# Chesapeake Bay
# Marine Environmental Assessment

## 1985 Annual Summary

VIMS

ORC

Virginia Sea Grant College Program

noaa

THE UNIVERSITY OF MARYLAND

In September 1981, the Marine Assessment Branch (MAB) of the National Oceanic and Atmospheric Administration's Assessment and Information Services Center initiated production of a series of periodic assessments of weather impacts on economic sectors of marine environmental activity. Using the Chesapeake Bay region as a prototype, monthly assessments were issued from September 1981 through March 1982. From March 1982 until November 1985, quarterly assessments were issued, and annual summaries were provided through 1984.

In 1985, a decision was made to determine if regional organizations could assume, with the support of MAB, the production of ongoing regional assessments, thereby freeing the MAB staff to initiate assessments in other regions. The Chesapeake Bay assessment was chosen as the test case, and the Chesapeake Research Consortium (CRC) was selected to prepare it.

CRC is a regional organization made up of major research organizations located in Maryland and Virginia, the states which contain the estuarine portion of the Chesapeake Bay system. Support for this project is provided through the Virginia Sea Grant College Program.

Comments on this report may be sent to either of the following:

Chesapeake Bay Assessment
Chesapeake Research Consortium, Inc.
P.O. Box 1120
Gloucester Point, VA 23062
(804) 642-7153

Chief, Marine Assessment Branch
Marine Environmental Assessment Division
AISC/NESDIS/NOAA
E/AI32
Universal Bldg., Rm. 520
1825 Connecticut Avenue, NW
Washington, DC 20235

Front Cover Design:

Ms. Kay Stubblefield, Virginia Institute of Marine Science

Photo Credits:

Mr. Jon Lucy, Virginia Institute of Marine Science (beach scene, pound-netter)
Mr. Scott Hardaway, Virginia Institute of Marine Science (storm)

Chesapeake Bay

# Marine Environmental Assessment

1985 Annual Summary

Karen L. Kelly

Virginia Institute of Marine Science
School of Marine Science
College of William and Mary
Gloucester Point, VA



Contributions by:

Robert E. Dennis
Michael J. Dowgiallo
Fred G. Everdale
Sylvia Z. Green
Martin C. Predoehl
Isobel C. Sheifer
Richard P. Stumpf

National Oceanic and Atmospheric Administration
Washington, DC

Production Editor:

Karen L. McDonald
Chesapeake Research Consortium, Inc.
Gloucester Point, VA

February 1988

CRC

Virginia Sea Grant College Program

VIMS

NOAA

THE UNIVERSITY OF MARYLAND

The Chesapeake Research Consortium, Inc.
P.O. Box 1120, Gloucester Point, VA 23062

This work is a result of research sponsored in part by the Office of Sea Grant/NOAA, U.S. Department of Commerce, under Grant No. NA85AA-D-SG016 to the Virginia Graduate Marine Science Consortium and Virginia Sea Grant College Program with funds provided by the Assessment and Information Services Center of the National Oceanic and Atmospheric Administration. The U.S. Government is authorized to produce and distribute reprints for governmental purposes notwithstanding any copyright notation that may appear hereon.

Chesapeake Research Consortium Publication # 128

Virginia Sea Grant College Publication VSG-88-01

Virginia Institute of Marine Science Special Scientific Report # 121

ISSN 0083-6443

Marine Environmental Assessment: Chesapeake Bay, Annual 1985, CRC Publication No. 128.

# CONTENTS

**Page**

## Figures

## Tables

# 1. Introduction

The Chesapeake Bay 1985 Annual Summary presents a synoptic view of the marine and atmospheric conditions and the direct and indirect impacts of these conditions on the Bay system. The environmental and human use relationships detailed in this report indicate the interdependent nature of economic activity and natural processes that coexist in the Chesapeake Bay area.

This report uses data gathered by scientists in the fields of physical oceanography, marine biology, meteorology, political science, and economics; it presents a multidisciplinary view of the Chesapeake Bay area. Relationships within and between the different economic sectors are presented in detail where possible. It is hoped that this collection of data will stimulate further investigation by natural and social scientists studying the Chesapeake Bay.

## 1.1. Scope of the Report

The geographical area considered in the annual assessment includes the main stem of Chesapeake Bay and all the tributaries in the drainage basin. Weather and oceanographic events during the 1985 calendar year are summarized, and the impacts of these events on various marine resource sectors are evaluated. Where discussion of environmental patterns or events requires reference to 1984 or to 1986, the report's coverage is extended as appropriate.

Three economic sectors are reviewed in this report: fisheries, recreation, and transportation. Discussions in these sections cover information available to the author, but are neither exhaustive nor definitive.

The fisheries section includes information related to finfish, shellfish, aquatic vegetation, algal blooms, and jellyfish. The distribution and abundance of many species depend strongly on salinity, temperature, and general coastal weather conditions over broad scales of space and time.

The Chesapeake Bay area is used heavily for various types of recreation including swimming, boating, fishing, and tourism. Impacts on recreation are evaluated through data on boating, marine advisories and warnings, recreational accident statistics, Coast Guard search and rescue activities, and state park usage. Since the recreational sector responds quickly to changes in weather, connections between weather and Bay area usage can be made in many instances.

Impacts on transportation are assessed related to shipping, ice clearing, and Chesapeake Bay Bridge traffic statistics. Thoughout most months of the year shipping and shore-related activities remain unaffected by weather. During severe winters, however, icebreaking requires Coast Guard ice cutters to keep shipping channels open.

# 2. Impact Summary

Economic sectors in the Chesapeake Bay area are affected in various ways by anomalies in temperature and precipitation. The year began in 1985 with colder-than-normal temperatures in January and higher-than-normal temperatures in February with below-normal precipitation throughout the winter months. As a result of a dry, warmer-than-normal spring and summer, annual recreational usage increased in the Chesapeake Bay area. Low rainfall resulted in increased surface salinities for extended periods into the summer before conditions returned to normal. High surface salinities affected oyster populations and altered other species distributions. November was unseasonably warm and wet with flooding occurring early in the month.

## 2.1 Fisheries

Ice cover on the Bay temporarily shut down harvest activities, mostly oystering, for up to four weeks in areas of the upper Bay in January and February of 1985. In addition to missed work days, watermen experienced damage to boat hulls, propellers, and rudders. Cold water temperatures in mid-January caused extensive mortalities of croaker resulting in the loss of much of the 1984 year class. Other finfish species (e.g., eels) also suffered mortalities due to unusually cold temperatures.

Extremely dry conditions and higher-than-normal surface salinities prevailed in spring 1985, contrasting sharply with the wet spring and below-normal surface salinities in 1984. Consistently low rainfall in the 1985 spring quarter provided favorable conditions for fishing activities. Large numbers of cownose rays, a species which normally prefers higher surface salinities, were reported in the upper Bay. Cownose rays are believed to adversely impact shellfish populations and shellfish habitats through their feeding habits. In addition, continued high salinities provided favorable conditions for oyster diseases such as the oyster pathogen, *Perkinsus marinus*, or Dermo.

Warmer-than-normal water conditions in the spring of 1985 may have caused an earlier-than-normal arrival of bluefish in the Chesapeake Bay. Bluefish generally follow the movement of the 55°-59° fahrenheit (° F) temperature band, which moved up the coast to the Bay mouth two weeks earlier than normal in 1985. Finfish that prefer high salinity, such as black sea bass and sea robins, were also reported in areas of the upper Bay tributaries which are normally nearly freshwater. Numerous blue crabs were reported in areas where they are usually scarce.

Blue crabs were plentiful in the Chesapeake Bay area during the summer of 1985. Landings of hard crabs in Maryland were considerably higher compared to the summer 1984 quarter. Crabbers in Virginia and Maryland experienced marketing problems from the abundance of crabs and subsequent low prices. The extended periods of dry weather in the spring and summer provided favorable working conditions for watermen. Virginia crabbers reported unusually large landings of pot-caught crabs in November during a period of above-normal water temperatures.

The Bay area experienced extensive flood damage from a 4 November storm that was the most devastating since Tropical Storm Agnes in 1972. However, the storm did not impart any significant damage to oyster beds in the Bay and its tributaries, nor were there any major changes in species distributions or mortalities of other commercial species. High winds and waves, however, prevented watermen from working for several days during the storm.

Warmer-than-normal water temperatures during the 1985-86 winter quarter resulted in less than 10 percent ice cover on the Bay during January 1986. As a result, watermen experienced few interuptions in finfish and shellfish harvests due to ice on the Bay and had many available fishing days (especially in Maryland waters, where freezing is most prevalent). Warmer-than-normal water temperatures provided favorable conditions for overwintering juvenile finfish species such as croaker and flounder.

Virginia blue crab dredge fishery landings in December 1985 were lower than the December 1984 landings. Higher December water temperatures may have contributed to the decline in landings of dredged crabs by allowing increased activity of female crabs, making them less accessible to dredging.

Although total yearly landings were down, Maryland oyster landings increased over all three months of the 1985-86 winter quarter compared to 1984-85. Conversely, Virginia reported decreases in December 1985 harvests compared to previous winter landings. The warm water temperatures appeared to adversely affect oyster quality, which was reflected in low weight of oyster meats shucked at packing houses in Virginia.

## 2.2 Recreation

Several boating accidents were reported due to ice conditions in the upper Bay during the early part of 1985. Warm air temperatures and low rainfall in the spring provided favorable conditions for all categories of marine-related recreation, especially park usage and boating on weekends. High surface salinities during spring 1985 provided favorable conditions for development of sea nettles, which appeared early, but also disappeared early in the season. Well-above-average abundances of nettles were reported during the summer of 1985, discouraging water-contact recreation, although park attendance and boating activity increased compared to the summer of 1984.

Because of their short duration, the storms of September and November minimally affected seasonal recreation trends. Recreational facilities, however, sustained extensive damage, with flooding causing over $500,000 in damage to state-owned boat ramps in Virginia alone. Tidal flooding and easterly winds associated with the storm, damaged piers and bulkheads, but resulted in no significant damage to oyster beds in the Bay area. Property damage in Maryland, Virginia, West Virginia, and the District of Columbia exceeded $1.3 billion. There were at least 60 storm-related deaths.

## 2.3 Transportation

Ice cover had little impact on large vessel operations, though smaller vessels were affected by horsepower and hull type restrictions during peak icing on the Bay tributaries and may have had difficulty leaving shallow, protected docking areas. Lack of ice in the Bay mainstem during the winter quarter 1985-86 allowed for uninhibited transportation on the Chesapeake Bay.

Shippers may have experienced in excess of $394,880 in costs from crane down-time due to excessive winds in 1985. Conditions were windier in March and April 1985 than in the same months in 1984. Crane down-time from excessive winds in the summer of 1985 occurred mostly during July. More than $128,000 may have been lost in crane down-time in the fall of 1985 due to the late September and early November storms.

Table 1 summarizes the impacts of environmental events on particular economic sectors.

| IMPACT SECTOR | 15 Jan–15 Feb: Below-normal water temp. | 15 Jan–15 Feb: Ice cover | 15-30 Feb: Above-normal air temp. | Mar-Apr: Low-rainfall | Mar-Apr: High salinity | Mar-May: Above-normal water temp. | Mar-May: Above-normal air temp. | Mar-Apr: High winds | Jun-Jul: Low rainfall | Jun-Aug: Low streamflow | Jun-Aug: High salinity | Oct-Nov: Above-normal air temp. | Nov: November storms | Nov: Above-normal water temp. | Dec: Above-normal water temp. | Dec: Below-normal rainfall |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **FISHERIES** | | | | | | | | | | | | | | | | |
| Fishing Activity | | - | | + | | | + | | | | | + | - | | | |
| Finfish harvest (quantity) | | | | | | + | | | | | | | | | + | |
| Oyster harvest (quantity) | | - | | | | | | | + | | | + | - | - | - | + |
| Summer flounder, croaker | - | | | | | | | | | | | | | | + | |
| Oyster harvest (quantity) | | | | | | | | | | | | | | - | - | |
| Blue crab harvest (quantity) | | | | + | | | | - | | | | | - | + | - | |
| Stinging nettles | | | | | + | + | | | + | | + | | | | | |
| Soft shell clam harvest (quantity) | | | | | + | | | | + | + | + | | | | | |
| Crab distribution (extent) | | | | | + | | | | | | | | | | | |
| Boat hulls | | - | | | | | | | | | | | - | | | |
| Oyster health (disease) | | | | - | - | | | | - | | - | | | | | |
| **RECREATION** | | | | | | | | | | | | | | | | |
| Boating | | | + | + | | | + | | + | | | + | - | | | |
| State park attendance | | | + | + | | | + | | + | | | + | | | | |
| Swimming | | | | | | + | + | | | | | | | | | |
| Fishing piers | | - | | | | | | | | | | | - | | | |
| **TRANSPORTATION** | | | | | | | | | | | | | | | | |
| Port operations | | - | | | | | | - | | | | | - | | | |
| Navigational aids | | - | | | | | | | | | | | | | | |
| Tug and barge traffic | | - | | | | | | | | | | | | | | |
| Safety | | - | | | | | | - | | | | | - | | | |

**KEY**

- [+] Favorable
- [-] Unfavorable
- [ ] No identifiable effect, data unavailable,or not applicable

Table 1 - Environmental impact summary, Chesapeake Bay, 1985.

# 3. Meteorology and Oceanography

The Chesapeake Bay region, represented by 11 meteorological stations (Figure 1), had below-normal precipitation totals from January throughout the spring of 1985. Temperatures for this time period were also below normal, but rose above normal in the spring, with extremely high temperatures in April. Precipitation was below normal for the month of April. May and June precipitation was highly variable at all stations with above-normal precipitation in May and below-normal precipitation in June. Summer temperature values were near normal to slightly below normal. Late August and early September were very dry periods for the region, with most stations exhibiting drought conditions. Rains during the latter part of September and in the following months, however, offset these dry conditions. Record high temperatures were set during November in Norfolk, Richmond, Patuxent, Royal Oak, and Baltimore. December again brought drought conditions to many stations (Table 2).

## 3.1 Precipitation and Temperature

The winter quarter of 1985 was a period of stong contrasts in temperature, with record low temperatures in January and record high temperatures late in February. Dry conditions prevailed over most of the quarter with frequent, but small, amounts of precipitation.

The spring quarter was dry and warm. Temperatures in each month of the 1985 spring were above normal (Table 3). This contrasts with lower-than-normal temperatures during all months of the same quarter in 1984. Daily high temperature records were established at several stations during March and April.

Precipitation in March and April was well below normal, with extremely dry conditions during April. Five Chesapeake Bay area stations had the driest April conditions ever recorded for those stations (Figure 1 and Table 2). The dry spring season contrasted sharply with the 1984 spring quarter during which abundant rainfall fell.

Conditions remained dry until the last half of May, when rainfall was above normal. May had above-average precipitation at all stations except those in the southern Bay area. Temperatures throughout the region were above normal for the season.

Cooler-than-normal temperatures prevailed in the area during June. Most of the stations were also very dry, especially in the middle Bay area. Norfolk, in contrast, experienced a very wet June. July was also somewhat below normal in precipitation, but was normal in temperature except at the northernmost stations, which were 1.5° F below normal. A residual effect of Tropical Storm Bob augmented precipitation to the Bay area for July.

In August most stations reported cool and dry weather. These conditions were particularly evident near Washington. However, a short heat wave near the middle of the month set new records in Washington and Patuxent on the 14th and 15th. At Patuxent, a new monthly maximum temperature record of 99° F was set on the 14th, and a new daily minimum temperature record of 58° F was set on the 21st.

The rains from Hurricane Gloria offset the extreme dryness of the rest of September (see section 3.2). Although fair weather and near-normal temperatures characterized most of the month, Pennsylvania stations experienced prolonged temperatures above 90° F

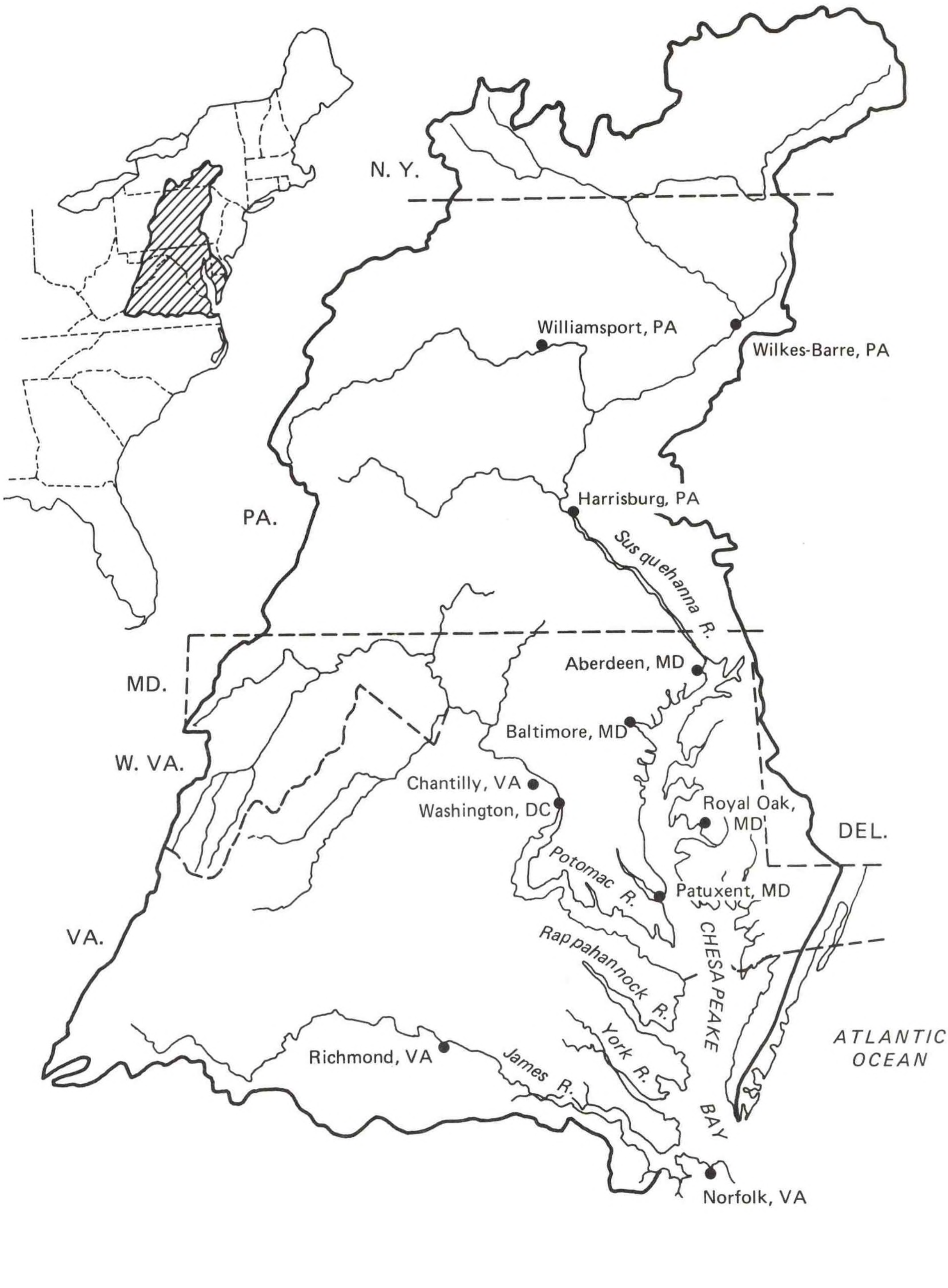



Figure 1 - Selected meteorological stations, Chesapeake Bay watershed (modified EPA map).

Table 2 - Normal monthly mean total precipitation (1951-1980) and 1985 departure from normal, selected stations, Chesapeake Bay region.

**A. Normal monthly total precipitation (inches)**

| Station | Jan. | Feb. | Mar. | Apr. | May | Jun. | Month Jul. | Aug. | Sep. | Oct. | Nov. | Dec. | total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Williamsport, PA | 2.88 | 2.83 | 3.66 | 3.53 | 3.66 | 3.88 | 3.92 | 3.26 | 3.57 | 3.22 | 3.63 | 3.24 | 41.28 |
| Wilkes-Barre, PA | 2.27 | 2.05 | 2.63 | 3.01 | 3.16 | 3.42 | 3.39 | 3.47 | 3.36 | 2.78 | 2.98 | 2.54 | 35.06 |
| Harrisburg, PA | 2.96 | 2.73 | 3.50 | 3.19 | 3.67 | 3.63 | 3.32 | 3.29 | 3.60 | 2.73 | 3.24 | 3.23 | 39.09 |
| Aberdeen, MD | 2.94 | 2.81 | 3.82 | 3.29 | 3.75 | 3.55 | 4.22 | 3.91 | 3.30 | 2.77 | 3.56 | 3.34 | 41.26 |
| Baltimore, MD | 3.00 | 2.98 | 3.72 | 3.35 | 3.44 | 3.76 | 3.89 | 4.62 | 3.46 | 3.11 | 3.11 | 3.40 | 41.84 |
| Washington, DC | 2.76 | 2.62 | 3.46 | 2.93 | 3.48 | 3.35 | 3.88 | 4.40 | 3.22 | 2.90 | 2.82 | 3.18 | 39.00 |
| Chantilly, VA | 2.83 | 2.64 | 3.43 | 3.14 | 3.62 | 4.23 | 3.75 | 4.16 | 3.26 | 3.01 | 2.99 | 3.29 | 40.35 |
| Royal Oak, MD | 3.44 | 3.20 | 4.07 | 3.41 | 3.63 | 3.43 | 4.39 | 5.09 | 3.72 | 3.46 | 3.73 | 3.74 | 45.31 |
| Patuxent, MD | 2.92 | 2.77 | 3.40 | 2.80 | 3.69 | 3.48 | 4.15 | 4.35 | 3.21 | 2.85 | 3.07 | 3.29 | 39.98 |
| Richmond, VA | 3.23 | 3.13 | 3.57 | 2.90 | 3.55 | 3.60 | 5.14 | 5.01 | 3.52 | 3.74 | 3.29 | 3.39 | 44.07 |
| Norfolk, VA | 3.72 | 3.28 | 3.86 | 2.87 | 3.75 | 3.45 | 5.15 | 5.33 | 4.35 | 3.41 | 2.88 | 3.17 | 45.22 |

**B. Departure from normal, 1985 (percent)**

| Station | Jan. | Feb. | Mar. | Apr. | May | Jun. | Month Jul. | Aug. | Sep. | Oct. | Nov. | Dec. | Annual departure |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Williamsport, PA | -82 | -60 | -23 | -67 | 9 | -36 | -11 | 31 | -28 | -43 | 65 | -56 | -23 |
| Wilkes-Barre, PA | -73 | -23 | -15 | -34 | 93 | -12 | 80 | -25 | 133 | -31 | 50 | -23 | 15 |
| Harrisburg, PA | -64 | 7 | -21 | -86 | 71 | -15 | -25 | -35 | 4 | -51 | 89 | -60 | -14 |
| Aberdeen, MD | -55 | -6 | -62 | -87 | 21 | 14 | 9 | 2 | 92 | 14 | 10 | -78 | -11 |
| Baltimore, MD | -32 | 2 | -36 | -88 | 75 | -35 | -35 | -19 | 80 | -20 | 51 | -75 | -12 |
| Washington, DC | -24 | 17 | -46 | -99 | 67 | -39 | -25 | -47 | 107 | 33 | 59 | -79 | -8 |
| Chantilly, VA | -18 | 41 | -50 | -89 | 33 | -73 | -38 | -19 | -9 | 35 | 76 | -72 | -18 |
| Royal Oak, MD | -2 | 6 | -60 | -83 | 24 | -30 | -10 | -16 | 108 | -41 | 37 | -74 | -12 |
| Patuxent, MD | -1 | 22 | -41 | -85 | 12 | -49 | -47 | 60 | 92 | 43 | 85 | -83 | 1 |
| Richmond, VA | 10 | 2 | -50 | -78 | -34 | 11 | 3 | 111 | 41 | 36 | 112 | -83 | 11 |
| Norfolk, VA | 7 | 7 | -48 | -85 | -14 | 97 | 19 | -65 | 46 | 15 | 98 | -75 | -1 |

Data are from National Weather Service.

Table 3 - Normal monthly mean air temperature (1951-1980) and 1985 departure from normal, selected stations, Chesapeake Bay region.

**A. Normal monthly air temperature (° F)**

| Station | Jan. | Feb. | Mar. | Apr. | May | Jun. | Jul. | Aug. | Sep. | Oct. | Nov. | Dec. | Annual average |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Williamsport, PA | 26.2 | 28.2 | 37.6 | 49.6 | 59.6 | 68.3 | 72.5 | 71.1 | 63.9 | 52.3 | 41.4 | 30.7 | 50.1 |
| Wilkes-Barre, PA | 25.2 | 26.8 | 36.1 | 48.3 | 58.6 | 67.4 | 71.8 | 70.0 | 62.8 | 51.7 | 40.9 | 29.7 | 49.1 |
| Harrisburg, PA | 29.4 | 31.5 | 40.6 | 52.2 | 62.0 | 71.2 | 75.8 | 74.3 | 66.9 | 55.0 | 43.9 | 33.4 | 53.0 |
| Aberdeen, MD | 33.3 | 34.7 | 42.5 | 53.5 | 63.3 | 72.5 | 76.4 | 74.8 | 68.4 | 58.0 | 46.3 | 35.0 | 54.9 |
| Baltimore, MD | 32.7 | 34.7 | 43.3 | 54.0 | 63.4 | 72.2 | 76.8 | 75.6 | 68.9 | 56.9 | 46.3 | 36.5 | 55.1 |
| Washington, DC | 35.2 | 37.5 | 45.8 | 56.7 | 66.0 | 74.5 | 78.9 | 77.6 | 71.1 | 59.3 | 48.7 | 38.9 | 57.5 |
| Chantilly, VA | 31.4 | 33.6 | 42.4 | 53.3 | 62.4 | 70.7 | 75.5 | 74.3 | 67.4 | 55.3 | 44.8 | 35.1 | 53.9 |
| Royal Oak, MD | 35.0 | 36.7 | 45.2 | 55.8 | 65.2 | 73.5 | 77.7 | 76.6 | 70.3 | 59.3 | 48.9 | 38.9 | 56.9 |
| Patuxent, MD | 37.0 | 38.0 | 46.0 | 55.0 | 65.0 | 73.0 | 78.0 | 77.0 | 71.0 | 60.3 | 49.0 | 39.6 | 57.4 |
| Richmond, VA | 36.6 | 38.9 | 47.2 | 57.9 | 66.1 | 73.5 | 77.8 | 76.8 | 70.2 | 58.6 | 48.9 | 39.9 | 57.7 |
| Norfolk, VA | 39.9 | 41.1 | 48.5 | 58.2 | 66.4 | 74.3 | 78.4 | 77.7 | 72.2 | 61.3 | 51.9 | 43.5 | 59.5 |

**B. Departure from normal, 1985 (° F)**

| Station | Jan. | Feb. | Mar. | Apr. | May | Jun. | Jul. | Aug. | Sep. | Oct. | Nov. | Dec. | Annual average |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Williamsport, PA | -2.8 | 1.7 | 2.5 | 3.7 | 1.4 | -3.9 | -1.5 | -1.0 | 1.4 | 0.6 | 3.7 | -2.8 | 0.3 |
| Wilkes-Barre, PA | -3.7 | 3.0 | 3.0 | 3.1 | 2.0 | -3.6 | -1.7 | -1.0 | 1.2 | 1.0 | 3.6 | -3.0 | 0.3 |
| Harrisburg, PA | -4.5 | 2.9 | 3.9 | 4.7 | 3.1 | -1.8 | 0.1 | -0.2 | 2.2 | 2.2 | 4.0 | -2.5 | 1.2 |
| Aberdeen, MD | -3.5 | 3.8 | 4.3 | 5.3 | 3.5 | -1.2 | 0.1 | 0.5 | 2.0 | 3.0 | 6.7 | 0.1 | 2.1 |
| Baltimore, MD | -3.4 | 4.0 | 2.7 | 3.9 | 1.7 | -1.8 | -0.4 | -1.1 | 0.5 | 1.9 | 6.1 | -2.7 | 1.0 |
| Washington, DC | -4.4 | 0.3 | 1.9 | 4.9 | 2.1 | -2.2 | 0.1 | -0.9 | 0.8 | 1.9 | 5.6 | -2.5 | 0.6 |
| Chantilly, VA | -3.3 | 2.2 | 2.6 | 3.8 | 1.4 | -1.0 | 0.4 | -0.9 | 0.1 | 3.1 | 7.8 | -1.9 | 1.2 |
| Royal Oak, MD | -3.5 | 0.9 | 3.2 | 3.5 | 1.7 | -1.6 | -0.6 | -1.0 | -0.1 | 3.1 | 6.5 | -2.1 | 0.8 |
| Patuxent, MD | -5.3 | 0.1 | 2.5 | 4.7 | 1.8 | -0.6 | 0.3 | -0.2 | 0.8 | 2.6 | 6.7 | -2.0 | 1.0 |
| Richmond, VA | -4.0 | 1.3 | 2.5 | 4.1 | 1.9 | 0.8 | 1.2 | 0.7 | 0.6 | 4.0 | 7.7 | -2.1 | 1.6 |
| Norfolk, VA | -5.0 | -0.7 | 3.3 | 3.8 | 2.4 | -0.1 | -0.2 | -0.5 | 1.2 | 4.6 | 8.4 | -2.3 | 1.2 |

Data are from National Weather Service.

during the first two weeks of September. In October two wet periods (1-5 October and 20-25 October) combined to raise rainfall levels in the Bay region. Fair weather prevailed, while temperatures averaged above normal.

November was warm and wet. It was the warmest November on record at Norfolk, Richmond, and Royal Oak and the second warmest at Baltimore. Temperatures during the month averaged 6.1° F above normal, ranging from 3.6° F above normal at Wilkes-Barre to 8.4° F above normal at Norfolk. The storm on the 4th and 5th, which brought devastating floods to the mountainous areas of Virginia and West Virginia, also brought the highest tidal flooding since 1933 to much of the Chesapeake Bay.

Total precipitation for December 1985 was extremely low. The average precipiation anomaly for the 11 meterological stations for December was -69 percent. Temperatures for the month averaged 34.3° F, 2.2° F below normal for the 11 stations.

## 3.2 Autumn Storms of 1985

Precipitation among the 11 stations in the region averaged 60 percent above normal in September, but streamflow remained below normal. Rainfall at the end of September was associated almost entirely with Hurricane Gloria over a short period of time and over a small area of the Bay, thus not adding significantly to the total freshwater inflow for September.

During the first several days in November, a low pressure system following Hurricane Juan moved through the southeastern United States (See Section 3.1, Precipitation and Temperature). During the last several days in October and early in November, the winds off the Chesapeake Bay mouth blew from the northeast, later becoming more easterly. Bay water levels mounted and crested on 2 November inside the mouth of the Bay around noontime. Hampton Roads and Chesapeake Bay Bridge-Tunnel water-level gauging stations reported the highest water levels of the month.

On 4 November a new storm developed over the Carolinas and Virginia, reaching full strength late in the day. In addition to the large amount of rainfall in the mountains of Virginia and West Virginia, the storm also generated strong southerly winds. Much of the accumulated water in the mouth of the Bay was pushed northward. River channels and inlets to the Bay were flooded from a combination of high tides and storm surge. As flood waters from the storm moved downstream in the Potomac River they crested at Washington, DC on the 8th (Figure 2). November river flows reached heights in some areas comparable to the devastating floods following Tropical Storm Agnes in 1972, although this flooding was of shorter duration.

The Chesapeake Bay region suffered damages ranging from minor to catastrophic as a result of the rain and winds from the remnants of Hurricane Juan and a low-pressure tropical air system which followed. Rainfall amounts of an inch a day were recorded in areas of the Bay drainage system saturating the soil and setting the stage for major flooding.

In West Virginia, along many rivers and streams, flooding of 100 to 500-year flood level frequencies occurred. West Virginia estimates put total damage figures at $578 million, with 38 people known to have died in the floods.

About $8 million in tobacco was lost in one of the many warehouses along the James River, which reached an historic high of 38.84 feet. The waste treatment plant in

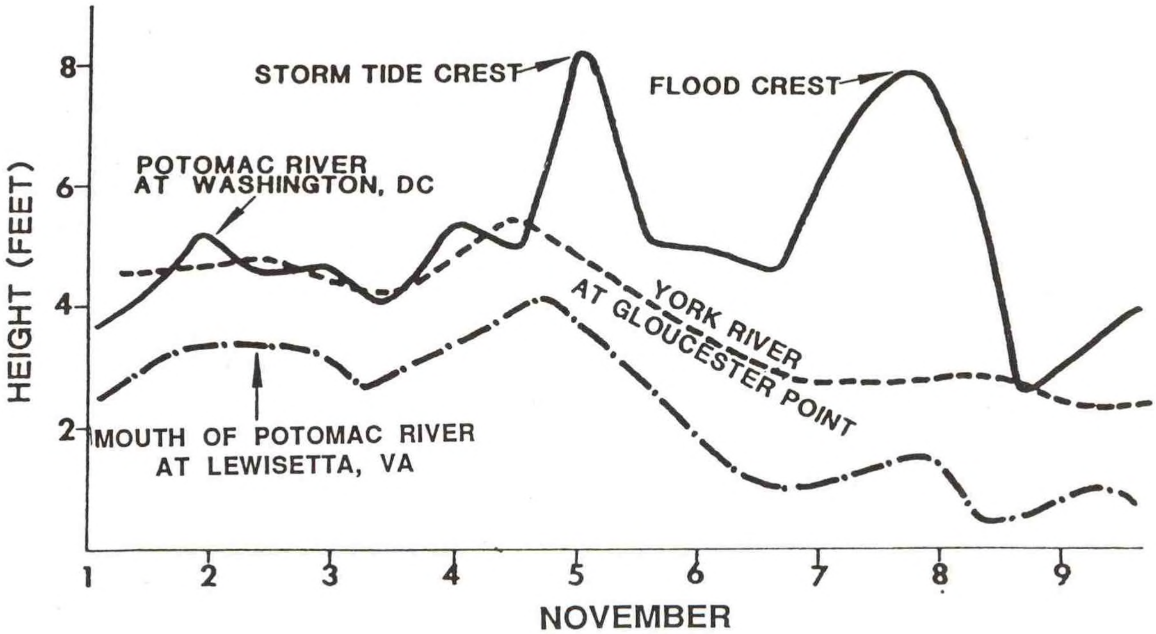



Figure 2 - Profiles of November tidal crests above mean low water.

Richmond was knocked out of operation and for a time raw sewage flowed into the river. In Gloucester County, Virginia, two municipal piers were damaged to the extent of $800,000. Total preliminary damage estimates for Virginia were over $753 million, with 22 people known dead.

Maryland experienced flooding both from storm surge and swollen rivers. Damages in Maryland, however, were not as extensive as those in Virginia and West Virginia. Winds blowing up the Bay generated high tides and backed up tributaries. Annapolis and Baltimore had minor flooding, while Anne Arundel County was most affected by tidal flooding. Homes, businesses, bulkheads, and piers were damaged, with additional loss from the erosion of beachfront and waterfront property. The Potomac River at Hancock crested on 5 November at 42 feet, 12 feet above flood stage. Maryland's only death from the storm occurred when a mudslide near Cumberland washed away railroad tracks and sent a train into the Savage River. Total estimated damages in Maryland were $19 million, with $9 million of that damage assessed to bulkheads, piers, and land loss from erosion.

The Washington, DC government estimated losses at under $1 million. Federally-administered property in the District did not fare as well. The grounds of the Jefferson Memorial and East and West Potomac Parks were inundated. The most serious damage occurred along the C & O Canal, which parallels the Potomac River on the Maryland side. Damage along its 189-mile expanse from Georgetown, in northwest Washington, to Cumberland, Maryland, was estimated at $9.3 million.

## 3.3 Streamflow

Streamflow was below normal in January and February following below-normal precipitation over the area in January. Streamflow rose to near normal in February, as rainfall over most of the Bay drainage area was above normal. The deficit streamflow of early 1985 contrasted with the streamflow excess of 5.4 trillion gallons at the end of 1984.

Bay streamflow remained below normal in all three months of the spring of 1985 (Table 4 and Figures 3 & 4). Streamflow had been below normal since September 1984 in all months except December. Below-normal streamflow in the spring quarter reflects the extremely dry conditions in the Bay region during March and April. The March 1985 flow of 95,100 cubic feet per second (cfs) was the third lowest during the period of record 1951-1985. April and May streamflow deficits greater than those in 1985 have been experienced in only four other years since 1951. Rainfall in May fell mostly in the latter part of the month causing average streamflow to be well below normal for May. The cumulative streamflow anomaly reached a deficit of 3.8 trillion gallons following the steady lower flow conditions in spring 1985 (Figure 5).

Bay streamflow remained below normal through July for the seventh consecutive month. In August, streamflow rose to above normal. The cumulative streamflow anomaly for January-August 1985 was a deficit of 4.3 trillion gallons.

Bay streamflow was below normal in September and October, although heavy upstream rainstorms early in November produced record-high streamflow in that month (Figure 4). The November 1985 flow of 164,000 cfs set a new record for that month, surpassing the previous record of 131,800 cfs set in November 1972. The 1985 cumulative streamflow anomaly for January through November was a deficit of 2.6 trillion gallons, but the heavy streamflow in November brought the cumulative anomaly closer to normal (Figure 5).

Although precipitation throughout the Bay drainage area was below normal, Bay streamflow was above normal during December 1985 . This above-normal streamflow was due to residual effects from the November record high streamflow.

Table 4 - Monthly streamflow, Chesapeake Bay streamflow stations, 1984-85 (Data from US Geological Survey).

| Year | Month | Cubic feet per second at section A | B | C | D | E |
|---|---|---|---|---|---|---|
| 1985 | January | 29,500 | 34,800 | 45,000 | 51,500 | 62,100 |
| | February | 36,800 | 42,300 | 68,800 | 79,400 | 97,000 |
| | March | 54,300 | 62,200 | 79,100 | 85,100 | 95,100 |
| | April | 49,600 | 52,100 | 74,900 | 79,000 | 86,000 |
| | May | 24,600 | 29,400 | 42,800 | 48,800 | 58,800 |
| | June | 18,300 | 22,700 | 33,500 | 36,100 | 40,800 |
| | July | 10,500 | 14,100 | 20,100 | 22,100 | 25,700 |
| | August | 7,650 | 10,900 | 15,800 | 23,700 | 36,600 |
| | September | 9,270 | 12,800 | 16,300 | 17,900 | 21,100 |
| | October | 13,400 | 17,700 | 23,300 | 25,200 | 28,700 |
| | November | 52,600 | 60,100 | 111,000 | 130,000 | 164,000 |
| | December | 52,500 | 60,000 | 81,500 | 90,200 | 104,300 |
| | Mean | 29,918 | 34,925 | 51,008 | 57,417 | 68,350 |
| 1984 | January | 20,900 | 25,500 | 39,600 | 45,800 | 56,000 |
| | February | 111,000 | 125,000 | 173,000 | 189,000 | 216,300 |
| | March | 54,800 | 62,800 | 107,000 | 123,000 | 151,000 |
| | April | 129,000 | 144,000 | 202,000 | 220,000 | 251,000 |
| | May | 67,200 | 77,400 | 103,000 | 114,000 | 134,000 |
| | June | 51,600 | 58,900 | 67,100 | 70,300 | 76,000 |
| | July | 37,100 | 42,600 | 52,200 | 56,100 | 62,700 |
| | August | 28,800 | 34,000 | 49,300 | 58,500 | 73,600 |
| | September | 10,400 | 14,100 | 19,300 | 22,400 | 27,900 |
| | October | 7,340 | 10,600 | 15,800 | 18,500 | 22,800 |
| | November | 14,100 | 18,300 | 24,700 | 27,800 | 33,200 |
| | December | 53,400 | 61,100 | 77,300 | 82,900 | 92,300 |
| | Mean | 48,803 | 56,192 | 77,525 | 85,692 | 99,733 |

Key to sections:

Cumulative Inflow to Chesapeake Bay at indicated dashed lines:

A : Mouth of Susquehanna River
B : Above mouth of Potomac River
C : Below mouth of Potomac River
D : Above mouth of James River
E : Mouth of Chesapeake Bay

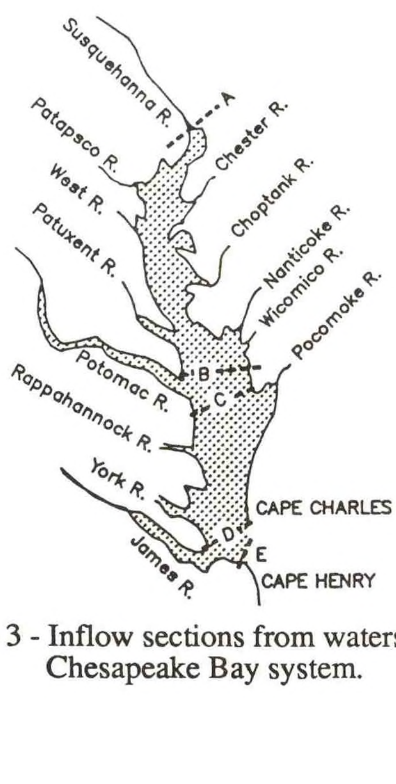
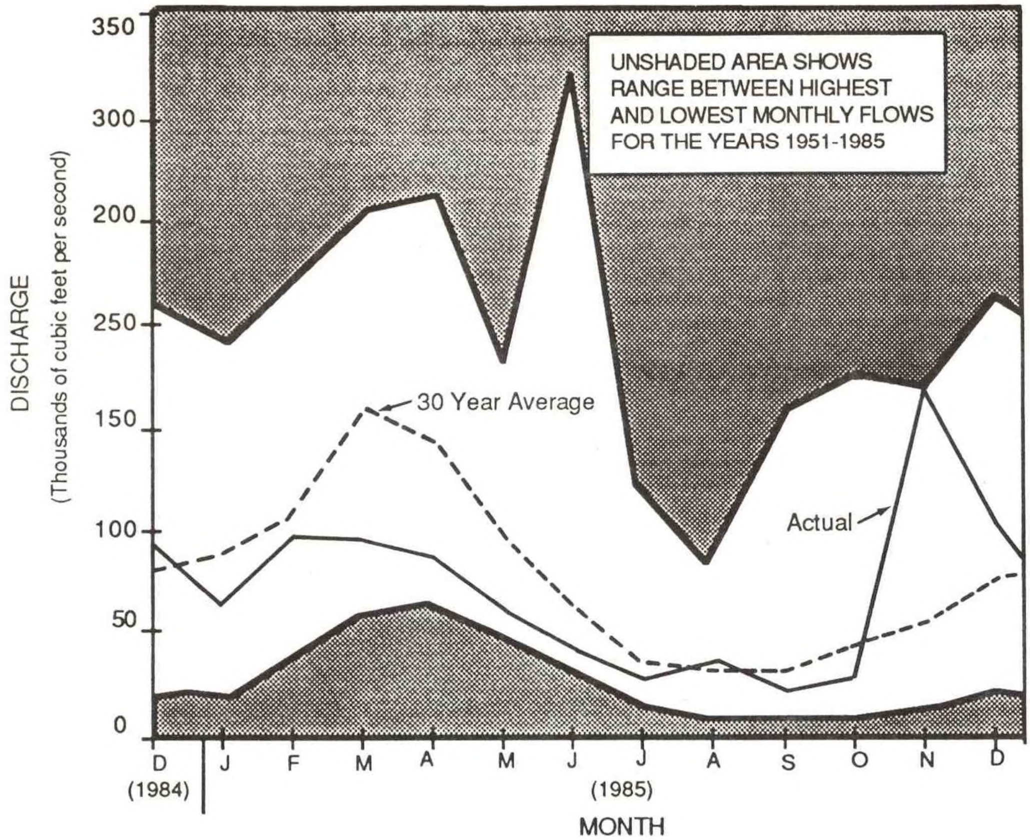



Figure 3 - Inflow sections from watershed to Chesapeake Bay system.



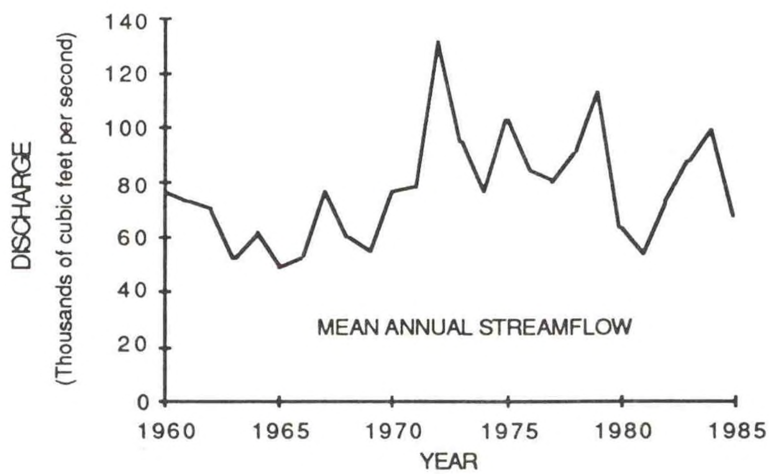




Figure 4 - Monthly mean streamflow into Chesapeake Bay, 1985.

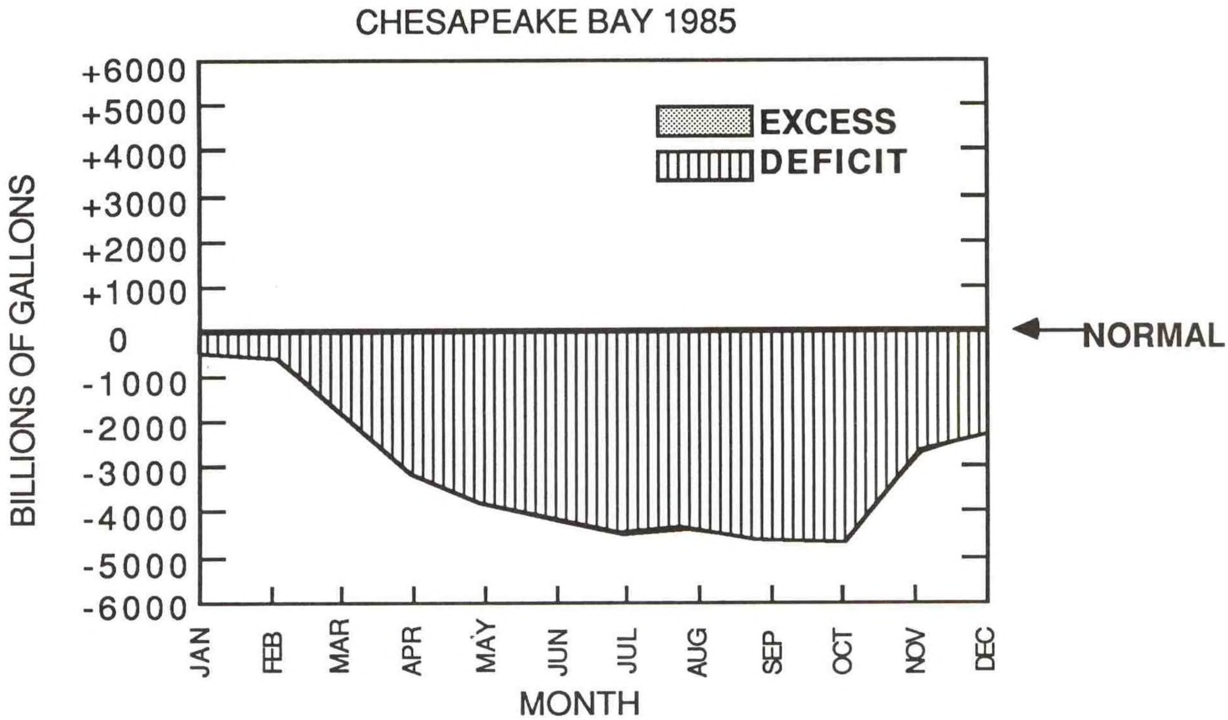



Figure 5 - Cumulative monthly streamflow into Chesapeake Bay, 1985.

## 3.4 Ice Cover

Significant freezing degree-days accumulated beginning 9 January when temperatures dropped well below freezing following a cold front. By mid-January strong winds combined with subzero temperatures resulting in a rise of cumulative freezing degree-days (Figure 6). Below-freezing temperatures continued into February until a thawing trend in late February. By 25 February, the ice cover had dissipated, and the Bay was ice free.

Maximum ice cover on the Chesapeake Bay reached 20 percent on 11 February, 1985 (Table 5). NASA studies show that, in a normal winter, maximum ice cover on Chesapeake Bay is about 10 percent of the total Bay area including tributaries. Chesapeake Bay ice cover has more closely approached the norm during the winters of 1983-85 than it did in the unusually cold winters which predominated the preceding six years.

Ice cover during the 1984-85 season was confined to the upper Bay. Some upper portions of tributaries in Virginia and Maryland had limited shoreline ice. Ice formed primarily on the eastern side of the Chesapeake Bay due to prevailing wind patterns, currents, and the shape of land mass areas. Unusually windy conditions in January 1985

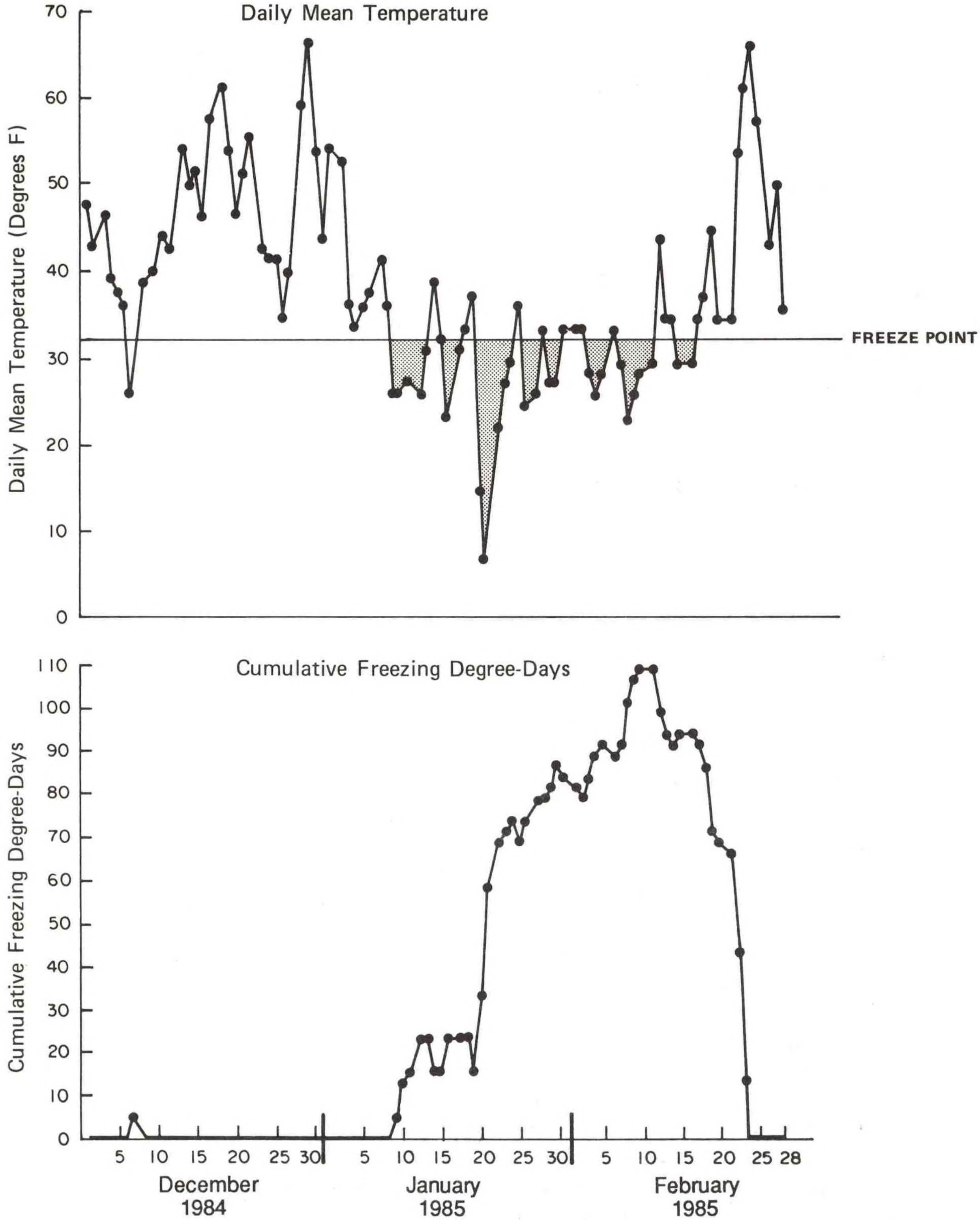



Figure 6 - Relationship between freezing degree-days and mean daily air temperature, Patuxent, Maryland, winter 1984-85.

hindered the formation of extensive ice cover in the more unprotected open-water areas in the main portion of Chesapeake Bay.

Warmer-than-normal water temperatures in December 1985 inhibited ice formation during the beginning of the 1985-1986 winter season resulting in less than 10 percent ice cover on the Bay during January 1986.

Table 5 - Maximum ice cover of Chesapeake Bay, 1978-1985.

| | 1978-79 | 1979-80 | 1980-81 | 1981-82 | 1982-83 | 1983-84 | 1984-85 |
|---|---|---|---|---|---|---|---|
| Estimated maximum extent (%) of ice cover | 60 | 15 | 50 | 55 | <10 | 30 | 20 |
| Date of maximum ice cover extent | Feb. 20 | Mar. 2 | Jan. 18 | Jan. 27 | Feb. 14 | Jan. 23 | Feb. 11 |

Data are from NASA (1978-81), estimated from Landsat and Coast Guard reports.

## 3.5 Oceanography

Bay surface salinity and water temperature vary under the influence of freshwater inflow, air temperature, and solar radiation. Surface salinities range from near oceanic [~24-28 parts per thousand (ppt)] at the Bay mouth to brackish (~1-2 ppt) at the head of the Bay. During 1985, surface salinities overall were higher than normal due to below-normal precipitation for most of the year.

The Bay had higher-than-normal temperatures at the beginning of the year, experienced higher-than-normal temperatures in spring followed by approximately normal temperatures in the summer, and ended the year with above-normal temperatures. Surface salinities were above normal monthly mean values until the November storms which reduced surface salinity values through December 1985.

### Surface salinity

The National Ocean Service (NOS) collects daily surface salinity and temperature data for selected stations around Chesapeake Bay (Figure 7). Tables 6 and 7 give mean monthly values of surface salinity and temperature computed in accordance with NOS instructions at five Bay area stations.

Stations around the Bay began the winter quarter showing slightly higher-than-normal mean surface salinities. All stations were above normal in January and February with the Chesapeake Bay Bridge-Tunnel station exceeding normal by 2.9 ppt in January. All stations followed a normal seasonal surface salinity cycle for March and April, but with

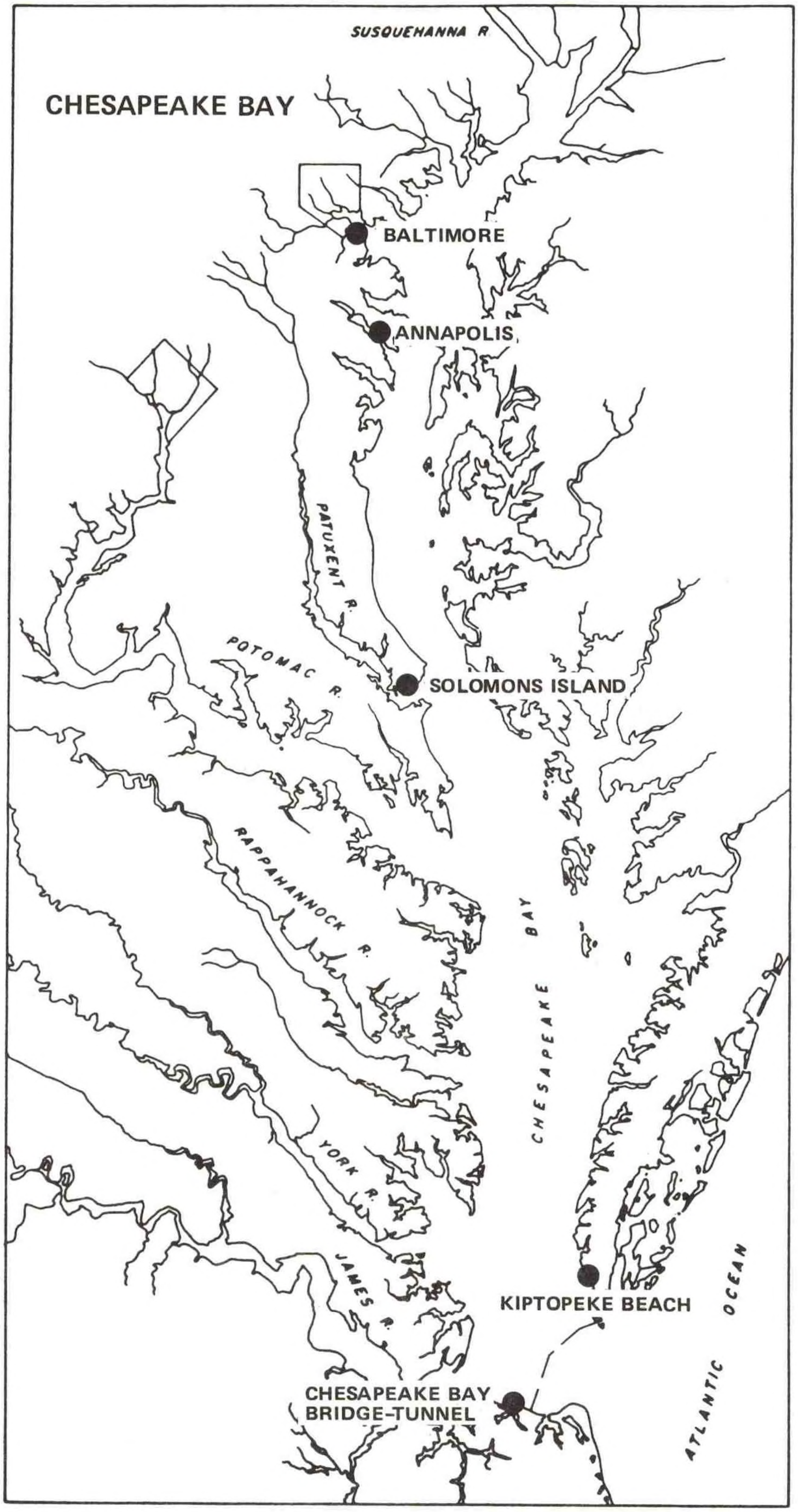



Figure 7 - Locations of National Ocean Service temperature and density stations, Chesapeake Bay.

Table 6 - Monthly long-term average surface water salinity and 1985 departure from normal, selected stations, Chesapeake Bay region.

**A. Monthly long-term average (ppt)**

| Station | Jan. | Feb. | Mar. | Apr. | May | Jun. (Month) | Jul. | Aug. | Sep. | Oct. | Nov. | Dec. | Annual average |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Baltimore, MD | 9.9 | 9.8 | 8.4 | 6.2 | 5.8 | 6.0 | 6.9 | 8.0 | 9.7 | 10.8 | 11.1 | 10.6 | 8.6 |
| Annapolis, MD | 11.4 | 10.8 | 9.6 | 7.2 | 6.9 | 8.0 | 9.2 | 10.2 | 11.6 | 13.1 | 13.6 | 12.0 | 10.3 |
| Solomons Is., MD | 15.0 | 14.5 | 13.1 | 11.2 | 10.8 | 11.2 | 12.6 | 13.5 | 14.8 | 16.0 | 16.6 | 15.8 | 13.8 |
| Kiptopeke Bch., VA | 26.7 | 26.1 | 25.4 | 24.4 | 24.6 | 25.8 | 26.4 | 27.3 | 27.7 | 27.7 | 27.1 | 26.5 | 26.3 |
| Chesapeake Bay Bridge-Tunnel, VA | 21.8 | 20.9 | 19.7 | 19.9 | 20.6 | 22.2 | 24.1 | 24.1 | 24.1 | 24.1 | 23.3 | 22.6 | 22.3 |

**B. Departure from normal, 1985 (ppt)**

| Station | Jan. | Feb. | Mar. | Apr. | May | Jun. (Month) | Jul. | Aug. | Sep. | Oct. | Nov. | Dec. | Annual average |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Baltimore, MD | 1.1 | 1.1 | 1.9 | 1.4 | 2.6 | 2.9 | 2.8 | 2.4 | 3.6 | 1.6 | 0.3 | -0.5 | 1.8 |
| Annapolis, MD | 0.6 | 2.0 | 0.6 | 1.7 | 3.7 | 3.1 | 2.8 | 2.3 | N/A | 1.3 | -0.5 | -1.8 | 1.4 |
| Solomons Is., MD | 0.3 | 0.5 | 1.5 | 2.5 | 3.5 | 3.9 | 3.2 | 3.4 | 1.9 | 1.9 | 1.1 | -0.5 | 1.9 |
| Kiptopeke Bch., VA | 0.6 | 1.0 | -0.3 | 2.4 | 2.2 | 1.6 | 2.4 | N/A | 1.3 | 0.2 | -0.3 | -2.6 | 0.8 |
| Chesapeake Bay Bridge-Tunnel, VA | 2.9 | 2.1 | 4.4 | 5.5 | 4.0 | 4.9 | 1.2 | 1.2 | 2.3 | 1.7 | -1.5 | 1.4 | 2.5 |

N/A = Not Available

Data are from National Ocean Service, NOAA.

Table 7 - Monthly long-term average surface water temperature and 1985 departure from normal, selected stations, Chesapeake Bay region.

**A. Monthly long-term average surface water temperature (°F)**

| Station | Jan. | Feb. | Mar. | Apr. | May | Jun. | Jul. | Aug. | Sep. | Oct. | Nov. | Dec. | Annual average |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Baltimore, MD | 37.4 | 37.0 | 42.6 | 53.1 | 64.2 | 74.1 | 79.5 | 79.5 | 75.2 | 65.7 | 54.0 | 43.0 | 58.8 |
| Annapolis, MD | 36.9 | 36.7 | 42.6 | 53.2 | 64.8 | 74.5 | 80.2 | 79.7 | 74.8 | 64.9 | 52.9 | 41.7 | 58.6 |
| Solomons Is., MD | 37.8 | 37.4 | 42.6 | 52.5 | 64.6 | 74.5 | 80.1 | 80.1 | 75.7 | 65.7 | 54.7 | 43.3 | 59.1 |
| Kiptopeke Bch., VA | 38.7 | 38.1 | 44.2 | 53.1 | 63.1 | 72.1 | 77.2 | 77.2 | 73.8 | 64.6 | 53.8 | 44.1 | 58.3 |
| Chesapeake Bay Bridge-Tunnel, VA | 39.6 | 41.2 | 46.9 | 55.2 | 65.7 | 74.1 | 79.0 | 79.9 | 75.4 | 65.8 | 55.2 | 45.1 | 60.3 |

**B. Departure from normal, 1985 (°F)**

| Station | Jan. | Feb. | Mar. | Apr. | May | Jun. | Jul. | Aug. | Sep. | Oct. | Nov. | Dec. | Annual average |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Baltimore, MD | 3.1 | 0.4 | 3.4 | 3.1 | 3.5 | -1.9 | -2.0 | -0.8 | -0.6 | 0.5 | 3.0 | 3.0 | 1.2 |
| Annapolis, MD | 0.6 | -0.9 | 1.0 | 0.6 | 1.8 | -1.3 | -1.6 | -0.7 | N/A | 0.5 | 3.9 | 3.0 | 0.6 |
| Solomons Is., MD | 1.3 | -1.6 | 2.1 | 3.4 | 2.7 | 0.4 | -0.2 | 0.5 | -0.1 | 2.8 | 5.5 | 4.1 | 1.7 |
| Kiptopeke Bch., VA | 0.7 | -0.5 | 3.1 | 4.2 | 5.9 | 2.6 | 0.9 | N/A | 3.1 | 3.4 | 6.5 | 1.9 | 2.9 |
| Chesapeake Bay Bridge-Tunnel, VA | 3.8 | -2.8 | -0.3 | 1.2 | 1.4 | -0.7 | -0.9 | -0.7 | 0.7 | 4.7 | 6.7 | 1.9 | 1.3 |

N/A = Not Available

Data are from National Ocean Service, NOAA.

higher-than-normal values, although at Kiptopeke surface salinity was slightly below normal in March. In May, all stations reported surface salinity values which were higher than either 1983 or 1984 (Figure 8). Surface salinities were above normal at all stations in June, July, and August. The higher-than-normal surface salinities probably reflect the deficit freshwater inflow during the summer of 1985. In Autumn, surface salinities were lowered by the large runoff from storm rainfall. December's below-normal salinities reflected above-normal streamflow through the Bay.

### Temperature

Bay surface water temperatures followed the seasonal temperature cycle with minimum temperatures in February and maximum temperatures in August. Ice cover during January and February 1985 was 20 percent.

Water temperatures around the Bay during the spring followed normal seasonal warming trends. Temperatures were above normal at all stations except at the Bay Bridge-Tunnel in March, which was 0.3° F below normal. The summer water temperatures were slightly below normal in the upper Bay and near normal in the lower Bay (except at Kiptopeke in June). Surface water temperatures were slightly below normal at Baltimore and Solomons in September; all other stations were slightly above normal. Water temperatures at all stations were very high for November with the Chesapeake Bay Bridge-Tunnel station reporting a departure of 6.7° F above normal. Surface water temperatures averaged above normal (+2.8° F) within the Bay during December, probably reflecting the warmer-than-normal November air temperatures. All stations reported above-normal surface water temperatures in December, with the Solomons Island station reporting the highest departure from normal (+4.1° F). The average surface water temperatures dropped from 43.4° F in December 1985 to 37.5° F in January 1986.

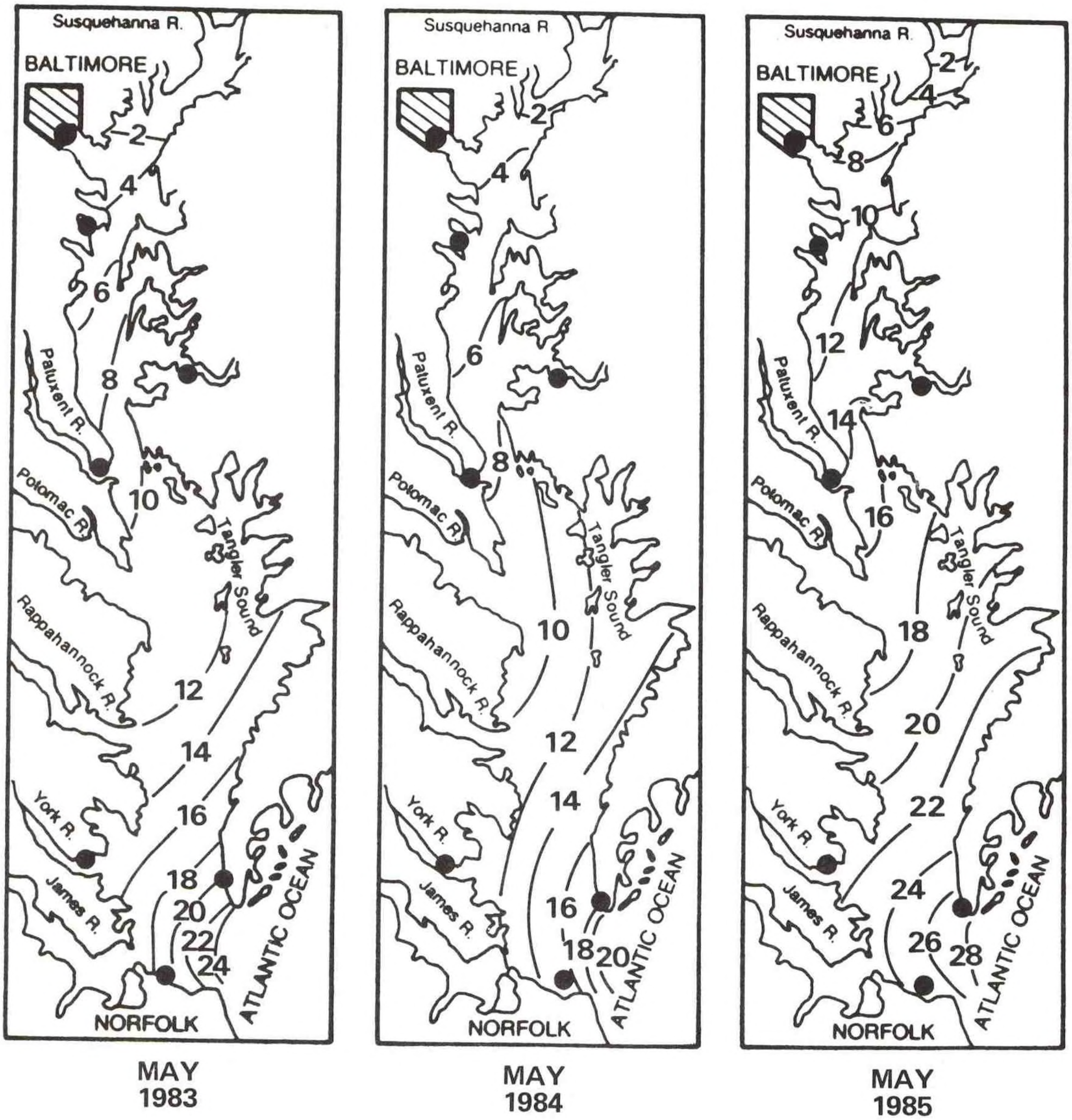



Figure 8 - Surface salinity distribution, Chesapeake Bay, May 1983-85.

# 4. Impact of Weather and Oceanographic Events: Fisheries

The Chesapeake Bay is the largest estuary in the United States and one of the largest in the world. The Bay supports extensive and valuable living resources such as oysters and blue crabs. It also serves as the spawning and nursery area for striped bass and many other important fishes, such as menhaden and bluefish. Many fish species use the Bay as a summer feeding ground and forage upstream as far as Baltimore to prey on the abundant estuarine food sources.

## 4.1 Finfish

Chesapeake Bay commercial fisheries comprised 2.8 percent of total landings in the United States in 1985, generating $64.7 million, with $43.4 million earned in Maryland and $21.2 million earned in Virginia (Table 8). Maryland 1985 total state landings were up 2.6 million pounds from 1984, although value decreased by $7.5 million. Maryland Bay landings in 1985 were 10.7 million pounds higher than in 1984. Virginia Bay landings in 1985 were down by 2.8 million pounds compared to 1984 landings, yet total Virginia state landings were 148.5 million pounds higher than in 1984. Landings of sea trout and bluefish increased in 1985 as compared to 1984 in both Maryland and Virginia. Baywide, the largest landing per pound in both Maryland and Virginia was menhaden. Catfish landings increased greatly in Maryland, but decreased in Virginia. Croaker and spot landings in Virginia were nearly double the 1984 values. Striped bass and white perch landings were greatly reduced in both Maryland and Virginia (Table 9). Total Chesapeake Bay finfish and shellfish landings increased by 7,955,066 pounds over 1984 with an increase of $855,289 (Table 10).

According to the Maryland Tidewater Administration, the relative abundance index for striped bass spawning success for 1985 was 2.9, which is lower than the 4.2 value of 1984 and well below the long-term average of 9.0 (Table 11). This index is based on the average number of young-of-the-year (inch-long fry) captured per seine haul in Bay tributaries. It has ranged from a low of 1.2 in 1981 to the high of 30.4 set in 1970. Based on the low index for 1985, a striped bass moratorium went into effect 1 January 1985 in Maryland to conserve the fishery. Virginia's commercial striped bass fishery was closed between 1 January and 31 May 1985.

Extensive mortalities of young-of-the-year croaker occurred in Virginia rivers early in 1985, representing a loss of most, if not all, of the 1984 year class. The mortalities occurred following a rapid drop in water temperatures in mid-January following the unusually warm water temperatures through December and early January. Virginia Institute of Marine Science (VIMS) sampling showed bottom water temperatures ranging from 32.0° F to 33.8° F in the York River in mid-January. Earlier in 1984, VIMS bottom trawling in July and August indicated the presence of a good 1984 year class; however, this year class suffered extensive cold water mortalities in winter 1984-85. Other species such as eels showed mortalities due to the severely cold winter water temperatures in mid-January.

Table 8 - Chesapeake Bay and total state landings, commercial finfish and shellfish, 1984 and 1985.

| | 1985 | | 1984 | |
|---|---|---|---|---|
| | Thousand pounds | Thousand dollars | Thousand pounds | Thousand dollars |
| Bay Landings 1 | | | | |
| Maryland, Bay only | 75,905 | 43,446 | 65,187 | 40,876 |
| Virginia, Bay only | 72,371 | 21,220 | 75,144 | 22,936 |
| Chesapeake Bay, total | 148,276 | 64,666 | 140,331 | 63,812 |
| State Landings 2 | | | | |
| Maryland | 91,931 | 47,418 | 89,301 | 54,979 |
| Virginia | 722,658 | 76,535 | 574,161 | 83,151 |
| Combined States | 814,589 | 123,953 | 663,462 | 138,130 |
| Total for U.S. | 6,257,642 | 2,326,237 | 6,437,783 | 2,350,462 |

Data are from National Marine Fisheries Service.

Landings are reported in live weight for all items except univalve and bivalve mollusks, such as clams, oysters, and scallops, which are reported in weight of meats (excluding the shell).

1 Bay landings include less than 1% ocean landings. Confidential data are not included for Virginia.

2 State landings include all state landings and confidential data.

Table 9 - Chesapeake Bay commercial finfish landings by state and species, 1984-1985.

| | Maryland | | | | Virginia | | | |
|---|---|---|---|---|---|---|---|---|
| | Thousand pounds | | Thousand dollars | | Thousand pounds | | Thousand dollars | |
| Species | 1985 | 1984 | 1985 | 1984 | 1985 | 1984 | 1985 | 1984 |
| Alewives | 183 | 133 | 31 | 17 | 406 | 1,195 | 19 | 71 |
| Bluefish | 396 | 103 | 67 | 14 | 1,208 | 867 | 194 | 147 |
| Butterfish | 1 | 0 | ** | 0 | 41 | 69 | 17 | 21 |
| Carp | 109 | 162 | 9 | 9 | 1 | 4 | ** | ** |
| Catfish | 1,274 | 885 | 439 | 263 | 469 | 835 | 105 | 181 |
| Croaker | 4 | 25 | 2 | 11 | 1,958 | 680 | 479 | 237 |
| Drum, Black | ** | 21 | ** | 6 | 15 | 3 | 4 | ** |
| Eels, Common | 24 | 109 | 44 | 66 | 254 | 371 | 153 | 221 |
| Flounder, Blackback | 8 | 9 | 6 | 10 | ** | ** | ** | ** |
| Flounder, Fluke | 39 | 31 | 52 | 33 | 216 | 395 | 172 | 287 |
| Gizzard, Shad | ** | 2 | ** | ** | 427 | 528 | 20 | 24 |
| Harvestfish | 0 | 0 | 0 | 0 | 83 | 84 | 62 | 60 |
| Menhaden | 5,366 | 5,341 | 278 | 268 | 17,321 | 14,526 | 713 | 588 |
| Mullet | ** | ** | ** | ** | 5 | 34 | ** | 7 |
| Sea Trout, Gray | 149 | 34 | 98 | 20 | 1,570 | 1,384 | 829 | 800 |
| Sea Trout, Spotted | 0 | 0 | 0 | 0 | 8 | 2 | 8 | 2 |
| Shad | 150 | 11 | 36 | 5 | 300 | 626 | 135 | 256 |
| Sharks, Dogfish | 15 | 0 | 10 | 0 | ** | 2 | ** | ** |
| Spanish Mackerel | 0 | 0 | 0 | 0 | 15 | 9 | 6 | 4 |
| Spot | 4 | 42 | 2 | 18 | 1,412 | 705 | 516 | 251 |
| Striped Bass | 41 | 1,075 | 44 | 1,346 | 241 | 505 | 258 | 472 |
| White Perch | 457 | 717 | 176 | 353 | 43 | 68 | 17 | 28 |
| Yellow Perch | 44 | 48 | 17 | 22 | ** | ** | ** | ** |
| Finfishes, Unc. food | 0 | 0 | 0 | 0 | 5 | 3 | 2 | ** |
| Finfishes, Unc. food & bait | 1 | 5 | 2 | 0 | 2,077 | 2,214 | 150 | 158 |
| Totals | 8,265 | 8,753 | 1,313 | 2,461 | 28,075 | 25,109 | 3,859 | 3,815 |

Data are from National Marine Fisheries Service. Landings are reported in live weight. Data include less than 1% ocean landings. Incidental catches of some ocean species and confidential data are not included. Dollar values are based on ex-vessel prices.

** Less than 1,000 pounds or 1,000 dollars not reported.

Table 10 - Chesapeake Bay finfish and shellfish landings - Maryland and Virginia (excludes all ocean catch).

| Year | 1980 - 1985 Pounds | Dollars |
|---|---|---|
| 1985 | 148,276,280 | 64,667,421 |
| 1984 | 140,321,214 | 63,812,132 |
| 1983 | 154,434,328 | 63,710,509 |
| 1982 | 154,897,700 | 60,859,535 |
| 1981 | 181,137,200 | 67,167,067 |
| 1980 | 152,392,700 | 56,195,941 |

Data are from National Marine Fisheries Service.

Table 11 - Relative abundance index for young-of-the-year striped bass, Maryland portion of Chesapeake Bay, 1954-1985.

| Year | Index | Year | Index | Year | Index | Year | Index |
|---|---|---|---|---|---|---|---|
| 1954 | 5.2 | 1962 | 12.2 | 1970 | 30.4 | 1978 | 8.4 |
| 1955 | 5.2 | 1963 | 4.0 | 1971 | 11.8 | 1979 | 4.2 |
| 1956 | 15.2 | 1964 | 23.5 | 1972 | 8.5 | 1980 | 1.9 |
| 1957 | 3.2 | 1965 | 7.4 | 1973 | 9.0 | 1981 | 1.2 |
| 1958 | 19.0 | 1966 | 16.7 | 1974 | 10.1 | 1982 | 8.4 |
| 1959 | 1.4 | 1967 | 7.8 | 1975 | 6.7 | 1983 | 1.4 |
| 1960 | 7.1 | 1968 | 7.2 | 1976 | 4.9 | 1984 | 4.2 |
| 1961 | 17.3 | 1969 | 10.2 | 1977 | 4.9 | 1985 | 2.9 |

Data are from Maryland Tidewater Administration.

Bluefish arrived in the Chesapeake Bay about two weeks earlier than normal in the spring of 1985 suggesting that the presence of bluefish corresponds to the 55-59° F (12-15° C) water temperature band along the east coast. The position of the temperature band in April 1985 was well north of its position along the coast in comparison to 1983 and 1984.

Cownose rays were reported to be unusually abundant in the upper Bay during the spring quarter. Rays and other species that prefer higher salinities moved into northern areas of Chesapeake Bay during the spring of 1985, when isohalines were shifted as much as 15 kilometers upriver from normal. Fishermen noted the unusual occurrence of several species of high salinity finfish in upper Bay tributaries where they are not normally found. The occurrence of these species in upper portions of Bay tributaries coincided with higher-than-normal Bay surface salinities that were observed in summer 1985. Black sea bass and sea robins were reported as far north in the Bay as the Magothy River. Higher surface salinities apparently also reduced the spawning area available to striped bass in the upper portions of Virginia rivers.

Plots of seine sampling data recorded by the Maryland Department of Natural Resources (DNR) for selected groups of species from 1958 to 1985 are shown in Figures 9, 10, and 11. Atlantic menhaden and blueback herring represent fish that prefer saltier, oceanic-type waters. Alewife and blueback herring have shown declines in numbers during sampling over the last 25 years, with the exception of single unusual years (alewife-1970, blueback herring-1969). In contrast, the numbers of Atlantic menhaden increased greatly after 1970 with a peak in 1977.

Croaker, striped bass, white perch, and bluefish are important commercial and recreational species in Chesapeake Bay. Croaker is particularly important as a commercial species in Virginia and landings in Virginia increased during 1985. In Maryland, however, croaker counts have been low in the sampling over the entire period except for 1973-74. The abundance of croaker is dependent largely on the ability of the year class to survive the winter. Juvenile croaker overwinter in the Chesapeake Bay and are vulnerable to severe cold. Striped bass and white perch have shown a decline after 1970 with no apparent improvement in the 1980's. Bluefish appear to have increased in number in the Maryland portion of the Bay after 1970. Bluefish and white perch have become more important in the Bay sport fishery as the striped bass fishery has declined.

## 4.2 Shellfish

Following the decline of oysters during the early 1980s, the crabbing industry in Maryland and Virginia became the dominant shellfish fishery in terms of value. In 1983, the value of blue crabs in Virginia totalled $11 million, whereas oysters totalled $5.9 million . Blue crabs were the most valuable shellfish species Bay-wide in 1985 contributing over $25 million to the combined economies of Maryland and Virginia (Table 12). The blue crab harvest in Maryland started slowly in the spring of 1985 due mostly to cooler weather, but recovered late in the spring. The abundance of crabs during the spring of 1985 reflected the highly successful 1983 year class of crabs which apparently reached market size in the late summer and the early fall of 1984. Maryland crabbers experienced marketing problems from the abundance of crabs and resulting low prices. However, in Virginia, blue crab landings in 1985 decreased by 6.5 million pounds.

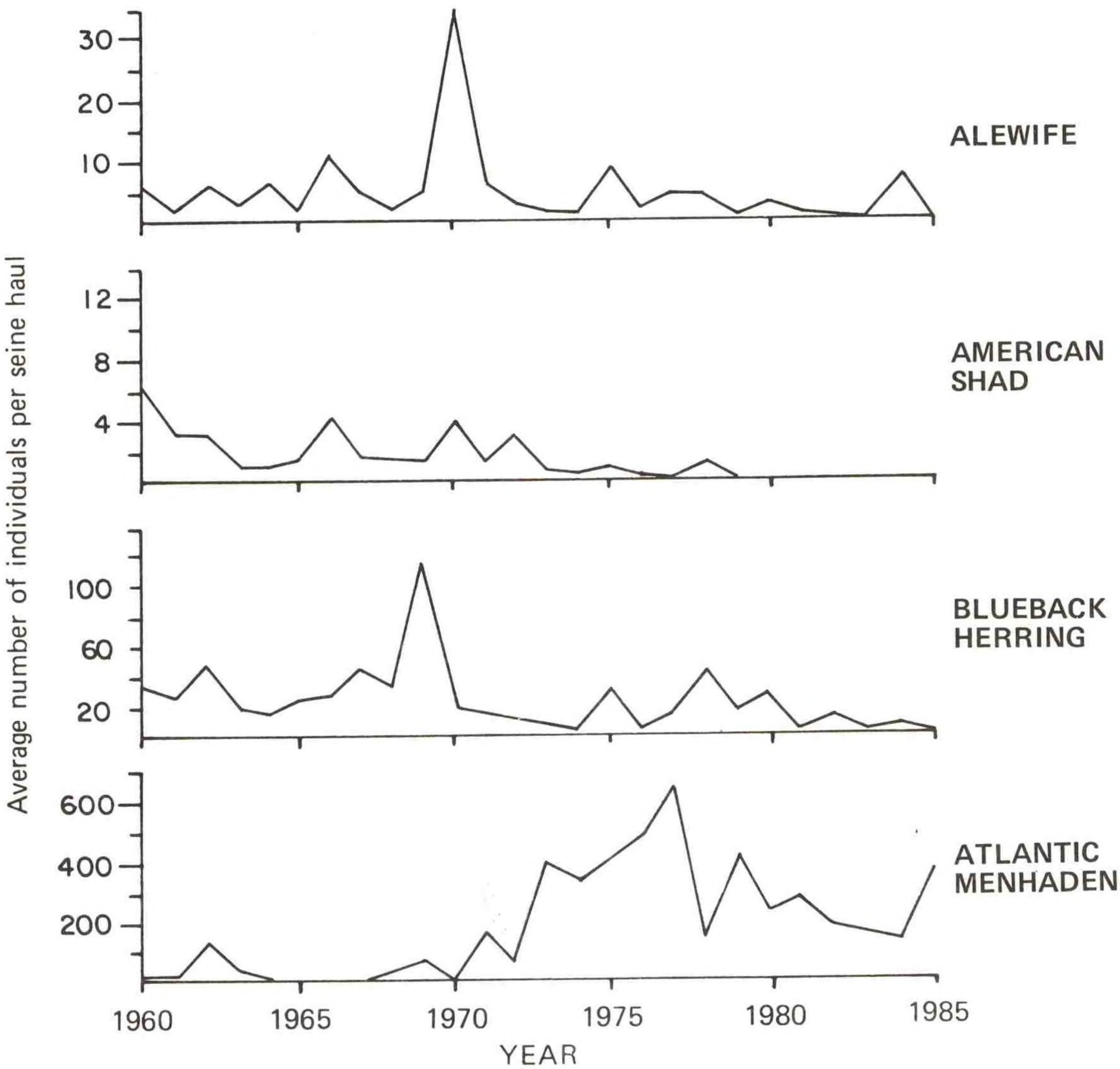



Figure 9 - Seine sampling of selected major herring species representing the average number of individuals collected at 22 sites in the Maryland portion of Chesapeake Bay.

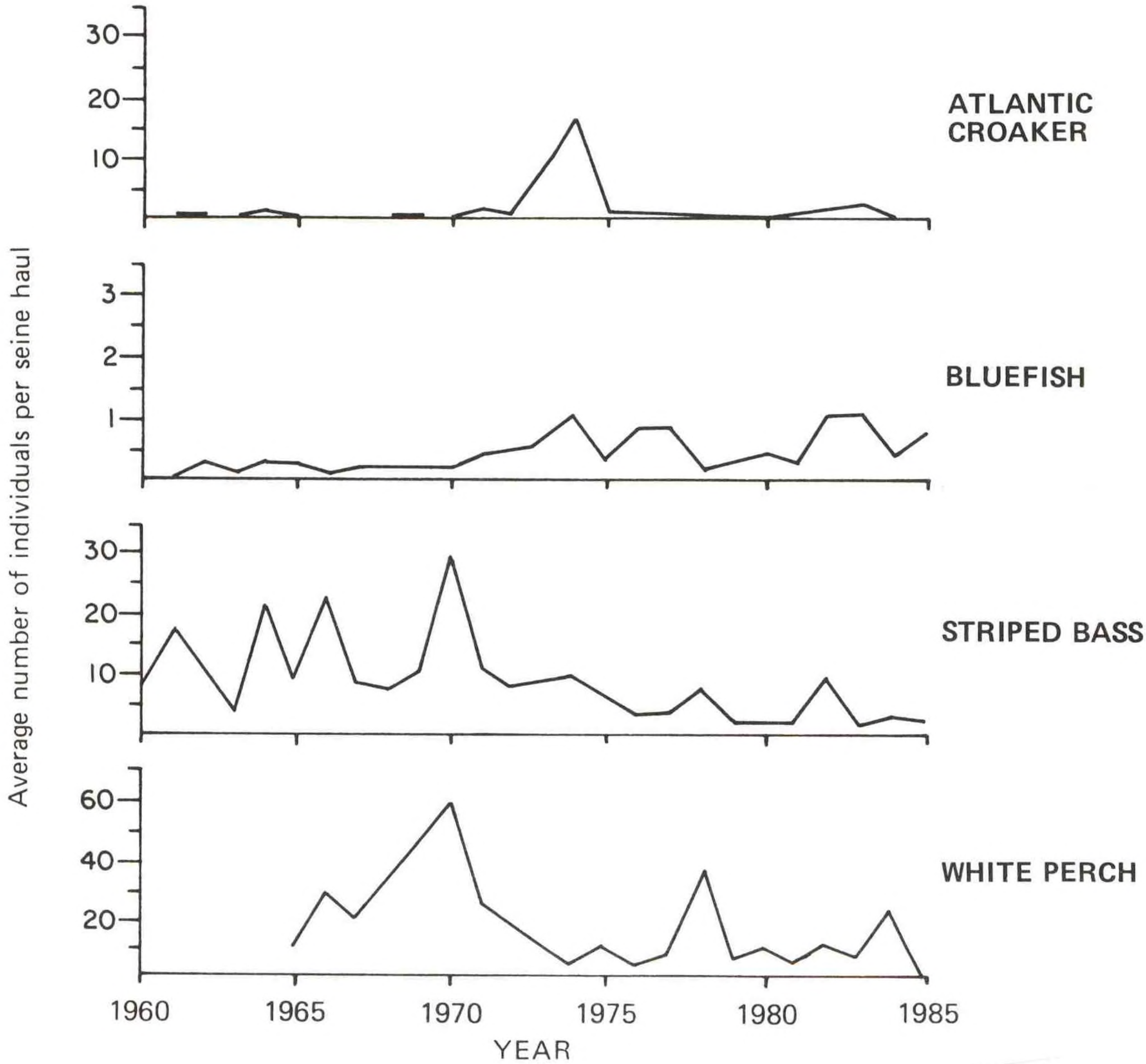



Figure 10 - Seine sampling of selected recreational and commercial species representing the average number of individuals collected at 22 sites in the Maryland portion of Chesapeake Bay.

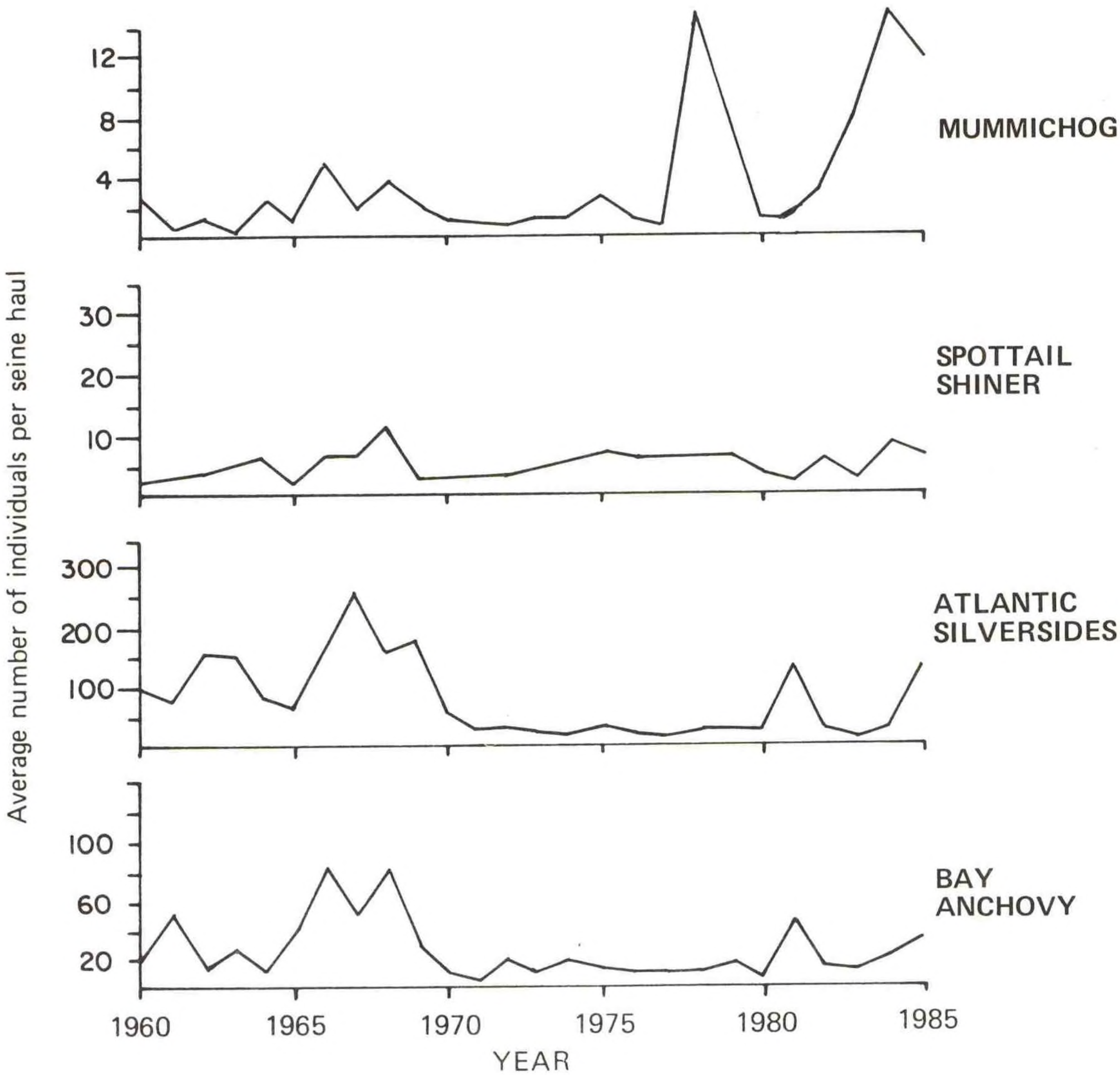



Figure 11 - Seine sampling of selected lower foodchain species representing the average number of individuals collected at 22 sites in the Maryland portion of Chesapeake Bay.

Table 12 - Chesapeake Bay commercial shellfish landings by state and species, 1984-1985.

| | Maryland | | | | Virginia | | | |
|---|---|---|---|---|---|---|---|---|
| | Thousand pounds | | Thousand dollars | | Thousand pounds | | Thousand dollars | |
| Species | 1985 | 1984 | 1985 | 1984 | 1985 | 1984 | 1985 | 1984 |
| Crabs, Blue, Hard | 55,476 | 46,802 | 17,958 | 16,023 | 38,123 | 44,608 | 7,889 | 10,068 |
| Crab, Soft & Peeler | 2,953 | 1,969 | 6,054 | 4,054 | 935 | 772 | 951 | 884 |
| Clam, Hard | 0 | 0 | 0 | 0 | 592 | 580 | 1,638 | 1,588 |
| Clam, Soft | 1,315 | 936 | 3,880 | 2,507 | 0 | 0 | 0 | 0 |
| Oyster Meat | 7,816 | 6,697 | 14,222 | 15,791 | 4,198 | 3,804 | 6,684 | 6,466 |
| Horseshoe Crab | 0 | 0 | 0 | 0 | 52 | 62 | 5 | 7 |
| Snails (Conchs) | 0 | 0 | 0 | 0 | 41 | 64 | 37 | 40 |
| Turtles (Snapper) | 20 | 0 | 12 | 0 | 76 | 127 | 36 | 61 |
| Totals | 67,580 | 56,404 | 42,126 | 38,375 | 44,017 | 50,017 | 17,240 | 19,114 |

Data are from National Marine Fisheries Service. Landings are reported in live weight except clams and oysters, which are reported in weight of meats (excluding the shell). Data include less than 1 percent ocean landings.

The range of suitable habitat for blue crabs was extended into the upper portions of Bay tributaries, following the above-normal surface salinities in summer 1985. Watermen reported an increase in the number and size of crabs in areas such as the upper portion of the Potomac River.

Large pot catches of crabs continued into November in Virginia coinciding with above-normal water temperatures. Some crab pots were lost during high winds and waves associated with the early November storms. The December 1985 dredge fishery in Virginia showed reduced landings from the previous year possibly as a result of warm water temperatures keeping the crabs active, making dredging less efficient. Landings of hard crabs decreased from 4.1 million pounds in December 1984 to 2.0 million pounds in December 1985.

Soft and peeler crab landings in 1985 increased by 1.1 million pounds from 1984 landings in Maryland. In April 1985, Virginia produced 20,126 pounds of soft crabs, a 20-fold increase over 1984 landings. Warm water temperatures in the spring of 1985 may have contributed to the increase in soft crab production in April and May, since shedding commences when water temperatures reach 60° F, and, also, shedding rates usually accelerate in warmer water temperatures.

Watermen in Virginia reported improvements in oyster landings over the 1983-84 season. Landings totalled 12.0 million pounds for 1985, but the oyster catch remained low compared to historical production in the Bay. Watermen were unable to reach oyster grounds in areas of the upper Bay that were iced over in January and February. Skim ice was reported 14 January and became solid on 20 January in the upper tributaries (Table 5). In addition to missed workdays, some watermen sustained property damage to boat hulls, propellers, and rudders. Oyster prices were high for the 1984-1985 season, ranging from $12 to $15 per bushel in December 1984 to $15 to $17 by mid-January 1985.

Monitoring agencies in Maryland and Virginia reported no large-scale mortalities of adult or seed oysters following the extensive flooding in early November (see section 3.2). Although flood levels in some of the tributaries were comparable to those reached during Tropical Storm Agnes in June 1972, lower water temperatures and a shortened duration of flooding allowed the oysters to tolerate reduced salinity levels. Sections of the James River were closed to oyster harvesting for several days as a result of sewage plant overflow conditions contaminating the area after the November flooding.

July and August 1985 soft shell clam landings and subsequent profits were greater in 1985 due to two factors (Table 13). First, bad weather during the spring season, when prices were at their highest, decreased harvest pressure on the population. Second, cooler and more favorable weather throughout the summer moderated the natural hot-weather-related mortality pressure on the soft-shell clam population.

Table 13 - Maryland soft-shell clam landings for June, July, and August 1984 and 1985.

| Year | Month | Pounds (meat) | Dollars |
|---|---|---|---|
| 1984 | June | 19,002 | 654,921 |
| | July | 12,160 | 504,847 |
| | August | 885 | 43,513 |
| 1985 | June | 17,445 | 585,416 |
| | July | 14,504 | 670,289 |
| | August | 6,156 | 349,184 |

Data are from Maryland Department of Natural Resources

## 4.3 Oyster Diseases

*Haplosporidium nelsoni* (MSX) showed no unusual outbreaks in Bay oysters following the above-normal surface salinities in spring 1985. Oysters that are infected by late summer and early fall often show signs of the disease in the following spring, except when surface salinities drop to 10 parts per thousand or lower. *Haplosporidium nelsoni* has spread rapidly up the Bay in past outbreaks and has caused extensive oyster mortalities. The increase in surface salinities in the spring of 1985 created the potential for organism activity and oyster mortalities.

During the summer of 1985, high prevalence of the oyster pathogen, *Perkinsus marinus* (Dermo), was found to be widespread in oysters on both the east and west sides of the Bay. Although the disease is usually prevalent in oysters in fall months the incidence of *Perkinsus marinus* in 1985 appeared to peak during July. New infections usually occur in mid-summer and mortalities occur after six weeks. High salinites during the summer provided favorable conditions for further infection by this disease.

## 4.4 Fish Kills

During the winter of 1985, a fish kill of approximately 500 1-3" spot attributable to temperature shock occurred on the Elizabeth River. In the spring, spawning stress tends to be the major cause of fish kills, whereas summer fish kills are usually caused by low dissolved oxygen combined with spawning stress. The Rappahannock River above Bluff Point was the site of a kill of undetermined cause of 4,000-5,000 spot during the summer of 1985. Many kills occurred in embayments or areas that experienced light winds and poor mixing, resulting in vertical statification of the water column, possibly creating anoxic conditions during extended dry periods in mid-to-late summer.

## 4.5 Blooms

Phytoplankton blooms are sampled by the Maryland Office of Environmental Programs (OEP) at 6 stations along the Maryland portion of the Chesapeake Bay and 10 stations along the Potomac River on a monthly basis. Blooms are generally characterized by a foul odor or a discoloration of the water. Patches of the blue green algae, *Microcystis*, were observed in July 1985 on the surface in a wide area of the Potomac River. This area included Gunston Cove and Mattawoman Creek, and Hallowing Point to Maryland Point. *Microcystis* last appeared as a bloom in the summer of 1983, affecting a 20-mile stretch of the Potomac River. Cell densities of combined species of phytoplankton sampled in July by Maryland OEP averaged 30,507 cells/milliliter, 39 percent higher than the previous five-year average for July.

## 4.6 Submerged Aquatic Vegetation

Submerged aquatic vegetation has shown a large increase in the number of species in the upper Potomac River in the last four years. Approximately 12 to 15 species were observed in the summer of 1985 in the tidal Potomac River. The submerged aquatic plant, *Hydrilla*, heavily infested areas of the upper Potomac. *Hydrilla* also heavily infested the

Potomac in the summer of 1984. *Hydrilla* can rapidly overtake large areas and is considered by boat users to be a threat to navigation and recreation. However, some scientists believe *Hydrilla* is creating improved habitat for finfish. In 1985, *Hydrilla* showed thicker growth in the same areas affected in the previous years and spread farther upstream and downstream in the Potomac River.

Eurasian watermilfoil begins seasonal growth in the spring and showed heavy infestations in the Potomac River during the 1985 summer. Eurasian watermilfoil is sometimes considered, like *Hydrilla*, a nuisance plant that clogs waterways.

## 4.7 Jellyfish

Higher-than-normal surface salinities during the spring of 1985 provided favorable conditions for stinging sea nettles in the upper Bay. Sea nettles detract from swimming and other water-oriented pursuits in the summer and present an unfavorable situation in affected areas of Chesapeake Bay.

The stinging nettle infestation began and ended early. Nettles appeared in well-above-average abundance in mid-summer. Nettle strobilation (generation of free-swimming, small medusae from the sessile polyp stage) occurred earlier than usual in 1985 and did not last the normal length of time compared to the previous 20-year period. Sampling by the Chesapeake Biological Laboratory (CBL) in May 1985 showed very high counts of sea nettle ephyrae (the free-swimming larval stage). The adult phase of the nettle, or medusa, lasts about three months. Medusae were first observed in early June and site counts by CBL at Solomons, Maryland, showed 50-70 individuals in mid-June. Nettle counts then increased rapidly, averaging 100 in the CBL observation area during the first week of July and 435 during the last week in July. One thousand nettle medusae were counted on 31 July, ten times the average count for the last week in July. Nettle counts dropped off sharply in the first two weeks of August to 200 per day. By mid-August, nettle counts were only eight per day, finally reaching days with zero counts by the third week in August. Nettle medusae normally disappear in the upper Bay in the second or third week of September. The exact cause of the sudden disappearance of the nettles in summer 1985 is possibly related to the earlier than usual beginning of the life cycle.

Winter jellyfish, *Cyanea capillata*, also occur in the Chesapeake Bay from the early winter to the late spring. CBL scientists noted unusually high numbers of *Cyanea capillata* in the upper Bay. This species, which is normally more abundant in the southern Bay, was observed in upper Bay tributaries through May 1985.

# 5. Impact of Weather and Oceanographic Events: Recreation

Climate and water quality determine much of the recreational use of the Bay area, including boating, fishing, swimming, and camping. Recreational boating is an important Bay-area activity, whose impact is felt especially in local areas of the upper Bay. Bay Bridge traffic indirectly indicates the use of ocean beaches and Eastern Shore recreational facilities. State park attendance and revenue are direct indicators of recreational use of the Bay.

## 5.1 Recreational Boating

Recreational boaters number over 1,000,000 in the Bay area. The Maryland Department of Natural Resources reported 125,798 boat registrations issued for Maryland waters for 1985. Most of these boats are less than 20 feet in length, 96 percent are owned by Maryland residents, and most are registered in Bay counties. Most of the boats are trailered and kept at home by their owners. Many of the remainder are kept at home ports in Bay counties. Boating fees and licenses generated $1,518,200 (Table 14) in revenue to the state of Maryland in 1985. Boating fee revenue figures indicate a steady yearly increase of the recreational load to the Bay system.

### 5.1.1 Marine Advisories and Warnings

The National Weather Service (NWS) issues marine advisories and warnings primarily for information to recreational boaters. The different conditions leading to NWS advisories appear to be seasonally distributed in the different regions of the Bay (Figure 12). Small craft advisories for the tidal Potomac (Region 5) and the lower Bay (Region 4) occur predominantly between February and April or from October to November. The small craft advisories for Regions 1, 2, and 3 occur in the same two seasons, but on fewer occasions. Small craft advisories covering the entire Bay are issued predominantly between November and April, reflecting winter wind conditions. Special marine warnings are usually issued in response to potentially damaging local events such as thunderstorms, tornadoes, or waterspouts. These localized phenomena may be spawned by major weather systems. Thunderstorms usually account for most of the special marine warnings. They are usually issued in the summer months throughout the Bay and are occasionally issued in late spring.

The National Weather Service issued a total of 265 advisories and warnings for the Bay area during 1985. Small craft advisories were most numerous (229), followed by gale warnings (34). From May to August 1985, low rainfall, very warm air temperatures, and low seasonal storm activity resulted in few instances that required marine warnings in those months. Thus, summer 1985 was an unusally favorable period for recreational boating on the Bay. In November, 37 small craft advisories and 9 gale warnings were issued (Table 15).

During 1985, gale warnings were issued 34 times, compared to 20 gale warnings issued in 1984. Gale warnings in 1984 were issued in late winter, early spring, early fall,

Table 14 - Maryland boating licenses and fees, 1980-1985.

| | Number Issued and Fees Collected[1] | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Item** | **1985** | | **1984** | | **1983** | | **1982** | | **1981** | | **1980** | |
| Boat Dealer Licenses | 0.73 | $18.20 | 0.72 | $18.10 | 0.70 | $17.70 | 0.60 | $15.00 | 0.60 | $14.20 | 0.60 | $14.30 |
| Boat Registrations | 125.80 | $1,340.00 | 108.10 | $1,297.00 | 128.30 | $1,295.90* | 117.80 | $527.20 | 124.10 | $517.40 | 111.90 | $510.00 |
| Boat Titles | 30.60 | $61.20 | 29.00 | $58.00 | 28.60 | $56.90 | 25.60 | $51.10 | 25.50 | $50.90 | 24.90 | $49.60 |
| Security Interest Filing Fee | 6.60 | $98.80 | 5.80 | $87.30 | 5.80 | $86.90 | 3.50 | $52.40 | 3.40 | $51.00 | 4.00 | $56.00 |
| Total Boat Related Fees | | $1,581.20 | | $1,460.40 | | $1,457.40 | | $645.70 | | $633.50 | | $629.90 |

[1]Values are represented in thousands.
*Fees were doubled in 1983.

Data are from Maryland Department of Natural Resources.

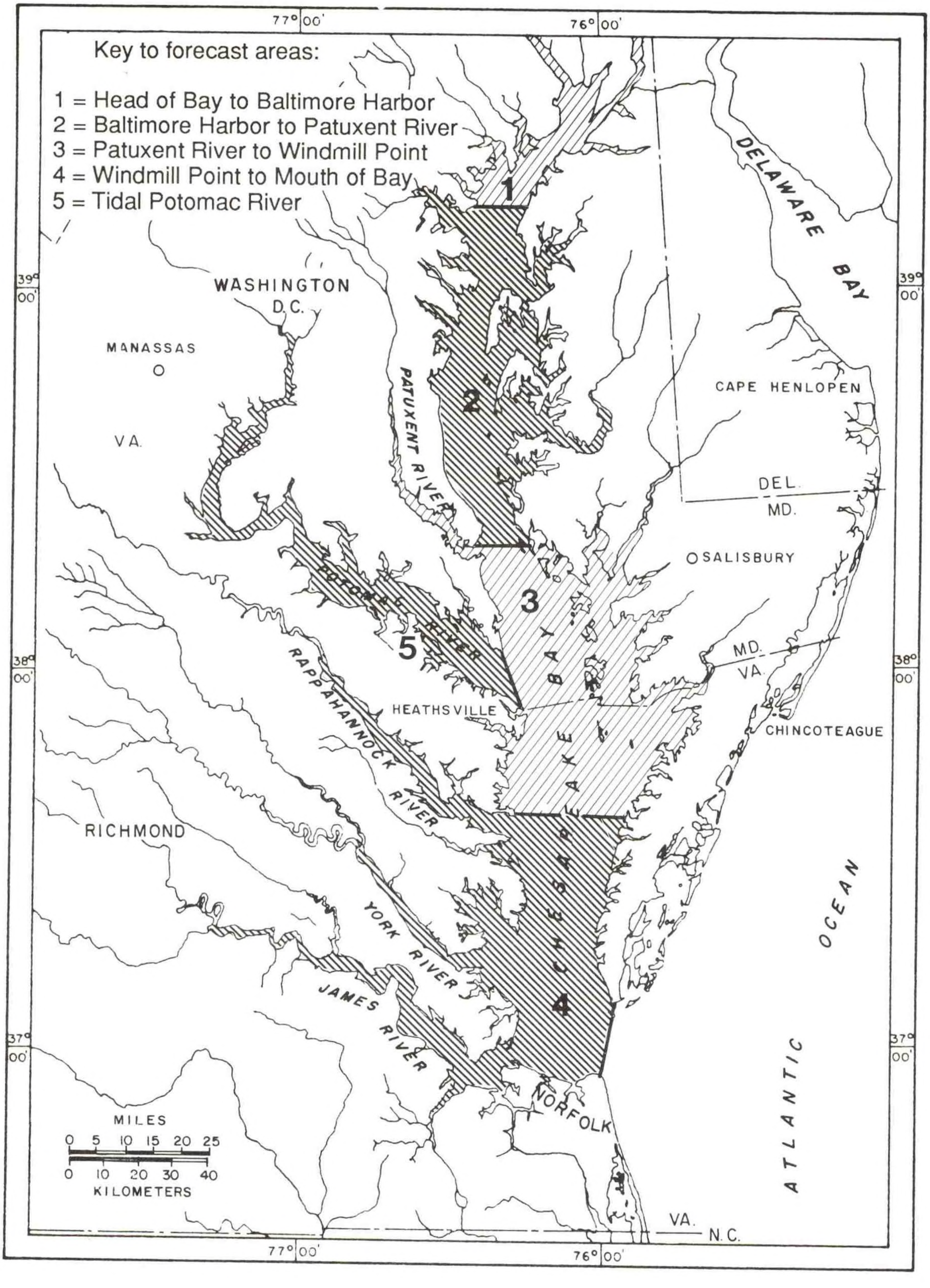



Figure 12 - National Weather Service (NWS) forecast areas for Chesapeake Bay.

| | HEAD OF BAY TO BALTIMORE HARBOR | BALTIMORE HARBOR TO PATUXENT RIVER | PATUXENT RIVER TO WINDMILL POINT | WINDMILL POINT TO MOUTH OF BAY | TIDAL POTOMAC RIVER | ENTIRE BAY |
|---|---|---|---|---|---|---|
| A | 3 | 3 | 3 | 2 | 8 | 7 |
| B | 2 | 1 | 2 | 4 | 2 | 2 |
| C | | | | | | |
| D | | | | | | |

JANUARY

| | HEAD OF BAY TO BALTIMORE HARBOR | BALTIMORE HARBOR TO PATUXENT RIVER | PATUXENT RIVER TO WINDMILL POINT | WINDMILL POINT TO MOUTH OF BAY | TIDAL POTOMAC RIVER | ENTIRE BAY |
|---|---|---|---|---|---|---|
| A | 2 | 2 | | 3 | 6 | 4 |
| B | | | | 1 | | |
| C | | | | | | |
| D | | | | | | |

FEBRUARY

| | HEAD OF BAY TO BALTIMORE HARBOR | BALTIMORE HARBOR TO PATUXENT RIVER | PATUXENT RIVER TO WINDMILL POINT | WINDMILL POINT TO MOUTH OF BAY | TIDAL POTOMAC RIVER | ENTIRE BAY |
|---|---|---|---|---|---|---|
| A | 3 | 3 | 4 | 5 | 5 | 4 |
| B | | | | 1 | | 1 |
| C | | | | | | |
| D | | | | | | |

MARCH

| | HEAD OF BAY TO BALTIMORE HARBOR | BALTIMORE HARBOR TO PATUXENT RIVER | PATUXENT RIVER TO WINDMILL POINT | WINDMILL POINT TO MOUTH OF BAY | TIDAL POTOMAC RIVER | ENTIRE BAY |
|---|---|---|---|---|---|---|
| A | 1 | 1 | 1 | 2 | 8 | 7 |
| B | | | | | 1 | 1 |
| C | | | | | | |
| D | | | | | | |

APRIL

| | HEAD OF BAY TO BALTIMORE HARBOR | BALTIMORE HARBOR TO PATUXENT RIVER | PATUXENT RIVER TO WINDMILL POINT | WINDMILL POINT TO MOUTH OF BAY | TIDAL POTOMAC RIVER | ENTIRE BAY |
|---|---|---|---|---|---|---|
| A | 1 | 1 | 1 | 2 | 7 | 6 |
| B | | | | 1 | | |
| C | | | | | | |
| D | | | | | | |

MAY

| | HEAD OF BAY TO BALTIMORE HARBOR | BALTIMORE HARBOR TO PATUXENT RIVER | PATUXENT RIVER TO WINDMILL POINT | WINDMILL POINT TO MOUTH OF BAY | TIDAL POTOMAC RIVER | ENTIRE BAY |
|---|---|---|---|---|---|---|
| A | 1 | 3 | 4 | 4 | 2 | 2 |
| B | | | | | | |
| C | | | | | | |
| D | | | | | | |

JUNE

| | HEAD OF BAY TO BALTIMORE HARBOR | BALTIMORE HARBOR TO PATUXENT RIVER | PATUXENT RIVER TO WINDMILL POINT | WINDMILL POINT TO MOUTH OF BAY | TIDAL POTOMAC RIVER | ENTIRE BAY |
|---|---|---|---|---|---|---|
| A | 1 | 1 | 1 | 1 | 2 | 1 |
| B | | | | | | |
| C | | | | | | |
| D | | | | | | |

JULY

| | HEAD OF BAY TO BALTIMORE HARBOR | BALTIMORE HARBOR TO PATUXENT RIVER | PATUXENT RIVER TO WINDMILL POINT | WINDMILL POINT TO MOUTH OF BAY | TIDAL POTOMAC RIVER | ENTIRE BAY |
|---|---|---|---|---|---|---|
| A | 2 | 2 | 3 | 1 | | |
| B | | | | | | |
| C | | | | | | |
| D | | | | | | |

AUGUST

| | HEAD OF BAY TO BALTIMORE HARBOR | BALTIMORE HARBOR TO PATUXENT RIVER | PATUXENT RIVER TO WINDMILL POINT | WINDMILL POINT TO MOUTH OF BAY | TIDAL POTOMAC RIVER | ENTIRE BAY |
|---|---|---|---|---|---|---|
| A | 3 | 3 | 3 | 2 | 7 | 5 |
| B | | | | | 2 | 1 |
| C | | | | | | |
| D | | | | | | 2 |

SEPTEMBER

| | HEAD OF BAY TO BALTIMORE HARBOR | BALTIMORE HARBOR TO PATUXENT RIVER | PATUXENT RIVER TO WINDMILL POINT | WINDMILL POINT TO MOUTH OF BAY | TIDAL POTOMAC RIVER | ENTIRE BAY |
|---|---|---|---|---|---|---|
| A | 1 | 1 | 3 | 4 | 4 | 2 |
| B | | | | | | |
| C | | | | | | |
| D | | | | | | |

OCTOBER

| | HEAD OF BAY TO BALTIMORE HARBOR | BALTIMORE HARBOR TO PATUXENT RIVER | PATUXENT RIVER TO WINDMILL POINT | WINDMILL POINT TO MOUTH OF BAY | TIDAL POTOMAC RIVER | ENTIRE BAY |
|---|---|---|---|---|---|---|
| A | 4 | 4 | 4 | 8 | 10 | 7 |
| B | 2 | 1 | 1 | 5 | | |
| C | | | | | | |
| D | | | | | | |

NOVEMBER

| | HEAD OF BAY TO BALTIMORE HARBOR | BALTIMORE HARBOR TO PATUXENT RIVER | PATUXENT RIVER TO WINDMILL POINT | WINDMILL POINT TO MOUTH OF BAY | TIDAL POTOMAC RIVER | ENTIRE BAY |
|---|---|---|---|---|---|---|
| A | 2 | 2 | 3 | 2 | | 9 |
| B | | | | | | 3 |
| C | | | | | | |
| D | | | | | | |

DECEMBER

**KEY:**

A - Small craft advisory (wind 25-34 knots)
B - Gale warning (wind 34-47 knots)
C - Storm (winds 47-64 knots)
D - Special marine warning (unusual weather phenomena)

Table 15 - Marine advisories and warnings, Chesapeake Bay, 1985.

and again in December around the lower Bay and tidal Potomac. During 1985, gale warnings were concentrated in two months, with 13 gale warnings issued in January and 9 issued in November. None were issued during the summer of 1985.

Only two special marine warnings were issued for the entire Bay region in August 1985. Multiple advisories and warnings were issued on 26, 27, and 28 September due to hurricane Gloria. On 26 September a small craft advisory was issued for the entire Bay and Tidal Potomac River changing to a gale warning later that day. A hurricane warning was issued that evening for the entire Bay and remained in effect until the next day. The hurricane warning on 27 September was later downgraded to a gale warning and by that evening a small craft advisory was in effect for the remainder of the day.

### 5.1.2 Marine Accidents

The number of boating accidents in the marine environment is related to the number of boats on the water and to the weather. The Maryland Department of Natural Resources keeps figures for boating accidents in the Maryland portions of the Bay in which property damage or injury occurs. During 1985, 18 persons died and 88 were injured in 227 boating accidents in Bay waters of Maryland (Table 16). Injuries and deaths associated with recreational boating depend strongly on individual safety practices for which no data exist.

### 5.1.3 Search and Rescue Operations

The U.S. Coast Guard recorded 3,184 Search and Rescue (SAR) operations for the entire Bay during 1985. SAR operations conducted by the Coast Guard in Chesapeake Bay are given by month for 1983-85 (Table 17). Normally, the higher the number of boaters in the water, the higher the SAR caseload. Coast Guard SAR operations peak in July and August, when recreational boating is at a maximum. SAR data are comprised of any type of call to the Coast Guard, including disabled boats and overdue vessels, and instances with no damage or casualties. Eighty percent of SARs in the Bay occurred between May and October of 1985. A few storm-related cases led to SAR caseload increases in September and November as compared to previous years. Cases handled by Group Hampton Roads during the two fall 1985 storms included boats blown away from piers, boats sinking, and disabled boats. Most months of 1985 had overall increases in SAR at Group Baltimore. The dry and warm conditions that prevailed during the spring and summer of 1985 may have contributed to increased boating activity and subsequent increases in SAR activity. Nevertheless, at Group Hampton Roads, the total number of SAR cases was slightly lower for 1985 than 1984.

## 5.2 State Park Activity Levels

Attendance and revenue for selected Maryland and Virginia state parks are displayed in Figures 13, 14, and 15. Most of the parks showed attendance increases during periods of warm weather in the spring, especially on weekends (except at Sandy Point State Park, Maryland and Westmoreland State Park, Virginia). Westmoreland and York River State Park, Virginia, had increases in attendance during the summer, and Seashore State Park,

Table 16 - Maryland accident statistics, recreational boating, 1970-1985.

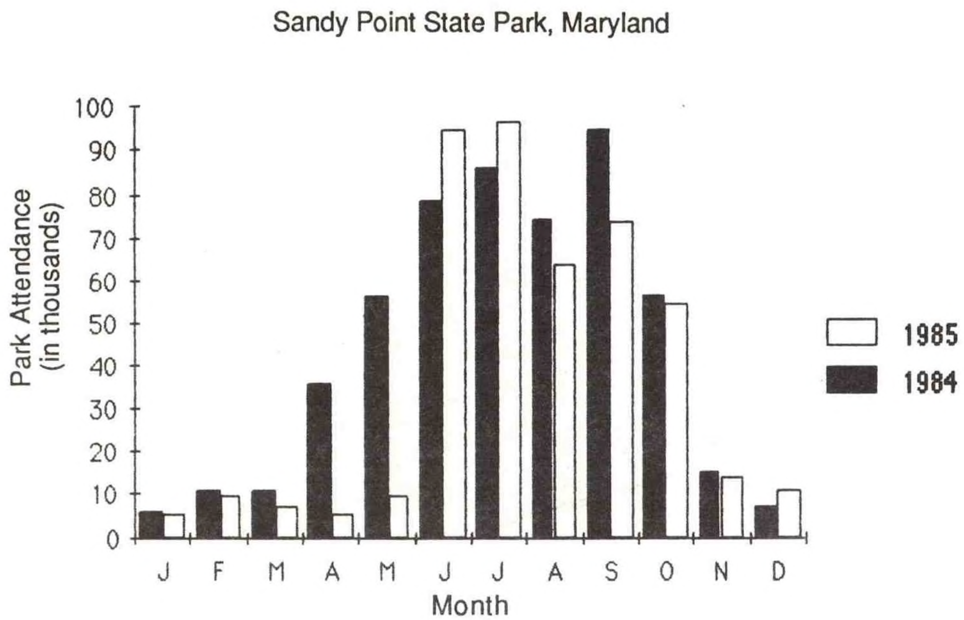
| Year | No. of boating accidents | No. of injuries | No. of deaths | Property damage (thousand dollars) |
|---|---|---|---|---|
| 1970 | 188 | 26 | 54 | 258 |
| 1971 | 198 | 26 | 58 | 763 |
| 1972 | 189 | 40 | 40 | 295 |
| 1973 | 210 | 62 | 42 | 503 |
| 1974 | 211 | 69 | 47 | 440 |
| 1975 | 177 | 55 | 17 | 631 |
| 1976 | 223 | 27 | 31 | 528 |
| 1977 | 218 | 30 | 19 | 626 |
| 1978 | 195 | 44 | 33 | 398 |
| 1979 | 224 | 84 | 38 | 781 |
| 1980 | 234 | 79 | 27 | 830 |
| 1981 | 224 | 74 | 27 | 427 |
| 1982 | 211 | 105 | 23 | 681 |
| 1983 | 220 | 53 | 27 | 371 |
| 1984 | 233 | 62 | 25 | 801 |
| 1985 | 227 | 88 | 18 | 757 |

Data are from Maryland Department of Natural Resources Marine Police and apply to recreational boating from Potomac River to Virginia shoreline.

Table 17 - Search and rescue operations U.S. Coast Guard, 1983-1985.

| Month | Group Baltimore | | | Group Eastern Shore | | | Group Hampton Roads | | |
|---|---|---|---|---|---|---|---|---|---|
| | 1985 | 1984 | 1983 | 1985 | 1984 | 1983 | 1985 | 1984 | 1983 |
| January | 16 | 14 | 10 | 3 | 1 | 3 | 23 | 29 | 26 |
| February | 18 | 16 | 9 | 6 | 1 | 3 | 27 | 31 | 15 |
| March | 36 | 18 | 18 | 6 | 2 | 4 | 36 | 36 | 36 |
| April | 100 | 66 | 68 | 7 | 2 | 2 | 88 | 57 | 72 |
| May | 215 | 127 | 132 | 17 | 12 | 9 | 144 | 209 | 156 |
| June | 167 | 215 | 139 | 30 | 10 | 25 | 176 | 210 | 240 |
| July | 286 | 216 | 288 | 35 | 20 | 35 | 184 | 239 | 330 |
| August | 312 | 203 | 156 | 36 | 23 | 22 | 204 | 160 | 207 |
| September | 269 | 157 | 128 | 21 | 5 | 15 | 192 | 140 | 175 |
| October | 186 | 142 | 139 | 9 | 14 | 10 | 79 | 97 | 120 |
| November | 93 | 77 | 52 | 14 | 7 | 4 | 52 | 51 | 59 |
| December | 41 | 28 | 23 | 17 | 4 | 1 | 39 | 32 | 32 |
| Totals | 1,739 | 1,279 | 1,162 | 201 | 101 | 133 | 1,244 | 1,291 | 1,468 |

Data are from U. S. Coast Guard. Group Baltimore handles all of the Bay north of Smith Point including Potomac River. Group Hampton Roads handles all of the Bay south of Smith Point. Group Eastern Shore covers the eastern portion of the Bay, but rescue vessels use some of the same port facilities as the other two Groups.



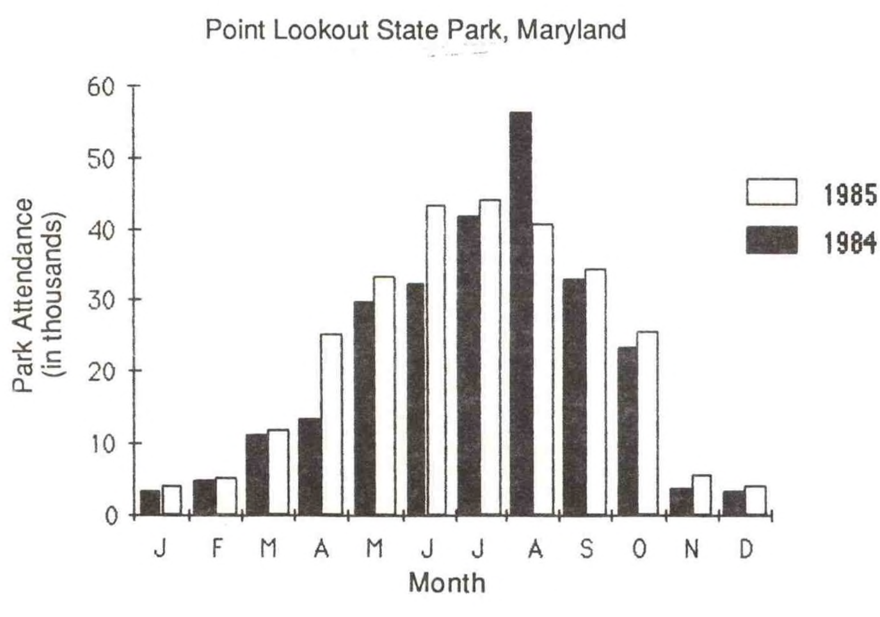
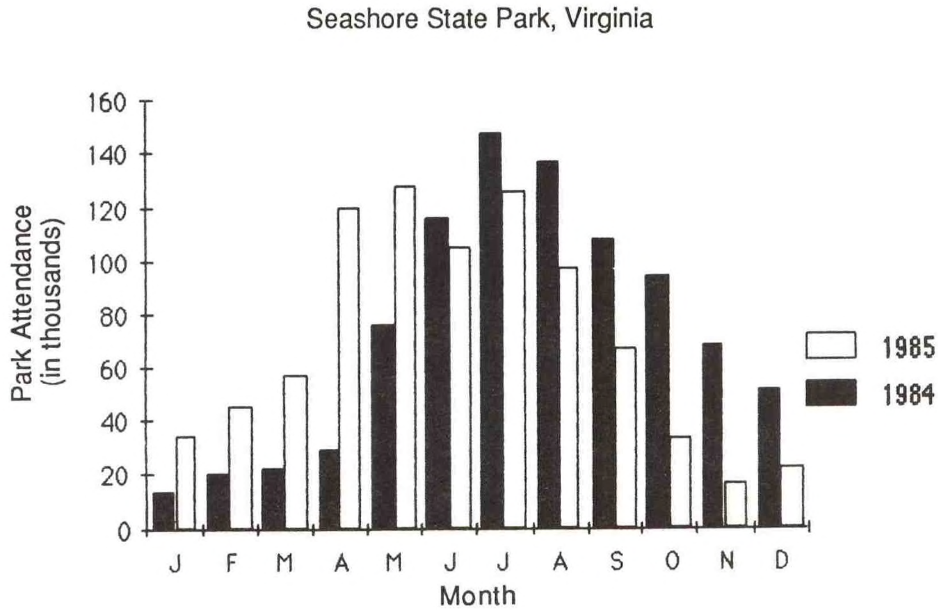




Figure 13 - Monthly 1984 and 1985 attendance at Sandy Point State Park, Maryland, and Point Lookout State Park, Maryland.



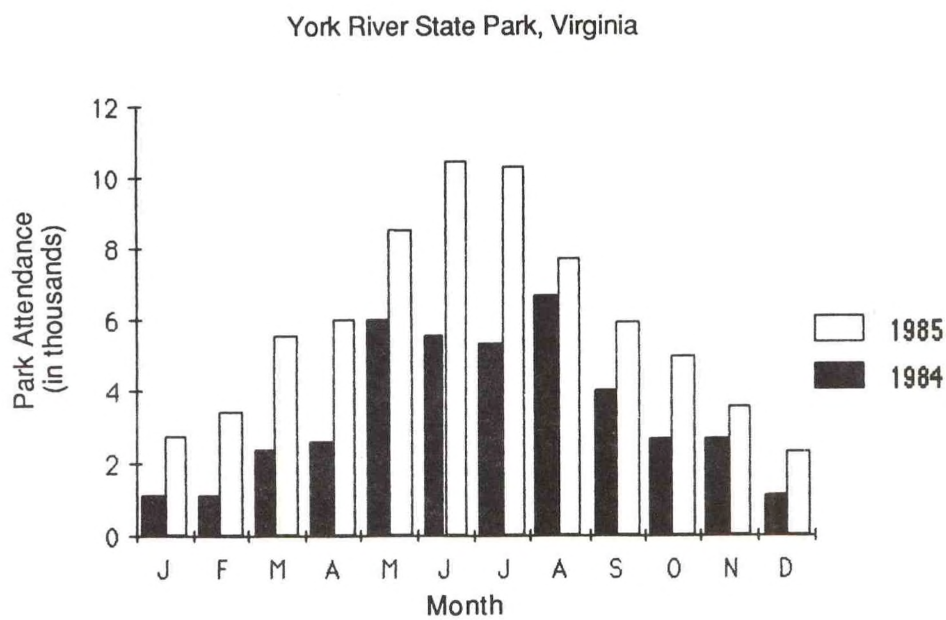




Figure 14 - Monthly 1984 and 1985 attendance at Seashore State Park, Virginia, and York River State Park, Virginia.

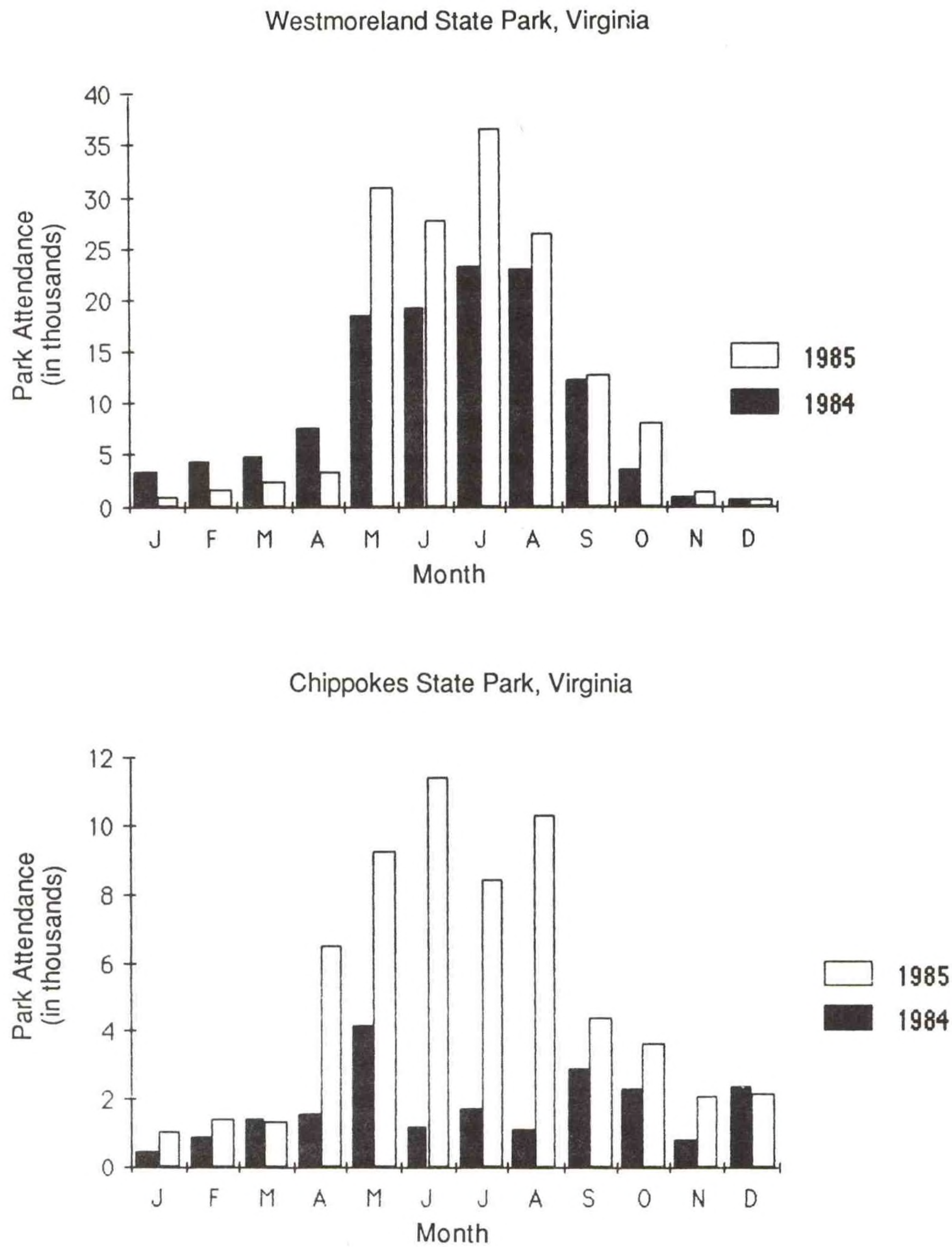



Figure 15 - Monthly 1984 and 1985 attendance at Westmoreland State Park, Virginia, and Chippokes State Park, Virginia.

Virginia, had increased attendance figures from January to May. The addition of a swimming pool contributed to the large attendance increases at Chippokes State Park, Virginia, in the summer of 1985. Although the average attendance at both Maryland and Virginia state parks increased during 1985, attendance in the late fall was low, perhaps due to fall storms.

Westmoreland experienced minor flooding, erosion, and groin wash-outs following the storm in late September, but overall attendance at Westmoreland in September showed a slight increase over 1984 levels for the month. Many people came to Westmoreland to observe storm damage, contributing to the increase in September 1985 attendance. Attendance at Seashore decreased during preparation for the fall storms. December 1985 had decreased attendance for all Virginia parks listed, except York River, which had increased attendance during each month of 1985 compared to 1984.

Sandy Point State Park, Maryland, had a decrease in fall 1985 attendance and revenue as compared to 1984. The storms were not a significant factor in this as they passed Sandy Point quickly. Some flooding resulting from hurricane Gloria occurred at Point Lookout State Park, Maryland, in late September. Attendance declined slightly as fewer campers visited the park during the month.

Overall, attendance at these selected Maryland and Virginia state parks during the winter of 1985-86 decreased compared to the 1984-85 attendance values. Monthly fluctuations in attendance may reflect variations in weather conditions, scheduling of special athletic events or inoperative census equipment.

# 6. Impact of Weather and Oceanographic Events: Transportation

Chesapeake Bay serves as an important resource in the eastern United States for both foreign and domestic transportation. Use of Chesapeake Bay by shipping companies located in Hampton Roads and Baltimore depends upon weather conditions, particularly during the winter since icing in the upper Bay delays water transportation operations.

## 6.1 Shipping and Shore-Related Activity

The ports of Baltimore and Hampton Roads account for nearly four-fifths of the export tonnage and one quarter of the import tonnage of all U.S. Atlantic ports. Each port handles an average of more than 10 ships per day. Principal cargos include exports such as coal and grain, and imports such as iron ore and petroleum. A study conducted by Booz-Allen & Hamilton, Inc., showed that, in 1980, trade through the port of Baltimore generated more than $1 billion in revenue and $52 million in state and local taxes (1980 dollars). Hampton Roads provides similar stimulus to the economy of Virginia. Table 18 shows total export and import tonnages for the two ports for recent years.

Total export tonnage in the ports of Baltimore and Hampton Roads increased from 53.3 million tons to 63.2 million tons from 1984 to 1985. This reversed the trend of the previous two years in Baltimore, where exports decreased. Imports in Baltimore, however, decreased by 1.8 million tons in 1985. Import activity increased in Hampton Roads from 7.1 to 8.3 million tons in 1985, while export volume increased 7.1 million tons over 1984.

Shipping and shore-related activities at Maryland and Virginia ports proceeded normally during the winter of 1984-1985. Although ice coverage on the Chesapeake Bay reached 20 percent, ports remained fairly accessible throughout the winter months and loading and unloading activities proceeded normally. Main shipping channels were clear of ice most of the quarter, with ice limited to the tributaries and shoreline of the upper Bay.

The port of Baltimore experienced crane shutdowns due to wind for 308 hours during 1985. Crane shutdowns due to excessive winds cost individual container-line shippers $2,500 per hour from crane delays with additional losses of $1,500 per hour from stevadore crew time (1985 dollars), crew overtime, and expenses from delayed tug boats. Based on the total downtime of 308 hours for 1985, shippers may have experienced losses of as much as of $1,232,000. Most of this lost time was during the period from January through May, when the cranes were shut down for 190 hours for winds in excess of 40 mph.

## 6.2 Effects of Ice on Transportation

Ice development in Chesapeake Bay slightly affected larger commercial ship operations into and out of the Port of Baltimore during January and February 1985. The Coast Guard imposed horsepower and steel hull restrictions from 21 January through 16 February and required vessels to proceed in convoys during the last eight days of January, when transiting the Bay north of Baltimore.

Table 18 - Export and import volume in Chesapeake Bay ports, 1981-1985 (millions of tons).

| | 1985 | 1984 | 1983 | 1982 | 1981 |
|---|---|---|---|---|---|
| **Export (Millions of Tons)** | | | | | |
| Hampton Roads | 49.3 | 42.2 | 41.0 | 66.5 | 59.8 |
| Baltimore | 13.9 | 11.1 | 12.2 | 20.8 | 21.5 |
| Total Bay Export Cargo | 63.2 | 53.3 | 53.2 | 87.3 | 81.3 |
| **Import (Millions of Tons)** | | | | | |
| Hampton Roads | 8.3 | 7.1 | 6.7 | 7.2 | 7.1 |
| Baltimore | 12.1 | 13.9 | 09.4 | 09.8 | 12.9 |
| Total Bay Import Cargo | 20.4 | 21.0 | 16.1 | 17.0 | 20.0 |

Data are from Maryland Port Administration

The abrupt drop in temperature on 20 and 21 January caused rapid formation of ice in the Bay north of Baltimore. Heaviest ice concentration was in the Tolchester Beach area, where ice thickness reached one foot. The Coast Guard responded promptly, imposing within one day (21 January) requirements of a minimum of 2500 shaft horsepower (SHP) and steel hull construction. Convoy operations commenced 24 January and lasted through 31 January. Restrictions remained in effect through 16 February. Vessels with less than 2500 SHP (mostly tugs) were permitted to operate within convoys under waiver from the Coast Guard Captain of the Port.

Ice conditions were most severe in the Tolchester Beach area adjacent to the principal Bay shipping lane. Solid ice formed in and around the mouths of the freshwater tributaries entering the Bay as far south as the Choptank River.

Ice conditions in the Potomac were not severe enough to require convoy operations, but resulted in the imposing of a minimum restriction of 1500 SHP and steel hulls being required of vessels. Large vessel operations were neither endangered by the ice nor operationally affected by the restrictions.

## 6.3 Bridge Traffic Statistics

Automobile and light commercial traffic on the Chesapeake Bay Bridge has increased every year since 1964 except from 1972-1974 where there was no change (Figure 16). Heavy commercial travel has also increased, but at a slower rate. In 1985 Bay Bridge tolls provided $18.2 million revenue to the State of Maryland. Sixty percent of the traffic occurs during the months of April through September, when tourists go to the Eastern Shore and Atlantic beaches.

Automobile and light commercial traffic over the Chesapeake Bay Bridge in 1985 was greater for all quarters (6.3 percent) over 1984 (Table 19). The second quarter showed the greatest increase, 9.0 percent over the same quarter in 1984, and the third quarter showed the least increase, 4.6 percent. Among heavy commercial traffic, the last quarter of 1985 showed the greatest increase (6.3 percent). In 1985, heavy commercial traffic increased by 5.2 percent from 1984. As in previous years, traffic volume was greatest during the third quarter and least during the first quarter for both commercial and automobile traffic. Toll revenue increased by $988,454 (5.8 percent) from 1984 to 1985 with a toll charge increase implemented on July 1, 1985.

Table 19 - Chesapeake Bay Bridge traffic volume and toll revenue, Maryland, 1984 and 1985.

| | 1984 Auto & Light Commercial | 1984 Heavy Commercial | 1984 Toll Revenue ($) | 1985 Auto & Light Commercial | 1985 Heavy Commercial | 1985 Toll Revenue ($) |
|---|---|---|---|---|---|---|
| First Quarter | 1,974,038 | 271,968 | 3,019,363 | 2,111,994 | 286,974 | 3,216,253 |
| Second Quarter | 3,144,061 | 313,709 | 4,619,537 | 3,426,141 | 324,596 | 4,961,398 |
| Third Quarter | 3,952,302 | 318,133 | 5,668,032 | 4,132,271 | 335,925 | 5,922,999 |
| Fourth Quarter | 2,609,039 | 304,801 | 3,888,228 | 2,744,286 | 324,091 | 4,082,964 |
| Total | 11,679,440 | 1,208,611 | 17,195,160 | 12,414,692 | 1,271,586 | 18,183,614 |

Data are from Maryland Highway Toll Administration.

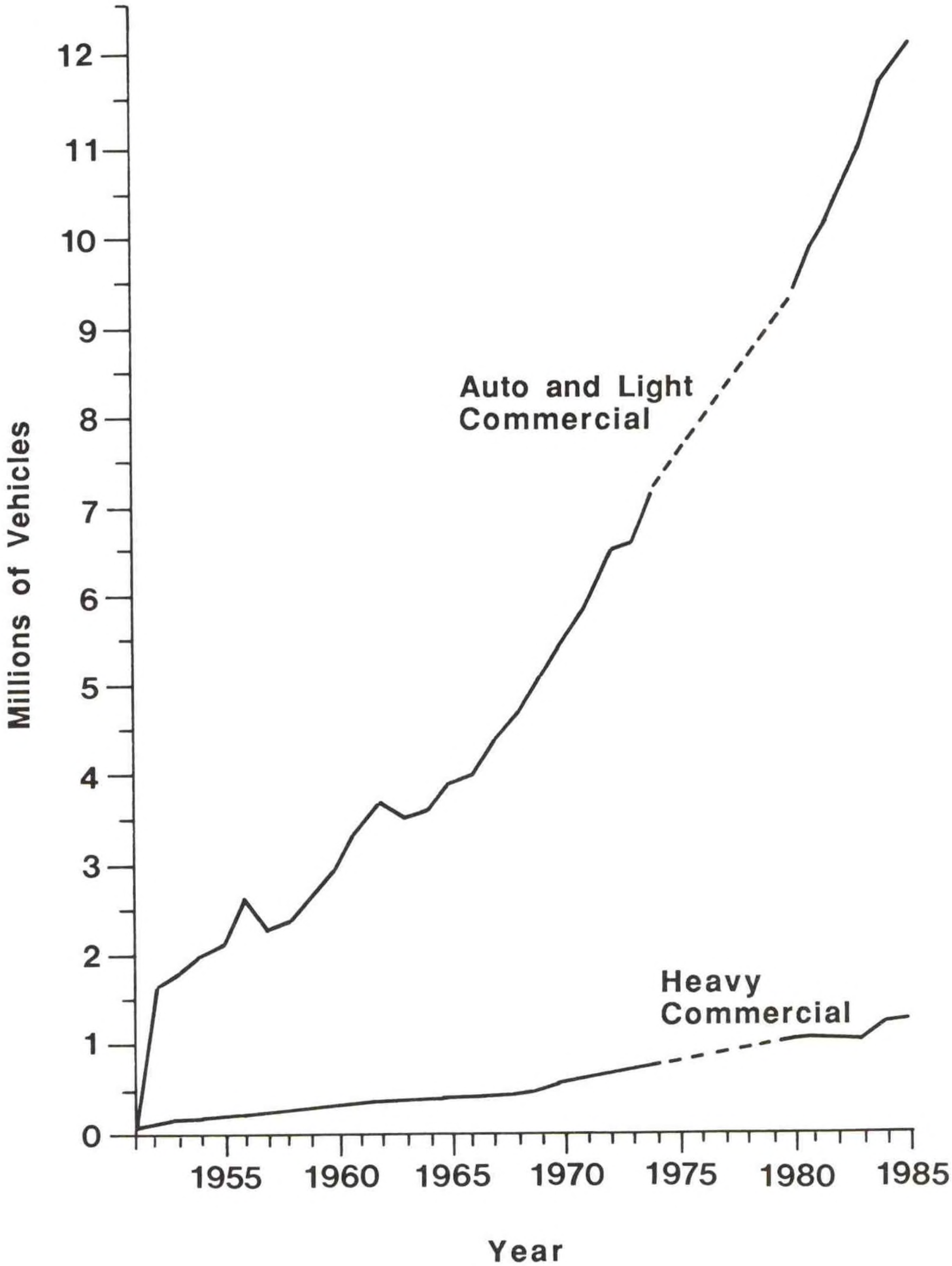



Figure 16 - Chesapeake Bay Bridge vehicle traffic 1951-1985. (Dashed line indicates data not available for years 1975-1979)

## Acknowledgments

Many organizations and individuals contributed information and guidance toward the preparation of this assessment. I would like to thank Dr. Maurice Lynch, Dr. Wayne Bell, Mr. Karl Pechmann, Mr. Glynn Rountree, Ms. Elizabeth Krome, Ms. Heidi Leiffer, Ms. Susan Myers, Ms. Pam Owens, and Ms. Tammy Rowe for their assistance on this project. The cooperation offered by the following is also particularly noteworthy:

- Cooperative Weather Station Observers
- Hampton Roads Maritime Association
- Maryland Department of the Environment
- Maryland Department of Natural Resources
  - Natural Resources Marine Police
  - Forest, Park, and Wildlife Service
  - Licensing and Consumer Services
- Maryland Highway Toll Administration
- Maryland Port Administration
- NASA/Goddard Space Flight Center
- National Oceanic and Atmospheric Administration
  - National Environmental Satellite, Data, and Information Service
  - National Marine Fisheries Service
  - National Ocean Service
  - National Weather Service
- United States Coast Guard
  - Baltimore Safety Office
  - Chesapeake Bay Groups
  - Public Affairs Office
- United States Geological Survey
- University of Maryland
  - Center for Environmental and Estuarine Studies
    - Chesapeake Biological Laboratory
- Virginia Department of Conservation and Economic Development
  - Division of State Parks
- Virginia Institute of Marine Science
- Virginia Marine Resources Commission
- Virginia Water Control Board

**Chesapeake Research Consortium, Incorporated**

P.O. Box 1120
Gloucester Point, VA 23062-1120
(804) 642-7150
7153

*The Johns Hopkins University*
*University of Maryland*
*Smithsonian Institution*
*Virginia Institute of Marine Science*

Chesapeake Research Consortium, Inc.
P.O. Box 1120
Gloucester Point, VA 23062-1120



CRC CHESAPEAKE RESEARCH CONSORTIUM