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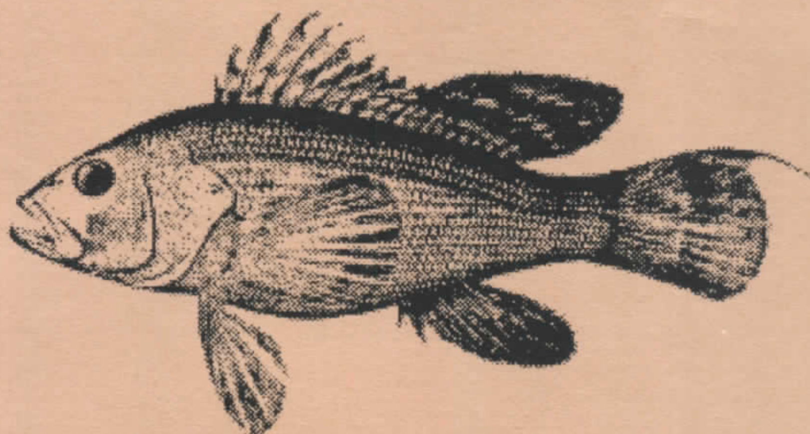
1996
Chesapeake Bay and Atlantic Coast

Black Sea Bass
Fishery Management Plan



October 1996

Chesapeake Bay Program

FISHERY MANAGEMENT PLANS
BACKGROUND

Chesapeake Bay Fishery Management Plans (FMPs) are prepared under the directive of the *1987 Chesapeake Bay Agreement* and serve as a framework for conserving and wisely using fishery resources. Bay fisheries are traditionally managed separately by Pennsylvania, Maryland, Virginia, the Potomac River Fisheries Commission, and the District of Columbia. A Chesapeake Bay FMP provides a format for undertaking compatible, coordinated management measures among the jurisdictions. In addition, it creates a forum to specifically address problems that are unique to Chesapeake Bay. This is particularly important concerning habitat issues. The goal of Chesapeake Bay FMPs is to protect the reproductive capability of a resource while allowing optimal harvest. The ecological, economic and sociological factors affecting the resource must be considered in the process. Objectives include: quantifying biologically appropriate levels of harvest; identifying habitat requirements and recommending protection and restoration measures; monitoring the status of the resource, including fishery-dependent and independent surveys; and defining and enforcing management recommendations.

Development of a FMP is a dynamic, ongoing process. It begins with initial input by the FMP Workgroup under the Living Resources Subcommittee (LRSc) of the Chesapeake Bay Program (CBP). The FMP Workgroup consists of resource managers, scientists, stakeholders, and conservationists. They evaluate the biological, economic and social aspects of a particular resource; define problems and/or potential problems; and recommend strategies and actions to address the problems. Throughout development, FMPs undergo scientific and public review. The FMPs are adopted when signed by the Chesapeake Executive Council, the policy-making body of the CBP. Upon adoption, the appropriate management agencies begin implementing the recommended actions. In some cases, regulatory and legislative action must be initiated to fully implement a management action. In other cases, additional funding and staffing may be required. Progress of FMP implementation and status of the stock and fishery are updated annually for each FMP species. As the status of a stock changes and management strategies are changed accordingly, amendments and revisions may be recommended by the FMP Workgroup.

Many important finfish species found in Chesapeake Bay also migrate along the Atlantic coast. These fish stocks can be subject to fishing pressure by recreational and commercial fishermen from other coastal states. The federal Atlantic Coastal Fisheries Cooperative Management Act of 1993 gave the Atlantic States Marine Fisheries Commission (ASMFC) authority to specify conservation and management actions needed by the States. The ASMFC is concerned with fishery resources within state jurisdictions (0-3 miles offshore). The federal Magnuson Fishery Conservation and Management Act of 1976 provided exclusive management authority over fishery resources (except for tuna) within a fishery conservation zone of 3 to 200 miles offshore (the Exclusive Economic Zone, EEZ). The Mid-Atlantic Fisheries Management Council (MAFMC) is composed of representatives from NY, NJ, PA, DE, MD and VA and is responsible for developing management and conservation measures in the EEZ. Both the ASMFC and the MAFMC prepare and adopt FMPs that specify compliance requirements by the states, but include a range of management options to meet the requirements. The states have the primary role determining what options are best for their region and how the options will be implemented. The Chesapeake Bay FMPs for coastal migratory species follow the guidelines established by the ASMFC and the MAFMC and outline how the Bay jurisdictions will comply with coastal management recommendations.

CHESAPEAKE EXECUTIVE COUNCIL

Chesapeake Bay Program

ADOPTION STATEMENT
BLACK SEA BASS FISHERY MANAGEMENT PLAN

We, the undersigned, adopt the *1996 Chesapeake Bay and Atlantic Coast Black Sea Bass Management Plan.* We agree to accept the Plan as a guide to conserving and protecting the black sea bass resource for long-term ecological, economic and social benefits. We further agree to work together to implement, by the dates set forth in the Plan, the management actions recommended to address overfishing, catch of undersized fish, stock assessment and research needs, and habitat degradation.

We recognize the need to commit long-term, stable, financial support and human resources to the task of managing the black sea bass stock and addressing important research needs. In addition, we direct the Living Resources Subcommittee to periodically review and update the plan and report on progress made with achieving the plan's management recommendations.

DATE OCTOBER 10, 1996

CHESAPEAKE EXECUTIVE COUNCIL

FOR THE UNITED STATES OF AMERICA

FOR THE STATE OF MARYLAND

FOR THE COMMONWEALTH OF PENNSYLVANIA

FOR THE COMMONWEALTH OF VIRGINIA

FOR THE DISTRICT OF COLUMBIA

FOR THE CHESAPEAKE BAY COMMISSION

GOALS AND OBJECTIVES

The goal of the *Chesapeake Bay and Atlantic Coast Black Sea Bass Fishery Management Plan* (FMP) is to:

> *"Enhance and perpetuate black sea bass stocks and their habitat in Chesapeake Bay and its tributaries, and throughout the Atlantic coast, so as to generate optimum long-term ecological, social and economic benefits from their commercial and recreational harvest and utilization over time."*

To meet this goal, the following objectives must be met:

1. Reduce exploitation to an annual rate of 23% ($F_{max} = 0.29$). An exploitation rate in excess of 23%, after year eight of the 1996 MAFMC's Black Sea Bass FMP implementation, will be used as a trigger to implement further reduction measures.

2. Maintain black sea bass maximum spawning potential at 22% to 30% of the total mature biomass to provide sufficient spawning biomass (Vaughan *et al*. 1992).

3. Improve yield-per-recruit (YPR) from the fishery.

4. Improve and promote the cooperative interstate collection of fundamental biological and fishery data necessary to monitor and assess black sea bass management efforts. For example, encourage the implementation of a standard, detailed, baywide fishery reporting system and tagging studies to estimate mortality rates.

5. Continue to provide guidance for the development of water quality goals and habitat protection necessary to protect the black sea bass population within the Bay and state coastal waters.

6. Enact consistent state and federal management measures when possible. This objective is necessary because the majority of black sea bass landed in the states of Virginia and Maryland are harvested in federal EEZ waters.

7. Promote conservation of the resource and an equitable distribution of the burden of resource conservation.

8. Promote protection of the resource by maintaining a clear distinction between conservation goals and allocation issues.

9. Promote fair allocation of allowable harvest among various components of the fishery.

1996
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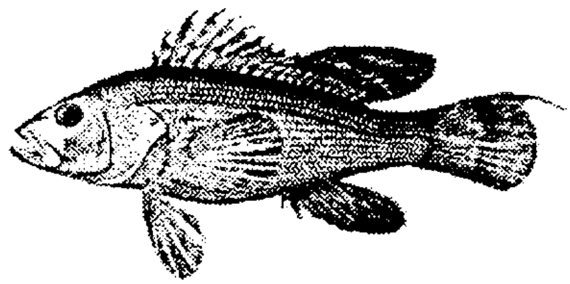
Black Sea Bass
Fishery Management Plan



Prepared by the
Fishery Management Plan Workgroup
Living Resources Subcommittee
Chesapeake Bay Program

October 1996

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EXECUTIVE SUMMARY

The goal of the *Chesapeake Bay and Atlantic Coast Black Sea Bass Fishery Management Plan* (FMP) is to: "enhance and perpetuate black sea bass stocks and their habitat in Chesapeake Bay and its tributaries, and throughout the Atlantic coast, so as to generate optimum long-term ecological, social and economic benefits from their commercial and recreational harvest and utilization over time."

The black sea bass stock supports important recreational and commercial fisheries along the Atlantic coast. Virginia and Maryland harvested approximately 34% of the total northeastern Atlantic Coast commercial landings (1983-1994) and 31% of the recreational landings (1983-1992). Over 84% of the commercial catch (1983-1994) and 79% of the recreational catch are harvested from the federal Exclusive Economic Zone (EEZ, 3-200 miles offshore). Even though the majority of the black sea bass are harvested from federal waters, there is a significant coastal fishery. The Chesapeake Bay serves as a vital nursery and feeding ground for young black sea bass.

Recent stock assessment results indicate that black sea bass are overharvested. According to a 1995 National Marine Fisheries Service Advisory Report, black sea bass in the Mid-Atlantic region are overexploited and at a low level of abundance. This assessment is based on the Northeast Regional Stock Assessment Review Committee's (20th SARC) determination that estimated fishing mortality rates on black sea bass (1984-1993) are above F_{max} or 0.29 (23% annual exploitation). F_{max} is one of the biological reference points used to define overfishing and is the fishing mortality that maximizes the yield per recruit. In 1991, fishing mortality reached 2.0 (81% annual exploitation rate) but decreased to 1.05 (60% annual exploitation) in 1993. In addition to high fishing mortality rates, black sea bass recruitment levels in 1992 and 1993 were the lowest on record. Continued low recruitment, could result in a collapse of the fishery. Recruitment during 1994, however, was above average (NEFSC 1995).

To begin immediate reduction in exploitation levels, to rebuild the spawning stock and to promote uniform management between federal and state agencies, the Bay jurisdictions will incorporate several fishery management measures pursuant to the Mid Atlantic Fishery Management Council (MAFMC)/Atlantic States Marine Fisheries Commission (ASMFC) Black Sea Bass Fishery Management Plan. The Bay jurisdictions will reduce exploitation and improve protection of the spawning stock in the Chesapeake Bay and the Atlantic by:

1) implementing a 9 inch total length (TL) minimum size limit for the first two years (1996, 1997) of the plan (After 1997, the size limit will be determined on an annual basis);

2) requiring a 4.0 inch minimum mesh size for trawlers harvesting more than 100 pounds (increasing to 4.5 inch minimum mesh size in year 3); and

3) requiring all black sea bass pots to have escape vents (as recommended by the MAFMC) as well as biodegradable hinges and fasteners.

The MAFMC/ASMFC plan, tentatively scheduled for completion in late 1996, reduces overfishing of black sea bass over an eight-year time frame. The goal of the eight year plan is to reach and sustain the fishing mortality rate that maximizes the yield per recruit. This rate (F_{max}) is currently calculated at 0.29 or 23% annual exploitation. The 9 inch minimum size should result in a 20% reduction in exploitation. Target exploitation rates are 48% in year 3, 37% in year 6 and 23% in year 8. Because the majority of the black sea bass harvest occurs in the EEZ (under federal jurisdiction), the MAFMC/ASMFC Plan calls for additional gear restrictions, a limited entry program (moratorium permit) and a coastwide quota beginning in year 3. This eight year plan should allow for significant stock rebuilding and sustainable yields that exceed the current landings.

In addition to the implementation of a size limit and gear restrictions, the Chesapeake Bay Program will continue its commitments to restoring water quality and living resources in the Chesapeake Bay. Special emphasis will be placed on the following specific habitat needs of black sea bass: the restoration of aquatic reef systems, the restoration of baywide water quality, and the restoration of submerged aquatic vegetation (SAV) and wetlands.

SECTION 1
BACKGROUND

The black sea bass, *Centropristis striata* (Linnaeus 1758), is a member of the family Serranidae or true sea basses. Also known locally as "black will" or simply sea bass, they are year-round inhabitants of the Mid-Atlantic Bight and Virginia waters. The range of black sea bass extends from Maine to the Florida Keys and into the Gulf of Mexico (USFWS 1978). Along the Atlantic coast, black sea bass are divided into two stocks for management purposes. The stock north of Cape Hatteras is considered a separate stock from the stock south of the Cape. The northern stock is also seasonally migratory; whereas, the southern stock is not. The Gulf coast population is sometimes considered a separate subspecies. Sea basses are typically bottom dwelling marine fishes. Most black sea bass are hermaphrodites and have the ability to change sexes.

In Virginia and Maryland waters, black sea bass are usually not confused with other species, as the occurrence of fish with similar morphology is relatively uncommon. The rock sea bass, *Centropristis philadelphica,* and the bank sea bass, *Centropristis ocyurus*, are closely related but have different color patterns and are normally restricted to waters south of Virginia.

Black sea bass are considered a temperate reef fish. They inhabit areas of rough bottom, associating with reefs, wrecks, oyster bars, outcroppings and manmade structure. They are predaceous fishes, relying on swift rushes and large mouths to capture their prey. Although black sea bass are not schooling fish, they can be found in large aggregations around structure or during inshore-offshore migrations.

Currently, the MAFMC, in cooperation with the Atlantic States Marine Fisheries Commission (ASMFC) is in the final stages of developing a coastal management plan for black sea bass. The tentative completion date for the plan is late 1996.

Life History

Spawning and larval development

Spawning in the Mid-Atlantic region takes place in continental shelf waters 59-148 feet deep (18-45 m; Musick and Mercer 1977), from June through October, with a peak in July and August off Virginia (Mercer 1978). In the cooler waters of Nantucket Sound, a spawning aggregation was observed with running ripe fish in water as shallow as 20 feet (6 m). These fish returned to the same spawning site on an annual basis (Kolek 1990). Spawning in the South Atlantic occurs from February through May. Black sea bass produce pelagic eggs which are buoyant and contain a single oil globule. Black sea bass two to five years old typically spawn about 280,000 eggs each. Mercer (1978) reported a range of 191,000-369,500 eggs per fish. Larval development takes place in coastal waters 2-50 miles (4-82 km) offshore; at depths up to 108 feet (0-33 m); at salinities of 30-35 parts per thousand (ppt.); and temperatures of 58-82^{0}F (14.3-28.0^{0}C, Kendall 1972).

Juvenile stage

Young black sea bass move inshore and assume a demersal estuarine existence when about 0.5 (13 mm) inches in total length. Nursery grounds include estuaries, bays and sounds along most of the Atlantic coast, especially from Cape Cod, Massachusetts to Cape Canaveral, Florida. Upon reaching the estuaries, juvenile black sea bass find shelter in beds of submerged aquatic vegetation (SAV); oyster reefs; and among wharves, pilings and other structure found in shallow inshore areas. Young black sea bass feed primarily on crustaceans, such as shrimp, amphipods and isopods, while adults rely on crabs and fish for the major part of their diet (Kendall 1977).

Data collected by the Virginia Institute of Marine Science (VIMS) indicate juvenile black sea bass typically enter Chesapeake Bay waters during April and remain until December (Geer *et al.* 1990; Bonzek *et al.* 1991, 1992). Large fish overwinter in depths of 60-650 feet (20-200 m; USFWS 1978), although some young-of-the-year (YOY) may remain in Chesapeake Bay throughout the winter. During the summer, peak abundance of black sea bass occurs at depths less than 121 feet (37 m; Musick and Mercer 1977). Juvenile black sea bass occur in salinities from 8 to 38 ppt. and temperatures between 46-86^{0}F (7.8-30^{0}C). In Chesapeake Bay, black sea bass have been captured as far north as the mouth of the Chester River, but most fish encountered near shore are juveniles (one to two-year-olds). Trawl surveys, conducted by VIMS, in the Virginia portion of the Bay and its three major tributaries, indicate that YOY and yearling black sea bass are rarely found in waters where the salinity is less than 12 ppt and are most common at salinities above 18 ppt (Musick and Mercer 1977). The average size of black sea bass caught by the VIMS juvenile finfish trawl survey in the Chesapeake Bay was 4.0 inches (101 mm) in 1989, 4.2 inches (107 mm) in 1990, and 4.0 inches (101 mm) in 1991 (Bonzek *et al.* 1991, 1992). Black sea bass have occasionally been caught in the Maryland Striped Bass Gill Net Survey during winter. Data on length frequency indicate two and three-year-old fish overwinter north of the Bay bridges [the ones near Annapolis].

North of Chesapeake Bay, juveniles leave nursery areas in the fall and return in the spring. In the South Atlantic, juvenile fish remain in nursery areas year-round. Juveniles in Chesapeake Bay probably move to deeper water, but may remain inshore year-round, especially during mild winters. If the juveniles do move to deeper waters in the winter, they return to shallower, inshore nursery areas during March, departing these areas again in December (Musick and Mercer 1977). As the fish grow larger, they gradually move to deeper water, while remaining in close association with structure. In addition, larger fish begin offshore migrations earlier than do smaller ones. Most black sea bass permanently leave inshore waters for coastal and ocean habitats by the time they reach a length of about ten inches (253 mm) and are approximately three years old.

Adults and reproduction

In waters north of Cape Hatteras, adult black sea bass migrate inshore and northward with rising water temperatures in the spring. They return to coastal and ocean waters, moving southward and offshore in the fall, as water temperatures drop below 46^{0}F (8^{0}C). This migration pattern varies somewhat with age; larger, older fish venture farther offshore and smaller fish remain closer to the estuaries. The northern stock typically overwinters along the 100-meter depth contour off the Virginia and Maryland coast (NOAA 1993). In the warmer waters of the South

Atlantic, black sea bass do not extensively migrate. Annual mortality for the black sea bass population north of Cape Hatteras, estimated from commercial pot and trawl data, was between 57% and 71% (Mercer 1978). Black sea bass length and age off Virginia averaged 3.7, 8.0, 10.3, 12.2, 13.9, and 15.7 inches at ages one through six, respectively (Figure 1). Growth rates vary according to the sexual state of an individual fish (Shepherd and Idoine 1992), with male fish growing faster than females (Mercer 1978, Lavenda 1949). Mercer (1978) found significantly faster growth rates in black sea bass from the Mid-Atlantic Bight than those from the South Atlantic. Black sea bass are thought to grow to a maximum of 24-25 inches in length (610-635 mm; Lavenda 1949, Mercer 1978) and 15-20 years of age (NMFS 1995, Lavenda 1949). However, a sample of almost 3,000 fish taken from the Mid-Atlantic, between 1973 and 1975, yielded a maximum age of only nine years, with few fish over six years old (Mercer 1978). This depressed maximum age is probably the result of overfishing since the mid 1970s.

Fifty percent of fish are sexually mature at 7.7 inches (19.6 cm) and two years old (NOAA 1993). A 1:1 ratio of male to female fish is not reached until the average total length of individuals in a year class is approximately 13.3 inches (34 cm) or the average age is approximately five years old (Mercer 1978). Black sea bass are protogynous hermaphrodites, with individual fish functioning first as females, then later in life as males. Sex reversal may not occur in all specimens, only 38% of the females in the Middle Atlantic and 23% in the South Atlantic were observed to be hermaphroditic (Mercer 1978). The phenomenon of sex reversal in black sea bass has been demonstrated through histological examination of gonadal tissue (Mercer 1978) and through the recapture of fish that had changed sex since being tagged (Kolek 1990).

In the Mid-Atlantic region, the average size at sex reversal is 9.4-13.3 inches (239-337 mm; MAFMC/ASMFC 1993, Mercer 1978); most fish below this size are females. The highest frequency of transitional individuals occurs from August through April, indicating sex reversal is probably a post-spawning event. Social interaction may play a role in sexual transformation, with the removal of large male fish from a local population inducing one or more of the largest remaining females to change sex and assume the male role. This process has been demonstrated for other protogynous serranid hermaphrodites (Fichelson 1970), but has not been conclusively shown in black sea bass.

Note: All lengths attributed to Mercer's work have been converted to total length (TL) from her measurements taken in standard length (SL). A formula (TL=1.42(SL)-30.5, all measurements in mm) provided by Dr. Chris Moore (pers. comm., 1993) and taken from measurements provided by National Marine Fisheries Service (NMFS) Northeast Fisheries Science Center (NEFSC) surveys was used for the conversion.

Table 1
Biological Profile

	Larvae	YOY	Subadults/adults
Location	2-50 mi (4-82 km) off the coast from N.C. to Delaware (Kendall 1972)	Move into Chesapeake Bay (VIMS Trawl Surveys 1989-1990)	Warmer months, inshore waters; fall and winter, offshore : Northern stock typically stays along 100-m contour (NOAA 1993)
Season	June-October (Mercer 1978)	April-December (Geer *et al.* 1990 and Bonzek *et al.* 1991, 1992)	Varies with season
Salinity	30-35 ppt (Kendall 1972)	8-38 ppt (Cupka *et al.* 1973)	12-38 ppt; prefer 18ppt (Musick and Mercer 1977)
Temperature	58-82°F, (14-28° C) (Kendall 1972)	46-86° F (8-30° C) (Cupka *et al.* 1973)	42-86°F (6-30°C) (Cupka *et al.* 1973)

The Fisheries

Black sea bass support important recreational and commercial fisheries along the Atlantic coast. Black sea bass landings from the recreational fishery are slightly greater than those from the commercial fishery. Recreational surveys conducted in 1960, 1965, and 1970 estimated that the catch from the recreational fishery exceeded the commercial landings north and south of Cape Hatteras, North Carolina during each survey period (Mercer 1978). Between 1983 and 1994, the commercial portion of the northeastern Atlantic coast sea bass catch was 47% of the total catch; 53% of the catch is recreational. Average landings were 3.4 million pounds for the commercial fishery and 3.8 million pounds for the recreational fishery (1983-1994). An average of 84% of the commercial landings came from the EEZ (1983-1994). Between 1983-1992 the mid-Atlantic region has harvested a wide range of percentages, from 49% to 86%, of the northeastern commercial coastal catch. (MAFMC 1996).

Table 2
Fishery Parameters

Status of exploitation:	Overexploited (MAFMC 1991b).
Long-term potential	Historical catches have been as high catch as 21.8 million pounds coastwide (NOAA 1989).
Importance of recreational fishery:	Significant. The recreational landings of black sea bass are slightly greater than the commercial landings.
Importance of commercial fishery:	Significant. Especially in the commercial Exclusive Economic Zone (EEZ), which extends from 3-200 miles offshore and is under the jurisdiction of the MAFMC. Black sea bass have traditionally brought a high price per pound ($1.22/lb., 1992 dockside value, VMRC data).
Fishing mortality rates:	The average estimated fishing mortality rate was approximately 1.39 (70% exploitation rate) between 1984 and 1993. The recommended rate is F_{max}= 0.29 or 23% annual exploitation.

Commercial fishery

In 1952, over 21 million pounds of black sea bass were harvested from the Atlantic coast (Figure 2), with Virginia landings comprising almost half of the record catch (Figure 3). Virginia landings, as well as coastal landings, dropped slightly after 1952, but remained steady until the mid-1960s, when both began to decline. In 1971, the record low coastal catch of 2.6 million pounds was reached. Since the early 1970s, landings have increased slightly and are holding at a fairly constant, but historically low, level. Maryland landings have been low but constant since the 1950s (Mercer 1978).

Annual landings of Virginia's commercial black sea bass averaged 868,000 pounds (Figure 4) and Maryland's commercial landings averaged 355,000 pounds over the last 12 years (Figure 5). Virginia ranked second among other Atlantic coast states (1983-1994), with 24% of the total commercial black sea bass landings. Maryland's average commercial landings were about 10% of the coastal total. From 1983-1990, an average of 97% of Maryland's commercial black sea bass harvest came from federal waters. In this same time period, an average of 96% of Virginia's commercial black sea bass harvest also came from federal waters (MAFMC 1994).

Commercial fishing gear used to harvest black sea bass include trawls, pots (traps), and hook and line. Coastwide, trawls accounted for about 64% of the total commercial black sea bass landings during the 1960s and 1970s, with pots providing 35% of the total (Mercer 1978, Frame and Pearce 1973). From 1983 through 1992, otter trawls caught about 56% of the total coastwide commercial landings. Fish pots accounted for 33% of the commercial landings; hook and line provided an additional 5% (Moore 1993). Black sea bass landed commercially in Virginia have been harvested primarily by otter trawls (Figure 6; NMFS 1983-1992), often as bycatch. Large numbers of black sea bass are traditionally caught by trawlers while the fish are migrating to and from offshore wintering grounds. Their association with rough bottom makes them inaccessible to traditional trawl gear at other times of the year. Historically, trawl landings are primarily a fall and winter occurrence, coincidental with the summer flounder, scup and butterfish trawl fisheries (Shepherd and Terceiro 1992). Associations have been demonstrated for black sea bass, summer flounder and scup using fishery-independent data (Musick and Mercer 1977) and commercial harvest data. Over 50% of commercial trawl trips that landed either black sea bass, summer flounder or scup (1982-1990) also landed at least one of the other two species (Shepherd and Terceiro 1992).

Other gear types used in Virginia included fish pots (7.7%) and hook and line (9.9%) (Figure 7). Beginning in the late 1970s, there was a steady decline in the percentage of black sea bass landed in Virginia by trawl. In addition to this general decline, in 1989, all trawling in Virginia waters was prohibited. As the number of black sea bass landings from trawl boats decreased, landings from other gear types, namely pots, wooden traps and hook/line increased significantly. From 1983-1992, Maryland's commercial sea bass fishery consisted primarily of landings from fish pots (90%), followed by otter trawls (9%) and hook and line (1%) (Figure 8).

A commercial pot fishery exists off Chincoteague and Virginia Beach, VA. Pot fishermen in Maryland and New Jersey use a mesh-type or roller-type apparatus, commonly referred to as a grader, to cull undersize fish from the catch. The extent of this practice in the Chesapeake Bay region is unknown. The commercial black sea bass pot fishery off Ocean City, Maryland, usually begins in mid-April and continues until the end of October. In 1995, there were six boats that participated in the fishery. The pots are generally tended every four to ten days. Pots are mostly constructed of wooden slat, but occasionally, wire pots are used. Escape vents, rings, or larger spaces between slats are not used. A cull box with spacing to allow small bass to pass through is used by at least two of the boats.

Most of the fishing in Maryland is conducted less than 30 miles offshore and in less than 30 fathoms of water (180 ft. or 55 m). Because structure is an important habitat for black sea bass, fishing effort is concentrated around wrecks and reefs. Seven- to eight-inch bass is the current minimum size accepted by the market. Smaller bass can be bought and are used for crab bait. The number of pots fished during the season varies between 500 and 1500 per boat, with an average of 700-800 per boat (A. Wesche, MDNR, pers. comm.)

A commercial hook and line fishery harvests black sea bass off Virginia Beach, VA. The Virginia hook and line commercial fishery generated the majority of its 1991 and 1992 landings from October to November, with a secondary peak from January through March (Figure 9).

The existence of a commercial hook and line fishery for black sea bass is testimony to their value as a food fish. Black sea bass consistently command one of the highest dollar values of any of Virginia's finfish. Larger fish are targeted in the hook and line fishery due to their higher value per pound. Although Virginia's average price per pound in 1992 was $1.22, dockside prices ranged from $0.50 for small fish up to $3.00-4.00 for jumbo grade fish (VMRC data). Maryland's average price per pound in 1992 ranged from $0.45 for small black sea bass to $2.80 for the large size. The average price per pound during 1992 was $0.92 (NMFS data). In 1993, the average price per pound increased to $1.15 (NMFS data).

During the winter of 1992/93, some trawlers working off the northeastern coast (New York-New Jersey) began targeting black sea bass with a new type of trawl gear, commonly named the "rockhopper". Rockhoppers consist of trawls with rollers (cookies) added to the footrope, so towing over naturally rough bottom was possible. Members of the MAFMC have expressed concern over the potential impact of this new gear type on both black sea bass populations and the bottom structure itself. Although live bottom reef habitat is virtually nonexistent off the Virginia coast, it is common from southern North Carolina southward (Struhsaker 1969); therefore, the potential impact of this gear type is not limited to the northeast. It is important to again note, that in 1989 all trawling was prohibited in Virginia state waters.

Recreational fishery

Approximately 35% of the Mid-Atlantic coast recreational black sea bass landings were harvested from state waters, which includes bay waters out to 3 miles (1983-1994). From 1983 through 1994, an average of 95% of the recreational catch was caught from the mid-Atlantic region, 1% from the North Carolina area (north of Cape Hatteras, NC), and 4% from New England. Virginia's average annual recreational harvest of black sea bass from 1983-1992 was 916,906 pounds. Maryland's average annual recreational harvest for this same time period was 1,811,733 pounds (Figure 10). Since 1986, there has been a steady decline in the number of black sea bass citations in Virginia (Figure 11). Citations are certificates which acknowledge that a person has caught what that state considers a large fish for that particular species. In the mid-Atlantic region, 74% of the black sea bass were caught by party or charter boats, 21% from private boats and 1% from shore (Tables 11 & 12; MAFMC 1992). Black sea bass are the main species caught over artificial reefs in the mid-Atlantic region.

Black sea bass are also the primary targeted species for headboats operating off Virginia Beach and are one of the first fish encountered in the spring and the last pursued in the fall. Their predictable occurrence on coastal wrecks, extended seasonal presence in nearshore waters, and amenability to headboat fishing practices make them a favorite for this type of fishing. The tendency of black sea bass to remain near cover often allows large catches to be made after productive structure is located.

Problems and Concerns

Development of a minimum size

Over the last several years, the MAFMC black sea bass technical committee has recommended several ways to reduce exploitation, including the implementation of a minimum size limit. The MAFMC and ASMFC have approved a recovery strategy to reduce black sea bass fishing mortality rate from 60% to 23% over an 8-year period. The recommendations include the implementation of a 9 inch minimum size limit for the first two years (1996-97). This is estimated to reduce exploitation by 20%. Beginning in year three, the size limit will be determined annually, based on current estimates of stock status. Commercial gear restrictions, such as minimum mesh sizes and minimum escape vents, are also recommended.

The determination of a minimum size limit is a complex issue, especially when sexual transformation occurs in a significant portion of the population. In the case of black sea bass, matters are further complicated by the fact that fundamental biological information on sexual transformation is limited. Only a few studies on black sea bass transformation exist and the findings of these studies indicate possible stock differences.

The 1996 MAFMC draft plan states that the highest probability that a female will transform to a male on the Atlantic coast occurs between 8.9 and 9.4 inches. The best available data from the Chesapeake Bay region indicates that, although a length of between 8.9 and 9.4 inches at transformation is appropriate for fish from the South Atlantic, fish from the mid-Atlantic range may change sex at a larger size (Mercer 1978; Figure 12). Further research in this area is necessary to clarify the minimum size that best protects the spawning stock as well as increases yield per recruit.

At present, the baywide adoption of a strategy to reduce exploitation similar to the MAFMC plan will promote uniform and effective management of black sea bass among the coastal states and federal agencies. This coordinated effort is vital when managing a migratory species such as black sea bass.

Vital black sea bass habitat is degrading

Coastal and estuarine habitats, namely submerged aquatic vegetation (SAV), tidal wetlands, and natural reef systems, provide vital food and refuge for both juvenile and adult black sea bass. All of these nearshore and inshore ecosystems have experienced great declines in both quality and quantity over recent decades, due to increased anthropogenic activities. The degradation of these habitats pose a serious threat to the health of the black sea bass population, which rely on shallow water, nearshore environments.

Elevated nutrient loadings from agriculture and urban runoff into the Bay, as well as increased urbanization, industrial development and shoreline alterations have all contributed to the decline of water quality. Productive nearshore aquatic habitats namely, SAV and wetlands, has also decreased. Poor water quality, the invasion of oyster pathogens, and the oyster harvest techniques have all contributed to the demise of the natural reef system in Chesapeake Bay. Recently, management efforts have intensified to restore and protect these important shallow-water nursery and sanctuary grounds.

Aquatic Reefs

Aquatic reefs are the most important and well-documented type of natural habitat used by both the juvenile and adult black sea bass (Figure 13). As black sea bass grow larger, they gradually move to deeper water while remaining in close association with structure (Musick and Mercer 1977). They inhabit areas of rough bottom, associating with reefs, wrecks, oyster bars, outcroppings and manmade structure. Black sea bass can be found in large aggregations around structure or during inshore-offshore migrations.

Healthy oyster reefs were once abundant in Chesapeake Bay and coastal waters. They provided major habitat for many important commercial fisheries. The salinity range for the oyster is approximately 12-27 ppt. The average minimum salinity value is approximately the same for oysters and black sea bass. Black sea bass, tautog and cobia inhabited reefs found in mid- to high-salinity waters in the middle and lower Bay regions. The healthy reefs provided the fish with food and shelter. Reefs provide an abundance of small invertebrates and shellfish, such as mussels and clams, which are important prey items for finfish (Chesapeake Bay Program 1994b).

Oyster reefs are created by the vertical and horizontal colonization of oysters, which use one another as a place for attachment. The three-dimensional nature of this community provides increased surface area and allows for greater biotic diversity. In addition to providing increased food and refuge for a variety of marine organisms, healthy reefs played a vital role in maintaining Bay water quality. As filter feeders, oysters remove tremendous quantities of algae and suspended particles from the water column, improving clarity and circulation. Oysters also played a primary role in nutrient recycling. Researchers have postulated that the downward shifts in water quality over the last several decades have contributed to a loss of historical oyster reefs in the Bay (Chesapeake Bay Program 1994b).

Of the recorded 243,000 acres of public oyster grounds (Baylor Grounds) in Virginia waters of Chesapeake Bay, less than 5% of this recorded acreage is still growing and producing healthy oysters (Wesson, pers. comm. 1996). Additionally, these last remaining oyster grounds are generally found in salinities below the minimum salinity tolerance of black sea bass and are probably not inhabited by the bass. Pollution, disease, harvesting pressure, and harvesting methods all contributed to the degraded status of oyster populations. Although remaining shell structures from "dead" reefs still offer some shelter and food to Bay finfish, the restoration of oyster reefs in Chesapeake Bay will provide ideal habitat for finfish species and should help improve water quality in the Bay.

Both Virginia and Maryland have implemented an oyster reef repletion program. New oyster shells are added to existing reefs and old shells are sometimes rearranged to provide better substrate for new settlement. Virginia is also experimenting with a technique for restoring the vertical profile to natural oyster reefs (Chesapeake Bay Program 1995).

Artificial Reefs

Reef habitat for juvenile and adult black sea bass has expanded through the use of artificial reef structures in both Virginia and Maryland waters. Artificial reef structures attract black sea bass, tautog, scup and other species of fish by providing shelter. Finfish may gather within days after shelter deployment. In addition to providing shelter, an overlay of encrusting marine organisms subsequently develops on the artificial structure, serving as the basis of the food chain around the reef. Artificial reef structures provide important habitat for juvenile and adult black sea bass along the coast and nursery areas for juveniles in Chesapeake Bay (See Figure 14).

Virginia's state-supported artificial reef program, a division under the Virginia Marine Resources Commission (VMRC), began in the early 1970s as an outgrowth of private efforts. Virginia now has a total of 11 sites extending from Gwynns Island , in the Bay, to the Triangle Wreck site about 30 miles offshore. Of the 11 reef sites, seven sites are located in bay waters and total 1,981.5 acres. Various materials have been used to construct these reefs including Liberty Ships, tire-in-concrete units, donated bridge and concrete pipe materials, and newer concrete structures designed specifically for the artificial reef program. More stringent environmental standards have curtailed the use of junked automobiles and wooden vessels.

The Maryland Reef Program supplements hard substrate habitats in Chesapeake Bay and coastal Atlantic Ocean. The program provides policy and guidelines for rebuilding and restoring reefs as habitat for oysters and other ecologically valuable aquatic species. The objective of the reef program is to provide habitat enabling the colonization of benthic communities and associated fish communities. The creation of reefs benefits the finfish community, especially reef-dwelling fish such as the black sea bass. Artificial reefs contribute to the abundance and diversity of filter-feeding organisms and increase the diversity and complexity of aquatic plants and animals at the site.

Maryland has 5,700 acres allocated to 20 reefs within Chesapeake Bay. Seven charted reef sites, between 1-18 miles offshore, stretch down Maryland's 33 miles of Atlantic coastline. Hard substrate with a high profile is being used to restore the substructure upon which the benthic epifauna, similar to the oyster reef community, can attach. Four sites totaling 3,800 acres are under development in 1995-1996. Maryland will continue to use the criteria for reef material, adopted by the ASMFC, during the development of these sites.

Submerged Aquatic Vegetation (SAV) and Coastal Wetlands

Young black sea bass move inshore and assume a demersal estuarine existence when they are approximately 0.5 inches (13 mm) in total length. Nursery grounds include estuaries, bays, and sounds along most of the Atlantic coast, where juvenile black sea bass rely heavily on shallow inshore aquatic habitats. SAV and estuarine wetlands are among the most productive of these shallow water environments. Vegetated areas generally yield greater fish densities than nonvegetated areas (Chesapeake Executive Council 1994, Funderburk 1991) because of food abundance and shelter from predation. Young black sea bass feed primarily on crustaceans, such as shrimp, amphipods and isopods (Kendall 1977), which are abundant on and among the SAV.

Data collected by the Virginia Institute of Marine Science (VIMS) indicate juvenile black sea bass typically enter Chesapeake Bay waters during April and remain until December (Geer *et al.* 1990; Bonzek *et al.* 1991, 1992). Trawl surveys, conducted by VIMS, in the Virginia portion of the Bay and its three major tributaries, indicate that young-of-the-year (YOY) and yearling black sea bass are occasionally found in waters where the salinity is 8 ppt, but usually inhabit waters where the salinity is above 12 ppt. Studies indicate that juvenile black sea bass are most common at salinities above 18 ppt (Musick and Mercer 1977). With a minimum salinity tolerance of 12 ppt and a maximum tolerance of 38 ppt, juvenile black sea bass are most likely to inhabit species of SAV commonly found in the middle to lower portions of the Bay and the lower portions of the major tributaries (Figure 14).

Ruppia maritima (widgeon grass) and *Zostera marina* (eelgrass) are commonly found in the black sea bass salinity regimes, including the mesohaline (5-18 ppt) and the polyhaline (18-30 ppt) areas of the Bay. *Spartina alterniflora* (saltmarsh cordgrass) is often the dominant plant in coastal marshes and is one of the most productive species in tidal wetlands. The cordgrass community is an important nursery area for many juvenile finfish including black sea bass.

In addition to providing vital nursery habitat to juvenile finfish, SAV and estuarine wetlands play important roles in maintaining good water quality for all marine species in the Bay. SAV and wetlands utilize nutrients and trap sediments entering the bay from agricultural and urban runoff. Lower nutrient levels decrease the likelihood of destructive algae blooms, which contribute to low dissolved oxygen levels and decreased water clarity in the estuarine environment.

In Chesapeake Bay, SAV underwent a dramatic decline from the late 1960s though the early 1980s. The decline was attributed, in part, to increased nutrient enrichment and sedimentation as a result of human population growth and changes in land use in the watershed (Kemp *et al.* 1983). Increased physical disturbance due to shoreline alterations, unregulated dredging activities, and intense boat traffic contributed to the decline of SAV. In 1976, the decline of SAV was chosen as one of the top three problems in the Bay by regional scientists and resource managers.

Researchers believe that recent efforts to improve water quality, through nutrient input reductions and managed shoreline development, have influenced the recovery of SAV in Chesapeake Bay (Maryland Sea Grant 1994). SAV acreage has increased from a 1984 low of 37,000 acres to just under 60,000 acres in the Bay and its tributaries in 1995 (VIMS data 1984-1995). Chesapeake Bay Program scientists estimate that historically 400,000 to 600,000 acres of SAV might have existed (Maryland Sea Grant College 1994).

Over several decades, wetland acreage has also significantly declined, as coastal development and land use pressures continue to increase. The U.S. Fish and Wildlife Service reported that of the 1.7 million acres of wetlands in the Chesapeake watershed, 12% are estuarine wetlands. Between 1982 and 1989, net losses of Chesapeake Bay estuarine wetlands averaged approximately 129 acres per year (Tiner 1994). This, however, is a significant reduction over the annual loss rate of 2,800 acres per year prior to actions to protect this resource throughout the Bay.

Water quality

The general decline in baywide water quality is directly and indirectly linked to the decline of vital black sea bass habitats such as oyster reefs, SAV, and wetlands. As stated above, increased nutrient inputs into the Bay from agriculture and urban runoff, as well as increased urbanization, industrial development and shoreline alterations, have negatively impacted water quality.

In 1987, efforts to improve water quality were assigned high priority by scientists and resource managers. Under the *1987 Chesapeake Bay Agreement* (Chesapeake Bay Program 1987), Virginia, Maryland, Pennsylvania, the District of Columbia, the Chesapeake Bay Commission, and the U.S. Environmental Protection Agency formally agreed to reduce and control point and nonpoint source pollution to improve water quality in the Bay. Also under that same agreement, the signatories committed to developing, adopting, and beginning implementation of a basinwide strategy to achieve a reduction of toxics that would ensure protection of human health and living resources. In 1992, the Tributary

Strategy Agreement was also developed. In 1992, the Bay Program partners committed to developing and implementing tributary-specific strategies for improving water quality (Chesapeake Bay Program 1992a). Nutrient reduction and pollution control programs have contributed to improvements in Baywide water quality, but more work needs to be done to reach and maintain the restoration goals.

FMP Status and Management Unit

Black sea bass from Maryland and Virginia waters are considered a unit stock and part of the northern black sea bass stock for management purposes. A coastwide management plan for the northern stock of black sea bass has been developed by the MAFMC, in conjunction with the ASMFC. As of mid-1996, this plan was in the final stages of adoption. The tentative date for completion is late 1996. Three species of sea basses in the south Atlantic are managed with snappers and groupers through the Fishery Management Plan for the Snapper-Grouper Fishery in the South Atlantic. The South Atlantic Fishery Management Council's (SAFMC) Snapper/Grouper FMP currently has an eight-inch total length minimum size for black sea bass south of Cape Hatteras, North Carolina. Recently, the Snapper/Grouper committee voted to consider a change in the minimum size limit from eight to ten inches (SAFMC 1995) but nothing to date was changed as a result of the consideration. In addition to the minimum size limit, the SAFMC requires that all black sea bass traps have a biodegradable door or panel fastern and a two inches square minimum open mesh area, with a one inch minimum length for the shortest side, a minimum distance of one inch between parallel sides of rectangular openings and 1.5 inches between parallel sides of mesh openings with more than four sides, and 1.9 inch minimum distance for diagonal measurement.

Status of the MAFMC black sea bass FMP

MAFMC originally planned to write a multi-species fishery management plan which included sea bass, summer flounder and scup because of their co-occurrence in the trawl fishery (Moore, pers. comm., 1993). The very high annual mortality rate in the summer flounder fishery and the desire to protect the first two good flounder spawns in seven years led the Council to draft an amendment to the summer flounder plan and defer work on sea bass and scup until 1994.

The MAFMC and the ASMFC have recommended a recovery program for black sea bass that extends over eight years and reduces exploitation from 60% (1994) to 23%. Exploitation is related to estimates of mortality and is the *fraction* of a population at a given time that is removed by fishing over the course of a year (Ricker, 1975); exploitation may also be expressed as a percentage of the population. During years one (1996) and two (1997), a minimum size limit and commercial gear restrictions will be implemented. A 20% reduction in exploitation should occur with a nine inch size limit for black sea bass, based on fish measured from the Marine Recreational Fishery Statistics Survey (MRFSS) (1990-1994). This calculation assumes a post-release mortality of 25% (MAFMC 1996). The nine inch minimum size limit will allow mature fish to spawn at least once and possibly twice. The length at which 50% of black sea bass are mature has been calculated at 7.5 inches. Because black sea bass are sequential hermaphrodites, which means they function first as females and then transform to males, the nine inch minimum size will also protect the greatest proportion of females. The protection of females is based on the highest probability of transformation from female to male which occurs between 8.9 inches and 9.4 inches. During years 1 and 2, the MAFMC will also implement federal requirements for operator, vessel and dealer permits and mandatory reporting. The data collected in the first two years will provide the information for evaluating the effectiveness of management efforts, monitor the reductions in exploitation and increases in stock size, and support any additional management measures for attaining the target exploitation rates.

In years three to five after adoption of the management plan, the target exploitation is 48%. Recommendations include a commercial quota and recreational creel limits. Reevaluation of the minimum size limit, minimum mesh size, escape vent size possession limit, and recreational season is recommended. These recommendations would be evaluated and implemented in a timely manner. For example, seasonal closures for the commercial fishery, recreational creel limits, and commercial quotas and their associated reductions in exploitation have already been evaluated based on available data.

In years six to seven, the target exploitation rate would be 37%. The MAFMC, working through a monitoring committee, will evaluate the success of management measures relative to the overfishing reduction goal and make adjustments accordingly. In year eight and subsequent years, the target exploitation rate would be based on F_{max} ,which is currently calculated at 0.29 or 23% annual exploitation. F_{max} is the level of fishing mortality that maximizes the yield (pounds) per recruit. It is used as a biological reference point to define overfishing. Annual exploitation is the percentage of a population at a given time that can be removed by fishing over the course of a year. Targeting a 23% annual exploitation for the black sea bass population would be considered the best yield (catch) that is possible without jeopardizing the sustainability of the population.

Directed fisheries for summer flounder, squid, scup, and whiting also harvest significant quantities of black sea bass. Because of the multispecies nature of the trawl fishery and the predominance of summer flounder as the targeted species (Shepherd and Terceiro 1992), some reduction in fishing mortality and bycatch of small fish has undoubtedly resulted from the 5.5-inch minimum mesh size imposed on directed summer flounder trips by Amendment #2 to the *Fishery Management Plan for Summer Flounder*, which became effective in December 1992. The 5.5-inch mesh may allow sea bass up to at least 11-12 inches to escape from flounder trawl tailbags (Shepherd, pers. comm., 1994).

Mortality from the release of small sea bass in hook and line fisheries could be important, because a large percentage of the fish caught are released in some areas of the fishery (over 36% in the South Atlantic, Vaughan *et al.* 1992). Hooking mortality has been estimated at 5% (Bugley and Shepherd 1991), but this study was done in relatively shallow water and others feel hooking mortality is depth-dependent and could be greater (Vaughan *et al.* 1992). For calculating the effects of exploitation, the MAFMC "assumes" a 25% post-release mortality.

A target biomass for maintaining sufficient spawning stock has been suggested as 22-30% of total mature biomass in the South Atlantic (Vaughan *et al.* 1992). Spawning stock biomass (SSB) is the weight of all adult females in the population. It is calculated as the number of individual females in each year-class times the percent that are mature times their average weight. A SSB of 22-30% should protect an adequate portion of the black sea bass stock until they can spawn at least one time and is thought to be large enough to protect the stock from changes in population abundance due to sexual transformation.

Research Needs for Black Sea Bass

1. Conduct seasonal distribution and migration research to emphasize size distribution and sex ratios from various areas.

2. Conduct more experiments determining average size/age at sex reversal, specific to Chesapeake Bay, with Yield Per Recruit (YPR) studies based on the size results and research to determine Spawning Stock Biomass (SSB) and Spawning Stock Biomass per Recruit (SSBR). This information would allow more precision in a stock assessment.

3. Determine the spawning areas, extent of spawning production, and estimate of optimum sizes for male and female fish to generate maximum viable egg production.

4. Determine local estimates of fishing mortality and natural mortality for age classes.

5. Examine the extent of the pot fishery, including seasonality, magnitude of its catch, size and sex distribution of black sea bass in this fishery.

6. Investigate the size and sex distribution of black sea bass catch in the trawl fishery.

7. Quantifiy the composition of diet and seasonal changes in diet (i.e. seasonal importance of mytilus and other reef fauna).

8. Conduct research on the optimal acreage of black sea bass habitat ie., determine what size SAV bed or oyster reef is best for nursery and refuge grounds for juvenile black sea bass.

Note: A tagging study could provide simultaneous estimates of several of these parameters, given sufficient time and resources. It would be beneficial to include work on tautog in the proposed study, if possible. The co-occurrence of these two species, their similar biological needs, and mutual dependence on limited reef habitat, would make combined research practical.

SECTION 2
BLACK SEA BASS MANAGEMENT

Problem Areas and Management Strategies

Problem 1: Overfishing

Recent stock assessments indicate that black sea bass stocks are overfished. The average fishing mortality rate (F) over the last decade is approximately 1.39 or 70% exploitation. The recommended fishing mortality rate is 0.29 or 23% exploitation (NMFS 1995).

Problem 1.1: High Fishing Mortality Rates and decline in spawning stock.

Results of a virtual population analysis indicate that the 1995 fishing mortality rate (F) is 1.05, which is significantly higher than the recommended fishing mortality rate of 0.29. (MAFMC 1995). This overfished condition may have existed since at least the mid-1970s (Mercer 1979). Current yield-per-recruit (YPR) is about 0.27 pounds (NMFS 1995). This trend has depressed the yield and economic return from the commercial fishery, the yield and economic return in the recreational fishery, and has contributed to a decline in the spawning stock.

Strategy 1.1

Reduce fishing mortality, increase YPR and provide more escape opportunities for small black sea bass to the spawning stock. A maximum spawning potential level of 22-30% should be achieved.

Action 1.1

A) The Bay jurisdictions will implement a nine inch minimum size limit for the commercial and recreational black sea bass fisheries in year one (1996) and two (1997) of the plan. Beginning in year three, the minimum size will be determined by the MAFMC on an annual basis. Regulations will be written so that they are applicable to all fish landed in a state, whether caught in state or federal waters.
Implementation: 1996

B) Based on the MAFMC Monitoring Committee's evaluation of the success of the FMP relative to the overfishing reduction goal, additional restrictions such as seasonal closures, creel limits, quotas, and limited entry may be established.
Implementation: 1998

Problem 1.2: Catch of undersized black sea bass

The catch of undersized black sea bass in the directed fishery and the incidental bycatch of small black sea bass in non-directed fisheries may hinder efforts to rebuild the stock. Gear modifications, such as escape vents in pots, have been recommended to decrease the catch of small fish. There is some concern that black sea bass behavior may negate the use of escape vents. Black sea bass prefer dark, secure places to hide, like a pot or trap, and may not efficiently use an escape vent. If escape vents do work in black sea bass pots, requirements for escape vents in pots could significantly impact Maryland fishermen, because 90% of the harvest is caught in pots. Bycatch in fisheries targeting other species occurs in the ocean flynet fishery off North Carolina and shrimp trawl fisheries in the South Atlantic states.

Strategy 1.2

Management agencies will require the use of escape panels, trawl efficiency devices, selective mesh sizes, culling devices and/or other methods to promote gear efficiency and reduce bycatch. For example, graders have been used in the Maryland and New Jersey pot fishery to cull out undersize sea bass. Escape vents are proposed in the draft MAFMC plan as a method to cull undersize sea bass in the pot fishery.

Action 1.2

A) Virginia, Maryland and the Potomac River Fisheries Commission (PRFC) will investigate the potential for innovative devices designed to reduce the bycatch of juvenile finfish in non-selective fisheries. Continued testing of these bycatch reduction devices will be encouraged.
Implementation: Continue

B) Virginia and Maryland will work with the MAFMC/ASMFC to develop and require the use of more efficient gear consistent with policies designed to reduce bycatch and/or discards.
Implementation: Continue

C) Maryland will implement a mesh size of 4.0 inch diamond mesh for trawl vessels harvesting more than 100 pounds of black sea bass per trip. Changes in minimum mesh size will be implemented based on MAFMC/ASMFC recommendations. Virginia will continue its ban on trawling in state waters. PRFC will continue its ban on trawling in Potomac River.
Implementation: 1996

D) Virginia and Maryland will require escape vents in black sea bass pots based on the recommendations of MAFMC/ASMFC. The minimum size requirements will be considered after the MAFMC completes its study on escape vents.
Implementation: The escape vent provision will be implemented at the start of the first calendar year following the approval of the MAFMC Black Sea Bass FMP so that fishermen will not be required to pull their pots and rebuild them in the middle of the season.

E) The jurisdictions will define a black sea bass pot for enforcement requirements as recommended by the MAFMC.
Implementation: 1997

F) Virginia and Maryland will require that black sea bass pots and traps have biodegradable hinges and fasteners on one panel or door.
Implementation: The biodegradable hinges and fasteners provision will be implemented at the start of the first calendar year following the approval of the MAFMC *Black Sea Bass FMP* so that fishermen will not be required to pull their pots and rebuild them in the middle of the season.

Problem 2: Stock Assessment and Research Needs

Fishery managers lack some of the biological and fisheries data necessary for effective management of the black sea bass resource. The effects of sex reversal on yield-per-recruit (YPR), total yield, and spawning biomass in the sea bass fishery are not well understood. The ability of sea bass to change sex requires a more complex model than in other fisheries to predict the effect of minimum size regulations on spawning stock size and yield. The estimates of recreational and headboat catch and size composition are poor. Data on landings and size composition of commercial landings in the trawl, pot and hook and line fisheries could also be improved.

Strategy 2

Research will be encouraged on the effects of sex-reversal on yield and spawning biomass for black sea bass. Tagging studies could provide valuable information on sex-reversal for a relatively small cost. The initial models developed to estimate these effects will be refined. In the MAFMC black sea bass plan, sexual reversal will be investigated to determine if it is appropriate for the Chesapeake Bay region. The stock assessment departments of VMRC, MDNR and PRFC will monitor the commercial catch for changes in YPR subsequent to implementation of minimum size limits. More emphasis will be placed on surveys of the recreational black sea bass fishery to refine estimates of landings.

Problem 2.1: Sex-reversal

Effects of sex-reversal on black sea bass populations are unknown, as well as the effects of minimum size limits on the spawning stock.

Strategy 2.1

Virginia and Maryland will work with the Institute of Marine Science, Old Dominion University and the University of Maryland to promote research concerning the effects of sex-reversal. The stock assessment departments of VMRC, MDNR and PRFC will continue to collect information on size composition in commercial catches as part of a coastwide effort to monitor the effects of minimum sizes on black sea bass stocks.

Action 2.1

A) Research on the effects of hermaphrodism on yield, spawning stock and other parameters will be encouraged. VMRC's stock assessment department, in cooperation with VIMS, will attempt to determine the appropriate size at which sex-reversal takes place for black sea bass in this region.

Implementation: Continue

B) Virginia will continue it's annual Virginia Institute of Marine Science Trawl Survey, of estuarine finfish species and crabs found in Virginia Bay waters, to measure size, age, sex, distribution, abundance and catch-per-unit- effort (CPUE).

Implementation: Continue

Problem 2.2: Missing data

Data on inshore-offshore migration of black sea bass is lacking. The use of inshore areas (Chesapeake Bay and its tributaries) as nursery and juvenile habitat and offshore (coastal and open ocean) as adult and spawning habitat complicates management. Migration between these areas and how it affects mortality rates and stock estimates in each area is poorly understood.

Strategy 2.2

The jurisdictions will promote research to define movements and mortality of black sea bass between state and federal waters.

Action 2.2

A) VMRC's Stock Assessment Program will continue to collect biological data (age, size, sex) from commercial catches of black sea bass.

Implementation: Continue

B) Research on migration of black sea bass between inshore and offshore areas will be encouraged. Tagging experiments to provide data on black sea bass migration may be funded from sales of Virginia saltwater fishing licenses.

Implementation: Continue

C) PRFC will collect information on black sea bass harvested and discarded in the Potomac River pound net fishery as part of a two year pound net study funded by the Atlantic Coastal Fisheries Cooperative Management Act (ACFCMA).

Implementation: 1996-1997

Problem 2.3: Catch and effort statistics

Catch and effort statistics for the recreational and commercial black sea bass fisheries need to be improved for fisheries stock assessment.

Strategy 2.3

Maryland, Virginia and the PRFC will continue to support interjurisdictional efforts to maintain a comprehensive database on a baywide level.

Action 2.3

(A) Maryland, Virginia and the PRFC will continue to collect fisheries landings data on black sea bass as part of ongoing commercial fisheries statistics programs.
Implementation: Continue

B) Virginia will continue to supplement the Marine Recreational Fisheries Statistics Survey to obtain more detailed catch statistics at the state level. Virginia's new recreational saltwater fishing license may provide funding for more extensive surveys of the state's recreational fishery.
Implementation: Continue

C) Maryland will require mandatory reporting for all black sea bass landed in Maryland regardless of where they are harvested.
Implementation: 1997

Problem 3: Habitat degradation

Resource managers involved in habitat decisions should begin to recognize that, in some cases, habitat loss and degradation has as an important effect on fisheries as overfishing (Able and Kaiser 1994). This is especially true of species such as black sea bass that inhabit estuarine and coastal areas during critical life stages. Coastal and estuarine habitats, namely submerged aquatic vegetation (SAV), tidal wetlands and natural oyster reefs, provide shelter and food for both juvenile and adult black sea bass. In Chesapeake Bay, these nearshore and inshore areas have substantially declined in both quality and quantity over the past several decades. Increased nutrient loadings from agriculture and urban runoff into the Bay, as well as increased urbanization, industrial development and shoreline alterations have all contributed to the decline of SAV and wetlands, as well as the decline in water quality. Decreased water quality, the invasion of oyster pathogens, and the oyster harvest techniques have all contributed to the destruction of the natural oyster reef system. The degradation of these vital habitats pose a serious threat to the health of the black sea bass population.

Strategy 3

The jurisdictions will continue their ongoing commitment to develop: "guidelines for the protection of habitats and water quality conditions necessary to support the living resources found in the Chesapeake Bay system, and to use these guidelines in the implementation of water quality and habitat protection programs" (Chesapeake Executive Council 1987). They also will strive to develop and implement new and innovative habitat restoration strategies to evaluate and supplement the progress of these programs. The importance of coordinating and integrating these habitat restoration programs will also be stressed. Integration will aid the effective management of the Bay's ecosystem (Chesapeake Bay Program 1995).

Problem 3.1 The destruction of aquatic reefs

Oyster reefs, once plentiful in the Bay, have slowly been destroyed by oyster harvest techniques, water pollution, and the spread of oyster pathogens. Reef structures are important to both juvenile and adult black sea bass. They provide habitat for the dispersal of young fish, thereby, reducing predation and competition. Healthy reef systems attract large numbers of adult black sea bass, tautog, scup and other species of fish, providing them with food and shelter. Of the recorded 243,000 acres of public oyster grounds in Virginia waters (Baylor Grounds), only about 3,000 acres are still capable of producing healthy oysters (J. Wesson personal comm. 1996). At the same time that the aquatic reef programs work toward the restoration of the Bay's reef systems, artificial reef programs are gaining popularity. Artificial reefs provide manmade habitats for a variety of marine life that once relied on the oyster reefs for food and shelter. Both Virginia and Maryland will continue to increase available habitat for black sea bass through artificial reef programs.

Strategy 3.1a

Restoration of aquatic reefs would lead to increased habitat for black sea bass. Jurisdictions will continue to expand and improve their current oyster restoration programs with periodic program evaluations to ensure maximum success. Specific attention should be focused on aquatic reefs in the salinity range of the black seà bass (Figure 13).

Action 3.1a

A) Maryland and Virginia will continue the implementation of the 1994 *Oyster FMP* (Chesapeake Bay Program 1994b), which combines the recommendations of both the Virginia Holton Plan and the Maryland Roundtable Action Plan. Strategies in both Virginia and Maryland have recently taken a new focus as the programs intensify efforts to manage around the devastating oyster diseases, Dermo and MSX, currently infecting Chesapeake Bay oysters.
Implementation: Continued

B) Maryland and Virginia will continue the implementation of the *Aquatic Reef Habitat Plan* (Chesapeake Bay Program 1994). "The purpose of the Aquatic Reef Habitat Plan is to guide the development and implementation of a regional program to rebuild and restore reefs as habitat for oysters and other ecologically valuable aquatic species."
Implementation: Continued

Strategy 3.1b

The creation of new artificial reefs and the expansion and improvement of preexisting reefs will provide additional habitat for the black sea bass population. Again, when the decisions are made concerning new reef locations and monies are spent on their development, the importance of this habitat to black sea bass should be considered.

Action 3.1b
A) Jurisdictions will continue to maintain, expand, and improve their artificial reef programs. In 1995, Virginia developed two new reefs within the Bay and expanded two existing sites.
Implementation: Continued

B) Virginia has recently prohibited the use of all gear except recreational rod and reel, hand-line, spear, or gig on four artificial reefs in state waters. The result of this regulation is similar to the MAFMC/ASMFC Special Management Zones that protect vital black sea bass habitat.
Implementation: Continued

Problem 3.2: The degradation of SAV

Submerged aquatic vegetation (SAV) provides important food and shelter to developing juvenile black sea bass. Vegetated areas generally yield greater fish densities than nonvegetated areas (Funderburk 1991) because of food abundance and shelter from predation. In Chesapeake Bay, SAV underwent a dramatic decline from the late 1960s though the early 1980s. The decline was attributed, in part to increased nutrient enrichment and sedimentation as a result of population growth and changes in land use in the watershed (Kemp *et al.* 1983). Increased physical disturbance due to shoreline alterations, unregulated dredging activities, and intense boat traffic also contributed to the decline of SAV. In 1976, the decline of SAV was chosen as one of the top three problems in the Bay.

Researchers believe that recent efforts to improve water quality, though nutrient input reductions and reduced shoreline development, have influenced the recovery of SAV in Chesapeake Bay (Maryland Sea Grant 1994). SAV acreage has increased from a 1984 low of 37,000 acres to just under 60,000 acres in the Bay and its tributaries in 1995 (VIMS data 1984-1995). Chesapeake Bay Program scientists estimate that historically 400,000 to 600,000 acres of SAV might have existed. In 1993 the Chesapeake Executive Council adopted an "interim SAV restoration goal" of 114,000 acres Baywide. This goal corresponds to the first of three target restoration goals established by the Chesapeake Bay Program:

- **Tier I.** Restore SAV baywide to areas currently or previously inhabited by SAV as mapped through aerial surveys conducted 1971-1990. If current recovery rates continue, this goal (114,000 acres) will be achieved by the year 2005.

- **Tier II.** Restore SAV to all shallow water areas delineated as existing or potential SAV habitat down to the one meter depth contour.

- **Tier III.** Restore SAV to all shallow water areas delineated as existing or potential SAV habitat down to the two meter depth contour (611,000 acres) (Figure 14.).

Strategy 3.2

Jurisdictions will continue efforts to: "achieve a net gain in submerged aquatic vegetation distribution, abundance, and species diversity in the Chesapeake Bay and its tributaries over current populations" (Chesapeake Executive Council 1990) by the following actions:

Action 3.2a

Protect existing SAV beds from further losses due to increased degradation of water quality, physical damage to the plants, or disruption to the local sedimentary environment as recommended by the *Chesapeake Bay Submerged Aquatic Vegetation Policy Implementation Plan* (Chesapeake Executive Council 1990).

The *Guidance for Protecting Submerged Aquatic Vegetation in Chesapeake Bay from Physical Disruption* (Chesapeake Bay Program 1995) was developed in response to the above action and should be used by agencies making decisions that influence SAV survival in Chesapeake Bay. The following recommendations from the guidance document should be strongly considered when making decisions that impact SAV, with special emphasis on SAV that falls within the salinity range of juvenile black sea bass (see Figure 14):

- Protect SAV and potential SAV habitat from physical disruption. Implement a tiered approach to SAV protection, giving highest priority to protecting Tier I and Tier II areas but also protecting Tier III areas from physical disruption.

- Avoid dredging, filling or construction activities that create turbidity sufficient to impact nearby SAV beds during the SAV growing season.

- Establish an appropriate undisturbed buffer around SAV beds to minimize the direct and indirect impacts on SAV from activities that significantly increase turbidity.

- Preserve natural shorelines. Stabilize shorelines, when needed, with marsh plantings as a first alternative. Use structures that cause the smallest increase in local wave energy where planting vegetation is not feasible.

- Educate the public about the potential negative effects of recreational and commercial boating on SAV and how to avoid or reduce them.

Implementation: Continue

Action 3.2b
Set and achieve regional water and habitat quality objectives that will result in restoration of submerged aquatic vegetation through natural revegetation as recommended by the *Chesapeake Bay Submerged Aquatic Vegetation Policy Implementation Plan* (Chesapeake Executive Council 1990).
Implementation: Continue

Action 3.2.c
Set regional submerged aquatic vegetation restoration goals in terms of acreage, abundance, and species diversity considering historical distribution records and estimates of potential habitat as recommended by the *Chesapeake Bay Submerged Aquatic Vegetation Policy Implementation Plan* (Chesapeake Executive Council 1990).
Implementation: Continue

The Submerged Aquatic Vegetation Habitat Requirements and Restoration Targets: A Technical Synthesis (Chesapeake Bay Program 1992), addressed the above two actions. It established the quantitative levels of relevant water quality parameters necessary to support continued survival, propagation and restoration of SAV, as well as established the regional SAV restoration target goals defined earlier in this section.

When choices must be made in selecting SAV restoration projects, to fund and support under the *Chesapeake Bay Submerged Aquatic Vegetation Policy Implementation Plan* (Chesapeake Executive Council 1990), specific attention should be given to action items that lead to the protection and restoration of SAV found within the juvenile black sea bass habitat range.

Problem 3.3 Wetland destruction and loss

Over the past forty years, wetlands have undergone a demise similar to SAV, as coastal development and land use pressures in the Chesapeake watershed continue to increase. The U.S. Fish and Wildlife Service reported that of the 1.7 million acres of wetlands in the Chesapeake watershed, 12 % are estuarine wetlands. Between the 1950s and 1970s, annual losses of Chesapeake Bay wetlands averaged over 2,800 acres (Tiner 1986). Although this average annual loss dropped to 129 acres from 1982 through 1989, the no net loss goal of the Chesapeake Bay Wetlands Policy has not yet been achieved. As coastal wetlands in Chesapeake Bay disappear so does vital black sea bass habitat; therefore, the protection and restoration of estuarine wetlands in the salinity range of the black sea bass, ie. the mesohaline and polyhaline range, should be given high priority in management decision-making.

Strategy 3.3

In 1988, the Chesapeake Executive Council adopted the *Chesapeake Bay Wetlands Policy* in recognition of the ecological and economic importance that wetlands play in the Chesapeake Bay. The *Wetlands Policy* establishes an immediate goal of no net loss with a long-term goal of a net resource gain for tidal and nontidal wetlands. (Chesapeake Executive Council 1990). It identifies specific actions necessary to achieve both the short term goal of the Policy, "no net loss" and the long term goal of "a net resource gain for tidal and nontidal wetlands.

Action 3.3

The Jurisdictions should strive towards achieving the following, especially in the salinity range of the black sea bass.

A) Define the resource through inventory and mapping activities.

B) Protect existing wetlands.

C) Rehabilitation, restoring and creating wetlands.

D) Improving Education

E) Further Research

Implementation: Continue

Problem 3.4: Degradation of water quality

Poor baywide water quality is partly to blame for the decline of estuarine and coastal habitats. Therefore, improvements in baywide water quality are paramount to protect black sea bass habitat.

Strategy 3.4

Jurisdictions will continue efforts to improve Baywide water quality through the efforts of programs established under the *1987 Chesapeake Bay Agreement* (Chesapeake Bay Program 1987). In addition, the jurisdictions will implement new strategies, based on recent program reevaluations, to strengthen deficient areas.

Action 3.4

A) Based on 1992 baywide nutrient reduction plan reevaluation, the jurisdictions will:

1. Expand program efforts to include the tributaries.
2. Intensify efforts to control nonpoint sources of pollution from agriculture and developed areas.
3. Improve on current point and nonpoint source control technologies.

Implementation: Continue

B) Based on the 1994 *Chesapeake Bay Program Toxics Reduction Strategy Reevaluation Report* (Chesapeake Bay Program, 1994a) the jurisdictions will emphasize the following four areas:

1. Pollution Prevention: Target "Regions of Concern" and "Areas of Emphasis".
2. Regulatory Program Implementation: Insure that revised strategies are consistent with and supplement pre-existing regulatory mandates.

3. Regional Focus: Identify and classify regions according to the level of contaminants.
4. Directed Toxics Assessment: Identify areas of low level contamination, improve tracking and control of nonpoint sources.

Implementation: Continue

C) The jurisdictions will continue to develop, implement and monitor their tributary strategies designed to improve bay water quality.

Implementation: Continue

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Appendix A
Schedule for reviewing fishery management plans

SPECIES	COMPLETION DATE	REVIEW DATE	STATUS
Shad/Herring Shad Targets	1989	7/95 10/95	The 1989 Alosid FMP will be revised (Tentative date: Dec. 1997). Shad targets will be completed during 1996 and incorporated into new 1997 Alosid FMP.
Blue Crab	1989	1994- ??	Draft Blue Crab FMP completed, on hold until CBSAC stock assessment is reviewed.
Oysters	1989	10/94	Revised Oyster FMP completed, Dec. 1994.
Striped Bass	1989	10/95	The 1989 Striped Bass FMP will be amended to adopt ASMFC Amendment #5. Amendment #1 to the Chesapeake Bay SBFMP is being developed (Tentative date: Dec 1996).
Weakfish/Seatrout	1990	4/96	The 1990 Weakfish/Spotted Seatrout FMP will be amended to include ASMFC Amendment #3 by Dec. 1996. A revision will be completed by Dec. 1997.
Bluefish	1990	7/95	Action was postponed on the 1990 Bluefish FMP pending the MAFMC review of the coastal plan. An amendment to the 1990 Chesapeake Bay plan will be developed after the MAFMC review is completed.
Croaker/Spot	1991	10/1996	
American Eel	1991	10/1996	
Summer Flounder	1991	4/96 1997	Amendment #1 to the 1991 Summer Flounder FMP which adds language to allow limited entry into the commercial fishery, has been drafted. A final draft will be developed by Dec. 1996. A second amendment will be developed to include an enhanced habitat section & updates on stock status (Tentative date: Dec. 1997).
Black Drum Red Drum	1993 1993	1997	
Mackerel	1994	1998	

SPECIES	COMPLETION DATE	REVIEW DATE	STATUS
Horseshoe Crabs	1994	1999	
Black Sea Bass	1996	2000	
Catfish			A draft Catfish FMP was developed during 1995/1996. Since the draft plan describes a healthy stock and fishery and has resulted in monitoring recommendations only, the FMP staff will recommend that the catfish plan be completed as a technical report.
Tautog	1998?		The ASMFC is developing a coastal plan for tautog with a tentative completion date of December 1996. The FMP workgroup has recommended that a Chesapeake Bay FMP should not be developed until the ASMFC plan has been adopted. As another consideration, the Maryland legislature did not add tautog to the list of species for the development of FMPs.
Menhaden	1997	2001	

Appendix B
Glossary of Terms and Acronyms

Anoxia: No oxygen.

Benthos: Community of organisms associated with the bottom, such as clams that live in the sediments.

Bivalve: Mollusk with two shells connected by a hinge (ex: clams, oysters).

Catchability coefficient (q): The average *portion* of a fish stock that a unit of gear (i.e. one crab pot) is capable of catching. Catchability is a measure of the catch efficiency of the gear.

Catch Per Unit Effort (CPUE): CPUE is an indicator of stock abundance or stock density. It is the *number or weight* (biomass) of fish caught by an amount of effort. Effort is a combination of gear type, gear size, and length of time a gear is used. CPUE may be influenced by changes in abundance. For example, higher CPUE may mean more black sea bass are available to be caught.

CBP: Chesapeake Bay Program

Exclusive Economic Zone (EEZ): The area in the ocean 3-200 miles offshore. Often called "federal waters, " because the U.S. federal government has exclusive management authority over fisheries resources (except for tuna) in this area. Formerly called the Fishery Conservation Zone.

Exploitation (u): The *fraction* of a population at a given time that is removed by fishing over the course of a year. Exploitation may also be expressed as a percentage of the population.

F_{max} : The level of fishing mortality (F) that maximizes the yield per recruit. F_{max} is one of the biological reference points used to define overfishing.

$F_{10\%}$: Fishing mortality rate that allows for at least 10% of the spawning stock to escape the fishery to reproduce. $F_{10\%}$ is measured as 10% of the estimated spawning stock under unfinished conditions.

Fishery-dependent: Data obtained from commercial or recreational harvest.

Fishery-independent: Data collected from an independent survey rather than from commercial or recreational harvest.

Fishing mortality (F): a measure of the *rate* at which fish are removed from the population by the fishing activities of man. If F is constant over time, harvest will be greater during times of high abundance and less during times of low abundance. Mortality rates can be expressed in terms of instantaneous or annual mortality. Instantaneous rates are used extensively in fisheries management for ease of comparing the relative importance of different sources of mortality. Annual mortality rates can be easily converted to percentages, whereas, instantaneous rates cannot. Fishing mortality is usually expressed in terms of an instantaneous rate (F), as is natural mortality (M). The instantaneous total mortality rate (Z) is the natural logarithm of the ratio of the number of fish alive at the end of a period of time to the number of fish alive at the beginning of the same period of time. Instantaneous mortality rates are additive, but annual rates are not. (F= Z-M)

FMP: Fishery Management Plan

Ghost pots: Fish or pots lost to storms or left abandoned at the end of the fishing season.

Growth overfishing: When fishing pressure on smaller fish/crabs is too heavy to allow the fishery to produce its maximum poundage. Growth overfishing, by itself, does not affect the ability of a fish population to replace itself.

Hypoxia: Low oxygen.

Insemination rate: The proportion of females in the population that successfully mated during their terminal molt.

Maximum Sustainable Yield (MSY): The largest average catch or yield that can continuously be taken from a stock under existing environmental conditions. The MSY for Chesapeake Bay blue crabs is the greatest poundage of crabs that can be removed from the Bay without reducing the capacity of the crabs to replenish the population to the same level for harvest in future years.

MDNR: Maryland Department of Natural Resources

Mean fish mortality rate (FBAR): Represents an average value of fishing mortality for fish of a given age. For example, the eleventh SAW measured fishing mortality for age 0 flounder between 1982 and 1988, derived a mean fishing mortality rate (FBAR) and applied this value to the age 0 flounder born in 1989 to determine how many age 1 flounder would be left in 1990.

Natural mortality (M): A mortality rate is the rate at which fish die from natural causes. Mortality rates can be expressed in terms of instantaneous or annual mortality. M is an instantaneous rate, which is used extensively in fisheries management for ease of comparing the relative importance of different sources of mortality. Instantaneous mortality rates are additive, but annual rates are not.

Nominal fishing effort (f): Fishing effort measured in time (days fished) and number of gear units (ie. number of pots).

Optimum yield (OY): A modified MSY that considers economic, social or ecological issues. OY is frequently used as justification for harvest exceeding MSY.

Plankton: Small or microscopic algae and organisms associated with surface water and the water column.

Post-release mortality: Death that occurs some time after a fish has been caught and released (in this context, similar to catch and release mortality). Post-release mortality could also refer to mortality after stocking efforts.

ppt: Parts per thousand.

PRFC: Potomac River Fisheries Commission

Recruitment: A measure of the number of fish entering a class during some period of time. Recruitment may be to a spawning class, age class, or size class.

Recruitment overfishing: The rate of fishing above which recruitment to the fishable stock is reduced. Recruitment overfishing is characterized by a reduced spawning stock and generally very low production of young year after year.

SAFMC: South Atlantic Fishery Management Council

SAV: Submerged Aquatic Vegetation. Also called grass beds.

Spawning stock: All females that survive natural and fishing mortality to reproduce.

Spawning Stock Biomass (SSB): SSB is the weight of all (mature) adult females in the population, calculated as the number of individual females in each year-class times the percent that are mature times their average weight. (The total weight of female fish in a stock that are old enough to spawn)

Spawning Stock Biomass per Recruit (SSBR): SSBR is the total contribution of a cohort (year-class) to the SSB over its lifetime, determined by summing its contribution at each age, [divided by the number of recruits to the stock.]

Static gear: Gear that requires the animal to enter voluntarily (as opposed to active gears) such as trawls and dredges which must move to trap animals and prevent them from escaping.

Total mortality (Z): The instantaneous total mortality rate (Z) is the natural logarithm of the ratio of the number of fish alive at the end of a period of time to the number of fish alive at the beginning of the same period of time. An instantaneous total mortality rate (Z) of 1.5 equals an annual mortality rate of 0.78 or 78 % annual total mortality. Instantaneous mortality rates are additive, but annual rates are not.

Virtual Population Analysis (VPA): An analysis of the catches from a given year-class over its life in the fishery.

VMRC: Virginia Marine Resources Commission

Yield-per-recruit (YPR): The theoretical yield that would be obtained from a group of fish of one year-class if harvested according to a certain exploitation rate over the lifespan of the fish.

Appendix C

Laws and Regulations

Limited entry:	Virginia's limited entry program, effective in 1992, requires previously unlicensed applicants to wait two years after registering with the respective state agency before a license to harvest finfish with commercial fishing gears will be issued. Maryland's limited entry law, effective April 1, 1994, limits the number of commercial tidal fish licenses available to individuals who can commercially harvest finfish in Maryland waters. Individuals who currently have licenses and people who applied for licenses before April 1, 1994 can retain their licenses. Waiting lists will be used to issue new licenses, but no new licenses will be issued until the number of licenses is more in balance with the harvestable resource.
Minimum size limit:	Not in effect for Maryland, Virginia or Potomac River; however, such measures are currently under consideration.
Creel limit:	Not in effect for Maryland, Virginia or Potomac River; however, such measures are currently under consideration.
Harvest quotas:	Not in effect for Maryland, Virginia or Potomac River; however, such measures are currently under consideration.
By-catch restrictions:	None in effect for Maryland, Virginia or Potomac River.
Season:	No closed season for Maryland, Virginia or Potomac River; however, such measures are currently under consideration.
Gear-Area restrictions:	Maryland: Purse seines, trawls, trammel nets and monofilament gill nets are prohibited (otter and beam trawls are legal on the Atlantic Coast at distances of one mile or more offshore). Prohibition on gill netting

in most areas of Chesapeake Bay and its tributaries during the summer.

Virginia: Trawling is prohibited in Chesapeake Bay and Territorial Sea. It is unlawful to set, place or fish a fixed fishing device of any type within three hundred yards, in either direction, from the Chesapeake Bay Bridge Tunnel. Also, Sections 28.1-52 and 28.1-53 of the Code of Virginia outline placement, total length and distance requirements for fishing structures.

Potomac River: Current moratorium on any new gill net, pound net, or hook and line licenses. The use of a purse net, beam trawl, otter trawl or trammel net is prohibited. Length restrictions for various gear types exist. Gill nets are restricted to a mesh size of 5.0 to 7.0 inches. Seasonal restrictions for gill net also exist.

APPENDIX D
Fishery Management Plan Workgroup Members

The *1996 Chesapeake Bay and Atlantic Coast Black Sea Bass Fishery Management Plan* was developed under the direction of the Fisheries Management Plan (FMP) Workgroup, of the Living Resources Subcommittee, Chesapeake Bay Program. Habitat recommendations were developed by the Submerged Aquatic Vegetation (SAV) Workgroup, Aquatic Reef Habitat Workgroup, and the Habitat Objectives/Restoration Workgroup, all of the Living Resources Subcommittee

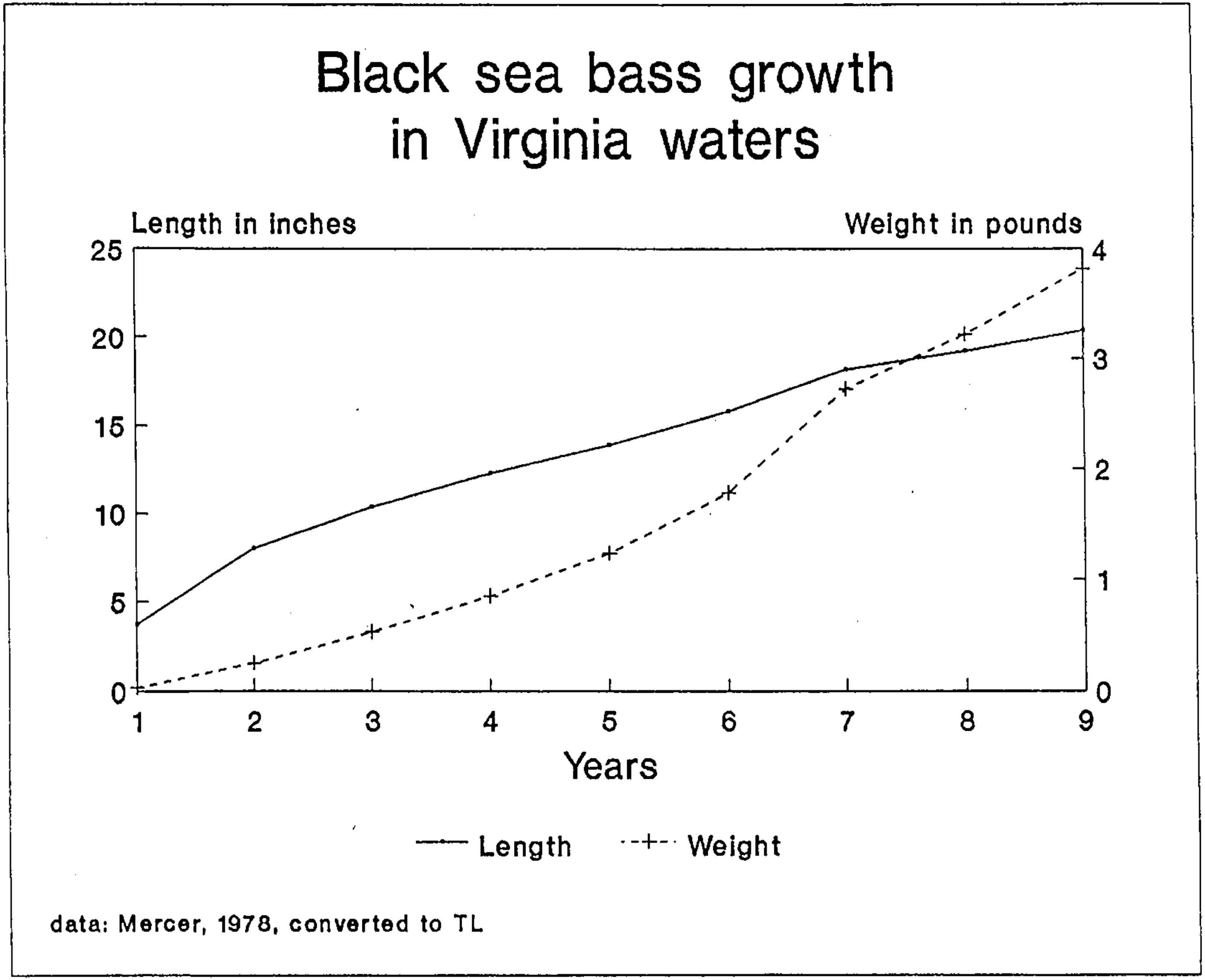
Chairs:

Dorothy Leonard	Maryland Department of Natural Resources (MDNR)
Jack Travelstead	Virginia Marine Resources Commission (VMRC)
Nancy Butowski, Asst. Chair	MDNR

Members:

Ernie Bowden	VMRC
K.S. Carpenter	Potomac River Fisheries Commission
James Drummond	Citizen
Jeffery S. Eutsler	Maryland Waterman
William Goldsborough	Chesapeake Bay Foundation (CBF)
Dave Goshorn	MDNR
Laura Grignano	VMRC
Rick Hoopes	Pennsylvania Fish and Boat Commission (PA FBC)
Edward Houde	Chesapeake Biological Laboratory (CBL), University of Maryland
Peter Jensen	MDNR
Roman Jesien	Horn Point Environmental Laboratory (HPEL), University of Maryland
Ron Klauda	MDNR
Andy Loftus	Chesapeake Advisory Committee (CAC)
David Martin	Maryland Seafood Dealer
Michele Monti	Alliance for the Chesapeake Bay (ACB)
Richard Novotny	Maryland Saltwater Sportmen's Association
Ed O'Brien	Maryland Charterboat Association
Ira Palmer	D.C. Dept. of Consumer and Regulatory Affairs
Larry Simns	Maryland Watermen's Association
Ellen Smoller	VMRC
Lt. Thomas Turner	MDNR Police

Figure 1



Black sea bass growth
in Virginia waters
Length in inches
Weight in pounds
25
20
15
10
5
0
4
3
2
1
0
1
2
3
4
5
6
7
8
9
Years
Length
Weight
data: Mercer, 1978, converted to TL

Figure 2

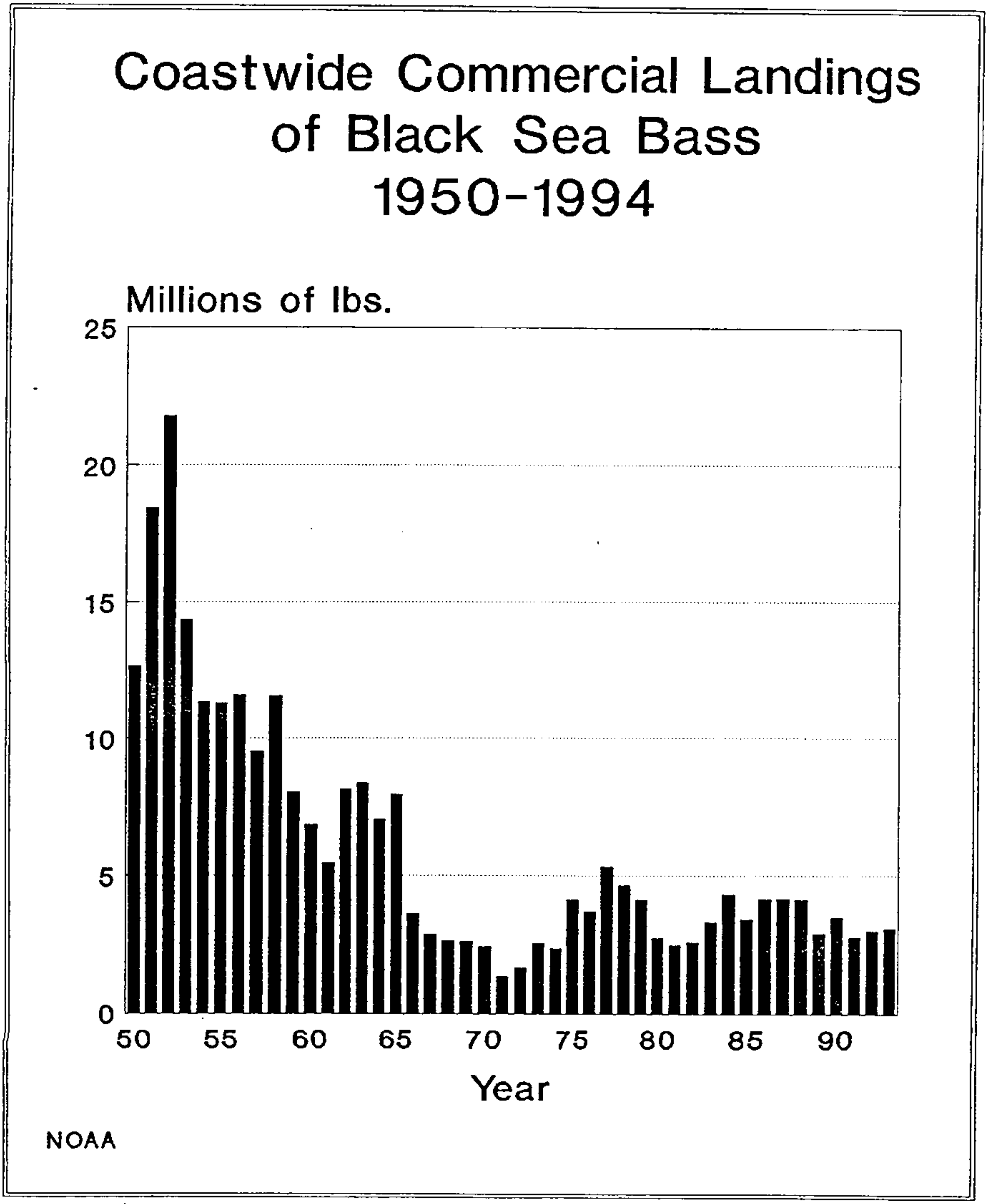

Coastwide Commercial Landings
of Black Sea Bass
1950-1994
Millions of lbs.
25
20
15
10
5
0
50
55
60
65
70
75
80
85
90
Year
NOAA

Figure 3

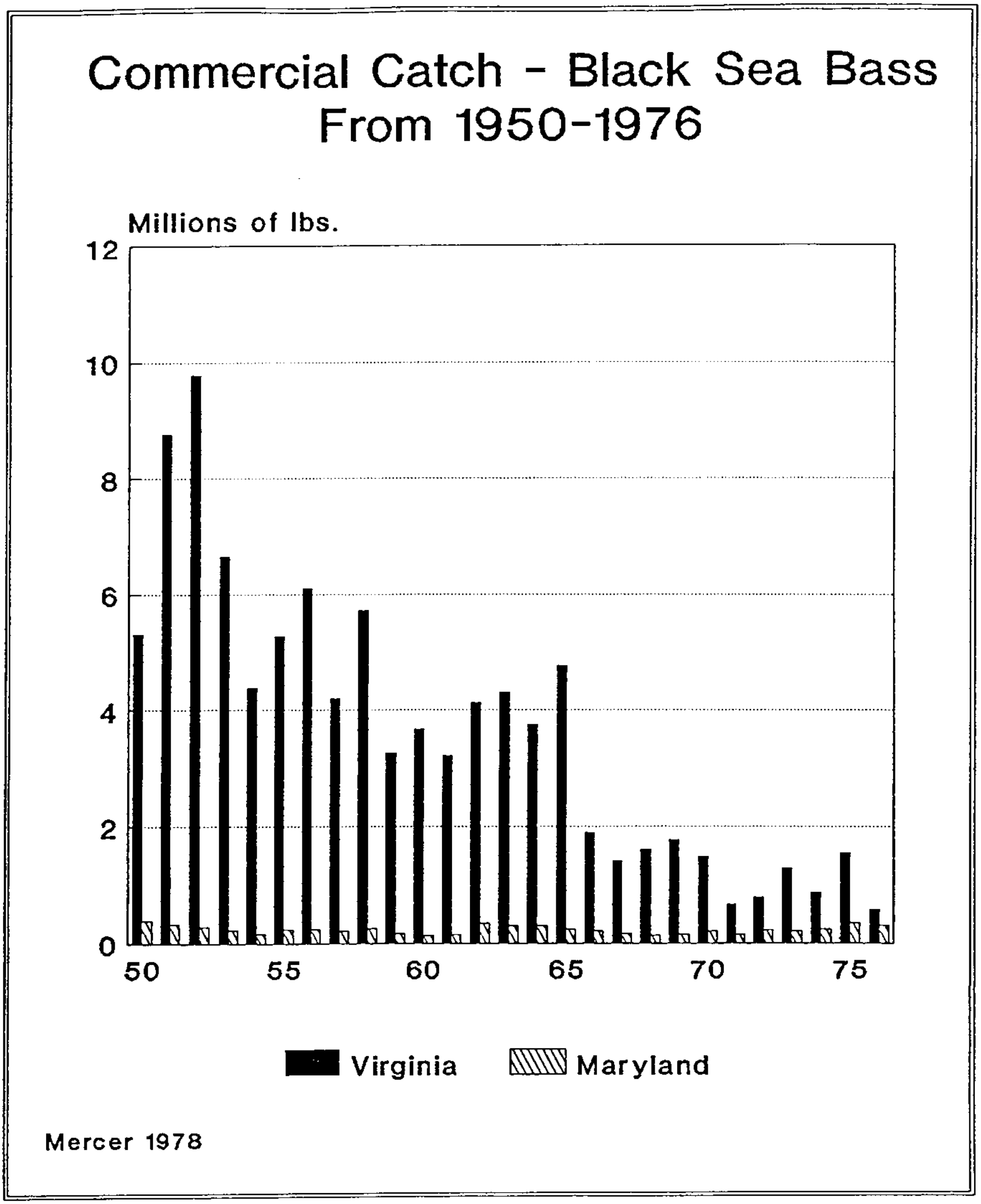
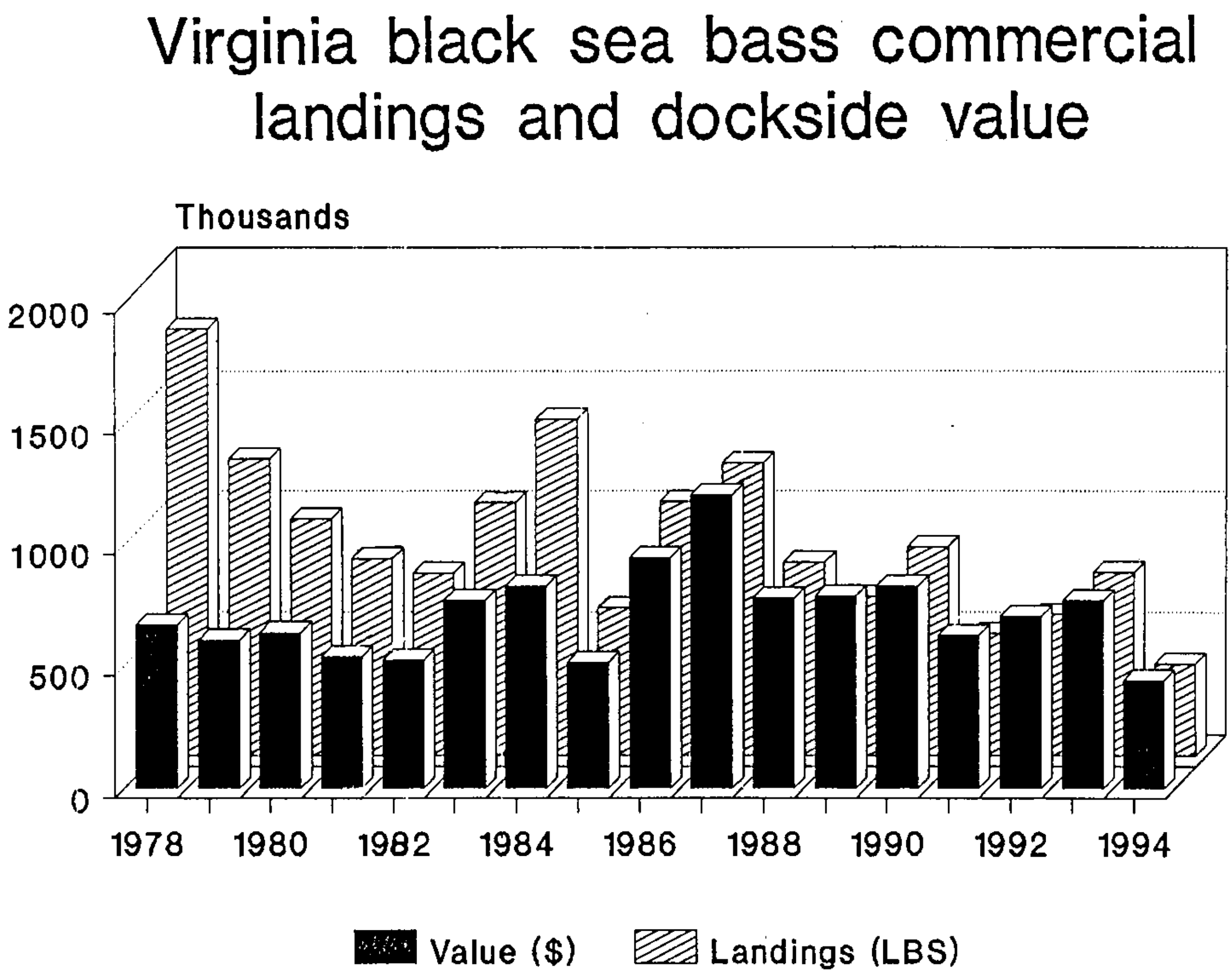

Commercial Catch - Black Sea Bass
From 1950-1976
Millions of lbs.
12
10
8
6
4
2
0
50
55
60
65
70
75
Virginia
Maryland
Mercer 1978

Figure 4



VMRC data

Figure 5

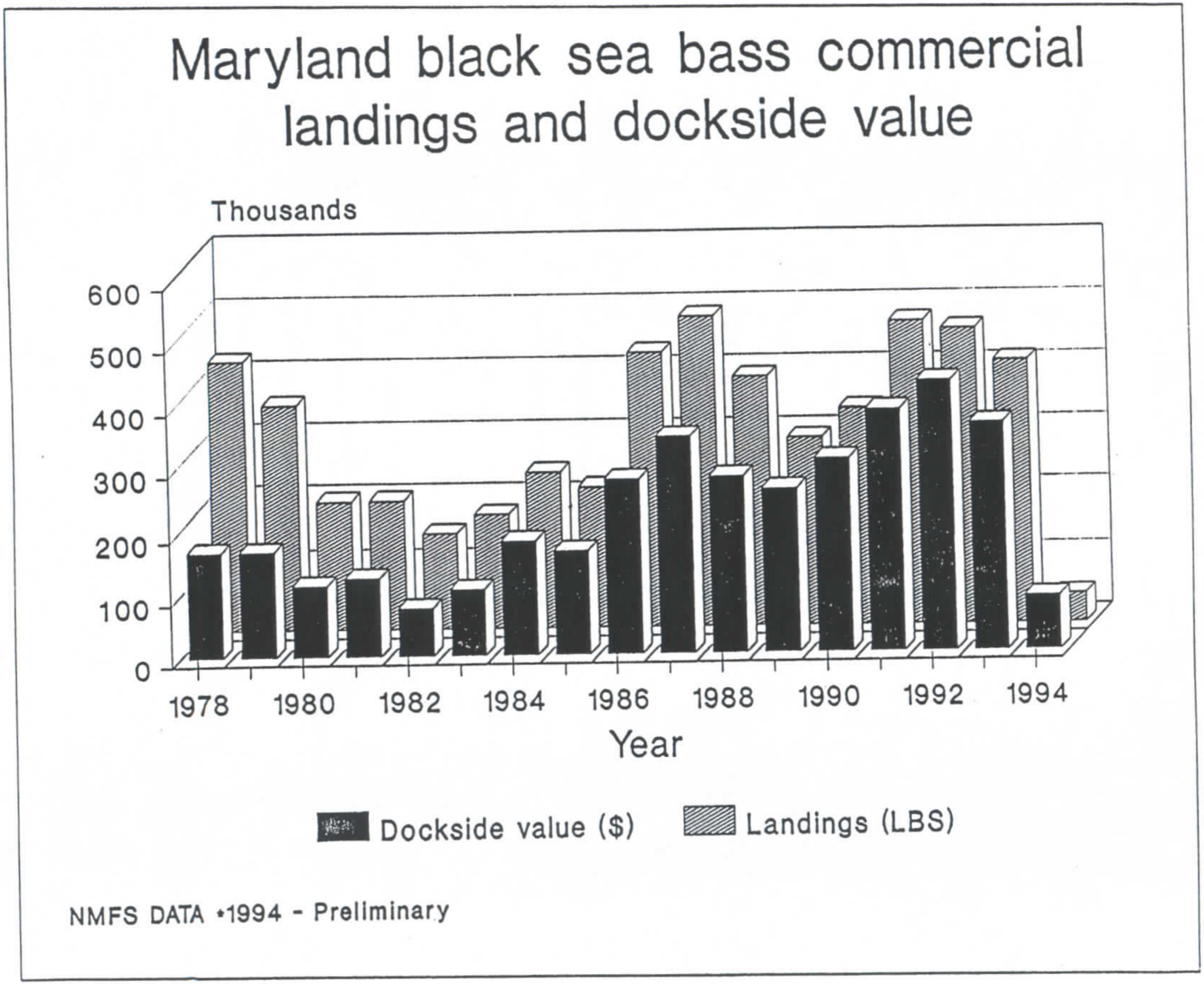

Maryland black sea bass commercial
landings and dockside value
Thousands
600
500
400
300
200
100
0
1978
1980
1982
1984
1986
1988
1990
1992
1994
Year
Dockside value ($)
Landings (LBS)
NMFS DATA •1994 - Preliminary

Figure 6

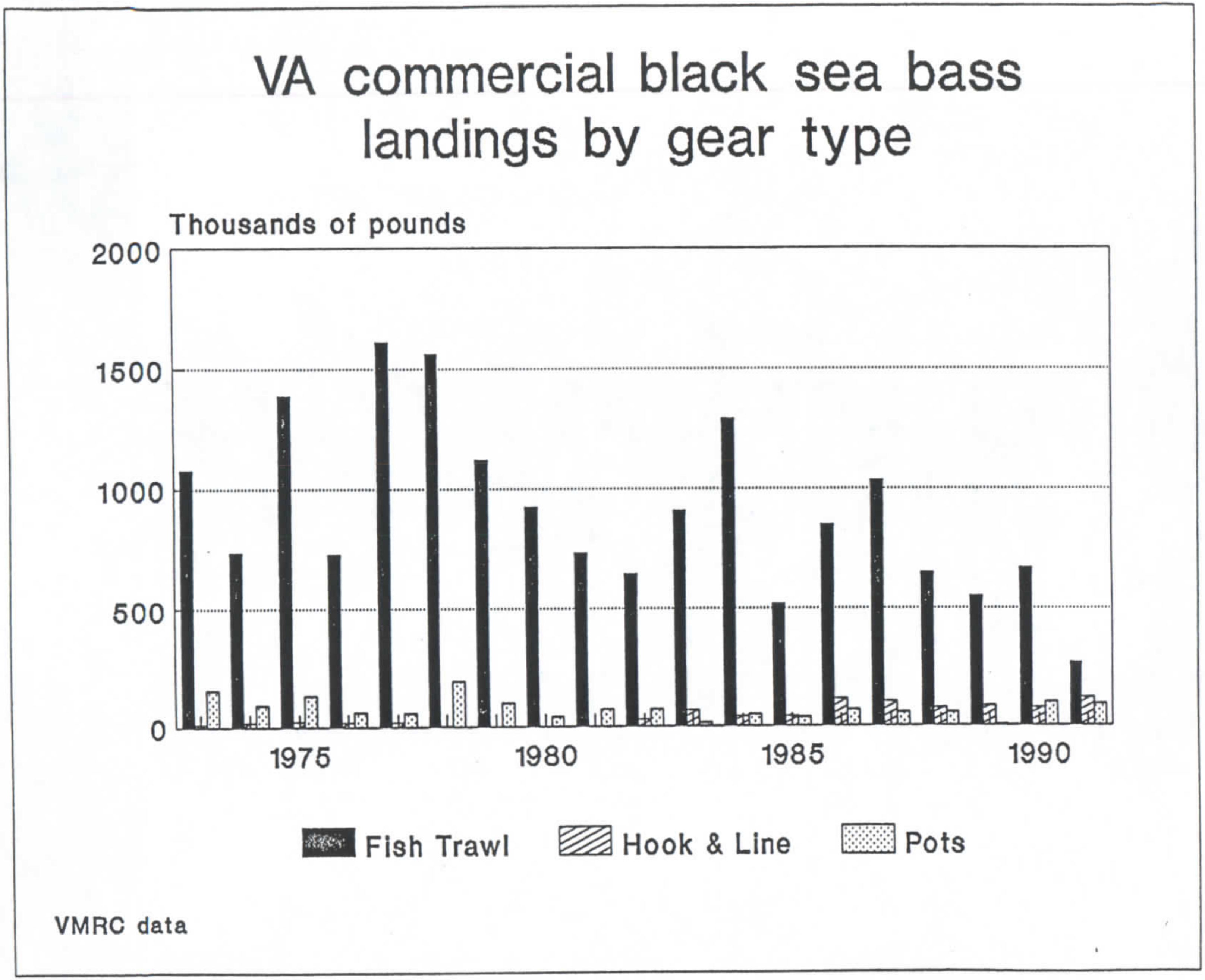

VA commercial black sea bass
landings by gear type
Thousands of pounds
2000
1500
1000
500
0
1975
1980
1985
1990
Fish Trawl
Hook & Line
Pots
VMRC data

Figure 7

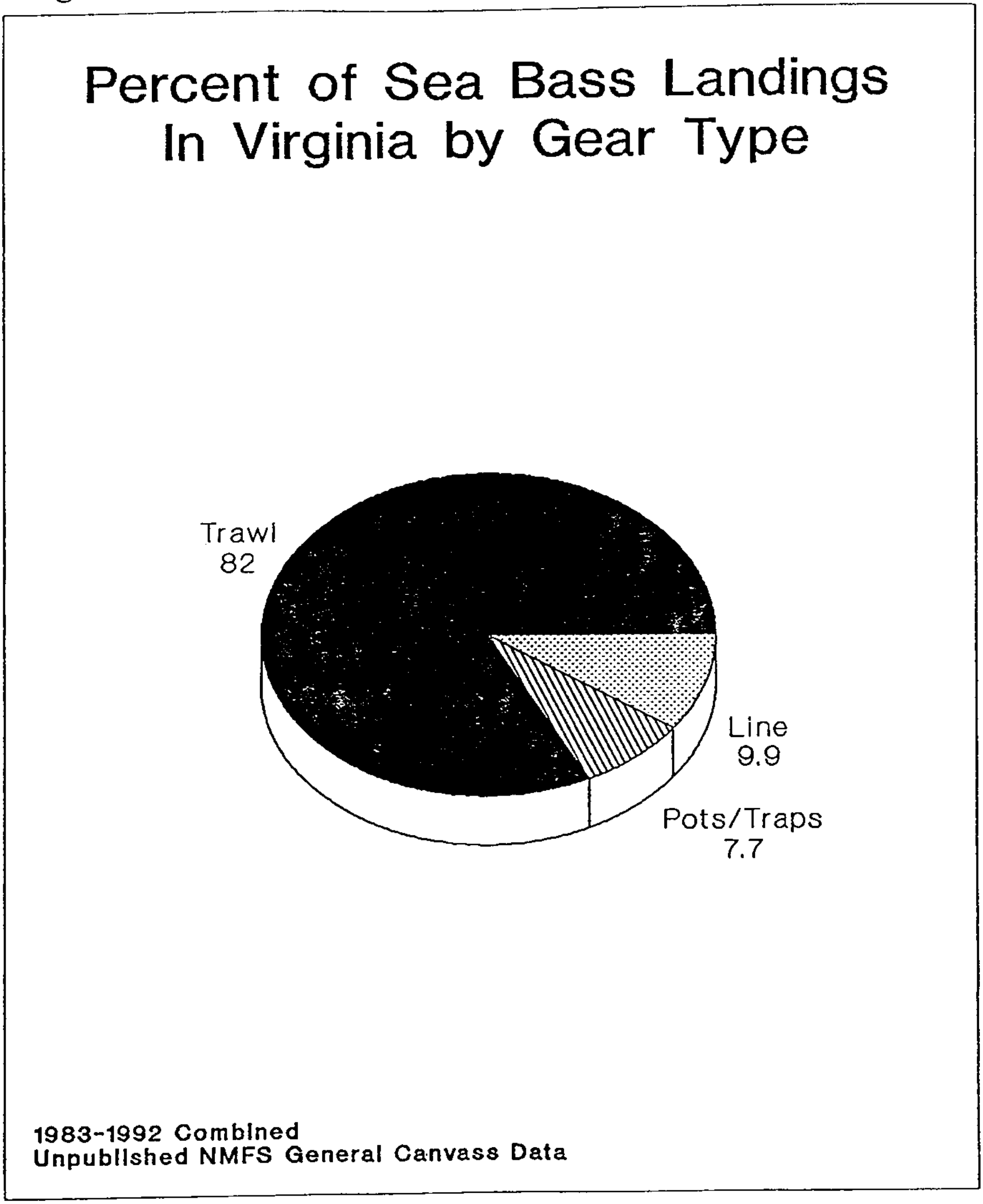

Percent of Sea Bass Landings
In Virginia by Gear Type
Trawl
82
Line
9.9
Pots/Traps
7.7
1983-1992 Combined
Unpublished NMFS General Canvass Data

Figure 8

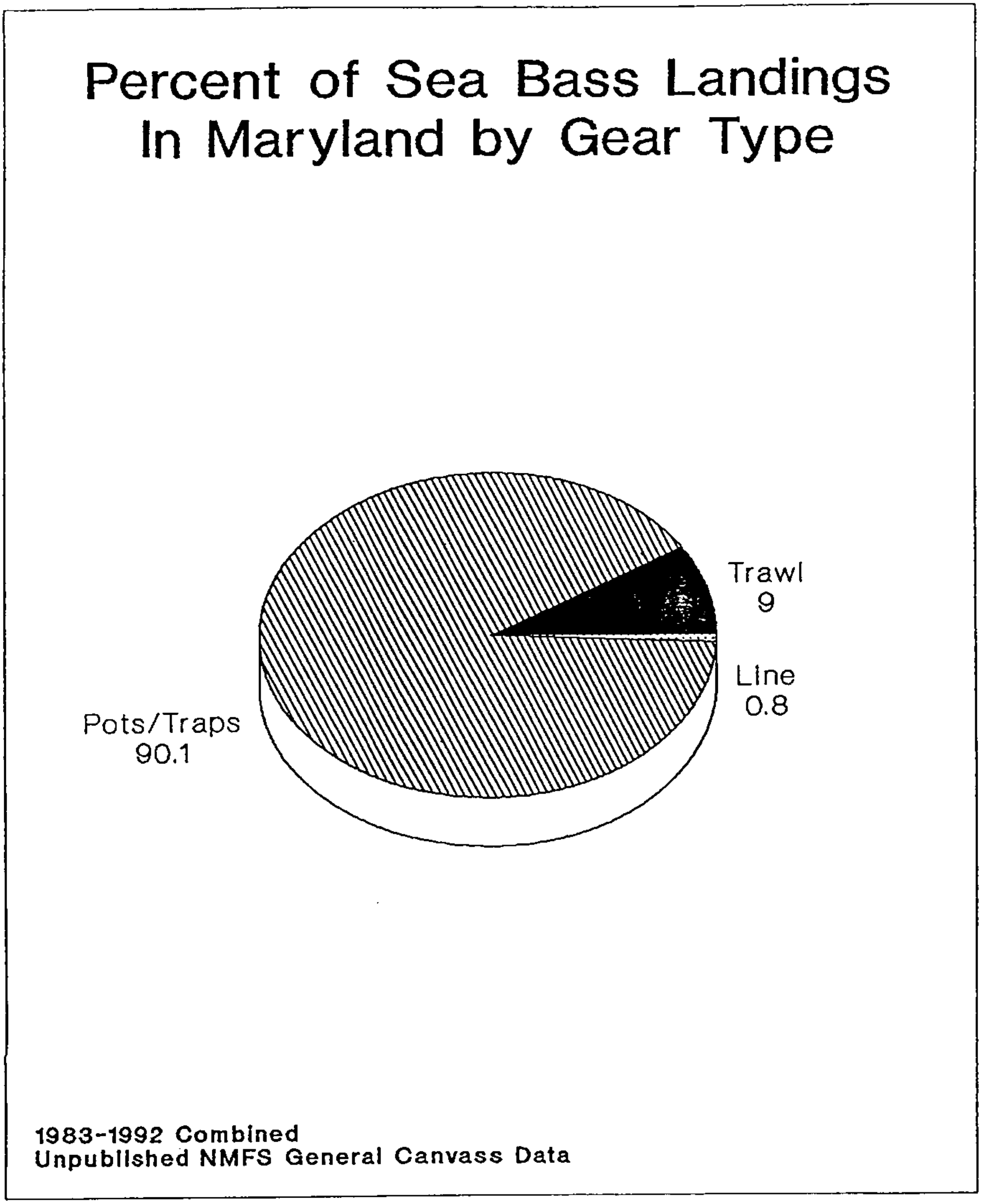
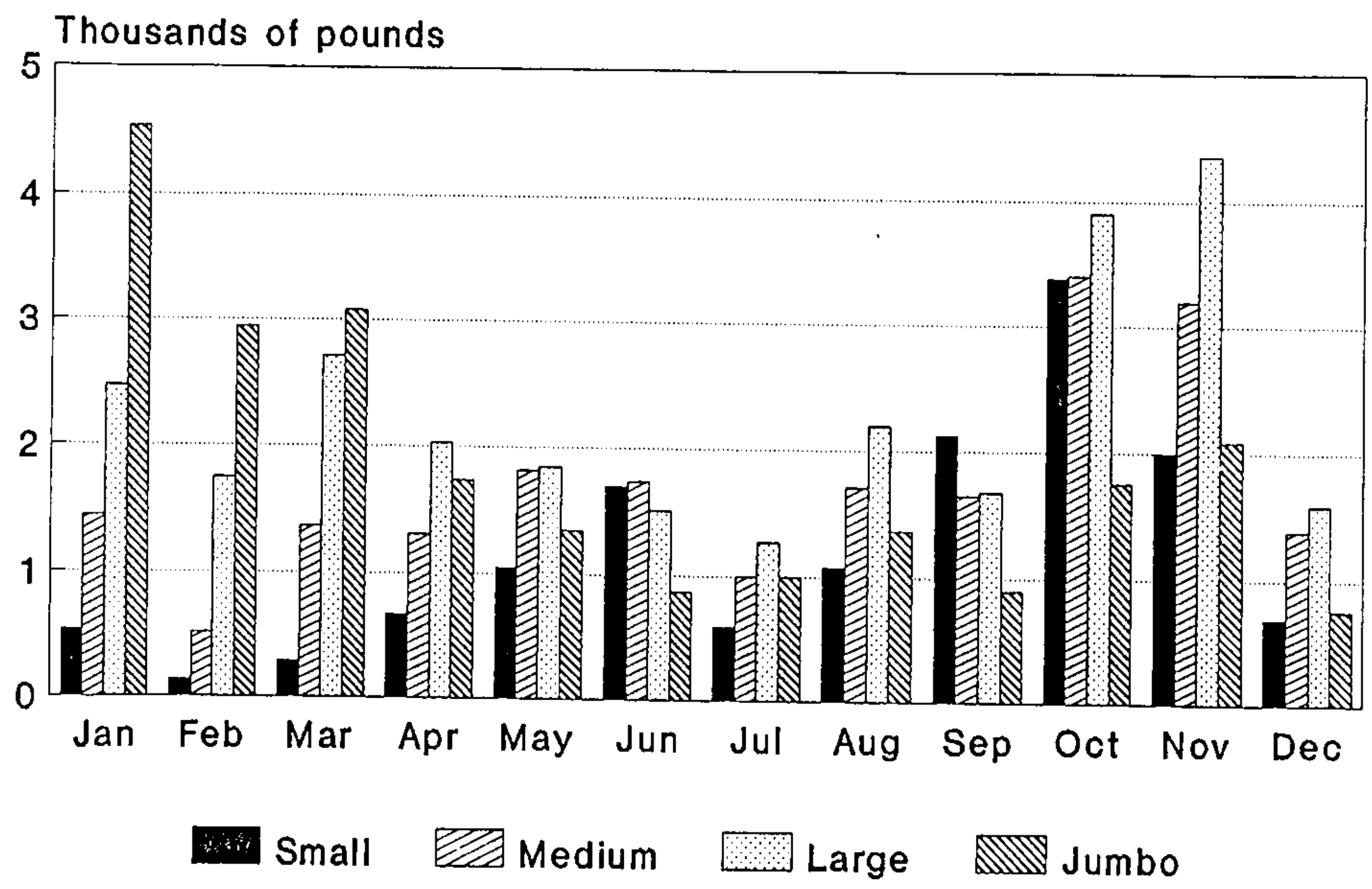

Percent of Sea Bass Landings
In Maryland by Gear Type
Trawl
9
Line
0.8
Pots/Traps
90.1
1983-1992 Combined
Unpublished NMFS General Canvass Data

Figure 9

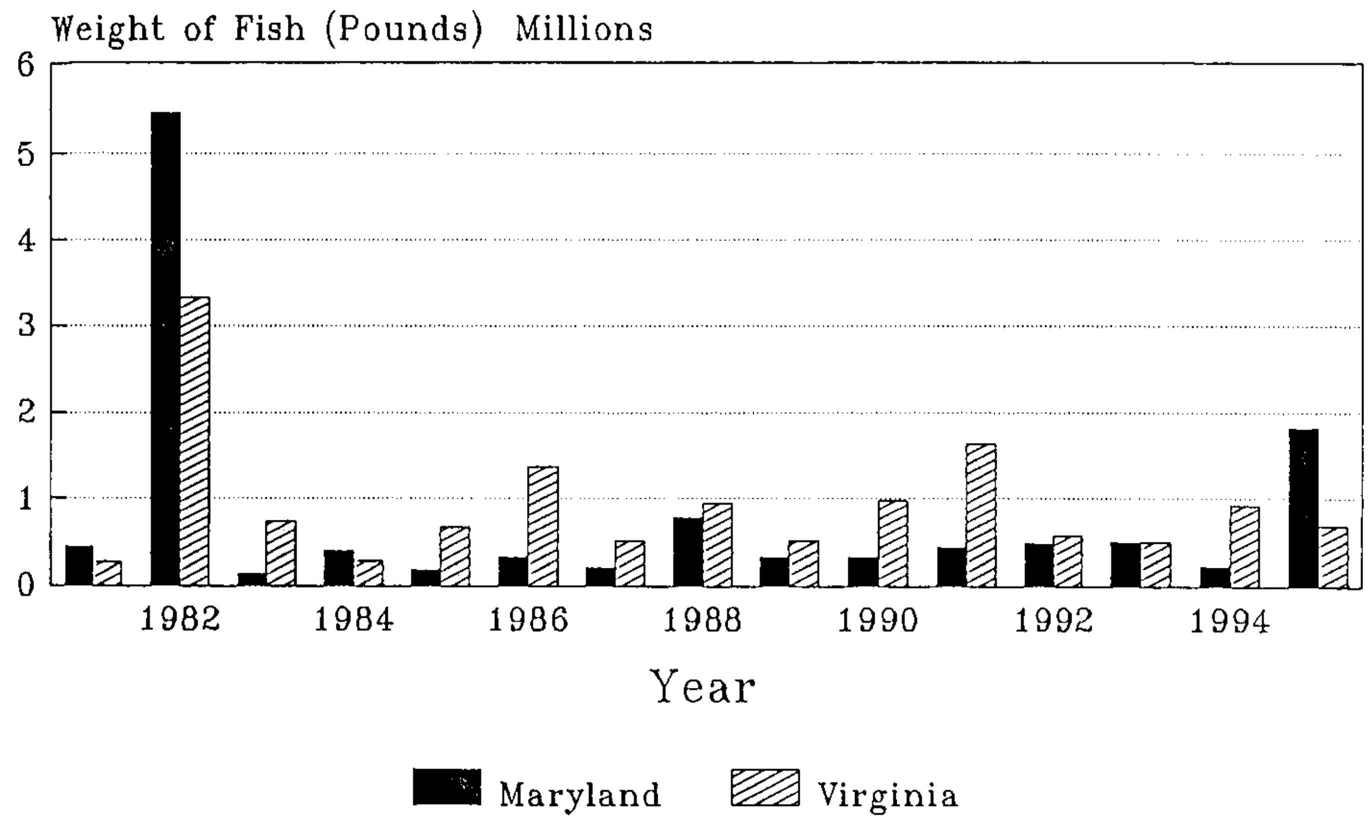
Average VA sea bass landings by size. Landings primarily hook and line.



Partial landings 1991-1992

Figure 10

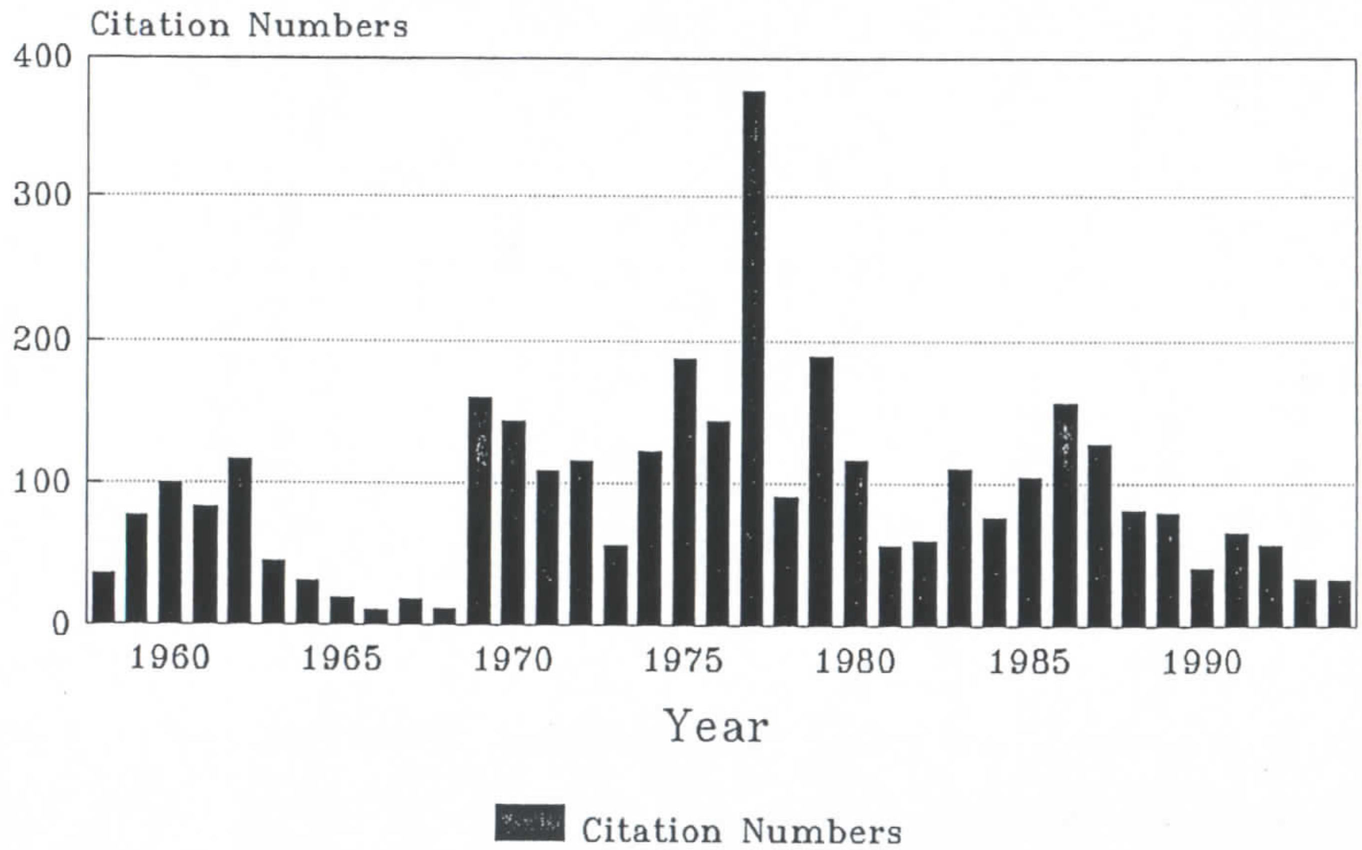
Recreational Harvest of Black Sea Bass From Maryland and Virginia, MRFSS data



Note: MRFSS (Marine Recreational Fisheries Statistics Survey);
Harvest data excludes live releases

Figure 11

Virginia Saltwater Fishing Tournament
Sea Bass Citations 1958–1994



Note: Catches made May 1–Nov 30 only;
Prior to 1978 it was 4#, after it was 5#

Figure 12

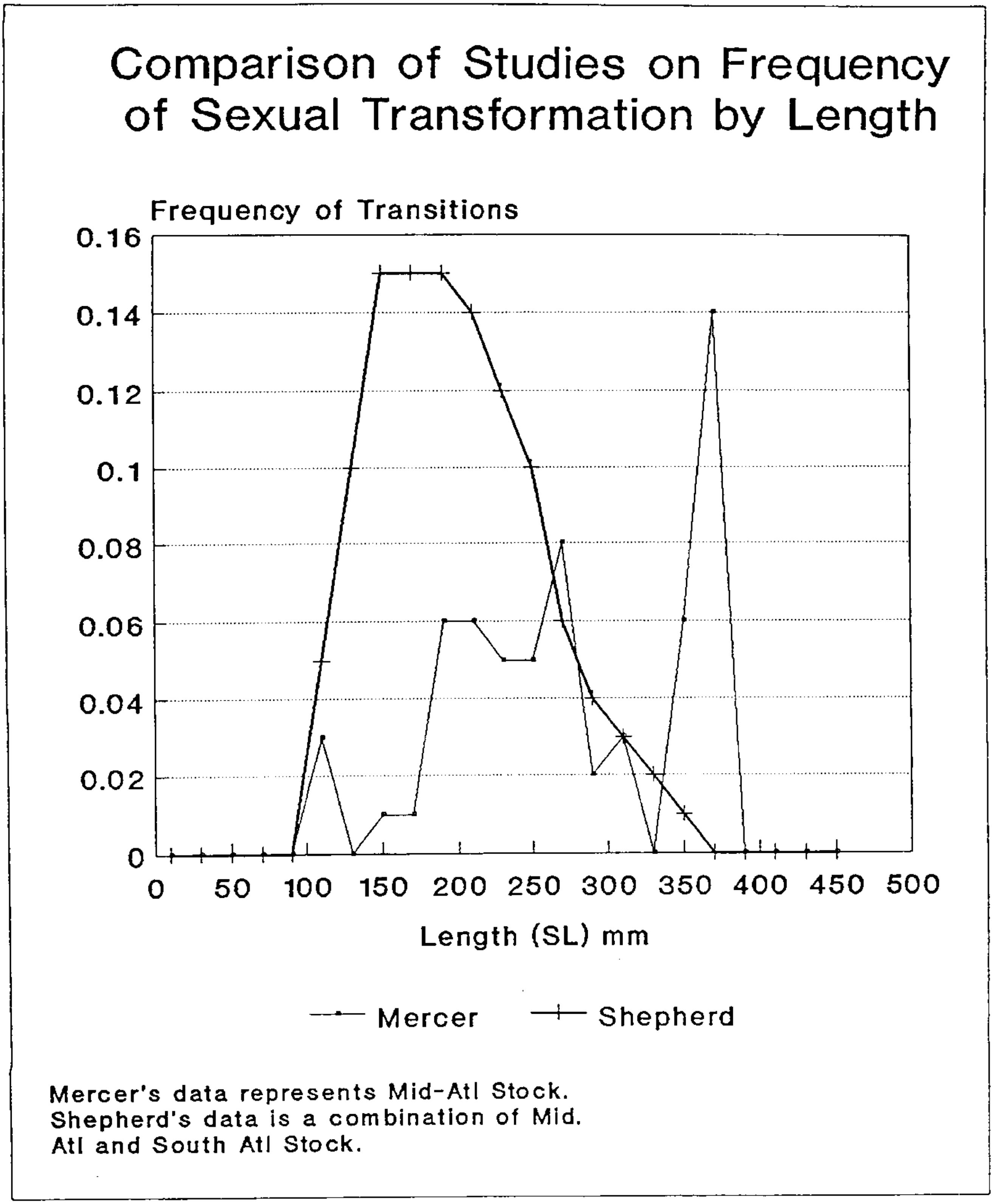

Comparison of Studies on Frequency
of Sexual Transformation by Length
Frequency of Transitions
0.16
0.14
0.12
0.1
0.08
0.06
0.04
0.02
0
0
50
100
150
200
250
300
350
400
450
500
Length (SL) mm
Mercer
Shepherd
Mercer's data represents Mid-Atl Stock.
Shepherd's data is a combination of Mid.
Atl and South Atl Stock.

Figure 13

Potential Black Sea Bass Habitat

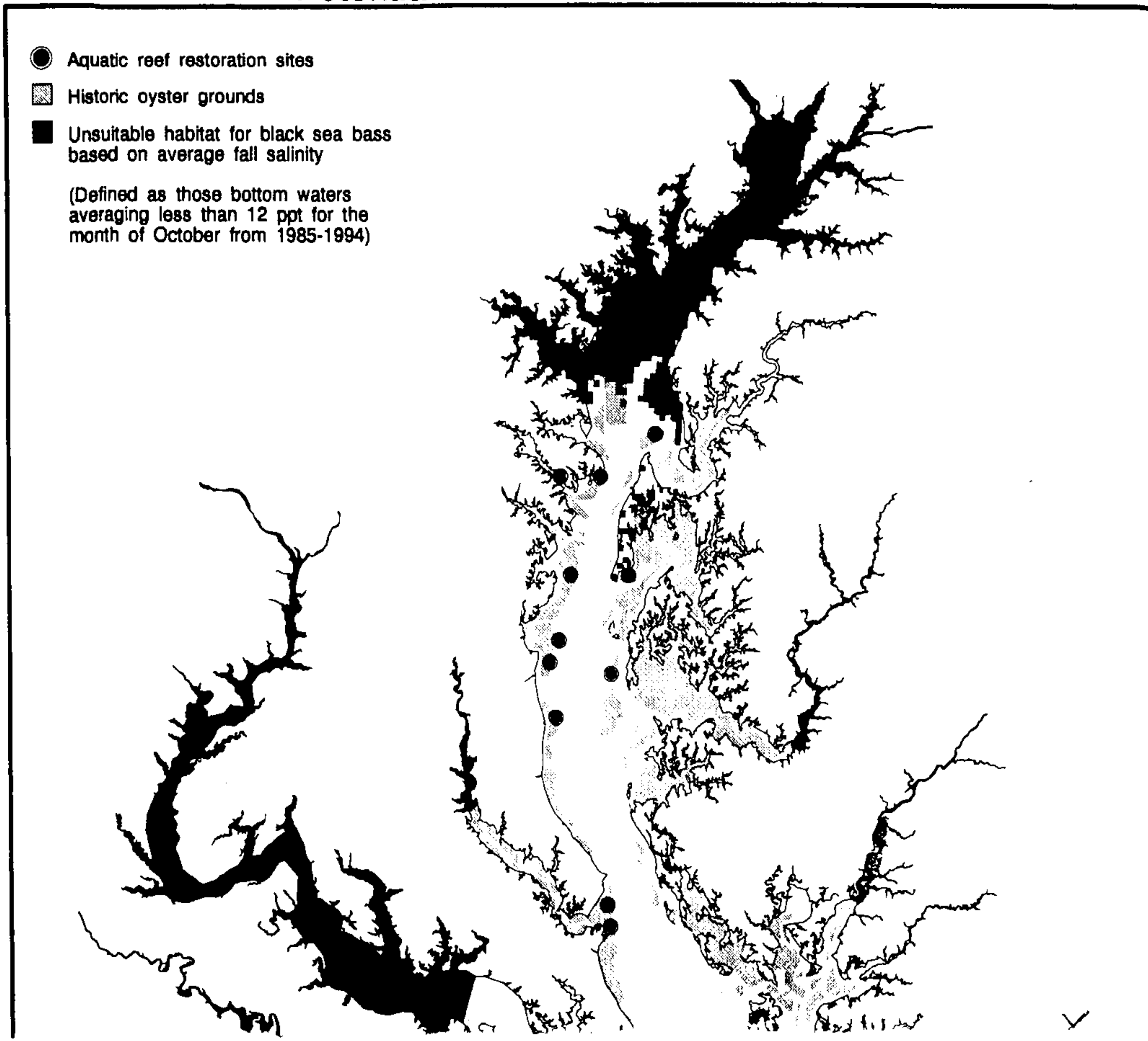
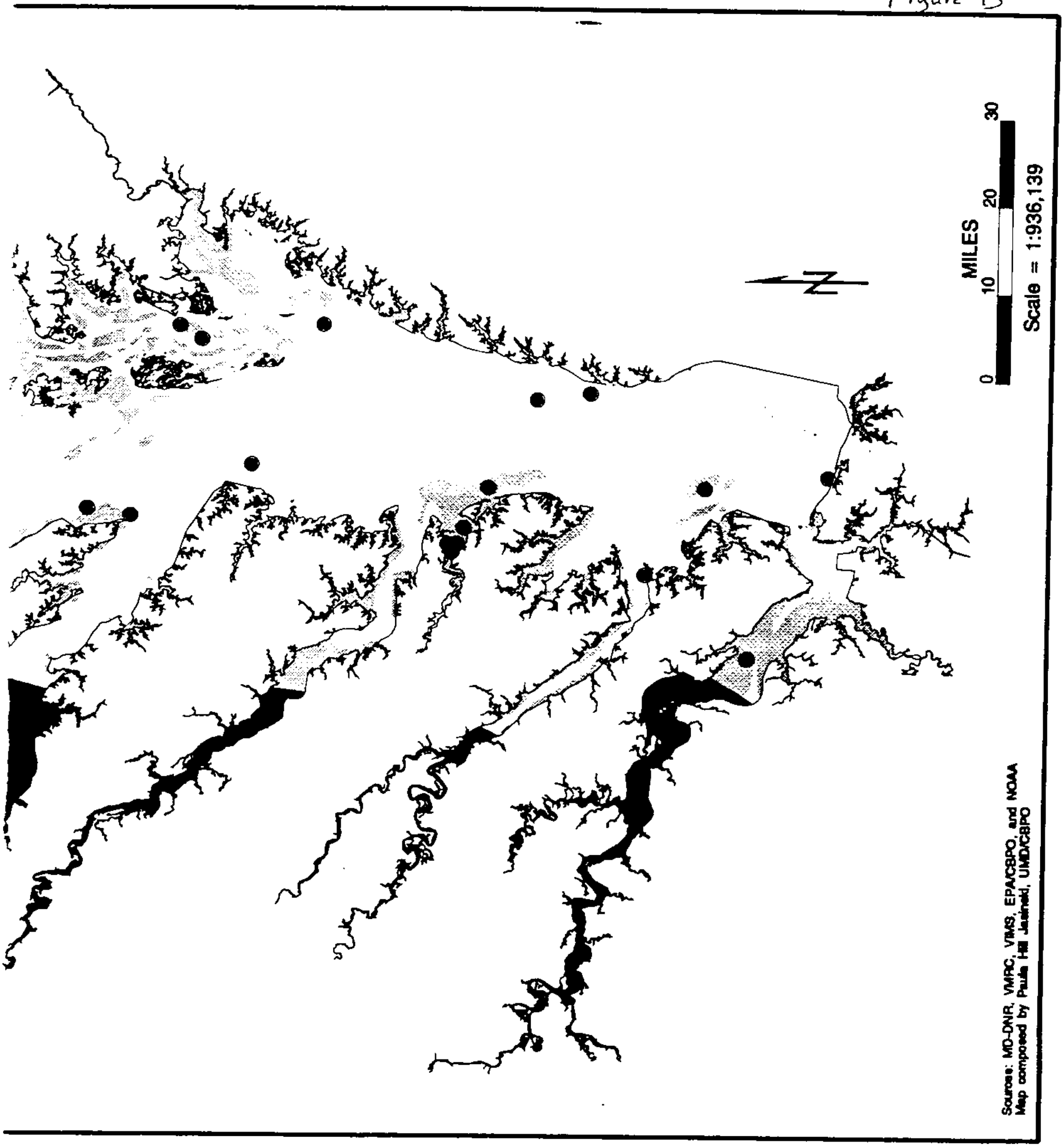


Figure 13



MILES
0
10
20
30
Scale = 1:936,139
Sources: MD-DNR, VMRC, VIMS, EPA/CBPO, and NOAA
Map composed by Paula Hill Jasinski, UMD/CBPO

Figure 14

Potential Nursery Habitat for Black Sea Bass

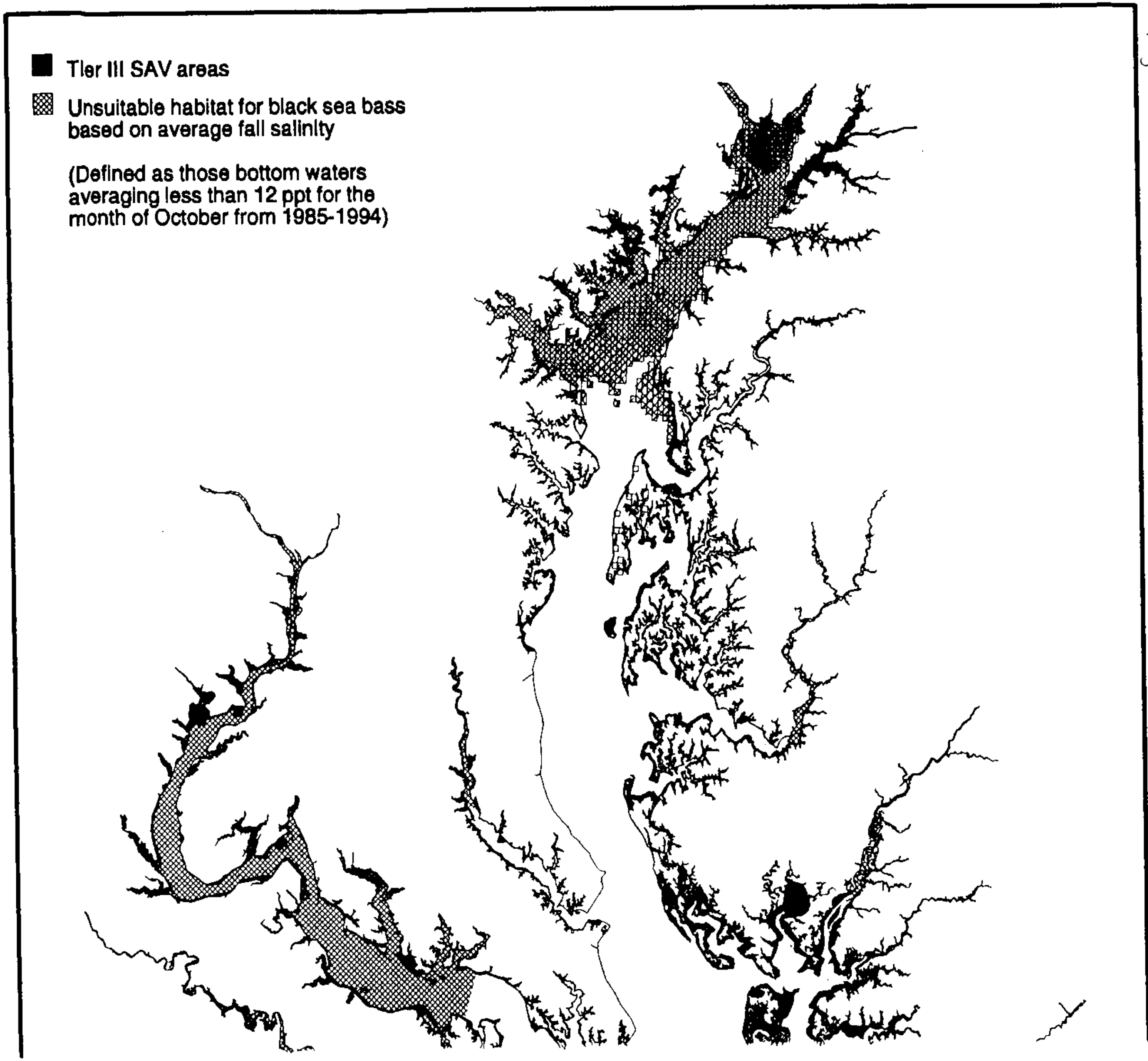
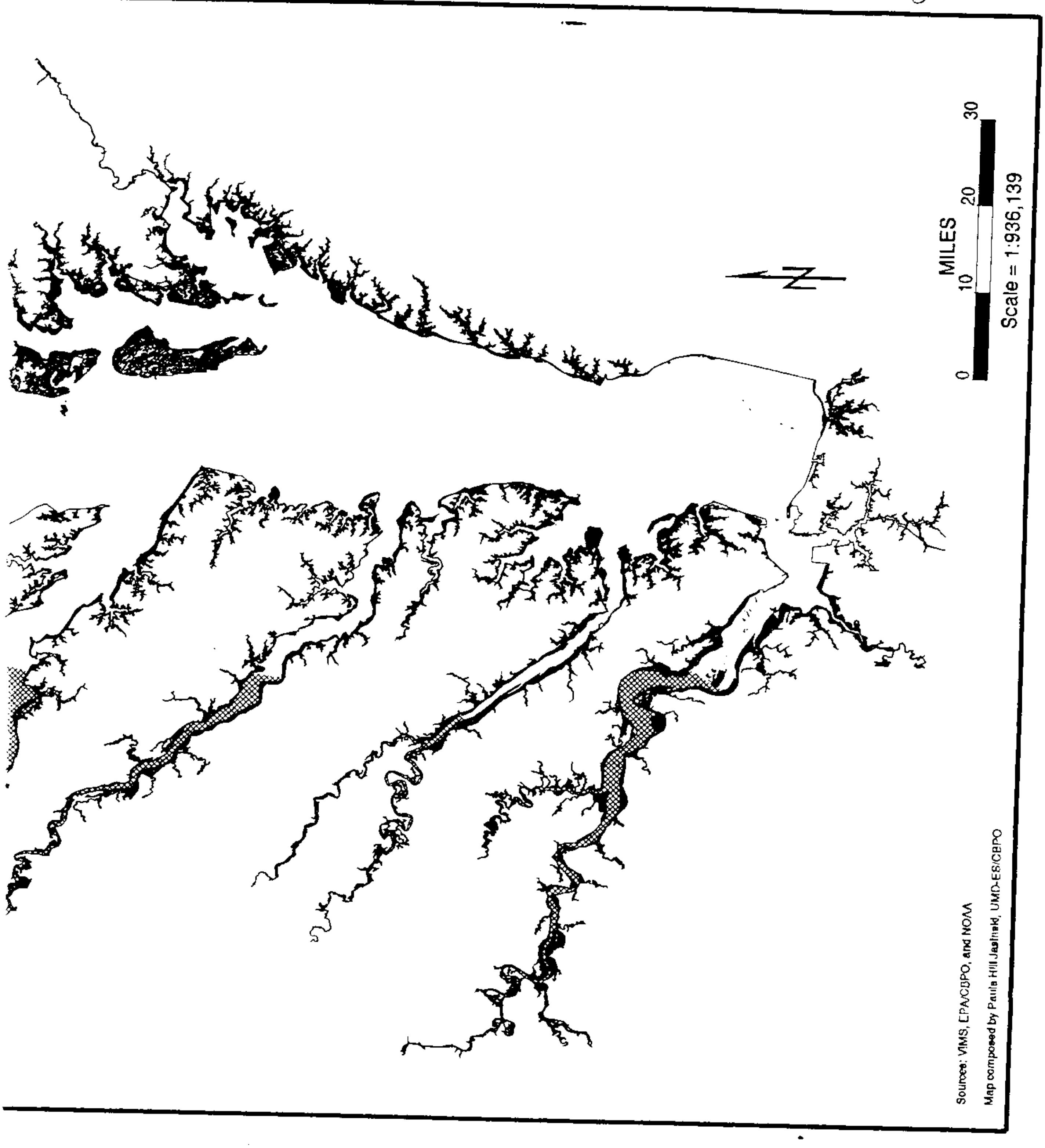


Figure 14



MILES
0 10 20 30
Scale = 1:936,139
Sources: VIMS, EPA/CBPO, and NOAA
Map composed by Paula Hill Jasinski, UMD-ES/CBPO

Chesapeake Bay Program

The Chesapeake Bay Program is a unique regional partnership leading and directing restoration of Chesapeake Bay since 1983. The Chesapeake Bay Program partners include the states of Maryland, Pennsylvania, and Virginia; the District of Columbia; the Chesapeake Bay Commission, a tri-state legislative body; the U.S. Environmental Protection Agency (EPA), which represents the federal government; and participating citizen advisory groups.

In the *1987 Chesapeake Bay Agreement*, Chesapeake Bay Program partners set a goal to reduce the nutrients nitrogen and phosphorus entering the Bay by 40% by the year 2000. In the *1992 Amendments to the Chesapeake Bay Agreement*, partners agreed to maintain the 40% goal beyond the year 2000 and to attack nutrients at their source--upstream in the tributaries. The Chesapeake Executive Council, made up of the governors of Maryland, Pennsylvania, and Virginia; the mayor of Washington, D.C.; the EPA administrator; and the chair of the Chesapeake Bay Commission, guided the restoration effort in 1993 with five directives addressing key areas of the restoration, including the tributaries, toxics, underwater bay grasses, fish passages, and agricultural nonpoint source pollution. In 1994, partners outlined initiatives for habitat restoration of aquatic, riparian, and upland environments; nutrient reduction in the Bay's tributaries; and toxics reductions, with an emphasis on pollution prevention.

Since its inception, the Chesapeake Bay Program's highest priority has been the restoration of the Bay's living resources--its finfish, shellfish, bay grasses, and other aquatic life and wildlife. Improvements include fisheries and habitat restoration, recovery of bay grasses, nutrient reductions, and significant advances in estuarine science.

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