statutes provide the license requirement if any of the catch is sold, however infrequently such sale might occur.

Commercial hook fishermen are likely to have the same complaint as recreational fishermen about the purse seining of menhaden and the supposed resulting depletion of that species which attracts and provides food for gamefish such as bluefish and striped bass.

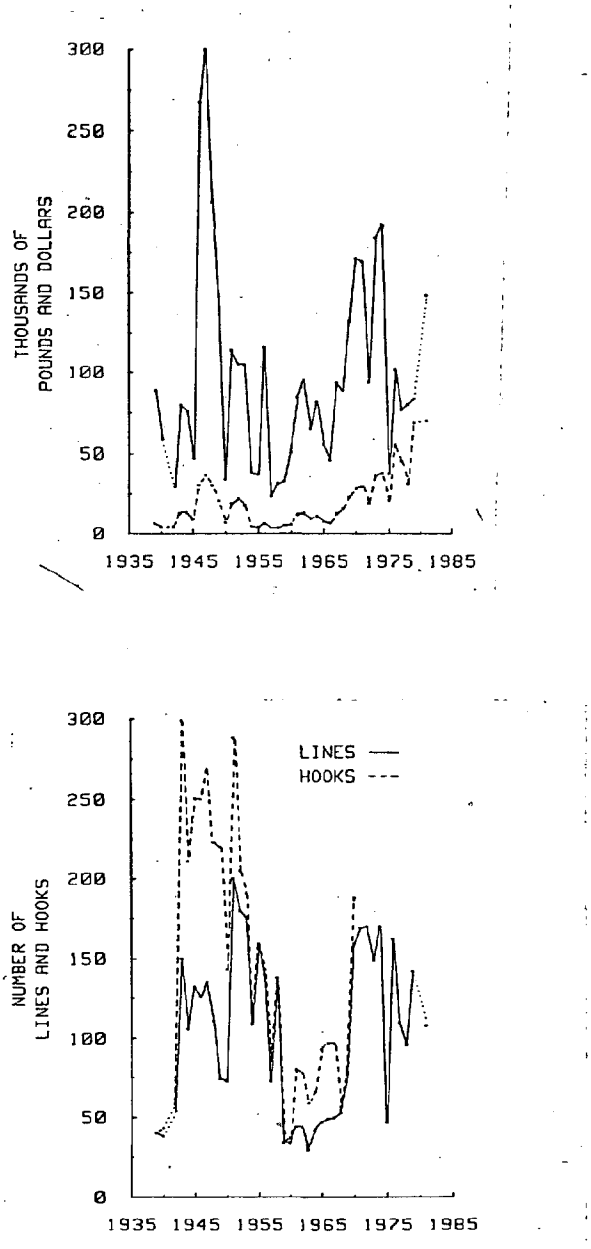


Figure 49. Connecticut hand line landings, value, and number of lines and hooks fished, 1939-1981.

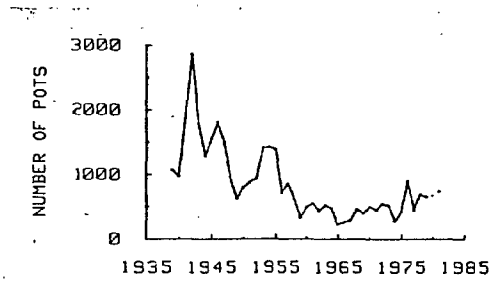
5.1.10 The Eel Pot Fishery

The eel pot fishery is a small fishery, accounting for less than one percent of the total annual revenue generated by Connecticut commercial fishing industries from 1977-1981. Record eel pot landings between 40,000 and 50,000 pounds occurred in the late 1960's and 1970's, although during the same period fluctuations from year to year were as great as 20,000 pounds (Figure 50).

Pots are constructed of wire and baited with horseshoe crab or fish. Green crabs are also caught in eel pots and are sought by some eel fishermen to sell for fishing bait. Approximately 2,000 pounds of green crabs were reported taken in eel pots in 1981. The number of eel pots reportedly fished each year does not appear to be correlated with the size of landings and thus does not serve as a useful indicator of fishing effort (Figure 50).

From 1977-79, 4-7 full-time and 10-16 casual commercial eel fishermen operated in Connecticut waters. New London Co. harbored the greatest number of eelmen (9-13) most of whom operated in the Thames and Connecticut Rivers. Middlesex Co. harbored about 5 eelmen who operated mainly in the Connecticut River. New Haven and Fairfield Counties each harbored less than 5 fisherman. Most eel fishermen operate from small (< 20 ft) outboard-powered, open skiffs. The number of boats operating in this fishery is nearly the same as the number of fishermen although some sharing of boats may exist. From 1977-79, most eel caught with eel pots (50-70%) was landed in New London County. Middlesex County received 20-30%, and New Haven and Fairfield Counties each received 2-13%.

No conflicts are apparent between the eel pot fishery and other commercial and recreational fisheries.



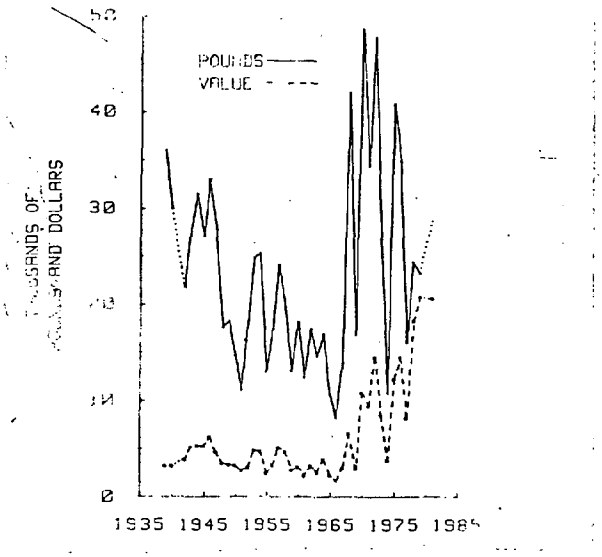


Figure 50. Connecticut eel pot landings, value, and number of pots fished, 1939-1981.

5.1.11 The Gill Net and Haul Seine Fisheries

Excluding the Connecticut River shad fishery, gill net and haul seine fisheries in the state are primarily directed towards catching fish for use as lobster bait and as bait for gamefish (bluefish, striped bass). The fishermen involved are commercial as well as personal use lobstermen, and commercial and recreational anglers. Each of these fisheries earns less than 1% of the total annual revenue generated by all industries that are based on the harvest of living marine resources.

The drift gill net fishery operates in LIS and the Connecticut River. Fifty to 60% of the annual catch is menhaden, and up to 20% is mackerel. White perch and unclassified species reported as lobster bait each account for up to 10%. Nearly all finfish species occurring in LIS and its major tributaries may, at times, be taken by this method.

In the early 1970's, landings of finfish species other than shad caught by drift gill nets increased to a peak of 600,000-800,000 pounds from previous landings of less than 100,000 pounds. In the late 1970's, landings decreased to 122,000 pounds and have since begun to increase again, to 213,000 pounds in 1981. In 1981, 240 fishermen reported using gill nets for species other than shad. Approximately 220 boats and the same number of gill nets were used. The home ports of the fishermen and the distribution of landings is divided about equally among the four coastal counties.

The haul seine fishery operates mainly in the Connecticut River and is directed towards catching river herring which, in 1979 and 1981, made up almost 100% of the annual catch. Some fishermen apparently seine along the shores of LIS, as evidenced by small catches of blackfish, winter flounder, fluke, mackerel, skates and other marine species that are reported annually.

A record haul seine landing of 2 million pounds of finfish, almost all of which was river herring, occurred in 1950. Landings decreased through the 1950's and have remained at less than 100,000 pounds per year since 1959.

In 1981, 25 fishermen reported using haul seines. A total of 12 boats and the same number of seines were used. River herring taken from the Connecticut River are landed mainly in Hartford County and also in Middlesex and New London Counties.

5.1.12 The Menhaden Purse Seine Fishery

Menhaden recently were harvested annually from June through October in LIS by 6-7 purse seining vessels which landed their catches in New Jersey. Thus, this fishery is not a Connecticut industry. It does, however, have a great impact on Connecticut's menhaden resource. From 1974 to 1981, 3-11 million pounds of menhaden were reported caught from LIS; in 1981, over six million pounds were taken.

Early in 1982, Seacoast Products, Inc., a company operating menhaden seiners, announced it would not fish in New England for a period of two years (1982-83), however company officials have expressed the desire to return to fishing in Long Island Sound in future years.

Schools of menhaden are spotted at the surface of the water from the 70-80 foot long vessels or by the pilots of small airplanes who direct the operation from the air. A school is encircled by the seine which is usually set by two smaller boats (tenders) which are 30-40 feet long. The bottom of the net is then drawn together so that the school is completely enclosed (pursed) by the net. The net is hauled in until the fish are concentrated in a small portion of the net from which they can be removed and transferred to the vessel's hold by a large pump.

Menhaden purse seining is not allowed north of a line from buoy to buoy which is one-half to one mile south of the Connecticut shoreline. This law eliminates hazards to navigation that may be caused during the seining operation, and also prohibits seining in some of the most productive sportfishing areas.

Recreational fishermen have expressed concern that the large scale purse seining operation in LIS might significantly deplete the menhaden stock entering the Sound, thus adversely impacting the gamefish stocks that utilize menhaden for food. However, there is no evidence of a correlation between catches of menhaden and gamefish.

5.2 The Recreational Fisheries

5.2.1 Recreational Finfishing

The Marine Recreational Fishery Statistics Survey, Atlantic and Gulf Coasts, 1979 (NMFS 1980), estimated that 304,000 resident and 78,000 non-resident anglers made 1.4 million and 0.2 million fishing trips, respectively in Connecticut during 1979, for a total of 1.6 million fishing trips that year. An independent estimate by the Connecticut DEP yielded an estimated total of 327,500 resident and non-resident anglers (Sampson 1981). On weekend days between July and November, 1979, aerial observations indicated that as many as 1,500-2,000 anglers per day were fishing at any given time.

Aerial flights and the composition of angling sites indicate that most marine angling in Connecticut waters is performed from boats. Approximately 66% of all anglers observed between July and November, 1979 fished from boats. Four different types of fishing sites were surveyed. The types of sites, or "modes", are listed in section 6.5.2. Briefly, they include natural sites, man-made sites, private boats, and party/charter vessels.

Private and rental boat sites were most numerous in all counties. Man-made structures also appear to be more popular among anglers than natural sites. Reasons for these differences may lie with patterns of coastal development as well as with factors such as availability of fish species. A second reason for the popularity of boats and man-made structures, is that docks and jetties furnish natural cover, currents, and backwater areas which tend to attract fish, and boats provide the angler freedom to locate and follow moving schools of fish (Sampson 1981).

The National Survey reported that 7.8 million fish of all species were caught by anglers fishing in Connecticut during 1979 (NMFS 1980). The greatest reported catches were for bluefish and scup (2.0 million and 1.9 million fish, respectively). Catches of the third through sixth ranked species were winter flounder 1.3 million fish, cunner 705,000, blackfish 423,000 and mackerel 254,000 (NMFS 1980). Cunner are not a target species and are considered either a trash fish or a simple nuisance because they frequently steal bait. Therefore, the reported catch may be low because some anglers fail to mention the species in their catch (Sampson 1981).

Winter flounder is considered the most popular recreational finfish species in Connecticut waters. When DEP interviewers asked anglers, "Are you fishing for anything in particular?", the most frequently reported response was, "winter flounder". It is sought year-round

despite seasonal changes in availability. In the spring and fall, a great deal of effort and success is recorded for this species. The high quality flesh and easy catchability makes flounder a very desirable fish.

When DEP interviewers asked anglers, "Are you fishing for anything in particular?", the second most frequently reported response was "No species in particular", or "Anything we can catch." The remaining annual ranking of species in order of directed fishing effort was bluefish, blackfish, striped bass, scup, fluke, tomcod, snapper bluefish, mackerel, weakfish, and cod. Fish such as snapper bluefish and mackerel ranked relatively low due only to their extremely short seasonal availability. Pressure on these species is intense, however it exists only for a few months each year (Sampson 1981).

The impact of Connecticut's marine recreational finfishery on the finfish resources of LIS is considerable relative to that of the commercial fisheries. When the numbers of fish of each species reported caught by NMFS (1980) in the national survey are converted to pounds with an average weight conversion factor, it is evident that recreational fishermen harvest as much, and in most cases more, of the LIS finfish resource than do commercial fishermen (Table 2). Average weights were calculated from data obtained by DEP interviewers and the observations of DEP biologists involved with the recreational fishery survey. Most are considered to be underestimates.

Notable examples of target species where the 1979 recreational catch exceeded the commercial catch and by what factor they were exceeded are: blackfish or tautog (49 times greater), mackerel (35 times), adult bluefish (31 times), cod (6 times), scup (2 times). The recreational catch of winter flounder, fluke, and weakfish exceeded the commercial catch but were less than 2 times greater. The only significant species for which commercial catches exceeded recreational catches were white perch, eels, and herrings. Management of marine finfish resources in the future must take into account the impact of Connecticut's marine recreational fishery on these resources.

Table 2. Comparison between the Connecticut recreational and Connecticut-licensed commercial catch of finfish species, 1979.

	1979 Recreational Catch			1979 Reported Commercial Catch, All Gear Types
	Number of Fish	Conversion (lbs/fish)	Weight (Lbs)	Weight (Lbs)
Scup	1,984,000	0.7	1,388,800	629,700
Snapper bluefish	1,511,250	0.2	302,250	
Flounder	1,377,000	0.66	908,820	777,900
Cunner	705,000	0.5	352,500	
Bluefish (Adult)	503,750	6.9	3,475,875	111,604
Blackfish	423,000	3.2	1,353,600	27,900
Other	256,000	0.5	128,000	
Mackerel	254,000	1.8	457,200	13,100
Sea robins	159,000	0.8	127,200	2,600
Tomcod	119,000	0.25	29,750	
Herrings	113,000	0.5	56,500	149,500 c
Windowpane flounder	86,000	0.3	25,800	18,000
Striped bass	65,000	14.9	968,500	
Fluke	39,000	1.5	58,500	51,600
Mackerel & Tunas	39,000 d	15.0	585,000	
Dogfish	39,000	2.0	78,000	58,800
Skates	39,000	1.0	39,000	68,069
White perch	31,000	0.5	15,500	23,700
Weakfish	30,000 a	5.0	150,000	125,800
Cod	15,000 b	6.0	90,000	15,700
Eel	15,000 b	0.9	13,500	27,600
Pollock	15,000 b	4.0	60,000	
Puffers	15,000 b	0.3	4,500	
Toadfish	15,000 b	0.7	10,500	
Total	9,863,000		10,679,295	

Sources: NMFS (1980); Sampson (1981); Connecticut DEP Marine Fisheries Information System

a) Less than 30,000 according to NMFS (1980), which is an underestimate (Sampson 1981); 30,000 assigned arbitrarily

b) Less than 30,000 according to NMFS (1980); 15,000 assigned arbitrarily

c) Includes sea herring and alewives

d) Assumed to be mostly tuna since there is a separate mackerel category

5.2.2 Recreational Shellfishing

In 1981, approximately 5,000 permits were issued by Connecticut coastal towns for the recreational harvesting of oysters, hard clams, and soft clams. For the taking of bay scallops, Stonington and Waterford - East Lyme, issued 2,103 and approximately 7,700 permits, respectively. Scalloping takes place in the area near Stonington's Barn Island salt marsh, and in the Niantic River in the towns of Waterford and East Lyme. The Poquonock River in Groton was closed to scalloping in 1981, but in 1980, 905 permits were issued there.

The recreational shellfish permitting process varies greatly from town to town. The towns of Old Lyme, Old Saybrook, Westbrook, Clinton, Milford, and Fairfield have a harvestable shellfish resource in unpolluted waters but do not issue permits, although shellfishing is allowed in open areas. Permits are issued by Stonington, Groton, Waterford-East Lyme, Madison, Guilford, Branford, Westport, Norwalk, Darien, and Stamford. The towns of New London, East Haven, New Haven, West Haven, Stratford, Bridgeport, and Greenwich have no areas open to recreational shellfishing. The period for which permits are issued varies among the towns from one day to one year. Daily limits on the amounts that can be taken by one permit holder vary from 1/2 bushel to 2 bushels per day for oysters, hard clams and soft clams, and 1/2 to 3 bushels per day for scallops. All towns with open shellfishing areas, including those that do not issue permits, have bag limits in effect.

Assuming that each permit holder harvested at least one bushel of oysters, or hard clams or soft clams, or a combination of the three, in 1981 (a desireable quantity for a few hours of shellfishing), at least 5000 bushels were harvested in 1981. Undoubtedly this is an underestimate because of the unknown number of individuals shellfishing in towns where permits are not required and because the number of recreational trips made by licensed and unlicensed individuals is unknown.

Except for scallops, the permits issued are general shellfishing permits which authorize the taking of any bivalve shellfish species. Therefore, the amounts of hard clams, soft clams, and oysters taken cannot be determined even if the number of recreational trips taken was known. An estimated 9,052 bushels of scallops were taken in 1981 from Stonington and the Niantic River.

The major impediment to recreational shellfishing in Connecticut is the closure of over 75% of the State's productive shellfish beds by the Connecticut Department of Health Services due to pollution (Jacklin 1980). Most towns, however, do have clean water areas that could be

utilized to depurate contaminated shellfish transplanted from productive closed areas in those towns (Table 3). Also, as sources of contamination become eliminated through the efforts of town and state health departments, some areas that are permanently closed may eventually be opened on a conditional basis depending on rainfall conditions and frequent water quality monitoring by town health officials. Such a program has been implemented in Old Saybrook and has shown the potential for success.

Table 3. Acres of ground under town jurisdictions that are open to shellfishing.

Town	Acres open	Acres conditionally opened *	Total
Madison	6,060	0	6,060
E. Lyme	3,127	0	3,127
Westport **	756	1,612	2,368
Stonington	1,940	0	1,940
Westbrook	1,860	0	1,860
Branford	1,798	0	1,798
Milford **	1,768	0	1,768
Norwalk	0	1,334	1,334
Old Saybrook	1,274	200	1,474
Guilford	907	69	976
Stamford	745	222	967
Clinton	913	0	913
Groton	895	0	895
Waterford	614	0	614
Fairfield	589	0	589
Darien	523	44	567
Old Lyme	445	0	445
New London	0	0	0
E. Haven	0	0	0
New Haven **	0	0	0
W. Haven **	0	0	0
Stratford	0	0	0
Bridgeport	0	0	0
Greenwich	0	0	0
	24,214	3,481	27,695

Sources: 1) Connecticut State Department of Health, June, 1980 - List of restricted shellfish areas in Connecticut where closure lines have been definitely established by the Department of Health Services.
2) Aquaculture Division, Connecticut Department of Agriculture, maps of shellfish grounds in Long Island Sound under state jurisdiction.

Acreages were determined using scales on maps.

*) Conditionally opened means opened to shellfishing depending on rainfall conditions and concentrations of coliform bacteria in the water as tested by local or state health department officials.

**) Towns where shellfish resources are under the state jurisdiction of the Aquaculture Division of the Connecticut Department of Agriculture.

5.2.3 Personal Use Lobster Fishing

From 1977-1981, the number of Connecticut personal use lobster license holders has increased from 2,227 to 3,304. Persons who wish to take lobster for personal use, but not for sale, can do so by the use of not more than 10 lobster traps, by skin or scuba diving, or by hand. An analysis of the 2,320 license holders in 1976 indicated that, of the total who fished, 89% fished with traps and 11% took lobsters using scuba. Twenty-three percent of the license holders did not fish. In 1976, trap users fished an average of 19 days, and scuba divers, 4 days. Trap users hauled an average of 5-6 traps per day and collectively made approximately 159,882 trap hauls in 1976 (DEP Marine Fisheries Statistics). A socio-economic survey of the personal use lobster harvesting force indicated that the boats used were 17 feet in average length and of 53 average horsepower; an average of 8-9 traps were owned and 6 were fished at one time; the mean age of individuals was 42 years old; an average of 3 trips per week were made, and an average of 3-4 hours per week and 13-14 weeks per year were spent lobstering (Smith 1977).

The total pounds of lobster reported caught by personal use lobstermen increased from 62,422 in 1977 to between 80,000-90,000 pounds in 1977, 1978, 1979, to 98,754 pounds in 1980. The amounts reported by personal use lobstermen represent approximately 8-13% of the total pounds of lobster reported caught by Connecticut commercial and personal use lobstermen from Long Island Sound during this period (Smith, E. -- unpublished data).

Of the 62,422 pounds of lobster reported by personal use license holders in 1976, 53,879 pounds (95%) were reported caught by traps; and 2,868 pounds (5%), by scuba divers. On the average, trap fisherman caught just less than 2 legal sized lobsters per day fished, and scuba divers, just less than 4 (Smith, E. -- unpublished data).

5.2.4 Recreational Blue Crabbing

Taking blue crabs for personal use is a fairly popular recreational fishing activity in Connecticut in years when blue crabs are abundant. However, nothing definite is known about the numbers of people involved or how many crabs are harvested because the activity is unregulated except for prohibitions on taking egg bearing females, hard shell crabs less than 5 inches, and soft shell crabs less than 3-1/2 inches measured from tip to tip of the shell spikes. Popular blue crabbing areas include virtually all salt water coves and the mouths of rivers in the eastern two-thirds of the state.

5.3 The Party and Charter Boat Industry

In contrast to commercial fisheries, whose primary purpose is to catch and sell fish, the purpose of the party and charter boat industry is to provide transportation, facilities, and equipment for paying customers to catch fish. It is a commercial industry, but its members profit by selling the recreational fishing experience as opposed to selling fish.

A total of five party fishing boats, or headboats, operate in Connecticut; three in New London County and two in Fairfield County (Sampson 1981). Including the captain, a crew of about 4-6 assist the customers and maintain the vessels which range from 60-80 feet in length. The vessels operate from March through November. From March through May, and October through November, they usually make three trips per week and may fish for cod, pollock, winter flounder, fluke, mackerel, blackfish, or scup. When the bluefish season begins in June, they operate daily until about October and fish for bluefish almost exclusively. The New London County boats specialize in cod, pollock and bluefish, often traveling to Block Island Sound, while the Fairfield County boats are known as porgy (scup) boats and usually fish within LIS largely for scup, but also for winter flounder, blackfish, mackerel, and bluefish. The capacity of Connecticut's party boats ranges from about 70 to 100 passengers. During bluefish season, the vessels make two 6 hour trips daily.

Charter boats are smaller (35-50 feet in length) than party boats and accomodate from 1-6 passengers. In 1979, thirty charter boats were located in New London County, three in Middlesex County, one in New Haven County, and two in Fairfield County (Sampson 1981). These figures have increased slightly since then (Sampson, R., pers. comm.). Charter boats generally fish for the same species as party boats but in addition, because they are faster and more flexible in making special trips to meet the desires of customers, they may also travel to offshore areas to fish for larger oceanic gamefish such as tuna and sharks.

In 1981, the first year that party and charter boat catch statistics were reported, bluefish accounted for 81% of Connecticut's party and charter boat catch. Cod, flounder, bluefin tuna, blackfish, pollock, mackerel, and scup each accounted for 1-4% of the total catch (Table 4). In 1979, during the months of July, August, and September, the catch per effort of bluefish taken from party and charter boats was greater than for any other fishing mode--i.e., beach/bank, man-made structures, and private/rental boats (Sampson 1981).

Table 4. Connecticut party and charter boat catch, 1981

Species	Weight (lbs)	Percent of total Weight
Bluefish	1,074,208	81.3
Cod	58,484	4.4
Flounder	33,949	2.6
Tuna, bluefin	25,984	2.0
Blackfish	24,463	1.8
Pollock	23,568	1.8
Mackerel	19,367	1.5
Scup	16,457	1.2
Striped bass	9,413	0.7
Sharks	8,735	0.7
Fluke	7,582	0.6
Tuna, other than bluefin	7,412	0.6
Weakfish	7,388	0.6
Bonito	3,021	0.2
Marlin	715	0.1
Menhaden	80	<0.1
River herring	30	<0.1
Total	1,320,856	

6.0 The Economics of Marine Resource Use in Connecticut

6.1 Marketing

6.1.1 Finfish and Squid

All Connecticut landings of finfish and squid caught offshore, as well as the majority taken in Connecticut waters are landed at the port of Stonington. Fair weighouts and reasonable prices per pound, which are sometimes higher than those offfered at major ports in Rhode Island and Massachusetts, are offered to trawlers by the principle buyer located at the dock. These factors often attract non-resident vessels which trawl offshore.

Stonington is principally a flounder port; over 60% of the total 1981 landings there were comprised of blackback, yellowtail, and summer flounder. All fish landed in Stonington are graded by size and quality, boxed in ice, and trucked to various markets. Fishermen are paid immediately for their catch based on the quality of the fish and the prevailing price per pound offered at other Southern New England ports. The Stonington buyer then either re-sells fish through previous agreements and orders from local wholesalers and retailers, exports it, or trucks it to major markets, mainly the Fulton fish market in New York City. Approximately 50% of the flounder species landed in Stonington are trucked to the Fulton market. Smaller blackback flounder, and most yellowtail, constituting about 40% of the total flounder landings, are trucked to New Bedford, where smaller flounders are processed on filleting machines and yellowtail are marketed. The remaining 10%, mainly the larger flounders, are sold to Connecticut wholesalers and a filleting company in Stonington. Most butterfish and all whiting are sold at the Fulton and Philadelphia markets. Fulton is the principle market for other species landed in Stonington including cod, bluefish, tautog, scup, weakfish, squid, anglerfish and others.

Fulton is also the major market for the trawlers fishing in LIS. Small amounts of their catch occasionally may be sold to Connecticut wholesale and retail markets especially when certain species such as scup and bluefish are in season. Generally, however, it is much easier for a LIS trawl fisherman, after fishing for 10-12 hours a day, to ship his entire catch to New York rather than attempting to market his catch in several small quantities to small Connecticut markets, after which he might still have to pack and ship the remainder to the Fulton market. Arrangements are made with a wholesaler who, for a fee, transports the catch of one or more fishermen at a time to the Fulton market where the prevailing price is paid, with variations depending on quality. Under this arrangement the harvester does not learn the price until after the sale is completed

(New Haven City Plan Dept. 1979).

Smaller scale LIS finfishermen such as commercial anglers, supply Connecticut wholesale and retail markets with their seasonal catches which are generally small and of an unsteady supply, not exceeding a few hundred pounds per day.

Eel pot fishermen sell their catch to wholesalers who transport and sell the eels in the Fulton market, to local Connecticut markets dealing in ethnic speciality seafoods, or to bait shops where the smaller eels are sold as gamefish bait. The export market to Japan and Europe was utilized in the past at which time air freight shipments of live eels were made, however, this market has since declined (Shen 1982).

Connecticut River shad are sold by the fishermen to several small filleting houses usually associated with wholesale and/or retail markets in several Connecticut River towns such as Old Lyme, Old Saybrook, and Haddam. Here they are filleted, boned, and the roe are removed. Removing the bones from shad fillets is regarded as an art, at which few people are adept. The majority of the boners are female and the "secrets" of the process are taught to only those who are associated with the individual businesses. The wholesale value of boned shad is approximately four times greater than the ex-vessel value. The ex-vessel price paid for female shad is usually twice that for males because of the value of the roe. The boned shad fillets and roe are distributed to Connecticut retail markets and restaurants where they are regarded as a seasonal delicacy. They are also trucked to major New York and Philadephia markets.

6.1.2 Molluscan Shellfish

One major shellfish company in Connecticut shucks only about 10% of its oysters, the remaining 90% being shipped in the shell. These are predominantly of the "medium" category with some 20% in the "half-shell" category. After being washed by dipping them into a tub of fresh water, the oysters are packed either in wooden baskets or one-bushel burlap bags. The packed oysters are then shipped by truck within 12 hours of packing to several places in the northeastern U.S., especially in the states of Pennsylvania, Rhode Island, Connecticut, Massachusetts, New York, and also to eastern Canada (Korringa 1976). The company also operates an oyster shucking and packing plant in Port Norris, New Jersey where oysters from LIS as well as New Jersey are processed (New Haven City Plan Dept. 1979).

A smaller volume harvester of market oysters in Guilford provides oysters and hard clams for an associated

restaurant and retail market. Another in Clinton ships market oysters to wholesalers on Long Island and in Massachusetts.

The other of the two major shellfish companies harvesting shellfish from LIS lands all of its oysters in Greenport, Long Island where it operates a processing plant. The setting of spat (larvae) and most growth (2-3 years) of these oysters takes place in Connecticut waters, mainly in leased beds located in polluted water. Before harvesting, they are transplanted to clean water beds off the northeastern Long Island, NY shore for about 3-6 months. They are then harvested and processed -- involving sorting to size, washing, and packing in water-resistant cardboard boxes of various sizes. The company's oysters are distributed in refrigerated trucks as fresh, unshucked product to the major New York, Boston, Los Angeles, and Chicago markets. Smaller orders are also filled for specific New England and Mid-Atlantic wholesalers and restaurants.

LIS oysters have the distinction of being of very high quality which greatly enhances their market value in the raw, unshucked state. They are considered more hardy than Chesapeake Bay or other, more southern, stocks because they are raised in colder water with greater temperature fluctuations. They have good proportions, are meaty, have a distinctive salty flavor, withstand the stress associated with shipping, and last from two weeks to several months under normal refrigeration.

The Connecticut Department of Health Services oversees the harvesting, processing, and distribution of Connecticut shellfish using a system of certification of all persons or firms involved. The certificate holders are responsible for record keeping, proper storage, handling, and tagging of shellfish. Tags must be kept a minimum of 60 days.

The Connecticut General Statutes require that shellfish shipping tags have the name and address of the shipper and consignee, the state of origin and certificate number issued, the date and area of harvest, and the date of shipment or re-shipment. The tag must remain on that container until the shellfish have been fully removed for sale, or until consumption in the case of restaurant operations. Certificate holders involved with interstate transport are included on the "Interstate Certified Shellfish Shippers List" published by the Federal Food and Drug Administration. Connecticut-licensed intrastate and interstate certified market shellfish dealers are included on a list provided by the Department of Health Services. Any shipment of shellfish by individuals or firms not appearing on either of these two lists 1) are of unknown origin, 2) would not be considered an approved food source

by the State Department of Health Services, or the other certifying states and countries appearing on the federal list and, 3) should not be found in food establishments (Shute, M., pers. comm.).

Conch landed by Connecticut fishermen are sold to processors in Rhode Island who also process conch from Rhode Island and Massachusetts. Serious conch fishermen, who consistently harvest large amounts, make their own shipments to these processors. Other fishermen, who periodically harvest small amounts, will sell their catch to certain wholesale seafood dealers for less than the going rate paid by the processors. Conch may be stored in sea water tanks until the wholesaler has a large enough shipment to truck to the Rhode Island processors for resale. The minimum shell width at which conch can be efficiently processed is 2.4 inches (Wood 1979); the minimum weight is approximately one third of a pound. Smaller animals yield less meat (weight) in proportion to shell weight, and the yield per 50 pound bushel is less (Sisson 1972). Conch are steamed, sliced, and frozen at the plants. The most common preparation for retail and restaurant sale is in an Italian conch salad called "scungilli".

Virtually all sea scallops caught offshore and landed in Connecticut have been landed at Stonington in recent years. They are either sold to Connecticut wholesalers or at the Fulton Fish Market depending on the magnitude of trip landings.

6.1.3 Lobster

Essentially all of the lobster landed by Connecticut lobstermen is marketed in the state as a live product. The demand for lobster is strong. Those lobstermen who also have retail markets or operate restaurants receive the highest returns by selling direct to the consumer. Although large volumes are more easily sold through wholesalers, some lobstermen feel that wholesalers are not paying fair prices. Recently wholesalers paying $2.10 per pound to the lobstermen reportedly would get up to $4.50 per pound on resale. Some lobstermen have expressed interest in forming a cooperative to increase their market power and get a better price (New Haven City Plan Dept. 1979).

The supply of lobsters created by the Connecticut catch cannot meet local demand. As a result, live lobsters are imported primarily from Rhode Island, Massachusetts, and Maine. Such imports tend to depress the prices paid to local lobstermen during periods of low abundance or seasonally low, local supply. Conversely, they are important in maintaining stability in retail prices. On the other hand, some landings of lobster from Connecticut, other

state, or offshore waters may be exported from Connecticut if suitable prices and marketing arrangements can be made.

6.2 Processing

Two companies are known to process fishery products in Connecticut. The Blue Ocean Fillet Co. in Stonington processes whole fish into fillets for eventual entry into the retail marketing system. Abbotts Seafood, Inc is the other Connecticut processing company. It prepares seafood enhancements and concentrates in a New London County plant and markets them nationally in canned form.

A final part of the processing sector would include the fresh fish filleting that is done by individual retailers or fishermen, however, since these activities relate to the activities of catches or marketers, they are addressed elsewhere in this report.

6.3 Consumer Preferences

Lobster, oysters, scallops, and clams, due to their relatively high retail prices, are considered gourmet items by most consumers. Finfish have the potential of serving as a regular source of meat protein in the diet of consumers and, particularly in a New England state with its own seafood resource such as Connecticut, may be a relatively inexpensive source of protein. However, the attitudes of many consumers prevent fish from being as popular as other meats such as beef and poultry.

There is evidence that the consumption of seafoods has increased in the last two decades. U.S. per capita consumption increased by 2% per year from 10.6 pounds in 1967 to 12.7 pounds in 1977. A record of 13.4 pounds per capita was reached in 1978; since then, per capita consumption has remained near 13 pounds (Fisheries of the U. S. 1981). Connecticut per capita consumption figures are likely to be much higher than the national averages. The increase in the number of Connecticut retail seafood outlets in operation in the last 10 years is also evidence of the trend towards a greater per capita consumption of seafood (Costa, E., pers. comm.).

The general distribution of New England seafood to the ultimate consumer--65% to restaurants, 5% to food service operations, 30% to the home -- illustrates the need to increase the home consumption of seafood. In contrast, 51% of other types of meats are consumed in the home. It appears that the beef industry has declined in the past five years as consumers are taking up the trend to eat what they believe to be fresh, more healthful foods. This situation

is favorable for the seafood industry (Harris 1982).

Fresh seafoods, finfish in particular, have the potential to become a major source of meat protein in the diets of people who are increasingly aware of their health, and who want to avoid the cholesterol and fat associated with eating red meats. The characteristics desired in fresh finfish are firm, white, bland flesh, and as prices of traditional species such as cod have risen, non-traditional species such as whiting have been used to meet this growing demand for white-fleshed fish (New Haven City Plan Dept. 1979).

Negative consumer attitudes about eating fresh fish can be overcome by improving retail quality and display. Several Connecticut retailers have conducted public seafood education seminars in libraries and at their markets to demonstrate proper preparation, innovative recipes, the use of underutilized species for food, and the promotion of the seafood industry as a provider of a nutritional, high quality protein source (Popa, J. pers. comm.).

Organizations that are instrumental in promoting the seafood industry include the New England Fisheries Development Foundation which is dedicated to product development and marketing programs that build demand for New England seafood products in both domestic and export markets. The Mid-Atlantic Fisheries Development Foundation has conducted extensive marketing campaigns with the theme of health, nutrition, fitness, and balanced diet through eating seafood. Seminars, workshops, and media blitzes have been conducted using the logos "CATCH AMERICA" in 1981 and "Seafood USA...a better choice" in 1982 on all posters and literature, as a trademark of the government/industry initiative. The program is coordinated nationwide through four major organizational structures: the NMFS, regional fisheries development foundations, the National Fisheries Institute, and DWJ, a private marketing firm (Mid-Atlantic Fisheries Development Foundation, Inc. 1982).

6.4. International Trade

Butterfish, fluke, anglerfish, swordfish, and bluefin tuna landed in Connecticut have been exported to Japan in the recent past through contracts made by a large wholesaler and a fish brokerage, both located in New London County. Japanese buyers have also expressed interest in purchasing squid. However, no long term exporting contracts for fish landed in Connecticut have yet been developed because the supply of the desired species has been unsteady.

6.5 Industry Support

6.5.1 Support to Commercial Fishing

Stonington is Connecticut's major commercial fishing port, supporting a fleet of 19 fishing boats and 15 lobster boats. Nine of the larger vessels are trip boats, going out for several days at a time before returning to port; the others make day trips. The activity of the fishing fleet is year round (CEM 1981). Trawlers from other states such as Rhode Island, Massachusetts, and New York also periodically land their catch at the Stonington town dock which is managed under a long-term lease by the Southern New England Fishermen's Association. The size of Stonington's trawlers ranges from 35-85 feet in length (Birmingham, R. 1982). Three new steel vessels in the 70 ft. class have been added to the fleet during 1980-81.

In the past two years, over $400,000 in funding has been provided to repair and develop the Stonington town dock. An initial grant of $50,000 was provided by the Connecticut Department of Economic Development for emergency dock repairs. Other funds were obtained from the Community Block Grant Program of the U. S. Department of Housing and Urban Development and the Industrial Development Grant Program of the Farmer's Home Administration. An addition was also built to expand the existing ice house at the dock (Birmingham 1982).

The town, with the assistance of the University of Connecticut Marine Advisory Service and the New England Innovation Group, submitted a proposal for financial assistance to the National Marine Fisheries Service Fisheries Development Grant Program for $900,000 over three years for a major development project which, unfortunately, was not funded. Proposed infrastructure developments included dock extensions, expansion of ice and fuel capacity, and the establishment of a small fillet operation. It was also proposed to obtain technical assistance for developing management and training activities, improving utilization and transfer of new fisheries technology, improving capital and minority business access to Stonington fisheries, and to increase awareness and utilization of public and private fisheries development programs. It was estimated that 100 new jobs at sea and on shore would result soon after the proposed plan was implemented. Those concerned with the revitalization project have expressed enthusiasm towards continuing these efforts. Stonington has the potential to become a moderately-sized, successful port with up to 30 trawlers if small filleting and freezing operations are begun. However, to accomplish this, a steady supply of fish of particular species is required, and cooperation must occur between the harvesters and processors (Birmingham 1982).

In the Mystic River harbor, mainly at Noank, two moderately-sized lobster wholesale establishments, one with an associated restaurant, provide unloading and fuel facilities for several lobster boats. The Thames River harbor supports the commercial activities of about 6 lobster boats, one party fishing boat and several small trawlers on the Groton side. Lobster boats, trawlers, and charter vessels also operate from the New London side.

From time to time commercial trawlers also land their catch at the New London City pier. Recently the owner of a 128 ft steel trawler began docking the vessel in New London and was seeking a waterfront site in the city to unload and process the catch. The city pier is unsuitable for such an operation according to the city's Marine Commerce and Development Committee (Cray 1982).

The city of New London prepared a feasibility study in 1979 for the development of a major commercial fisheries facility. The analyses indicated that a fishing operation using five 95 ft trawlers would be feasible if located at either of two potential sites. The financial returns calculated indicated that a facility in New London would have to produce an annual throughput of at least 15 million pounds of round (whole) fish under a harvest strategy of 40% whiting, 40% squid, and 20% mixed groundfish to obtain a reasonable return on investment. It was assumed that the ownership and operation of the facility would lie with private entrepreneurs, and that the harvest strategy selected would be based upon the development of contracts for the sale of frozen whiting fillet blocks and frozen long-finned squid. Whiting would be sold to U.S. buyers who now purchase similar products from abroad, and squid would be produced for export (Development Sciences, Inc. 1979). Employment projections for the 95 ft fleet option include 40 jobs for personnel manning the vessels (crew of 8 per vessel) and a minimum of 40 jobs ashore to operate the processing/support facilities as direct employment effects. In addition to direct employment, another 80 jobs could be expected to result from the enterprise under an assumed multiplier of 2.0 (Development Sciences, Inc. 1979).

Other ports include Niantic, where several lobster boats, two party fishing boats, and about 15 charter vessels are harbored in the Niantic River. Many Connecticut River towns such as Old Lyme and Old Saybrook are home to several small-scale commercial lobstermen and eel fishermen in addition to commercial shad fishermen. Further north, shad fishermen also fish out of Haddam, Portland, Rocky Hill, and other Connecticut River towns.

Commercial fishermen are harbored in the Patchogue River in Westbrook, and in Clinton where 6 slips and 100 ft

of dock space are available for commercial fishermen. Several oyster boats along with several other fishing boats provide the total commercial activity of Guilford Harbor. In Stony Creek, Branford, the primary commercial commodity is fresh fish, including shellfish; in all of these harbors, lobster boats go out almost daily in season (CEM 1981).

Facilities in New Haven Harbor support 6-11 boats of the two major oyster companies on LIS and about 10 other boats; two use small otter trawls, several are engaged in both lobstering and trawling, and several in lobstering only (New Haven City Plan Dept. 1979).

In 1980, the city of New Haven applied to the NMFS Research and Development Grant Program for a grant to study the feasibility of establishing commercial fisheries facilities in New Haven Harbor. A preliminary document which accompanied the proposal was prepared by the City Plan Department which analyzed development potentials for such a facility. It was concluded that there is a significant demand for a modern commercial fishing berthing and landing facility in New Haven and a potential to establish a fish processing and distribution facility, supplied by both LIS and offshore fishing vessels. If a modern fisheries facility and a buyer offering attractive ex-vessel prices for fish were located in New Haven, it was expected that 5 offshore boats in the 60-90 ft class would be based there. This would provide 35-40 on-vessel jobs and, with an initial 8-10 million pounds of fish landed annually, create a demand for 25-30 jobs in fish handling and processing. Assuming a multiplier of 2.0, another 50-60 jobs would be generated in the local economy as a result of the processing operation. Several sites considered suitable for development of an active commercial fishing operation were analyzed on a preliminary basis to suggest approximate development costs. These ranged from $1.0-2.5 million.

Approximately 5-6 lobster boats operate out of the Bridgeport area. A commercial fishing facility is presently being privately financed and built in Black Rock Harbor. A dock with 6000 sq ft deck space and berths for about 10 vessels, an ice house, fueling facility, retail seafood market, and a small, "take out" seafood stand are under construction. It is expected to attract close to six trawlers, being mainly designed for those operating in LIS that are presently docked at deteriorated facilities and recreational marinas along the central and western Connecticut coast. It is also hoped that boats trawling near Block Island and further offshore will use the facility. A tourist attraction atmosphere will be developed through the sale of "fresh off the boat" seafood at the small restaurant. The retail market will feature fresh seafood caught in Long Island Sound by local fishermen at prices that will probably tend to be lower than at other

markets because there will be no transportation costs involved. A larger restaurant may also be built in the future. A Co-op atmosphere will be promoted for the fishermen. The main method of marketing the fish will be to truck it to the Fulton fish market in New York City although sales to local wholesalers and retailers will be encouraged (Williams, K. pers. comm.).

Five full-time lobstermen, two of which have combination trawl and lobster boats, 6 part-time lobstermen, and 8 boats operated by a major shellfish company are harbored in Norwalk. Most commercial fishing boats are docked in recreational marinas at which dockage fees are quite expensive. Moreover, there are no shoreside facilities available to store lobster traps and other equipment. The shellfish company has a relatively large facility at which they maintain a large supply of oyster cultch. They also rent dock space at this site to several lobstermen.

The city of Norwalk has recently developed plans to construct a multi-million dollar "Norwalk Seaport" which would include a much needed commercial fishing dock for year round use. However, it is believed that the city plans to develop the facility and turn it over to a private investor which would presumably keep the docking prices high. For such a facility to meet the needs of commercial fishermen, it is felt that the city would have to own and operate it to keep prices low.

Other harbors in Darien, Stamford and Greenwich also provide limited opportunities for commercial fishermen to dock and unload their catches. Competition for dock space in predominantly recreational boating marinas often increases costs of operation beyond what might be experienced if commercial space were available and some fishermen avoid these costs by mooring their boats and using a skiff to travel to and from the boat.

It is important to realize that many small harbors have one or a few vessels which fish daily on a seasonal basis for lobsters and finfish. A listing of these ports would include every navigable harbor in the sate and is therefore not presented.

6.5.2 Support to Recreational Fishing

The Connecticut Marine Recreational Fisheries Survey (Sampson 1981) identified a total of 528 angler fishing sites of four modes along the Connecticut coast. The four mode classifications, number of sites and percentage of sites of each mode are:

1) Beach and bank fishing from natural structures such as beaches or rock outcroppings (145, 27.5%)
2) Man-made structures such as docks, bridges, and jetties (113, 21.4%)
3) Private and rental boat areas (the small boat fishery) (229, 43.4%)
4) Party or charter boats (41, 7.7%).

Sites in the private and rental boat mode include private marinas. The number of slips and moorings available in these marinas are presented in CEM (1981), although no distinction is made among the accomodations for sailboats, power yachts, and smaller power boats such as are used for sportfishing. There are 25 major boat launch sites along the coast, all of which are state-owned.

New London and Fairfield counties have the highest total number of angling sites, with 196 and 156 respectively, however they averaged only 0.57 sites per coastal mile. In contrast, Middlesex and New Haven counties have equal or fewer coastal miles but higher site densities (0.61 and 0.72 per mile). The distribution of sites by coastal town appears to reflect a combination of topography and coastal residential development. Towns with natural harbors have high concentrations of fishing sites, whereas those with heavily settled coastal areas have fewer sites. For example, towns such as Greenwich, Darien, Westport, Guilford, and East Lyme are all heavily developed with single family dwellings and contain few sites per mile. In contrast, commercially developed harbor areas such as Norwalk, Bridgeport, Stratford, New Haven, and New London have many more sites per coastal mile (Sampson 1981).

While many sites in these areas are in private ownership, some are industrial areas in which relatively open fishing may occur without objection from the land owners. Harbors heavily developed for boating rather than industry such as Milford, Westbrook, and Clinton have the same relative number of fishing sites per mile as other commercially developed areas (Sampson 1981).

A survey of the telephone books of coastal Connecticut towns indicated that there are at least 60 shops that sell bait and tackle to Connecticut marine recreational fishermen. Marine fishing tackle alone may be purchased at these 60 shops in addition to a large number of department

and sporting goods stores throughout Connecticut. These stores also sell clam rakes, tongs and other equipment to support recreational shellfishing.

Several towns have developed programs to enhance recrational shellfishing activity. These programs are based upon the transplanting of contaminated shellfish from polluted beds to depuration areas in certified clean water where recreational harvesting is allowed after the required depuration period - two weeks in water of 52 F. In the towns of Madison and Old Saybrook, the programs were the result of comprehensive Shellfish Management Plans prepared at no charge to the towns by Timothy Visel, a graduate student at the University of Rhode Island. The main objectives of the plans are to:

1) re-establish recreational shellfishing,

2) improve the yield and quality of shellfish on existing beds,

3) increase employment opportunities for commercial shellfishermen,

4) generate revenue from commercial harvesting to spend on improving the yield and quality of shellfish on existing beds.

The plans call for making the best use of shellfish populations, particularily oysters, that are overcrowded, slow-growing, and dying in potentially productive habitats. These resources cannot be legally harvested for market or consumption because they are located in polluted waters. Under the shellfish management plans implemented in Madison and Old Saybrook, commercial natural growth seed oyster harvesters were allowed to harvest these oysters to sell to large shellfish companies for use as seed oysters. At the same time, they transplanted specified amounts of oysters to town waters that are open to recreational shellfishing. In 1978, 600-800 bushels were transplanted in Madison. In 1981, 1,500 bushels were transplanted in Madison, and 200 bushels, in Old Saybrook.

Madison had a successful recreational season in 1979 when the transplanted oysters were harvested (Maco, J. pers. comm.). Old Saybrook was unfortunate in 1981 because their recreational transplanting grounds are conditionally opened and steady rainfall during the fall recreational season caused the grounds to remain closed. The oysters could not be found the following spring probably because currents washed them out of the area or buried them, causing high mortality (Milkofsky, J., pers. comm.). A similar oyster

and hard clam transplanting program is being conducted by the Branford Shellfish Commission in cooperation with a commercial harvester who will transplant 30% to recreational grounds and 70% to his privately-leased beds (Infantino, M., pers. comm.).

The Waterford-East Lyme Shellfish Commission recently purchased and planted 23,000 seed hard clams in a clean area of the Niantic River and covered them with plastic mesh to protect them from predators. After sufficient growth, they will eventually be available for recreational harvest. Scallop seeding has been undertaken in Stonington, the Poquonnock River in Groton, and the Niantic River with the assistance of the UCONN Marine Advisory Service.

6.5.3 Dredging Needs

The U.S. Army Corps of Engineers has projected the federal maintenance dredging requirements of Connecticut's major harbors over the 50 year period from 1985 - 2035 (U.S. ACE 1982). The number of times each harbor requires dredging and the amounts of material to be dredged during this period are presented based on a "most probable future scenario" (Table 5). Stonington harbor, supporting Connecticut's major commercial fishing fleet, requires no dredging of its main channel due to its natural depths. However, in the area of the town dock, especially on the north side, vessels with drafts greater than ten feet have limited access because of a silting problem, and can only dock at the end of the pier. There are also problems in turning on the south side of the pier because of shallow areas (CEM 1981). New Haven and Norwalk harbors, where commercial fish landing facilities have been proposed, will require substantial future dredging. New London harbor will require a moderate amount of dredging, however, while this activity would mainly support naval submarine navigation, the benefits would be accrued by all deep draft users of the port. A proposed commercial fishing fleet based in New London would have little problem with existing channel depths.

The Center for the Environment and Man, Inc. (CEM), in its Market User Survey for Selected Long Island Sound Ports (1981) has described in detail all Connecticut harbors including the smaller ones, their industrial/commercial and recreational uses, and projections of future harbor activities. Information is provided about needed dredging projects that would not be eligible for federal maintenance dredging such as harbors which support only recreational boating traffic. Considerable discussion has been stimulated lately by the need to dredge these small harbors so that even the very shallow draft recreational vessels will have access to Long Island Sound.

One proposal for disposal of dredge spoils is to create containment structures that would be designed to receive spoils over an extended period of time from several small projects in a given area (U.S. ACE 1979, 1980). They would be constructed as either shoreward extensions of existing land features, or as containment islands. In either case, they would be impermeable structures in which spoils would be deposited and then capped with relatively clean sediment for later uses, such as recreation areas. Such proposals are thought provoking and bear review. However potential impacts related to endeavors of such magnitude must be addressed in an equally careful manner.

Table 5. Projected federal maintenance dredging most probable future scenario - 1985-2035

Coastal Area	Project	Number of Projects	Average Volume Per Project (Cubic yards of	Average Annual Volume dredged	50-year Cumulative Quantity material)
Western Coastal Area	Greenwich Hrbr	2	50,000	2,000	100,000
	Mianus River	2	35,000	1,400	70,000
	Stamford Hrbr	2	100,000	5,000	200,000
	Westcott Cove	3	20,000	1,200	60,000
	Fivemile River	2	70,000	4,200	140,000
	Norwalk Hrbr	9	150,000	21,000	1,350,000
	Westport Hrbr & Saugatuck River	2	35,000	2,100	70,000
	Southport Hrbr	3	50,000	3,000	150,000
	Bridgeport Hrbr	9	275,000	55,000	2,475,000
	Housatonic River	5	200,000	20,000	1,000,000
				112,900	5,615,000
Central Coastal Area	Milford Hrbr	6	40,000	4,800	240,000
	New Haven Hrbr	22	225,000	99,000	4,950,000
	Branford Hrbr	5	100,000	10,000	500,000
	Stony Creek Hrbr	2	35,000	2,100	70,000
	Guilford Hrbr	3	80,000	6,400	240,000
	Clinton Hrbr	6	30,000	4,200	180,000
	Duck Island Hrbr	2	100,000	4,000	200,000
	Patchogue River	7	50,000	7,000	350,000
	Connecticut River (below Hartford)	28	200,000	100,000	5,600,000
	Total			241,500	12,330,000
Eastern Coastal Area	Niantic Bay & Harbor	2	40,000	2,400	80,000
	Thames River	6	200,000	16,000	1,200,000
	New London Hrbr	2	100,000	10,000	200,000
	Mystic River	2	25,000	1,000	50,000
	Stonington Hrbr	0	--	--	--
	Pawcatuck River	4	25,000	2,000	100,000
				31,400	1,630,000

Source: U.S. ACE (1982)

6.6 Economic Comparison Among Connecticut's Commercial and Recreational Fishing Industries

In section 5.1, "The Commercial Fisheries", Connecticut's commercial fishing industries have been ranked in order of their economic value, and the percentage of the total annual revenue generated from the harvest of living marine resources that each fishery earned from 1977-1981 is presented.

In terms of economic value to the harvestors, the total value of the finfish catch of Connecticut licensed commercial fishermen in 1979 ($893,000) is considerably less than the total value of finfish caught by recreational fishermen that year. When commercial ex-vessel prices per pound for each species are applied to the 1979 recreational finfish catch, a value of 3.3 million dollars is obtained. However, the actual value of the recreational catch may be at least double this value, considering that the retail price of a fish is a more realistic indicator of its value to the recreational fisherman, who would otherwise have to purchase it from a retail outlet if he wanted it for consumption. Similarly, the value of commercial finfish landings to the economy of Connecticut due to the multiplier (or "ripple") effect of 2.0 for marine fishery products approaches 1.8 million dollars.

In 1979, 88,000 pounds of lobster were harvested by personal use lobster license holders. If a conservative retail value of $3.50 per pound is applied, this lobster was worth approximately $308,000 to its harvesters. This amount represents 13% of the value of lobster harvested by Connecticut licensed commercial lobstermen in 1979 (939,810 pounds, ex-vessel value $2,406,000 at $2.56 per pound). Considering the "ripple" effect, the value of these commercial lobster landings to Connecticut approaches 5.0 million dollars.

Because precise information on the recreational harvest of oysters and hard clams is lacking, a quantitative comparison of commercial and recreational shellfishing cannot be made. Qualitatively, however, it may be said that the economic value of the commercial harvest of Connecticut's private shellfish companies far exceeds the value of shellfish that is harvested recreationally.

7.0 Groups with Special Interest in Marine Resources

Many groups, through many affiliations, associate themselves with the catch, marketing, consumption, research into, education about, and conservation of Connecticut's marine resources. Before listing the identifiable groups, however, it is important to note that the largest, although most silent group, is the general population of Connecticut. While not indicating a particular affiliation, uncounted numbers of Connecticut citizens are interested in marine resources as food, as a source of recreation, and for their intrinsic aesthetic value.

Appendix II provides an annotated list of the principle organizations and interest groups involved with marine resources in Connecticut. These organizations do not include resource management agencies; those agencies are identified in Section 2.0. However, government-supported programs and services which influence the use of marine resources are included in this section. Examples of such groups are the Sea Grant-Marine Advisory Service and the various university research programs. The list generally is composed of commercial and recreational fishing organizations, conservationists, development foundations, trade associations, educational services, and universities conducting marine research investigations. The reader should refer to the "Directory of Environmental Organizations" prepared by the Connecticut Department of Environmental Protection in 1979 for a statewide listing of environmental organizations without particular reference to the marine environment.

Interested groups may be categorized broadly as those which contribute to management programs and those which benefit from such programs. Examples of the former group are the many fishermen organizations active in Connecticut while the latter group includes marine retailing and trade associations, marine oriented businesses, and consumers. Some organizations obviously belong in both groups (fishing organizations) since they contribute to the management process and also derive benefits from that process.

Groups not necessarily concerned with the use of marine resources but which nonetheless recognize the advantage of having those resources available include commerce and planning committees looking for ways of diversifying community developments. Examples are the efforts of waterfront commissions in several communities which, within the past few years, have explored the potential for development of fish piers along presently unused water frontage. Such activities generally are not related to government activities but rather, relate to the ad hoc designation of committees, by government, for the purpose of exploring development potential in the coastal area.

8.0 Problems, Issues, and Opportunities

8.1 Introduction

The relationship of Connecticut's citizens to Long Island Sound is diverse and complex. Conflicts arise between commercial and recreational fishermen, between different types of commercial or recreational fishermen, between fishermen and other boating trafic, and between competing users of the environment such as those who take fish or shellfish for fun and profit, and those who use Long Island Sound as a repository for dredge spoils, municipal sewage and industrial waste. Resolution of such conflicts without prohibiting any one type of user from traditional or legitimate, new use of the Sound is the challenge facing marine resource managers.

The following sections document principle areas of concern to fisheries managers in planning for future uses of Long Island Sound. The list is by no means complete nor are the individual sections representative of final philosophies on dynamic issues. Part Two of the Marine Resources Management Plan will provide a comprehensive set of issues which pose problems to managers of living marine resources. The following subsections are intended solely to address problems, issues, and opportunities that have been provoked during preparation of Part One.

8.2 Man's Influence on the Long Island Sound Ecosystem

Major sources of pollution affecting Long Island Sound include: inadequately treated municipal and industrial wastes, overflows from combined sanitary-storm sewers, non-point sources, wastes from pleasure craft and other boats, oil and other hazardous materials spilled from ships and also from bulk storage areas, heated water inputs from power plants, dredging and dredge spoil disposal, and both sediment and other substances flowing into the Sound from rivers. The relative significance of man-made sources of water pollution is complicated by the fact that contaminants often enter the water in complex mixtures of many substances whose specific chemical identifies are largely unknown, and by the fact that LIS has a complex water circulation pattern (NERBC 1975).

The worst contributors of pollution in LIS are municipal and industrial sources. Municipal sources are dominated, in terms of volume and costs of treatment, by the New York City discharges to the East River which flow back and forth past Throg's Neck into western LIS (NERBC 1975). An engineering solution to this problem was proposed by Bowman (1976) to construct tidal locks across the upper East River which would result in a undirectional flow of LIS out into the New York Bight. By eliminating the input of polluted East River water into LIS, the essential estuarine characteristics of western LIS would also be changed to those of a coastal embayment; salinity would increase by about 4%.. The study noted that the implementation of such a project would have many political, socio-economic, ecological, sedimentary, navigational, engineering and hydrographic ramifications, further discussions of which were beyond the scope of the paper.

Some scientists have voiced concern over the acceleration of eutrophication caused by man's introduction of nutrients into LIS. The short term effects of excessive enrichment are generally rapid growth or blooms of algae resulting in large daily fluctuations in oxygen concentrations, lowered dissolved oxygen due to algal die-off and biodegradation, and possible benthic animal and fish kills because of oxygen stress. An attendant problem is a general lowering of the aesthetic and recreational values of the water. Long term effects include an increased rate of aging of the body of water, characterized by increased plant production, shifts in species composition, and a net increase of plant and animal biomass due to increased flow of food through the food chain (NERBC 1975).

Artificial nutrient enrichment may be a favorable factor in maintaining the LIS ecosystem at a high level of productivity. Much of the natural nutrient input that was once provided by Connecticut's extensive tidal marshes (many

of which were subsequently eliminated during this century by shoreline development) is now derived from the organic discharge of municipal sewage systems. Unfortunately, this type of "compensatory" nutrient enrichment is not purely organic, since heavy metals and other toxic substances often accompany this input (Stewart, L. pers. comm.).

Connecticut's tidal marshlands and shellfish beds are the two most ecologically and economically important habitats to suffer because of man's influence. By 1965, shoreline development activity in Connecticut had destroyed or altered the ecology of more than 50% of the tidal marshland existing in 1914 (Niering and Bowers 1966). Causes of tidal marshland loss and the percentage of loss attributable to each cause are: miscellaneous fill (48%); waste disposal (14%), bridges, roads, and parking (9%); industry (7%); airports (7%); marinas, docks, and channels (6%); housing (5%); recreational developments (3%); and schools (1%). As one moves from east to west, the number of impacts intensifies and the ecological integrity of the marshes tends to decline in environmental quality. This can be correlated with increased development in western Connecticut (U.S. Fish and Wildl. Serv. 1965).

Seventy-five percent of Connecticut's 60,000 acres of shellfish grounds are closed to the harvest of shellfish for consumption (Figure 51) due to poor water quality (Jacklin 1980). The decision to close areas is made on the basis of the concentration of coliform bacteria, which are not normally considered to be pathogens in themselves, but which may indicate the presence of human pathogens transported to the Sound in sewage. Areas are closed to shellfishing by the Connecticut Department of Health Services if they:

1) are located near sewage treatment plants,
2) are exposed to direct sewage discharges, chemical or radiation contaminants,
3) have levels of coliform indicator organisms greater than 70 total coliform per 100ml or more than 10% of the samples taken have levels above 230 total coliform per 100ml.

It might be noted that most of the closures in both the western and eastern ends of LIS are in the shallower bays and harbors that are most accessible to the recreational shellfisherman. In the western half particularly, this is also the area of greatest population and greatest shellfishing demand. It must be understood, however, that population density is the factor that has contributed significantly to the detrimental environmental impact on the Sound's waters and it is unlikely that this negative impact

can be entirely eliminated (NERBC 1975).

Periodic historic use of Long Island Sound as a "dump" for large unwanted articles has posed recurring problems to commercial fishermen attempting to derive their livlihood from the Sound. The condition of otherwise good trawling areas, especially in western LIS, has been adversely impacted by the dumping of scrap refuse. Furnaces, boilers, cement reinforcing rods, and cement have been hauled up by trawlers trying to recover snagged nets. Sunken wrecks of barges, boats, and automobiles in certain areas make bottom trawling virtually impossible (Staplefeldt, C. pers. comm.).

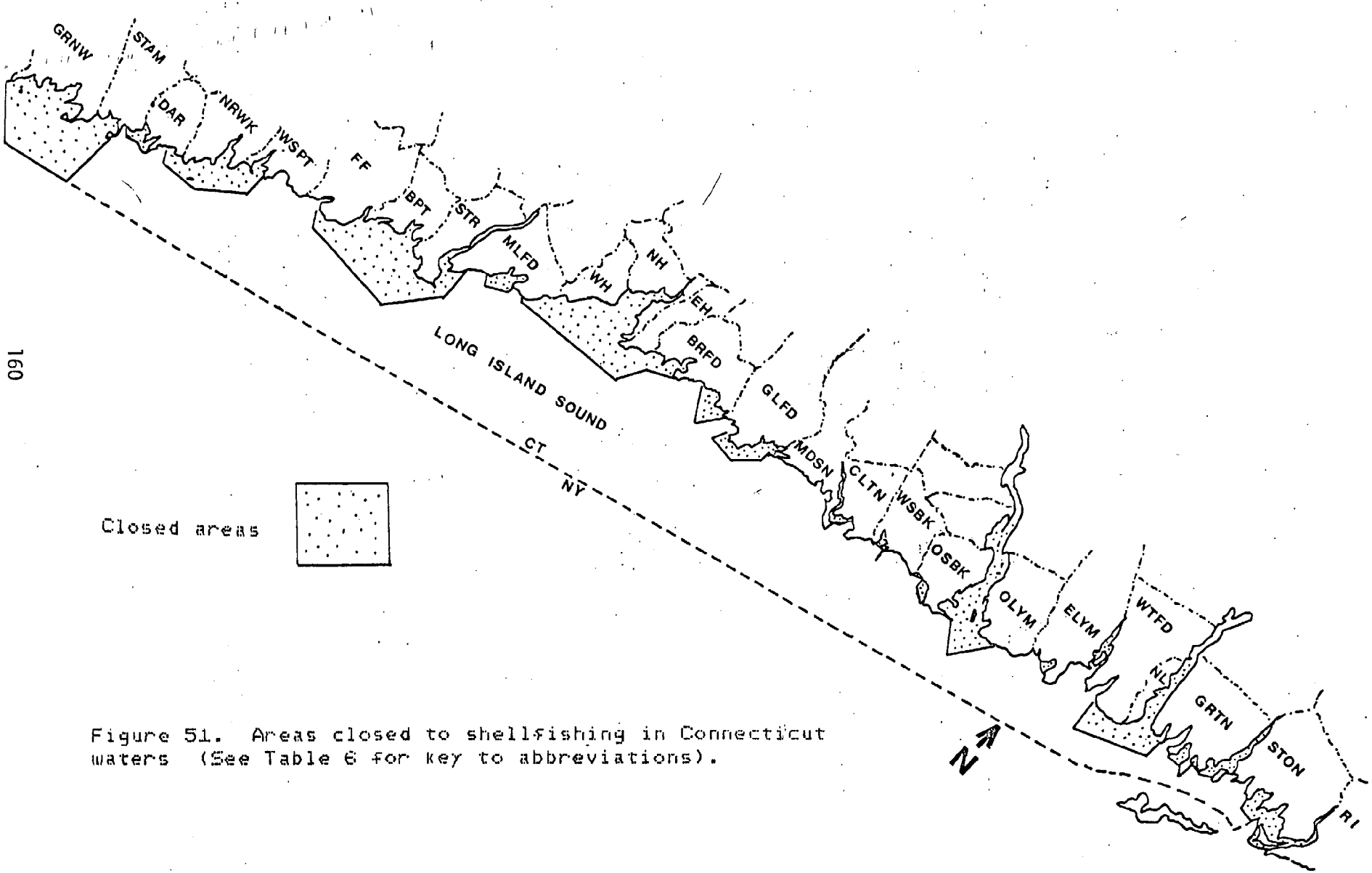


Figure 51. Areas closed to shellfishing in Connecticut waters (See Table 6 for key to abbreviations).

Table 6. Key to abbreviations used in Figure 51.

GRNW	Greenwich
STAM	Stamford
DAR	Darien
NRWK	Norwalk
WSPT	Westport
FF	Fairfield
BPT	Bridgeport
STR	Stratford
MLFD	Milford
WH	West Haven
NH	New Haven
EH	East Haven
BRFD	Branford
GLFD	Guilford
MDSN	Madison
CLTN	Clinton
WSBK	Westbrook
OSBK	Old Saybrook
OLYM	Old Lyme
ELYM	East Lyme
WTFD	Waterford
NL	New London
GRTN	Groton
STON	Stonington
CT	Connecticut
RI	Rhode Island
NY	New York

8.3 Scientific Information

Although basic life history information is available for essentially all species of importance found in Long Island Sound, this information usually is not specific to the species as they occur in the Sound. Variability in such parameters as temperature and food supply may affect a species' life history thus making Sound-specific studies of important species essential.

For migratory species, it is important to design future studies to determine what proportion of the species' population actually enters the Sound and what levels of harvest of that population are compatible with optimum sustainable yields as determined by interjurisdictional management plans. Important migratory species that are harvested when seasonally present in LIS are bluefish, butterfish, fluke, mackerel, menhaden, scup, weakfish, striped bass, and squid. Spawning populations of the anadromous American shad and river herring are also important migratory fishery resources in Connecticut.

For resident species, in addition to standard stock assessments that evaluate population size, growth rates, and mortality rates, early life history studies are needed that will determine the recruitment process and factors that affect recruitment to the population so that, through annual monitoring programs, predictions can be made as to the relative success and eventual abundance of each year class of a species. Ideally, such information might help reduce the chances of stock declines caused by recruitment overfishing. Important resident resource species are blackfish, winter flounder, eels, white perch, lobster, blue crabs, oysters, hard clams, soft clams, bay scallops, and conch.

There is clear need for comprehensive and detailed surveys of molluscan shellfish habitats and populations. Some of the most productive natural oyster and clam beds in Connecticut are unusable because they are located in polluted waters. The extent of these beds and their potential productively should be determined. Through utilization of existing methods and technology for transplantation, depuration, and aquaculture, many of these resources could provide productive shellfishing opportunities for Connecticut's citizens.

The type of assessments which estimate stock size and predict future stock potential are, without question, some of the most necessary of all management related research activities. However, they are difficult to justify because, while they attempt to provide information on what will happen in the future, the funding to support them may have to be generated in a year during which the condition of the

stock may be quite good. Often the only funding available for such endeavors is of short duration and is, in fact, made available only because of a real or perceived resource emergency. Such funding strategies effectively eliminate the ability of the manager to monitor the condition of resources in a consistent manner, over time. While "after the fact" funding allows one to perform a post-mortem on a fishery that has collapsed, the long term information needed for effective management may always be lacking.

8.4 Fishery Statistics

A serious problem in managing resources has always been the lack of sound fishery statistics with which to document the utilization and condition of Connecticut's living marine resources. With the implementation of the DEP Marine Fisheries Information System in 1975, considerable progress was made in resolving this problem. However, improvements to the existing system are necessary and important species presently omitted should be incorporated within the statistics program.

The Information System documents trip catches, the fishing effort used to take those catches, and area, method, and port of landing information. The relationship of catch to fishing effort may be used as one indicator of relative stock abundance or the "condition" of the resource. Currently, information of value is obtained only for the lobster pot, bottom trawl and shad gillnet fisheries. Other fisheries of importance for which annual catch statistics are available but less than acceptable are those conducted by hook, gillnet, and eelpot. Fisheries for which virtually no timely harvest and effort statistics are available are the oyster, hard clam, and conch fisheries.

In 1981, through a contract with NMFS, the DEP Marine Fisheries Office collected commercial landings statistics on all finfish and shellfish species landed in Connecticut. In addition to landings of each species by gear type and county, information on operating units -- the number of fishermen employed in each fishery and the number of boats and fishing gear used -- was supplied to the Resource Statistics Division of NMFS. A number of important problem areas needing resolution were encountered in 1981.

A review of the current statistics program, the relationship of the Connecticut program to those of adjoining states and the National Marine Fisheries Service, and the opportunities and disadvantages posed by such programs is a necessary requirement of future marine fisheries planning activities.

8.5 Commercial Fishing

Although some potential may exist for expanding the level of commercial fishing in LIS, further development of the offshore fishing fleet and landing facilities to support that fleet is the most realistic opportunity for expansion of Connecticut's commercial fishing industry. Efforts to expand facilities and revitalize the industry, as described in Section 6.5.1, "Industry Support to Commercial Fishing", should be continued.

The harvest strategy proposed in the New London fisheries facility feasibility study (Development Sciences 1979) appears to have potential for an offshore fleet based in Connecticut, although not necessarily in New London. By concentrating on the harvest of whiting and squid, two underutilized species, a Connecticut offshore fleet and a port designed to support such a fleet would not be competing with traditional, well-established groundfish fleets as those at New Bedford and Ft. Judith. Development of in-port processing facilities, and contracts for domestic and export marketing of the landings is the most important factor in the success of such a fleet.

Other considerations include a continuation of attempts to provide an appropriate tax and business climate to the commercial fishing industry similar to that provided in other states and to the agricultural industry in Connecticut. Also, some provision for exempting commercial vessels from competition with recreational boaters and other harbor users for dock space is necessary and justifiable if Connecticut is to retain a food-producing industry in coastal communities. Such diversification in community development is considered highly desirable.

8.6 Recreational Fishing

Other than the five coastal state parks, occasional town parks and docks, and some privately owned commercial sites, there are few recreational fishing sites on the Connecticut coast for anglers who do not own private boats. The most popular boat launches cannot handle peak demands for launching and mooring. With national angling activity increasing on the order of 300,000 anglers per year (Deuel 1973), the problem of fishing access is one that will surely increase in future years (Sampson 1981).

Sampson (1981) recommended that marine recreational angling sites should be procured and developed by the State, particularly in the shore-based modes. However, before embarking on development activities, sites should be evaluated for their potential as productive fishing areas. Several means of improving saltwater angling opportunities are summarized below.

a) Launch improvement

   i. increase parking
   ii. install loading docks in state launch areas to improve the ease and speed of transferring boats to and from the water.
   iii. improve approach channels.

b) Redevelopment of existing, high quality fishing structures

c) Construction of fishing piers and barges

   i. large "pay to fish" piers are a costly but viable method of improving angler fishing opportunities. Preliminary informal surveys indicate such a project would be well received by the fishing public. Other methods, such as construction of offshore anchored fishing barges have proven successful in other states.
   ii. fishing walkways on coastal bridges will improve angler opportunities, however the legal and procedural difficulties in accomplishing this task may be prohibitive. Such development would be an inexpensive way of creating additional fishing sites. For example, a 50 foot walkway leading to and circling the first abutment on the I-95 bridge in Groton, CT would provide a safe and productive fishing site for 40 to 50 anglers.

iii. development of small, inshore fishing sites in bays and estuaries would provide areas that would be utilized by anglers throughout the year. The almost constant availability of either winter flounder, tomcod, or snapper bluefish would provide the stimulus for heavy use of these sites.

Potential exists for re-establishing recreational shellfishing in Connecticut on a much larger scale than exists at the present time. Towns can provide the support necessary, at minimal cost, by combining commercial and recreational harvesting programs. Shellfish commissions must become more active, shellfish surveys need to be conducted, and management plans are needed for towns that are not presently taking advantage of their shellfish resources.

Consistent with this philosophy, recent amendments to section 19-59 of the Connecticut General Statutes require that towns prepare shellfish management plans subject to state review by the Department of Agriculture, Division of Aquaculture. It must be realized that shellfish beds in polluted waters can be utilized if transplanting programs are developed. Revenues earned from the sale of commercial and recreational harvesting permits should be used to purchase and spread oyster cultch to enhance the success of larval settlement and recruitment to the population. However, cultch is quite expensive, and large quantities are needed. To gain revenue necessary for adequate cultch purchase, it has been recommended that the price of a town-issued commercial seed oyster harvesting permit be increased from the present $50.00 charged by Old Saybrook and Madison to $100 and the fee per bushel harvested should be increased from $0.25 to $0.50 per bushel. If towns cannot raise sufficient funds to purchase the necessary amounts of cultch, it is felt that State assistance should be solicitied for this purpose (Visel, T. pers. comm.).

8.7 Marketing

With over 60% of the seafood consumed in this country being imported, the U. S. seafood industry must obtain a larger share of the existing market, as well as develop new markets, if it is to flourish. This means that the industry must collectively increase exports and decrease dependence on imports to help reduce the balance of trade deficit. Marketing, both domestic and export, is the single most important factor within the seafood industry that must be addressed if the industry is to develop to its fullest potential (Mid-Atlantic Fisheries Development Foundation, 1982).

A significant problem with marketing seafood in Connecticut is that the majority of local landings are transported to out-of-state markets due to considerations of price and stability in demand. It was found that the majority of Connecticut wholesale and retail fish markets, especially those in western Connecticut, purchase most or all of their stock from out-of-state major markets such as Fulton. The problem created by this marketing system is that seafood sold to Connecticut consumers is priced higher than it could be if seafood landed in Connecticut were sold in this state. Simply removing the cost of transportation could significantly reduce cost to consumers. Reasons for shipping to large out-of-state dealers are that the local supply is unsteady and the variety of species that the market wants to sell are not available from Connecticut harvesters. It is easier to buy from a major market such as Fulton from which any quantity of almost any desired species is available.

This problem may also create an opportunity for Connecticut harvesters, processors, and marketers to undertake a cooperative venture to create an in-state marketing system whereby profits will be greater to them, and prices of fresh seafood will be lower for the consumer.

8.8 Law Enforcement Needs

One of the most common complaints of fishermen relates to their perceived lack of law enforcement coverage on Long Island Sound. Conservation law enforcement is difficult due to the large area of coverage, the high visibility of officers on the water, enormous numbers of users, and frequent bad weather which precludes small boat operations.

A staff of seven conservation officers and one supervisor is responsible for the enforcement of conservation laws and regulations in the area south of Interstate 95 in Connecticut. In this zone, one finds the most densely populated areas of the state which increases the level of impacts between resources and their users. Imaginative and innovative planning will be required in future years in order to provide effective coverage of the Sound and protection of the States marine resources for all of its citizens.

8.9 Management

Of all the issues raised so far, none is more complex than management itself since it encompasses all elements of resource related activities. Research, law enforcement, education, public relations, health, and the maintenance of opportunities in an equitable fashion for each user all must be assimilated into the activities of managers to yield effective management of the marine resources of the state.

To address all management issues at this point would lessen the importance of the previous sections which are intended to be descriptive. Rather, Part Two of the Marine Resources Management Plan will include a full treatment of the problems, issues and opportunities facing managers as an introduction to the intended purpose of Part Two which is to provide a comprehensive statement of the policies and priorities of Connecticut marine resource managers as they plan for future use of the state's living marine resources.

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Appendix I: Government agencies responsible for the management of marine fisheries resources

Connecticut Department of Agriculture
Division of Aquaculture
23 Rogers Ave. P.O. Box 97 John Volk, Director
Milford, CT 06430
203-874-0696

Connecticut Department of Environmental Protection
Division of Conservation and Preservation
Bureau of Fisheries Robert A. Jones, Director
State Office Building
165 Capitol Ave
Hartford, CT 06106
203-566-2287

Connecticut Department of Environmental Protection
Division of Conservation and Preservation
Bureau of Fisheries
Marine Fisheries Office Eric M. Smith, Assistant Director
P.O. Box 248
Waterford, CT 06385
203-443-0166

Connecticut Department of Environmental Protection
Planning and Coastal Management Arthur J. Rocque, Director
71 Capitol Ave
Hartford, CT 06106
203-566-7404

Mid-Atlantic Fishery Management Council
Room 2115 Federal Building John C. Bryson,
300 South New Street Executive Director
Dover, DE 19901-6790
302-674-2331

New England Fishery Management Council
Suntaug Office Park Douglas G. Marshall,
5 Broadway (Route 1) Executive Director
Saugus, MA 01906

New Hampshire Fish and Game Department
Division of Fisheries
34 Bridge St.
Concord, NH 03301
603-271-3421

New York Department of Environmental Conservation
Division of Marine Resources
Bldg. 40
Stony Brook, NY 11794
516-751-7900

Rhode Island Department of Environmental Management
Division of Fisheries and Wildlife
Washington County Government Center
Tower Hill Road
Wakefield, RI 02879
401-789-3094

U.S. Department of the Army
New England Division, Corps of Engineers
424 Trapelo Rd
Waltham, MA 02254
617-894-2400

U.S. Department of Commerce
National Oceanic and Atmospheric Administration
National Marine Fisheries Service
Northeast Regional Office Allen E. Peterson, Jr., Director
14 Elm St.
Gloucester, MA 01930
617-281-3600

U.S. Department of Commerce
National Oceanic and Atmospheric Administration
National Marine Fisheries Service
Northeast Fisheries Center
Water Street
Woods Hole, MA 02543
617-548-5123

U.S. Department of the Interior
Fish and Wildlife Service
Ecological Services
Northeast Regional Office

University of Connecticut
Department of Marine Sciences Dr. S.Y. Feng, Chairman
Avery Point Campus
Groton, CT 06340
203-446-1020 Ext. 211

University of Connecticut
Sea Grant Institute Dr. Victor Scottron, Director
Avery Point Campus
Groton, CT 06340
203-446-1020 Ext. 258

University of Connecticut
Sea Grant Institute
Marine Advisory Service
Avery Point Campus
Groton, CT 06340
203-445-8664

Dr. Lance L. Stewart,
Program Leader

Department of Fish and Game
Vermont Agency of Environmental Conservation
Fish and Game Department
State Office Bldg.
5 Court St.
Montpelier, VT 05602
802-828-3371

Appendix II: Groups with Special Interest in Marine Resources

Commercial

Southern New England Fishermen's Association
Front St.
Stonington, CT 06378

Connecticut Commercial Fishermen's Association
P.O. Box 84
Fairfield, CT 06430

Interstate Party Boat Owners and Operators Association
3rd District Professional Boatsmen's Association
P.O. Box 90
Niantic, CT 06357

Recreational

Branford Bluefish, Inc.
William Brown
51 Stevens St.
East Haven, CT 06512

Central Conn. Striper Club, Inc.
Raymond R. Campion
697 Allen Ave.
Meriden, CT 06450

Connecticut Citizen's Advisory Committee
on Striped Bass Management
Pat Carrol
91 Henderson Rd.
Fairfield, CT 06403

Conn. Saltwater Flyrodder's Assn.
Mr. Tabory
77 Clapboard Hill Rd.
Green Farms, CT 06436

Connecticut Sportsman's Alliance
P.O. Box 315
Niantic, CT 06357

Fairfield County League of Sportsmen's Clubs
Don Grosner
79 Everett St.
Stratford, CT 06497

Groton Sportsmen's Club, Inc.
RR 2, Box 76
Al Harvey Rd.
Stonington, CT 06378

Guilford Sportsmen's Assn.
Robert C. Janesky
481 Durham Rd.
Guilford, CT 06437

Hammonassett Fishing Assn.
Wilbur G. Downs
10 Halstead Lane
Branford, CT 06450

Hartford Surf Fishing Club
Agnes E. Smith
36 Hanlock Rd.
Granby, CT 00035

Milford Striped Bass Club Inc.
Main P.O. Box 103
Milford, CT 06460

New London County League of Sportsmen's Clubs
George W. Bloom
Kate Downing Rd.
Plainfield, CT 06374

Norwich Striper Club
Thomas Gionet
556 Boswell Ave.
Norwich, CT. 06360

Salt Water Sports Assn.
Dr. John Gray
72 Park Ave.
Bridgeport, CT

Stonington Angler's Assn.
Edwin Browning
25 Water St.
Stonington, CT 06378

Waterbury Deep Sea Fishing
Donald McKennernery
73 Overlook Ave.
Waterbury, CT

Westbrook Fishing Club
Harold Dahl
20 East Town St.
Norwich, CT 06360

Westport Fish and Game Club, Inc.
Leroy McElwee
15 Powers Court
Westport, CT 06880

Westport Striped Bass Club
Westport, CT

Universities

Connecticut College
Mohegan Avenue
New London, CT 06320

Southern Connecticut State College
501 Crescent Street
New Haven, CT

University of Bridgeport
380 University Avenue
Bridgeport, CT 06604

University of Connecticut
Dept. of Marine Sciences
Avery Point
Groton, CT 06340

Yale University
Biology Dept.
Prospect St.
New Haven, CT

Development Foundations

Mid-Atlantic Fisheries Development Foundation, Inc.
Suite 600, 2200 Somerville Rd.
Annapolis, MD 21401

New England Fisheries Development Foundation
1 Court St.
Boston, MA 02108

Research Programs

University of Connecticut
Marine Sciences Institute
Avery Point Campus
Groton, CT 06340

University of Connecticut
Marine Research Laboratory
Main St.
Noank, CT 06340

Little Harbor Laboratory
69 Andrews Rd.
Guilford, CT 06437

Educational Programs

Oceanic Society
7 Magee Ave.
Stamford, CT 06902

Project Oceanology
UCONN
Avery Point
Groton, CT 06340

Schooner, Inc.
60 South Water St.
New Haven, CT 06519

University of Connecticut
Sea Grant Institute
Avery Point Campus
Groton, CT 06340