South Shore Estuary Reserve
Technical Report Series

Crustacean Shellfish

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Acknowledgements

This report is one in a series of technical reports prepared by the Department of State or its consultants as baseline information and considered by the South Shore Estuary Reserve Council during preparation of a comprehensive management plan for the Reserve. Members of the Technical Advisory Committee and Citizens Advisory Committee (see end of report) contributed information and insights throughout the preparation of these reports.

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Introduction

Purpose

This document is intended to provide a base level of knowledge and preliminary management recommendations regarding blue crab for participants of the South Shore Estuary Reserve (SSER) Comprehensive Management Plan (CMP) effort. As an overview of information, it is not a treatise on blue crab, but a document to guide blue crab management decision-making. A specific objective of this technical report is to support:

management recommendations for the preservation of plant, fish and wildlife and their habitats (Article 46, Section 966(l));

management recommendations for protection and supporting indigenous economic activities such as aquaculture, finfishing, shellfishing, boating and tourism (Article 46, Section 966(n));

recommendations for increased enforcement of laws and regulations pertaining to preservation and management of resources (Article 46, Section 966(o)).

As components of the SSER CMP, recommendations address management goals of the SSER Council by providing direction for federal, state and local governments to protect, preserve and properly manage the crab resources of the south shore estuary.

Study Area

This report will focus on the blue crab and briefly mention other crabs found within the south shore embayments of Long Island and their associated tributaries. The Atlantic Ocean and inland waters are not considered.

How This Draft Technical Report is Organized

This report is presented in four sections. **Section 1** is a general discussion of blue crab biology, life history, ecology and habitat. **Section 2** describes the commercial and recreational blue crab fishery. **Section 3** presents an assessment of resource status and concerns. **Section 4** identifies information required to develop a crab management component for the SSER CMP.

Section 1: General Biology, Ecology, and Habitat

A variety of crab species are common to the embayments and tributaries of the south shore estuary. They play important ecological roles as prey and predator. Commercial and recreational crabbing, an activity of increasing economic significance, relies on abundant and healthy crab stocks.

Most crab species are alike in physical appearance. General body form however, is the limit of their similarity as each species has unique behaviors, capabilities, and life strategies. The SSER Council and Living Resources Subcommittee recognize blue crab (Callinectes sapidus), a common and edible species, as deserving special consideration. Other crabs identified in the following discussions of habitat, exploitation, and management are the Jonah crab (*Cancer borealis*), rock crab (*Cancer irroratus*), lady crab (*Ovalipes ocellatus*), fiddler crabs (*Uca spp.*), green crabs (*Carcinus spp.*), spider crabs (*Libinia spp.*), hermit crabs (*Pagurus spp.*), mud crabs (*Neopanope sayi* and *Panopeus herbsti*), and a crab in name only, the horseshoe crab (*Limulus polyphemus*), which is a member of the Arachnid family.

In the western Atlantic, blue crabs range from Florida to Nova Scotia. Mostly an inhabitant of the mid-Atlantic coast, southern New England is regarded as the northern limit of its major distribution. It is found throughout the shallow estuarine waters of Long Island's south shore. The species is dioecious, and sex can be determined by examining the abdomen or apron. The male's apron is much narrower than the female's. A member of the crab family Portunidae, blue crabs are capable swimmers and have an aggressive disposition.

A great deal of information exists that describes blue crab life history in Chesapeake Bay (Van Heukelem 1991), the Carolinas (Dudley and Judy 1971, Fischler and Walburg 1962, Archambault et al., 1990), and more recently the Delaware Estuary (Epifanio 1995). Equally extensive investigation and documentation of blue crab biology specific to the south shore estuary are lacking. In south shore estuary waters, the animal's life history is probably consistent with that observed in other coastal waters. Growth, molting, and size at maturity, are believed to be influenced by environmental conditions (Hill et al. 1989), and regional variances should be expected.

Reproductive activity begins in low salinity waters of the estuary and its tributaries. Typical of Portunid crabs (Barnes 1980), the males carry pre-molt females. Females are released to complete their molt just before actual mating. After mating, females commence well-defined migration, moving to waters of higher salinity and burrowing into the substrate to overwinter (Hill et al. 1989, Van Heukelem 1991). Males however, simply disperse. In the Chesapeake, Hill et al. (1989) cite the work of Fiedler (1930), Truitt (1937) and Cronin (1949) that describes male migration as non-directional. Males remain in deeper areas of less saline water where they too burrow into mud to overwinter.

Spawning commences in the mid-Atlantic bight in May (Hill et al. 1989) and continues through early September. In the Delaware Bay it peaks in late July and early August (Van

Heukelem 1991). The female extrudes the eggs and broods them under its flexed apron. Females carrying eggs are said to be berried; the egg mass itself is often called a sponge (Barnes 1980). Hatching of the 750 thousand to two million eggs takes about two weeks (Lippson 1982). The first stage larvae are known as zoea that are planktonic filter feeders that bear no morphological resemblance to the adult form. Environmental factors strongly influence zoeal development and survival.

The crab zoea grows through successive molts, with seven molts required to achieve the next larval form called a megalopa. The free-swimming post larval megalopa then molts to the juvenile crab stage and develops recognizable adult physical characteristics. Subsequent molts and increase in size lead to the adult form. Development from egg to mature adult requires approximately eighteen to twenty months (Lippson 1982, Epifanio 1995). Blue crab growth is interrupted while overwintering and resumes with the increasing water temperatures of spring (Hill et al. 1989). Adults rarely live longer than three years in the mid-Atlantic (Churchill 1919, Williams 1965).

Although blue crabs can be found throughout the south shore estuary, habitat usage and distribution of juveniles and adults depend on salinity, season, and reproductive cycle. In Great South Bay, blue crabs are abundant year round; eggs and larvae are present June through October (Stone et al. 1994, Briggs pers. comm.). Blue crabs migrate within the estuary from deeper, warmer, wintering grounds to tributaries, tidal wetlands and upper estuary areas in spring. Wind, tide, current, and possibly behavioral traits influence the distribution of planktonic larval forms. Oceanographic and meteorological forces governing larval distribution in the Chesapeake and Delaware systems have been studied extensively, but are not completely understood (Epifanio et al. 1984, Johnson et al. 1984, Johnson 1985). Generally, zoea flow out of the estuaries on ebb tides, develop nearshore and offshore, and return as megalopa by estuary inflow. Larval blue crabs have a physiological requirement for salinity greater than 20 ppt. (Van Heukelem 1991), a need that the estuary only marginally meets. Storm events might play an important role in megalopa return and major inflow events (Van Heukelem 1991).

Eelgrass beds, macroalgae, and marsh creek habitats are likely as important for blue crab in the south shore estuary as they are in the Chesapeake Bay region. The structure afforded by these habitats provides nursery grounds for settling juveniles and safe harbor for molting crabs (Ryer et al. 1990). Adkins (1972) describes shallow estuarine water with soft bottom as the optimal habitat for small crabs; large crabs preferring deeper depths and harder bottoms. According to Wilson and Able (1992), habitat use by blue crab can vary from one estuarine system to the next. This suggests that life requirements are general enough to allow opportunistic use of a diversity of habitat types. In the Delaware Bay for example, seagrass beds are lacking, and saltmarshes may serve as nursery habitat (Epifanio 1995).

As noted above, some habitat use is related to salinity preference (Hill et al., 1989). Mature males and immature females occur more frequently in less saline upper estuary water; mature females migrate to more saline lower waters where eggs hatch. In the south shore estuary, the recreational blue crab catch in Great South Bay reported by Briggs (1985) suggests this same pattern of habitat use.

Salinity influences optimal temperatures for blue crab. Adults and juveniles can inhabit water as warm as ninety-five degrees Fahrenheit, but are less tolerant of low temperatures at low salinity. During the winter, blue crabs can avoid cold stress by moving to deeper portions of the estuary and burrowing into the bottom (Hill et al. 1989, Van Heukelem 1991, Epifanio 1995). Yet winter mortality is a common occurrence. According to Briggs (1992), winter kills of blue crabs in Long Island waters are expected events and are normally attributed to low temperature, consistent with the northern limit of the species' range. Briggs (1996a) also reported that gray crab disease is a contributing factor, an observation supported by Newman and Ward (1973), Couch (1983), and Messick and Sindermann (1992).

Blue crabs are sensitive to dissolved oxygen levels below one part per million (Lowery and Tate 1986) and can avoid hypoxic areas (Van Heukelem 1991).

Suspended sediments, ammonia, nitrites, and pH, are identified by Van Heukelem (1991) and Epifanio (1995) as having potential adverse effects. Their discussions related to shedding operations however, and not to effects identified as significant in the field.

All life stages of blue crab are trophically important as prey and predator, and some consider this crustacean to be a major factor controlling benthic populations (CBP 1987), including its own (Mansour and Lipcius 1993). Blue crab cannot be described as occupying any particular trophic niche or level at any specific size or age. Blue crab are opportunists and will eat whatever is available. As Van Heukelem (1991) summarizes, its diet varies with the size of the crab, where it lives, and the season. In turn, blue crab larvae, post larvae, and juveniles are preyed upon by many animals, including other blue crabs. Adults are also vulnerable during molts.

Section 2: The Fishery

Crabbing in the south shore estuary was well established by the turn of the century. Gabriel (1921) wrote,

"In the shallow tide-water creeks that empty into Moriches Bay and Great South Bay, the business of catching crabs has grown up and become extensive. A little sailing skiff or power boat, a heavy line two hundred yards or there-abouts in length, a small dip-net and several barrels are all the equipment needed for the occupation of 'crabbing.' The line is held in place by two stakes in mid-channel and is weighted until it lies close to the bottom. Every yard or so, is a piece of bait, usually a bit of salted eel. The 'crabber,' during the early hours of the morning, sails up and down the line, lifting it and taking off the crabs with his dip net. It is a simple business."

Commercial Crabbing

Briggs (1996b) described New York State's blue crab fishery. They are commercially harvested with crab pots for the most part, although dredges are used in Great South Bay and Moriches Bay and elsewhere to take wintering crabs. Other crab species harvested for human consumption are the Jonah crab, rock crab, and lady crab. Green crabs, fiddler crabs, hermit crabs, and spider crabs are also taken and sold as fishing bait.

Recorded blue crab landings for New York date back a little over a century. The numbers vary widely, and for many years information is missing. Table 1 provides landings and ex vessel values for New York State as recorded by the National Marine Fisheries Service from 1950 to 1996. The information is regional and does not identify landings from specific New York waters. Several trends are clear. Landings and ex vessel value, although revealing interannual variation, have risen continuously since the late 1970's , and reached record levels by the mid 1990's (Figures 1 and 2).

Catch data has improved with the institution of a state commercial food fish license, although the number of crabbing permits issued does not identify harvest level or effort. Some catch data by area does get reported however, and crab catch from the south shore bays can be identified. Since 1986, and likely earlier, the south shore bays reportedly produced more blue crab than any other area of New York State's marine district (Table 2 and Figure 1). In many years the south shore harvest exceeded all other areas combined. Preliminary information for 1997 (Table 3) suggests that the south shore bays have again produced a substantial harvest of not only blue crab, but horseshoe, green, rock, and lady crabs as well.

The ex-vessel price per pound is apparently sufficient inducement to participate in the fishery. Briggs (1996b) reported some crabbers shipping blue crabs south for as much as $20.00 a bushel over local prices. Given the low overhead required to enter the fishery, the ease of capture, and the depressed state of the south shore's shellfish industry, crabbing is an attractive alternative for baymen and others wishing to generate income. In 1995 New York State issued a high of nearly 1,100 commercial crabbing permits. The importance of the crab fishery as an alternative to shellfishing cannot be understated as a means of shifting harvest pressure and contributing to the economic stability of commercial fishing on the south shore.

The explosive growth in the commercial pot fishery for crabs in SSER waters that has occurred in the past decade has produced a serious conflict between crab fishermen and other users of Reserve waters. Boaters, charter/party boat operators, and recreational fishermen contend that indiscriminate setting of large numbers surface buoys marking the location of strings of crab pots has made navigating the waters of the Reserve difficult. The frequent fouling of propellers by pot warp lines is cited as a personal hazard by those plying the waters of the Reserve and the time lost in clearing these foulings is seen as an increasing economic loss by these individuals. Concern has also arisen about ghost fishing by strings of pots that go unattended for prolonged periods because their marking buoys have been sheared off by boat propellers.

Responding to these concerns, the New York State Legislature has developed a proposal to prohibit the setting of commercial crab pots in certain nearshore and channel areas of Great South Bay, the SSER waterbody where these space conflicts have been most severe. This legislation requires that commercial crab pot buoys be marked with information identifying the owner and also prohibits disturbing or tampering with commercial crab pots and related equipment. This legislation passed the Senate in the 1998 legislative session but was not acted on by the Assembly. It is likely that the legislation will again be discussed in the 1999 legislative session.

Recreational Crabbing

In the 1960's blue crab from the south shore waters of the Town of Hempstead was regarded an important recreational resource (McHugh and Ginter 1978). The south shore's crab fishery was not seriously examined until Briggs (1985) investigated recreational crabbing in Great South Bay during the late summer, early autumn months of 1981, 1982, and 1983.

Recreational crabbing in Great South Bay was found to be a significant activity supported by the blue crab. Daytime recreational fishermen using banks and piers were surveyed, and it was determined that more crabbers used the north shore of the bay than the south shore. The north shore catch was mainly male crab and the south shore catch was mostly female crab, consistent with the salinity patterns of the bay. Recreational crabbers employed collapsible traps, hand lines, and dip nets.

The recreational take of lady crabs and rock crabs from the south shore locations, and the existence of a night fishery for blue crab were also reported. Briggs (1996b) later elaborated that: the lady crab recreational fishery is in and near Fire Island Inlet during the summer; the rock crab fishery was in the same area during late fall; and that blue crabs are taken at night from boats, docks, and piers by dip net. Recreational landings of crabs from the estuary are unknown but are likely to be substantial.

Section 3: Resource Status and Concerns

Interannual abundance of blue crab in the estuary has been variable. This may relate to density independent factors controlling blue crab populations proximate to the northern extreme of their geographic distribution (i.e., sensitivity to winter kill). It may also be that stock abundance is more dependent on post larval abundance and settlement. Fishing down a single year-class rather than multiple year-classes could be another factor. Fisheries for the short-lived blue crab largely depend each season on the juveniles and adults of a single cohort, the strength of which meteorological events over the continental shelf may strongly influence. Higher than average winter temperatures in recent years has been suggested as the basis for blue crab population increases. The increase in population is not isolated to the south shore estuary, but is a regional phenomenon. For example, blue claw crab populations have increased in range and abundance in the lower Hudson in recent years. In any case, blue crab stock size and stock composition within the estuary are unknown. Presently, blue crab and other crab species are available in numbers sufficient to support a largely unmanaged industry for which little regulation exists.

Holding crabs till they molt, a commercial practice known as "shedding," is a way to supply the market with soft-shelled crabs. In southern states, crab mortality associated with this practice runs as high as 60 percent and represents a huge waste of the resource (Briggs pers.comm.). Techniques for reducing mortality in shedding practices have received attention in recent years (Budney, pers.comm.) and may warrant reconsidering views of this commercial industry. Regardless of the techniques used in shedding, a current NYS DOH health advisory on consumption of the crustacean green gland raises an additional concern with respect to marketing undressed softshell crabs.

"Ghost" fishing by lost crab traps is an issue considered in the 1997 Chesapeake Bay Blue Crab Fishery Management Plan. The plan cites the work of several authors (Eldridge et al., 1979, Casey and Wesche 1981, Casey and Daugherty 1989, Guillory 1993) clearly showing yet another source of high blue crab mortality. Blue crabs are cannibalistic, and lost and abandoned traps are essentially self-baiting as crabs outside a trap are attracted to dead and dying crabs inside a trap. Guillory (1993) recommends escape vents, solid floats, non-floating line, and trap owner identification, as management measures to reduce ghost fishing mortality. These measures are similar to state and federal regulations already in effect in New York State waters for the purpose of reducing mortality of fish and lobsters due to lost traps. The use of non-floating line especially, may also diminish conflict between crabbers and recreational boaters. Its use can lower the probability of pot warp being cut by propellers and reduce gear loss.

There is no state or federal management plan for any crab species. Persons are presumed to be commercial crabbers only if they take more than fifty crabs a day or offer any crabs for sale or barter[1]. This activity requires a state-issued permit and there are no limits on the number of crabs harvested. Sponge crabs, females bearing eggs, cannot be taken. This restriction is enforced in other states as well. Epifanio (1995) relates that there is no evidence that such restriction protects stocks and that Virginia in fact has a directed fishery for gravid females. Dredging for crabs is prohibited in South Oyster Bay and in the Great South Bay west of Captree bridge. This restriction does not reduce crabbing efficiency, but according to Ginter (1974) "satisfies the special interests of local shellfishermen who feel the dredgers would pick up quantities of shellfish other than crabs in these areas. . . . "

The winter practice of dredging traditionally uses modified scallop dredges which are retrieved by hand. Although a much less common practice, there is concern regarding the use of much larger dredges which are mechanically hauled. The impacts of the larger dredges on the benthic community are not known.

Blue crabs are a host to a suite of viruses, bacteria, fungus, protozoans, and parasites that can cause mortality or reduce marketability. Messick and Sindermann (1992) have provided a thorough summary of known diseases. In table format they present pathogenic information, histopathology and tissues affected, affect on blue crab, gross signs of disease, geographic location and prevalence.

Many identified diseases are probably ubiquitous to the Atlantic coast but their occurrence in south shore estuary waters is largely undocumented. Some diseases have potential for causing widespread mass mortality. Briggs (1992) reported a blue crab kill in South Oyster Bay and western Great South Bay attributed to a protozoan parasite, *Paramoeba perniciosa,* commonly called gray crab disease. In his report, Briggs made comment on the likelihood of similar epizootic events in the future. Another condition described by Briggs (1996a) in Great South Bay is shell disease syndrome. This bacterial infection of the exoskeleton causes necrotic, black lesions that reduce marketability. Shell disease is believed to occur in all blue crab populations (Messick and Sindermann 1992).

Several contaminants such as metals, pesticides, domestic and industrial wastes that negatively affect blue crab have been identified (Hill et al., 1989, Van Heukelem 1991, Epifanio 1995). A sampling of these contaminants would include the following: kepone, mirex, malathion, DDT, chlorine, chlorine oxidants and other halogenated compounds, cadmium, chromium, selenium, mercury, petroleum hydrocarbons, polynuclear aromatic hydrocarbons, and polycarbonated biphenols.

Exposure to toxic material can produce many stress responses in blue crab. For example, increased gill ventilation, longer intermolt cycle, behavioral abnormalities, and a slow rate of limb regeneration. Mortality, if not direct, can be induced when stressed animals are further

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[1] Environmental Conservation Law, Article 13, Section 0331.

subjected to temperature or salinity extremes. Hill et al. (1989) identify the potential for many toxicants to bioaccumulate in blue crab and subsequent predators. Van Heukelem (1991) referenced work done in South Carolina that revealed elevated tissue burdens of PCB in blue crabs taken from the outfall of a waste water treatment facility.

Chemicals in blue crabs have been studied in the New York-New Jersey Harbor Estuary (Skinner et al. 1996). It was determined that the hepatopancreas of blue crab had average concentrations of PCB, DDT, and Chlordane that exceeded regulatory criterions. Jamaica Bay, near the SSER's western boundary, was sampled as part of the study. Blue crabs from Jamaica Bay had hepatopancreas concentrations of PCB and DDT that were much lower than the other areas of the harbor estuary. Chlordane concentrations by area were not significantly different. Health advisories for human consumption of blue crabs from all New York State waters recommend that the hepatopancreas ("tomally") not be eaten. Similar studies for the SSER have not been pursued.

Section 4: Preliminary Recommendations and Next Steps

Management policy decisions require comprehensive information on crabs and the fisheries they support. Given the paucity of estuary-specific data, **it is recommended that preliminary studies focus on understanding the fundamental biology and population dynamics of crabs and the nature of their exploitation.** The states of Delaware, Maryland, and Virginia have done much work for the Delaware and Chesapeake Bays. Their efforts can provide valuable guidance to fill blue crab information gaps such as:

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- larval, juvenile, and adult abundance,
- sex ratio,
- spawning and wintering areas,
- tidal and wind influence on egg, pre larval, and post larval drift,
- growth,
- size at maturity,
- sex specific information on size and age,
- habitat, (bottom type, submersed vegetation, tributaries, wetlands)
- catch and effort,
- disease, and
- contaminants.

The 1997 Chesapeake Bay Blue Crab Fishery Management Plan presents a wealth of information, direction, and strategy that has been under development since 1989. The plan identifies priority biological, economic, and management data needs for research (Appendix A), many of which were also identified during development of this report. Most importantly for the south shore, **it is recommended that identifying populations from which the estuary recruits its supply of larvae be a research priority.** This will require analysis of seasonal and long term hydrographic parameters and effects of wind stress on nearshore and offshore circulation. Investigations of south shore estuary blue crab zoea export and megalopa import will be needed.

This information will have high value in addressing questions of spawning biomass and stock-recruitment relationships. At present, the relative contribution of larvae to the south shore estuary by it's own population, that of the Hudson/Raritan estuary, and the southern estuaries, is unknown.

Sulkin et al. (1982) discuss a conceptual model describing the mechanism of recruitment to the Mid Atlantic Bight estuaries. They speculate that the relative contribution of larvae from the offshore supply lends itself to substantial recruitment in Long Island estuaries only in years of pronounced northward flow of shelf waters. The greatest contributions of larvae to the offshore pool may be the southern estuaries and it was suggested that data from northern estuaries could be used to test the model. Recent work by Blanton et al. (1995) examined wind-generated coastal circulation and transport of megalopa. Although relying on simulations of the southeastern U.S. continental shelf, they felt the basic physical principles are applicable to other coastal regions with broad shallow continental shelves. It was hypothesized that downward and upward water movement caused by winds blowing across the ocean surface can influence shelf waters in a way that concentrate larvae for advection through inlets during flood tide. Hansen (1977) described the shelf of the Middle Atlantic Bight as broad and shallow and subject to winds producing similar advection of waters, although of lesser effect.

Although immediate study should concentrate on blue crab, it is suggested that other crab species may warrant attention and their study should be a next step. Jonah and rock are edible crabs that might be considered. In 1985 Briggs suggested that the fishery biology of the lady crab needs more study. The uncontrolled harvest of fiddlers and green crabs, popular as fish bait, may be cause for concern. It is interesting that the Europeans introduced the green crab and within the last century it has become the most common crab along the coast of Maine (Amos and Amos 1985). A new exotic has been reported in New York State waters, the Asian shore crab (*Hemigrapsus sanguineus*). Although not known to favor habitats common to the south shore, opportunities to understand the invasion dynamics of an exotic species may prove valuable.

Various crab species have been identified as possible molluscan shellfish predators, and this may have consequences for south shore estuary hard clam restoration. Mud crabs (*Neopanope sayi* and *Panopeus herbsti*), lady crabs, rock crabs, blue crabs, hermit crabs, and the horseshoe crab, were specifically mentioned as clam predators in a 1982 U.S. Environmental Protection Agency / WAPORA, Inc. study of Great South Bay, South Oyster Bay and Hempstead Bay. It was reasoned that if bay salinities increased, the abundance of certain hard clam predators would also increase. Lady crabs (also called calico crabs) were the only crab hard clam predator species identified to have a salinity dependent distribution, and increased predation would only apply to seed clams in areas suitable as habitat for lady crabs. It was elaborated that lady crabs are diverse in their food gathering and not dependent on hard clams. Mud crabs were reported as the most abundant hard clam predator, but no increase in its abundance based on salinity was expected. Blue crabs, presented as significant predators of hard clams in southern estuaries, were less abundant than other crabs during the EPA's study period. Its abundance was not identified as affected by changes in salinity. Presently, hard clams are not abundant, but blue crabs and mud crabs are. This suggests that these crabs also are not dependent on hard clams. The USEPA / WAPORA report noted that predator abundance does not directly relate to hard clam predation rates, but if salinities in the bay increased, some increase in lady crab abundance and predation on seed clams could be expected. **It is recommended that field investigations be made to determine actual rates of crab predation on hard clams.** Aquarium studies and studies conducted in southern estuaries are useful, but for the south shore, crab predation on such an important resource as the hard clam justifies estuary-specific study. The expanding blue crab population has been cited as a cause for the low abundance of hard clams and warrants investigation.

Fisheries exist for horseshoe crabs. They are harvested for use as eel bait and for pharmaceutical purposes. The volume of eggs produced by spawning congregations of horseshoe crabs provides important forage for wading and shore birds. For a two-week period in Delaware Bay the food supply for staging migratory birds provided by horseshoe crab eggs has been estimated at 320 tons (DDNR 1987). Along the mid-Atlantic there is growing alarm that reduced abundance of horseshoe crabs may, in light of its important food web role, have adverse effects on species that depend on it. Concerns in Delaware, Maryland, New Jersey, and Virginia have induced the Atlantic States Marine Fisheries Commission to adopt a coastwise fishery management plan for horseshoe crab (ASMFC 1998). Implementation of this plan includes capping fishing effort and developing a landings cap beginning in 2000. Future reductions in fishing effort may be needed based on the results of plan-mandated monitoring.

The significance of blue crab habitats is emphasized in the 1997 Chesapeake Bay Blue Crab Fishery Management Plan. It recommends as a priority the protection and restoration of submersed aquatic vegetation (SAV), eelgrass in particular. The highest priority in the Delaware Estuary is identifying critical habitat for megalopae settlement and growth of early juvenile stages (Epifanio 1995). **It is recommended that SAV and intertidal wetlands and shallow waters be recognized for their role as important blue crab habitats, providing additional justification for continued protection and need for better understanding of the function and distribution of these habitats.** The blue crab is a species of interest to the Atlantic States Marine Fisheries Commission, and the important role of blue crab habitats will be considered should the Commission take action to develop a blue crab management plan.

As Briggs (1996b) correctly summarized, New York State's blue crab fishery is wide open. **It is recommended that responsible stewardship of crab resources include an objective approach to assure maximum economic return for commercial crabbers; to support a maximum sustainable catch; and allow for the maximum participation of recreational crabbers.** The New York State Department of Environmental Conservation has the authority until the end of 1999 to adopt management measures that can establish size limits, harvest limits, seasonal, effort, and gear restrictions for the management of crabs. The approach must be adaptive, allowing management to adjust each year according to recruitment and stock abundance. The interplay between molluscan and crustacean shellfisheries should be considered. It has been suggested that if blue crabs are major hard clam predators, and sources of larval blue crabs are outside the south shore estuary, then blue crab harvest should be maximized.

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Table 1: New York Annual Blue Crab Landings 1950 to 1996				
Year	**Metric Tons**	**Pounds (lbs)**	**Ex Vessel Value ($)**	**Averaged Price/Pound ($/lbs)**
1950	3.8	8300	$2,335	$0.28
1951	3.2	7000	$2,240	$0.32
1952	25.8	56900	$5,268	$0.09
1953	34.2	75300	$8,600	$0.11
1954	20.2	44600	$4,987	$0.11
1955	19.4	42700	$4,880	$0.11
1956	4.2	9200	$974	$0.11
1957	3.9	8500	$968	$0.11
1958	8.3	18300	$1,678	$0.09
1959	0.8	1800	$248	$0.14
1960	0.5	1100	$140	$0.13
1961	0.6	1300	$152	$0.12
Data for 1962 to 1973 not available				
1974	1.5	3200	$645	$0.20
1975	7.3	16000	$4,000	$0.25
1976	23.7	52300	$19,845	$0.38
1977	5.8	12800	$5,760	$0.45
1978	0.6	1400	$700	$0.50
1979	25.7	56600	$21,210	$0.37
1980	90.0	198400	$90,804	$0.46
1981	14.9	32900	$14,145	$0.43
1982	20.8	45800	$23,839	$0.52
1983	60.4	133100	$58,474	$0.44
1984	60.8	134100	$69,069	$0.52
1985	127.0	280070	$134,712	$0.48
1986	65.3	143900	$70,137	$0.49
1987	140.7	310165	$183,766	$0.59
1988	93.2	205360	$131,260	$0.64
1989	297.0	654700	$388,713	$0.59
1990	232.6	512715	$269,438	$0.53
1991	370.8	817545	$441,034	$0.54
1992	347.3	765565	$447,033	$0.58
1993	551.0	1214840	$759,350	$0.63
1994	402.3	886840	$558,718	$0.63
1995	790.7	1743111	$1,481,783	$0.85
1996	1,042.5	2298351	$1,717,982	$0.75

Source: US Fish and Wildlife Service

Table 2: New York Blue Crab Catch (Pounds) by Area as Reported on Following Year's Commercial Crabbing Permit Applications 1986 to 1994

Year	Hudson River	New York City Harbor	Jamaica Bay	South Shore Bays	Eastern Long Island	Long Island Sound
1986	3,000	16,000	4,000	88,000	0	1,000
1987	14,000	21,000	49,000	108,000	7,000	1,000
1988	23,000	22,000	18,000	226,000	12,000	2,000
1989	74,000	59,000	20,000	322,000	4,000	4,000
1990	25,000	116,000	26,000	343,000	30,000	6,000
1991	44,000	99,000	19,000	310,000	51,000	7,000
1992	36,000	165,000	76,000	233,000	57,000	22,000
1993	47,000	155,000	58,000	306,000	54,000	6,000
1994	23,000	198,000	83,000	745,000	70,000	8,000

Source: Briggs 1996b

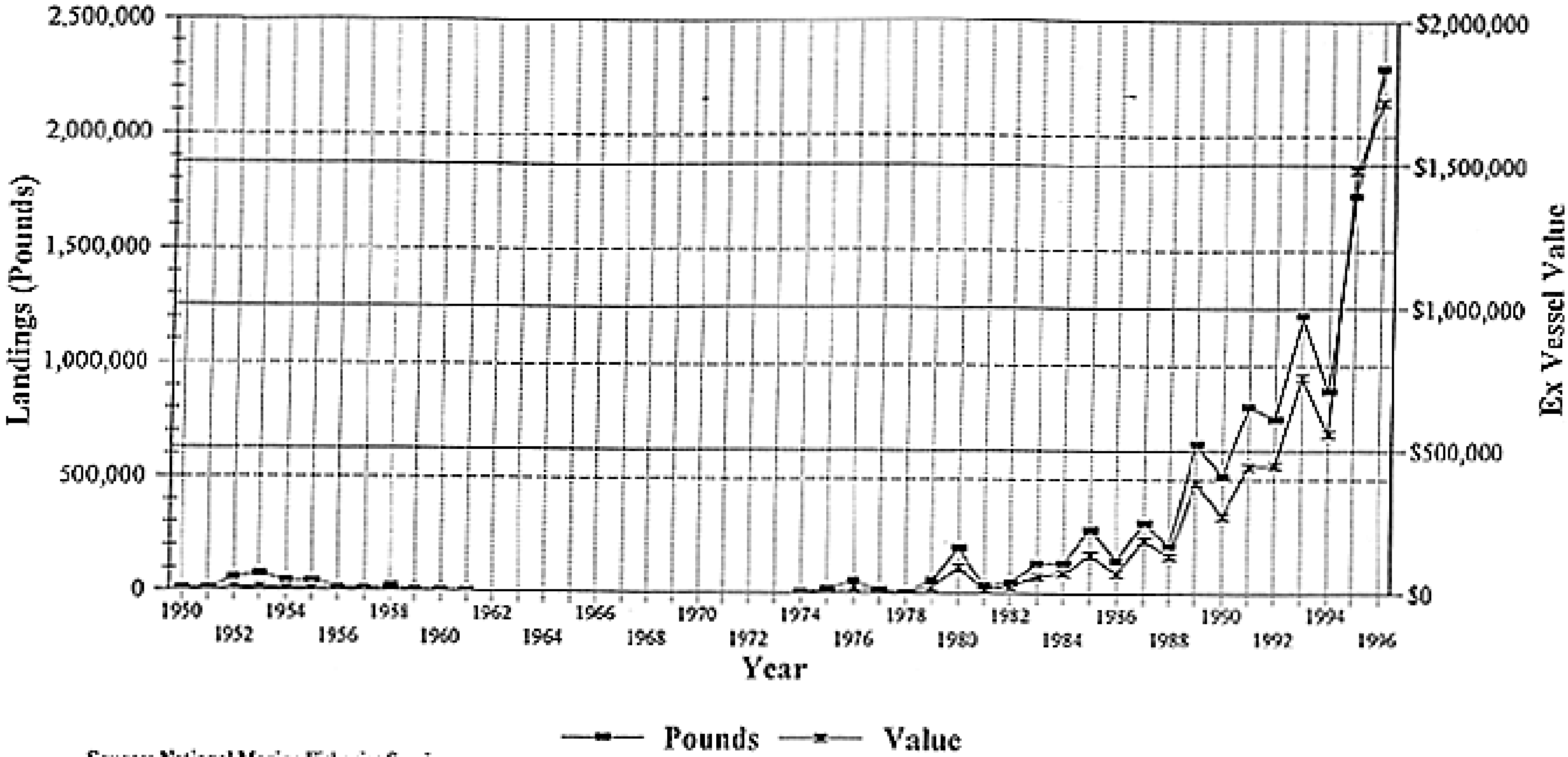
Table 3: Preliminary Summary of New York's 1997 Commercial Crab Landings as Reported Through New York's Annual Permit Survey

SPECIES (lbs)	ATLANTIC OCEAN (OFFSHORE - EEZ)	ATLANTIC OCEAN (INSHORE)	LONG ISLAND SOUND	SOUTH SHORE BAYS	EAST END	WEST END	TOTAL
BLUE	460	52,485	6,772	744,605	23,065	183,457	1,010,844
HORSESHOE	*	88,720*	19,100	209,950	349,860	0	667,630
JONAH (WHOLE)	42,410	15,805	21,010	11,550	1,236	0	92,011
JONAH (CLAWS)	1,140	2,400	0	0	1,400	0	4,940
GREEN	0	350	16,380	52,285	5,730	0	74,745
ROCK	11,800	32,830	5,900	14,975	2,775	1,450	69,730
HERMIT	1,000	395	22,960	2,000	9,760	0	36,115
LADY	0	12,800	40	5,175	100	1,450	19,565
FIDDLER	0	0	0	*	570*	0	570
SPIDER	180	4,045	25,200	0	24,400	0	53,825

East End includes Block Island Sound, Gardiners Bay, Peconic Bays, Montauk
West End includes: NY Bight, NY Harbor, Raritan Bay, Hudson River
*Poundages combined to protect confidentiality.

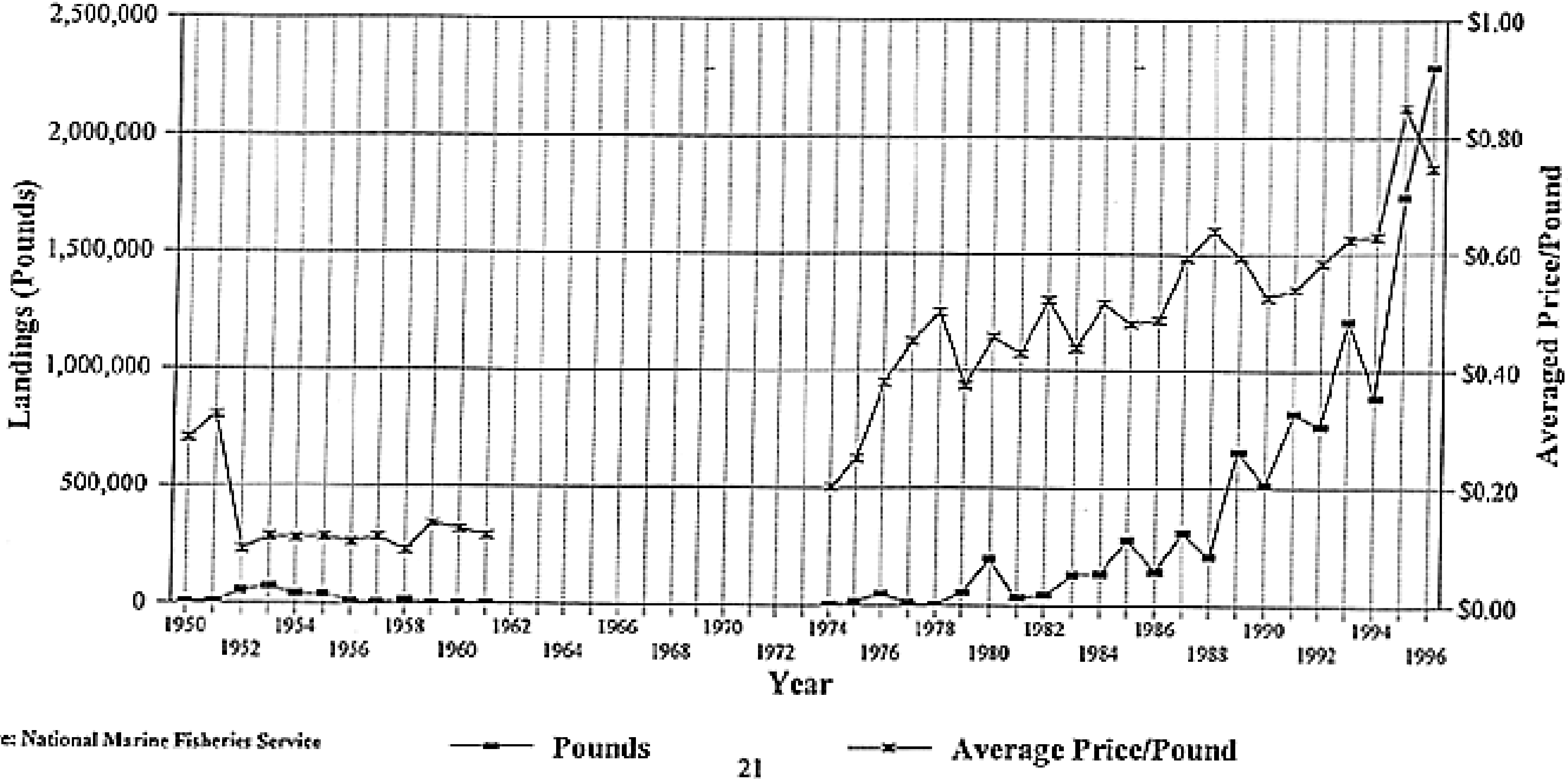
Source: New York State Department of Environmental Conservation, Bureau of Marine Resources

Figure 1: NYS Blue Crab Landings and Ex Vessel Value 1950 to 1996



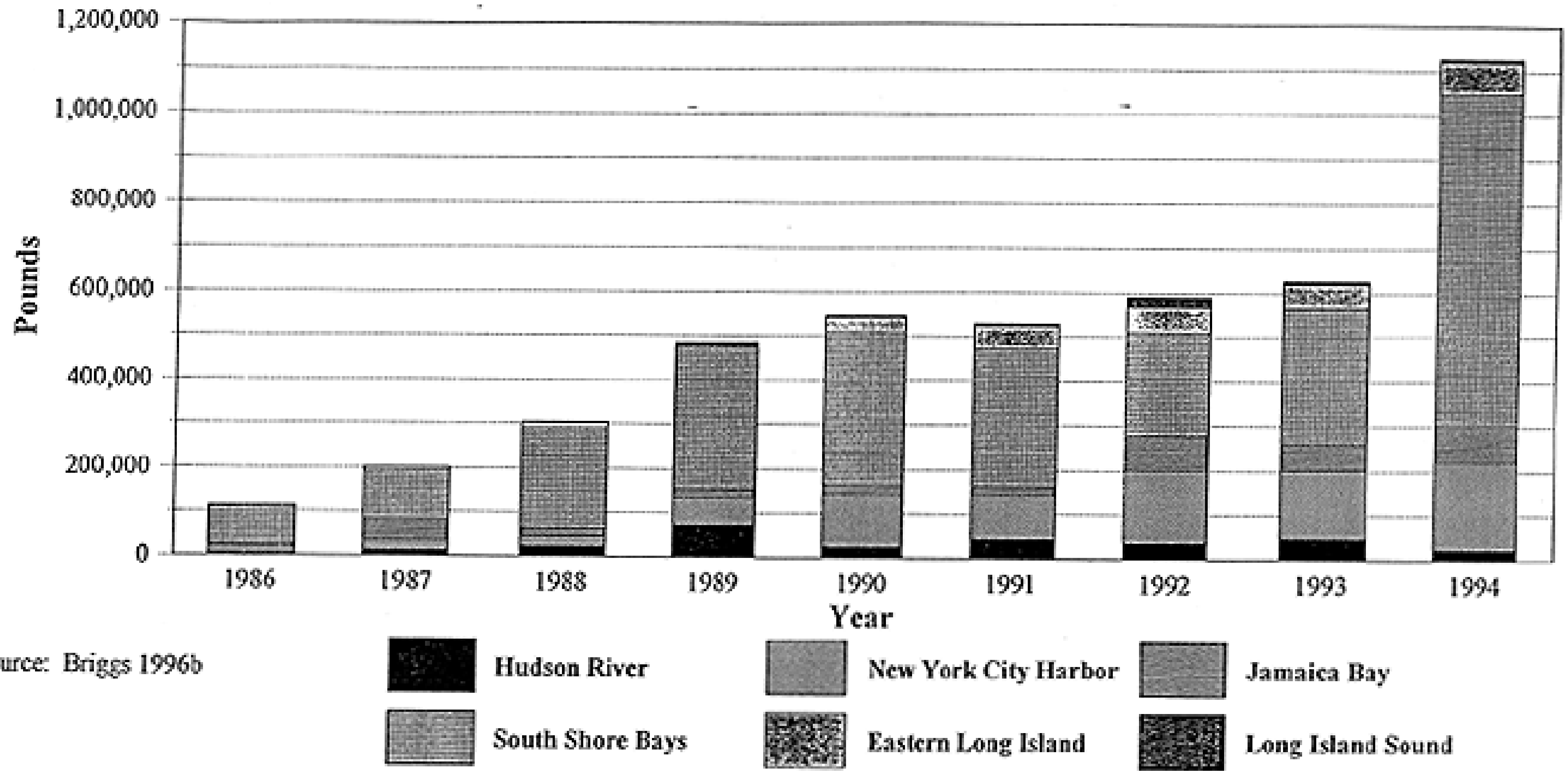
Source: National Marine Fisheries Service

Figure 2: NYS Blue Crab Landings and Averaged Ex Vessel Price per Pound 1950 to 1996



Source: National Marine Fisheries Service

Figure 3: New York Blue Crab Catch by Area as Reported on Following Year's Commercial Crabbing Permit Applications 1986 to 1994



Source: Briggs 1996b

Appendix A: Priority Research Needs Identified in the 1997 Chesapeake Bay Blue Crab Management Plan

1. Develop an accurate method and determine criteria that may be used to assess the age of blue crabs and use these data to determine the age structure of the population and longevity of the species.

2. Develop criteria that would define overfishing, its potential effects on the adult and juvenile portions of the stock, and methods for recovering the stock should it become overfished. Set stock targets and indicator triggers that will signal potential problems.

3. Determine annual estimates of spawning stock size and size of the recruiting year class and examine their relationships and factors that affect their relationship.

4. Determine the level of spawning stock which would conserve reproductive potential in a range of environmental conditions and develop prudent targets for the size of that stock.

5. Develop Chesapeake Bay-wide estimates of catch and effort by life history stage, year class, sex, and gear type in the commercial and recreational fisheries.

6. Quantify the carrying capacity of habitats for different sizes and sexes of blue crabs to identify critical areas of habitat which provide maximum blue crab productivity.

7. Obtain basic information pertaining to the reproductive biology of blue crabs and stock recruitment relationships.

8. Develop analytical models and supporting databases to evaluate the social and economic conditions in the fishery and the effects of management and actions on those conditions.

9. Support fishery independent surveys to augment or refine collection and compilation of fisheries data and improve and fully utilize the winter dredge survey, the only bay-wide sampling program.

10. Study the relationship between laws, regulations, and enforcement and the status of the stock.

11. Encourage studies of atmospheric and aquatic environments of the continental shelf, their effects on the blue crab larval and megalopal populations, and their relationship to stock size of the blue crab in Chesapeake Bay.

12. Evaluate sources of natural mortality (including predation mortality rates) at various life history stages of the blue crab.

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