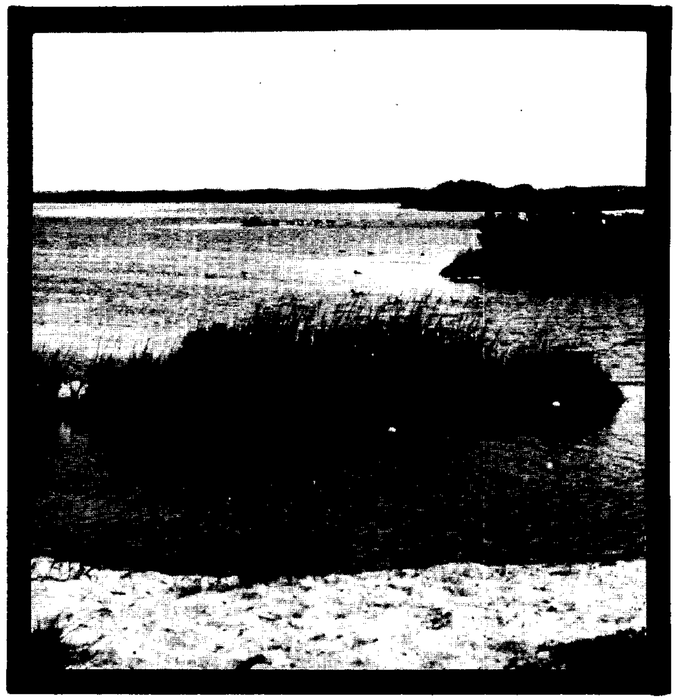
Marine Environmental Assessment
CHESAPEAKE BAY
ANNUAL SUMMARY 1984



U.S. DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
National Environmental Satellite, Data, and Information Service
Assessment and Information Services Center

E IMPACT ASSESSMENT
STATES

The AISC/Marine Environmental Assessment Division (MEAD), Marine Assessment Branch (MAB), produces periodic assessments of weather impacts on economic sectors of marine environmental activity. The Chesapeake Bay region served as a prototype for assessment development. From September 1981 through March 1982, MAB issued monthly assessments of Chesapeake Bay in the economic sectors of fisheries, recreation, and transportation. We now issue quarterly assessments in order to extend the service to other marine areas within existing resource limitations. Once each year we publish an Annual Summary giving a longer-term perspective of the impacts for the calendar year.

Please send any comments or subscription queries to the Chief, Marine Assessment Branch, Marine Environmental Assessment Division, NOAA/NESDIS/AISC, E/AI32, 3300 Whitehaven Street, NW, Washington, DC 20235, or call (202) 634-7379.

Front Cover Photographs

Wave Damaged Coastline - Star News Photo by J. Nesbitt
Beach Scene - EPA Documerica - Hope Alexander
Salt Marsh - NOAA File Photo
Catch on Fishing Boat - NOAA Photo by M. Dowgiallo

Marine Environmental Assessment
CHESAPEAKE BAY
ANNUAL SUMMARY 1984

by Michael J. Dowgiallo
Martin C. Predoehl
Sylvia Z. Green
David F. Johnson
Robert E. Dennis

Marine Assessment Branch
Marine Environmental Assessment Division

Washington, D.C.
August, 1985

U.S. DEPARTMENT OF COMMERCE
Malcolm Baldrige, Secretary

National Oceanic and Atmospheric Administration
Anthony J. Calio, Deputy Administrator

National Environmental Satellite, Data, and Information Service
William E. Bishop, Acting Assistant Administrator

Assessment and Information Services Center
Joan C. Hock, Director

Chesapeake Bay Marine Environment - 1984 Annual Summary

Table of Contents

List of Figures

List of Figures (continued)

List of Tables

List of Tables (continued)

1. Introduction

The Chesapeake Bay 1984 Annual Summary presents a synoptic view of several economic sectors and their direct and indirect relations to the physical and biological marine and atmospheric environment. The economic sectors are not independent, nor are the environmental processes.

Using research results of scientists in the fields of physical oceanography, marine biology, meteorology, political science, and economics, the Marine Assessment Branch (MAB), Marine Environmental Assessment Division (MEAD), the Assessment and Information Services Center (AISC) has attempted to give a multidisciplinary view of the Bay. Assessment is an integrative approach to a system. Data appear without bias. Only confirmable relationships are presented as correlations.

Relationships may appear between variables in one sector and those in another sector (e.g., transportation and fisheries), but, on the whole, relationships between different sectors are not precise. Interactions among different sectors must exist since heavy multi-purpose use of the Bay contributes to the cost of operation, maintenance, safety, and clean-up in each sector. Even where direct relationships are unclear, the presentation of data from several scientific and economic areas has value by displaying the multiple use of the Bay system.

Presenting the collection of data here, we intend to stimulate further investigation by scientists and provide information to those persons responsible for usage regulations of the Bay.

1.1 Organization of the Report

The report comprises seven sectors. In the introductory section we delineate the concept of marine environmental assessment embodied in this report, specify the coverage of the present report, and suggest extensions and future development for the assessment function.

In section 2 we present a summary of impacts identified for 1984. Only confirmed relationships appear as impacts.

Sections 3-7 contain details of the weather and oceanography, fisheries, recreation, transportation and safety sectors, and pollution events of the Chesapeake Bay marine environment for 1984. Discussions in these sections cover all information available to the Marine Assessment Branch at this time but are neither exhaustive nor definitive. The review gives a limited synoptic view of several sectors and their relationships for a single year.

1.2 Scope of the Report

The geographical area considered in the annual assessment includes the Chespeake Bay and all tributaries in the drainage basin contributing to the Bay waters. We present a summary of weather and oceanographic events during 1984 over the region. Coverage is only for the calendar year 1984, though regional environmental cycles in the Bay are from December through November. The calendar year serves the assessment function in tracking economic variables. Where discussion of environmental patterns or events requires reference to 1983 or to 1985 we extend coverage at those specific instances.

Four economic sectors appear in this report: fisheries, recreation, transportation and industry. The fisheries section covers finfish, shellfish, diseases, and predators. Distribution and abundance of species depends strongly on salinity and temperature and to general coastal conditions over a broader span of space and time. Harvest of the commerical species varies with climate conditions, fishing effort, and market conditions. Pollution and transportation sectors affect distribution of the fisheries species as well as harvest activity.

Recreation includes park usage, boating, Cheaspeake Bay Bridge traffic, and recreational accident statistics. The recreational sector responds quickly to weather variations, but also correlates with pollution incidents and the presence of annoying or dangerous organisms in the water. The Bay is used heavily for recreation including swimming, boating, fishing, and tourism.

Transportation includes shipping, navigational aids, dredging, ice clearing, and related shore activity. Through most months of the year shipping and related shore activities remain unaffected by climate. During winter, however, icebreaking requires resources to keep the Port of Baltimore operating.

Industry in this report appears only as specific events such as spills of oil and hazardous substances and sewage disposal discharge. The Bay and tributaries form a large resource for waste disposal for surrounding industry and populations. Heavy use of the Bay for transportation leads to spills of cargo substances, some harmless, others potentially harmful.

2. Impact Summary

Economic sectors in the Bay area responded to anomalies in temperature and precipitation in 1984 as seen in the wet and cool spring and summer. High rainfall reduced salinities for extended periods in 1984 until the fall period when conditions returned to normal. Soft shell clam landings were greatly reduced because of harvesting restrictions imposed in Maryland following a period of low salinities which stressed clam populations. Low salinities also affected oyster populations and altered other species distributions. Bay recreation was affected by the cool and wet spring.

Table 1 summarizes impact of environmental events in 1984 by economic sector.

Fisheries

Ice cover disrupted finfish and shellfish harvest activities in late December through January in tributaries and portions of the Upper Bay. The intensity of cold and rapid onset of icing in late December made conditions hazardous for fishing boats and denied watermen access to oyster grounds in many areas of the Upper Bay. Ice also caused damage to wooden-hulled boats, docks, and fishing gear.

Unusually cold water temperatures observed in winter 1983-84 increased the mortality rate of juvenile summer flounder in the York River, coinciding with the peak infection period of a blood parasite. Extensive cold water mortalities of young-of-the-year croaker occurred in Virginia rivers, indicating the loss of most, or all, of the 1983 year class.

Lower-than-normal water temperatures delayed blue crab catches during the spring quarter, reducing availability to consumers and increasing prices, though prices were lower than the record high prices in spring 1983. Cool water temperatures also delayed the summer arrival of stinging nettles.

Heavy rainfall in March and April greatly reduced salinities Bay-wide, reducing the range of suitable conditions for oysters in upper portions of Bay tributaries and the Upper Bay. Higher-than-average oyster mortalities occurred in the James River in Virginia following the heavy freshwater influx during March and April.

Soft shell clam beds in the northern Bay were closed to harvesting by the state of Maryland from July 30 to August 29. Low salinities in spring and summer weakened clams, causing clam mortalities and rapid deterioration once taken out of the water. The reduced clam landings represent a possible loss of over $0.9 million to the Maryland economy.

Blue crabs were in sporadic supply over most of the summer 1984 quarter. High rainfall and lowered salinities may have altered normal crab distributions as seen in the sporadic catches reported by watermen.

High runoff and low salinities provided unfavorable conditions for the survival of oyster young during summer 1984.

Unusually warm air temperature in October through mid-November provided favorable conditions for finfish and shellfish harvest activities. Winds

Table 1.--Environmental impact summary, Chesapeake Bay, 1984.

	Finfish harvest activities	Shellfish harvest activities	Juvenile summer flounder, croaker	Oyster populations	Blue crab harvest	Stinging nettles	Soft shell clam harvest	Fishing nets	Boat hulls	Docks	Boating	State park attendance	Swimming	Fishing piers	Marina (structural)	Port operations	Cost to shippers	Navigational aids	Tug and barge traffic	Safety
Below-normal water temp., Jan.			-																	
Ice cover, Jan.	-	-						-	-	-	-			-				-	-	-
Above-normal air temp., Feb.											+	+								
High rainfall, Mar., Apr.				-																
High streamflow				-																
Low salinity, Mar., Apr.					-	-	-													
Below-normal water temp, Mar-May						-	-													
Below-normal air temp., Mar-May											-	-								
High winds (March storm)															-					
High rainfall, July				-		-	-													
High streamflow, Jun-Aug.				-			-													
Low salinity, Jun.-Aug.				-	-		-													
Below-normal air temp., Jul.											-	-								
Low numbers stinging nettles													+							
Above-normal air temp. Oct-Nov.	+	+									+	+								
Low dissolved oxygen (late summ)				-																
Above-normal water temp., Nov.					+						+									
Winds in excess of 40 mph																-	+			
Above-normal water temp., Dec.	+	+																		
Above-normal air temp., Dec.	+	+			+						+	+								

[+] Favorable

[-] Unfavorable

[ ] No identifiable effect, data unavailable, or not applicable

associated with a storm prevented watermen from going out for several days in late November.

Oysters remained scarce in Maryland in the fall 1984 oyster season, leading to intense fishing pressure in remaining productive areas. Oyster prices held at record high levels and quality of meats was good. Anoxic conditions in the Bay spread into shallower depths in 1984, causing mortalities in some oyster beds.

Above-normal water temperatures kept crabbing activity high through the end of November.

Though striped bass landings showed improvements over the record low landings in 1983, landings remained extremely low as striped bass have shown a steady decline in recent years. Increased fishing pressure and the fair success of the 1982 striped bass year class contributed to the improved landings.

Return to seasonally normal salinity structures throughout the Bay in fall 1984 contributed to a return to normal distribution patterns for species inhabiting the Bay. Bay stations had shown well-below-normal salinities throughout spring and summer 1984 following record streamflow levels.

Unusually warm temperatures in December provided favorable conditions for finfish and shellfish harvesting. The above-normal water temperatures had no detectable effect on crab dredging. Crabs were abundant in the lower Bay in December, and watermen received low prices for their catch. Crabs from southern states contributed to the December glut in Virginia crab market.

Recreation

State park attendance during unusually warm February weather was higher than during the comparable period in February 1983. Ice caused extensive damage to fishing piers at Hart-Miller Island, MD.

State park usage and boating activity were reduced during periods of high rainfall and cooler-than-normal temperatures during spring 1984.

High winds associated with a severe March storm caused some structural damage to a marina in the Upper Bay area.

Marine recreation showed reduced activity during extended period of rainfall in July and August. Park attendance and boating figures were below 1983 levels in all three months in the lower Bay, while July figures were lower than 1983 Baywide.

Stinging nettles appeared later than normal and were present in very low numbers during summer 1984 in areas of the Maryland portion of Chesapeake Bay, where they normally proliferate in summer months.

Unusually warm weather in October was favorable for recreation in the Bay area. Both park usage and boating activity showed increases over October 1983.

Park usage and boating showed increased activity during periods of warm weather in December, especially on weekends.

Transportation

Large vessel traffic and port operations proceeded uninterrupted by ice cover during winter 1983-84, with main shipping channels open at all times. Ice caused $200,000 worth of damage to navagational aids in the Middle and Upper Bay. One tugboat was sunk after colliding with an ice floe on January 8 on the Potomac River.

Winds in excess of 40 mph shut down crane operations in 1984 34 times resulting in 109 hours lost productive time at the Port of Baltimore. Most of the lost time was during the period February through May when cranes were shut down for 82 hours.

3. Weather and Oceanography

The Chesapeake region (Figure 1) began 1984 with well below-normal precipitation totals in January. However, during the next four months most stations exceeded normal rainfall totals. Several stations in the lower Bay region experienced more than twice normal monthly precipitation. June was near normal in the northern part of the region but drier-than-normal for the southern stations. September was a very dry month over the region with most stations exhibiting drought conditions. December again brought drought conditions to many stations following a normal October and November (Table 2).

Temperatures over the region were normal or slightly above normal during most of the year (April through September). The early months and late months of the year were quite different from normal temperature. In January, the area experienced record cold temperatures for much of the month, followed by extreme, unseasonal warming during the last week of the month. Monthly average values give an inaccurate indication of the real temperature regime for this month. During February the unusual warmth remained, with the region averaging more than six degrees above normal. In March, cooler-than-normal temperatures returned with the area registering almost five degrees below normal for that month. The mean area temperature for February was actually warmer than the area average for March, a very unusual occurence. Following the nearly normal summer months, October showed a mean area temperature nearly five degrees above normal and December was more than seven degrees above normal (Table 3).

3.1 Summary of Events

January was stormy and cold for much of the region. Colder-than-normal temperatures which began in late December continued into most of January. A snowstorm giving Baltimore and Aberdeen five inches of snow set the stage for a rapid decline in surface air temperatures. Most stations experienced daily record low temperatures on the 22nd. The 18 degrees Fahrenheit below zero at Chantilly on the 22nd is the coldest January temperature of record for that station. After the 22nd temperatures rose quickly following a frontal wave from the southwest.

Weather at the eleven Bay stations was springlike in February. Temperatures averaged more than six degrees above normal and the precipitation for the area was more than 40 percent above normal. Norfolk experienced an unusual five-inch snowfall on the 5th. Strong wind occurred frequently during this month.

March 1984 weather was dominated by numerous cyclonic systems striking the Chesapeake Bay region. Precipitation was well above normal (+64%) and temperatures well below normal (-4.7°) for the region. A strong storm near the end of March brought over a foot of snow in Pennsylvania and 70 mph winds damaged boats, homes, and trees in the northern end of the Chesapeake Bay.

April weather was dominated by cyclonic activity on a regional scale but with fewer storms than March. Precipitation was well above seasonal norms (47%); temperatures were close to normal expected values (-1.9).

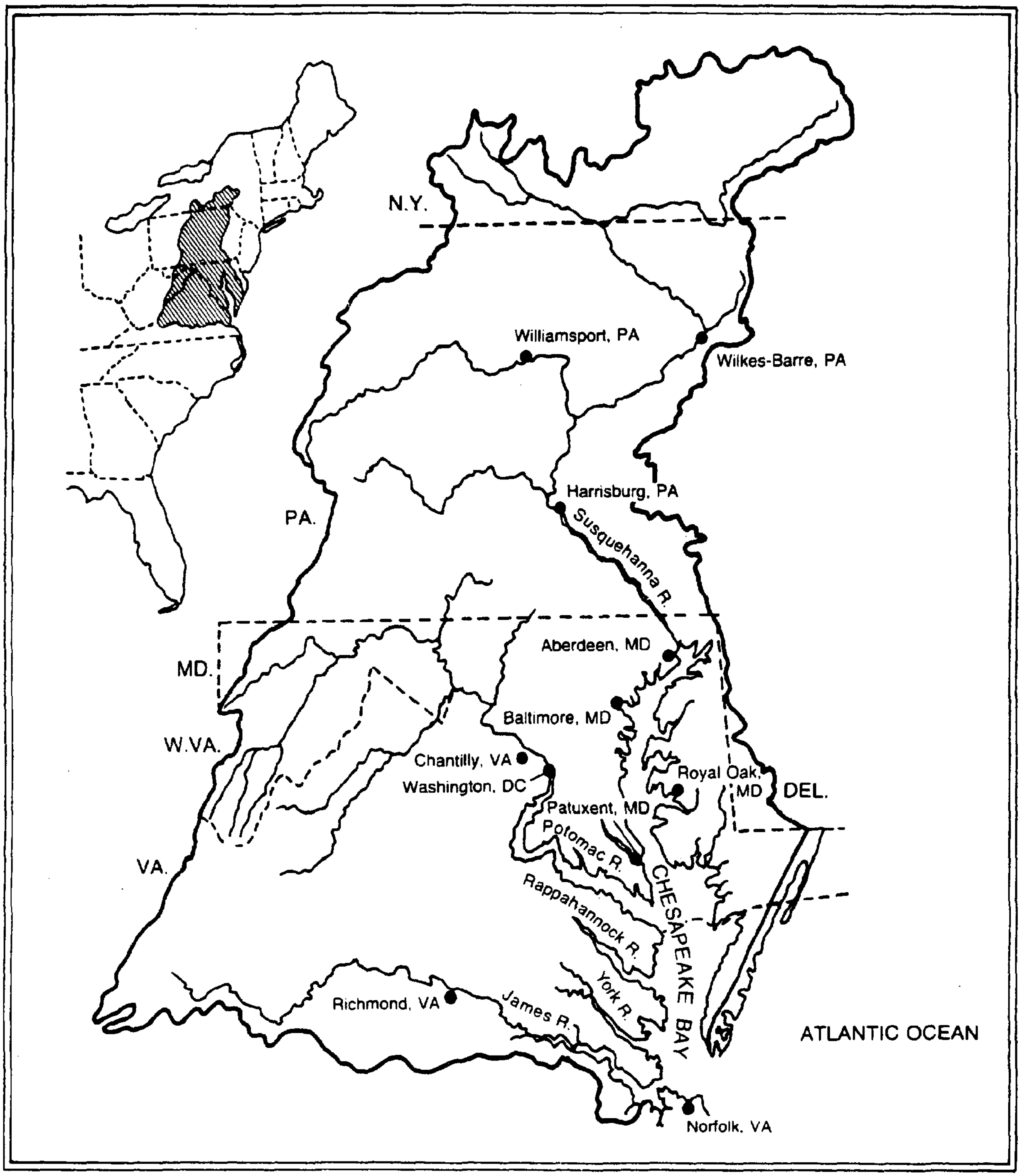


Figure 1. Selected meteorological stations, Chesapeake Bay watershed (Modified EPA map).

Table 2.--Normal monthly mean total precipitation (1951-1980) and 1984 departure from normal, selected stations, Chesapeake Bay region.

A. Normal monthly total precipitation (inches)

Station	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Annual 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	35.08
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, 1984 (percent)

Station	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Annual total
Williamsport, PA	-62	71	-1	-30	34	33	64	10	-83	-14	31	-28	17
Wilkes-Barre, PA	-51	42	-8	36	112	39	51	19	-60	-17	-12	-7	23
Harrisburg, PA	-62	60	53	40	67	75	13	-11	-59	-27	17	-29	24
Aberdeen, MD	-61	42	3	10	44	-12	1	-62	-54	32	-12	-46	35
Baltimore, MD	-35	31	56	-12	25	-56	-16	-11	-31	-38	-3	-50	22
Washington, DC	-38	31	77	27	9	-32	-2	-48	-2	10	30	-63	33
Chantilly, VA	-50	56	69	60	17	-48	-34	157	-54	-13	22	-62	14
Royal Oak, MD	-29	17	80	29	105	8	8	-48	-61	-16	-12	-63	32
Patuxent, MD	11	55	96	70	198	-49	-21	3	-53	84	19	-52	44
Richmond, VA	23	27	142	104	27	-44	-31	-9	-47	-43	2	-55	-1
Norfolk, VA	-26	42	32	153	66	-57	49	-58	-56	-83	-7	-30	9
Average departure for region	-38	22	51	139	24	46	-69	-38	-21	37	52	107	23

Table 3.--Normal monthly mean air temperature (1951-1980) and 1984 departure from normal, selected stations, Chesapeake Bay region.

A. Normal monthly air temperature (Deg. F)

Station	Month												
	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, 1984 (Deg. F)

Station	Month												
	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Annual average
Williamsport, PA	-5.2	6.5	-7.2	-2.2	-3.7	0.4	-1.9	1.1	-3.3	4.4	-1.1	5.0	-0.6
Wilkes-Barre, PA	-2.2	9.1	-5.2	0.0	-1.1	1.9	-0.2	2.6	-1.1	6.3	-0.1	7.6	0.6
Harrisburg, PA	-4.6	5.2	-6.9	-4.2	-3.8	1.7	1.5	1.5	-2.5	6.5	0.0	8.2	-0.6
Aberdeen, MD	-5.2	6.7	-3.2	0.4	-1.7	0.0	-1.9	0.7	-2.5	4.9	0.0	9.8	0.9
Baltimore, MD	-4.2	7.0	-5.1	-2.5	-2.1	1.2	-2.9	-0.6	-4.1	5.3	-2.4	7.6	0.2
Washington, DC	-3.0	6.3	-4.0	-1.8	-1.1	2.3	-2.4	0.1	-2.9	5.9	-2.4	6.7	0.9
Chantilly, VA	-5.6	5.3	-4.9	-2.4	-2.6	0.6	-3.5	-0.1	-4.7	6.5	-2.2	8.2	-0.5
Royal Oak, MD	-4.8	6.0	-4.0	-2.1	-0.6	1.2	-2.2	0.3	-2.8	5.5	-1.4	7.2	0.4
Patuxent, MD	-4.7	4.7	-4.2	-1.1	-0.5	1.9	-2.1	0.2	-2.3	4.5	-2.1	6.8	1.0
Richmond, VA	-4.0	5.6	-3.6	-2.1	-0.7	4.2	-1.8	0.2	-2.7	7.5	-2.3	7.8	0.2
Norfolk, VA	-4.4	5.6	-3.1	-2.6	-1.4	1.9	-1.7	0.7	-1.7	5.6	-2.0	7.4	0.1
Average departure for region	2.2	1.2	2.9	-2.4	-1.8	-0.3	1.2	1.7	0.3	0.0	0.9	-3.0	0.2

May weather records are dominated by three storms, two early in the month and a major storm at the end of the month. Precipitation totals were well above normal (+64%) for the fourth successive month. Temperatures averaged two degrees below normal. A tornado caused minor damage in Kent County on the eighth. June weather was mild. A warm front and cold front in quick successsion on the 24th, brought more than an inch of rain to Aberdeen. Precipitation during June divided into two sub-areas. The three Pennsylvania stations in Table 2 were above normal (49 percent) by amounts ranging from 1.27 inches at Williamsport to 2.73 inches at Harrisburg. The remaining eight stations except Royal Oak averaged 43 percent below normal. Temperatures for the month averaged slightly above normal for the region.

July weather was again mild with only occasional thunderstorm activity. Precipitation was almost exactly normal and temperatures were slightly cooler than normal.

August followed much the same pattern of mild summer weather with almost exactly normal temperatures and rainfall over the region, although Washington, DC, Royal Oak, and Norfolk each experienced a very dry month.

The fall quarter began with stations having approximately normal cumulative precipitation through the preceding eight months. During September the entire region experienced a distinct shortage of rain with most stations recording deficits greater than 50 percent of normal, despite Hurricane Diana pushing a warm front over the region with locally heavy rains, three large deep cold air masses covered the area setting seasonal daily low temperature records and bringing the extreme dryness. The area averaged nearly three degrees below normal temperature and 53 percent below normal precipitation during a cold and dry September.

The weather of October was very warm for the season while remaining overall quite dry for the area. The frontal low following Tropical Storm Isidore on the 2nd and cold fronts on the 23rd and 29th brought most of the October precipitation, especially the slow-moving front on the 23rd. Total precipitation over the area was slightly below normal (average -16 percent) but the stations individually exhibited some spectacular departures between -83 percent (Norfolk) and +84 percent (Patuxent).

Weather during the month was seasonally cool but for much of the period drier than normal. Only after near record rainfall late in the month associated with a cold front did precipitation totals approach or exceed normal November totals. Temperatures at most stations were more than a degree below normal for this time of year. A series of cold fronts passed through the region as is normal for the mid-fall regime.

Bitter cold weather during the second half of December caused early ice formation on Chesapeake Bay, topping off a month of frequent strong winds and heavy rains. Precipitation averaged 6.73 inches for the 11 stations, 107 percent above the area normal of 3.26 inches. Monthly temperatures averaged 3.0 degrees below normal for the region.

3.2 Streamflow

The freshwater flow into the Chesapeake Bay during 1984 was below normal for the months of January, October, and November; near normal in March and September; and far in excess of normal for the remaining seven months of the year (Figures 2 and 3, Table 4). This pattern of heavy runoff brought the total streamflow for the year to the fourth highest total on record with a cumulative excess flow of more than five trillion gallons. The flow in February was the greatest on record, and more than twice the average value. April flow of 251,000 cubic feet per second was the second highest on record for that month. Summer of 1984 was one of the wettest summer seasons in the Chesapeake region and a period of excess runoff into the Bay estuarine system.

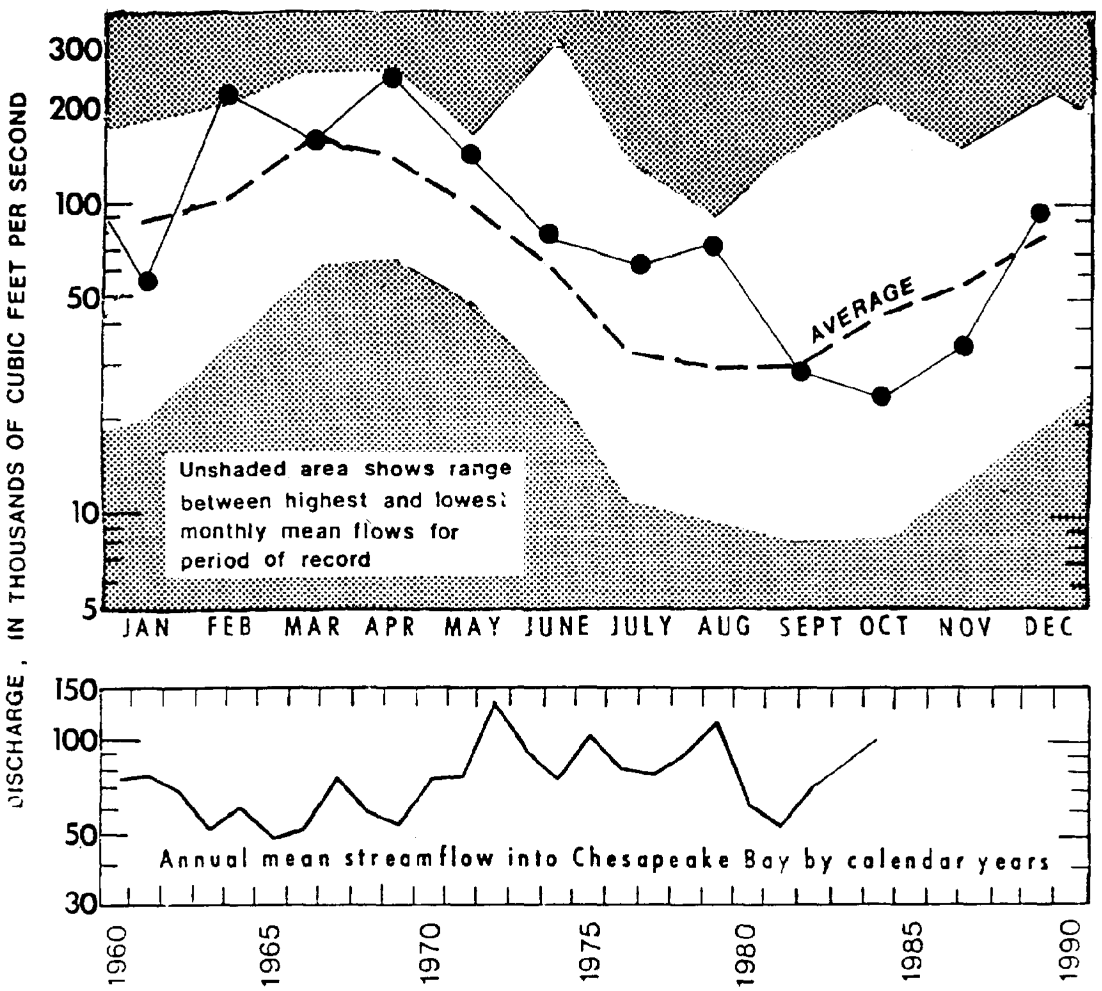


Figure 2.--Monthly mean streamflow into Chesapeake Bay, 1984. Streamflow for 1984 exceeded normal in seven months with record flow in February and near record flow in April. The total flow for the year averaged 99,700 cubic feet per second, the fourth highest flow on record.

Table 4.--Monthly streamflow, Chesapeake Bay sections, 1983-84 (data from U.S. Geological Survey).

YEAR	MONTH	Cubic feet per second at section A	B	C	D	E
1983	January	19,900	24,500	31,000	34,100	39,500
	February	46,800	53,200	73,200	83,600	100,800
	March	53,500	61,200	93,000	106,200	128,500
	April	129,000	144,000	202,000	224,000	264,000
	May	82,900	94,300	125,000	134,000	149,000
	June	32,600	38,100	53,000	57,200	64,400
	July	18,000	22,500	28,300	30,000	33,300
	August	7,400	10,600	14,200	15,100	16,900
	September	4,840	7,450	10,500	11,300	13,000
	October	7,240	10,500	18,000	21,200	26,800
	November	22,600	27,300	40,700	46,100	55,100
	December	89,600	101,000	134,000	146,000	167,000
	Mean	42,900	49,600	68,600	75,700	88,200
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	27,000	33,200
	December	53,400	61,100	77,300	82,900	92,300
	Mean	48,800	56,200	77,500	85,700	99,700

Key to sections in Table 4

Cumulative Inflow to Chesapeake Bay at Indicated Dashed Lines:

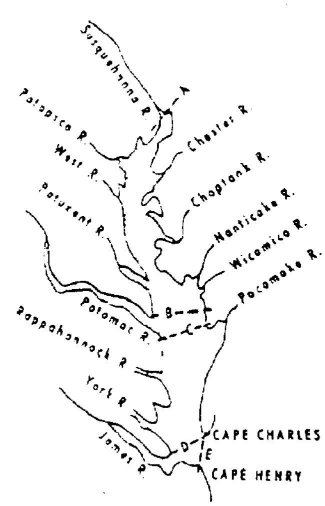
A Mouth of Susquehanna R.

B Above mouth of Potomac R.

C Below mouth of Potomac R.

D Above mouth of James R.

E Mouth of Chesapeake Bay



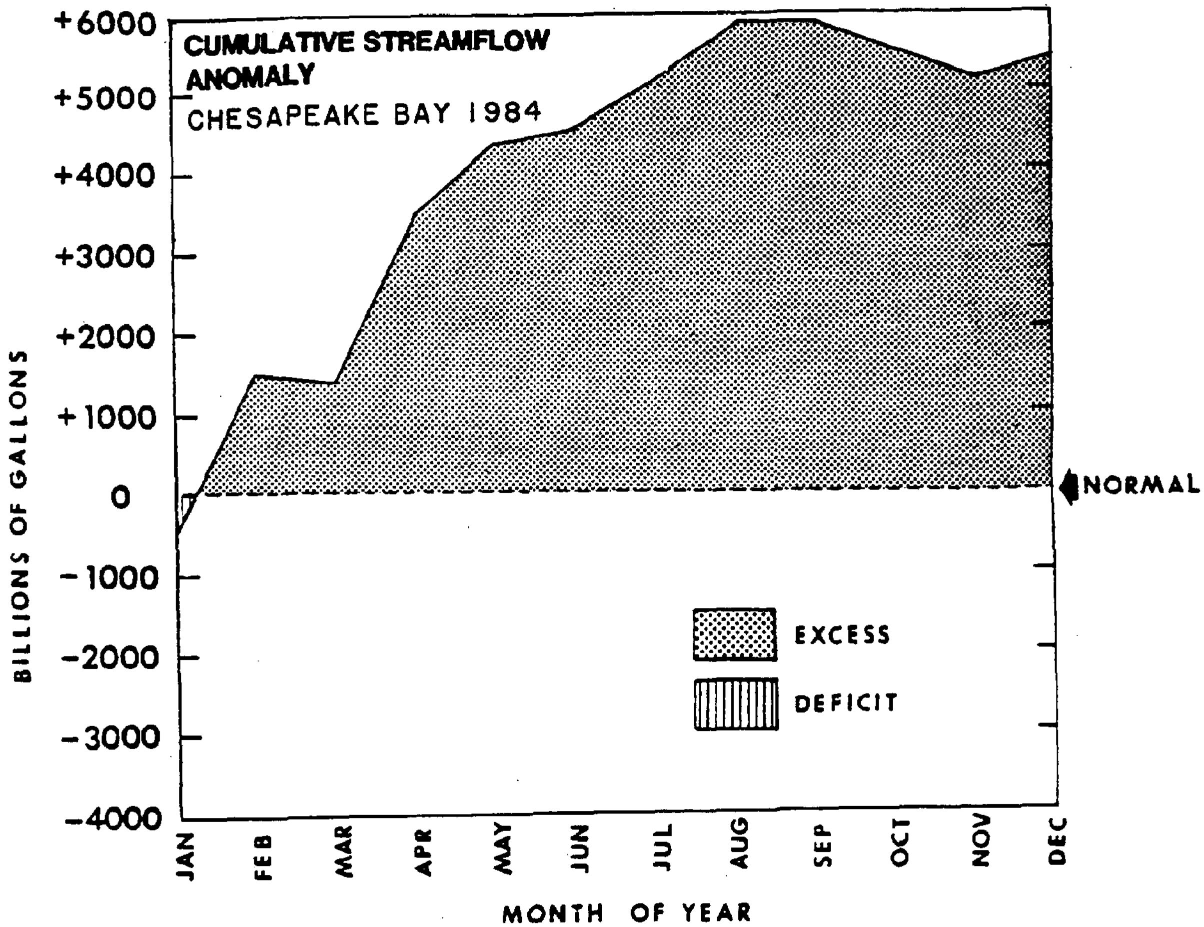


Figure 3.--Cumulative monthly streamflow into Chesapeake Bay, 1984. Cumulative flow into the Bay in 1984 began lower than normal following low January streamflow. The record flow in February brought the cumulative total above average and the excess flow in April through September brought the yearly total to nearly six trillion gallons in excess of normal. Lower than normal flow in October and November slightly reduced the excess and the December flow brought the final tally to near 5.5 trillion gallons above normal.

3.3 Surface Water Salinity and Temperature

Bay salinity and temperature vary together under the influence of freshwater inflow, sea water, air temperatures, and solar radiation. Bay salinities range from near oceanic (30.0 ppt) at the mouth to brackish at the head of the Bay. During 1984 salinities were overall lower than normal. Temperatures exhibited much variability during the year.

The National Ocean Service (NOS) maintains daily surface water salinity and temperature measurements at selected stations (Figure 4) along the U.S. Coast. Table 5 gives mean monthly values of salinity and temperature computed in accordance with NOS instructions at five NOS stations on Chesapeake Bay.

Salinity:

Bay salinities followed the normal annual cycle during 1984 but with all stations showing lower-than-normal values during the months February through October. Values started the year lower than normal due to large amounts of precipitation and runoff during December 1983. During March, 1984 the uppermost and southernmost stations, Baltimore and Chesapeake Bay Bridge Tunnel, achieved near-normal readings of salinity following the lower-than-normal runoff of that month. However, near-record streamflow into the Bay during April 1984 plunged salinity values far lower than normal and kept them there throughout the summer and early fall. May values at Kiptopeke averaged 6.7 parts thousand below normal. By December all station salinity averages had returned to near normal.

The comparisons shown in Figure 6 illustrate the isohaline in the Bay for Mays of recent years. The patterns show salinity in the central and lower portions of the Bay were lower in 1983 and 1984 than in previous years. The lower salinities were a response to an extremely large influx of fresh water runoff and subsequent mixing which had measurable effects on microorganisms such as the MSX disease in Bay oysters. Measurements in late 1982 indicated widespread prevalence of the organism in the Bay. Sampling later in 1983 revealed a large decrease in the prevalence of the disease following the high runoff of late spring and early summer 1983. Lowered salinities also appear to limit the distribution of stinging nettles in the Bay.

Temperature:

Bay surface water temperatures followed very closely the annual cycle with minimum temperatures in late January and maximum temperatures in late July to August (Table 6). All stations began 1984 with colder than normal temperatures. Ice cover during January 1984 was thirty percent (Table 7), following extreme cold during late December 1983 and mid-January 1984.

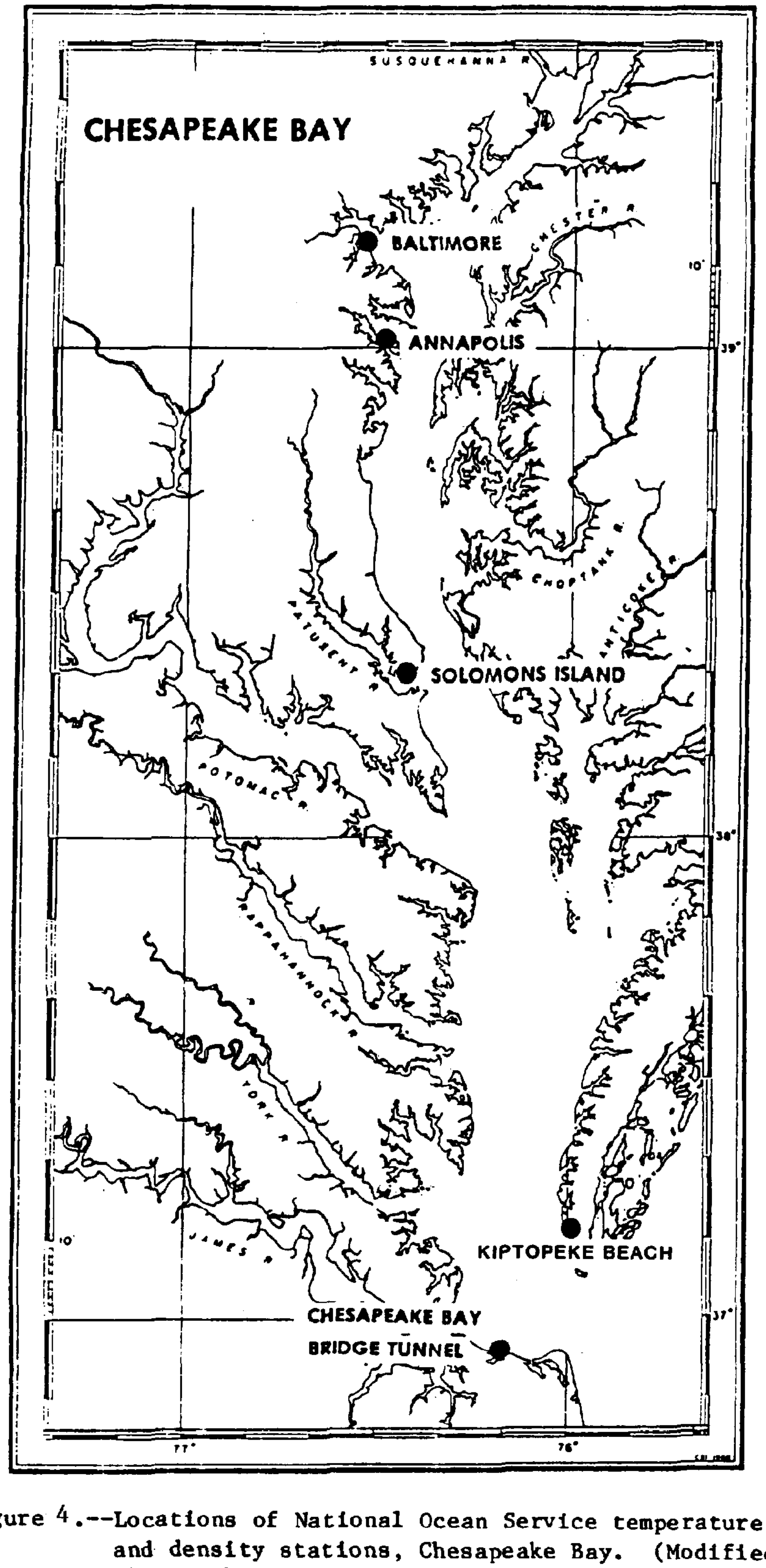


Figure 4.--Locations of National Ocean Service temperature and density stations, Chesapeake Bay. (Modified Chesapeake Bay Institute Map)

Table 5.--Monthly long-term average surface salinity and 1984 departure from normal, selected stations, Chesapeake Bay region.

A. Monthly long-term average (ppt)

Station	Month												
	Jan.	Feb.	Mar.	Apr.	May	Jun.	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
Solomon 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	20.2

B. Departure from normal, 1984 (ppt)

Station	Month												
	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Annual average
Baltimore, MD	-0.8	N/A	-0.2	-2.0	-2.1	-0.9	-3.1	-1.6	1.0	-1.4	0.3	-0.7	0.8
Annapolis, MD	-0.7	-1.4	-2.0	-3.2	-2.4	-4.6	-4.9	-4.3	-1.1	-1.2	-0.1	0.5	0.3
Solomon Is., MD	-2.3	-1.0	-2.3	-3.6	-3.0	-3.7	-3.6	-3.5	-1.0	-0.7	-0.3	0.3	-0.6
Kiptopeke Bch., VA	0.4	-2.4	-4.3	-5.8	-6.7	-5.4	-4.6	-4.4	-1.9	-0.5	1.1	0.6	-0.2
Chesapeake Bay Bridge Tunnel, VA	-0.6	-1.4	-0.3	-4.3	-5.5	-4.5	-5.0	-5.0	-2.6	0.1	1.3	2.0	0.7

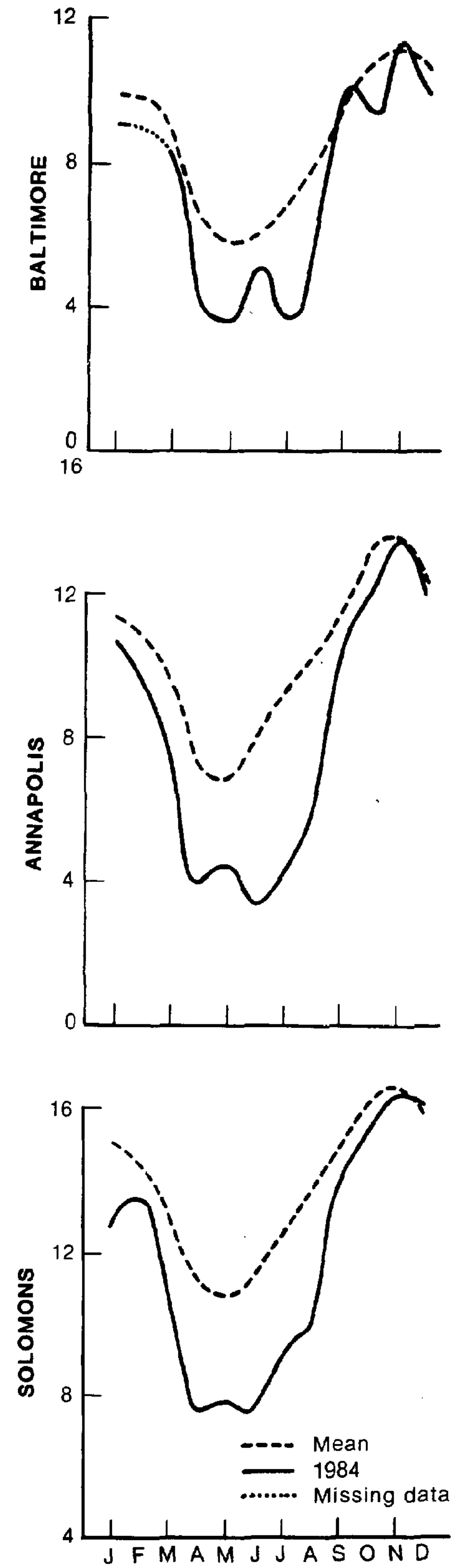


Figure 5. --Seasonal cycle of salinity, selected stations, Chesapeake Bay, 1984.

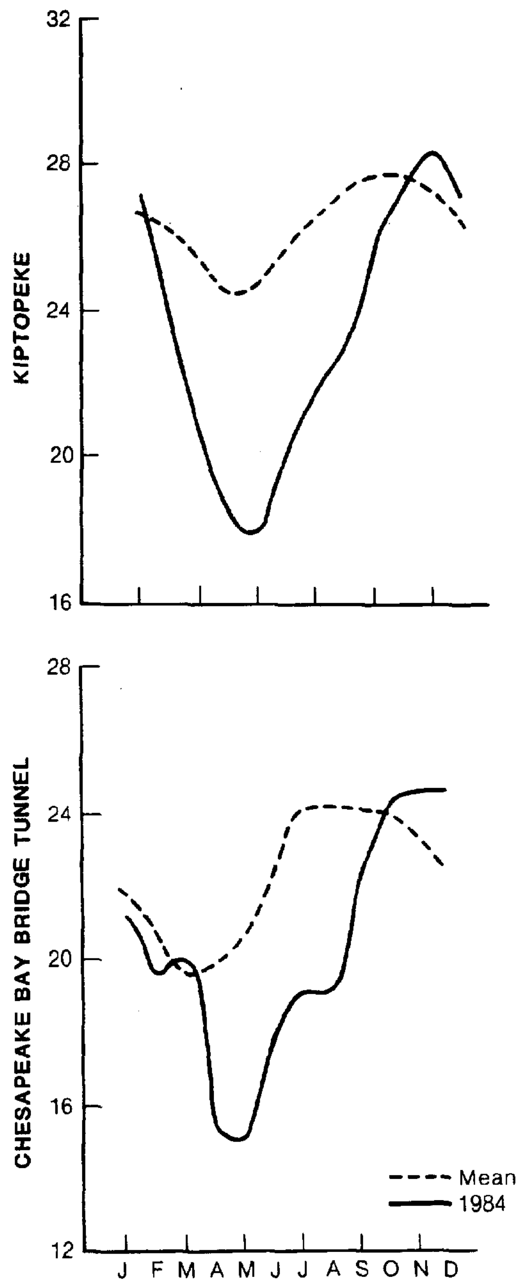


Figure 5 (continued).--Seasonal cycle of salinity, selected stations, Chesapeake Bay, 1984.

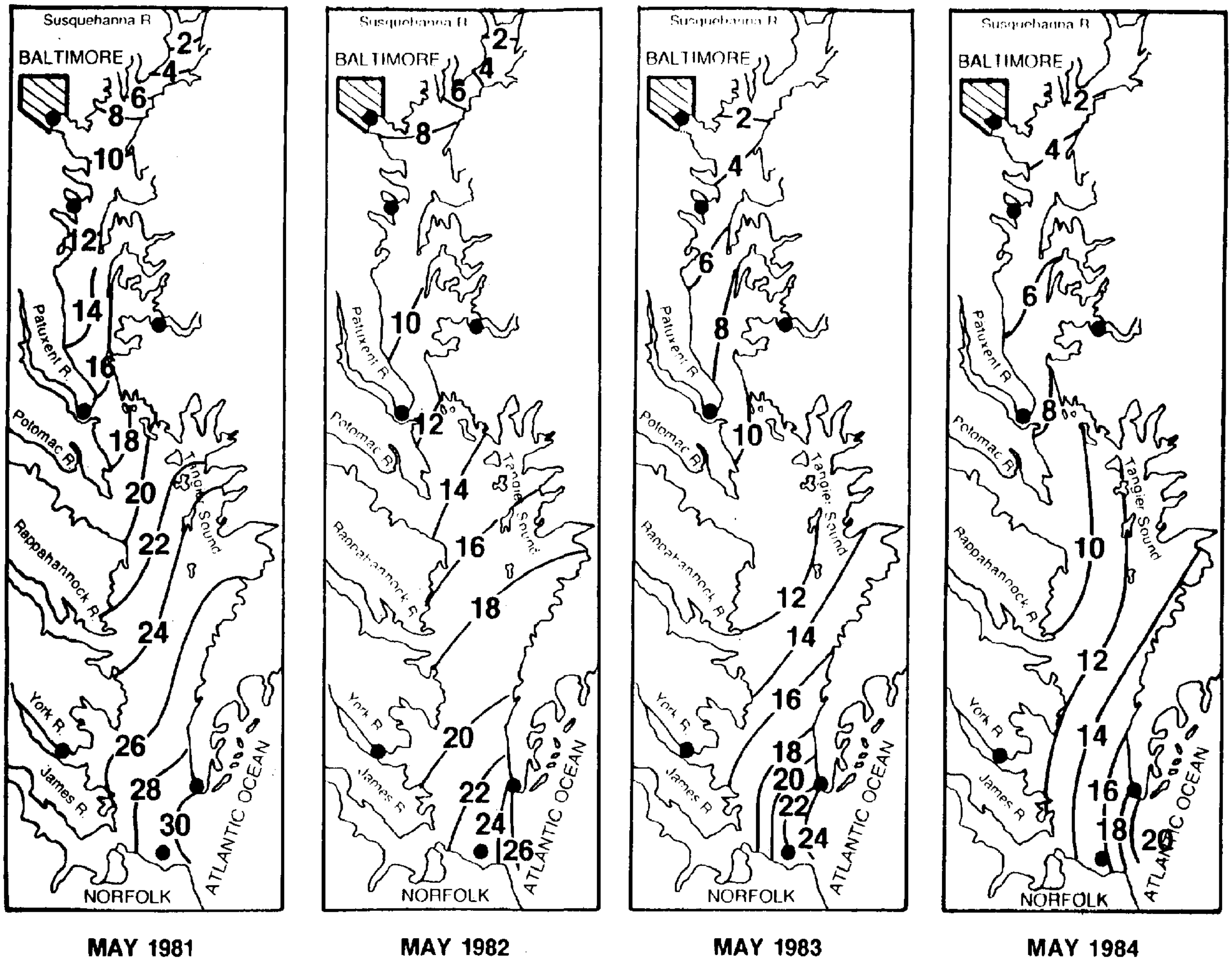


Figure 6.--Surface salinity distribution, Chesapeake Bay, May 1981-84.

Table 6.--Monthly long-term average surface water temperature and 1984 departure from normal, selected stations, Chesapeake Bay region.

A. Monthly long-term average (Deg. F)

Station	Month												
	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
Solomon 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, 1984 (Deg. F)

Station	Month												
	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Annual average
Baltimore, MD	-3.3	N/A	-0.7	0.1	-1.9	0.3	-0.3	-0.3	-1.4	1.5	2.1	4.4	0.5
Annapolis, MD	-4.0	+0.3	-3.7	-2.3	-3.4	-1.0	-2.1	-0.8	-2.0	0.0	0.8	3.2	0.1
Solomon Is., MD	-3.2	+0.9	+0.1	-1.0	-1.7	0.2	-0.8	1.1	-1.1	1.3	1.7	4.3	1.0
Kiptopeke Bch, VA	-3.8	2.7	+0.2	0.0	1.3	1.8	-0.6	3.1	0.9	2.2	0.3	4.5	1.0
Chesapeake Bay Bridge Tunnel, VA	-2.7	-2.6	0.6	-0.5	-0.4	1.8	-1.5	0.6	-2.3	-0.6	1.2	5.0	0.5

Table 7.--Maximum Ice Cover of Chesapeake Bay, 1977-1983.

	1976-77	1977-78	1978-79	1979-80	1980-81	1981-82	1982-83
Estimated maximum ice cover extent (%)	85	30	60	15	50	55	10
Ice cover extent maximum ice cover extent	Feb. 10	Feb. 20	Mar. 2	Jan. 18	Jan. 27	Jan. 27	Feb. 14

Data courtesy of NASA (1976-81), estimated from Landsat and Coast Guard reports.

Bay waters in February remained warm through April when a pool of cooler-than-normal water appeared in northern portion of the Bay, remaining evident until July. The Bay stations gradually showed warmer-than-normal temperatures through the late summer and fall, responding to the weather. December water temperature averages were much warmer than normal, most stations recording nearly 4.5 degrees Fahreheit above normal for the month. These warm temperatures reflect even warmer conditions during the first three quarters of December, since the last week of that month was a bitter cold week, dropping water temperatures suddenly to the point of ice formation in many of the Bay tributaries.

Icing occurred on the Bay during winter 1983-84 in response to a series of short, severely cold periods of weather, two in late December, one in early January, and two-week cold snap in mid-January. The sustained severe cold which created record icing in winter 1976-77 and intensive icing in winter 1978-79 did not occur during the 1983-84 winter. Close pack and compact pack ice occurred as early as December 26, 1983 on the Potomac River from the 301 bridge north to Alexandria and in the Bay near Swan Point. The Magothy, Back Gunpowder, Bush, Sassafras, Middle, upper Chester, and lower Susquehanna Rivers all froze to a compact pack by December 27th. Kent Island Narrows was reported frozen and inaccessible by the 28th of the month. On the 25th, Stillpond Coast Guard station was unable to respond to search and rescue (SAR) requests. One day later, the Taylor's Island station indicated difficulty in responding to SAR due to ice conditions on Slaughter Creek. By the 28th the Taylor's Island station was unable to respond to SAR, and the St. Inigoes station was able to respond only to urgent SAR requests, having to break 200 yards of ice to exit from the station. The stations continued to have to break ice to obtain open water at various periods during January.

The main icing period began near January 12, 1984 and reached maximum ice condition on or about the 23rd. Conditions on the 23rd (Figure 7) were these: compact pack on the Bay from the Bay Bridge to C and D Canal; Susquehanna mouth open pack; very close park ice conditions on the Bay from Cove Point, MD (Western shore above mouth of Patuxent River) to the South River and in Eastern Bay; Choptank River and Potomac River) from the 301 bridge to Washington showed

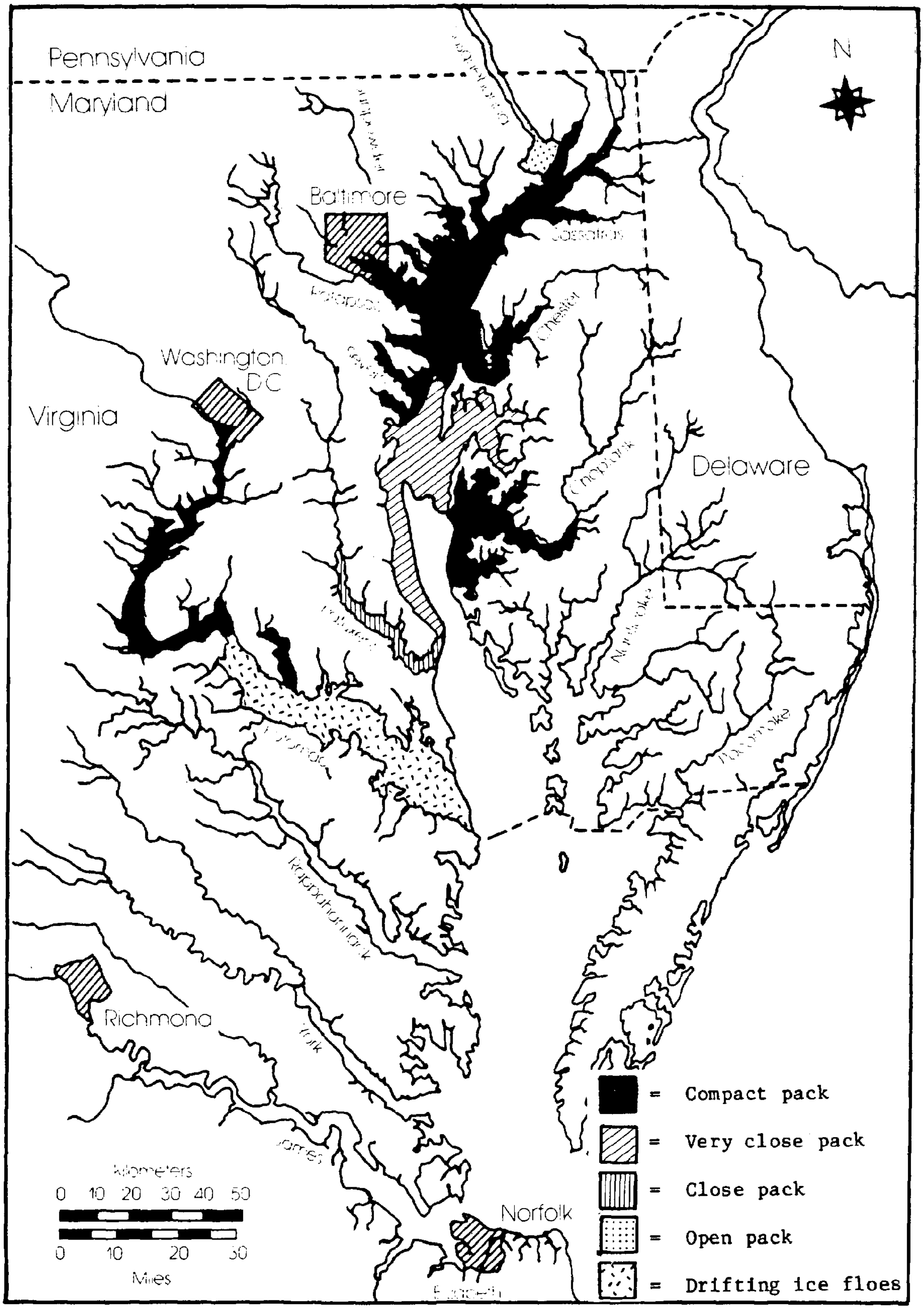


Figure 7.--Conditions at near period of maximum icing on Chesapeake Bay, winter 1983-84.

compact pack; Patuxent showed close pack ice; and the lower Potomac showed very close pack, close pack and compact pack dominated by drifting ice floes. During the week of January 16-22 the Coast Guard reported 11 preventative ice-breaking patrols and three vessel-assistance operations. The upper Potomac required five ice-breaking cruises each week between December 26th and January 23rd. Ice cover at peak extent appears to be around 30 percent of the Bay area in compact pack ice conditions.

Figure 8 shows the relationship between cumulative freezing degree-days (FDD) and the local air temperature at Patuxent River station. The relative maxima in FDD correspond with periods of maximum ice development. The total ice thickness is related to the cumulative FDD total in approximately a square-root relation only when the ice is stationary. For example, the cumulative FDD total reached 96, indicating approximately 7 inches of ice. However, at Patuxent, when the ice had been broken and freed to drift developed a total of only 4 inches of ice on the 23rd. On the smaller tributaries and creeks around the Bay, conditions at maximum icing showed closer to the empirical relationship with the following thicknesses: Back River (8"), Middle River (10"), Chester, Gunpowder, Bush Rivers (12"), and Sassafras River (14"). The 14 inches of ice in the Sassafras River reflects the 263 FDD's accumlated by January 23rd at Aberdeen, MD just across the Bay.

Ice disappeared rapidly around the Bay after January 26th despite a short cold wave in early February. By February 9th, only a few small rivers showed any ice and by February 17th, all stations reported clear water. The Gunpowder and Middle Rivers were the last to report ice on the 16th.

The values in Table 7 indicate a systematic difference in the dates of maximum icing which may depend upon the manner of the accumlation of freezing degree days. The late dates of maximum icing appear in 1977, 78, 79, and 83 when icing developed in response to sustained cooling periods. The icing in 1980, 81, 82, and 84 appear to peak earlier and may be due to the pattern of short severe cold snaps with warming between. More study needs to be done before firm relationships can be delineated. All of the 1984 icing analysis been done on the basis of Coast Guard reports. The aid of LANDSAT imagery was unavailable for the period due to cloud cover.

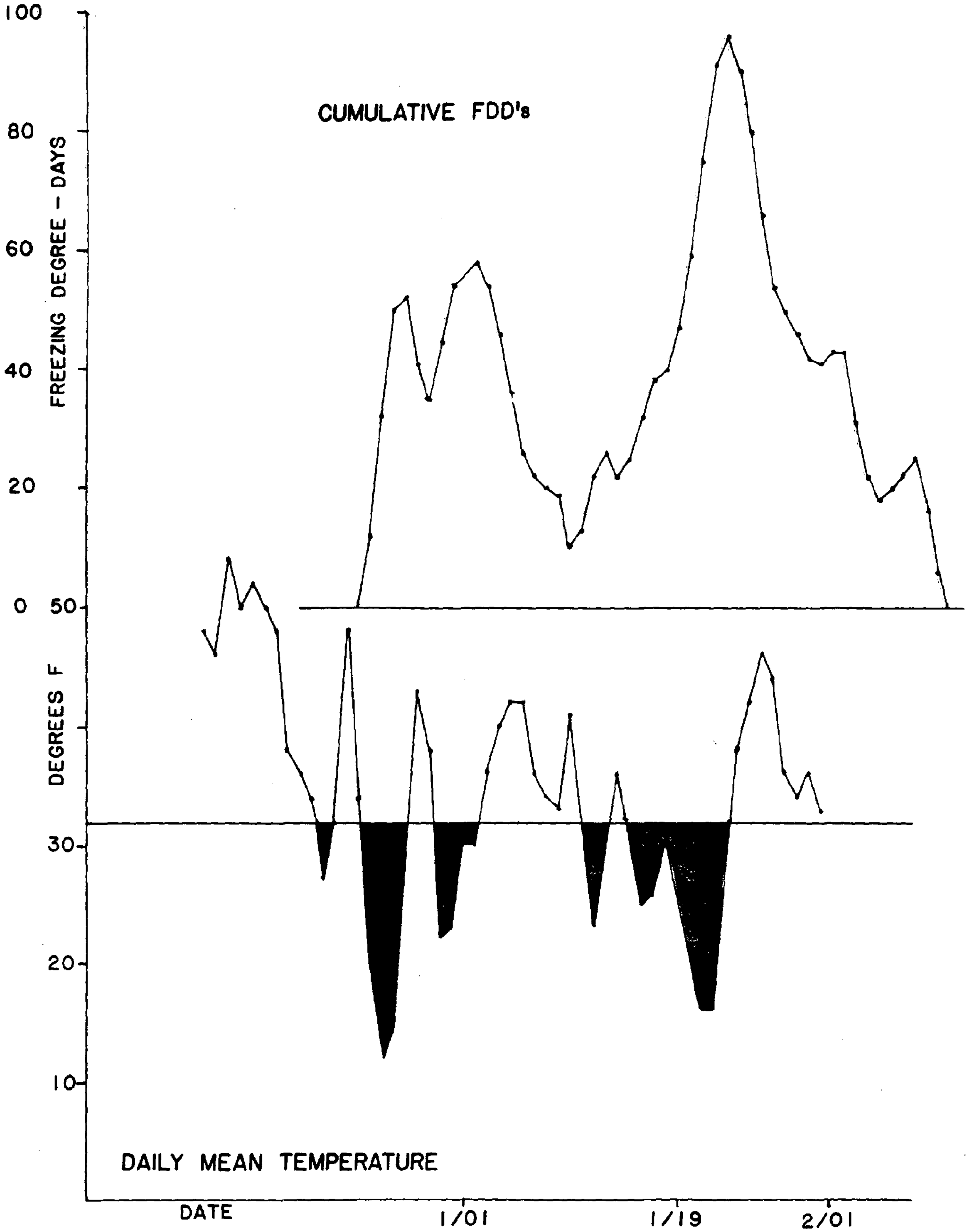


Figure 8.--Relationship between freezing degree-days and mean daily temperature, Patuxent, MD, winter 1983-84.

4. Fisheries

Chesapeake Bay is the largest estuary in the United States and one of the largest in the world. The Bay provides extensive and valuable resources. Oyster and blue crab production rank among the highest in the United States, and the Bay serves as the spawning and nursery area for the Atlantic coast striped bass and the nursery area for many other commercially important marine fishes such as menhaden and bluefish. Many marine fishes use the Bay as a summer feeding ground and forage upstream as far as Baltimore to prey on the abundant estuarine species.

4.1 Summary of Commercial Fishing

Chesapeake Bay commercial fisheries composed 2 percent of total landings in the United States in 1984, generating $63.6 million in the overall economy Table 8), $29.6 million in Maryland and $34.1 million in Virginia.

Maryland 1984 total state landings were down 1 million pounds from 1983, though value increased by $9.5 million (Table 8). Maryland Bay landings in 1984 were 5.0 million pounds lower than in 1983. Virginia Bay landings in 1984 were 9.1 million pounds lower than 1983 landings. Total Virginia state landings were 176.9 million pounds lower than in 1983 due mainly to a decrease in the menhaden catch. The record high for Maryland state landings is 141.6 million pounds, set in 1890. Virginia state landings of 751.1 million pounds in 1983 are the highest on record for Virginia.

4.2 Finfish

Six species of finfish dominated Chesapeake Bay landings in 1984: menhaden, catfish, striped bass, gray sea trout, alewives, and bluefish (Table 9). Bay-wide, menhaden landings were highest of all finfish species in quantity and total dollar value. Since 1977, confidential purse seine data for Virginia are not published by the National Marine Fisheries Service. Confidential menhaden data are included for 1975 and 1976 in Table 10 to show the magnitude of the total menhaden catch. Menhaden are used primarily for the production of meal, oil, and solubles. Small quantities are used for bait and canned pet food. Menhaden spawning stock sizes have improved somewhat since the population crashed in the early 1960's. However, National Marine Fisheries Service (NMFS) scientists report the magnitude and distribution of current fishing effort will likely prevent short-term landings from reaching much higher levels than at present.

Striped bass, as in 1983, retained the highest ex-vessel price per pound of Bay finfish ($1.02 average in 1984 and $1.87 average in 1983). Striped bass landings in Maryland were 1.1 million pounds in 1984, 0.65 million pounds higher than in 1983.

Table 8.--Chesapeake Bay and total state landings, commercial finfish and shellfish, 1983 and 1984.

	1984		1983	
	Thousand pounds	Thousand dollars	Thousand pounds	Thousand dollars
Bay Landings (1)				
Chesapeake Bay, total	140,307	63,642	154,436	70,051
Maryland, Bay only	65,163	29,557	70,174	31,830
Virginia, Bay only	75,144	34,085	84,262	38,221
State Landings (2)				
Combined States	663,462	138,130	841,428	130,240
Maryland	89,301	54,979	90,359	45,497
Virginia	574,161	83,151	751,069	84,743
Total for U.S.	6,437,783	2,350,462	6,438,744	2,355,446

All data are preliminary 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). Bay landings (1) include less than 1% ocean landings. Confidential data are not included for Virginia. State landings (2) include all State landings and confidential data.

Table 9.--Chesapeake Bay commercial finfish landings by State and species, 1983-1984.

	Maryland				Virginia			
	Thousand pounds		Thousand dollars		Thousand pounds		Thousand dollars	
Species	1984	1983	1984	1983	1984	1983	1984	1983
Alewives	133	159	17	26	1,195	1,838	71	236
Bluefish	103	257	14	41	867	1,072	147	167
Butterfish	0	0	0	0	69	51	21	19
Carp	162	187	9	21	4	6	**	**
Catfishes	885	816	263	168	835	1,128	181	249
Croaker	25	**	11	**	680	134	237	42
Drum, Black	21	3	6	**	3	19	**	2
Drum, Red	0	64	0	**	**	40	**	8
Eels, Common	109	92	66	31	371	315	221	80
Flounder, Blackback	9	7	10	2	**	23	**	17
Flounder, Fluke	31	30	33	21	395	269	287	174
Gizzard Shad	2	47	**	3	528	5	24	**
Harvestfish	0	0	0	0	84	71	60	40
Menhaden	5,341	6,596	268	258	14,526	24,483	588	559
Mullet	**	2	**	**	34	25	7	5
Sea Trout, Gray	34	116	20	82	1,384	1,893	800	1,040
Sea Trout, Spotted	0	0	0	0	2	4	2	4
Shad	11	26	5	12	626	463	256	231
Sharks, Dogfish	0	0	0	0	2	**	**	**
Spanish Mackerel	0	0	0	0	9	3	4	2
Spot	42	128	18	53	705	1,539	251	480
Striped Bass	1,075	425	1,346	806	505	150	472	268
Swellfishes	0	**	0	**	5	12	2	6
White Perch	717	575	353	344	68	62	28	25
Yellow Perch	48	40	22	19	**	**	**	**
Finfishes, Unc. food	0	0	0	0	3	4	**	1
Finfishes, Unc. food & bait	5	4	**	**	2,214	4,147	158	261
Totals	8,753	9,581	2,461	1,887	25,114	37,762	3,817	3,917

Data are preliminary from National Marine Fisheries Service. Landings are reported in live weight. Data include less than 1 percent ocean landings. Maryland 1983 landings include some finfish from seaside bays. 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 reported.

Table 10.--Maryland and Virginia finfish and shellfish landings for Chesapeake Bay and coastal ocean (0-3 miles), 1975-1984.

	Maryland		Virginia	
Finfish	Thousand pounds	Thousand dollars	Thousand pounds	Thousand dollars
All species, 1984	8,726	2,516	28,437	6,191
All species, 1983	9,069	1,596	41,463	5,507
All species, 1982	9,697	1,686	42,347	4,483
All species, 1981	14,836	3,101	38,305	3,965
All species, 1980	14,131	3,224	56,710	6,332
All species, 1979	8,840	1,776	53,045	5,960
All species, 1978	10,917	2,086	72,870	5,952
All species, 1977	12,402	1,735	72,420	5,198
All species, 1976	9,057	1,504	423,719	14,829
All species, 1975	11,291	1,549	306,733	10,173
Shellfish				
All species, 1984	56,576	41,614	56,349	21,732
All species, 1983	61,136	34,708	53,104	20,617
All species, 1982	67,647	39,836	52,202	19,037
All species, 1981	76,944	43,058	49,777	23,687
All species, 1980	43,593	31,622	45,640	17,765
All species, 1979	39,555	27,147	50,226	19,390
All species, 1978	33,855	24,352	46,524	19,887
All species, 1977	35,039	22,791	44,104	14,243
All species, 1976	36,612	23,554	33,031	12,229
All species, 1975	42,372	18,706	38,680	10,191

Data are preliminary from National Marine Fisheries Service.

The Maryland Tidewater Administration reports the relative abundance index for striped bass spawning success for 1984 is 4.2, which is higher than the 1.4 value in 1983, but below the long-term average of 9.3 (Table 11). The relative abundance index is based on the average number of young-of-the-year (inch-long fry) captured per seine haul in Bay tributaries. The index has ranged from a low of 1.2 set in 1981 to the record high of 30.4 set in 1970. Striped bass landings in Maryland exceeded 5 million pounds in 1961 and 1969. Landings have shown a steady decline since they last reached 5 million pounds in 1973. The decline in striped bass stocks prompted the State of Maryland to issue a moratorium on striped bass landings beginning January 1, 1985. The rise in landings in 1984 over 1983 is related to the strength of the 1982 year class of striped bass which were of marketable size in 1984. The relative abundance index for striped bass was 8.4 in 1982, higher than each year since 1974, except 1978.

Table 11.--Relative abundance index for young-of-the-year striped bass, Chesapeake Bay, 1954-1984.

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		

Data from Maryland Tidewater Administration.

Landings of striped bass from the Potomac River in fall 1984 were considerably higher than the same period of 1983. Landings for the period October-December 1984 exceeded one-half million pounds compared to the same period of 1983 when only 109,375 pounds were reported. Dockside prices fell from $4 per pound in the spring to as low as 60 cents/pound in November as market supplies of striped bass were plentiful. The 1982 relative abundance index for spawning success in the Potomac River was 10.0, higher than the long-term average of 6.6 for the Potomac River.

The 1982 striped bass year class had only recently attained the legal size limit (14 inches total length) in early fall 1984. Apparently fishing pressure for striped bass intensified in the last three months of 1984 as legal sized fish became abundant preceding the upcoming January 1 ban in Maryland and unusually warm air temperatures in October through mid-November provided favorable conditions for harvest activities. Fisheries managers expressed concern that heavy exploitation of the 1982 year class could jeapordize the only abundant source of future broodstock for Chesapeake Bay striped bass.

The Maryland Department of Natural Resources records seine sampling counts of selected species at 22 stations around the Maryland portion of the Chesapeake Bay. These data present the only regularly sampled data on natural abundance for Bay species. Figures 9, 10, and 11 show plots of the data for selected groups of species from 1958 to 1984. The data are available only for the Maryland part of the Bay, but can indicate for each species environmental adjustments to climate or the effect of man's development of the Bay.

The grouping of Atlantic menhaden, blueback herring, American shad, and alewife (all species of herring, Figure 9) represent fish which prefer saltier oceanic type waters. Blueback herring and alewives were at very low levels in the sampling in 1984 though alewives remain a commercially important species in Bay landings. Alewife, shad, and blueback herring all showed declines in numbers in the sampling over the last 25 years, with the exception of single unusual years (alewife-1970, blueback herring-1969). No American shad have been captured in seine sampling since 1973. In contrast the Atlantic menhaden numbers increased greatly after 1970 with a peak in 1977. Since 1979, the menhaden sample numbers have declined consistently. The increase in menhaden seine sampling numbers during the 1970s may reflect the species adjustment to lower runoff during the period and the consequent increase in Bay salinities in the upper Bay.

Striped bass, white perch, and bluefish (Figure 10) are important commercial and sport species in Chesapeake Bay. The croaker has been low in the sampling over the entire record except for 1973-74. The abundance of croaker is dependent on the success of the year-class. Juvenile croaker overwinter in Chesapeake Bay and are vulnerable to severe cold, thus croaker may be abundant in years with a good year-class and a warm winter. Croaker landings showed large increases in Maryland and Virginia in 1984 over 1983 due mainly to the highly successful 1982 year class. Striped bass and white perch show a decline after 1970 with no apparent improvement in the 80's. Bluefish appear to have increased in number in the Maryland portion of the Bay after 1970. Both spot and channel catfish sampling numbers (data not shown) follow the same pattern in abundance, increasing in the years after 1970 and decreasing to normal in 1981. Bluefish and white perch have become more important in the Bay sport fishery as the striped bass fishery declined.

Extensive cold water mortalities of young-of-the-year croaker occurred in Virginia rivers during the 1984-85 winter, indicating the loss of most, or all, of the 1984 year class. Extensive mortalities of croaker also occurred during the 1983-84 winter when most or all of the 1983 class was lost. Water temperatures dropped rapidly in mid-January below the croaker tolerance limit of 39.2°F following the unusually warm water temperatures through December 1983 and early January 1984.

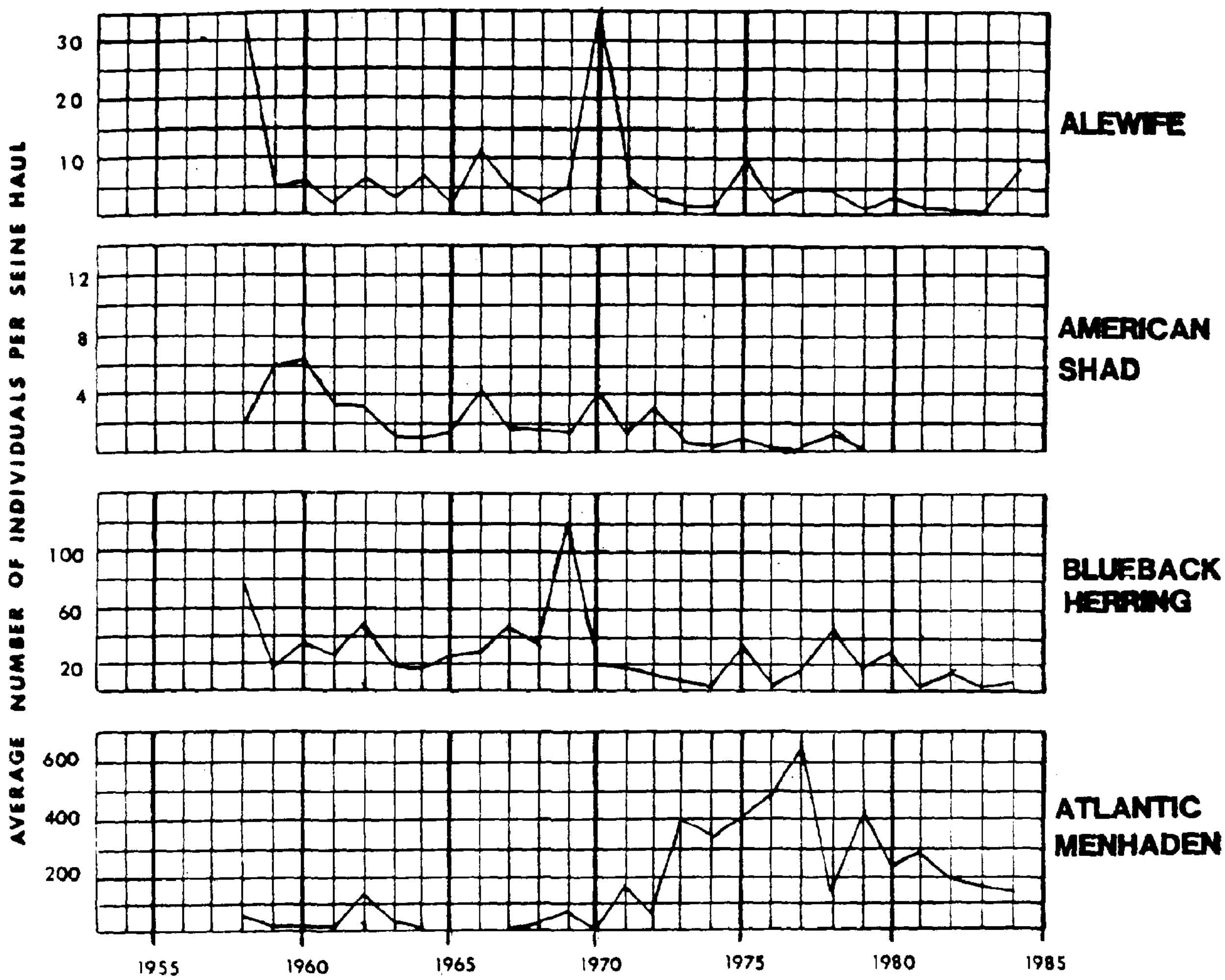


Figure 9.--Seine sampling, major herring species.

Average number of individuals collected at 22 sites in the Maryland portion of Chesapeake Bay. Three major herring species show declines after 1970. Atlantic menhaden, a commercially valuable species, has shown an increase in population 1970-77, a decrease in 1978-84.

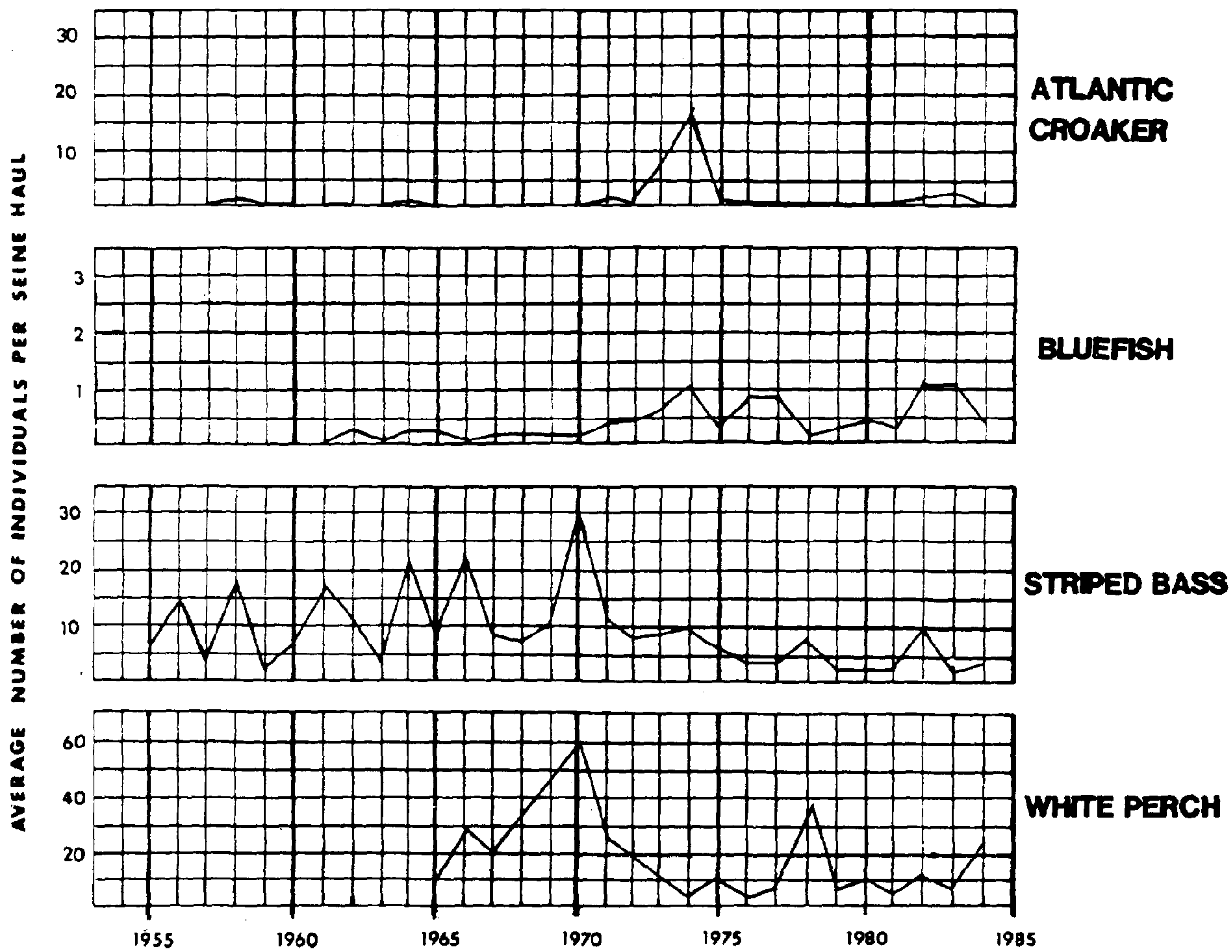


Figure 10.--Seine sampling, selected recreational and commercial species.

Average number of individuals collected at 22 sites in the Maryland portion of Chesapeake Bay. Striped bass and white perch show decreases after 1970. Bluefish shows an increase after 1970. Atlantic croaker show population increases in years following warmer-than-normal winters.

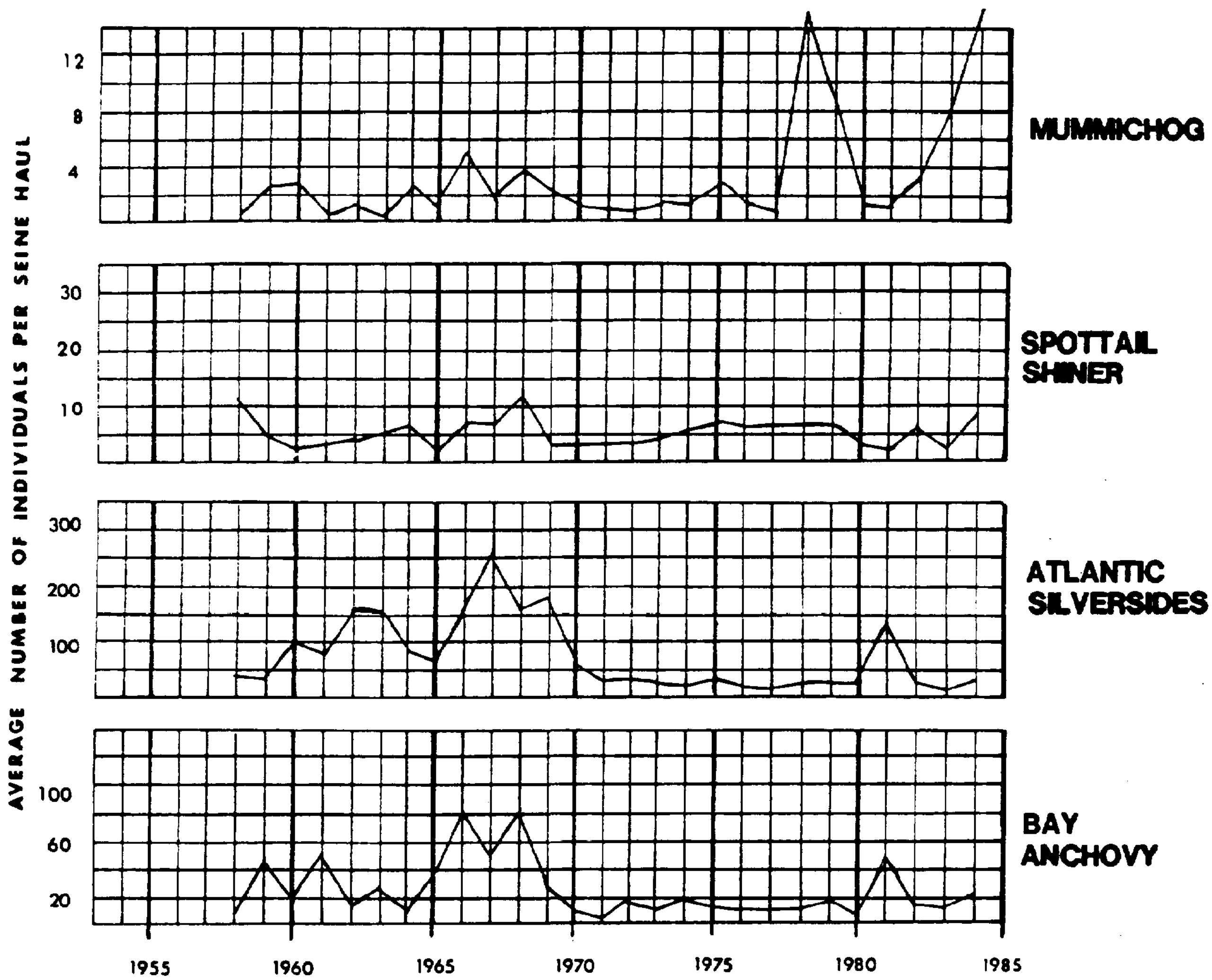


Figure 11.--Seine sampling, selected lower foodchain species.

Average number of individuals collected at 22 sites in the Maryland portion of Chesapeake Bay. Population of each species appears stable 1970-80, although lower than the sample results of 1958-70. Note the unusual mummichog increase in 1978 and 1984.

Virginia Institute of Marine Sciences (VIMS) sampling showed bottom water temperatures of 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. Croaker of the highly successful 1982 year class survived the very mild winter of 1982-83 and have been of marketable size since summer 1984. Once the adults of the 1982 year class are depleted, croaker landings should decline until another successful year class survives a winter in Chesapeake Bay.

Spottail shiner, mummichog, Atlantic silversides, and Bay anchovies (Figure 11) are important in the food chain, but are not commercially harvested species. The shiners, silversides, and anchovies all show definite declines in numbers 1970-1980, a slight increase in 1981, a return to lower levels in 1982 and 1983, and a slight increase again in 1984. The mummichog follows the same pattern to 1977, but shows a very large increase in 1978-79, and another increase 1982-84. The trend after 1980 is not clear. Atlantic needlefish (data not shown) which prey on many of these species show the same uniform decline in abundance after 1970.

4.2.1 Fish Kills in Virginia

The Virginia State Water Control Board identified and investigated 41 fish kills in Virginia waters during 1984 (Table 12). Data on the extent of fish kills and estimates of dollar loss are unavailable at present.

Table 12.--Virginia fish kill events, 1984.

Month	Location	Probable Cause
February 8	Cow Branch	Oil spill, Moone, STP
April 30	Gravelly run	Sulfuric Acid Leak from Allied Chemical
May 17	Lake Dale (Chester, VA)	Algae bloom
June 13	Kings Grant Lake	Temperature stress
June 15	Rappahannock River	Unknown (Suspected net
June 17	Rose Creek	Natural menhaden kill dumping)
June 18	James River	Unknown
July 2	Lake Wicomico	Pesticide/herbicide runoff
July 12	Machodic Creek	Low dissolved oxygen Algae bloom
July 20	Tributary to Motts Run	Unknown
July 26	Queens Creek	Low dissolved oxygen Algae bloom
August 7	Lake Meade	Insectiside runoff
August 17	Tributary to Sugarland Run	Sludge release for Potomac River filtration Plant
September 17	Bailey Creek	Unknown
September 18	South Run	Unknown
October 12	Gravely Run	Unknown
October 26	Tributary to North Landing River	Low dissolved oxygen Algae bloom
October 29	Stumpy Lake	Low dissolved oxygen Algae bloom
November 8	Cedar Run	Unknown

The summer flounder provides a highly valuable fishery in Chesapeake Bay and adjacent coastal waters. Sampling by the Virginia Institute of Marine Sciences (VIMS) in the York River indicated an above normal mortality rate of juvenile summer flounder in late December. Juvenile summer flounder (approximately 15 to 23 cm size range) are parasitized by the blood parasite or hemo-flagellate, *Trypanoplasma bullocki*. VIMS studies over the last several years show up to 100 percent of a juvenile summer flounder population may be infested by *T. bullocki*. The blood parasite is transferred from fish to fish by a marine leech (*Calliobdella vivida*) in summer flounder nursery areas in Chesapeake Bay and nearshore ocean waters. Infection intensities peak in late December through early January, resulting in mortalities of juvenile summer flounder which vary in rate from year to year. Unusually cold water temperatures may increase mortalities of summer flounder weakened by the blood parasite during the peak infestation period. VIMS sampling in the severely cold winter in January 1981 showed a 100 percent mortality of trawl-caught juvenile summer flounder in the York River. Previous sampling during the very mild winter of 1982-83 showed no large-scale mortalities. Intense cold in late December 1983 and early January 1984 coincided with the peak infection intensity of *T. bullocki*, and VIMS trawl survey data show high mortalities of juvenile summer flounder in the York River.

Extensive cold water mortalities of young-of-the-year croaker occurred in Virginia rivers, indicating the loss of most, or all, of the 1983 year class. Sampling by the Maryland Department of Natural Resources in the Chesapeake Bay Deep Trough in December 1983 showed the presence of the 1982 and 1983 year classes of croaker. Further sampling in February 1984 in the Deep Trough showed no croaker present. The absence of croaker in the Deep Trough and water temperatures below the croaker tolerance limit of 4°C during the 1983-84 winter suggested the possibility of a major croaker kill. This situation was confirmed in observed croaker kills in Virginia rivers by the Virginia Institute of Marine Sciences. However, croaker of the 1982 year class survived the 1983-84 winter due to their movement out of Chesapeake Bay and into waters warmer than 4°C. Croaker of the highly successful 1982 year class survived the very mild winter of 1982-83 and were of marketable size in 1984 as seen in the relatively good catches of croaker during 1984.

4.3 Shellfish

Blue crabs were the most valuable shellfish species Bay-wide in 1984, contributing over 26 million dollars to the combined economics of Maryland and Virginia (Table 13). Blue crab landings decreased 1.8 million pounds in 1984 over 1983 in Maryland, and increased by 3.2 million pounds in Virginia. Soft and peeler crab landings decreased by 1.5 million pounds in Maryland. Soft clams showed large decreases in landings due to harvesting restrictions in Maryland in July and August. Oyster landings totalled 10.5 million pounds in Chesapeake Bay in 1984, but the oyster catch remained low compared to historical production in the Bay.

Blue crabs

In April and May 1984, watermen experienced delays in normal springtime blue crab catches due to cooler-than-normal water temperatures which delayed crabs from becoming active. Adverse weather conditions, including strong northeasterly winds, abnormally high tides, and heavy rainfall prevented some crabbers from working for some periods in April and May in Virginia. However, blue crab landings showed increases in spring 1984 over 1983. Cooler-than-normal water temperatures during spring 1984 reduced crab activity but the relative abundance of the highly successful 1982 year class (crabs hatched in summer and fall 1982) gave impressive landings for watermen. During similar spring environmental conditions in early 1983, landings were very low due to the overall shortage of crabs following a very poor 1981 hatch and recruitment.

Soft crab production in Virginia also showed delays as a result of cooler-than-normal water temperatures. The first seasonal soft crab production run in mid-May was delayed for up to 2 weeks in the Northern Neck and Rappahannock areas in lower Chesapeake Bay. During this period soft crab prices were depressed in the Baltimore and New York City markets due to the availability of soft crabs from the southern states of Georgia, North Carolina, and South Carolina. Southern states have greatly increased soft crab production over recent years and begin seasonal production earlier than more northern states including Maryland and Virginia.

Blue crabs were in sporadic supply in summer 1984. Total Chesapeake Bay blue crab landings of 40.5 million pounds were down 21 percent in June - August 1984 from the 51.2 million pounds landed in June - August 1983. Total value was down 23 percent, reflecting a $4.7 million decline in the June - August catch.

Hard crab landings were lower than 1983 in all three months except in June in Virginia where landings were 50 percent higher than 1983. However, the hard crab catch in Virginia fell much further below summer 1983 as the 1984 harvest proceeded through August. Spot checks of market conditions in late summer 1984 showed high variability in the supply of crabs according to location. Hard crabs showed a decrease in price per pound from June through August, reflecting the seasonal increase in abundance of market-sized crabs.

Table 13.--Chesapeake Bay commercial shellfish landings by State and species, 1983-84.

	Maryland				Virginia			
	Thousand pounds		Thousand dollars		Thousand pounds		Thousand dollars	
Species	1984	1983	1984	1983	1984	1983	1984	1983
Crabs, Blue, Hard	46,802	48,611	16,023	17,084	44,608	41,401	10,068	10,013
Crab, Soft & Peeler	1,969	3,501	4,054	5,438	772	630*	884	779*
Clam, Hard	0	0	0	0	580	779	1,588	1,860
Clam, Soft	936	1,961	2,507	4,285	0	0	0	0
Oyster Meat	6,697	6,950	15,791	10,198	3,804	3,599	6,466	4,986
Horseshoe Crab	0	0	0	0	62	28	7	2
Snails (Conchs)	0	0	0	0	64	4	40	3
Turtles (Snapper)	0	0	0	0	127	60	61	25
Totals	56,404	61,083	38,375	37,005	50,017	46,501	19,114	17,668

Data are preliminary 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. Maryland 1983 landings include some shellfish from seaside Bays.

* Figures are underestimates and actual landings and value may be much higher, due to the voluntary reporting system in Virginia, according to Virginia officials.

Soft and peeler crabs also showed reduced landings in summer 1984 compared to 1983. However, 1983 was a bumper soft and peeler crab year. The supply of soft and peeler crabs held closer to 1983 levels in Virginia than in Maryland. Landings of soft and peeler crabs were below 1983 in all months in both states except July in Virginia when landings were up 35 percent. Maryland landings in July were down 70 percent. Prices were highest in both states in July.

Some of the juveniles from crabs hatched in 1983 apparently attained market size in summer 1984, but more smaller crabs may have been present because of delayed warming of water temperatures in spring 1984. Reduced salinities Bay-wide may have altered normal crab distributions, as seen in the sporadic catches reported by watermen.

The quantity of crabs landed in Maryland in September and November was very close to that in the same months in 1983. Maryland October landings, however, showed a 24 percent decline from 1983. Price per pound of Maryland crabs decreased in all three months from 1983. The relationship between price, quantity, and quality of supply is unclear. Virginia landings were down in September by 42 percent, though landings improved later in the quarter. Virginia crabs showed an increase in price per pound in September, while there was no change from 1983 in October.

Watermen in Virginia experienced poor market conditions in December. Prices for crabs in Virginia began at an average of $18 per barrel in early December at the start of the dredge season and reached $25 per barrel at the end of the month. In December 1983, crabbers in the lower Bay received an average price of $15 to $20 per barrel. December 1983 prices were low, reflecting the abundance of crabs from the highly successful 1982 year class.

Dredgers in Virginia normally compete with suppliers in southern states which ship pot-trapped crabs to the Bay area in colder months, when Bay crabs are less available. Crabs were in good supply from southern states which experienced unseasonably warm weather in December. Packing houses in Virginia saw a glut in supply of crabs as the better quality, sand-free pot-trapped crabs from southern states were readily available.

Water temperature in the lower Bay reached 47°F on January 9, 1985, the latest date of any winter dredge season during the period of record 1960-85. Water temperatures above 47°F can keep crabs active and have some effect on the December harvest in Virginia by making dredging less efficient. In 1984, the combination of market conditions and an abundance of crabs in the lower Bay were the overriding factors contributing to the December 1984 crab landings of 4.14 million pounds, which were higher than the previous 24-year average of 4.01 million pounds. Warmer-than-normal water temperatures in late fall 1984 allowed more time for juvenile crabs to reach maturity before the winter inactivity period. Crabs had more time to shed and grow in fall 1984 than in any year during the period of record 1960-present. Blue crabs leave creeks and rivers in late fall when 85 to 95 percent of the adult females move toward the lower Bay. When water temperature goes below 47°F early in the fall season, crabs become inactive and may settle down in the middle or even upper Bay. In 1984, more crabs probably made it to the lower Bay than would have a cooler fall. Virginia Institute of Marine Science (VIMS) 1984 trawl data indicated a below-average sized year class of blue crabs spawned in 1983. Crab landings in period crabs become inactive and may settle down in the middle or even upper Bay. In 1984, more crabs probably made it to the lower Bay than would have in a cooler fall. Virginia Institute of Marine Science (VIMS) 1984 trawl data indicated a below-average sized year class of blue crabs spawned in 1983. Crab landings in Virginia in September-November 1984 were lower than landings for the same period of the previous three years, reflecting the below-average strength for the 1983 year class. However, December 1984 landings were higher than the previous three years, probably a result of the extended period of growth and movement allowed by the warmer-than-normal temperatures in 1984. Dredging, which may be less efficient when crabs remain active because of warm water temperatures, possibly showed a decrease in catch per effort, though warm weather allowed for more boats to work and more time on the water. Even though prices remained low (at $18 per barrel), landings were above average.

Oysters

Bay oyster stocks have shown a steady decline following years of poor reproduction the 1970's and intense fishing pressure. Stocks were further reduced by disease-related mortalities in 1982 and more recently, by the spread of anoxic conditions in late summer 1984.

The shortage of oysters and inaccessibility to oyster beds from ice cover in winter 1983-84 affected oyster prices, which were unusually high throughout the winter 1983-84 quarter. Oysters from the Gulf of Mexico supplemented the Maryland market, during winter 1983-84, though some areas in the Gulf were closed early to oystering due to increased harvesting effort. The demand for Gulf oysters has increased following the steady decline of Chesapeake Bay stocks.

Heavy rainfall in March and April greatly reduced salinities Bay-wide during the spring 1984 quarter, reducing the range of suitable conditions for oysters in upper portions of Bay tributaries and the Upper Bay. Oysters are distributed in most Chesapeake Bay tributaries upstream to a mean salinity of 7 to 8 parts per thousand. The heavy freshwater influx during April shifted isohalines 10 to 12 miles downstream in the upper James River. Sampling by the Virginia Institute of Marine Sciences during the spring 1984 quarter showed higher-than-average oyster mortalities in the upper portions of the James River The Deep Water Shoals area of the upper James River, which produces approximately 4 to 5 percent of the total Virginia seed oyster resource, experienced up to 60 percent mortality. The next seed producing areas downriver from Deep Water Shoals showed mortalities of 15 to 20 percent. The James River has extensive oyster bars which produce approximately 80 percent of Virginia's seed oysters (379,000 seed oyster bushels). Estimating conservatively that up to 15 percent of the seed oysters may have been damaged by fresh water conditions, high runoff may have caused $200,000 of potential losses in the River. Weather-related damage to seed oysters at Deep Water Shoals may have contributed $32,000 of the total. Market prices for seed oysters were higher in 1984 ($3.00 - $4.00 per bushel in 1984 vs. $2.50 - $3.50 per bushel in 1983) but probably responded more to the market pressures for larger size available seed oysters in 1984 rather than to any supply problems.

The James River is primarily public oyster ground except in some areas close to shore which are privately leased for the harvesting of market size oysters. Some damge to these areas in the upper James River occurred at the 10-20 percent level.

Low dissolved oxygen in late summer in many areas of the Bay was associated with oyster mortality. Anoxic conditions (dissolved oxygen = 0) in Chesapeake Bay were apparently more widespread than usual in 1984. Anoxia in 1984 occurred at shallower depths (15-20 feet) not previously affected. Heavy freshwater inflow coupled with the lack of wind-induced mixing in 1984 caused Bay waters to become strongly stratified, which may have caused an increase in the areal extent of the anoxia. The lack of oxygen causes mortalities of shellfish such as oysters which cannot move. Crabs can move to areas with higher oxygen levels.

Chesapeake Bay Institute studies show that extensive mortalities of market-sized oysters occurred on an oyster bar in the Choptank River in late summer, probably as a result of oxygen depletion. Watermen working in the Maryland portion of Chesapeake Bay also reported mortalities of oysters, particularly on the western shore. Dollar value estimates of damage are not available.

Oysters were scarce in Maryland waters during fall 1984, and watermen receive high prices for their catch. The quality of oyster meats was good. Prices ranged from $14 to $20 per bushel in Maryland compared to the record high of $20 per bushel in 1983 and a high of $16.25 per bushel in 1982. Virginia landings showed considerable improvements over 1983, while good quality oyster meats and market demand kept prices high.

The scarcity of oysters caused intense fishing pressure for available stocks in the most productive oystering areas. Two productive shaft-tonging areas, the Choptank and Tred Avon Rivers, attracted watermen from a wide area of Maryland. Maryland Natural Resources Police counted 250 boats at one time working in the Tred Avon River.

Oyster spatfall

Summer 1984 oyster spatset was poor in Chesapeake Bay, according to reports received from Maryland and Virginia agencies. Spatset in Maryland waters was almost non-existent except for Tangier Sound where light spatset was detected. High streamflow and reduced salinities during summer 1984 may have influenced the low survival rate of young oysters spawned in 1984.

Large numbers of ctenophores, commonly known as comb jellies, were present in Chesapeake Bay during summer 1984. The abundance of the ctenophore, which feeds on oyster larvae, may be contributed to the reduced spatset in 1984. Stinging nettles were present in reduced number in 1983 during a period of high streamflow and reduced salinities. Low numbers of nettles, which feed on ctenophores, probably allowed the ctenophore population to proliferate in summer 1984. Bay scientists have observed that oyster spatset was high in certain years with high salinities in which nettles were abundant. Although salinity appears to be the overriding factor involved in the survival of oyster larvae, ctenophore predation in 1984 may have been a major contributor to the reduced spatset.

Soft shell clams

Soft shell clam beds in a portion of the northern Bay were closed to harvesting by the state of Maryland from July 30 to August 29. The restriction was in effect in all waters of the Bay and its tributaries north of a line running westerly from Blackwalnut Point on Tilghman Island to Chesapeake Beach (Figure 12).

Abnormally high streamflow in spring and summer 1984 greatly reduced salinities in the northern Bay. The long duration of low salinities, combined with seasonally higher summer water temperatures and low dissolved oxygen, caused clams to weaken, making them susceptible to rapid deterioration once removed from the water. The potential for bacterial contamination after the clams were harvested prompted the ban on soft shell clamming.

The soft shell clam (Mya arenaria) is a cold-water, high-salinity species which prefers salinities between 9-11 parts-per-thousand (ppt) and water temperatures less than 60°F. Soft shell clams are at the southernmost edge of their range in Chesapeake Bay, and are thus highly vulnerable to extreme changes in climate. Salinities in 1984 fell to 5 ppt and below over large soft shell clam areas. Clam mortalities occurred in June off Tilghman Point in Eastern Bay where hundreds of thousands of dead clams were observed by the Maryland Department of Natural Resources. Mortalities up to 30 percent were reported in soft shell clams being transported from harvesting areas to docks.

The effect of low salinities on soft shell clam beds in Maryland during summer 1984 was seen in landings in June, July, and August (Figure 13). Clam mortalities contributed to the lowered landings in June which were 5,040 bushels less than in June 1983. Clam prices were high at $32.89 per bushel in June 1984 compared to $21.65 in June 1983. The combined effect of clam mortalities and the closing of clam beds to harvesting is evident in the July and August landings which fell 61 percent and 96 percent, respectively, below the same months in 1983. If the harvest had been comparable to the same period for 1983, which was close to the 1979-83 average of 75,878 bushels, landings for June - August 1984 may have been as high as 75,219 bushels worth $2.1 million. The actual catch in June - August 1984 was only 31,780 bushels. The difference, 43,439 bushels, shows a possible loss (dockside value) of over $0.9 million.

The July 30 to August 29 ban on harvesting soft shell clams was not pollution related. The extreme stress on the northern Bay soft shell clam population in summer 1984 is a natural phenomena which has occurred several times in past years. Low salinity conditions in 1954 and 1968 contributed to high mortalities of soft shell clams in Chesapeake Bay, though there was no need to restrict harvesting because at that time soft shell clams were used primarily for fishing chum. After a market developed for soft shell clams as a food product in the 1970's, the first ban on clamming was issued in 1973 when low salinity conditions occurred in the Bay.

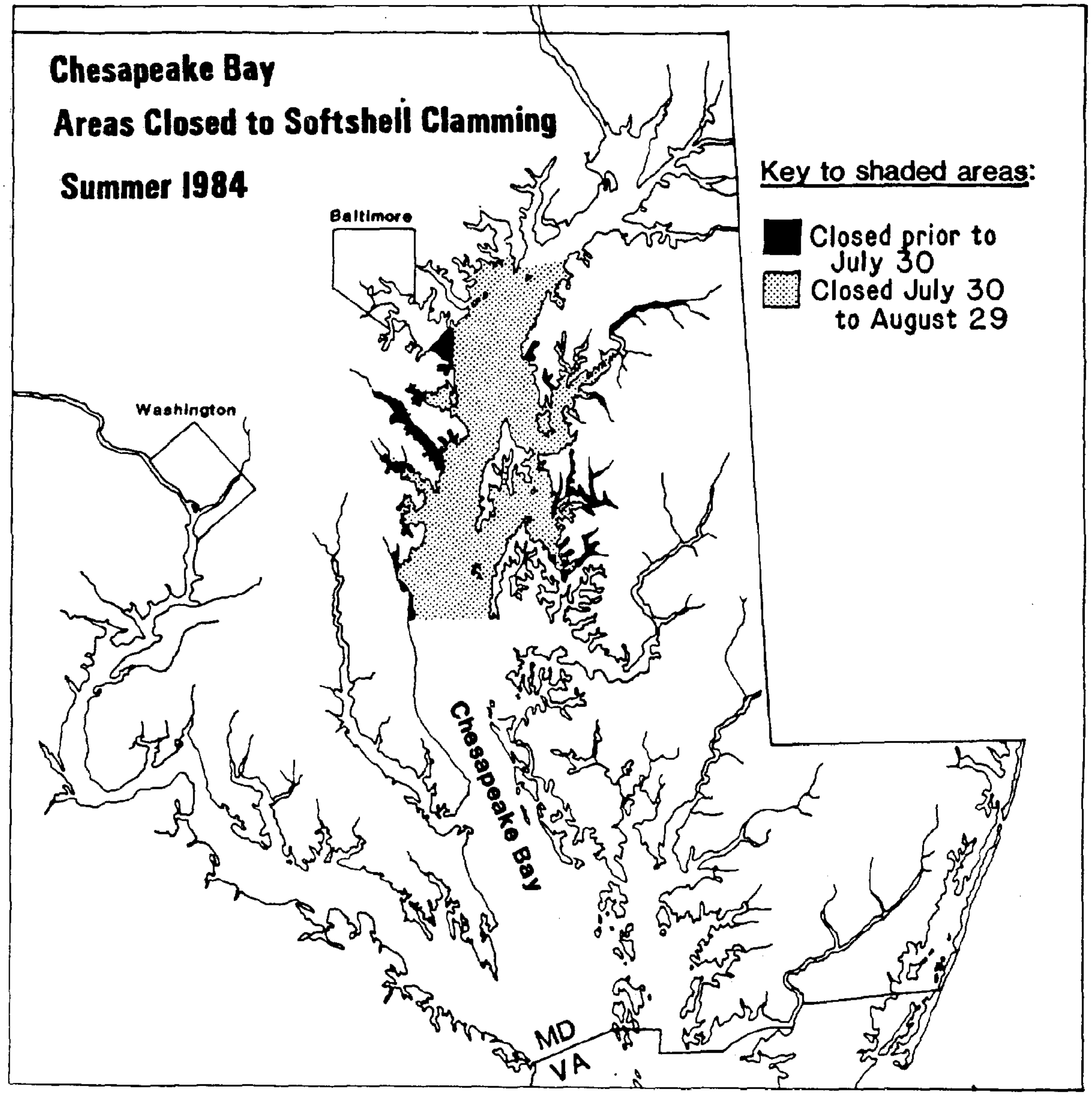


Figure 12.--Chesapeake Bay areas closed to soft shell clamming, summer 1984. Soft shell clam beds north of a line from Tilghman Island to Chesapeake Beach were closed to harvesting by the state of Maryland Department of Health and Mental Hygiene July 30 to August 29. High streamflow during spring and summer 1984 caused salinities to become very low in clam harvesting areas. The long duration of low salinities combined with seasonally higher summer water temperatures stressed clam populations and caused clam mortalities in some areas. The ban on soft shell clamming was issued because the weaker condition of the clams made them more susceptible to contamination after harvesting.

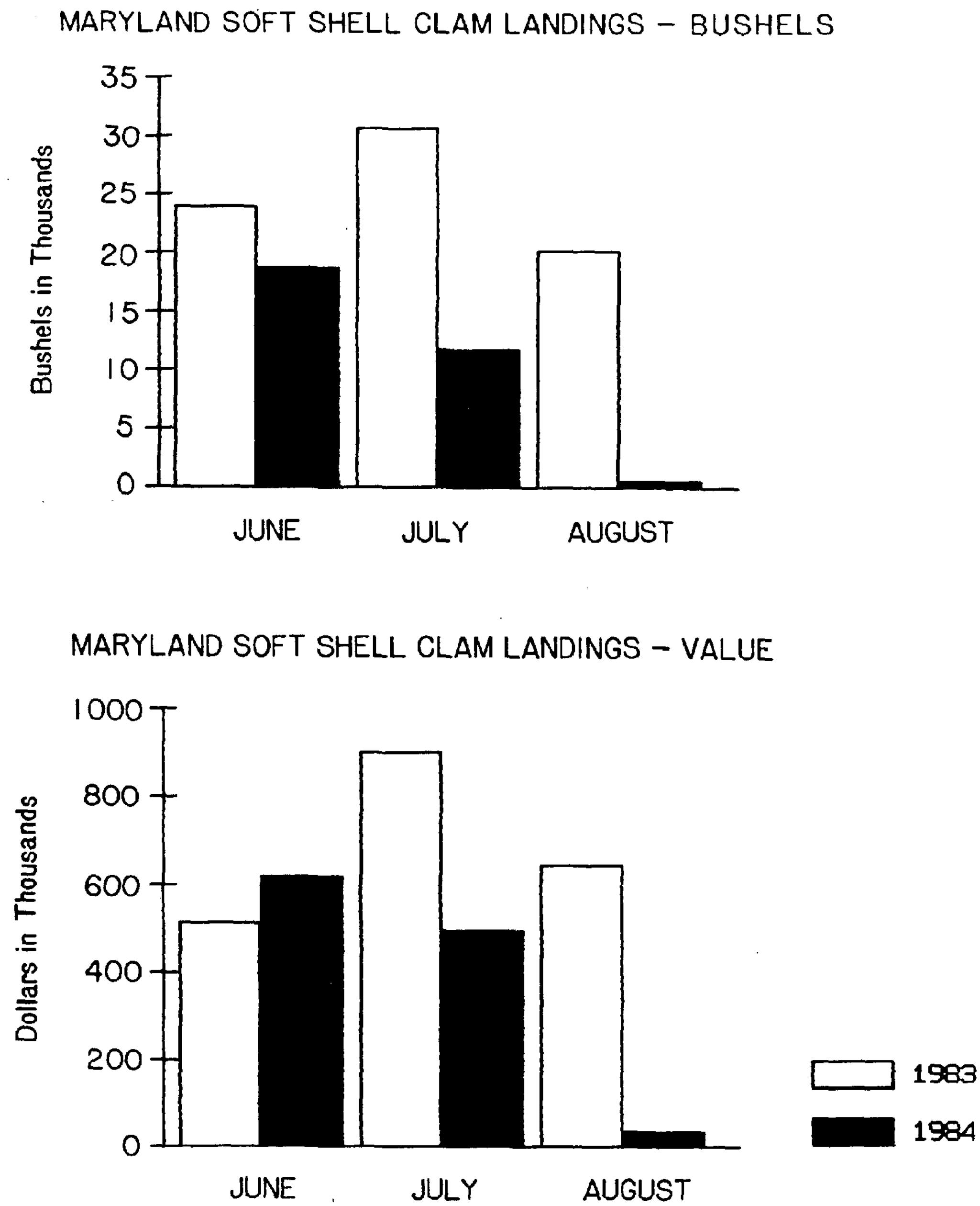


Figure 13.--Maryland soft shell clam landings, June, July, and August 1983, 1984. The effect of low salinities on soft shell clam beds during summer 1984 is seen in landings in June, July, and August. Clam mortalities were detected in June, and landings were lower than in June 1983. Once beds were closed to harvesting in July and August, landings fell 61 percent and 96 percent, respectively, below the same months in 1983.

4.4 Blooms, stinging nettles, submerged aquatic vegetation

Bloom events are summarized in this report from phytoplankton sampling by the Maryland Office of Environmental Programs (OEP). Phytoplankton bloom conditions are generally characterized by a foul odor or a discoloration of the water. To produce bloom conditions, concentrations of at least 1/2 - 1 million cells/ml are generally required. Maryland OEP samples 6 stations along the Maryland poriton of the Chesapeake Bay and 10 stations along the Potomac River on a monthly basis. Additional samples are collected at reported sites of blooms.

There were reports of minor blooms in small creeks or ponds, but Maryland OEP reported no major blooms in the Chesapeake Bay for 1984. The extensive blooms of blue-green algae which occurred in the upper Potomac River in summer and fall 1983 did not recur in 1984. The highest reported cell concentration was 292,894 cells/ml at Smith Point in July. Environmental conditions in summer 1984 were unfavorable for blooms in the upper Potomac estuary, contrasting sharply with conditions in 1983. Water quality in the Potomac improved in the fall of 1984, following extensive flooding of the upper estuary with above normal streamflow in the spring and summer. Also, average temperatures and hours of sunlight were lower than normal, whereas wind speeds were higher than normal in summer of 1984. All of these conditions were unfavorable for high algal concentrations.

Stinging nettles

Stinging nettles appeared later than normal and were present in very low numbers during summer 1984 in areas of the Maryland portion of Chesapeake Bay. Nettles were first observed in Maryland Bay waters about July 8. Site counts by the Chesapeake Biological Laboratory (CBL) at Solomons, MD were well below the long-term average (1960-present). The average daily count did not exceed 5 per day in summer 1984 in the CBL observation area. The 24 year average daily count (July-September) is 100. Below-normal salinities and cooler-than-normal water temperatures during spring 1984 provided unfavorable conditions for stinging nettles in the upper Bay.

Sea nettles detract from swimming and other water-contact pursuits along 85 percent of all Bay beaches. The low number of stinging nettles presents in obviously favorable situation for water-oriented recreation in the Chesapeake Bay area. The fluctuation in abundance of the nettles from year to year is also important in the Bay food web. Scientists at the CBL noted an unusually large number of ctenophores during summer 1984. The ctenophore, a smaller species of jellyfish without tentacles, is a major food item of nettles. Reduced numbers of nettles feeding on ctenophores probably allowed the ctenophore population of proliferate in summer 1984.

Submerged aquatic vegetation

The submerged acquatic plant, *Hydrilla*, showed heavy infestations in areas of the upper Potomac in summer 1984. The Heavy infestations of *Hydrilla* apparently abated in fall 1984 with the seasonal decline in water temperatures. *Hydrilla* is a threat to navigation and recreation and can rapidly infest large areas.

4.5 Icing

Ice cover in late December 1983 and up to three weeks of January 1984 prevented many fishing boats from working in the Maryland portion of chesapeake Bay. Finfishing activities were curtailed even longer in upper Bay tributaries where thicher ice persisted longer into the winter quarter. Ice damaged fishing gear such as anchor gill nets which were set during the onset of the ice cover, though precise damage estimates were unavailable. Cold weather in late December 1983 onset quickly and was intense. Ice began forming in upper Bay tributaries along the Eastern Shore approximately December 20. By December 25, ice completely covered over upper portions of tributaries. Ice thichnesses of up to "12" were reported on January 1.

Oystermen in some areas lost up to four weeks of working time due to ice cover. Ice locked boats in creek and tributary harbors and many productive oystering areas were ice covered. In Maryland, the Governor extended the oyster season for two additional weeks because of lost working time due to icing and the generally poor harvest of the 1983-84 season. Tonging and diving were extended through April 14 and dredging through March 29.

4.6 Diseases

Bay oyster stocks have shown a steady decline following years of poor reproduction in the 1970's and intense fishing pressure. Stocks were further reduced by disease-related mortalities in 1982 following a period of higher-than-normal salinities which provide favorable conditions for the oyster pathogens MSX and Dermo. The widespread oyster mortalities from disease as seen in 1982 have abated following greatly increased annual streamflow which reduced salinities in 1983 and 1984.

5. Recreation

Climate and water quality in the Bay determine much of the recreational use of the Bay area, including boating, fishing, swimming, and camping. Boating licenses indicate potential demand for boating. Recreational boating is an important economic and environmental activity, especially in local areas of the Upper Bay. Bay Bridge traffic indicates indirectly the use of ocean beaches and Eastern Shore recreational facilities. State park attendance and revenue are direct indicators for recreation.

5.1 Recreational Boating

Maryland Department of Natural Resources reports 142,795 boats registered for Maryland waters for 1984. Counting the federally registered yacht owners there are more than 148,000 pleasure boats as candidates for use of Maryland Bay waters at any time. Most of these boats are less than 20 feet in length, most (96 percent) are owned by Maryland residents, and most are registered in Bay counties. Most of the boats are trailered boats kept at home by their owners. Many of the remainder are kept at homeports in Bay counties. Baltimore City and County and Anne Arundel County have the largest number of boat registrations, accounting for 37 percent of all registered boats in Maryland.

Boating fees and licenses generated $1,297,006 (Table 14) in revenue to the state of Maryland in 1984. Approximately 84 percent of these fees were in the Bay counties of Anne Arundel, Baltimore, Calvert, Caroline, Cecil, Charles, Dorchester, Harford, Kent, Prince Georges, Queen Anne, St. Mary, Somerset, Talbot, Wicomico, and Worchester, and the city of Baltimore. Recognizing that registration fees for boats doubled in 1983, fee revenue figures reflect a steady increase year-by-year of persons joining the recreational load to the Bay system. Figures are not presently available to determine the specific impact of weather events on the boating sector of the Bay economy.

Table 14.--Maryland boating licenses and fees, 1978-1984.

License Type	Total Number of Licenses and Fees (thousands)													
	1984		1983		1982		1981		1980		1979		1978	
Boat Dealer	0.724	$18.1	0.7	$17.7	0.6	$15.0	0.6	$14.2	0.6	$14.3	-----		-----	
Original Cost Boat Registration	108.1	$1,297.0	128.3	$1,295.9[1]	117.8	$527.2	124.1	$517.4	111.9	$510.0	113.0	$513.5	125.4	$510.
Original Boat Title	29.0	$58.0	28.6	$56.9	25.6	$51.1	25.5	$50.9	24.9	$49.6	26.9	$53.5	28.1	$55.7
Security Interest Filing Fee	5.8	$87.3	5.8	$86.9	3.5	$52.4	3.4	$51.0	4.0	$56.0	5.2	$77.7	5.4	$81.7
Total All Boat Related Fees		$1,460.4		$1,475.6		$682.5		$642.3		$636.3		$650.9		$709.3

Data from Maryland Department of Natural Resources.

[1] Fees were doubled in 1983.

5.1.1 Marine Advisories

The National Weather Service issues marine advisories and warnings primarily for information to recreational boaters who number over 1,000,000 in the Bay area. During 1984 NWS issued 197 warnings on 89 different days. The greatest number of warnings in 1984 and 1983 were small craft advisories, 161 and 115 respectively (Table 15).

The different conditions leading to NWS advisories appear seasonally distributed in the different regions of the Bay (Figure 14). Small craft advisories for the tidal Potomac (Region 5) and the lower Bay (Region 4) occur predominantly between February and April or between October and November. The small craft advisories for Regions 1, 2, and 3 occur in the same seasons, but on fewer occasions, and the majority are issued in the fall months. Small craft advisories covering the entire Bay are issued predominantly between November and April, reflecting winter wind conditions over the Bay.

Fewer gale warnings were issued during 1984 than during 1983. In 1983 gale warnings were issued in late winter, early spring, early fall, and again in December around the lower Bay and Tidal Potomac River. Gale warnings during 1984 were issued in late winter and early fall. Twenty gale warnings were issued for different regions with February having the highest number (7).

The special marine warnings usually are issued in response to potentially damaging local events such as thunderstorms, tornadoes, or waterspouts, although these localized phenomena may be spawned by major weather systems. Twelve special marine warnings were issued in 1984. Thunderstorms are common in summer months throughout the Bay, usually accounting for most of the special marine warnings. Special marine warnings were issued during May, July, and August 1984.

Table 15.--Marine advisories and warnings, Chesapeake Bay, 1984 (National Weather Service data).

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				1	3	3
B						
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	6	5
B	1	1	1	3	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	4	4	3	5	9	7
B					2	2
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				4	5	5
B						
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	2	3	3	4	4	3
B						
C						
D					4	

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
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	1	1	1		2	1
B						
C						
D					6	

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						
B						
C						
D					4	

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			4	4	2	2
B						
C						
D			1	1		

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	2	2	4	2	2	
B			1	2		
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	1	2	2	2	8	7
B						
C						
D						

DECEMBER

	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	2	1	8	6
B	1	1	2	1	1	
C						
D						

KEY:

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

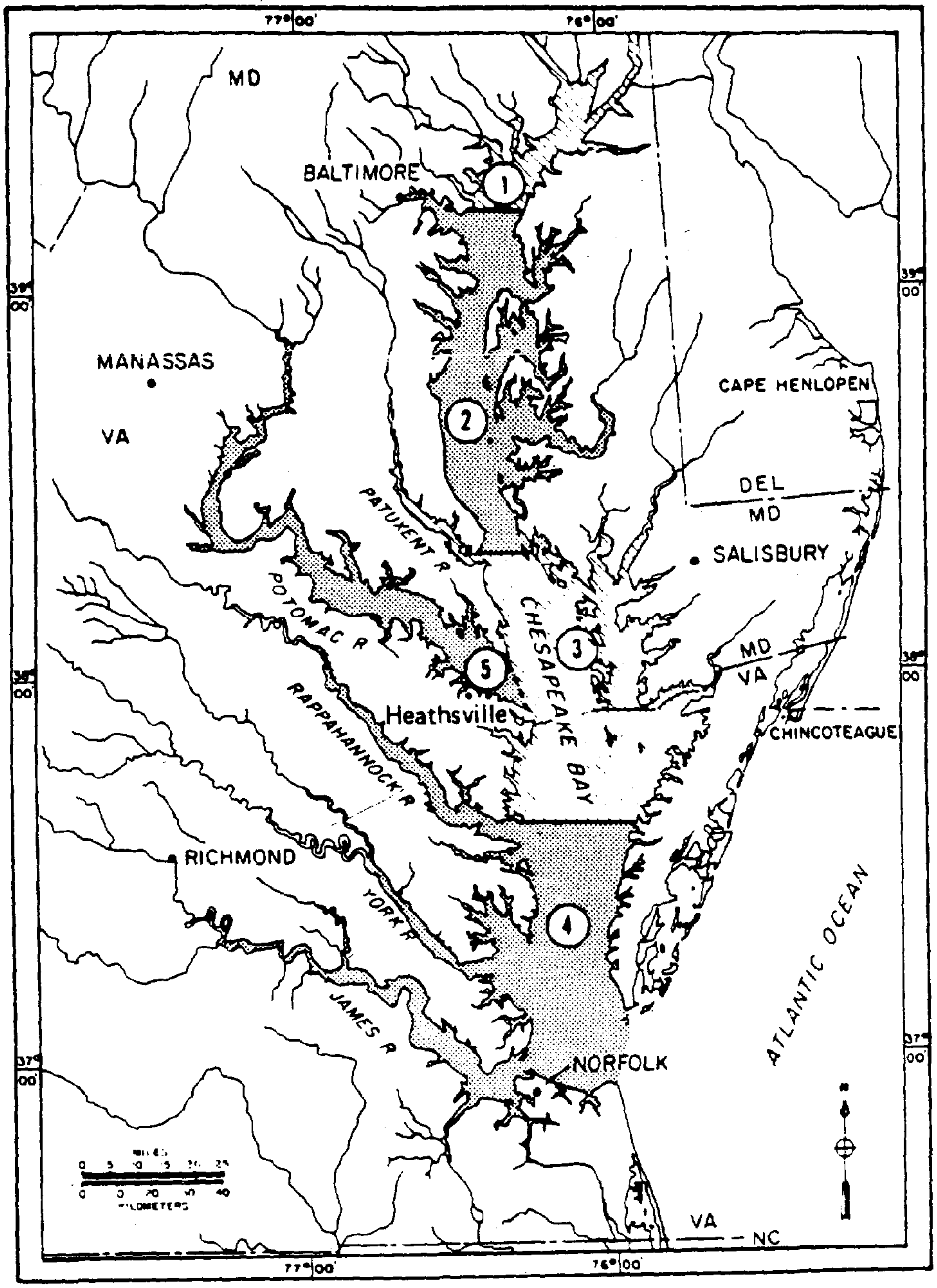


Figure 14.--National Weather Service (NWS) forecast areas for Chesapeake Bay.

Key to forecast areas:

1 = Head of Bay to Baltimore Harbor
2 = Baltimore Harbor to Patuxent River
3 = Patuxent River to Windmill Point
4 = Windmill Point to Mouth of Bay
5 = Tidal Potomac River

5.1.2 Marine Accidents and Search and Rescue Operations

Boating accidents in the marine environment relate to the number of boats on the water and to the weather. During 1984, 25 persons died and 62 were injured in 233 boating accidents in Maryland Bay waters (Table 16). Figures are not available for Virginia portions of the Bay. The Maryland Department of Natural Resources keeps figures for boating accidents where property damage or injury occurs. The Coast Guard recorded 2671 Search and Rescue (SAR) operations for the entire Bay during 1984. (Table 17).

Though the number of boating accidents in Maryland waters during 1984 was only slightly more, 233 in 1984 compared with 220 in 1983, the total cost for property damage was nearly twice as great ($800,819 in 1984 compared with $428,928 in 1983). During July, the usual peak month for boating accidents (and boating), there were 22 fewer accidents in Maryland waters in 1984 (55) than in 1983 (77); however, over the three summer months of June through August 1984 the number of boating accidents in Maryland waters was only 3 fewer than for the same three months in 1983. A rafting accident during high flow rate on the Potomac River May 5th claimed 5 lives. The flow rate was 36,000 cubic feet per second (cfs), compared to the usual May flow rate of 14,700 cfs. A passenger was killed and the boat captain injured on May 28th when lightning struck the 32 foot motorboat they were aboard between Point Lookout and Smith Island, Maryland on the Chesapeake Bay.

Most months of 1984 showed increases in SAR at Group Baltimore over 1983. However, in April, May, and July SAR caseloads were lower than in 1983, perhaps reflecting the cool and wet weather of April and May and the cooler July 1984 compared to the exceptionally fine weather of July 1983.

At Group Norfolk the first four months of 1984 followed the pattern at Group Baltimore, two months of increased SAR followed by a month of no change and a month of decrease. Thereafter their SAR patterns differ. Group Norfolk had a 34 percent increase in May 1984 over 1983, but thereafter had fewer SARs in all months than during 1983. In December 1984 and 1983 the number of SARs was the same, 32. Over the six months from June through November the average number of SARs was 21 percent below the level in 1983. The total number of SARs for Group Norfolk during 1984 was 177 fewer than during 1983.

Group Eastern Shore had 32 fewer SAR operations in 1984 (101) than in 1983 (133). Decreases occurred in the first three months of the year and during June, July, and September.

Table 16.--Maryland accident statistics, recreational boating, 1970-1984.

Year	No. of boating accidents	No. of injuries	No. of deaths	Property damage (thousands)
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

All data from Maryland Department of Natural Resources Marine Police and apply to recreational boating. Includes Potomac River to Virginia shoreline.

Table 17.--Search and rescue operations U.S. Coast Guard, 1982-84.

Month	Group Baltimore			Group Eastern Shore			Group Norfolk		
	1982	1983	1984	1982	1983	1984	1982	1983	1984
January	--	10	14	5	3	1	38	26	29
February	--	9	16	3	3	1	31	15	31
March	29	18	18	2	4	2	39	36	36
April	77	68	66	3	2	2	93	72	57
May	146	132	127	13	9	12	184	156	209
June	162	139	215	19	25	10	182	240	210
July	229	288	216	31	35	20	262	330	239
August	210	156	203	30	22	23	176	207	160
September	149	128	157	34	15	5	151	175	140
October	130	139	142	14	10	14	106	120	97
November	48	52	77	3	4	7	64	59	51
December	20	23	28	3	1	4	37	32	32
Totals	1200	1162	1279	106	133	101	1363	1468	1291

Group Baltimore handles all the Bay North of Smith Point including Potomac River. Group Norfolk 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.

5.2 Bridge Traffic Statistics

Automobile and light commerical traffic on the Bay Bridge has increased every year since 1952 (Figure 15) except 1957 and 1963. Heavy commerical travel has increased at a slower rate.

In 1984 Bay Bridge tolls provided over $17 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 beaches. Warm summer weather strongly influences the revenue of Chesapeake Bay Bridge.

Automobile and light commerical traffic over the Chesapeake Bay Bridge in 1984 was greater for all quarters (7.1 percent) over similar traffic in 1983 (Table 18). The first quarter showed the greatest increase, 10.9 percent, over the same quarter in 1983, and the third quarter showed the least increase, 3.6 percent. Among heavy commercial traffic the first quarter of 1984 also showed the greatest increase (16.4 percent). Over the whole year heavy commercial traffic increased by 11.0 percent. 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 from 1983 to 1984 by $1,254,698 (7.9 percent) while toll charges remained constant.

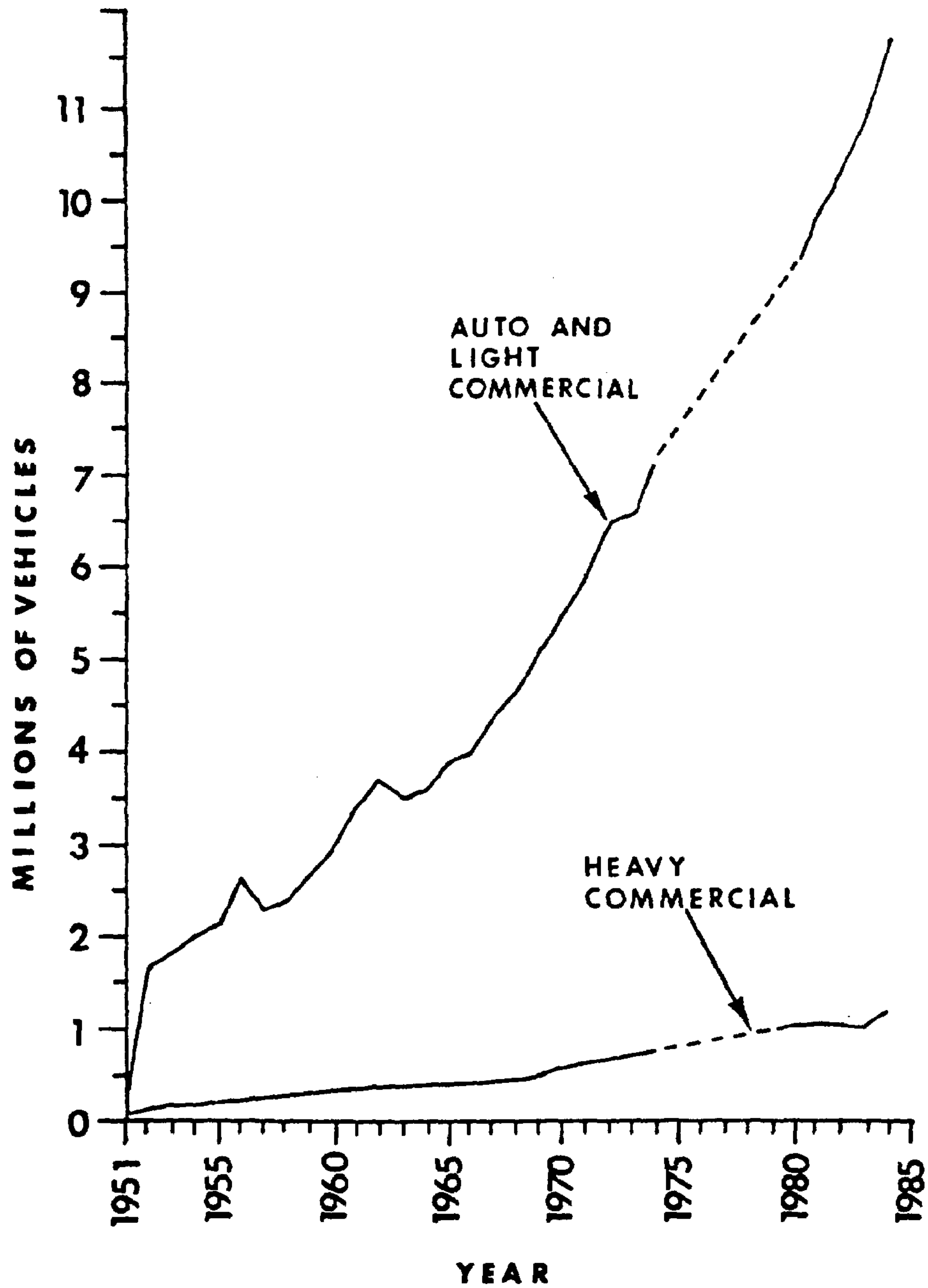


Figure 15.--Chesapeake Bay Bridge vehicle traffic, 1951-1984. (Dashed line indicates data not available for years 1975-1979).

Table 18.--Chesapeake Bay Bridge traffic volume and toll revenue, Maryland, 1983 and 1984.

	1984 Auto & Light Commercial	1984 Heavy Commercial	1984 Toll Revenue	1983 Auto & Light Commercial	1983 Heavy Commercial	1983 Toll Revenue
First Quarter	1,974,038	271,968	$ 3,019,363	1,779,739	233,730	$ 2,680,717
Second Quarter	3,144,061	313,709	$ 4,619,537	2,934,551	278,469	$ 4,258,418
Third Quarter	3,952,302	318,133	$ 5,668,032	3,815,609	298,868	$ 5,457,579
Fourth Quarter	2,609,039	304,801	$ 3,888,228	2,377,592	277,629	$ 3,543,747
Total	11,679,440	1,208,611	$17,195,160	10,907,491	1,088,696	$15,940,462

Data from Maryland Transportation Authority Quarterly Financial Reports March 31, 1984, June 30, 1984, September 30, 1984, and December 31, 1984.

5.3 State Park Activity Levels

The 37 Maryland state parks provide recreation facilities to more than 5 million persons each year. These parks provide useful information about weather effects on recreational activity. Since a majority of the revenue derives from day use, and weather may determine day usage of the parks, the weather directly affects revenue from the parks. Parks around the Bay proper account for 36 percent of all Maryland state parks attendance.

Park attendance during very mild conditions in February 1984 was generally higher than during the comparable period in February 1983. Sandy Point Park and Seashore State Park showed especially large increases during the unusually warm weather in February 1984 compared to the same period in 1983.

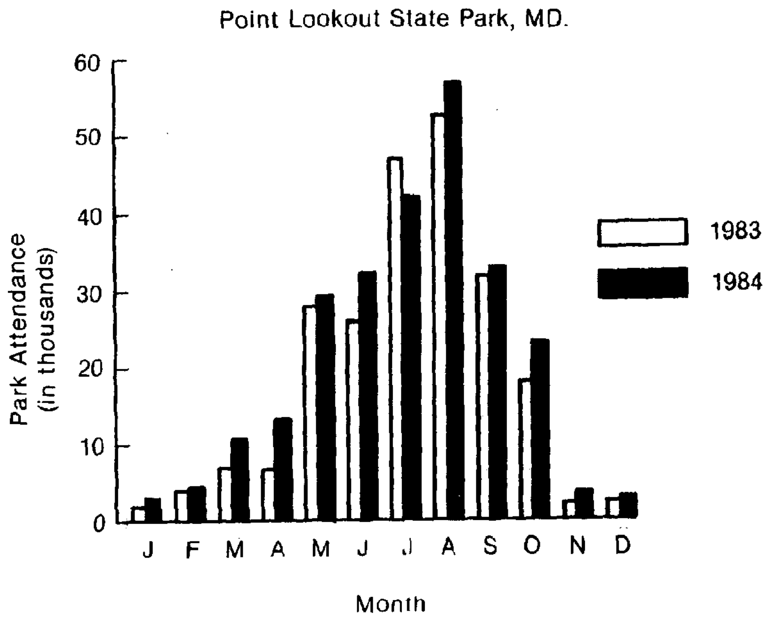
Figures 16 through 18 show increasing attendance as temperatures increase seasonally, though attendance was reduced during periods of cooler-than-normal temperatures and above-normal rainfall. Seashore State Park in Virginia showed greatly reduced attendance in April 1984 (28,990 in 1984 compared to 89,431 in April 1983) due to heavy rainfall and flooded campsites. Attendance at Point Lookout was higher during all three months of the spring 1984 quarter than during the same months in 1983. Increased weekday usage and heavy fishing activity contributed to the increases at Point Lookout. Spring attendance at Point Lookout is closely related to the start of the fishing season and attendance is usually high regardless of weather conditions.

Both Maryland parks showed lower attendance in July 1984 than in July 1983. August 1984 attendance was higher than August 1983 at the Maryland parks. Point Lookout had more park visitations in August than in any other month due to increased crabbing and fishing activities.

Attendance at Westmoreland, Chippokes, and York River State Parks in Virginia was lower in summer 1984 than in 1983. Rainfall over many weekends contributed to the reduced summer 1984 attendance. Attendance in July, normally the peak month for park visitations, was further reduced in 1984 due to the occurrence of the July 4th holiday on a weekday. Attendance at Seashore State Park showed increases in all months of the 1984 summer quarter over summer 1983. Increased daily usage and higher counts from newly installed traffic counters contributed to the increase seen in summer 1984.

Attendance at most parks in October 1984 showed large increases over October 1983. Unusually warm weather in October 1984 provided favorable conditions for outdoor recreation in the Bay area. All parks except Sandy Point showed an increase in attendance in October 1984 over October 1983. Seashore had the largest increase in October (up 174 percent), though higher counts from traffic counters (not in use in 1983) contributed to the increase seen in all months in fall 1984 at Seashore. The warm weather which continued through mid-November contributed to increases in November 1984 attendance over November 1983 at both Maryland parks.

Most of the parks showed large attendance increases during periods of warm weather in December, especially on weekends. Both Maryland state parks showed large increases in attendance over December 1983. All Virginia state parks, except Westmoreland, showed an increase in attendance in December 1984 over December 1983.



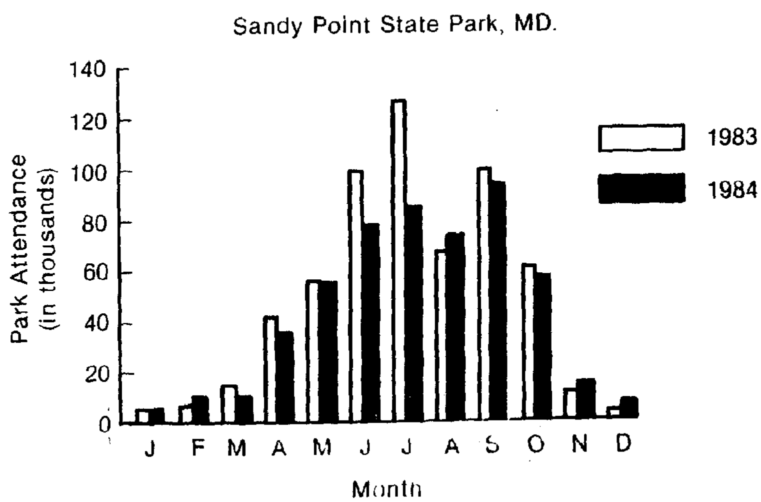
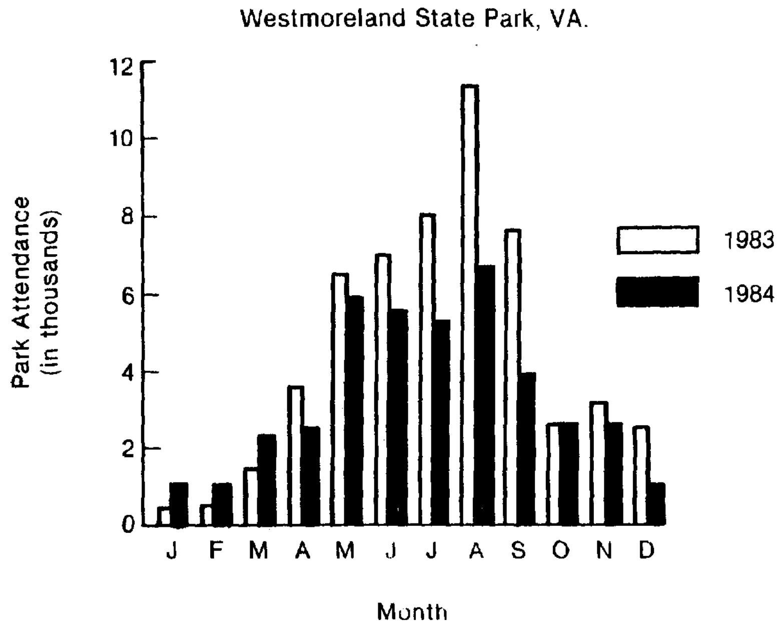


Figure 16.-- Monthly 1983 and 1984 attendance at Point Lookout State Park, Maryland and Sandy Point State Park, Maryland.



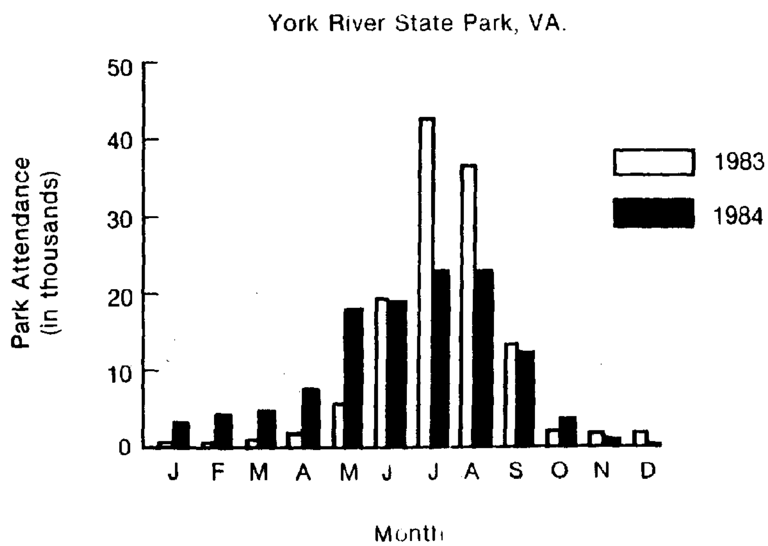
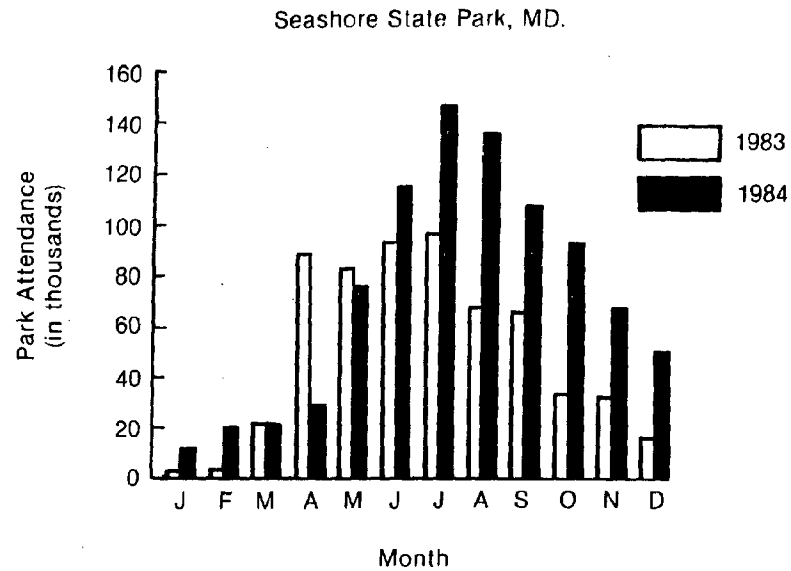


Figure 17.--Monthly 1983 and 1984 attedance at Westmoreland State Park, Virginia and York River State Park, Virginia.



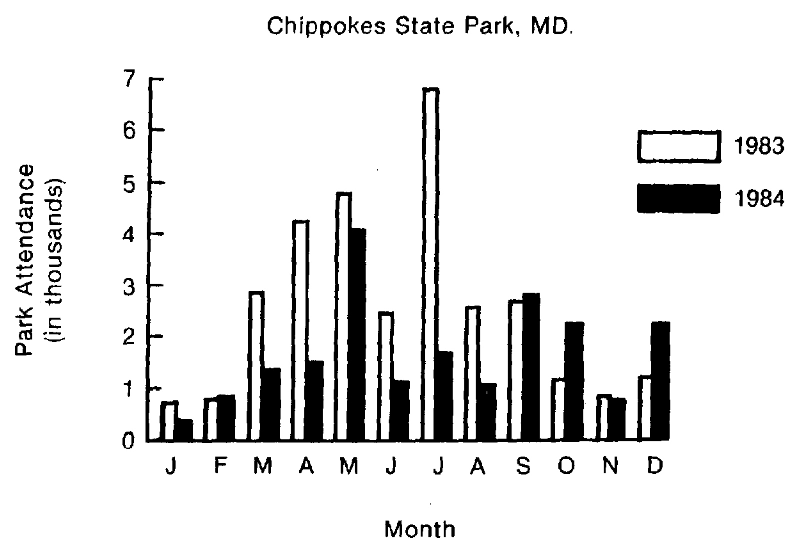


Figure 18.--Monthly 1983 and 1984 attendance at Chippokes State Park, Virginia and Seashore State Park, Virginia.

6. Transportation

The Chesapeake Bay serves as an important resource for transportation both foreign and coastwise in the eastern United States. Heavy usage of an estuary such as the Chesapeake Bay by shipping to Norfolk, Hampton Roads and Baltimore places unusual stress on the Bay. Pollution incidents are more probable with frequent shipping. Dredging of key channels for development and maintenance is a requisite operational expense. Icing in the upper Bay requires clearing during extremely cold winters. Frequent rains in spring 1983 caused unusual numbers of delays in cargo handling in Baltimore and Hampton Roads.

6.1 Shipping and Shore Related Activity

The ports of Hampton Roads and Baltimore account for nearly four-fifths of the export tonnage and one quarter of the import tonnage for all Atlantic ports. Each port handles more than 10 ships per day on the average. Principal cargoes include coal (export), iron ore (import), petroleum (import), and grain (export). Trade through the port of Baltimore reportedly generated more than $1 billion in revenue, $52 million in State and local taxes and employment for 79,000 workers in port-related jobs during 1980 according to a Booz-Allen & Hamilton, Inc., study. Hampton Roads provides similar stimulus to the economy of Virginia. Table 19 shows total export and import tonnages for the two ports for recent years.

Table 19.--Export and import volume Chesapeake Bay ports, 1980-84 (millions of tons).

	1984	1983	1982	1981	1980
Export (Millions of Tons)					
Hampton Roads	42.2	41.0	66.5	*59.8	*58.7
Baltimore	11.1	12.2	20.8	21.5	*21.7
Total Bay Export Cargo	53.3	53.2	87.3	81.3	80.4
Import (Millions of Tons)					
Hampton Roads	7.1	6.7	7.2	*7.1	9.4
Baltimore	13.9	9.4	9.8	12.9	*15.2
Total Bay Import Cargo	21.0	16.1	17.0	20.0	24.6

*Revised figures

Total export tonnage in the port of Baltimore declined 9 percent during the from 1983 totals. This is the fourth consecutive year of decline in shipping tonnage at Baltimore, a total decrease of 49 percent from the record volume of 21.7 million tons in 1980. Although tonnages of cargo handled through Hampton Roads increased slightly, the total volume through the Bay ports remained near its lowest value since 1978.

Imports through the two ports increased significantly during 1984, rising more than 30 percent over the 1983 volume. Baltimore experienced the larger increase (48%).

Shipping and related shore activities at Maryland and Virginia ports proceeded normally during the winter of 1983-84. Ports were accessible throughout the winter months and loading and unloading activities proceeded normally. Main shipping channels were clear of ice at all times with ice limited to the tributaries and shoreline of the Upper Bay.

The port of Baltimore experienced crane shutdowns due to wind (and subsequent additional delays and costs to shippers) for 109 hours during 1984. Most of this lost time was during the period February through May when the cranes were shut down for 82 hours for winds in excess of 40 mph.

6.2 Dredging

U.S. Army Corps of Engineers dredging operations in Chesapeake Bay navigable waters normally follow 5-,6-, and 7-year cycles due to scheduling.

A dredging operation summary for fiscal year 1984 appears in Table 20. During 1984 five projects were contracted by the Army Corps of Engineers in the Chesapeake region. Materials removed totalled 4,518,000 cubic yards at a total dollar cost of $14,103,751. Baltimore Harbor dredging accounted for the largest portion (95 percent) of materials removed during 1984.

Cost increases at Baltimore Harbor ($4,200,605 in 1983 to $13,241,451 in 1984) represent increases in net cost per cubic yard removed from $2.80/cubic yard in 1983 to $3.07/cubic yard in 1984, still below the average net cost per cubic yard in both years for dredging at depths from 6 to 12 feet.

In the Wicomico River, where dredging is being done to 14 feet, net cost per cubic yard removed decreased from $6.62/cubic yard in 1983 to $3.94 per cubic yard in 1984. The overall cost for this contract decreased from $847,654 in 1983 to $532,000 in 1984.

No new dredging projects were undertaken at Ocean City during 1984; however rehabilitation of South Jetty, a $5,000,000 project over a three-year span, continues.

The total cost figures omitting Ocean City suggest net costs per cubic yard of dredged material has decreased slightly over the past year. Net costs per cubic yard of material depend upon the area of operation, the size of the job, and the depth at which dredging is to be performed.

Table 20.--Summary of dredging operations, Maryland Chesapeake Bay region, U.S. Army Corps of Engineers, during fiscal year 1984 (October 1 - September 30).

Project location	Authorized depth	Dredging quantity (cu yds)	Disposal area	Environmental window	Cost
Baltimore Harbor and Channels	12 Ft	4,312,000	Hart-Miller Is.	Jan - Dec 31	$13,241,451
Ocean City Harbor Inlet (Rehabilitation of South Jetty)					5,000,000 over 3 years
Chester River	7 Ft	41,000	Open water	Oct 1 - May 31	175,000
Wicomico River (Webster Cove Shoal)	14 Ft	135,000	Confined unline	Oct 1 - Dec 15	532,300
Potomac River at Mount Vernon	9 Ft	30,000	Open water	Nov 1 - Feb. 28	155,000

Summary of Operations by Fiscal Year

Year	No. of projects	Materials removed	Dollar cost	Cost per unit of material removed
1980	7	1,644,000	$5,200,000	3.16
1981	7	2,700,000	9,600,000	3.56
1982	13	1,450,000	4,934,474	3.40
1983*	7*	1,887,070	6,392,374	3.38
1984*	4*	4,518,000	14,103,751*	3.12

* Does not include projects at Ocean City.

7. Pollution Events Summary

The Chesapeake Bay system is heavily used for conflicting purposes. Oil and hazardous materials enter the Bay waterways only accidentally, but are related to the use of the Bay for transportation and industrial cooling. Manufacturers must dump some waste products into the Bay, and municipal sewage treatment and power generation all require water from the Bay. Only accidential spills and sewage outfall volume appear in this report.

7.1 Accidental Spills of Oil and Hazardous Substances

The U.S. Coast Guard, Department of Transportation, maintains records of spills of all hazardous substances which utlimately may enter navigable waters. Tables 21-24 give information on spills in the Chesapeake Bay region from the Pollution Incident Report System (PIRS) database managed by the Coast Guard. During 1984 a total of 834 spills put 68,543 gallons, 10,522 pounds, and 119 sheens of various pollutants into the Bay and its tributary waters.

The 1984 total of 834 spills in the Bay system shows a large increase over the 504 reported in 1983. The total of all oil spilled in 1984 reached 604 spills, a 47.3 percent increase over 1983. Diesel oil showed the highest number of oil spills in 1984, a total of 248 compared to 172 in 1983. The largest number of spills in 1984 occurred during January, April, June and July. July had the highest for the entire year (Table 22). Spills in excess of 1,000 gallons are listed in Table 23. Most spills originated from onshore fueling, onshore facilities, or tank trucks. Most spills occurred near the major ports of Baltimore, MD and Hampton Roads, VA.

Spills of hazardous substances increased in 1984 (13 in 1984 and 7 in 1983) (Table 24). Pyrethrins, benzyl chloride, ammonia and caustic soda were the main hazardous substances spilled in 1984, originating primarily from onshore industrial facilities. Figure 19 shows the locations of spills of 1,000 gallons or greater in Chesapeake Bay during 1984.

Table 21.--Number of spills by material type, Chesapeake Bay region, 1982-84.

Material	No. of spills 1982	1983	1984	1983-84 % Change
Diesel Oil	130	172	236	37.2
Other Oil	82	144	248	72.2
Residual Fuel Oil	24	36	41	13.9
Other Distillate Fuel Oil	10	18	23	27.8
Crude Oil	0	5	2	-60.0
Waste Oil	42	35	51	45.7
Animal Vegetable Oil				
Total All Oil	288	410	604	47.3
Gasoline	16	31	69	122.6
Other Pollutant	2	13	21	61.5
Other Material	5	18	24	33.3
Unknown	12	10	38	280.0
Natural Substance	2	3	25	733.3
Asphalt or Other Residual	1	5	9	80.0
Hazardous Substance	5	10	42	300.0
Other	2	2	0	100.0
Solvents	0	2	2	0.0
Total Chesapeake Bay region spills	333	504	834	65.5
Total spills, all U.S. waters	10,175	10,969	5,750	N/A
Chesapeake Bay region spills as percentage of all U.S. spills	3.27%	4.59%	14,8.3%	N/A

Preliminary data from U.S. Coast Guard Pollution Incident Reporting System (PIRS). All spills listed here are within latitudes 39°36'N and 36°46'N, longitudes 077°22'W and 075°38'W. Figures for 1983 and 1984 are higher because potential spills are included.

Table 22.--Chesapeake Bay spills of oil, hazardous materials, and other substances by month, 1984.

Month	Oil	Hazardous Materials	Other Substances	Totals
January	70	1	1	72
February	46		1	47
March	42	3	1	46
April	61	2	1	64
May	56	1	1	58
June	64	1		65
July	91	3		94
August	56	1		57
September	51			51
October	45			45
November	21	1		22
December	19			19
Total	622	13	5	640

Note: Does not include potential spills.

Table 23.--Spills of 1,000 gallons or greater, Chesapeake Bay region, 1984.

Materials	Gallons	Date	Location	Source
Residual Fuel Oil:	1500	May 15	37°00'N 76°32'W	Unknown
	6000	Januay 21	39°16'N 76°37'W	Tank Truck
	2100	May 29	38°49'N 77°02'W	Pipeline
	1000	June 15	38°49'N 77°02'W	Power Plant
	2000	July 5	38°49'N 77°02'W	Pipeline
Diesel	6000	January 27	36°57'N 76°19'W	Combatant Vessel
	1000	July 7	37°15'N 75°45'W	Fishing Vessel
	2500	August 28	36°53'N 76°20'W	Onshore Fueling
	1500	September 10	36°56'N 76°21'W	Other onshore facility
	2000	January 10	39°18'N 76°38'W	Tank Truck
	1000	November 5	39°17'N 76°32'W	Rail vehicle cargo
	1500	March 30	39°18'N 76°38'W	Natural Source
Vegetable Oil:	1000	May 14	39°12'N 76°33'W	Other onshore facility
Gasoline:	3500	January 5	37°49'N 75°59'W	Onshore Fueling

Table 24.--Spills of hazardous substances, Chesapeake Bay region, 1984.

Materials	Gallons/Pounds	Date	Location	Source
Pyrethrins:	1 lb.	April 7	39°12'N 76°33'W	Onshore industrial plant
Benzyl Chloride:	465 lbs.	May 20	39°14'N 76°35'N	Onshore industrial plant
Ammonia:	7000 Gals.	June 6	37°12'N 76°37'W	Other onshore facility
Caustic Soda:	1000 Gals.	January 24	39°12'N 76°32'W	Onshore industrial facility
Sulphuric Acid:	650 Gals.	May 1	37°18'N 77°16'W	Onshore industrial facility
	10 Gals.	July 7	36°48'N 76°17'W	Onshore bulk cargo
	90 Gals.	March 22	39°11'N 76°38'W	Onshore bulk storage facility
PCB's:	6 Gals.	August 16	37°17'N 76°42'W	Power plant
Hydrochloric Acid:	100 Gals.	March 15	39°15'N 76°52'W	Miscellaneous
	100 Gals.	March 30	39°10'N 76°30'W	Onshore industrial facility
	83 Gals.	November 6	39°15'N 76°35'W	Tank Truck
Dursban:	1 Gal.	July 26	39°22'N 76°44'W	Other land vehicle

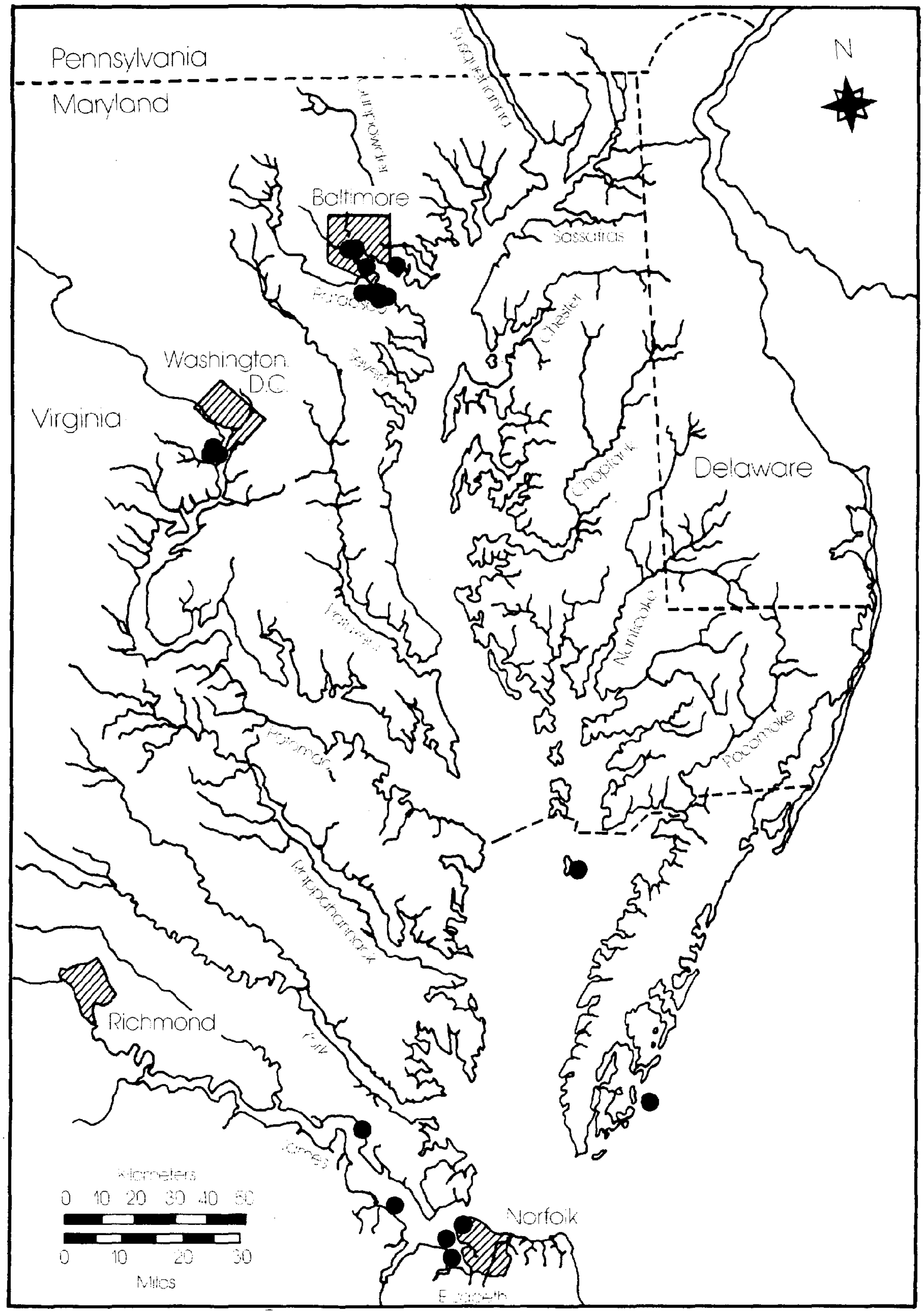


Figure 19.--Locations of spills of 1,000 gallons or greater, Chesapeake Bay region, 1984.

7.2 Sewage Disposal Discharge

Environmental Protection Agency (EPA) studies estimate the Chesapeake Bay drainage basin at 64,000 square miles in six states - Pennsylvania, New York, Maryland, and Virginia, Delaware, and West Virginia. Five hundred eighty-four sewage treatment plants discharge greater than 0.5 million gallons per day (MGD), per plant into the Bay system. Although many smaller plants are operational throughout the Bay region (approximately 400 in Maryland alone), plants with discharge rates in excess of 0.5 MGD of twenty-two treatment facilities are listed in Table 25 for the years 1981-84. Six of the sewage treatment facilities showed an increase in flow in 1984.

Table 25.--Average daily discharge of selected sewage treatment facilities, Chesapeake Bay region, 1981-1984.

Sewage Treatment Plant	Capacity MGD)	Drainage Basin	1981	1982	1983	1984
Blue Plains	650.0	Potomac River	324.0	332.0	*322.0	333.0
Back River	N/A	Upper Chesapeake Bay Delmarva	64.0	76.0	90.0	N/A
Richmond	N/A	James River	63.0	63.8	N/A	N/A
Wyoming Valley Sanitary Authority	40.0	Susquehanna River	31.5	27.5	25.8	N/A
Hopewell	50.0	James River	31.9	28.8	34.2	32.2
Patapsco	52.0	Upper Chesapeake Bay Delmarva	24.9	27.4	36.1	N/A
Blue Plains Bypass	3.0	Potomac River	15.3	17.7	0	N/A
Alexandria	54.0	Potomac River	28.9	32.1	32.9	N/A
Upper Potomac River Commission	21.5	Potomac River	21.5	21.9	19.7	18.4
Arlington Co.	30.0	Potomac River	22.2	25.9	25.4	26.3
Lower Potomac	36.0	Potomac River	22.4	28.2	30.4	33.4
Scranton Sewer Authority	28.0	Susquehanna River	20.2	16.0	14.3	N/A
Lamberts Point	30.0	James River	21.3	25.2	23.9	N/A
Harrisburg	30.1	Susquehanna River	19.6	22.6	25.6	N/A
Binghampton-Johnson City	18.3	Susquehanna River	14.0	17.2	*19.5	20.3
Chesapeake-Elizabeth	30.0	James River	19.9	25.1	22.2	16.8
Boat Harbor	25.0	James River	17.6	18.9	18.2	17.4
York City	26.0	Susquehanna River	16.0	16.3	18.2	18.4
Piscataway	30.00	Potomac River	13.9	15.3	17.3	16.2
Western Branch	30.0	Upper Chesapeake Bay Delaware	9.9	10.4	11.3	11.2
James River	20.00	James River	13.9	15.8	14.7	N/A
Army Base	18.0	James River	11.5	12.9	13.4	14.1

N/A = Not available

ACKNOWLEDGMENTS

Many organizations and individuals contributed information and guidance toward the preparation of this assessment. The cooperation offered by the following is particularly noteworthy:

Army Corps of Engineers, Baltimore District
    Navigation Branch
Chesapeake Research Consortium
Cooperative Weather Station Observers
    Ross Aviation, Inc., Aberdeen, MD
    John L. Swaine, Jr., Royal Oak, MD
Hampton Roads Maritime Association
Maryland Department of Environmental Programs
Maryland Department of Natural Resources
    Natural Resources Marine Police
    Forest, Park, and Wildlife Services
    Tidal Fisheries
    Licensing and Consumer Services
Maryland Highway Toll Administration
Maryland Pilots Association
Maryland State Climatologist
Maryland Steamship Trade Association
Metropolitan Washington Council of Governments
NASA/Goddard Space Flight Center
Naval Oceanographic Command Detachment, Patuxent River, MD
NOAA/National Environmental Satellite, Data, and Information Service
NOAA/National Marine Fisheries Service
    Office of Data and Information Management
    Oxford Laboratory
NOAA/National Ocean Service
    Tidal Datums Branch
NOAA/National Weather Service
    Baltimore Weather Service
    Harrisburg Weather Service Office
    Norfolk Weather Service Office
    Richmond Weather Service Office
    Washington Dulles Weather Service Office
    Washington Weather Service Forecast Office
        Marine Service Warning and Forecast Unit
    Wilkes-Barre-Scranton Weather Service Office
    Williamsport Weather Service Office
Potomac River Fisheries Commission
T. L. Courtney, Independent Commercial Fisherman
University of Maryland
    Chesapeake Biological Laboratory
U.S. Coast Guard
    Group Baltimore
    Group Eastern Shore
    Group Norfolk
    Pollution Information Reporting System
    Balitmore Safety Office
    Public Affairs Office
    District Office - Hampton Roads

ACKNOWLEDGEMENTS (Continued)

U.S. Geological Survey
Virginia Water Control Board
Virginia Institute of Marine Sciences
Virginia Department of Conservation and Economic Development
Division of State Parks
Virginia Marine Resources Commission

☆ U.S. Government Printing Office : 1985 - 461-135/36654

U.S. DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
ASSESSMENT AND INFORMATION SERVICES CENTER, E/AI1
Washington, DC 20235

AN EQUAL OPPORTUNITY EMPLOYER

OFFICIAL BUSINESS
Penalty for Private Use. $300

POSTAGE AND FEES PAID
U.S. DEPARTMENT OF COMMERCE
COM-210

FIRST CLASS