Chesapeake Executive Council

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Chesapeake Bay Alosid Management Plan

Chesapeake Bay Program

Agreement Commitment Report

July 1989

Chesapeake Bay Alosid Management Plan

An Agreement Commitment Report from
the Chesapeake Executive Council

Annapolis, Maryland
July 1989

ADOPTION STATEMENT

We, the undersigned, adopt the **Chesapeake Bay Alosid Management Plan**, in fulfillment of Living Resources Commitment Number 4 of the 1987 Chesapeake Bay Agreement:

> *"...by July 1989, to develop, adopt, and begin to implement Bay-wide management plans for oysters, blue crabs, and American shad."*

We agree to accept the Plan as a guide to protecting, restoring, and enhancing the shad and river herring resources 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: (1) declining abundance; (2) overfishing; (3) stock assessment deficiencies; and (4) habitat loss and degradation.

We recognize the need to commit long-term, stable financial support and human resources to the task of protecting, restoring, and enhancing the shad and river herring fisheries. In addition, we direct the Living Resources Subcommittee to review and update the Plan yearly and to prepare an annual report addressing the progress made in achieving the Plan's management recommendations.

Date July 31, 1989

For the Commonwealth of Virginia

For the State of Maryland

For the Commonwealth of Pennsylvania

For the United States of America

For the District of Columbia

For the Chesapeake Bay Commission

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ACKNOWLEDGEMENTS

Development of this management plan is the result of concerted efforts by members of the Fisheries Management Plan Workgroup (FMPW), particularly by providing direction for and review of the plan. Staff from the Maryland Department of Natural Resources (DNR), Tidewater Administration, and the Virginia Marine Resources Commission (VRMC) authored the plan and addressed comments on the draft versions. Contributing DNR staff included Nancy Butowski, Harry T. Hornick, Phil Jones, Randy Schneider, and Harley Speir. Mark Bundy provided assistance with economic aspects of the fishery. VRMC staff included Erik Barth, Lewis Gillingham, Roy Insley, Robert O'Reilly, Randy Owens, Ellen Smoller, Jack Travelstead, and Lyle Varnell. Thanks are also due to Verna Harrison and Ed Christoffers for guiding the plan through the development and adoption process. Finally, we are grateful to members of other committees and workgroups associated with the Chesapeake Bay Program and the public who commented on the plan.

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EXECUTIVE SUMMARY

Introduction

One of the strategies for implementing the Living Resources Commitments of the 1987 Chesapeake Bay Agreement is to develop and adopt a series of Bay-wide fishery management plans (FMPs) for commercially, recreationally, and selected ecologically valuable species. The FMPs are to be implemented by the Commonwealth of Pennsylvania, State of Maryland, Commonwealth of Virginia, District of Columbia, and Potomac River Fisheries Commission as appropriate. Under this strategy, a timetable was developed for completion of fishery management plans for several important species. Oysters, blue crabs, and American shad were given highest priority, with plans due for these species in July 1989.

A comprehensive approach to managing Chesapeake Bay fisheries is needed because biological, physical, economic, and social aspects of the fisheries are shared among the Bay's jurisdictions. A Fisheries Management Plan Workgroup (FMPW), under the Chesapeake Bay Program's Living Resources Subcommittee, was formed to address the commitment in the Bay Agreement for Bay-wide management plans. The FMPW is composed of members from government agencies, the academic community, and public interest groups from Pennsylvania, Maryland, Virginia, and the District of Columbia.

Development of Fishery Management Plans

A fishery management plan is a dynamic, ongoing process to wisely use a fishery resource. Each of the fishery management plans prepared under the 1987 Chesapeake Bay Agreement is a concise summary of the fishery under consideration, problems and issues that have arisen, and recommended management actions.

The process of developing a management plan incorporates public and scientific evaluation, and appropriate governmental approvals. After an FMP is adopted by the Executive Committee, an implementation plan will be developed to provide more detail on actions that participating jurisdictions will take and the mechanisms for taking these actions. In some instances, regulatory and legislative action will have to be initiated, while in still others, additional funding will be required. An annual review of each FMP will be conducted, under the auspices of the Living Resources Subcommittee, to incorporate new information and to update management strategies.

Goal of the Chesapeake Bay Alosid Management Plan

The goal of the Chesapeake Bay Alosid Management Plan is to protect, restore, and enhance baywide shad and river herring stocks to generate the greatest long-term ecological, economic, and social benefits from the resource.

Problem Areas and Management Strategies

Problem 1: Declining Abundance. Bay-wide stocks of shad and river herrings are very low compared to historical levels. The commercial American shad fishery in Maryland became insignificant by 1979, and is greatly reduced in Virginia. Commercial catches of river herring in the 1980s are 80-90% lower than during the 1970s. Hickory shad no longer support a viable commercial fishery in Virginia or Maryland.

Strategy 1: Recommendations by the Atlantic States Marine Fisheries Commission (ASMFC) for harvesting of alosids should be followed to optimize interjurisdictional coordination. These include a moratorium in Maryland for fishing of American and hickory shad until stocks have recovered, and 25% exploitation rates for alosids in Virginia. Management of river herring on an area-by-area basis, and regulation or closure of areas slated for restoration are discussed. In order to improve management decisions, studies to determine stock levels and exploitation rates need to be conducted.

Problem 2: Overfishing. Overfishing has contributed to the decline of alosid populations and, at current stock levels, is affecting recruitment and stock recovery. High exploitation rates in some of Virginia's waters, and the combined effect of direct and indirect coastal fishing are important factors.

Strategy 2: Pennsylvania, Maryland, and Virginia will continue to participate in ASMFC programs targeting coast-wide, directed alosid fisheries as well as foreign and domestic mackerel fisheries, which have a by-catch of alosids. Virginia will follow ASMFC recommendations to reduce shad and river herring harvests to a 25% exploitation rate.

Problem 3: Stock Assessment Deficiencies. Data on harvest levels, fishing effort, and biological characteristics of the harvest are limited and may not accurately represent stock abundance when alosid populations are low. There are also limited fishery-independent measures of alosid stocks.

Strategy 3: Specific data on alosid biology and the Chesapeake Bay alosid fisheries is needed to improve management. A combination

of surveys, research, fish reporting programs, tagging efforts, and assessments are among the actions recommended.

Problem 4: Habitat Loss and Degradation. Changes in and loss of spawning habitat for alosids have contributed to declining stocks. Dams and other stream blockages have removed thousands of acres of spawning and nursery grounds, and poor water quality has harmed other areas.

Strategy 4: Signatory jurisdictions will implement plans under the Chesapeake Bay Agreement to remove impediments to migratory fishes and improve water quality, and will undertake restoration projects. Recommended actions include constructing fish passage facilities, restocking areas with hatchery-raised juvenile fish or transported adult fish, and adopting water quality standards.

INTRODUCTION

MANAGEMENT PLAN BACKGROUND

To protect and manage the natural resources of Chesapeake Bay, the jurisdictions are developing and will implement a series of fishery management plans under the Chesapeake Bay Agreement. This agreement adopted a schedule for the development of Bay-wide fishery management plans for commercially, recreationally, and selected ecologically valuable species. The strategy for implementing the Living Resources Commitments in the 1987 Agreement listed the priority of each species and a timetable for completion of fishery management plans:

- oysters, blue crabs and American shad by July 1989
- striped bass, white perch, bluefish, weakfish, and spotted trout by 1990
- croaker, spot, summer flounder and American eel by 1991
- red and black drum by 1992

A comprehensive approach to Bay problems and a means to coordinate the various state and federal groups was also necessary. Bay fisheries are managed separately by the States of Pennsylvania, Maryland, and Virginia, the District of Columbia, and the Potomac River Fisheries Commission. There is also a federal Mid-Atlantic Fishery Management Council (MAFMC) which has jurisdiction for management planning over offshore fisheries (3-200 miles), and a coast-wide organization, the Atlantic States Marine Fisheries Commission (ASMFC), which coordinates the preparation of plans for migratory species in state coastal waters from Maine to Florida. The state/federal Chesapeake Bay Stock Assessment Committee (CBSAC) is responsible for developing a Bay-wide Stock Assessment Plan which includes collection and analysis of fisheries information but does not include the development of fishery management plans. Consequently, a Bay-wide Fisheries Management group, under the Living Resources Subcommittee of the Chesapeake Bay Program, was formed to address the commitment in the Bay Agreement for management plans.

The Fisheries Management group is responsible for developing and writing the fishery management plans and includes: Maryland Department of Natural Resources, Fisheries Division; Pennsylvania Fish Commission, Office of Chief Counsel, Planning and Environmental; Potomac River Fisheries Commission; Virginia Marine Resources Commission, Fisheries Management Division; and Washington, D.C. Department of Consumer and Regulatory Affairs, Fisheries Management Division. The management workgroup also included representatives from the Chesapeake Bay Foundation,

Chesapeake Bay Commission, University of Maryland, College of William and Mary/Virginia Institute of Marine Science, Maryland Watermen's Association, Virginia Watermen's Association, Charter Boat Association, and Maryland Saltwater Sportsfishermen's Association. Plans developed by this group reflect the multijurisdictional management requirements appropriate to the species.

WHAT IS A FISHERY MANAGEMENT PLAN?

A management plan is a dynamic process of analyzing the complex biological, economic and social components of a particular finfish or shellfish fishery, defining problems, identifying solutions, and implementing decisions regarding habitat problems and human usage of the resource.

GOALS AND OBJECTIVES FOR FISHERY MANAGEMENT PLANS

The goal of fisheries management is to protect the reproductive capability of the resource and provide for optimal harvests. Fisheries management must include biological, economic and sociological considerations in order to be effective. It requires an adaptive management scheme which responds to the most current status of the stock, therefore, it is of primary importance to prepare a plan which provides a means of regular review and reevaluation of current management actions. Three simply stated objectives to protect the reproductive capabilities of the resource while allowing optimal harvest include:

- quantify biologically appropriate levels of harvest
- monitor current and future resource status to ensure harvest levels are conserving the species while maintaining an economically viable fishery, and
- adjust resource status if necessary through management efforts.

MANAGEMENT PLAN FORMAT

The background section for each management plan summarizes:

- biological profile
- habitat requirements
- historical fishery trends
- economic profile

- current stock status
- current regulations (in effect as of September 1988), and
- data needs

This information was modified from the Chesapeake Bay Fisheries: Status, Trends, Priorities and Data Needs document. Including this section as part of the management plan provides historical background and basic biological information for each of the species.

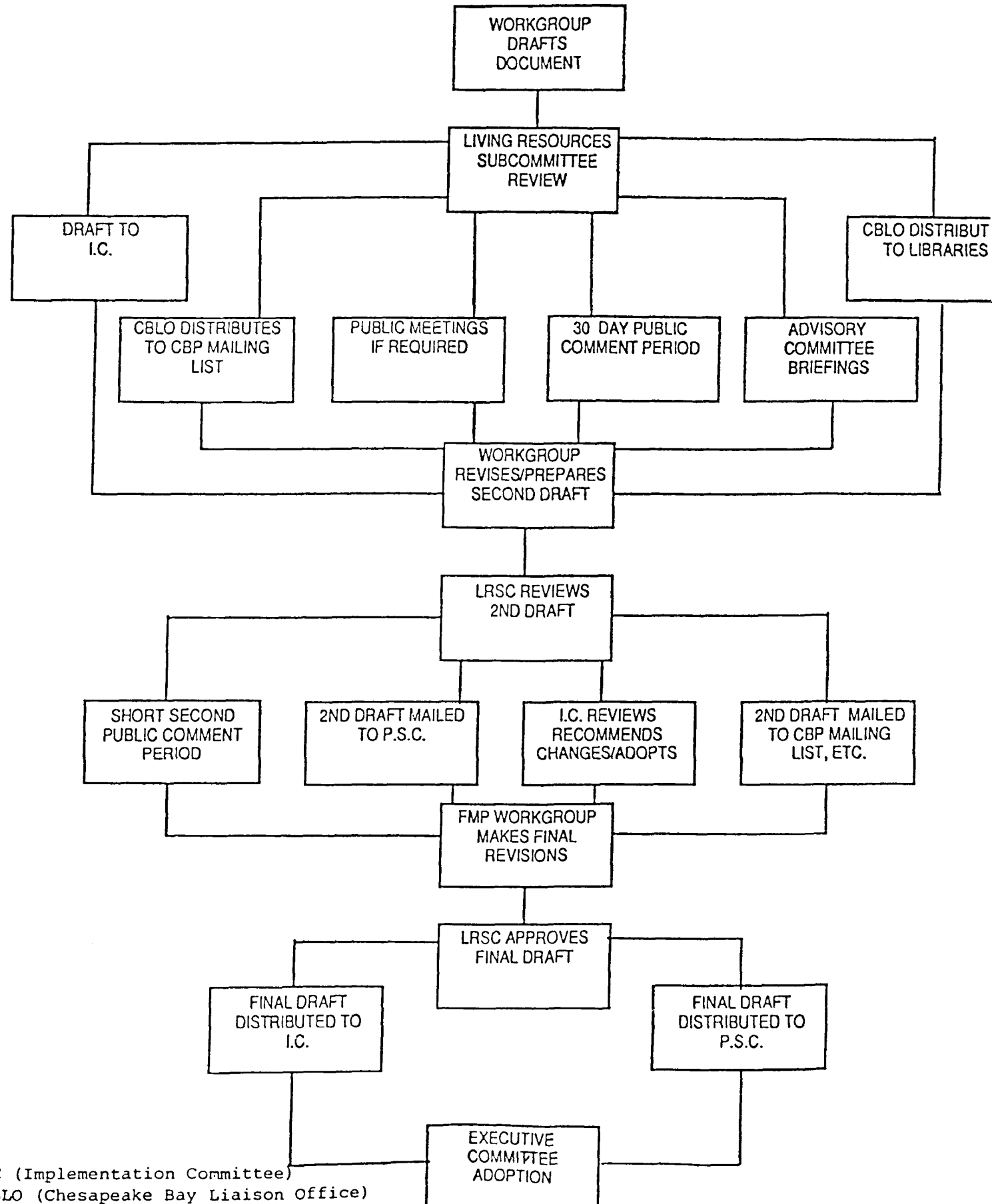
The management section of the plan defines:

- specific goals and objectives for each species
- problem areas for each species
- management strategies to address each problem area, and
- action items with a schedule of implementation.

These plans are concise summaries that consider interjurisdictional issues and recommend regulations which will be subject to public review and appropriate approvals. Management planning provides the opportunity for public and scientific evaluation, and debate of management options and regulation strategies prior to actual regulatory proposals. As the management plan review process continues, changes will be necessary. The strategies will be further defined as new information becomes available and, therefore, must reflect some flexibility.

Once the plan has been adopted by the Executive Committee appropriate regulatory and legislative action will be initiated. An annual review of the management plans will be required to continually update management strategies and actions. A workgroup will be established to annually review the plan. Completed management plans will follow the schedule set forth by the Chesapeake Bay Agreement. The process of fishery management plan review and acceptance is presented in the flow chart below.

COMMITMENT PREPARATION AND ADOPTION FLOW CHART



IC (Implementation Committee)
CBLO (Chesapeake Bay Liaison Office)
CBP (Chesapeake Bay Program)
LRSC (Living Resources Subcommittee)
PSC (Principal Staff Committee)

SECTION 1. BACKGROUND

SHAD AND RIVER HERRING INTRODUCTION

American shad, hickory shad, alewife and blueback herring are anadromous species that spend most of their lives at sea. Adults migrate to the Chesapeake Bay primarily during March, April and May where they spawn in low salinity and fresh waters. After spawning, adults return to the sea and are prey for many marine fish. Young-of-the-year inhabit fresh and brackish waters in the summer, migrate to the ocean in the fall, and generally do not return to estuarine waters until sexual maturity is reached between the ages of three and six years.

American and hickory shad have declined to such low levels of abundance in Maryland that they have been determined to be in need of conservation. Regulations banning the capture, possession, and sale of American shad in Maryland waters became effective April 12, 1980. Similarly, hickory shad capture was prohibited as of January 23, 1981. Current MDNR studies reveal that American and hickory shad populations are at extremely low levels of abundance and consequently the fisheries for both species remain closed. Shad and river herring are absent from the Susquehanna River basin in Pennsylvania. Historically they used this area for spawning and nursery habitat. Access to this major river system has been blocked by dams at four locations for over 80 years.

American and hickory shad, once an important component of the commercial and/or recreational landings in Virginia, have also dramatically decreased in abundance in the last decade. Virginia American shad stocks are at very low levels relative to historical abundances.

Alewife and blueback herring are nearly identical in appearance and, as a result, both species are called river herring by commercial and recreational fishermen. Alewife range from Newfoundland and the St. Lawrence River to South Carolina with the center of the distribution of the species skewed towards the northern states. Blueback herring occur from Nova Scotia to northern Florida and are most common in the southern portion of their range.

In the Chesapeake region, both alewife and blueback herring spawn in the northern Bay and in all major tributaries. The spawning season for alewife generally runs from late March through April. Blueback herring spawn from the last half of April to mid-May. With the exception of the spring months, adults inhabit near-shore Atlantic Ocean waters. Young-of-the-year river herring migrate from estuarine to coastal waters in the early fall and remain at sea until sexual maturity is reached in three to five years.

At one time, these species had a vital ecological role. Young-of-the-year river herring, along with other alosids, were one of the dominant pelagic prey species in freshwater and upper estuarine nursery areas, while adults were prey for many marine fish.

FMP Status and Management Unit

The Atlantic States Marine Fisheries Commission (ASMFC) alosid FMP was approved in 1985. The plan was developed because of stock depletion from overfishing, loss of habitat, inconsistencies in management actions and lack of adequate data. Since the ASMFC program promotes cooperative management of marine, estuarine and anadromous fisheries throughout the states along the Atlantic coast, the Chesapeake Bay alosid FMP is consistent with the goals and objectives of the ASMFC plan. The baywide FMP will be effective by July 1989.

The management units are the Chesapeake Bay stocks of American shad (Alosa sapidissima), hickory shad (Alosa mediocris), alewife (Alosa pseudoharengus) and blueback herring (Alosa aestivalis) throughout their range on the Atlantic coast.

Fishery Parameters - American Shad:

Status of exploitation:	American shad stocks south of Delaware Bay are depressed. There is a moratorium on the harvest of American shad in the Maryland portion of the Bay. No open season in the Susquehanna River and its tributaries in Pennsylvania. Recreational shad harvest currently in the District of Columbia. Commerical and recreational harvest in Virginia.
Long term potential catch:	Unknown.
Importance of recreational fishery:	Historically significant in Maryland and Pennsylvania; currently seasonally and regionally significant in District of Columbia and Virginia.
Importance of commercial fishery:	Historically very significant.
Fishing mortality rate:	Unknown for District of Columbia, Maryland, Pennsylvania or Virginia stocks.

Fishery Parameters - Hickory Shad:

Status of exploitation:	There is a moratorium on the recreational and commercial harvest of hickory shad in the Maryland portion of Chesapeake Bay. There is no open season for hickory shad in Pennsylvania's portion of the Conowingo Reservoir. Recreational harvest in the District of Columbia. In Virginia, commercial hickory shad landings are insignificant due to low current abundance levels and value constraints.
Long term potential catch:	Unknown.
Importance of recreational fishery:	Historically significant but not of the magnitude of American shad.
Importance of commercial fishery:	Insignificant.
Fishing mortality rates:	Unknown for District of Columbia, Maryland, Pennsylvania or Virginia stocks.

Biological Profile - American and Hickory Shad:

Natural mortality rate:	Currently unknown for the District of Columbia, Maryland, Pennsylvania or Virginia stocks.
Fecundity:	59,000 - 660,000 eggs/female
Longevity:	Approximately 7 years.

Spawning and larval development (probably very similar for both species):

Spawning season:	April - June.
Spawning area:	The freshwater portion of the northern Chesapeake Bay and all major tributaries. It is generally accepted that shad return to their natal streams to spawn. Considerable mixing

	and consequent straying may occur among the spawning stocks which utilize tributaries of the Chesapeake Bay.
Spawning location:	Mostly in tidal freshwater, usually in areas dominated by extensive flats.
Salinity:	0 - 2.0 ppt.
Spawning temperature:	55^{o} - 68^{o} F.
Dissolved oxygen:	Probably at least 5.0 ppm.
pH:	Reported range - 6.5 to 7.8.
Flow:	Tidal or fluvial movement of 0.5 - 3.0 feet/second required.

Young-of-the-Year

Location:	Fresh and low salinity estuarine waters through early fall.
Salinity:	0-7.5 ppt through summer months.
Temperature:	60^{o} F minimum reported.
Dissolved oxygen:	5.0 ppm minimum.
pH:	5.0 - 9.0.

Subadults and adults

Salinity:	0 - 35 ppt.
Temperature:	45^{o} - 64^{o} F.
Dissolved oxygen:	5.0 ppm minimum.

Fishery Parameters-Alewife and Blueback Herring:

Status of exploitation:	Currently unknown.
Long term potential catch:	Currently unknown.

Importance of recreational fishery:	Seasonally significant, highly directed; availability is limited to the spring months.
Importance of commercial fishery:	Significant; available in March, April and May.
Fishing mortality rates:	Unknown for District of Columbia, Maryland, Pennsylvania and Virginia stocks of alewife and blueback herring.

Biological Profile - Alewife and Blueback Herring:

Natural mortality rate:	Currently unknown.
Fecundity:	46,000 - 350,000 eggs/female.
Longevity:	7 to 8 years.
Age/size at maturity:	80 percent of the females return to spawn by 4 years of age. Males generally mature at an earlier age and size than females. Limited data exists for size at maturity for Chesapeake Region fish.

Spawning and Larval Development

Spawning season:	Alewife - late March through April; Blueback - April to mid May.
Spawning area:	Northern Chesapeake Bay and all major tributaries.
Spawning location:	Alewife - usually in sluggish water less than one foot deep. Blueback - generally swift flowing relatively deep water.
Salinity:	0-6.0 ppt, mostly below 1 ppt.
Spawning temperature:	Alewife- 50^{o}-70^{o} F; blueback herring 57^{o}-80^{o} F.
Dissolved oxygen:	5.0 ppm minimum.
pH:	6.5-7.8

Flow:	Tidal or fluvial movement required.

Young-of-the-Year

Location:	Fresh and low salinity estuarine waters through summer and early fall.
Salinity:	0-2.0 ppt through mid-summer.
Temperature:	60^{o} F minimum reported.
Dissolved Oxygen:	3.6 ppm minimum.

Subadults and Adults

Location:	Ocean waters, except during spawning migrations into estuaries.
Salinity:	0 - 35 ppt.
Dissolved oxygen:	At least 5.0 ppm.

Habitat Issues

Shad and herring spawning migrations have been blocked by dams across the mainstem or tributaries of the Susquehanna, Patapsco, Potomac, Rappahannock, James, York and Chowan Rivers and resulted in the loss of spawning and nursery habitat. Smaller mill dams, gauging stations and road culverts throughout tributaries in the Bay watershed also limit the amount of available spawning and nursery areas. Large kills of herring occasionally occurred below Conowingo Dam in the late 1960's when the dam ceased water release. It is believed that the dissolved oxygen in pools below the dam was low and easily depleted by large numbers of migrating fish. Current operating procedures at the dam should prohibit a reoccurrence of this situation.

The alosid passage issue at Conowingo Dam and other hydropower dams upstream is being addressed by the Susquehanna River Anadromous Fish Restoration Committee (SRAFRC) through detailed annual plans and activities using both agency and project owner funding. In Virginia, appropriations from General Funds and the City of Richmond will be used to provide fish passages for the Machester and Brown's Island Dams on the James River. The Virginia Anadromous Fish Restoration Committee is constructing a plan for restoration of anadromous fish in Virginia. Implementation of a fish ladder for Walker's Dam on the Chickahominy River is also in progress. The dam at Little Falls, District of Columbia, has been a major barrier to migratory fish since the early 1950's. Plans are underway for a fish passage facility which would open the Potomac

River spawning habitat another 11 miles to Great Falls, the historical limit for shad and river herring. Plans to remove impediments to migratory fishes in the Chesapeake Bay watershed are being coordinated and implemented by the Fish Passage Workgroup established by the Chesapeake Bay Program.

Acid deposition and stream acidification may be a major problem in the decline of many anadromous fish. Laboratory studies have shown that river herring eggs and larvae suffer high mortalities below pH 6.5 and total dissolved aluminum levels greater than 0.34 mg per liter. There is a high incidence of low pH and high dissolved aluminum events in many Eastern shore streams following heavy spring rains. The existing information on tolerance of shad to low pH is limited and does not allow conclusions on the importance of this factor to shad declines.

The Fisheries

American Shad

Historically, shad and river herring supported some of the most valuable commercial fisheries in the Chesapeake Bay. From the late 1800s to the mid-1900s, shad was the most economically valuable food fish harvested in the District of Columbia, Maryland, Pennsylvania and Virginia. As is the case with river herring, most American shad harvest occurred in March, April and May from gill nets, haul seines and pound nets. Maryland commercial shad landings generally declined from the early to late 1930s, increased through the late 1950s and then declined precipitously through the 1960s and 1970s (Figure 1). By 1980, the Maryland stock was reduced to the point where capture and possession were banned for the first time in the history of the fishery. American shad runs disappeared from the upper Potomac River in the District of Columbia in the 1950's and have not returned to any substantial degree. Pennsylvania stocks were eliminated beginning with canal dams in the late 1800's and finally by the construction of hydroelectric dams on the Susquehanna River in the early 1900's. These dams block nearly 400 miles of habitat historically used by shad and herring. A similar problem occurs on the James River in Virginia. There are five dams on the James River which block fish access to nearly two-thirds of the historic habitat. In the Virginia fishery, landings declined dramatically during the decade of the 1930s, generally increased through the late 1940s and have continuously declined since that time (Figure 2). The recreational American shad fishery was extensive in both Maryland and Virginia. Although statistics for the Bay are not available, data collected for the East Coast fisheries in 1965 and 1970 reveal that the recreational shad harvest was 61% and 65% respectively, of the commercial harvest.

Hickory shad

Hickory shad were historically harvested by fishing gears set primarily for American shad and striped bass. Landings rarely

Figure 1. Maryland commercial landings for American shad from Chesapeake Bay

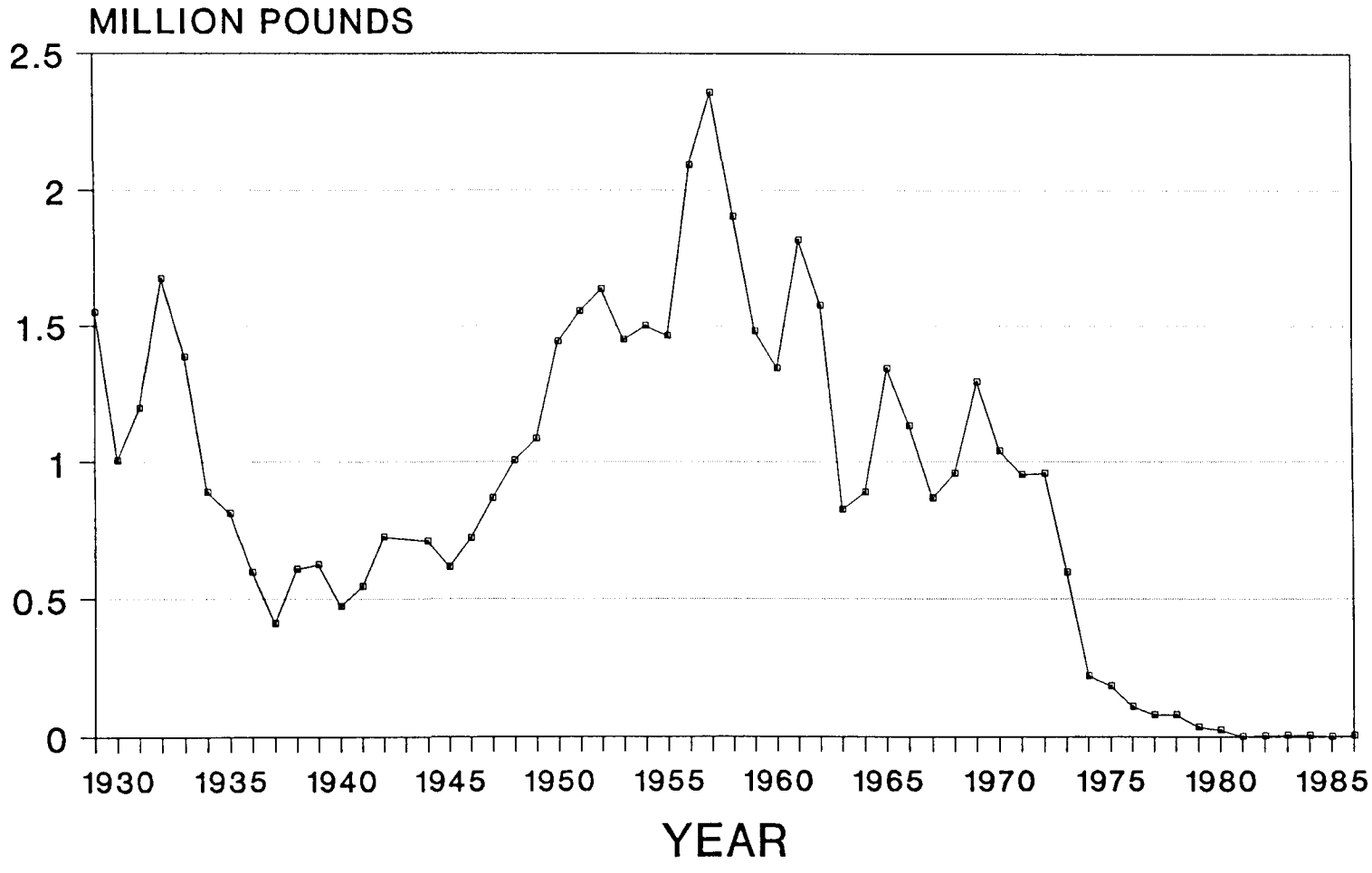
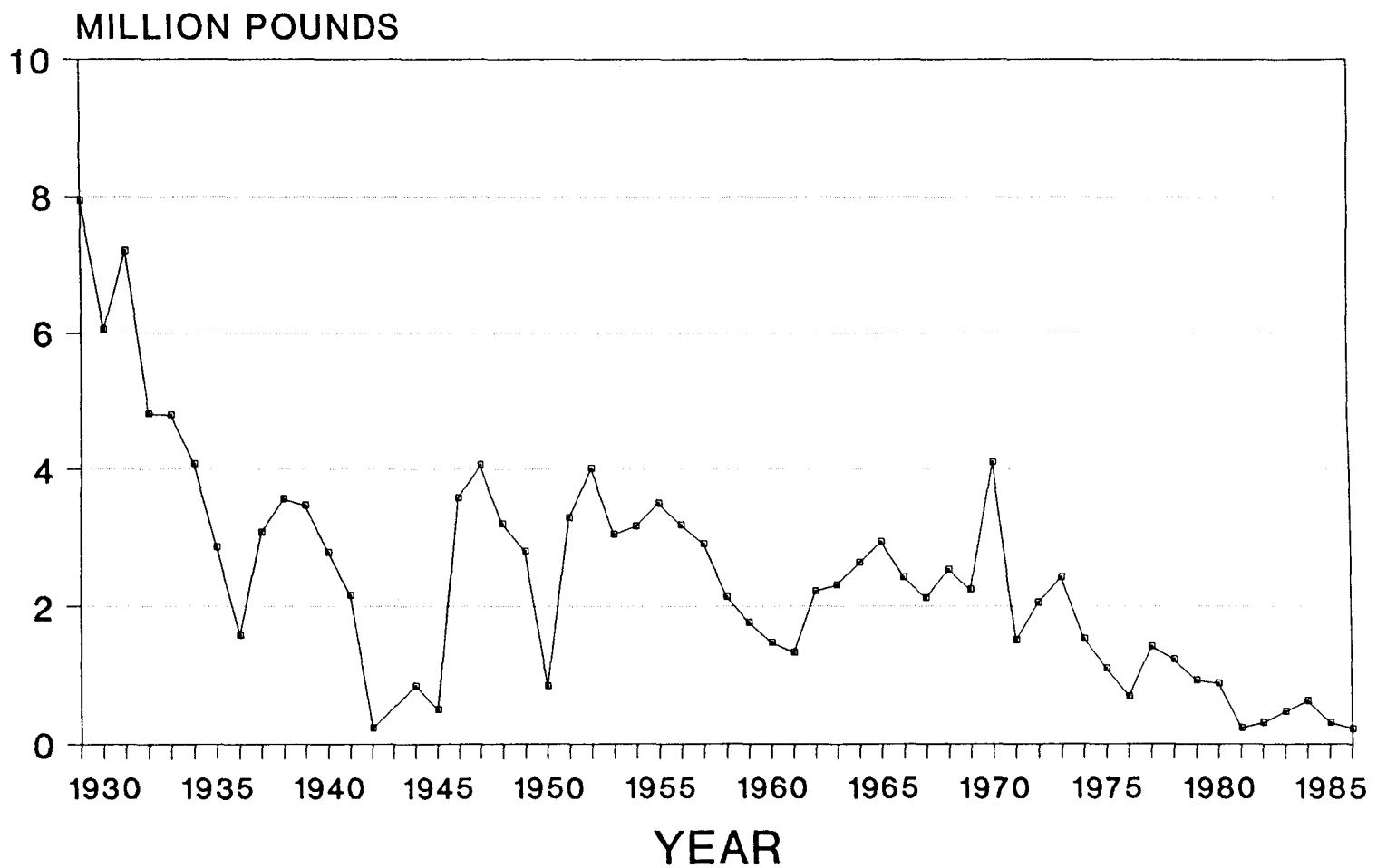


Figure 2. Virginia American shad commercial landings from Chesapeake Bay



reached 50,000 pounds a year in Maryland and annual harvests of less than 10,000 pounds were not uncommon (Figure 3). Harvests started to decline dramatically in 1976 and by 1980 only 2,101 pounds were landed. No significant data exist for hickory shad landings from the District of Columbia or Pennsylvania, although they probably were taken with American shad catches in early upriver commercial fisheries. Hickory shad landings in Virginia were historically somewhat higher than those in Maryland. However, as was the case in Maryland, harvests began a dramatic long term decline in Virginia in 1976 (Figure 4). Hickory shad were never as abundant as the other commercial anadromous herrings although they were a highly desirable sportfish. Most were caught by hook and line during the spring months in the spawning reaches of Chesapeake Bay tributaries.

Economic Perspective - American and Hickory Shad

The commercial shad fishery seldom commanded a high price per pound and the small incremental increases in value did not keep pace with the annual inflation rate for food items. Consequently, the value of American and hickory shad decreased in both real and inflated dollars. The value of the recreational shad fishery in Maryland was substantial and would be even greater if the fishery was restored. Estimated values of a restored shad run utilizing different econometric models range from 42 million to 178 million dollars.

The Fisheries

River Herring

In 1931 over 25 million pounds were harvested making herring second in quantity and fifth in value of all Chesapeake finfish, and first in quantity and fourth in value of all finfish landed in Maryland. Principal gears used in the Chesapeake Bay river herring fishery include pound nets, drift and anchor gill nets, haul seines and fyke nets. Most of the annual harvest was taken in March, April and May during the annual spring spawning migration. River herring landings in Maryland have more or less steadily declined from levels of about 5 to 8 million pounds in the early 1930s to less than 250,000 pounds a year since 1976 (Figure 5). No historic data have been found to indicate the significance of river herring harvest in the Susquehanna River Basin in Pennsylvania or in the upper Potomac River, District of Columbia. Virginia has historically taken the largest portion of the total Chesapeake harvest, catches in recent years have declined to levels comparable to those in Maryland (Figure 6).

In the past, river herrings supported an apparently extensive recreational fishery in the tributaries of Chesapeake Bay during March, April and May. Although some fish were caught by hook and line, most were harvested with dip nets. As was the case in the commercial fishery, recreational catches of river herring have decreased dramatically since the mid-1970s.

Figure 3. Maryland hickory shad commercial landings from Chesapeake Bay

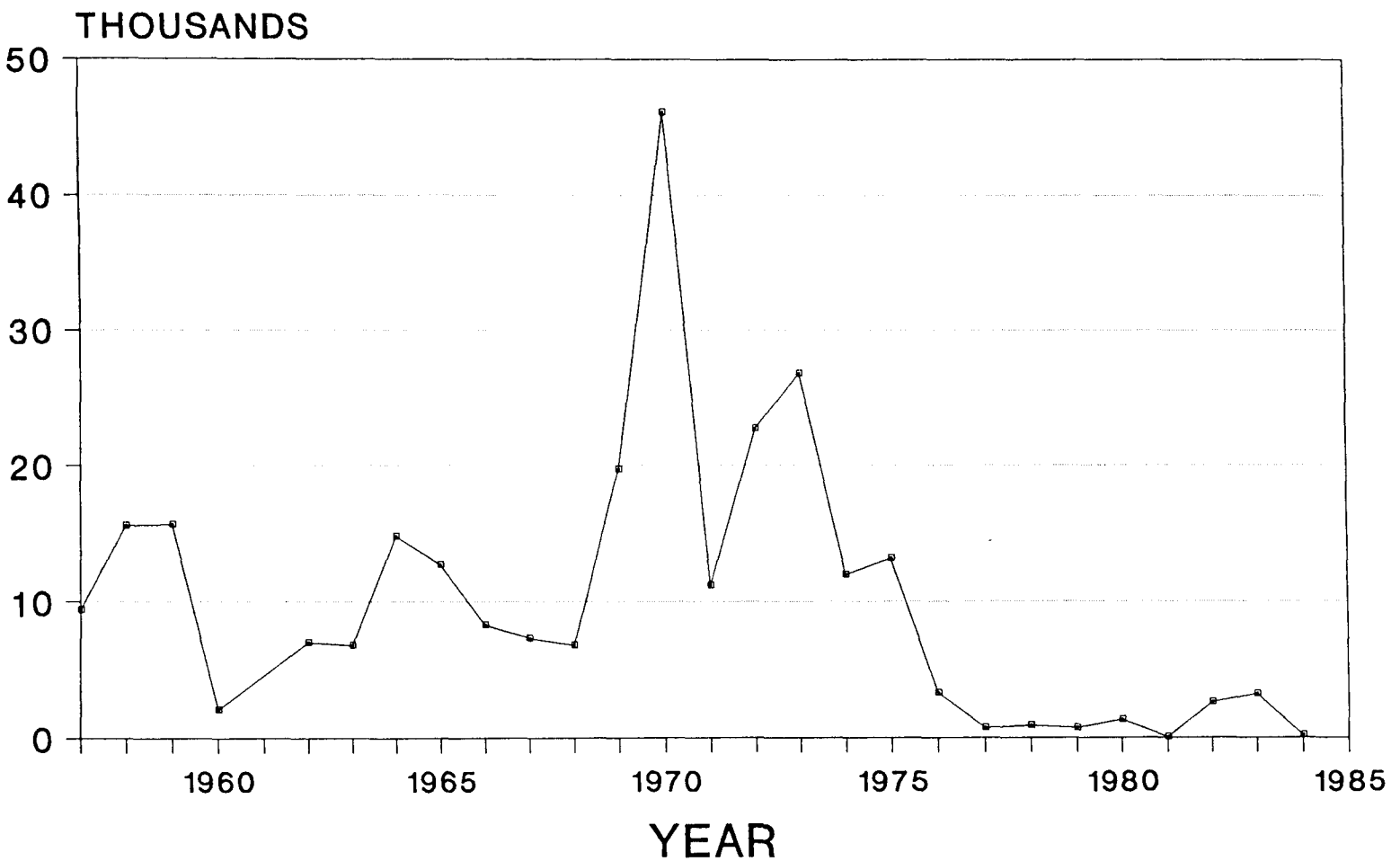


Figure 4. Virginia hickory shad commercial landings from Chesapeake Bay

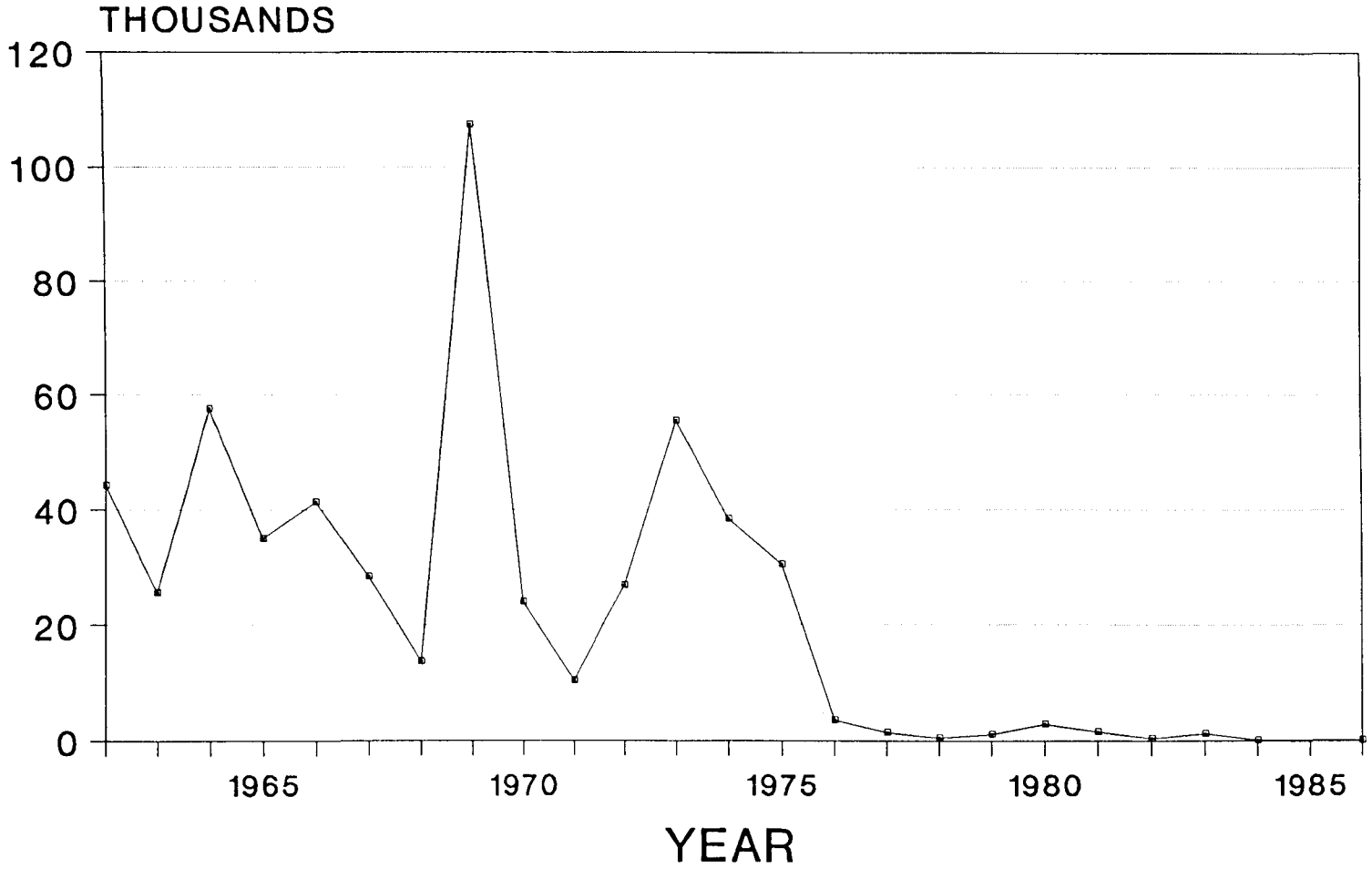


Figure 5. Maryland commercial landings for river herring from Chesapeake Bay

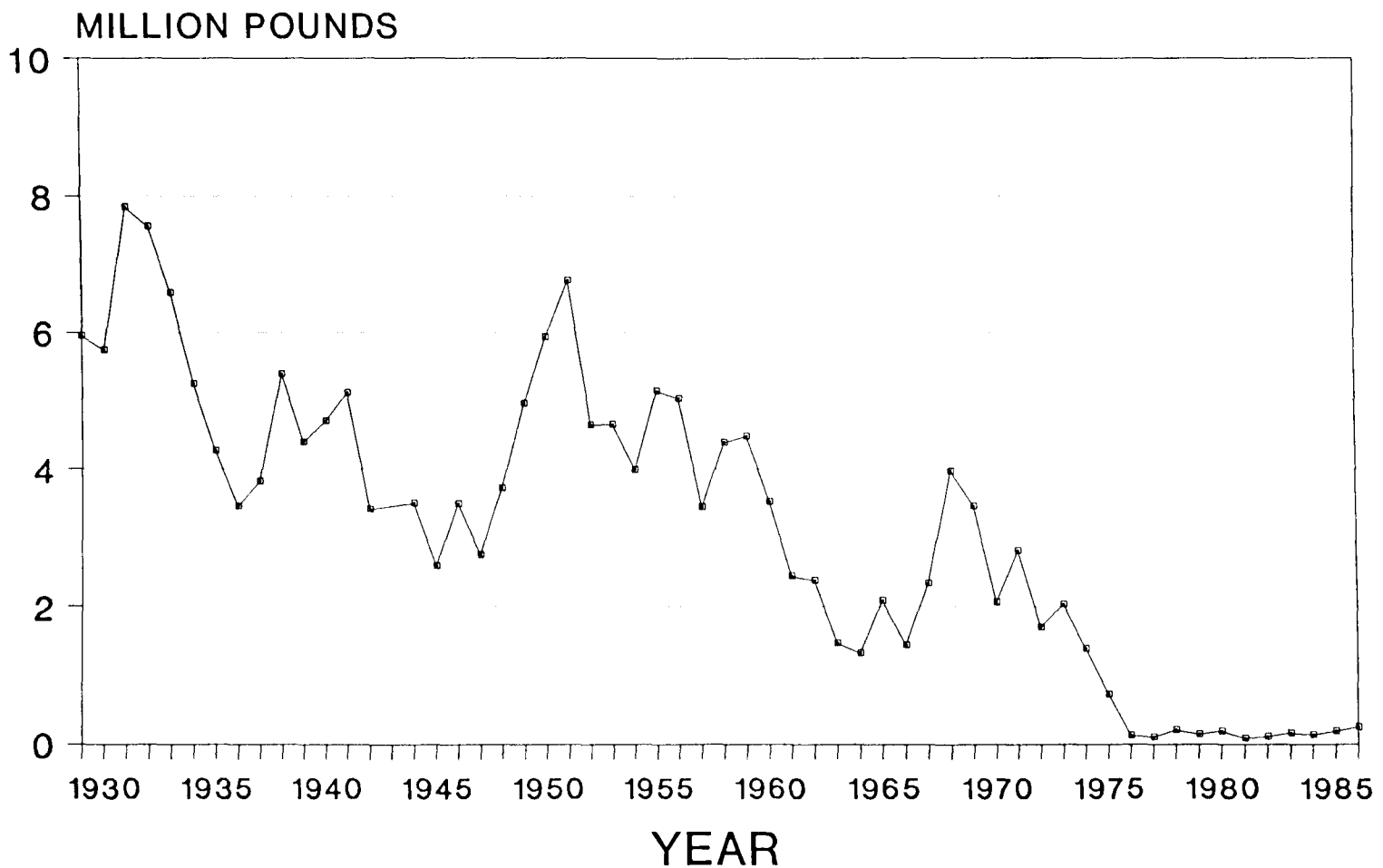
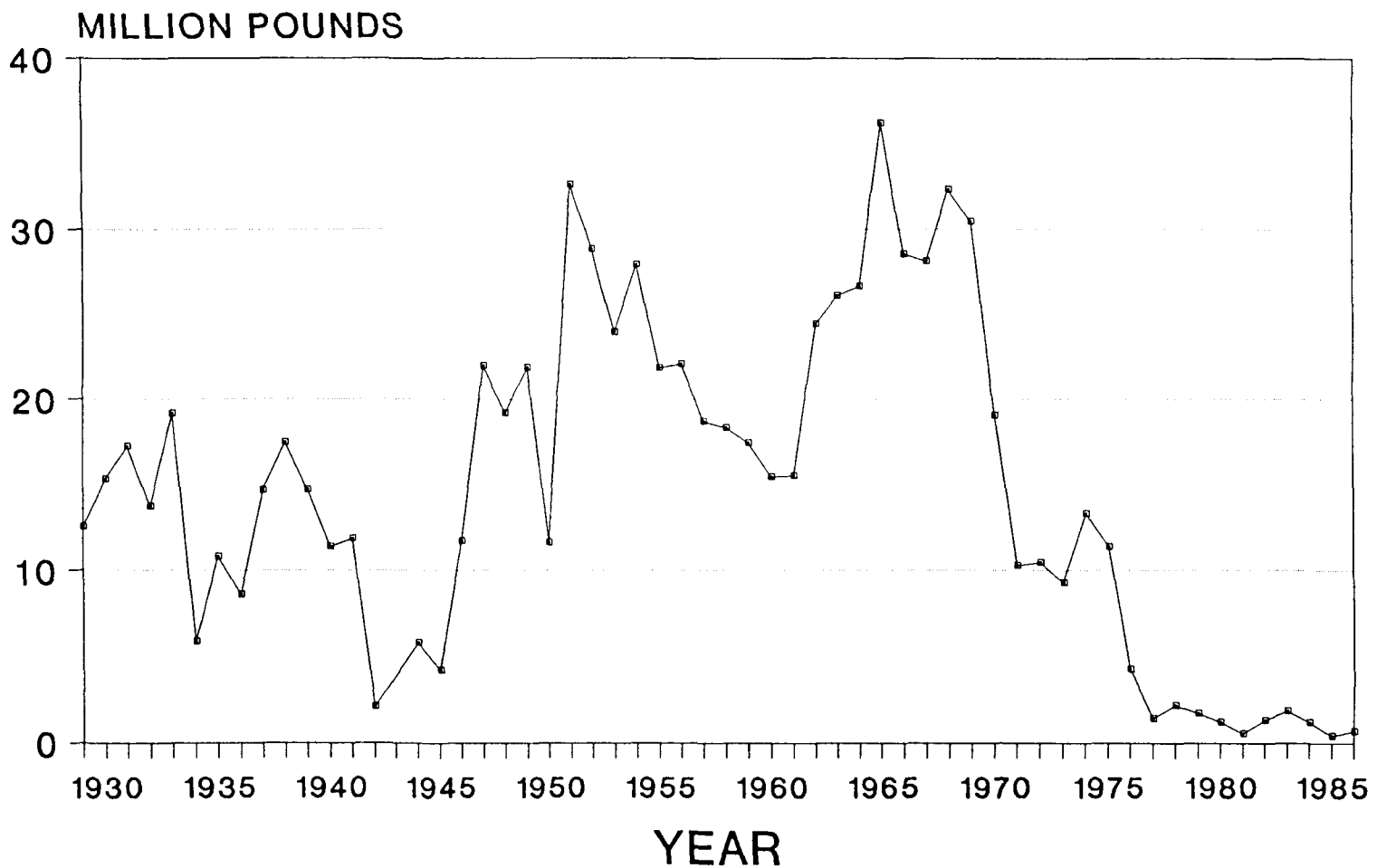


Figure 6. Virginia commercial landings for river herring from Chesapeake Bay



Economic Perspective - Alewife and Blueback Herring

River herring have commanded a relatively low price per pound and has not kept pace with the inflation rate for food items. Some quantity of commercial herring landings are kept as eel and/or crab bait and bait herring have a greater value than the dockside value. The roe of herring is still an important food item especially on a local basis. Roe herring commands a higher price than non-roe herring and the level of demand is unknown as is the price schedule. Currently, there is not enough information available to document the total value of the commercial herring industry. Recreational exploitation of river herring was widespread in the 1960's but has severely decreased. There is no information about the economic value of the recreational sector.

Resource Status

American and Hickory Shad

At the present time, both the American and the hickory shad spawning stocks are at low levels of abundance in all spawning tributaries of the Maryland portion of the Bay. Restoration efforts and the moratorium on American shad have contributed to an increase in the population in the upper Bay. Maryland DNR adult population estimates have projected a spawning population of approximately 75,000 fish for 1989, up from an estimated 2,600 in 1980. In the same area in 1965, estimates of the spawning stock approached 1.4 million fish.

In Virginia, the precipitous decline in landings over the last 15 years is, in part, related to changes in fishing effort. Virginia shad stocks appear to be at low levels of abundance relative to earlier years.

Alewife and Blueback Herring

Stock status, based primarily on landings, reveals that there has been a large decline in river herring abundance from the 1930s to present. Causes of the long term decline in Chesapeake Bay are not known with certainty but apparently relate to the effects of fishing and habitat loss. There is strong circumstantial evidence that the precipitous decline in landings that occurred in Chesapeake Bay in the 1970's was attributable to large river herring harvests by offshore fleets operating along the East Coast of the United States from 1967 -1972 (the offshore fishery no longer exists). At present, alewife abundance may be more depressed than that of blueback herring. However, this relationship cannot be quantified at the present time.

Current Maryland Laws and Regulations for American and Hickory Shad:

American shad:	Capture, sale, or possession of American shad caught in Maryland waters of the Bay prohibited; except that two per day may be possessed for personal consumption if the shad were found dead when fishing gear operated for other fish was retrieved from the water.
Hickory shad:	Capture, sale, purchase or possession of hickory shad caught in Maryland waters of Chesapeake Bay prohibited; except that the incidental catching of hickory shad by gear set for other species will not be considered a violation if the hickory shad is returned to the water.
Both species:	Provisions of Maryland's Delay of Application Process will apply if the fisheries re-open. Provisions which apply to shad are as follows: after August 31, 1988 previously unlicensed applicants must wait two years after registering with MDNR before a license to harvest finfish with commercial fishing gears will be issued.

Current Pennsylvania Regulations for American and Hickory Shad (Susquehanna Basin):

Conowingo Reservoir:	No open season for American or Hickory shad.
Susquehanna River and its tributaries:	American shad only, closed year round.

Current Potomac River Laws and Regulations for American and Hickory Shad:

Minimum size:	None other than those resulting from gear specific limitations.

Creel Limit:	American shad- 2 per person per day or 2% by volume of total catch per license. Hickory shad- none.
Season:	None other than those resulting from gear specific limitations.
By-catch Restriction:	None other than those resulting from gear specific limitations.

Current District of Columbia Laws and Regulations for American and Hickory Shad:

Limited Entry:	No commercial harvest.
Minimum size:	None.
Creel Limit:	American and Hickory shad- 3 per person per day.
Season:	Not in effect.
By-catch Restrictions:	Not in effect.

Current Virginia Laws and Regulations for American and Hickory Shad:

Limited entry:	Not in effect.
Minimum size limit:	None.
Creel limit:	Not in effect.
Harvest quotas:	Not in effect.
By-catch restrictions:	Not in effect.
Season:	Not in effect.
Gear restrictions:	Trawling prohibited in the Chesapeake Bay. 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. From April 1 through 31 May the spawning areas of the James, Pamunkey, Mattaponi, and Rappahannock Rivers are closed to stake and anchor gill nets. Minimum stretch mesh size restrictions:

pound net, 2"; haul seine, 3" (nets over two hundred yards long); trawl net, 4.5" (cod or bunt end). In addition, no haul seine can be longer than one thousand yards in length or deeper than forty meshes; and the cod or bunt end of a trawl net shall have a minimum of fifty meshes deep. Any gill net, whether floating or submerged, that is not assigned a fixed location shall be set in a straight line, have no greater depth than 330" and shall be fished no closer than 200 feet to any other such gill net. Also, Sections 28.1-52 and 28.1-53 of the Code of Virginia outline placement, total length and distance requirements for fishing structures.

Possession: Not in effect.

Area closures: None in effect.

Other prohibitions: Obstructing passage of fish and dynamiting streams.

Current Laws and Regulations for Alewife and Blueback Herring:

Limited entry: Maryland's Delay of Application Process, which goes into effect September 1, 1988, requires previously unlicensed applicants to wait two years after registering with MDNR before a license to harvest finfish with commercial fishing gears will be issued.

Delayed or limited entry is not in effect in the District of Columbia, Pennsylvania or Virginia.

Minimum size limit: None.

Creel limit: Not in effect.

Harvest quotas: Not in effect.

By-catch restrictions: Not in effect.

Gear - Area restrictions:

Maryland - gill nets prohibited in striped bass spawning reaches; monofilament gill net, otter trawls, beam trawls, trammel nets, troll nets, drag nets and purse nets prohibited. (Otter and beam trawls are legal on the Atlantic Coast at distances of one mile or more offshore). Minimum stretch mesh size restrictions - 1.5" in pound nets, 2.5" in gill nets, 2.5" in haul seines and 1.5" in fyke and hoop nets.

Pennsylvania-No gear restrictions. In a cooperative river herring restoration venture with MDNR, regulations are being promulgated for the Elk Creek Basin in Chester County to prohibit the taking and possession of blueback and alewife herring 8 inches or larger, effective 1/1/90.

Potomac River- Minimum mesh size: pound net-1 1/2", haul seine-1 1/2", fyke net- 1 1/2", fish pot-2", bait pot-1", eel pot-1/2 x 1/2", gill net-3 3/4' with a maximum of 7". Length limitations: pound net-600', stake gill net-600', anchor gill net-600' x 12', fyke net-400', haul seine-1200' or 2400', fish pot and eel pot-10', bait pot-24" cube.

District of Columbia - No commercial gears.

Virginia - trawling prohibited in the Chesapeake Bay. 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. From April 1 through 31 May the spawning areas of the James, Pamunkey, Mattaponi, and Rappahannock Rivers are closed to stake and anchor gill nets. Striped bass taken in spawning areas by any gear must be released immediately. Minimum stretch mesh size restrictions: pound net, 2" haul seine, 3" (nets over two

	hundred yards long); trawl net, 4.5" (cod or bunt end). In addition, no haul seine can be longer than one thousand yards in length or deeper than forty meshes; and the cod or bunt end of a trawl net shall have a minimum of fifty meshes deep. Any gill net, whether floating or submerged, that is not assigned a fixed location shall be set in a straight line, have no greater depth than 330" and shall be fished no closer than 200 feet to any other such gill net. Also, Sections 28.1-52 and 28.1-53 of the Code of Virginia outline placement, total length and distance require- ments for fishing structures.
Season:	Pennsylvania- no closed season. Potomac River- none other than those resulting from gear specific limitations. District of Columbia - no closed season. Virginia - no closed season.
Possession:	Pennsylvania- not in effect. Potomac River- not in effect. District of Columbia- not in effect. Virginia- not in effect.
Other prohibitions:	Obstructing passage of fish and dynamiting streams.

Status of Traditional Fishery Management Approaches for American Shad, Hickory Shad, Alewife and Blueback Herring:

Catch-Effort:	Data is available for both shad and river herring, however, the catch data is of low quality and there is no usable effort data.
Estimates of mortality based on the abundance of successive age groups of shad or herring:	Unknown - no historical information on age specific relative abundance.
Yield-Per-Recruit:	Can be calculated, however, estimates of natural and fishing mortality rates would be required.

Stock-Recruitment Relationship:	Unknown - No information on the species specific relative abundance of either the spawning stock or young-of-the-year.
Maximum Sustainable Yield (MSY):	Unknown.
Virtual Population Analysis (VPA):	Has not been carried out - no historical information on age specific estimates of catch.

Data and Information Needs for American and Hickory Shad:

Closed fisheries

1. Estimates of the impact of the Virginia, Delaware Bay and Atlantic Coast shad fisheries on Maryland and Pennsylvania restoration efforts.

2. Basic biological data on hickory shad.

3. Effects of water quality factors on reproductive success.

4. Estimates of the survival rate of stocked juveniles.

Open fisheries

1. Species, age and sex specific estimates of population structure and relative annual abundance.

2. Measures of annual reproductive success for each species.

3. Species specific estimates of natural mortality rates.

4. Annual age and sex specific estimates of fishing mortality for each species.

5. Annual species and age specific estimates of yield.

6. Information relating to the stock-recruitment relationship of American shad and hickory shad.

Data and Information Needs for Alewife and Blueback Herring:

1. Annual species specific estimates of relative abundance.

2. Long term measures of annual reproductive success for each species.

3. Annual species and age specific estimates of fishing mortality rates.

4. Annual species specific estimates of catch and effort in the commercial and recreational fisheries.

5. Information relating to the stock-recruitment relationship of alewife and blueback herring.

6. Better definition of offshore migration patterns and the extent of mixing of Chesapeake Bay and Atlantic Coast stocks.

7. Information on the influence of market factors on fishing effort.

References

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SECTION 2. ALOSID MANAGEMENT

The source documents for this plan, Richkus and DiNardo (1984), Loesch and Kriete (1984-1986), and Atlantic States Marine Fisheries Commission (1985), discuss many problems associated with the current status of the Chesapeake Bay stocks and fisheries for shad and river herrings. Problems and management strategies have been defined and grouped into specific categories and served as the basis for identifying the goal and objectives. The management strategies and actions will be implemented by the jurisdictions in order to protect and enhance the stocks of shad and herring (alosids) in Chesapeake Bay. Existing regulations regarding the harvest of alosids will continue to be enforced except where otherwise indicated by the plan.

Fishery activity on the tidewater portion of the Potomac River is managed by the Potomac River Fisheries Commission, a six member body empowered under the Maryland-Virginia Compact of 1958. The Commission meets quarterly to establish and maintain a program of conservation and improvement of the seafood resources and to regulate and license fisheries in the Potomac River. The Commission will develop appropriate Actions and Implementations to address those Problems and Strategies identified in this Management Plan which are within the purview of the Commission by July 1990.

A. GOAL AND OBJECTIVES

The goal of this plan is:

> Protect, restore and enhance baywide shad and river herring stocks to generate the greatest long term ecological, economic and social benefits from the resource. The management plan for alosids will be adaptive and involve continuous responses to new information about the current state of the resource.

In order to achieve this goal, the following objectives must be met:

1) Maintain a spawning stock at a size which eliminates low reproductive potential as a cause of poor spawning success.

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

3) Reduce fishing effort on alosid stocks until they exhibit increased abundance.

4) Improve knowledge of alosid stock dynamics to develop more accurate data bases and minimize interjurisdictional conflicts.

5) Redefine the tributary survey program to improve water quality and habitat accessibility specifically for alosids.

6) Continue programs to restock alosids into areas which historically supported natural spawning migrations and to expand existing stock restoration programs to include areas which do not presently support alosids.

B. PROBLEM AREAS AND MANAGEMENT STRATEGIES

Problem-Declining abundance: Commercial landings for shad and river herrings are at low levels relative to historical catches. Juvenile indices indicate reduced reproduction.

Strategy-Declining abundance: The Atlantic States Marine Fisheries Commission (ASMFC) has recommended a maximum annual exploitation rate of 0% for American shad, hickory shad, and river herring in Maryland due to their severely depleted status. Exploitation rate was defined as the percentage of female fish in the spawning run that are captured in recreational or commercial fisheries during their spawning run in a single year. Recommended rates were arrived at by a concensus of the ASMFC committee and were deemed to be conservative. Maryland has addressed the problem of reduced alosid stocks by initiating a moratorium on American shad and hickory shad beginning in 1980. The Maryland river herring fishery is a seasonally significant fishery and current stocks are low. The ASMFC has recommended an annual exploitation rate of 25% for American shad and hickory shad in Virginia due to their depleted status. River herring, likewise, are identified as depleted and a 25% annual exploitation rate is recommended for Virginia stocks.

PROBLEM 1.1
In Maryland, American shad landings decreased from slightly more than 1,000,000 pounds in 1970 to about 18,000 pounds in 1979. As a result of this severe decline, the Maryland fishery was closed in 1980. Maryland stocks have not yet recovered and the ban is still in effect. In Virginia, the average annual catch of American shad during the period 1980-87 was 730,000 pounds, or 58% below the average 1970-79 landings (1,740,000 pounds).

STRATEGY 1.1.1
Removing the moratorium on Maryland American shad will not occur until the stocks of American shad in the upper Bay are fully recovered. Reestablishing a fishery will occur when annual population estimates in the upper Bay increase for three consecutive years and stock size

reaches at least 50% of historical levels (approximately 500,000 fish) during one of those three years. Regulations will be established to ensure that initial annual exploitation in the upper Bay does not exceed 10% when the fishery is opened. Stock levels will be determined from an annual stock estimation study and exploitation rates will be established based on recreational and commercial surveys.

ACTION 1.1.1
American shad abundance in the upper Bay has improved but has not sufficiently recovered to warrant an open fishery. American shad abundance is also low in other Maryland river systems. Maryland will continue the moratorium on American shad in the Chesapeake Bay.

IMPLEMENTATION 1.1.1
Open. Dependent on stock recovery.

STRATEGY 1.1.2
Virginia will follow ASMFC recommendations for a 25% exploitation rate for alosids.

ACTION 1.1.2
Virginia will utilize the Virginia Marine Resources Commission's Stock Assessment Program and the fishery surveys of the Virginia Institute of Marine Science to assess current alosid exploitation rates. If the data concludes that exploitation is above the 25% rate, Virginia will take the appropriate steps to limit fishing effort.

IMPLEMENTATION 1.1.2
Stock assessment program will initiate activity in winter 1989. VIMS surveys are currently being implemented.

PROBLEM 1.2
River herring catches have declined substantially in recent years in the Chesapeake Bay. The average 1980-87 Virginia harvest was 1,000,000 pounds, or 88% below the average 1970 -79 catch (8,300,000). Similarly, the average harvest in Maryland during the period 1980-87 (262,000 pounds) was 79% below the average annual catch during the decade of the 1970's (1,228,000).

STRATEGY 1.2
Maryland will recommend management of river herring on a system by system basis. Criterion for closing a system

to river herring harvest will be based on juvenile indices from 1985 through 1989 and commercial harvests over the last 10 years. Maryland, Pennsylvania and Virginia will recommend that harvest from all systems slated for restoration be regulated or closed. Technical criterion will be submitted to ASMFC for reevaluation of the 0% exploitation rate for river herring in Maryland. In addition, Maryland will control the harvest of river herring by one or a combination of the following: harvest limits; harvest season; areal closures; or gear restrictions. Virginia will use similar measures to control harvests of river herring, American shad and hickory shad.

ACTION 1.2
River herring harvest will be controlled. Types of management actions which will be considered in the regulation of river herring are as follows:

- Harvest- Quotas would be a reasonable regulation if the size of the spawning stock in a given year was predictable
- Seasons- Setting a season during a segment of the "average" spawning period to regulate exploitation
- Areal closures- Restrict exploitation in those areas where the potential for harvest is greatest such as restricted portions of migratory routes or at migration barriers
- Gear restrictions- Restrict large-volume harvesting by pound nets and/or haul seines

IMPLEMENTATION 1.2
January 1990

PROBLEM 1.3
Hickory shad no longer support a viable commercial fishery in Virginia or Maryland. Hickory shad landings in Virginia averaged 774 pounds a year during the period 1980-87, which is less than 1% of those in the 1970's (19,638 pounds). In Maryland, declines in the hickory shad harvest throughout the decade of the 1970's, led to a 1981 ban on fishing, which is still in effect. Hickory shad landings may not adequately reflect the status of the stock since they are often identified and reported as American shad.

STRATEGY 1.3
Maryland will continue the moratorium on the fishery for hickory shad and consider opening a recreational fishery when the American shad stocks have recovered.

ACTION 1.3
Management actions and strategies for American shad and hickory shad will not be separated due to the paucity of information available on hickory shad and by nature of their similar life history.

IMPLEMENTATION 1.3
Will follow the American shad schedule.

PROBLEM 1.4
Alosid migration into the Susquehanna Basin in Pennsylvania has been totally blocked by hydropower dams for over 80 years.

STRATEGY 1.4
Pennsylvania will continue to prohibit the harvest of American shad in the Susquehanna River and its tributaries, and American and hickory shad in the Conowingo Reservoir while restoration efforts are in progress.

ACTION 1.4
As restoration of alosids progresses over dams on the Susquehanna River, additional regulations in Pennsylvania will be promulgated to protect these species until a degree of restoration is achieved.

IMPLEMENTATION 1.4
Permanent fish passage facilities are currently under design at Conowingo Dam. Progress will be determined when fish passage is also provided at the three remaining dams.

Problem-Overfishing: The combined effect of overfishing, habitat degradation, and climatic variables has led to the decline in alosid abundance. There is strong evidence to suggest that the decline in river herring in the 1970's was due to large offshore harvests. An analysis of American shad fishing mortality rates suggest that some shad stocks were experiencing very high exploitation levels prior to their recent declines. At current stock levels, harvest is affecting recruitment, and probably prevents stock recovery in some areas.

Strategy-Overfishing: Both shad and river herring are vulnerable to recruitment overfishing at present low stock sizes. Adding to this potential for overfishing are the interjurisdictional offshore fisheries which target mixed stocks of shad and river herring from different river systems along the coast. Offshore harvests of alosids impact inshore stocks and make management strategies difficult. Interjurisdictional problems require coordinated efforts to be successful.

PROBLEM 2.1
Spring coastal fisheries from South Carolina northward, a fall fishery in Canadian waters, and offshore foreign (or joint venture) fisheries all exploit mixed stocks of shad, some of which originate in the Chesapeake Bay. At current stock levels, the cumulative effect of these interjurisdictional fisheries affects recruitment and complicates harvest management for shad.

STRATEGY 2.1
Maryland, Pennsylvania and Virginia will continue to participate in ASMFC-coordinated coastal fishery stock identification and ocean landing studies of alosids.

ACTION 2.1
Maryland, Pennsylvania and Virginia will participate in the ongoing ASMFC alosid management program, both in Board and Scientific and Statistical Committee activities, with the goal of providing adequate protection to the component of the coastal stock which returns to Chesapeake Bay to spawn.

IMPLEMENTATION 2.1
Currently being implemented.

PROBLEM 2.2
Relatively high exploitation rates for American shad have been documented in recent years for a number of Virginia's spawning rivers; the high rates of exploitation in inshore fisheries, coupled with offshore fisheries, will severely depress recruitment.

STRATEGY 2.2
Virginia will follow ASMFC recommendations to reduce shad harvest to a 25% exploitation rate.

ACTION 2.2
A) Implement a coastal shad tagging program to determine which stocks are being exploited in its intercept fishery

B) Control the coastal intercept fishery through a combination of gear restrictions, seasonal and areal closures, and harvest limits
C) Continue to monitor and document its territorial sea intercept fishery for American shad

IMPLEMENTATION 2.2
Shad tagging program implemented by 1990.

PROBLEM 2.3
Current offshore and coastal harvests of river herring are now relatively low, but target immature fish. Consequently, a low harvest in total poundage can represent a large impact in terms of numbers. Notably, there is a growing problem with river herring bycatch in the foreign and domestic mackerel fishery, particularly when carried out nearshore in conjunction with joint ventures.

STRATEGY 2.3.1
Virginia will follow ASMFC recommendations to reduce river herring harvest to a 25% exploitation rate.

ACTION 2.3.1
Virginia will control river herring harvest during spawning migrations through gear restrictions and spawning area closures.

IMPLEMENTATION 2.3.1
1991

STRATEGY 2.3.2
Maryland and Virginia will ensure that river herring by-catch in the foreign and domestic mackerel fisheries is minimized.

ACTION 2.3.2
Maryland and Virginia will monitor river herring by-catch through the Mid-Atlantic Fishery Management Council and support the following recommendations:
a) The foreign fishery will stay 20 miles offshore.
b) Maximum by-catch of 1% for river herring in the foreign and domestic mackerel fisheries with a cap on total allowable by-catch.
c) Intercept fisheries will be discouraged.

IMPLEMENTATION 2.3.2
Currently being implemented.

Problem-Stock assessment deficiencies: With declining abundance and low population numbers, alosid juvenile indices, catch per unit effort and landings data may not accurately represent stock abundance.

Strategy-Stock Assessment: Data deficiencies are apparent for all alosid stocks in the Chesapeake Bay. The migratory nature of these species makes stock assessment a complicated issue. Data bases are limited concerning harvest, fishing effort, biological characteristics of the harvest, and fishery independent measures of alosid stocks.

PROBLEM 3.1

A) At low stock size, juvenile abundance data does not correspond well to landings data, as no declining trends are evident with juvenile abundance.

B) When stock size is declining or low, catch per unit effort data may not be proportional to changes in stock size, and normalization of effort across the wide variety of gear types is not practical.

C) Factors other than the abundance of the stock, influence the magnitude of alosid landings. These factors include the amount of fishing effort, extent of recreational harvest, and market demand for fish.

D) There is frequent alosid misclassification (e.g., American shad classified as river herring and hickory shad classified as American shad) by foreign and domestic fishing vessels.

E) There is limited knowlege of some life history aspects of alosid stocks. Ocean distribution and movement patterns are almost entirely unknown for hickory shad and the offshore migration pattern of the river herrings is not well defined.

F) For all alosids, information is needed on early life mortality from the egg to the juvenile stage.

G) The effects of restoration practices on alosid stocks have not been quantified.

H) American shad abundance is unknown for many river systems.

STRATEGY 3.1

The jurisdictions will collect specific data on alosid species to improve stock assessment databases.

ACTION 3.1

A) Maryland will continue the alosid juvenile survey and develop an index of stock abundance. Virginia will continue to collect shad and herring juvenile abundance data with the objective of developing a baywide index of abundance for these species. (Currently being implemented) The juvenile index will be used in conjunction with adult stock estimates to trigger regulatory changes and harvest rates.

B) Maryland will continue research projects for American shad in the upper Bay and Nanticoke River which provide annual estimates of adult shad. (Currently being implemented)

C) Virginia will improve assessment of current fishing rates on shad stocks in territorial waters and seek to improve catch and effort data through mandatory reporting. (1990)

D) The VMRC Stock Assessment Program will provide additional fishery dependent data collection for Virginia's shad fisheries. (on-going)

E) Virginia will initiate an ocean intercept tagging program to determine stock composition in the coastal shad fishery. (1990)

F) Maryland will examine the exploitation rates of alewife and blueback herring in selected tributaries of the Chesapeake Bay and improve the accuracy and utility of herring landings data. (1990)

G) Virginia will cooperate with research institutes to implement a survey of selected shad and herring spawning grounds, compiling information on basic spawning stock characteristics including relative adult abundance,juvenile abundance, size, age and sex ratios. (Currently being implemented)

H) American shad abundance will be investigated in the Potomac River, a system of historic importance, through a joint effort by Maryland, Virginia, and District of Columbia. (1991)

IMPLEMENTATION 3.1

Variable, depending on the project.

Problem-Habitat Loss and Degradation: Changes in alosid spawning habitat has contributed to stock declines. Prior to 1960, loss of habitat to dams and other stream blockages removed thousands of acres of spawning and nursery grounds. Unlike habitat loss due to the contruction of stream blockages, water quality degradation has

had a less obvious, but harmful effect on the remaining habitat available to alosids.

Strategy-Habitat Loss and Degradation: Loss of spawning habitat through damming and other blockages has contributed to alosid stock declines. Declining alosid stocks in the Chesapeake Bay have also been attributed to water quality problems but the specific mechanisms contributing to the decline have not been conclusively demonstrated. In conjunction with harvest restrictions, improving water quality and removing impediments to migratory fishes will have a positive impact on alosid stocks.

PROBLEM 4.1
Denial of access to spawning grounds by dams limits the reproductive potential of shad and herring.

STRATEGY 4.1
The Chesapeake Bay Program's Fish Passage Workgroup has analyzed the problem of impediments to alosid migration and presented its recommendations for acceptance in December 1988. Maryland will develop a multi-faceted program based on the program's recommendations to restore spawning habitat to migratory fishes by removing blockages. Virginia, through its Anadromous Fish Restoration Committee, will develop a comprehensive inventory of dams and other impediments restricting the migration of the shad and river herring to their historical spawning grounds and establish fish passage facilities. The Pennsylvania Fish Commission (PFC) will continue to refine its inventory of low head dams through SRAFRC and continue to promote fish passage at structures on the Susquehanna River tributaries having the potential for alosid spawning and nursery habitat. Maryland, Virginia, District of Columbia, U.S. Fish and Wildlife Service and Corps of Engineers will continue its work for fish passage at Little Falls and Rock Creek.

ACTION 4.1
The District of Columbia, Maryland, Pennsylvania and Virginia will implement the plan adopted by the Fish Passage Workgroup to remove fish barriers. Projects include:

A) Permanent fish passage facilities are being designed and will be constructed at Conowingo Dam at a cost of $12.5 million. (1989)
B) Design planning and implementation of fishways at Holtwood, Safe Harbor and York Haven dams on the Susquehanna River. (In progress)
C) A comprehensive inventory of dams and other impediments restricting the migration of shad and

river herring to their historical spawning grounds has been completed. (1989)

D) Removal of stream blockages, re-stocking efforts, and construction of fish ladders at sites of barriers on priority streams and rivers will begin. (1990)

E) A demonstration fish ladder project has been developed with the Chesapeake Bay Foundation and the town of Elkton as an example with public access. (1989)

F) A program to reduce turbine mortalities by implementing guidance and avoidance techniques,i.e., use of fish attraction or avoidance devices to guide shad away from turbines to "sluice gate". (1991)

G) Fish passage facilities on the James and Rappahannock Rivers will be established. (Currently being implemented)

H) The recently constructed passage facility on the Chickahominy River at Walker's Dam will be evaluated for its effectiveness. (1990)

I) Fish passage facilities at Little Falls Dam on the Potomac River will restore about 10 miles of spawning habitat and at Rock Creek Park will open an additional 5 miles of spawning habitat.

In addition to the strategies detailed in the Fish Passage Plan, several aspects must be coordinated with the Fishery Management Plan:

J) Sources of adult fish used for restocking areas will be coordinated with other states and agencies. (1990)

K) The reintroduction of alosid stocks will require specific regulatory measures to protect the newly-introduced fish until populations have been established.

L) Monitoring is essential in gauging the impact of fish passage projects on restoration efforts.

IMPLEMENTATION 4.1
Variable, depending on the specific project.

Problem 4.2
Restoration in the Susquehanna River through the Susquehanna River Anadromous Fish Restoration Committee (SRAFRC) continue through the capture and transportation of adult spawners to open flowing areas upstream from dams and hatchery production of eggs, fry and juvenile shad for stocking at facilities owned and operated by the Pennsylvania Fish Commission (PFC), with major financial support from upstream hydropower project owners. These stockings have

occurred both below Conowingo Dam and above the other mainstem Susquehanna River dams. There is uncertainty about the success of outmigrating adult and juvenile alosids. The origins of hatchery produced eggs, fry, and juvenile shad have been from a variety of locations due to the scarcity of Susquehanna River stock and the desire to have sufficient genetic diversity resulting in a successful Susquehanna River genetic strain. Presently there is a lack of knowledge about the effects of combining outside genetic strains with the endemic stock.

Strategy 4.2
Restoration of shad and river herring to suitable unoccupied habitats will be accomplished by introducing hatchery-raised juveniles or transplanting gravid adults. Present policy fully supports the transportation of adult shad using fish passage facilities at Conowingo Dam under the assumption of reasonable outmigration. However, if adequate outmigration is not obtained, then the effects of transporting adults from the population below the dam needs to be reevaluated.

ACTION 4.2.1
Maryland and Pennsylvania will continue to work within SRAFRC's ongoing programs as described in the annual work plan to evaluate methods for ensuring successful downstream passage for juveniles and adults. This will include spills, diversion devices, and bypass systems.

IMPLEMENTATION 4.2.1
Annual activities as approved by SRAFRC members

ACTION 4.2.2
A) Maryland, Pennsylvania, and Virginia working within SRAFRC, will promote using Susquehanna River brood stock for hatchery production.
B) Virginia will expand funding to the recently constructed Pamunkey/Mattaponi Indian Reservation shad hatcheries.

IMPLEMENTATION 4.2.2
Annual activities as approved by SRAFRC members

PROBLEM 4.3
Minimum flows are required at different life stages, i.e., spawning, hatching, juvenile growth, and adult migration. Temporal changes in river flow and temperature during early larval development are known to affect American shad year-class strength in other systems. The effect of water

withdrawal or water regulation at certain dams may interfere with spawning success and juvenile survival.

STRATEGY 4.3.1
Technical issues concerning water quality standards for dissolved oxygen and minimum flows in the Susquehanna River below Conowingo Dam have been negotiated.

ACTION 4.3.1
The following technical issues have been accepted:
A) Adoption of Maryland water quality standard for dissolved oxygen of 5.0 mg/liter in the Susquehanna River below the Conowingo Dam (1989)
B) Installation of turbine venting systems and intake air injection capabilities (1991)
C) Operation of turbines as necessary to meet the D.O. standard (1989)
D) Monitored spills as necessary (1989)
E) A schedule of minimum and continuous flows (1989)

IMPLEMENTATION 4.3.1
Variable

PROBLEM 4.4
Water quality can be affected by water diversion which impacts dissolved oxygen, water temperature, sedimentation, soil erosion, eutrophication, and related substrate alteration. All of these water quality aspects can impact alosid stocks.

STRATEGY 4.4
Maryland DNR has proposed new criteria for use in the revised water use classification and water quality standards system setting standards for temperature, dissolved oxygen, pH, amount of suspended solids and a number of "priority pollutants" in anadromous fish spawning areas.

ACTION 4.4
Establish new categories in the water classification system to guide resource management based on the physical habitat and water quality characteristics. The revised system would define anadromous fish spawning areas as either Class II waters (fresh, nontidal warm water streams, creeks and rivers) or Class III waters (tidal estuarine waters and Chesapeake Bay).

IMPLEMENTATION 4.4
1990

PROBLEM 4.5
Although water quality problems are strongly suspected as contributing to alosid stock declines, the actual mechanisms decreasing survival have not been precisely identified. State water quality standards must be maintained for all species in the Bay.

STRATEGY 4.5
The District of Columbia, Maryland, Pennsylvania and Virginia will cooperatively evaluate the available scientific data on the effects of impaired water quality on alosids as a means of developing more effective water quality criteria for spawning and hatching areas and take action now to reduce pollution from several sources.

ACTION 4.5
The first three action items are commitments under the 1987 Chesapeake Bay Agreement. Maryland DNR, PFC, DC and VMRC will not carry out the specific commitments, but are involved in setting the objectives of the programs to fulfill the commitments and reviewing the results of the action programs. The achievement of these commitments will lead to improved water quality and enhanced biological production.

A) Develop and adopt a basinwide plan that will achieve a 40% reduction of nutrients entering the Chesapeake Bay by the year 2000.
   1) Construct public and private sewage facilities.
   2) Reduce the discharge of untreated or inadequately treated sewage.
   3) Establish and enforce nutrient and conventional pollutant limitations in regulated discharges.
   4) Reduce levels of nutrients and other conventional pollutants in runoff from agricultural and forested lands.
   5) Reduce levels of nutrients and other conventional pollutants in urban runoff.

B) Develop and adopt a basinwide plan for the reduction and control of toxic materials entering the Chesapeake Bay system from point and nonpoint sources and from bottom sediments.
   1) Reduce discharge of metals and organic compounds from sewage treatment plants receiving industrial wastewater.
   2) Reduce the discharge of metals and organic compounds from industrial sources.
   3) Reduce levels of metals and organic compounds in urban and agriculture runoff.

4) Reduce chlorine discharges to critical finfish areas.

C) Develop and adopt a basinwide plan for the management of conventional pollutants entering the Chesapeake Bay from point and nonpoint sources.
   1) Manage sewage sludge, dredge spoil and hazardous wastes.
   2) Improve dissolved oxygen concentrations in the Chesapeake Bay through the reduction of nutrients from both point and nonpoint sources.
   3) Continue study of the impacts of acidic conditions on water quality.
   4) Manage groundwater to protect the water quality of the Chesapeake Bay.
   5) Continue research to refine strategies to reduce point and nonpoint sources of nutrient, toxic and convential pollutants in the Chesapeake Bay.

D) Develop and adopt a plan for continued research and monitoring of the impacts and causes of acidic atmospheric deposition into the Chesapeake Bay. This plan is complemented by Marylands research and monitoring program on the sources, effects, and control of acid deposition as defined by Natural Resources Article Title 3, Subtitle 3A, (Acid Deposition: Sections 3-3A-01 through 3-3A-04).
   1) Determine the relative contributions to acid deposition from various sources of acid deposition precursor emissions and identify any regional variability.
   2) Assess the consequences of the environmental impacts of acid deposition on water quality.
   3) Identify and evaluate the effectiveness and economic costs of technologies and noncontrol mitigative techniques that are feasible to control acid deposition into the Bay

IMPLEMENTATION 4.5
Variable, depending on the specific project.