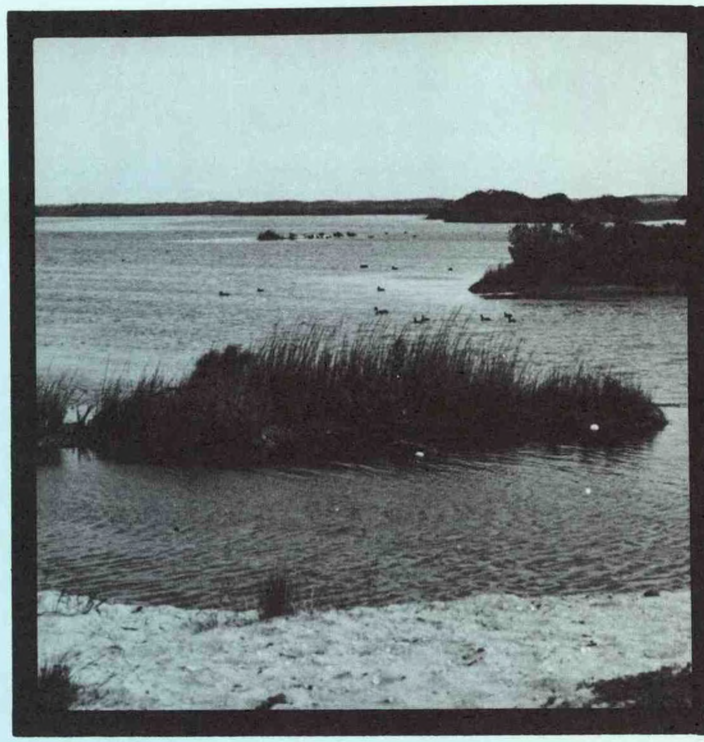
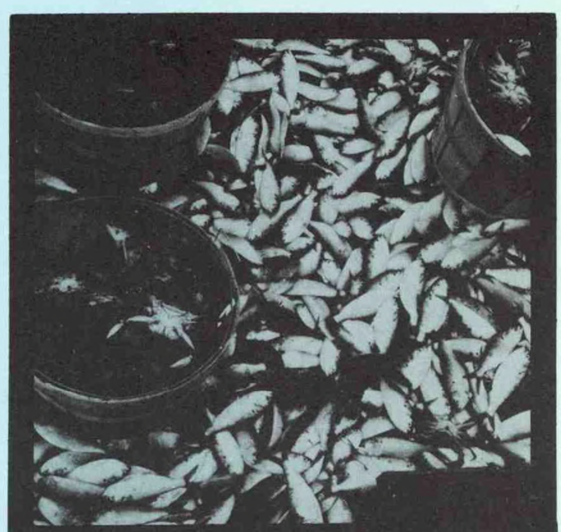


Marine Environmental Assessment
CHESAPEAKE BAY
ANNUAL SUMMARY 1983



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

CLIMATE IMPACT ASSESSMENT
UNITED 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 1983

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

Marine Assessment Branch
Marine Environmental Assessment Division

Washington, D.C.
October, 1984

U.S. DEPARTMENT OF COMMERCE
Malcolm Baldrige, Secretary

National Oceanic and Atmospheric Administration
John V. Byrne, Administrator

National Environmental Satellite, Data, and Information Service
John H. McElroy, Assistant Administrator

Assessment and Information Services Center
Joan C. Hock, Director

Chesapeake Bay Marine Environment - 1983 Annual Summary

Table of Contents

List of Figures

List of Tables

1. Introduction

The Chesapeake Bay 1983 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 from several sectors are brought together for a single viewing. 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 sections. 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 1983. 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 1983. 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 Chesapeake Bay and all tributaries in the drainage basin contributing to the Bay waters. We present a summary of weather and oceanographic events during 1983 over the region. Coverage is only for calendar year 1983, 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 1982 or to 1984 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 regimes in the Bay which in turn relate to precipitation and air temperature and to general coastal conditions over a broader span of space and time. Harvest of the commercial 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, Chesapeake 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.

1.3 Future Work

The Assessment and Information Services Center, Marine Environmental Assessment Division recognizes the need for extension of this assessment to other sectors and more detailed and rigorous analyses in those sectors already discussed. The industrial complex surrounding the Bay includes heavy manufacturing (steel, automobiles), food processing (spices, sugar), refining, shipbuilding, and chemicals. The use of water in each of these industries contributes to the quality of water entering the Bay system.

In fisheries the assessment may ultimately treat species specific problems. The analysis should treat species life stages sensitivity to environmental conditions.

Future work in the recreation sector will include assessment of sport fishing, marina usage, and sales of recreational equipment.

In transportation the detailed distribution of Search and Rescue (SAR) in categories of damage, injury, cost, and geography may enhance the usefulness of the assessment. The costs related to maintenance of navigational aids and icebreaking are of interest to port authorities.

The discharge of heated water from power generation loads the Bay system with waste energy. While local changes to the system can be measured at present, the cumulative impact of heat loading on the Bay ecosytem needs to be assessed.

Finally, the Chesapeake Bay assessment will increase in convenience to each user if sensitivity scales for impacts can be derived. For each sector or resource factor (e.g. streamflow, salinity change, temperature anomaly, wave height, number of rain days) the assessor needs to know not only if the impact is positive or negative, but the degree of impact.

Table 1. Climate impact summary, Chesapeake Bay, 1983.

IMPACT SECTOR

EVENT	FISHERIES: Finfish harvest activities (general)	Shellfish harvest activities (gen.)	Oyster population (impact of MSX)	Croaker 1982 yearclass	Blue crab harvest	Stinging nettles	Bumper crop peeler & soft crabs	Menhaden	Juvenile summer flounder	RECREATION: Boating activity	Bridge traffic	Park usage	Safety	TRANSPORTATION: Port operations	Vessel traffic	Cost to shippers
Mild 1982-83 winter	+	+		+												
Low ice coverage, Jan., Feb.	+	+												+	+	
February snowstorm														−		
Below normal spring water temp.					−	−										
April squalls													−			
Lightning													−			
High spring precipitation			+													
High streamflow, Apr., May			+													
Below normal salinity, May, June			+			−										
Low rainfall, July, August	+	+								+	+	+	+	+		+
Low storm activity, July, Aug.	+	+								+	+	+	+	+		+
High air temp., July, August										+	+	+	+			
Delayed arrival stinging nettles										+		+	+			
High amounts sunlight, July										+	+	+	+			
Algal blooms										−		−	−			
Mild fall air temperatures	+	+								+		+	+			
Low dissolved oxygen								−								
Tropical storm Dean	−	−								−		−	−			
Low fall storm activity	+	+								+		+	+			
Below normal Dec. water temp.									−							

+ Favorable

− Unfavorable

(blank) No identifiable effect, data unavailable, or not applicable

2. Impact Summary

Economic sectors in the Bay area responded to anomalies in temperature and precipitation in 1983, as seen in the mild winter of 1982-83, the wet and cool spring, and the hot, dry summer. MSX disease in oysters became greatly reduced; watermen experienced a bumper year for soft and peeler crabs, though prices for hard crabs reached record highs; and Bay recreation showed substantial increases over 1982.

Table 1 summarizes impacts of climate events in 1983 by economic sector.

Fisheries

Watermen had unrestricted access to fishing grounds during the extremely mild winter of 1982-83. The abnormally mild air and water temperatures resulted in less than ten percent ice cover, the lowest in at least seven years.

Warmer-than-normal water temperatures during the 1982-83 winter favored the survival of the highly successful 1982 year class of croaker which over-wintered in Chesapeake Bay.

The normal springtime activity pattern of blue crabs was delayed due to cooler-than-normal water temperatures. The delay in crab activity and market conditions pushed crab prices to record highs. Crab meat sold for as much as $17.95 per pound, and live crabs sold for $75 per bushel in Baltimore during the peak of the shortage.

MSX disease in oysters was reduced to non-detectable levels in areas of the Upper Bay which had experienced extensive oyster mortalities during the 1982 oyster season. High rainfall during spring 1983 greatly reduced Bay salinities, providing unfavorable conditions for MSX, which prefers salinities above 15 parts per thousand.

Watermen experienced a bumper year for soft and peeler crabs, the result of a good hatch and excellent survival of the 1982 year class. Hard shell blue crabs of the 1982 year class reached market size in late summer and were plentiful through the fall months.

Unusually low rainfall and low storm activity July through September provided favorable conditions for all categories of fishing activities.

Above normal water temperatures and generally calm conditions in September provided favorable conditions for bloom organisms. Several menhaden kills were reported in Maryland in September, due probably to oxygen depletion.

Unusually cold water temperatures observed in late December 1983 increased the mortality rate of juvenile summer flounder in the York River coinciding with the peak infection period of a blood parasite.

Maryland striped bass landings were the lowest on record, continuing the sharp decline in the fishery for the Bay's most valuable finfish.

Recreation

Lowered salinities and cooler-than-normal water temperatures during the spring 1983 delayed the arrival of stinging nettles three weeks later in the summer than normal.

Intense squalls on April 17 capsized dozens of boats on the Potomac River and portions of middle Chesapeake Bay and injured at least 12 persons. Lightning caused a death on a small boat in May on the Severn River.

Recreational activity around Chesapeake Bay was unusually high in July and August as reflected by boating activity and park usage. The low incidence of major storms and generally mild air temperatures also provided favorable conditions for recreation through most of fall 1983 except during several rainy weekends and Tropical Storm Dean in late September.

Extensive blooms of blue green algae occurred in a 20-mile stretch of the upper Potomac River in summer and fall 1983. The presence of the algae deterred most recreation activities and was a safety hazard for swimming in that area.

Transportation

The Port of Baltimore experienced short-term delays in cargo handling due to the heavy snowstorm of February 11.

Unusually low rainfall in July and August resulted in savings to shippers from minimal rain delays.

3. Weather and Oceanography

Following a January with less-than-normal precipitation at all the 11 stations in Figure 1, Chesapeake Bay area stations received larger-than-normal rainfalls from February through June, with most stations receiving more than twice normal precipitation during April (Table 2). Dry weather dominated the months of July and August, and most of September. October, November and December showed increasingly above-normal precipitation. At year's end all stations except for Richmond had precipitation totals above their normals (Table 2).

Air temperatures around the Bay were warmer-than-normal during the first three months of the year (Table 3). Temperatures became markedly cooler-than-normal in April and continued cooler-than-normal, with gradual recovery, through June. July and August temperatures were above normal. Although the area average temperature for September to November remained near normal, the individual stations showed much variability, from 2.4°F below normal (Williamsport, October) to 2.9°F above normal (Aberdeen, November). In December temperatures averaged well below normal (3.0°F), in strong contrast with the warmer-than-normal temperatures during December 1982.

3.1 Review of Events

January was warmer and drier than normal at all area stations. Very little icing occurred in the Bay. Minor flooding in the Norfolk area accompanied a coastal storm on the 28th. Four other storms occurred during the month.

February continued warmer-than-normal temperatures, particularly among the more northern stations. Precipitation exceeded normal amounts except for northern stations. A mid-February snowstorm dropped nearly 2 feet of snow in much of the Bay area. Five additional storms passed through the area during the month.

March was warm and very wet throughout the region, setting precipitation records at Baltimore and Harrisburg. Tides pushed by storm winds during the latter half of the month caused minor coastal flooding along the lower and middle portions of the Bay.

April was very wet and cool. Record-setting amounts of precipitation fell in the Wilkes-Barre area, much of it during a coastal storm April 15th and 16th. Greatly increased streamflows resulted from the heavy rainfall.

May continued the relative coolness of April but with more moderate excesses of precipitation.

June temperatures averaged nearly normal. Precipitation was quite variable around the Bay.

Warm and very dry weather characterized the month of July. Only a trace of rain fell at Abeerdeen during the entire month. Other stations received between 0.51 inches and 3.38 inches.

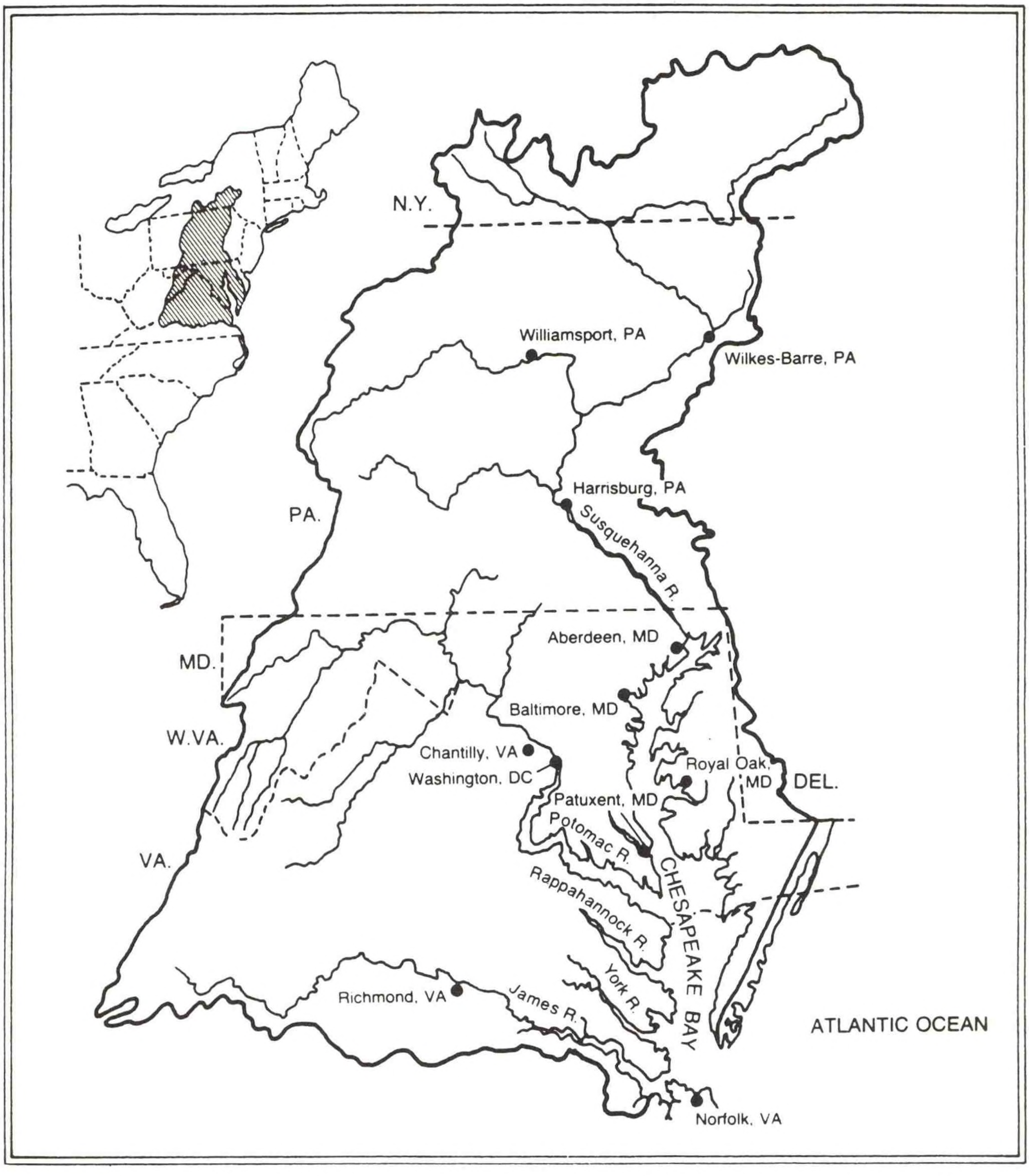


Figure 1. Selected meteorological stations, Chesapeake Bay watershed (Modified EPA map).

Table 2.--Normal monthly mean total precipitation (1951-1980) and departure from normal, selected stations, Chesapeake Bay region, 1983.

A. Normal monthly total precipitation (inches)

Station	Month												
	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, 1983 (percent)

Station	Month												
	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Annual total
Williamsport, PA	-38	-34	-17	99	23	43	-14	13	-47	-7	62	102	17
Wilkes-Barre, PA	-48	-29	25	218	4	41	-19	-49	-37	-2	25	159	23
Harrisburg, PA	-24	24	39	150	46	-23	-71	-24	-61	54	63	133	24
Aberdeen, MD	-12	-12	91	156	18	64	-100	11	-32	66	39	152	35
Baltimore, MD	-26	61	83	96	59	39	-66	-66	-49	15	61	98	22
Washington, DC	-39	18	40	135	33	112	-54	-29	-10	68	77	86	33
Chantilly, VA	-51	42	23	131	0	-5	-75	-68	-10	99	69	72	14
Royal Oak, MD	-49	3	83	165	75	74	-81	-27	3	-9	46	139	32
Patuxent, MD	-36	27	101	196	40	112	-80	-31	24	80	48	116	44
Richmond, VA	-51	26	69	80	-30	52	-90	-81	-13	7	71	33	-1
Norfolk, VA	-41	90	18	114	-6	11	-85	-42	4	55	13	92	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 1983 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, 1983 (Deg. F)

Station	Month												
	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Annual average
Williamsport, PA	3.1	3.3	3.4	-1.7	-3.3	-2.0	-0.3	0.0	-1.9	-2.4	-1.3	-4.0	-0.6
Wilkes-Barre, PA	2.1	2.6	2.7	-2.4	-2.9	0.2	0.6	1.6	2.0	0.8	1.9	-2.6	0.6
Harrisburg, PA	3.6	2.0	2.1	-2.9	-3.6	-2.1	0.1	0.6	-0.7	-1.4	-0.1	-4.7	-0.6
Aberdeen, MD	2.4	2.1	3.8	-2.4	-1.7	-0.7	1.9	3.1	1.8	-0.3	2.9	-1.5	0.9
Baltimore, MD	1.9	-0.5	2.1	-2.2	-1.9	-0.1	1.9	2.4	0.6	0.4	0.8	-3.2	0.2
Washington, DC	2.9	1.2	3.0	-2.9	-1.1	0.5	2.3	3.4	1.5	1.1	1.6	-2.9	0.9
Chantilly, VA	3.3	1.4	3.6	-3.1	-2.9	-0.7	-0.9	1.0	-1.2	-0.6	-0.1	-4.8	-0.5
Royal Oak, MD	2.0	0.6	2.6	-2.7	-1.3	0.0	1.5	1.2	0.4	0.7	1.2	-2.2	0.4
Patuxent, MD	1.0	0.1	2.6	-1.3	-1.0	1.2	2.7	3.2	1.4	0.9	2.1	-1.4	1.0
Richmond, VA	1.2	0.2	3.2	-1.8	0.0	2.1	1.6	1.1	-1.4	-0.5	0.1	-3.7	0.2
Norfolk, VA	0.3	-0.3	2.5	-2.5	-0.6	-1.3	1.9	1.3	0.6	1.4	0.7	-1.9	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

August was hot and dry. Temperatures exceeded 100°F at several stations. Thunderstorm wind gusts exceeding 60 mph were recorded August 31st at the south end of the Bay.

September total precipitation remained lower than normal despite heavy frontal rains and the passage of Tropical Storm Dean over the lower Bay on the 29th and 30th. Temperatures ranged from record highs during the first two-thirds of the month to record lows the last third of the month.

October was marked by frequent rains and cloudy weather.

November was warmer and wetter than normal. A blustery cold front on the 25th brought traces of snow to much of the area.

Precipitation for December averaged more than twice normal, ranking the month as the wettest December on record at Wilkes-Barre, Royal Oak, and Norfolk. Temperatures averaged 3 degrees below normal, having fallen to record lows over the 24th to the 26th, which resulted in ice formation in the upper Chesapeake Bay.

3.2 Precipitation

Precipitation data (Table 2) show the 11 stations in Figure 1 had normal or above-normal precipitation during 1983. Only Richmond's annual total is below normal (-1 percent) while the remaining totals range from 9 percent above normal at Norfolk to 44 percent above at Patuxent. Precipitation among the stations in 1983 exceeded that in 1982 by 25 percent.

Precipitation among the 11 stations in January 1983 averaged 38 percent below normal with deficits ranging from 12 percent below at Aberdeen to 51 percent below at both Chantilly and Richmond. Precipitation in 1983 was from 25 percent lower (Washington) to 57 percent lower (Wilkes-Barre) than in January 1982.

February precipitation averaged 22 percent above normal, ranging from 34 percent below at Williamsport to 90 percent above at Norfolk. A snow storm on the 11th deposited near record amounts in the Baltimore to Aberdeen area along the upper Chesapeake Bay. Southern portions of the Bay received much rain from coastal storms on the 14th and 17th. Precipitation in February 1983 averaged 6 percent less than in 1982 with comparisons ranging from 76 percent greater at Harrisburg to 36 percent lower at Wilkes-Barre than in 1982.

In March precipitation was well above normal and in excess of that in 1982 by nearly 90 percent. Average precipitation was 51 percent above normal, ranging from 17 percent below normal at Williamsport (the only below normal station) to 101 percent above normal at Patuxent. Five stations in the central part of the Bay region had precipitation amounts of 6 inches or more. Streamflow remained slightly below normal at month's end.

April precipitation, which exceeded that in 1982 by 108 percent, averaged 139 percent above normal for the 11 stations. Amounts ranged from a low of 80 percent above normal at Richmond to a high of 218 percent above normal at Wilkes-Barre, where 9.56 inches of rain fell during the month. In April Williamsport, for the first time since June 1982, had above-normal precipitation. Though precipitation was frequent during the month, a storm on the 15th and 16th deposited record amounts of rainfall in the Pennsylvania area. Streamflow, responding strongly to the excess rainfall, reached a new record high for the month.

May precipitation, which averaged 21 percent greater than in 1982, ranging from 28 percent below 1982 amounts at Richmond to 196 percent above 1982 amounts at Baltimore, was down sharply from that of April. Precipitation averaged 24 percent above normal among the 11 stations and ranged from 30 percent below normal at Richmond to 75 percent above normal at Royal Oak. Streamflow declined from its April high, but it still remained above normal.

In June precipitation, much of it resulting from active frontal systems on the 18th, the 21st, 22nd, and 28th, averaged 46 percent above normal and ranged from 23 percent below normal at Harrisburg to 112 percent above normal at both Washington and Patuxent. Thunderstorms over the 21st and 22nd deposited nearly 7 inches of rain at Patuxent. June precipitation was 10 percent lower than that in 1982.

July brought very dry weather to the region. Precipitation, which was 67 percent below that in 1982, averaged 69 percent below normal for the 11 stations and ranged from 14 percent below normal at Williamsport to 100 percent below normal at Aberdeen, where only a trace of rain fell during the month.

Dryness persisted in August as precipitation for the 11 stations averaged 38 percent below normal, ranging from 13 percent above normal at Williamsport to 81 below normal at Richmond. August precipitation was 10 percent below that in 1982, but comparisons varied widely from station to station. Streamflow at the end of August was 40 percent below normal.

Frontal rains at the beginning of September and twice during the middle of the month, as well as Tropical Storm Dean near the end of the month, did not entirely overcome the tendency toward dryness continuing from July and August. This was most apparent in the northern part of the region where precipitation deficits of 40 percent were present at several stations. Small excesses at stations on the Bay from Royal Oak to Norfolk helped to shift the average precipitation for the 11 stations upward to 21 percent below normal from the 38 percent below in August. Rainfall amounts in September 1983 were 7 percent below those in 1982. Streamflow remained below normal.

October brought a return to frequent rains and above normal precipitation, 37 percent above normal for the region and 126 percent above that of a year ago. Six stations had precipitation totals ranging from 54 to 99 percent above normal, and, of the remaining stations, three where slightly below normal and two where slightly above. Rainfall from a frontal occlusion on the 23rd exceeded that from any of the other occasions. Streamflow continued below normal.

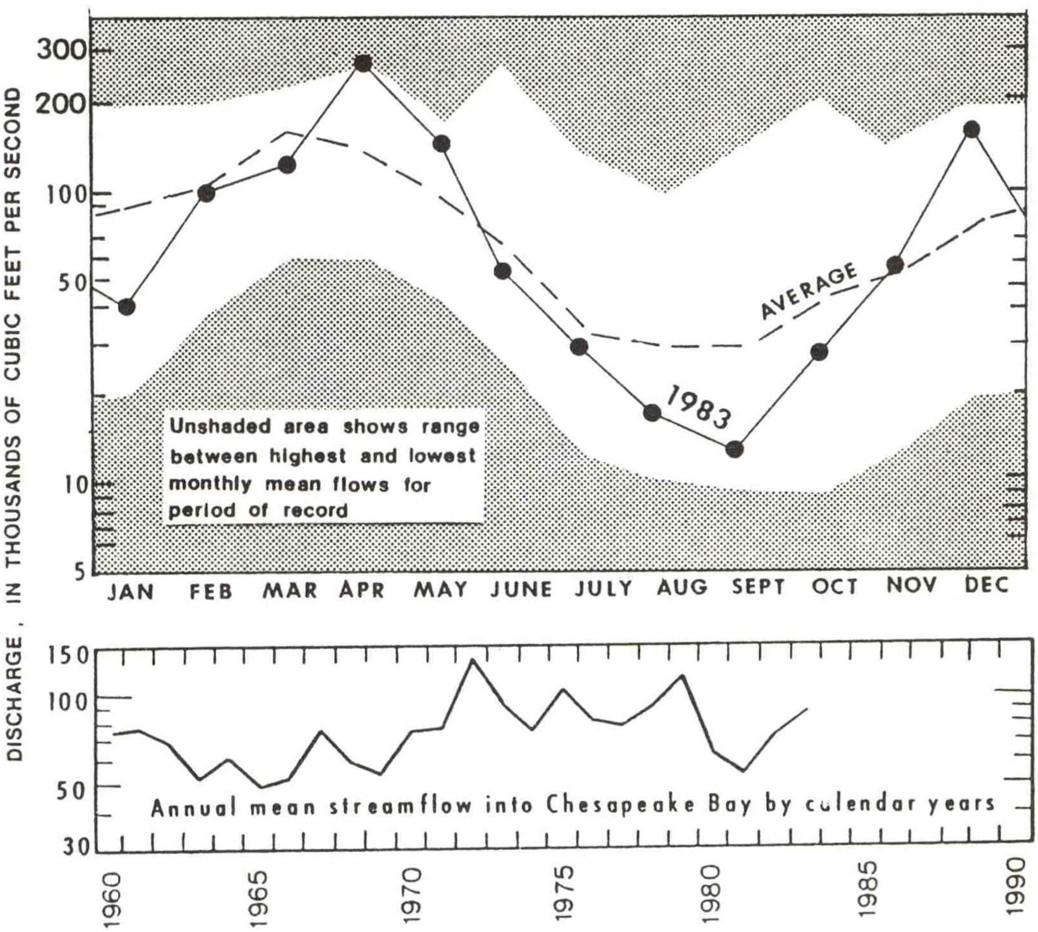
Precipitation in November, principally from six major weather systems, averaged 52 percent above normal, ranging from 13 percent above normal at Norfolk to 77 percent above normal at Washington, and exceeded that in 1982 by 35 percent. Streamflow rose by the end of November to just over normal.

In December a series of frontal storms produced an average of 6.73 inches of precipitation, 107 percent above normal and 174 percent above that of the previous December, among the 11 stations. Precipitation excesses ranged from 33 percent above normal at Richmond to 159 percent above normal at Wilkes-Barre. It was the wettest December on record at Wilkes-Barre (where flooding occurred over the 12th and 13th), Royal Oak, and Norfolk, and the second wettest at Williamsport. Streamflow by the end of December was far above normal.

3.2.1 Streamflow

During 1983 the streamflow entering the Bay ranged both well above and well below established monthly normal flows. January was moderately dry over the region and is reflected by well-below-average flow for the month (Figure 2). February and March experienced near normal runoff into the Bay. April 1983 established a new high flow record for the month, when more than a quarter of a million cubic feet per second came into the Bay. The Susquehanna River which normally contributes 57 percent of the flow contributed 49 percent in this month, while the Potomac River which normally contributes only 17 percent of the flow, contributed 22 percent of the month's freshwater input (Table 4). May showed higher-than-normal flow, creating a five month cumulative excess of almost two trillion gallons of freshwater runoff in the Bay (Figure 3). The runoff figures are reflected in lowered salinities all around the Bay (see section 3.4) and the disappearance of MSX disease from Bay oyster stocks (see section 4.6).

Lower-than-normal freshwater flow occurred in June through October but not on the order of the excesses in April and May. By November, which had normal runoff, the cumulative streamflow still registered more than one trillion gallons excess. December 1983, however, yielded very high streamflow (167,000 cfs) which brought the total annual excess cumulative streamflow to nearly three trillion gallons. Salinities around the Bay reflected the volume of freshwater throughout the Bay (see section 3.4).



Streamflow around the Bay was near normal except during four individual months. January and September flows were more than 50 percent below normal. April and December flows were 85 percent and 113 percent, respectively, above normal. The flow for April 1983 was the largest April flow on record and the largest single monthly flow ever on record. This volume of freshwater contributed to downward salinity adjustments in the Bay which eliminated the outbreak of MSX disease in Maryland oysters.

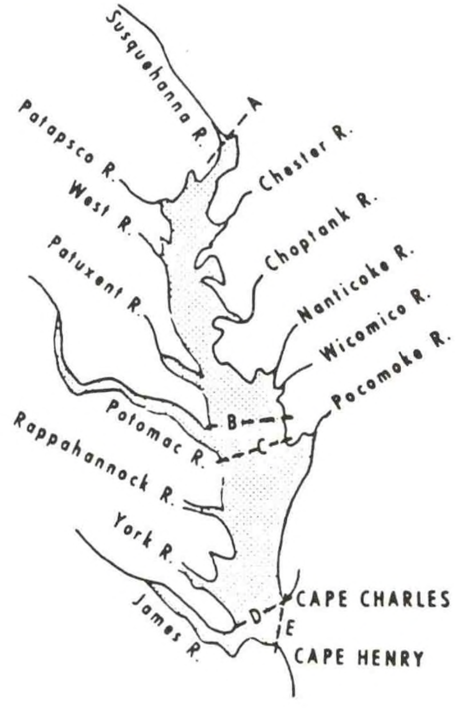
Figure 2.--Monthly mean streamflow into Chesapeake Bay, 1983, and annual mean flow 1960-1983.

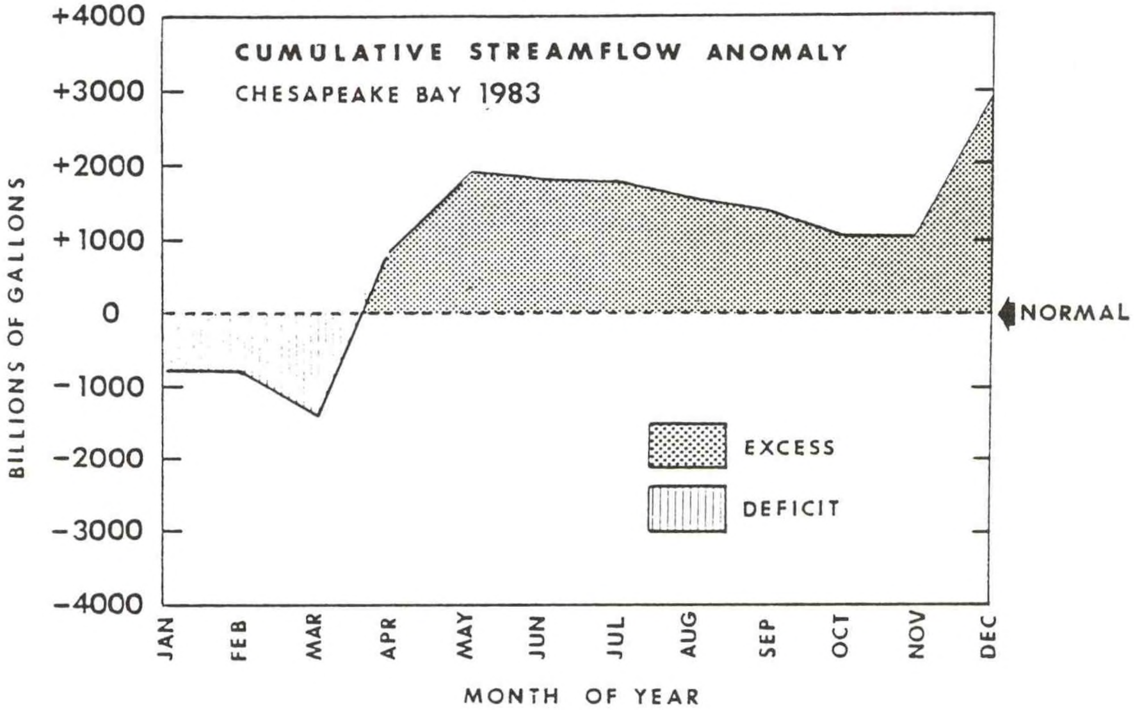
Table 4.--Monthly streamflow, Chesapeake Bay sections, 1982-83 (data from U.S. Geological Survey).

		Cubic feet per second at section				
YEAR	MONTH	A	B	C	D	E
1982	January	28,100	33,300	44,200	50,500	60,900
	February	53,000	60,600	95,400	110,000	134,900
	March	89,400	101,200	137,200	149,400	169,900
	April	78,000	89,300	106,600	112,800	123,000
	May	24,100	28,900	39,900	45,200	54,100
	June	72,700	83,600	111,600	124,800	147,200
	July	20,500	25,000	33,600	36,800	42,400
	August	9,860	13,500	19,300	21,700	25,900
	September	6,180	9,200	12,700	13,700	15,700
	October	6,100	9,100	12,800	14,300	17,300
	November	11,400	15,200	19,900	22,000	25,700
	December	22,100	26,800	36,500	44,900	58,500
	Mean	35,100	41,300	55,800	62,200	73,000
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

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





Cumulative total streamflow into the Chesapeake Bay in 1983 began with lower-than-normal values due to a dry January. Following a record total streamflow in April 1983 the cumulative streamflow was nearly two trillion gallons excess of normal. Near normal summer flows and low September flow reduced the excess to only one trillion gallons. Very high December flow brought the annual total cumulative streamflow to nearly three trillion gallons excess.

Figure 3.--Cumulative monthly streamflow into Chesapeake Bay, 1983.

3.3 Air Temperatures

In marked contrast with 1982, 1983 began with temperatures warmer than normal and ended with temperatures colder than normal. The first three months of 1983 averaged warmer than normal, with March having the largest positive departure; the second three months averaged cooler than normal, with the greatest negative departure in April; the next five months averaged normal or above, with August having the largest positive departure of this group; and finally, December averaged strongly colder than normal (-3.0°F). The average for the entire year among the 11 stations was almost exactly normal (Table 3).

January air temperatures for the 11 stations in Figure 1 averaged 2.2°F above normal, ranging from 0.3°F above normal at Norfolk to 3.6°F above at Harrisburg. These temperatures were 5 to 10 degrees above those of 1982. Average temperatures dropped below freezing for several days at most Bay stations during the middle third of the month, producing a high number of freezing degree days during the period January 11-20.

During February, air temperatures for the 11 stations averaged 1.2°F above normal, the same as in 1982. Temperature departures ranged from 0.5°F below normal at Baltimore to 3.3°F above normal at Williamsport (Table 3B). The coldest period of the month occurred during the middle third of the month.

March air temperatures ranged between 2.1°F and 3.8°F above normal, more than 3 degrees warmer than in 1982. This continued the trend of warmer-than-normal temperatures begun in November 1982. Highest temperatures were reached early in the month (62°F at Williamsport, 77°F at Baltimore and Royal Oak on the 4th), and lowest toward the end of the month (16°F at Williamsport on the 26th, 25°F at Baltimore on the 26th and 30th, and 27°F at Royal Oak on the 30th). Average area temperature for the 11 stations showed 2.9°F above normal.

Temperatures during April were uniformly cooler than normal, ranging from 1.7°F below normal at Williamsport and Patuxent to 3.4°F below normal at Washington, DC. The average departure for the 11 stations in Figure 1 was 2.4°F below normal, in sharp contrast with the strongly above-normal temperatures of March, but nearly half a degree warmer than in 1982.

May temperatures remained cool, averaging 1.8°F below normal for the 11 stations and 4.6°F cooler than in May 1982. Departures ranged from normal at Richmond to 3.6°F below normal at Harrisburg. Warmest tempertatures occurred in the middle of the month: Royal Oak recorded a high of 88°F and Norfolk recorded 89°F on May 15th.

Temperatures around the region during June averaged near normal with individual station averages running from 2.1°F below normal at Harrisburg to 2.1°F above normal at Richmond. Temperatures in June averaged nearly 2°F above their average in June 1982.

July temperatures for the 11 stations in Figure 1 averaged 1.2°F above normal, ranging from 0.9°F above normal at Chantilly to 2.7°F above normal at Patuxent. Early in the month several stations experienced record low morning temperatures, but cloudfree skies permitted afternoon temperatures to soar into the 90s. Several stations experienced record numbers of days during the month with temperatures of 90°F or above. The average temperature in July was 1°F greater than in 1982.

During August Bay area temperatures averaged 1.7°F above normal, ranging from just normal at Williamsport to 3.4°F above normal at Washington. On the 14th an outbreak of Canadian air plunged temperatures into the 50's, but they climbed above 100°F at several stations between the 20th and the 22nd. The average temperature in August 1983 was 4.5°F greater than in 1982.

Chesapeake Bay area temperatures ranged well above normal during the first two-thirds of September, then remained well below normal during the last third. Many of the 11 stations in the area established new daily high temperature records during the first 20 days of the month and set daily low temperature records during the last 10 days. Monthly mean temperature departures are not as meaningful when the patterns are of such a dichotomous nature. Correspondingly, the average departure from normal of the 11 stations in Figure 1 is only +0.3°F. The average area temperature was 1.3°F warmer than in 1982.

October temperatures averaged exactly normal for the 11 stations of the Bay region, ranging from 2.4°F below normal at Williamsport to 1.4°F above normal at Norfolk. Generally stations in the western portion of the region ended the month with average temperatures below normal while those in the eastern portion ended the month with averages above normal.

November temperatures averaged 0.9°F warmer than normal among the 11 stations in Figure 1 but 1.9°F colder than the year before. Monthly average temperature departures from normal ranged from 2.9 above normal at Aberdeen to 1.3°F below normal at Williamsport.

December temperatures, which averaged 9.8°F colder than those in 1982, averaged 3.0°F below normal, ranging from 1.4°F below normal at Patuxent to 4.8°F below normal at Chantilly. The cold snap from the 24th through the 26th set many new low temperature records over the area, for example, Chantilly and Norfolk set new low temperature records on each of the three dates.

3.4 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 1983 salinities were overall higher and temperatures overall cooler than normal.

The Bay water had higher-than-normal temperatures and salinities at the beginning of the year, experienced lower-than-normal temperatures in spring followed by approximately normal temperatures in the summer, and ended the year at above-normal temperatures. Salinities fell below normal monthly mean values at most stations by May and returned to near normal values at all stations by late summer, remaining near normal through the rest of the year.

Salinity

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.

During 1983 stations around the Bay followed overall normal cyclical variations in the salinity (Figure 5) but with local displacements from normal. Higher than normal salinity appeared at all stations in the late winter and spring months followed by lower than normal salinity in late spring and summer in response to extremely high runoff. By fall all stations showed near normal salinity values again. Only the station at the Chesapeake Bay-Bridge Tunnel (south end) did not show salinity values below normal during the spring. At that station values were near normal from March through October except for the single monthly mean of July.

Salinities in 1983 dropped below normal for the first time in more than two years. The comparisons shown in Figures 6 and 7 illustrate the isohalines in the Bay for selected months of recent years. The patterns show salinity in the central and lower portions of the Bay were lower 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.

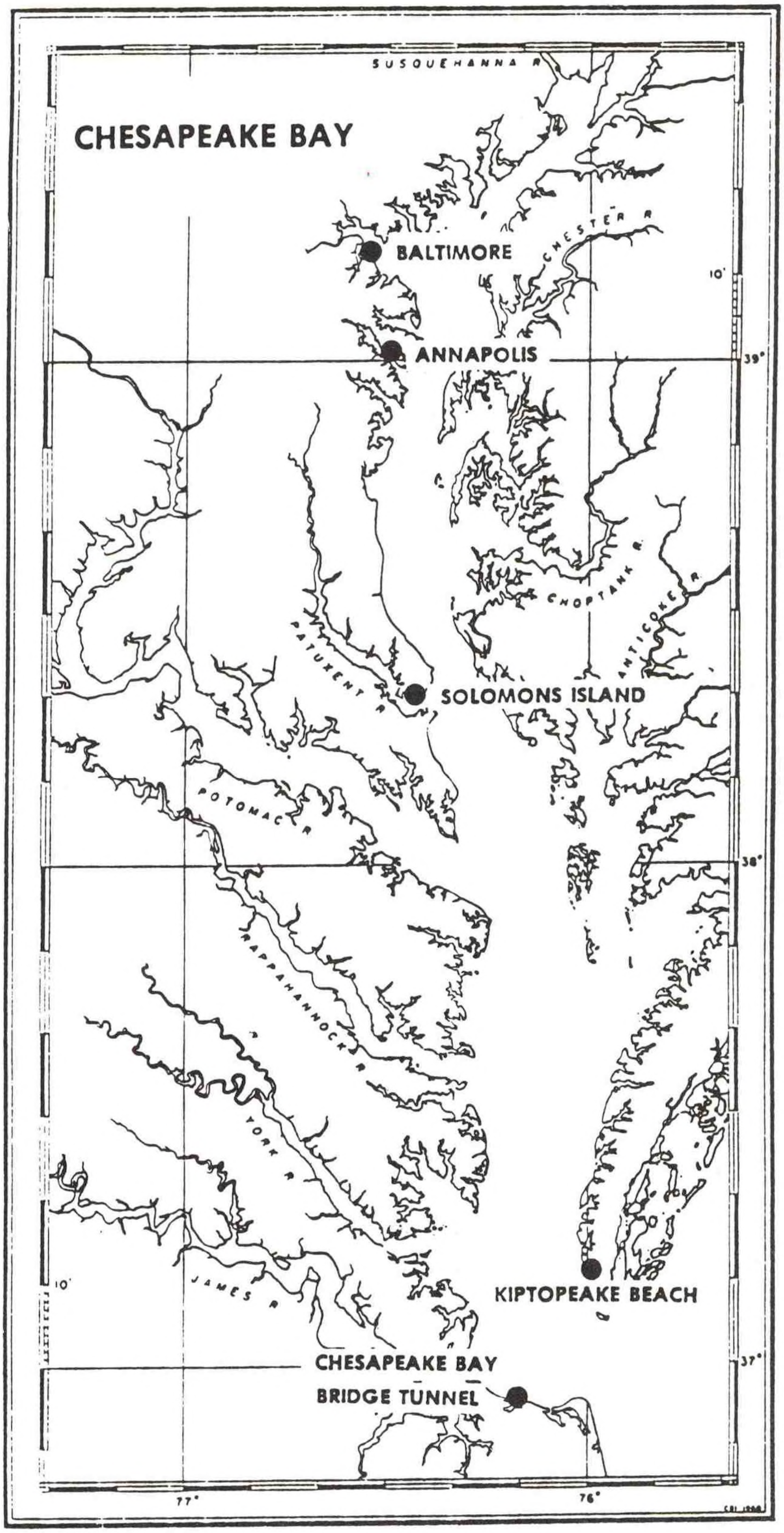


Figure 4.--Locations of National Ocean Service temperature and density stations, Chesapeake Bay. (Modified Chesapeake Bay Institute Map)

Table 5.--Monthly long-term average surface salinity and 1983 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
Kiptopeake 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, 1983 (ppt)

Station	Month												
	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Annual average
Baltimore, MD	3.8	2.8	2.9	1.9	-2.3	-1.9	-0.1	---	1.0	0.1	1.6	-0.9	0.8
Annapolis, MD	4.2	---	5.4	1.2	-1.8	-3.1	-2.4	-0.1	0.6	0.4	0.3	-1.1	0.3
Solomon Is., MD	2.9	3.0	4.2	1.6	-2.1	-4.0	-3.7	-1.6	-1.5	-2.1	-2.2	-1.2	-0.6
Kiptopeake Bch., VA	3.0	2.6	2.0	-1.8	---	-2.9	-4.5	-2.4	-0.4	0.9	0.8	0.2	-0.2
Chesapeake Bay Bridge Tunnel, VA	2.5	3.0	0.2	0.6	0.0	-0.3	-2.1	+0.4	0.7	0.2	1.8	1.4	0.7

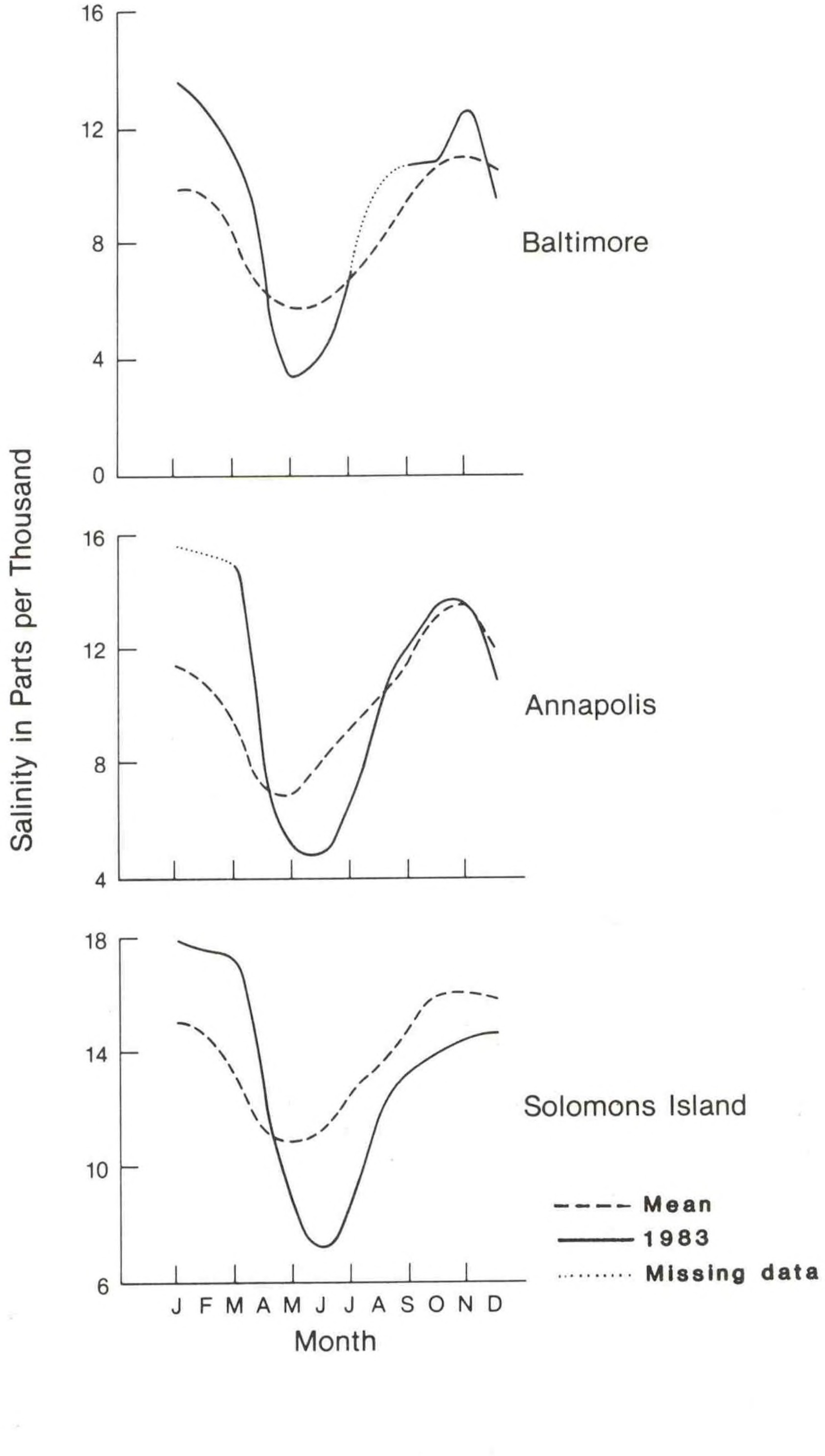


Figure 5.--Seasonal cycle of salinity, selected stations, Chesapeake Bay, 1983.

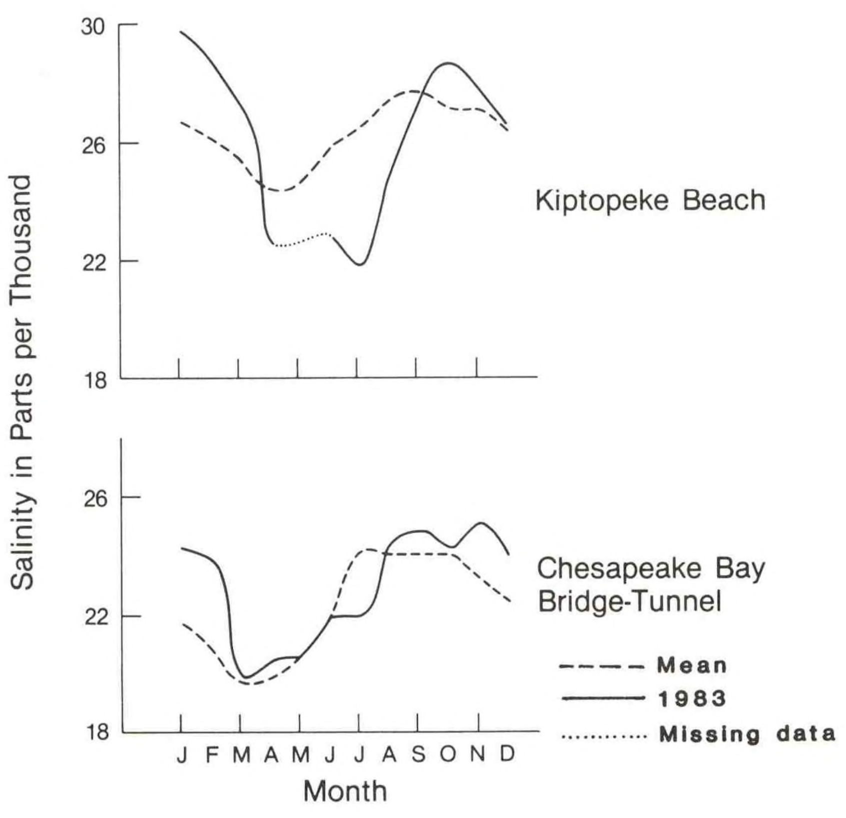


Figure 5 (continued).--Seasonal cycle of salinity, selected stations, Chesapeake Bay, 1983.

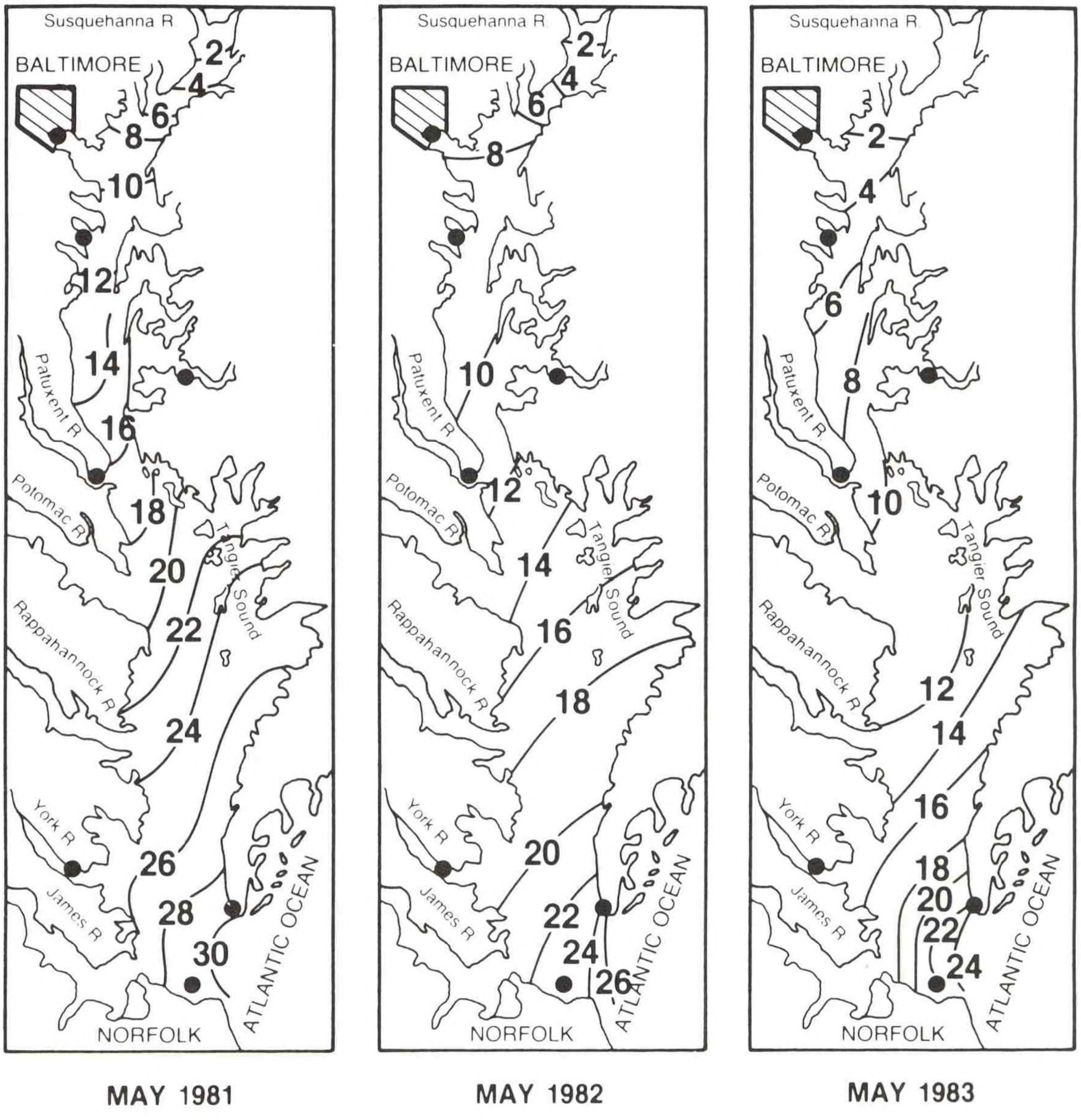


Figure 6.--Surface salinity distribution, Chesapeake Bay, May 1981-83.

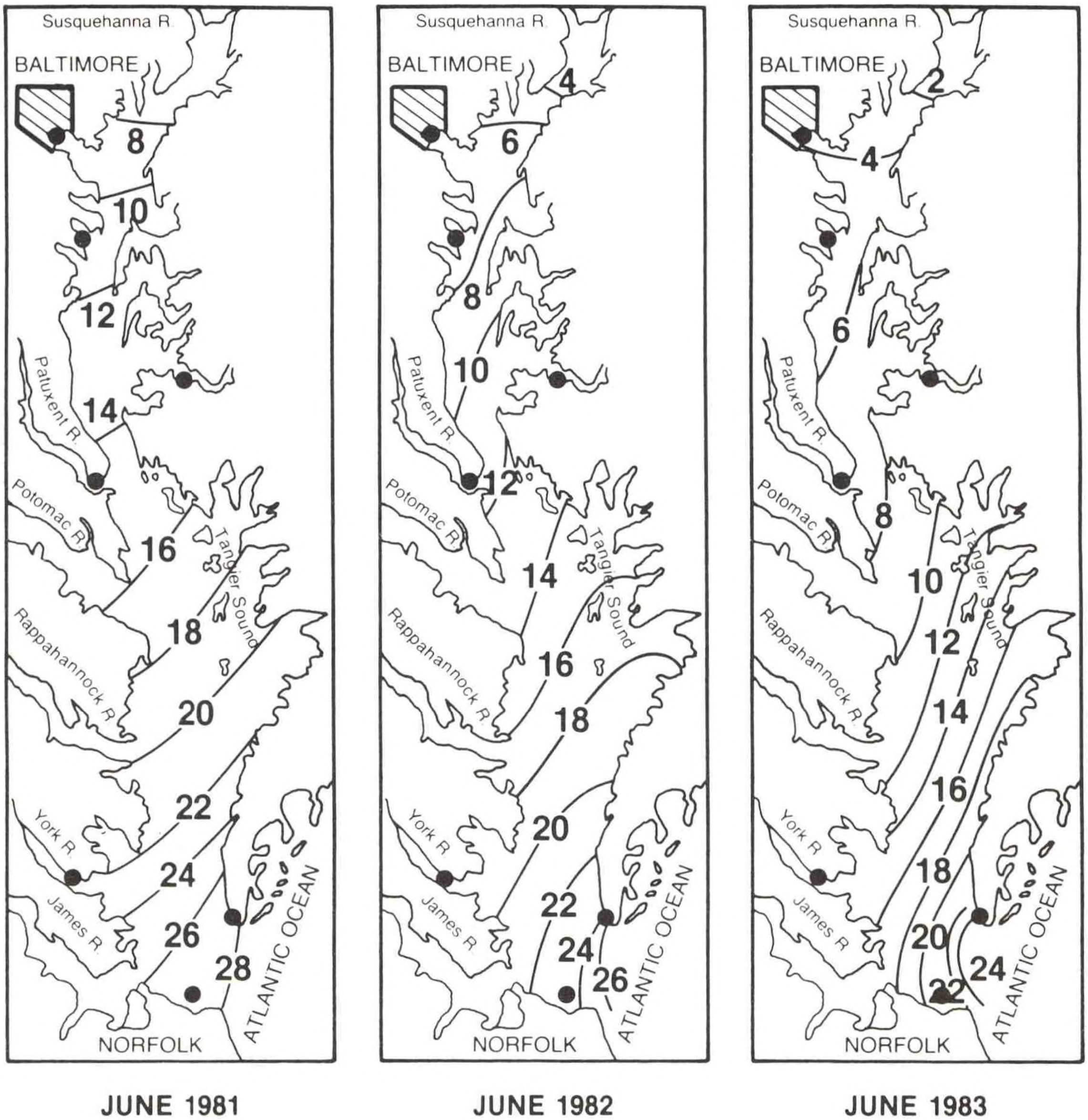


Figure 7.--Surface salinity distribution, Chesapeake Bay, June 1981-83.

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 7). All stations began 1983 with warmer than normal temperatures. Ice cover during January and February 1983 was less than ten percent (Table 6).

Table 6.--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
Estimated date of maximum ice cover extent	Feb. 10	Feb. 17	Feb. 20	Mar. 2	Jan. 18	Jan. 27	Feb. 14

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

Water temperature anomalies fell quickly in April to below normal, with Annapolis being the farthest below normal at -3.7 F (Figure 8). Temperatures at Baltimore and Annapolis rose to near normal in May and remained normal through November. At Solomons the temperature rose to normal in late summer and remained above normal through the end of the year. Kiptopeke and Chesapeake Tunnel station station showed rapid progression from large negative anomalies to large positive anomalies in early summer and decreases in late summer. The patterns in the water temperature anomaly at stations up the Bay appeared to have followed the pulse of changing from below normal to above normal at a slower rate. In the lower Bay, mid- to late-summer decreases in temperature anomaly are not identified with particular environmental events, but may be a response to intensified wind mixing at the mouth of the Bay or to intrusions and mixing of cooler ocean/shelf waters at that period.

Table 7.--Monthly long-term average surface water temperature and 1983 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
Kiptopeake 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, 1983 (Deg. F)

Station	Month												
	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Annual average
Baltimore, MD	1.5	1.7	1.9	-2.1	0.8	0.6	-0.6	---	0.9	-0.1	-0.1	1.3	0.5
Annapolis, MD	2.7	---	1.8	-3.7	-2.5	-0.5	-1.1	0.4	0.9	-0.7	0.3	3.1	0.1
Solomon Is., MD	3.2	0.8	0.9	-1.5	-1.9	+0.4	1.0	2.1	2.0	1.4	0.3	3.6	1.0
Kiptopeake Bch, VA	2.3	2.5	1.9	-2.2	---	-0.4	2.3	0.3	1.5	1.0	-0.2	2.1	1.0
Chesapeake Bay Bridge Tunnel, VA	4.2	2.0	1.9	-2.6	-3.4	+4.8	-0.1	-1.2	0.6	1.4	1.5	3.5	0.5

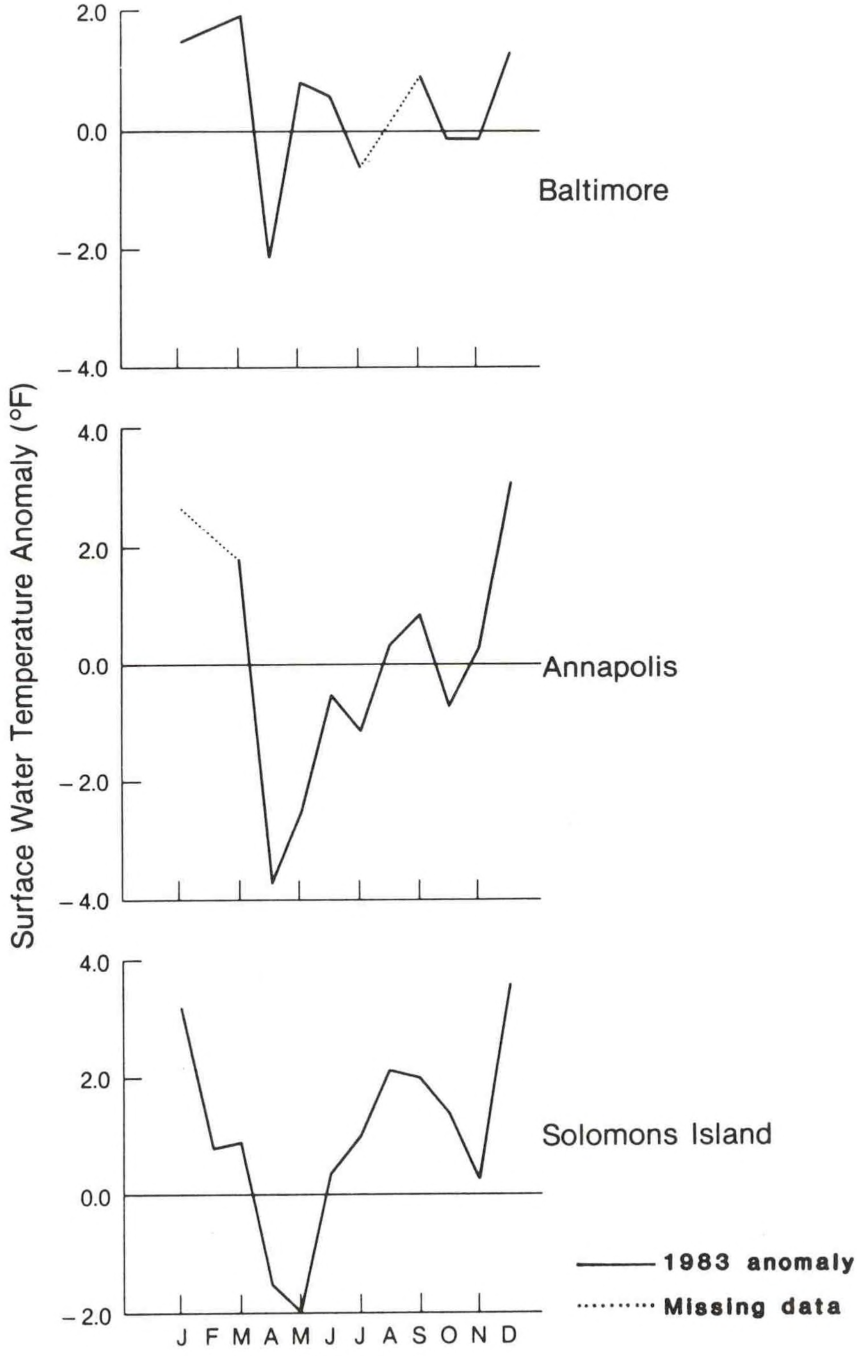


Figure 8.--Monthly surface water temperature anomaly, selected stations, Chesapeake Bay, 1983.

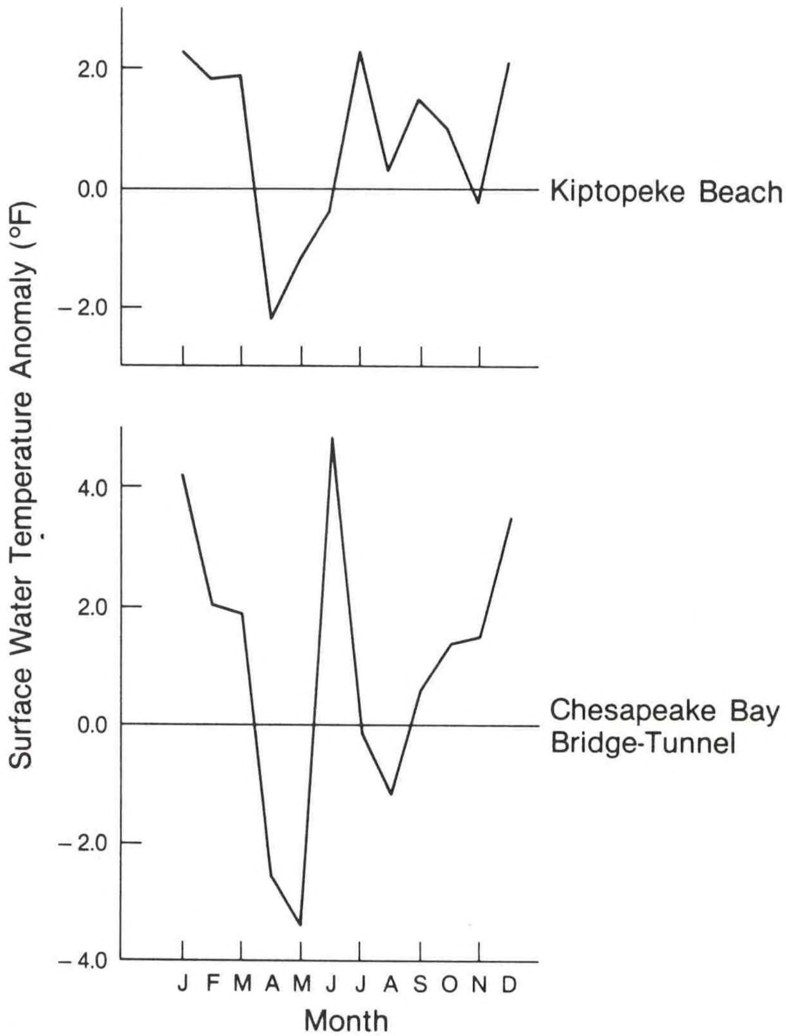


Figure 8 (continued).--Monthly surface water temperature anomaly, selected stations, Chesapeake Bay, 1983.

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 1983, generating $60.5 million in the overall economy (Table 8), $38.9 million in Maryland and $21.6 million in Virgina.

Maryland 1983 total state landings were down 10.1 million pounds from 1982, a loss of $6 million (Table 8). Maryland Bay landings in 1983 were 1.9 million pounds higher than in 1982. Virginia Bay landings in 1983 were 1.9 million pounds less than 1982 landings though total Virginia state landings were 60 million pounds higher than in 1982 due to an increase 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 1983: menhaden, gray sea trout, alewives, catfish, spot, 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 landings showed large increases in 1983 compared to 1982 along the Atlantic coast. The record high finfish landings in Virginia (751.1 million pounds) reflect the increase in menhaden landings, which also helped make Virginia the third highest state in total landings in 1983 behind Louisiana and Alaska. 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. Menhaden 1983 landings in Maryland show a decrease from 1982 though 1983 landings are preliminary and the actual value may be higher.

Striped bass, as in 1982, retained the highest ex-vessel price per pound of Bay finfish ($1.51 average in 1982 and $1.79 average in 1983). Striped bass landings in Maryland were 425 thousand pounds in 1983, 89 thousand pounds less than in 1982, reflecting the continuing decline of striped bass stocks in Chesapeake Bay. Virginia striped bass landings increased 8,000 pounds (6 percent) in 1983, though the landings are still very low when compared to the

Table 8.--Chesapeake Bay and total state landings, commercial finfish and shellfish, 1982 and 1983.

	1982		1983	
	Thousand pounds	Thousand dollars	Thousand pounds	Thousand dollars
Bay Landings (1)				
Chesapeake Bay, total	154,893	63,556	154,927	60,477
Maryland, Bay only	68,751	39,322	70,664	38,892
Virginia, Bay only	86,142	24,234	84,263	21,585
State Landings (2)				
Combined States	791,155	120,206	841,428	130,240
Maryland	100,478	51,438	90,359	45,497
Virginia	690,677	68,768	751,069	84,743
Total for U.S.	6,367,310	2,389,993	6,438,724	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, 1982-1983.

Species	Maryland				Virginia			
	Thousand pounds		Thousand dollars		Thousand pounds		Thousand dollars	
	1982	1983	1982	1983	1982	1983	1982	1983
Alewives	110	159	24	26	1,304	1,838	104	236
Bluefish	235	257	37	41	2,251	1,072	355	167
Butterfish	**	0	**	0	39	51	17	19
Cobia	0	0	0	0	2	**	**	**
Carp	289	187	17	21	6	6	**	**
Catfishes	624	816	73	168	1,125	1,128	232	249
Crevalle	0	0	0	0	0	4	0	1
Croaker	6	**	**	**	91	134	40	42
Drum, Black	**	3	**	**	31	19	7	2
Drum, Red	0	64	0	**	**	40	**	8
Eels, Common	85	92	50	31	306	315	119	80
Flounder, Blackback	3	7	**	2	2	23	1	17
Flounder, Fluke	3	30	2	21	110	269	74	174
Flounder, Unc.	**	0	**	0	18	0	12	0
Gizzard Shad	5	47	**	3	7	5	**	**
Harvestfish	0	0	0	0	69	71	41	40
Hickory Shad	3	3	**	**	**	1	**	**
King Mackerel	0	0	0	0	7	**	6	**
Mackerel, At.	9	0	**	0	**	**	**	**
Menhaden	8,925	6,596	531	258	26,055	24,483	781	559
Mullet	**	2	**	**	11	25	3	5
Sea Basses, Black	0	0	0	0	5	0	5	0
Sea Trout, Gray	96	116	55	82	1,765	1,893	946	1,040
Sea Trout, Spotted	0	0	0	0	3	4	3	4
Shad	2	26	**	12	308	463	120	231
Sharks, Dogfish	0	0	0	0	28	**	12	**
Spanish Mackerel	0	0	0	0	13	3	4	2
Spot	6	128	2	53	994	1,539	380	480
Striped Bass	514	425	853	806	142	150	220	268
Sunfishes	1	4	**	**	0	0	0	0
Swellfishes	0	**	0	**	**	12	**	6
White Perch	684	575	354	344	86	62	43	25
Whiting	0	**	0	**	11	**	11	**
Yellow Perch	29	40	14	19	**	**	**	**
Finfishes, Unc. food	**	0	**	0	11	4	11	1
Finfishes, Unc. food & bait	20	4	**	**	2,824	4,147	2,824	261
Totals	11,649	9,581	2,012	1,887	37,626	37,762	6,371	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), 1975-1983.

	Maryland		Virginia	
Finfish	Thousand pounds	Thousand dollars	Thousand pounds	Thousand dollars
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, 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.

record high Virginia striped bass landings of 2,888,000 pounds in 1973. The total ex-vessel value (price received by the harvester) for striped bass in Maryland decreased $47 thousand in 1983 over 1982.

Warmer-than-normal Bay water temperatures during the 1982-83 winter provided favorable conditions for stocks of overwintering juvenile croaker spawned in October 1982. Young-of-the-year (7 to 8 inch) croaker were abundant in the Bay during summer and fall 1983.

Cooler-than-normal water temperatures in spring months delayed the arrival of certain finfish species including bluefish and flounder along the coast and in Chesapeake Bay during spring 1983. Movement of some finfish species is related to the northern extent of the coastal 15°C (59°F) isotherm which remained south of Chesapeake Bay later in spring 1983 than in most years. Persistent offshore winds during the spring quarter increased the seasonal drift of bottom water shoreward, resulting in cooler water temperatures along the Virginia coast (See Section 3.4).

Watermen and Maryland Department of Natural Resources researchers noted the unusual occurrence of several southern species of higher salinity finfish such as channel bass and grunts in normally freshwater areas of upper Bay tributaries during fall 1983. The occurrence of higher salinity species in upper portions of Bay tributaries coincides with higher-than-normal Bay salinities. Species which normally prefer the higher salinities of the lower Bay and coastal ocean were also noted in catches by the Maryland Department of Natural Resources in December in the Chesapeake Bay Deep Trough. Harvest fish, squid, hake (3 species), and weakfish (Cynoscion regalis) were caught in Deep Trough sampling in December during a period of higher-than-normal salinities.

The Maryland Tidewater Administration reports the relative abundance index for striped bass spawning success for 1983 in Chesapeake Bay is 1.4, compared to 8.4 in 1982 (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 1983 value is the second lowest index value on record, following the record low of 1.2, set in 1981. The record high of 30.4 occurred in 1970. Commercial striped bass landings in Maryland in 1983 was 397,000 pounds compared to 474,000 pounds landed in 1982. The 1983 landings value is the lowest on record, continuing the dramatic decline in the striped bass fishery. Striped bass landings in Maryland exceeded 5 million pounds in 1961, 1969, and 1973. Landings have shown a steady decline since they last reached 5 million pounds in 1973.

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 represent 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 1983. 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

Table 11.--Relative abundance index for young-of-the-year striped bass, Chesapeake Bay, 1954-1983.

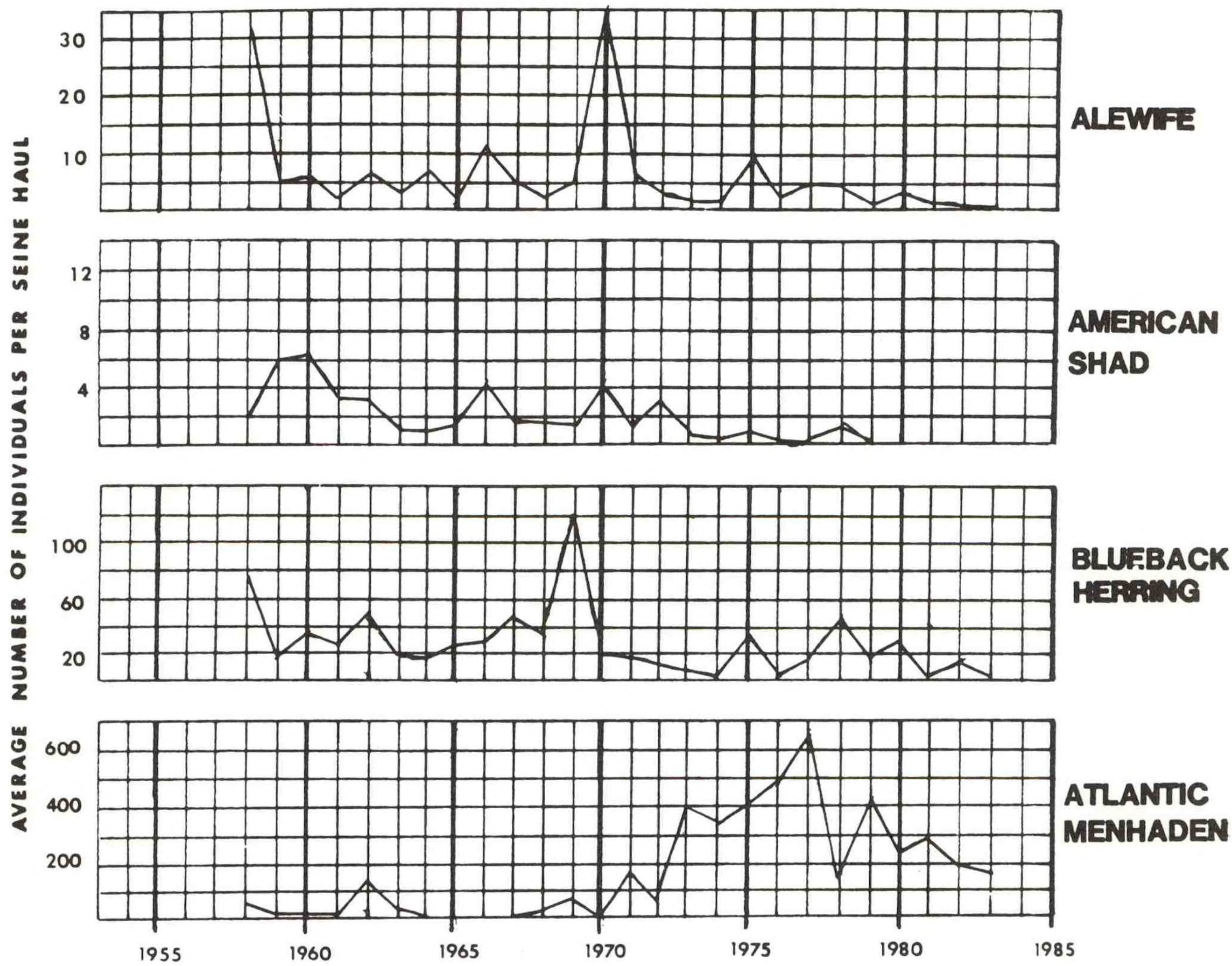
Year	Index	Year	Index	Year	Index	Year	Index
1954	5.2	1962	12.2	1970	30.4	1978	8.4
1955	5.5	1963	4.0	1971	11.8	1979	4.2
1956	15.2	1964	23.5	1972	8.5	1980	1.9
1957	3.2	1965	7.4	1973	9.0	1981	1.2
1958	19.0	1966	16.7	1974	10.1	1982	8.4
1959	1.4	1967	7.8	1975	6.7	1983	1.4
1960	7.1	1968	7.2	1976	4.9		
1961	17.3	1969	10.2	1977	4.9		

Data from Maryland Tidewater Administration.

the sampling in 1983 though alewives remain a commercially important species in Bay landings. Atlantic menhaden is a major commercial species, contributing $7 million to the Maryland economy in 1983. 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-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 number 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.

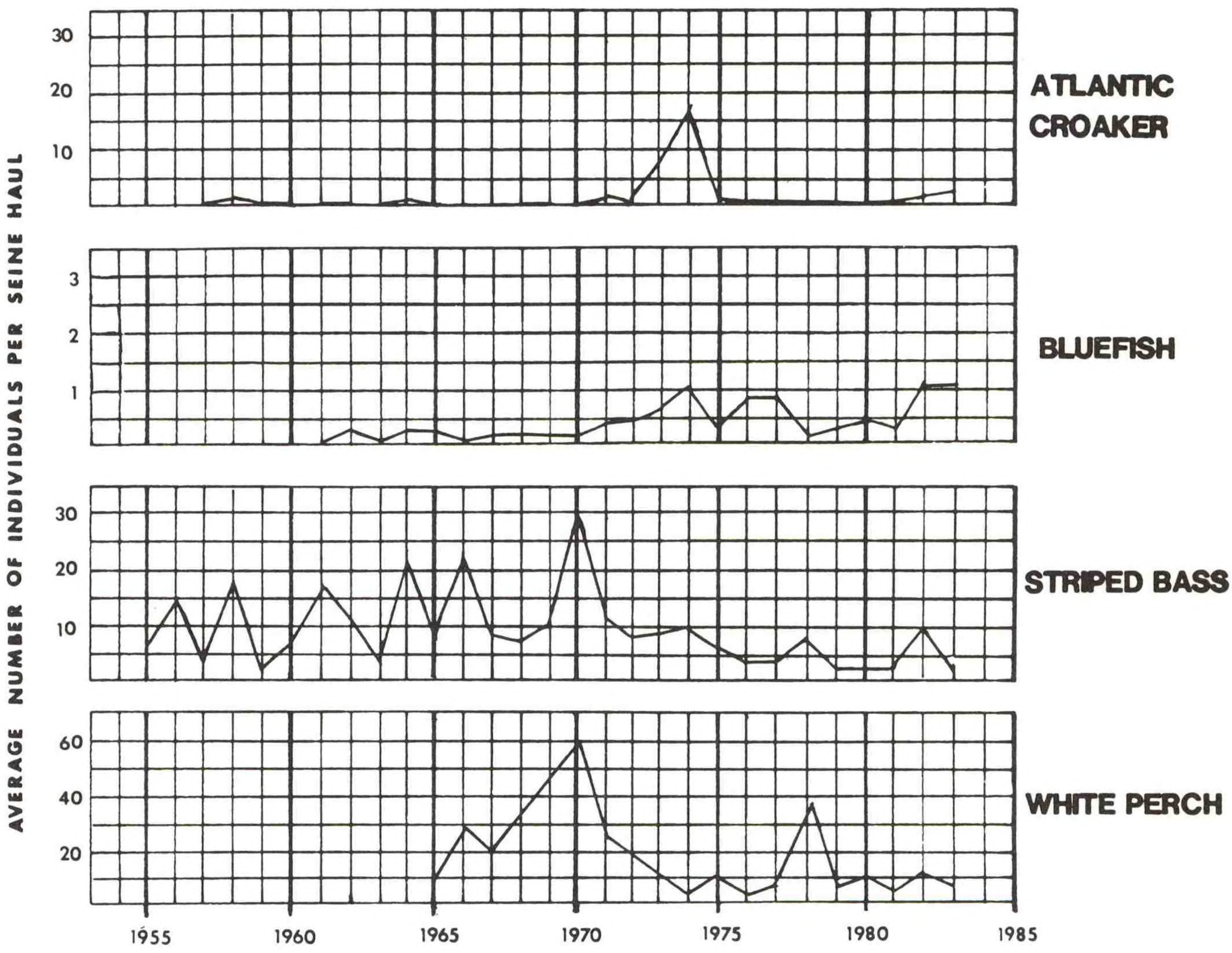
Striped bass, white perch, and bluefish (Figure 10) are important commercial and sport species in Chesapeake Bay. The croaker has been low in the sampling over the entire record except for 1973-74. The abundance of croaker is dependent on the success of the year-class. Juvenile croaker overwinter in Chesapeake Bay and are vulnerable to severe cold, thus croaker may be abundant in years with good year-class and a warm winter. The striped bass and white perch show a decline after 1970 with no apparent improvement in the 80s. 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, however, increase again in 1982 and 1983. Bluefish and white perch have become more important in the Bay sport fishery as the striped bass fishery declined.

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, and a return to lower levels in 1982 and 1983. The mummichog follows the same pattern to 1977, but shows a very large increase in 1978-79, and another increase 1982-83. 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.



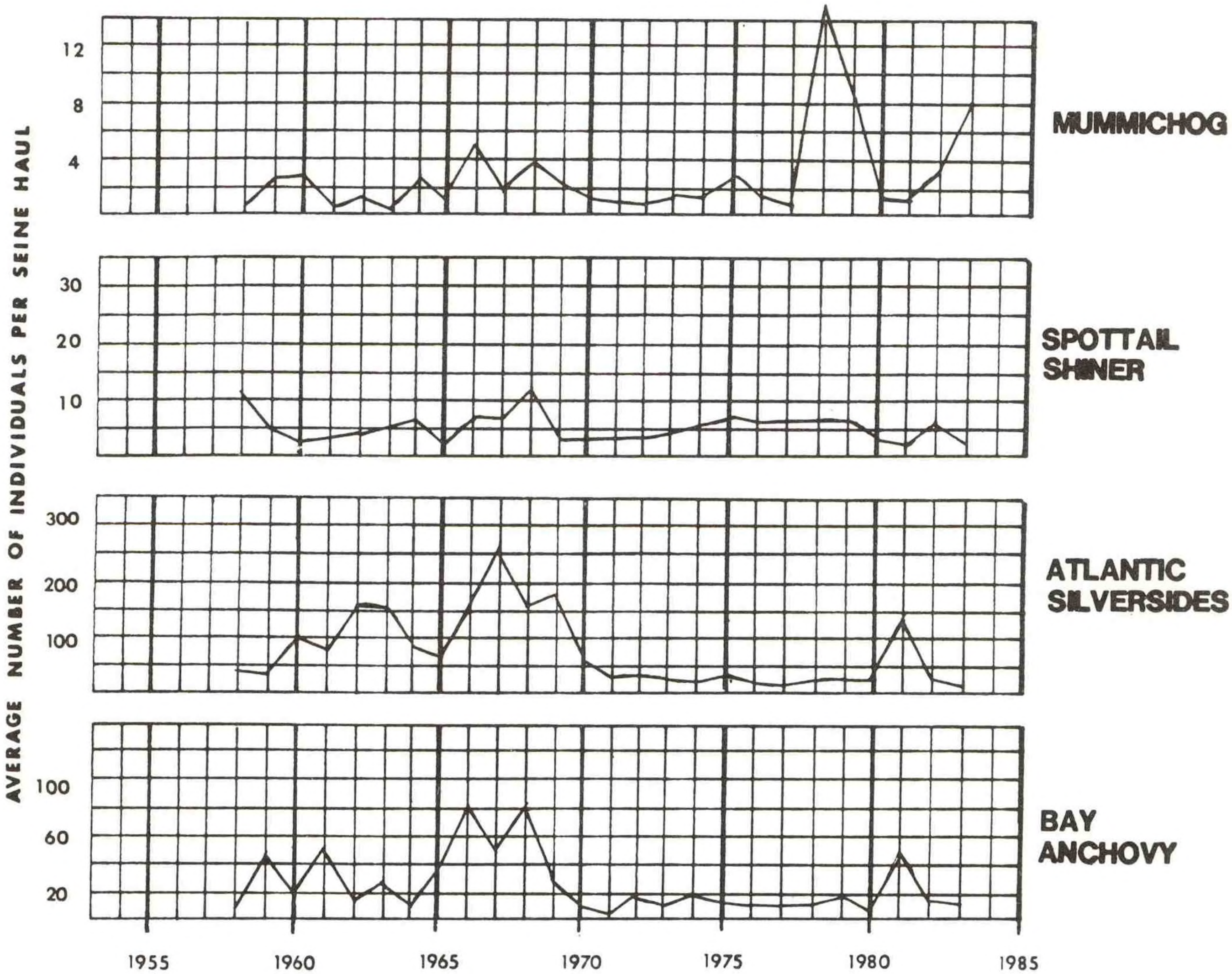
Average number of individuals collected at 22 sites in the Maryland portion of Chesapeake Bay. Three major herring species show declines after 1970. Atlantic menhaden, a commercially valuable species, has shown an increase in population 1970-77, a decrease in 1978-83.

Figure 9.--Seine sampling, major herring 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 10.--Seine sampling, selected recreational and commercial 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 for 1958-70. Note the unusual mummichog increase in 1978. Trend after 1981 not clear at present

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

4.2.1 Fish Kills in Virginia

The Virginia State Water Control Board identified and investigated 41 fish kills in Virginia waters during 1983 (Table 12). Data on the extent of fish kills and estimates of dollar loss are unavailable at present.

Table 12.--Virginia fish kill events, 1983.

Month	Location	Probable Cause
January	Clinch River	Oil spill
January	Fort Monroe Moat	Temperature (Menhaden kill)
January	Dry Run	Unknown
March	Private Pond, Rockingham County	Low DO from animal waste
April	Layfayette River	Unknown
April	Appomattox River	Chlordane
April	Thalia Creek	Salt water fish movement into fresh water area
May	Indian Lake	Low DO (Sunfish kill)
May	Univ. of Richmond Lake	Spawning stress
May	Haven Estates Lake	Unknown
May	Chestnut Creek	Unknown
May	Four Seasons Pond	Chlordane
May	Pohick Creek	Ferric chloride
May	Mill Creek	Chicken waste
May	Moffatt Creek	Cattle waste
June	Private Pond (VRO)	Unknown
June	Hudgins Lake	Algae bloom
June	Kings Grant Lake	Algae bloom (Low DO)
June	Rappahannock River	Algae bloom (Low DO)
June	Rappahannock River	Net Dumping
June	Maggoddee Creek	Gasoline Spill
June	Deer Branch	Wash down water runoff used on fire
June	Elizabeth River	Octylamine
June	Smith Creek	Chlorine
June	Elizabeth River	
June	Private Pond (SWRO)	Unknown
July	Occoquan Reservoir	Algae bloom (Low DO)
July	North Lake Anna Cooling Lagoon	Temperature, DO stress
July	Billsby Impoundment	Disease (In catfish)
July	Claytor Lake	Disease (In catfish)
July	Rudee Inlet	Unknown

Table 12.--(continued). Virginia fish kill events, 1983.

Month	Location	Probable Cause
August	Big Wilson Creek	Bridge collapse
August	Marl Creek	Animal waste
August	Clinch River	Low DO
August	James River	Low flow/high temperature
August	Stroubles Creek	Nitric and sulfuric acid
September	Back Bay	Unknown
September	Goodes Creek	Unknown
October	Powell Creek	Unknown
October	Elk Creek	Oil film
November	Little Creek	Unknown

Data from Virginia State Water Control Board. Data are preliminary and subject to revision. (DO = dissolved oxygen deficiency)

4.3 Shellfish

Blue crabs were the most valuable shellfish species Bay-wide in 1983, contributing over 33 million dollars to the combined economies of Maryland and Virginia (Table 13). Blue crab landings increased nearly 8,000,000 pounds in 1983 over 1982 in Maryland, becoming Maryland's most valuable shellfish species in total dollar value. Until 1983, oysters were Maryland's most valuable shellfish species. Oyster landings in 1983 in Maryland were only 6,950,000 pounds compared to 12,275,000 pounds in 1982. Oyster landings were down in 1983 in both Maryland and Virginia compared to 1982, though Maryland showed the greater decline. Total Bay shellfish landings in Virginia were slightly lower in 1983 compared to 1982 due to the lower landings of blue crabs and oysters (Table 13). Maryland total Bay shellfish landings were up 4 million pounds, despite the low oyster catch, due to the large increase in blue crab landings.

Blue Crabs

Blue crabs were in unusually short supply in spring 1983. Spot checks of market conditions showed the last two weeks of March and the first two weeks of April in Maryland and the last week of May in Virginia to be particularly hard hit. Wholesale and retail blue crab prices for live crabs and crab meat reached record highs during spring 1983. The effect of high prices was evident at retail markets, where crabs were in short supply, and in restaurants, many of which added supplementary charges to crab meat. Highest recorded retail market prices were in Maryland at $75 per bushel of live crabs and $17.95 per pound of crab meat. Several factors contributed to the high blue crab prices: an overall shortage of crabs due to smaller year class recruitment from the 1981 hatch; delayed normal seasonal activity of crabs due to cooler-than-normal water temperatures; a shortage of crab meat pasteurized in the fall of 1982; and a shortage of crabs from southern states which normally supplement Bay crab supplies in colder months.

Hard crabs in Virginia were of generally small size and poor quality in the peak season in June and early July, though market size crabs were abundant in late summer. These conditions gave watermen poor marketing situations for hard crabs in late July and August in Virginia following a relatively good market in June. Hard crabs became more available in Virginia late in the summer, especially in July and August as the 1982 year class reached marketable size.

Price and catch for hard crabs remained steadier in Maryland than in Virginia during summer 1983. Unusually calm weather during the summer quarter allowed more working time on the water, contributing to the steady catch of crabs.

Blue crabs were of good quality and were abundant September through November. Blue crab landings in September and October 1983 showed large increases over the same months in the 1981 and 1982 seasons.

Table 13.--Chesapeake Bay commercial shellfish landings by State and species, 1982-83.

Species	Maryland				Virginia			
	Thousand pounds		Thousand dollars		Thousand pounds		Thousand dollars	
	1982	1983	1982	1983	1982	1983	1982	1983
Crabs, Blue, Hard	40,840	48,611	12,621	17,084	42,484	41,401	8,758	10,013
Crab, Soft & Peeler	2,404	3,501	3,038	5,438	793	630*	881	779*
Clam, Hard	0	0	0	0	557	779	1,420	1,860
Clam, Soft	1,583	1,961	3,332	4,285	0	0	0	0
Oyster Meat	12,275	6,950	18,319	10,198	4,502	3,599	6,710	4,986
Horseshoe Crab	0	0	0	0	12	28	1	2
Snails (Conchs)	0	0	0	0	72	4	51	3
Turtles (Snapper)	0	0	0	0	96	60	42	25
Totals	57,102	61,083	37,310	37,005	48,516	46,501	17,863	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.

A combination of biological and economic factors contributed to the high fall 1983 blue crab landings. Blue crabs from the 1982 year class were in good supply and harvesting effort increased. Because of the shortage of oysters and the abundance of blue crabs, many watermen continued crabbing longer into the fall months than in years of more plentiful oyster stocks.

The Virginia December 1983 commercial hard blue crab dredge harvest of 4.3 million pounds was above the previous 23-year average of 4.0 million pounds. The high December 1983 landings reflected the abundance of blue crabs which were in good supply since late summer 1983. Landings primarily reflect year-class strength, though other factors sometimes influence the amount of crabs caught such as when unseasonably warm water temperatures cause crabs to remain active longer into the start of the dredge season, making the dredging less effective. Crabs from the strong 1982 year class were very abundant through December 1983 and the warmer-than-normal water temperatures observed in December 1983 had no detectable effect on the dredge harvest.

Soft Shell Crabs

Chesapeake Bay, which normally produces approximately 90 percent of the soft crab harvest in the United States, experienced a bumper crop of peeler and soft crabs in the summer of 1983.

The first run of the soft crab season in May started several weeks later than normal in 1983. The second large run, normally in August, started a month earlier in July 1983. Prices (ex-vessel) for peeler crabs were down from 30 cents to 25 cents each, June 30 to July 25, on the Virginia Eastern Shore. Prices were lowest at the end of July, coinciding with abundant peeler and soft crabs, with lowest prices for peeler crabs at Northern Neck, VA at 20- to 25-cents per crab. Maryland landings of soft and peeler crabs increased in 1983 by 1.1 million pounds and $2.4 million, though Virginia showed a slight decline. Virginia landings are underestimated and actual landings are probably much higher based on spot checks of the soft crab market in 1983.

Oysters

Oysters were in short supply during fall 1983. Ex-vessel prices (price paid to the harvester at dockside) reached a record $20 per bushel compared to a high of $16.25 in 1982. Prices early in the season ranged from $10 to $12 per bushel. By mid-November bushels routinely sold for $16 to $17. Prices varied according to location and oyster quality. The average price for the 1983-84 season was $12 per bushel compared to $9.40 for the 1982-83 season.

The overall Bay-wide scarcity of oysters due to years of poor spawning seasons and sustained high levels of fishing pressure combined with higher-than-normal mortalities attributed to disease during the 1982-83 season (section 4.5, Diseases) contributed to the much lower 1983 landings.

The seasonal decline in water temperatures in fall 1983 brought an unusually good increase in quality of oyster meats in Maryland and Virginia. Oysters store increased amounts of glycogen as water temperatures cool, increasing meat yields. Watermen reported oysters of excellent quality which brought higher prices in late November.

Oyster Spatfall

Virginia Institute of Marine Science shellstring surveys for summer and fall 1983 show the James and Piankatank Rivers experienced exceptionally spat-set, while spatset of other Virginia Rivers was poor to average. The overall spatfall in Virginia was average to above average due to the high set in the James River, which, because of its extensive oyster bars, normally produces a large proportion of the overall spatfall. Below average spat counts were reported in the Upper Bay.

Soft Shell Clams

Productive soft-shell clam beds north of a line drawn from Bodkin Point, Rock Hall, MD were reduced to commercially unproductive levels by low salinities in spring 1983. Soft-shell clam beds had become re-established farther north during periods of high salinities in 1980 and 1981.

4.4. Blooms

Bloom events are summarized in this report from phytoplankton sampling by the Maryland Office of Environmental Programs (OEP). An unusually large and persistent bloom of blue-green algae occurred on the Potomac River in the summer and fall of 1983.

A heavy dinoflagellate bloom occurred in January in the Morgantown area of the Potomac River. Dark reddish-brown water was observed inshore containing the dinoflagellate, *Heterocapsa triquetra* at cell densities of over 23 million cells per liter. In Baltimore Harbor and off Sandy Point, high phytoplankton cell counts (over 24 million cells per liter) were observed in January.

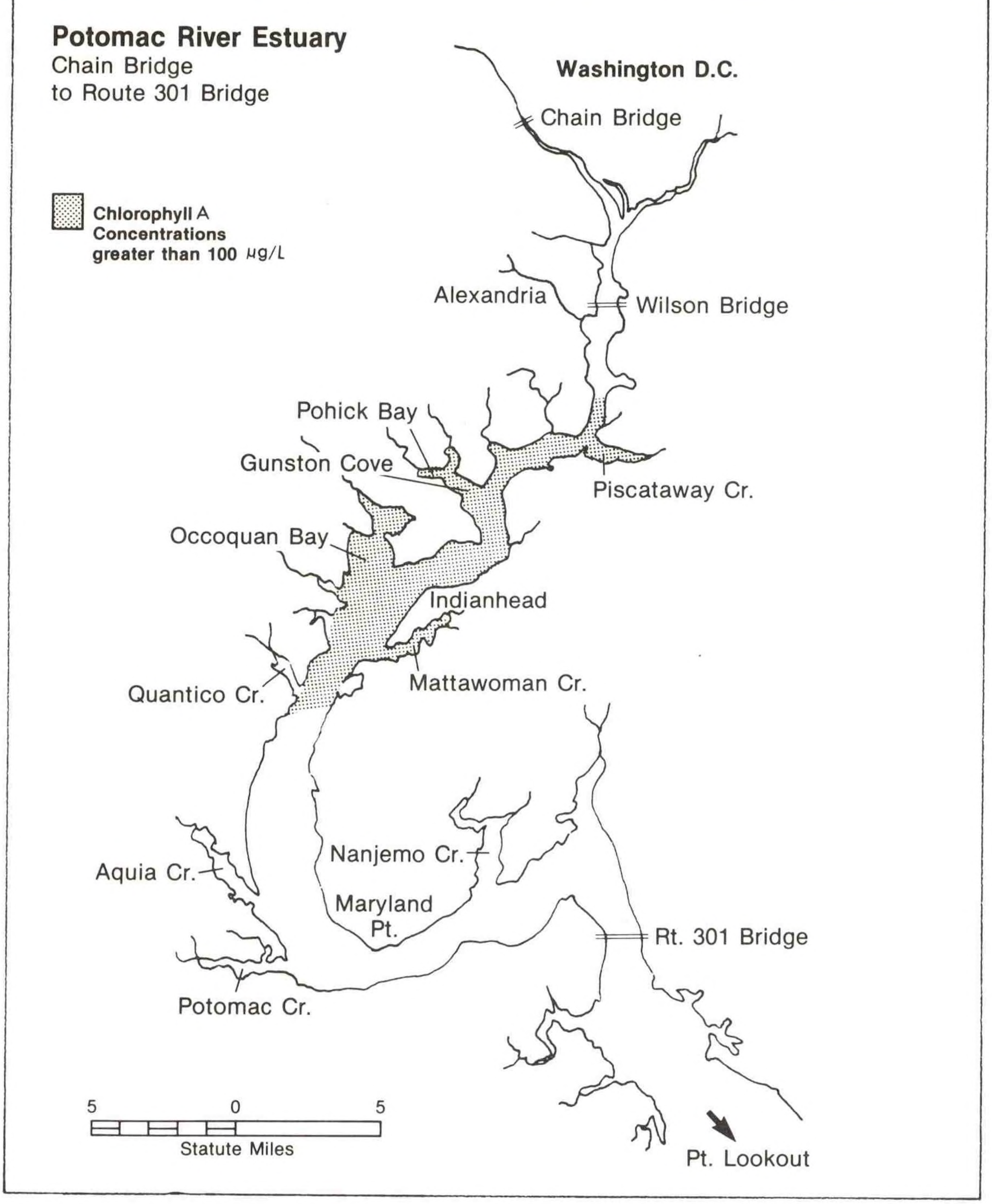
High cell densities were reported in Baltimore Harbor in February. Though February phytoplankton counts at several other Bay stations showed decreases from January levels, sample counts in the Potomac River near Morgantown showed a three-fold increase over January. The diatom, *Cyclotella sp.*, was present at bloom levels from Nanjemoy to Possom Point. Bloom levels are generally characterized by discolored water or odor.

March 1983 phytoplankton counts were 416 percent higher than in March 1982, and 93 percent higher than March 1981 at Potomac River stations. Counts were highest at the Morgantown area of the Potomac River where a heavy dinoflagellate bloom was evident constantly from January through March.

April sampling showed low cell densities in the Morgantown area of the Potomac, coinciding with greatly reduced surface salinities. Maximum cell counts in April were observed in Baltimore Harbor. The high counts reported in Baltimore Harbor in April and other months in 1983 do not necessarily indicate a bloom level which depends not only on the cell density but also on the size of the species involved.

May sampling showed greatly reduced phytoplankton levels around the Bay and its tributaries, probably a result of the diluting effect of extremely heavy rainfall during spring 1983. Cell counts at six stations monitored by the Maryland OEP averaged 24 percent lower than April and 177 percent less than May 1982, 271 percent less than May 1981, and 216 percent less than May 1980. Discolored water was observed in May in the South River. Water analysis by the Maryland OEP showed high levels of *Prorocentrum minimum*.

Extensive blooms of blue-green algae occurred in a 20-mile stretch of the upper Potomac River beginning in June 1983. The bloom was dominated by the blue-green algae, *Microcystis aeruginosa*, and was the first bloom of such magnitude recorded on the Potomac River since 1977. Floating mats of algae were observed in mid-June in Gunston Cove, VA. The algae dissipated in late June and early July, but returned in mid-July. From mid-July, the algae steadily increased in concentration in the area from Gunston Cove to Occoquan, VA. By the end of August the range of the algae extended from Marshall Hall, MD to Quantico, VA. The algae, a freshwater variety, were not observed in heavy concentrations south of Quantico in higher salinity waters. Figure 12 shows the heaviest concentrations of the algae derived from observed concentrations of chlorophyll A, the plant pigment used as an indicator of the density of algal growth. The presence of the algal mats deterred many recreational water



Extensive growth of algae occurred in a 20-mile stretch of the Potomac River (shaded area) during summer 1983. The presence of thick algal mats deterred many recreational water users, resulting in reduced marina usage and boat rentals along the 20-mile affected area. The algae also presented a safety hazard to persons in the water and caused fouling of boat hulls.

Figure 12.--Areas showing heavy chlorophyll A concentrations (exceeding 100 micrograms per liter) during August 1983, Potomac River estuary (data from Metropolitan Washington Council of Governments).

users, resulting in reduced marina usage and boat rentals in areas along the 20 mile affected area. The algae also presented a safety hazard to persons in the water and caused fouling of boat hulls. The presence of the thick algal mat created a potential safety hazard in that persons in the water could not be sighted once under the surface.

Extremely high spring runoff conditions, reduced summer river flows, high air temperatures, high amounts of sunshine (no clouds), and low wind speeds appear to have created optimal conditions for algal growth in the Potomac during the summer 1983 (Table 14).

The extensive blooms of Microcystis continued through October. Persistent concentrations of the algae were observed in September and October in the same general areas as in the summer months with highest concentrations off Hallowing Point near Indian Head, MD. Concentrations declined in the fall months, coinciding with decreasing water temperatures and lower growth rates for the algae. Below average streamflow in September and October favored the continued presence of the algae. Concentrations decreased gradually and no sudden die-offs of the algae were observed. The gradual decrease in concentration of the algae seems to reject the meteorological conditions of the fall months with the absence of any extreme changes (see Section 3 and Tables 2 and 3). Sudden die-offs and decay of the algae can result in oxygen depletion and fish kills. No fish kills were observed associated with the algae.

In addition to the Microcystis bloom in the Potomac River 1983, the Maryland portion of Chesapeake Bay showed widely distributed and frequent incidence of dinoflagellate blooms with associated discolored water, odor, and fish kills. Algal blooms were reported in many locations including the Gunpowder, Magothy, Severn, and Potomac Rivers and in Rock Creek, Spa Creek, and Mattawoman Creek.

Scattered phytoplankton blooms continued in the upper Bay in September. Above-normal water temperatures and generally calm conditions coincided with an above-average number of reports of discolored water and odor. Fish kills occurred on September 11 at Back River and Spa Creek during a period of very warm air temperatures and little wind. The dominant species in both fish kills was menhaden, and the probable cause was low dissolved oxygen, according to the Maryland OEP. Occasional localized blooms were reported in the Patuxent River, Kent Narrows, and Sandy Point areas during November.

Table 14.--Average and observed 1983 July and August Potomac River streamflow, air temperature, water temperature, percent sunshine, and wind speed.

Condition	Year	July	August
Potomac River Flow (in cubic feet per second)	1983	3,660	1,893
	1977-83 average	4,956	5,018
Air temperature (degrees Fahrenheit)	1983	81.2	81.0
	1943-83 average	78.9	77.6
Water temperature (degrees Fahrenheit)	1983	82.0	81.0
	1977-83 average	81.4	81.0
Percent sunshine	1983	81	72
	1943-83 average	64	64
Wind Speed (miles per hour)	1983	6.5	6.5
	1977-83 average	8.3	8.1

Data are for Washington, DC, compiled by Metropolitan Washington Council of Governments.

4.5 Icing

Ice cover on Chesapeake Bay during the winter of 1982-83 (December 1982, January and February 1983) was very limited, minimally affecting finfish and shellfish harvest activities. Abnormally mild air and water temperatures resulted in less than ten percent ice cover during the 1982-83 winter, the lowest in at least seven years (Table 6).

Although watermen had unrestricted access to oyster grounds in winter 1982-83, reduced availability and other factors kept landings below expected harvest levels. (sections 4.3 Shellfish and 4.6 Diseases).

4.6 Diseases

The high prevalences of the oyster pathogen Haplosporidium nelsoni ("MSX") declined Bay-wide following heavy rainfall and decreased salinities in spring and summer 1983. In 1981 and 1982, following periods of low rainfall and sustained higher-than-normal salinities, the oyster stocks showed the reappearance and spread of MSX into susceptible oyster populations in northern Maryland waters. Maryland and Virginia monitoring agencies reported an unusually high mortality of oysters during the winter quarter, December 1982 - February 1983. Oyster stocks, already in low supply from years of poor spawning seasons during 1975-1979, were reduced further by MSX. Areas hardest hit by the disease included Eastern Bay, lower portions of the Choptank and Little Choptank Rivers, the Honga River and upper Tangier Sound. Areas less severely affected included the mouth of the Potomac and the lower Patuxent Rivers. Infestations of MSX were reported up to 40 miles north of oyster beds hit by the last outbreak of MSX in the 1960's. Oyster landings were reduced up to 80 percent in Eastern Bay and up to 40 percent in other hard-hit areas.

Sampling by the National Marine Fisheries Service and Maryland Department of Natural Resources (DNR) of MSX infested areas in Maryland in spring 1983 showed little or no change in prevalence of the disease in oyster beds previously shown to be infected during 1982 sampling. MSX appeared to reach a peak in northern areas of Chesapeake Bay in June 1982. High freshwater inflow during spring 1983 greatly reduced surface salinities in areas of the Middle and Upper Bay (See section 3.4). This trend toward lower salinities apparently prevented explosive development of the disease as was seen in the mid-1960's in the lower Chesapeake Bay. Continued low salinities into summer and fall 1983 provided unfavorable conditions for MSX disease.

Peak oyster mortalities from MSX are normally observed in June, September, October, and early November. Areas such as Eastern Bay off Kent Island, MD, which experienced extensive mortalities in fall 1982, showed very low mortalities in fall 1983. Northern Chesapeake Bay, an area considered at high risk of MSX infection, showed low prevalence of the disease in August. Lower-than-normal salinities in June following the very wet spring may have contributed to the reduced prevalence of MSX which prefers salinities above 12 ppt. In fall 1983 oysters in most areas of the Upper Bay, with the exception of Cornfield Harbor, MD showed very low prevalence of MSX. High levels of MSX (40 percent prevalence of all stages of the disease) were detected in the Cornfield Harbor area of the lower Potomac River. The Maryland DNR projected total Bay oyster harvest for the 1982-83 season was 1,822,000 bushels. The actual catch was 1,450,000 bushels. MSX was considered the major causative factor in the difference of 372,000 bushels, which represents a dockside value of $3.7 million.

Virginia oyster stocks did not experience the unusually high oyster mortalities from MSX in 1982. Studies by the Virginia Institute of Marine Science in summer-early fall show MSX activity was either non-existent or very low in sampled oysters in Virginia. Natural resistance of oyster populations in the lower Bay may have been a factor in lower MSX-induced mortality rates in Virginia. Oysters that survived the 1960's outbreak of MSX in the lower Bay were potentially disease resistant.

Oyster stocks in both Maryland and Virginia have shown continual declines in recent years. Disease-related mortality, sustained high levels of fishing pressure, and natural fluctuations in abundance are contributing factors to the decline in the oyster harvest.

Another oyster parasite, *Perkinsus marinus* ("Dermo"), was suspected of contributing to oyster mortalities during the MSX outbreak. Dermo, which has salinity requirements similar to MSX, occurred farther north than usual in 1982, and remained prevalent in 1983 in the northern Bay. Scientists have suggested that Dermo had possibly become adjusted to lower salinities since it was found in some areas where salinities as high as 15 ppt were not maintained for the greater part of the year.

Clams

Scientists at the National Marine Fisheries Service reported the unusual occurrence of sarcomatous neoplasia disease in soft clams in Maryland in 1983. The first case of this disease, apparently introduced from New England shellfish populations, was detected in 1979 in Maryland. The next case was not detected until January 1983, though intensive study of the disease showed that by December 1983 it had reached epizootic (epidemic) prevalences of 50 percent in Maryland waters. The neoplasia appears to disappear as soon as water heats up in the spring, when the older, larger clams die out of the populations. Because the larger clams are not of the preferred quality for marketing, mortalities have not shown any effect on harvests.

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. 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.

Recreational boating is an important economic and environmental activity, especially in local areas of the Upper Bay. 1983 was a good year for recreational boating, especially the late summer and early fall. Both parks usage (section 5.3) and U.S. Coast Guard search and rescue operations (section 5.1.2) reflect an increased number of recreational boaters on the Bay.

5.1 Recreational Boating

Maryland Department of Natural Resources reports 142,515 boats registered for Maryland waters. Counting the federally registered yacht owners there are more than 134,000 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 (89 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 34 percent of all registered boats in Maryland.

Boating fees and licenses generated for $1,296,000 (Table 15) in revenue to the state of Maryland in 1983. Approximately 70 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, 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 more than 100,000 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 15.--Maryland boating licenses and fees, 1978-1983.

License Type	Total Number of Licenses and Fees (thousands)											
	1983		1982		1981		1980		1979		1978	
Boat Dealer	0.7	$17.7	0.6	$15.0	0.6	$14.2	0.6	$14.3	-----		-----	
Original Cost Boat Registration	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	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	$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		$1,475.6		$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 1983 NWS issued 147 warnings on 99 different days. The greatest number of warnings in 1983 and 1982 were small craft advisories, 115 and 141 respectively (Table 16).

The different conditions leading to NWS advisories appear seasonally distributed in the different regions of the Bay (Figure 13). 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 two seasons, but on fewer occasions, and the majority 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.

Low rainfall and very warm air temperatures during May to August 1983, coupled with low seasonal storm activity, provided favorable conditions for an unusually sustained period for boaters, and resulted in few instances requiring marine warnings in those months.

Gale warnings were issued more frequently during 1983 than in 1982. In 1982, there were only seven gale warnings, three in October and four in December. Twenty-seven gale warnings were issued in 1983. Gale warnings in 1983 were issued in late winter, early spring, early fall, and again in December around the lower Bay and tidal Potomac. In December, at least one gale warning was issued for all areas in the Bay. Sixteen gale warnings were issued for different regions between December 1982 and April 1983 with February having the highest number (8).

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. No special marine warnings were issued in 1983. Though thunderstorms are common in summer months throughout the Bay, usually accounting for most of the special marine warnings, none were reported as a hazard to marine boaters in 1983. During 1982 the Bay received 26 separate special marine advisories related to 18 different weather events.

Table 16.--Marine advisories and warnings, Chesapeake Bay, 1983 (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	2	2	1	9	3	10
B				2		
C						
D						

FEBRUARY

	HEAD OF BAY TO BALTIMORE HARBOR	BALTIMORE HARBOR TO PATUXENT RIVER	PATUXENT RIVER TO WINDMILL POINT	WINDMILL POINT TO MOUTH OF BAY	TIDAL POTOMAC RIVER	ENTIRE BAY
A	3	3	7	7	8	4
B				3	2	3
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	3	4	3	4	7	5
B				3	1	1
C						
D						

APRIL

	HEAD OF BAY TO BALTIMORE HARBOR	BALTIMORE HARBOR TO PATUXENT RIVER	PATUXENT RIVER TO WINDMILL POINT	WINDMILL POINT TO MOUTH OF BAY	TIDAL POTOMAC RIVER	ENTIRE BAY
A	4	4	4	5	8	6
B			1			
C						
D						

MAY

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

JUNE

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

AUGUST

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

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	2	1	3	3	2	1
B			1	2		
C						
D						

OCTOBER

	HEAD OF BAY TO BALTIMORE HARBOR	BALTIMORE HARBOR TO PATUXENT RIVER	PATUXENT RIVER TO WINDMILL POINT	WINDMILL POINT TO MOUTH OF BAY	TIDAL POTOMAC RIVER	ENTIRE BAY
A	1	1	3	4	2	2
B				1		
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	3	3	1	3	7	4
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	3	3	3	6	9	7
B	1	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)

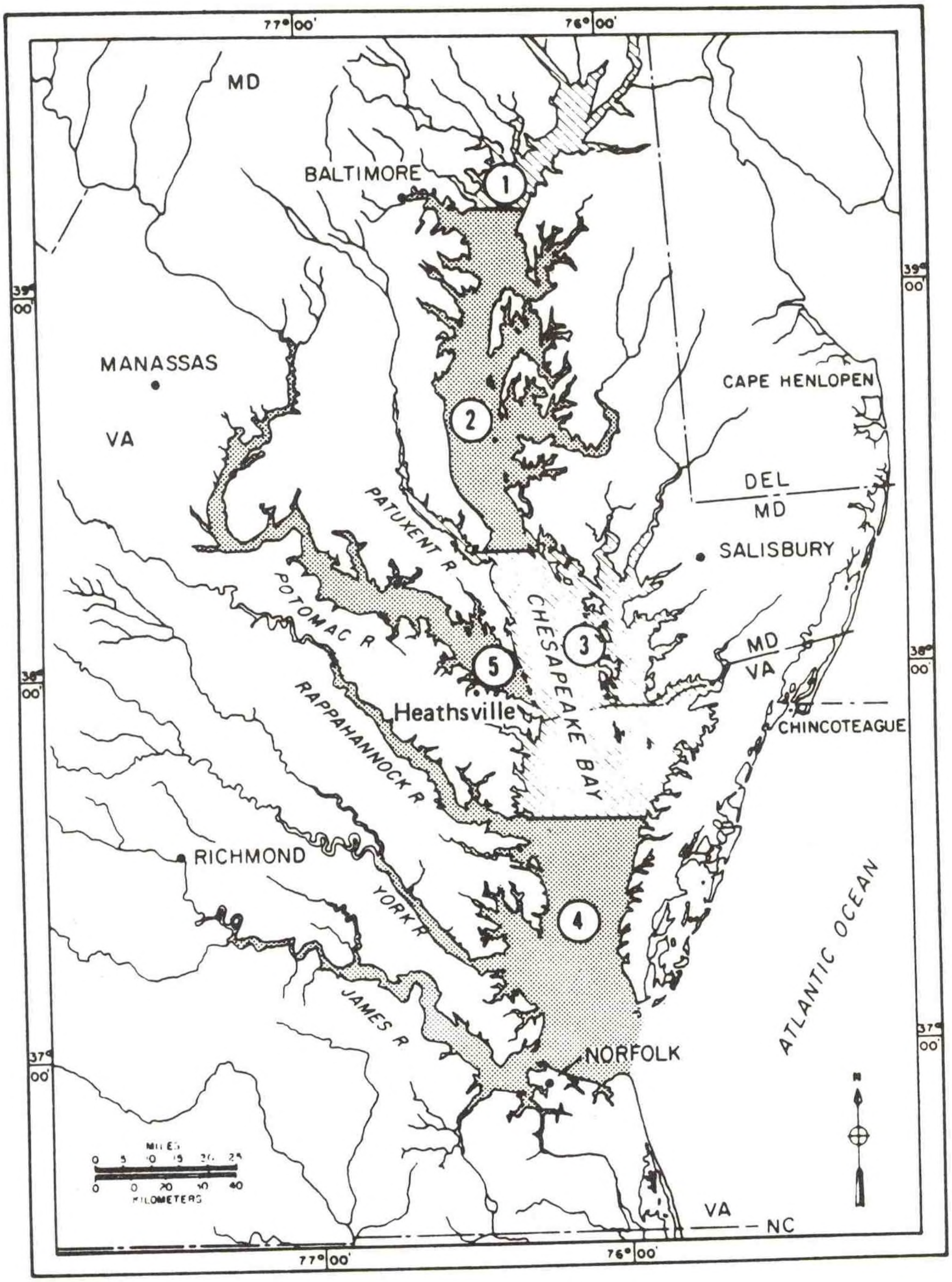


Figure 13.--National Weather Service (NWS) forecast areas for Chesapeake Bay.

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 1983, 27 persons died and 53 were injured in 220 boating accidents in Maryland Bay waters (Table 17). 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 2,784 Search and Rescue (SAR) operations for the entire Bay during 1983. (Table 18). The high number of accidents in July 1983 contributed to the high annual total in 1983. The extended period of rain-free days and unusually hot weather probably attracted a higher number of boaters to the Bay in July 1983 which may have contributed to the higher accident level. Injuries and deaths associated with recreational boating depend strongly on individual safety practices for which no data exist. An unusual incident occurred on May 23 on the Severn River when lightning struck and killed a boat operator at the helm of the boat.

SAR operations conducted by the U.S. Coast Guard in Chesapeake Bay are given in Table 18 by month for 1981-83. Normally, the higher the number of boaters in the water, the higher the SAR caseload. Coast Guard SAR operations peak in July when recreational boating is maximum. Eighty-five percent of SARs in the upper Bay are between May and October. SAR data include any type of call to the Coast Guard including disabled boats and overdue vessels regardless of whether any damage or casualty results.

Most months of 1983 showed considerable decreases in SAR at Group Baltimore. However, large increase in July caseload +26 percent, normally the busiest month for the Coast Guard SAR response, brought total SAR for 1983 nearly to the 1982 total (only 3 percent drop for the year). SAR caseloads for July 1983 were higher than July 1982 at all three Groups reflecting the exceptional July 1983 weather conditions.

Similarly at Group Hampton Roads, the first five months were lower for 1983 than 1982, but excellent boating weather from June through September appears to have created a greater number of SAR cases than normal, hence an increase of 9 percent over the 1982 yearly total. For Group Hampton Roads both 1982 and 1983 total cases are much lower than 1981, when a very mild winter and spring brought the total SAR caseload early in the year to record numbers.

Group Baltimore handled an unusually high caseload (13 cases) on April 17 on the Potomac River and Chesapeake Bay during a series of sudden, intense squalls which capsized dozens of boats, injured at least 12 persons and damaged some sailboats. Group Baltimore also experienced a high caseload on October 28-29 when 11 boats ran aground during strong winds and abnormally low tides in the South River and Annapolis area. Group Norfolk reported an unusually high number of cases in late September and early October during a period of north-easterly winds associated with Tropical Storm Dean.

Table 17.--Maryland accident statistics, recreational boating, 1970-1983.

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

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

Table 18.--Search and rescue operations U.S. Coast Guard, 1981-83.

Month	Group Baltimore			Group Eastern Shore			Group Hampton Roads		
	1981	1982	1983	1981	1982	1983	1981	1982	1983
January	11	--	10	3	5	3	34	38	37
February	15	--	9	4	3	3	26	31	26
March	30	29	18	0	2	4	43	39	36
April	95	77	68	5	3	2	115	93	72
May	135	146	132	11	13	9	255	184	156
June	178	162	139	18	19	25	280	182	240
July	206	229	288	28	31	35	312	262	330
August	163	210	156	19	30	22	231	176	207
September	124	149	128	6	34	15	165	151	175
October	79	130	139	7	14	10	129	106	120
November	42	48	52	3	3	4	68	64	69
December	28	20	23	3	3	1	36	37	31
Totals	1106	1200	1162	107	106	133	1694	1363	1489

Group Baltimore handles all the Bay North of Smith Point including Potomac River. Group Hampton Roads handles all of the Bay South of Smith Point. Group Eastern Shore covers the eastern portion of the Bay but rescue vessels use some of the same port facilities as the other two Groups.

5.2 Bridge Traffic Statistics

Automobile and light commercial traffic on the Bay Bridge has increased every year since 1952 (Figure 14) except 1957 and 1963. Heavy commercial travel has increased at a slower rate.

In 1983 Bay Bridge tolls provided nearly $16 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 commercial traffic over the Chesapeake Bay Bridge in 1983 was greater for all quarters (7.2 percent) over similar traffic in 1982 (Table 19). The first quarter showed the greatest increase, 10.3 percent, over the same quarter in 1982, and the third quarter showed the least increase, 6.4 percent. Among heavy commercial traffic the fourth quarter of 1983 showed the greatest increase (12.8 percent) Over the whole year heavy commercial traffic increased by 4.9 percent. Since commercial traffic decreased during all quarters of 1982 with respect to 1981, the overall increase in heavy commercial traffic 1981-1983 is 2.6 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 1982 to 1983 by nearly $840,000 (5.5 percent) while toll charges remained constant. The Maryland Highway Toll Administration reported an increase in traffic on major bridges in Maryland in 1983. Lower fuel costs and a general improvement in the economy in 1983 contributed to the increase in recreation-related travel.

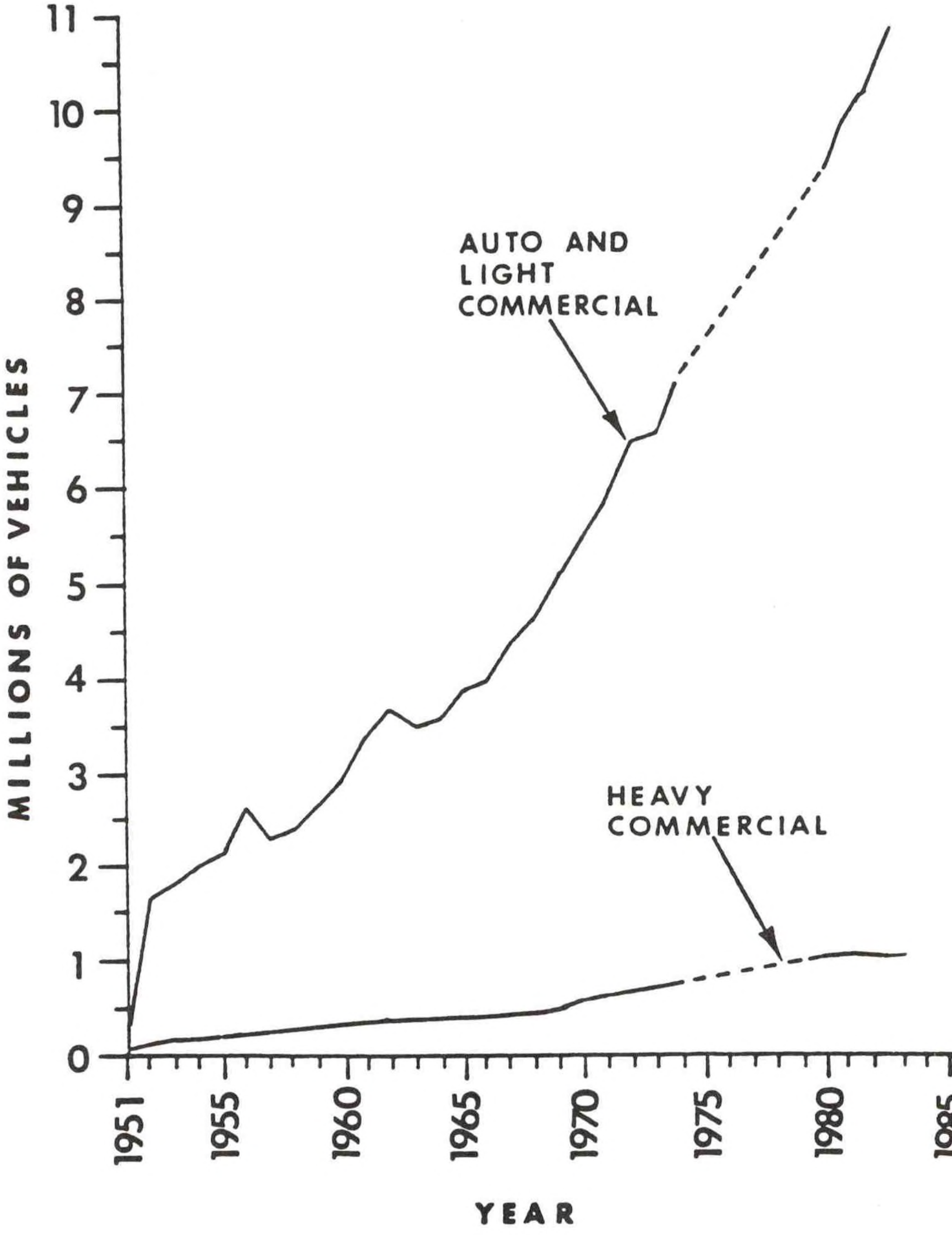


Figure 14.--Chesapeake Bay Bridge vehicle traffic, 1951-1983. (Dashed line indicates data not available for years 1975-79).

Table 19.--Chesapeake Bay Bridge traffic volume and toll revenue, Maryland, 1982 and 1983.

	1982 Auto & Light Commercial	1982 Heavy Commercial	1982 Toll Revenue	1983 Auto & Light Commercial	1983 Heavy Commercial	1983 Toll Revenue
First Quarter	1,613,522	233,990	$ 2,517,958	1,779,739	233,730	$ 2,680,717
Second Quarter	2,740,578	277,864	$ 4,138,130	2,934,551	278,469	$ 4,258,418
Third Quarter	3,587,595	279,424	$ 5,156,552	3,815,609	298,868	$ 5,457,579
Fourth Quarter	2,232,443	246,101	$ 3,290,002	2,377,592	277,629	$ 3,543,747
Total	10,174,138	1,037,379	$15,102,642	10,907,491	1,088,696	$15,940,462

Data from Maryland Transportation Authority Quarterly Financial Reports March 31, 1983, June 30, 1983, September 30, 1983, and December 31, 1983.

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.

Both Sandy Point and Point Lookout state parks in Maryland had a greater number of visitors over all in 1983 than in 1982 (Figure 15). Both Maryland parks showed attendance increases in 1983 over 1982 in seven months of 1983. Attendance at Seashore State Park in Virginia is highest of the Virginia parks bordering the Bay area, and usually reflects weather conditions of the lower Bay area. Seashore showed higher attendance in eight months of 1983. Of the four Virginia state parks, comparisons between 1983 and 1982 can be made only for Chippokes and Seashore (Figure 16), since 1982 attendance data on Westmoreland and York River are not available at present (Figure 17).

The frequent rains and cooler-than-normal temperatures in spring 1983 appear to have had little effect upon park attendance. Sandy Point had 74 percent greater attendance in 1983 than in 1982. Of the six parks, Seashore shows the greatest attendance increase in April. Attendance at Seashore in May exceeded that in 1982 by 42 percent. Specially scheduled activities and opening of the fishing season appear to have had a greater effect on attendance during spring 1983 than weather condition.

In June both Maryland state parks show attendance increases in 1983 over 1982, particularly at Sandy Point. The same applies for Seashore State Park in Virginia. In both 1983 and 1982 the month was wetter-than-normal, though in 1983 much of this wetness was concentrated between periods of very fine weather. In 1982 June was much cooler-than-normal.

July is normally the month of peak park attendance. The hot, and extremely dry weather of July 1983 is reflected in the increases in attendance at both Sandy Point and Point Lookout. Chippokes attendance in July 1983 is far lower than in July 1982, partly attributable to an increase in fees charged, and partly to rain during the yearly peanut festival in July. July attendance at Seashore is the largest in 1983, and slightly higher than in July 1982. At Westmoreland attendance during July 1983 is also greater than in any other month, but at York River peak attendance in 1983 was in August.

Attendance peaked in August and was slightly greater than in 1982 at Point Lookout, but at Sandy Point 1983 attendance in August was down sharply from that in July. Seashore also showed reduced August attendance, while attendance at Chippokes for all the remaining months of the year is very low and down in every month from the previous year.

The near normal weather of September 1983 was favorable for park attendance, and September ranks strongly as one of the months of high attendance at nearly all of the parks.

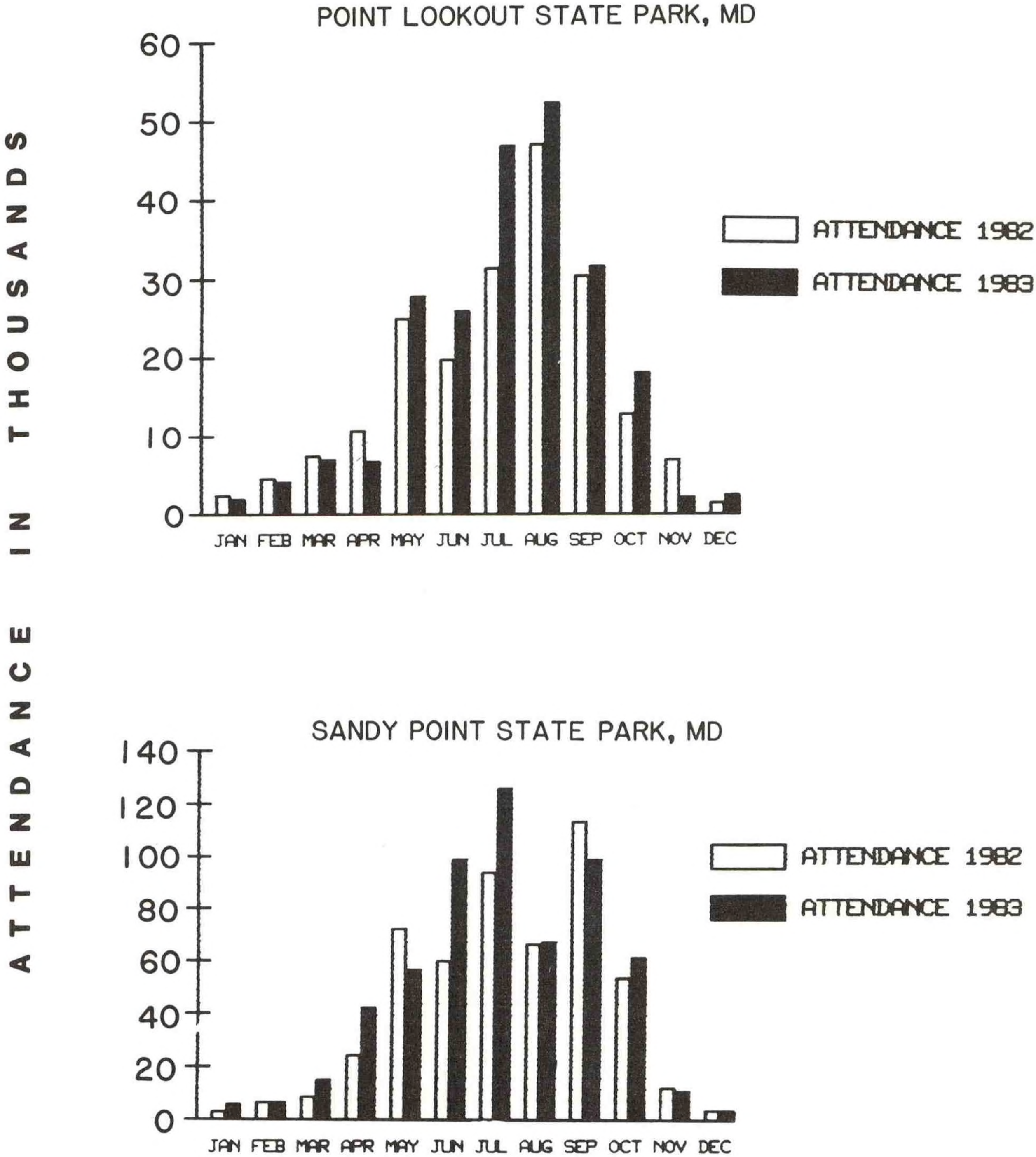


Figure 15.--Monthly 1982 and 1983 attendance at Point Lookout State Park, Md. and Sandy Point State Park, Md.

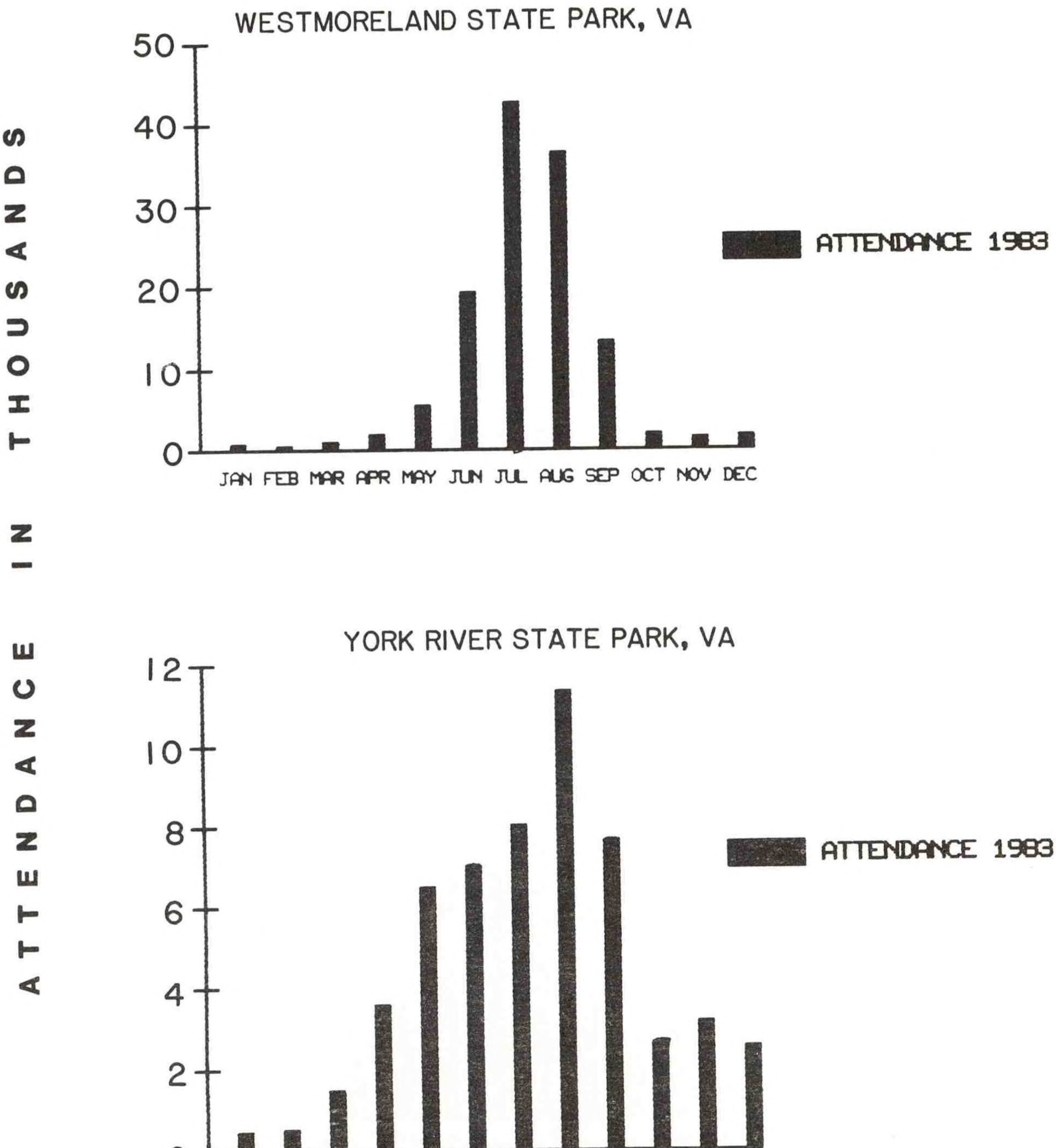


Figure 16.--Monthly 1983 attendance at Westmoreland State Park, Va. and York River State Park, Va.

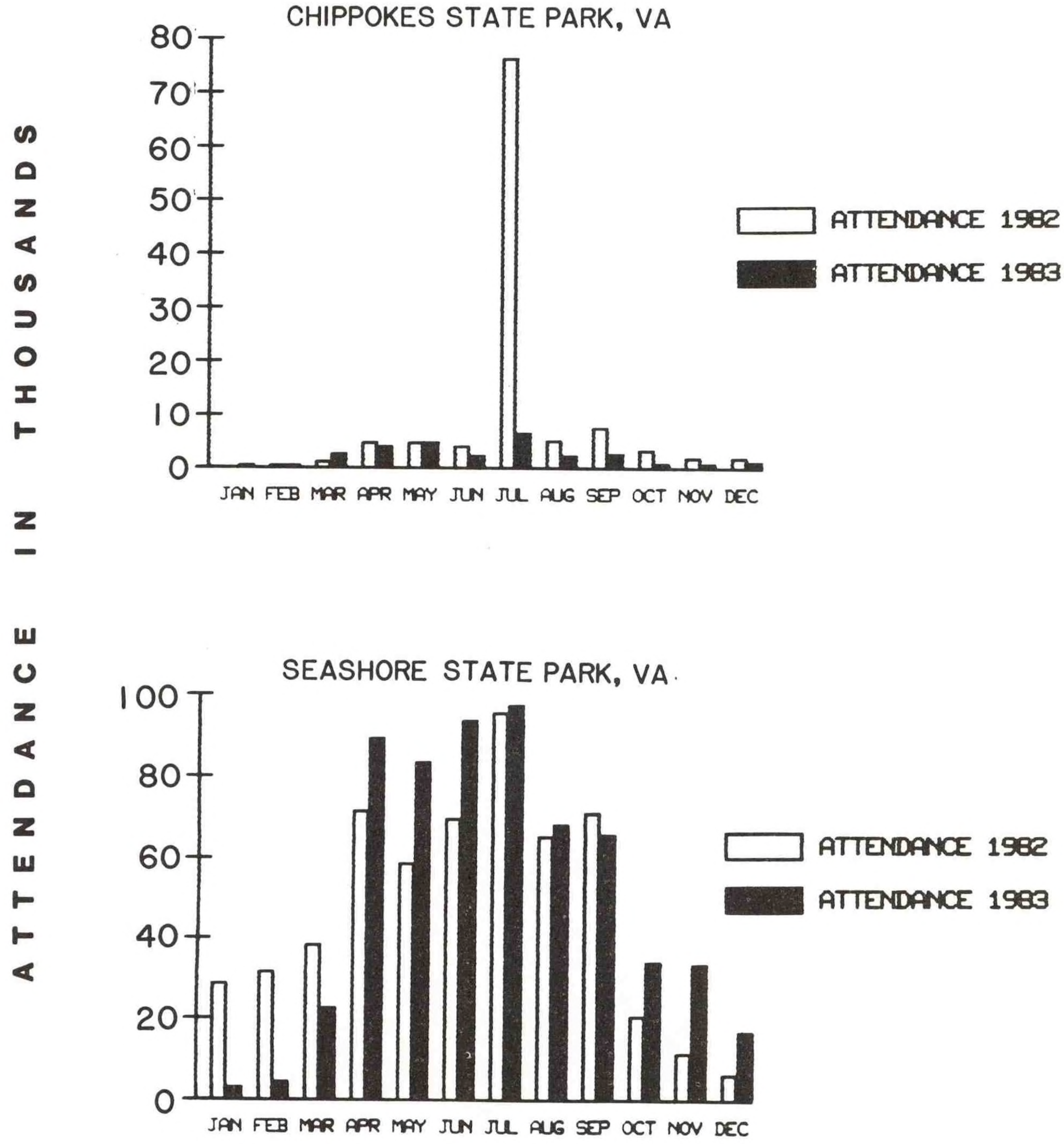


Figure 17.--Monthly 1982 and 1983 attendance at Chippokes State Park, Va. and Seashore State Park, Va.

In October, Sandy Point, Point Lookout, and Seashore had lower attendances in 1983 than in 1982.

Attendance at Sandy Point and Point Lookout in Maryland was down in November 1983 from 1982, while attendance at Seashore in Virginia was up strongly from 1982. Very mild temperatures at Seashore at the southern extremes of the Bay influenced the higher attendance in November 1983.

The decline in attendance in December 1983 over 1982 at Sandy Point may be attributable to the bitter cold and wet conditions in December 1983 compared to the balmy and dry conditions of December 1982. Seashore State Park attendance in December 1983 was nearly 2-1/2 times that in 1982 though much of the increase may have been in the earlier part of December preceding the cold.

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 80 percent of export tonnage and 24 percent 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 20 shows total export and import tonnages for the two ports for recent years.

Total export cargo in the port of Baltimore during 1983 reached only 12.2 million tons, a 41.4 percent decline from export trade recorded the prior year. Total import commerce in 1983 was 9.4 million tons, a 4.4 percent drop from the previous year.

Hampton Roads total export cargo during 1983 reached only 41.0 million tons, a 25.5 million ton decrease from exports recorded the prior year. Total imports decreased by 0.5 tons in 1983.

The decline in export was primarily in bulk cargo, due to a lowered demand for U.S. coal and grain products in 1983. Iron ore, the major import bulk cargo, also decreased in shipment quantity. Port authorities attribute this decrease in demand for coal and iron ore in 1983 to reduced activity at major steel making plants, which require large amounts of coal and iron ore for processing.

Shipping and related shore activities at Maryland and Virginia ports proceeded normally during the unusually mild winter of 1982-83. 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 short-term delays in outside cargo handling due to the snowstorm of February 11.

The unusually heavy rainfall during spring 1983 caused delays in vessel loading and cargo handling at the ports of Baltimore and Hampton Roads. Rain delayed movement of general ship cargo (loose cargo) at Port of Hampton Roads, resulting in increased costs to shippers for rain pay to dock workers and for vessel delays. Loss of productive time due to rain at Port of Baltimore during spring 1983 was greater than in spring 1982.

Table 20.--Export and import tonnages (in millions) Baltimore, MD and Hampton Roads, VA 1976-1983.

	1983	1982	1981	1980	1979	1978	1977	1976
Export (Millions of Tons)								
Hampton Roads	41.0	66.5	*59.8	*58.7	42.0	22.5	31.8	40.0
Baltimore	12.2	20.8	21.5	*21.7	*18.2	*14.3	14.0	14.9
Import (Millions of Tons)								
Hampton Roads	6.7	7.2	*7.1	9.4	10.4	11.3	12.3	11.9
Baltimore	9.4	9.8	12.9	*15.2	20.3	*19.2	*16.4	*19.7

*Revised figures

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. Dredging in Ocean City, Maryland is every eight months and is included here because of its economic importance and proximity.

A dredging operation summary for fiscal year 1983 appears in Table 21. During 1983 eight projects were contracted by the Army Corps of Engineers in the Chesapeake region. Materials removed totalled 1,967,070 cubic yards at a total dollar cost of $11,348,174. Baltimore Harbor dredging accounted for the largest portion of materials removed during 1983.

Cost increases at Baltimore Harbor from $1,459,400 in 1982 to $4,200,605 in 1983 represent increases in net cost per cubic yard removed from $1.96/cubic yard in 1982 to $2.80/cubic yard in 1983, 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 increased from $4.14/cubic yard in 1982 to $6.62 per cubic yard in 1983. The overall cost for this contract nearly doubled ($454,392 in 1982; $847,654 in 1983).

The major increase from 1982 to 1983 occurred at Ocean City where the 1983 contract includes rehabilitating the South Jetty. The 1982 net cost per cubic yard dredged (at 10 ft depth) was $6.89 per cubic yard. The total cost in 1983 for 2 1/2 times the volume of dredging plus Jetty rehabilitation, was $4,955,800. Proportional costs for the dredging operations and the rehabilitation work are not available.

The total costs figures omitting Ocean City suggest the net costs per cubic yard of dredged material has not inflated over the last four years. 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 21.--Summary of dredging operations, Maryland Chesapeake Bay region, U.S. Army Corps of Engineers, during fiscal year 1983 (October 1 - September 30).

Project location	Authorized depth	Dredging quantity (cu yds)	Disposal area	Environmental window	Cost
Baltimore Harbor and Channels	42 ft	1,498,730	Mouth of Patapsco River	Dec 1 - Apr 30	$4,200,605
Fishing Creek	7 ft	63,943	Beach nourishment, Upland	Oct 1 - May 31	273,179
Nanticoke River	12 ft	26,961	Upland	Jul 1 - Feb 28	164,085
Wicomico River	14 ft	128,010	Tangier Sound	Oct 1 - Dec 15	847,654
Ocean City Harbor Inlet (Rehabilitation of South Jetty)	10 ft	80,000	Mouth of Inlet	Sep 1 - Mar 31	4,955,800
Lowes Wharf	7 ft	27,759	Confined upland	Oct 1 - May 31	148,000
Muddy Hook	6 ft	25,537	Confined upland	Oct 1 - May 31	126,074
Northeast River	7 ft	116,130	Confined upland	Jun 16 - Feb 28	632,777

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	1,450,600	4,934,474	3.40
1983*	7	1,887,070	6,392,374	3.38

* 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 accidental 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 ultimately may enter navigable waters. Tables 22-25 give information on spills in the Chesapeake Bay Region for 1981-83 from the Pollution Incident Reporting System (PIRS) database managed by the Coast Guard. During 1983 a total of 504 spills put 219,242 gallons, 48,537 pounds, and one sheen of various pollutants into the Bay and its tributary waters. The spills represent 5.4 percent of the incidents nationwide but only 0.1 percent of the total volume.

The 1983 total of 504 spills in the Bay system shows a great increase over the 333 in 1982 and 364 in 1981 (Table 22). The increase in spills in 1983 is primarily represented by petroleum spills probably due to increased shipments and handling of petroleum products. Although there was a decrease in transportation around the Bay, export cargo of petroleum and petroleum products increased in 1983 over 1982 at Hampton Roads, and imports of miscellaneous petroleum products at Port of Baltimore increased by 229 percent in 1983 over 1982. The total of all oil spilled in 1983 reached 410 spills, a 42.4 percent increase over 1982. Diesel oil showed the highest number of oil spills in 1983, a total of 172 compared to 130 in 1982.

The largest number of spills in 1983 occurred during June through August, August showing 59 spills which was the highest for the entire year (Table 23). In 1982, January, August, and December had the most spills, with the highest of 40 in December.

The largest quantity of oil spilled in 1983 was 11,777 gallons in January. A total of 150,000 gallons of chemicals and industrial waste were spilled into the Bay system in June. The material type, date, location, and source of substances in excess of 1,000 gallons are listed in Table 24. Most of these spills originated from onshore plants or facilities, or tank trucks. Figures 18-19 show location of spills of oil and hazardous substances which entered navigable waters during 1982 and 1983. Most of the spills occurred near the major ports of Baltimore, MD and Hampton Roads, VA.

Spills of hazardous substances also increased in 1983 (Table 25). Sulphuric acid, phenol, caustic soda and other materials are the main sources of hazardous substances spilled in 1983 and they originated primarily from onshore plants and dry cargoships. The distribution of the total number of all spills shows a uniform increase in 1983 when compared to the distribution in 1982. Figures 18 and 19 show the locations of the spills in 1982 and 1983, respectively.

Table 22.--Number of spills by material type, Chesapeake Bay region, 1981-83.

Material	No. of Spills 1981	1982	1983	1982-83 % change
Diesel Oil	136	130	172	+32.3
Other Oil	75	82	144	+75.6
Residual Fuel Oil	49	24	36	+50.0
Other Distillate Fuel Oil	12	10	18	+80.0
Crude Oil	5	0	5	0.0
Waste Oil	31	42	35	-16.7
Total All Oil	308	288	410	+42.4
Gasoline	17	16	31	+93.8
Other Pollutant	4	2	13	+550.0
Other Material	2	5	18	+260.0
Unknown	25	12	10	-16.7
Natural Substance	3	2	3	+50.0
Asphalt or Other Residual	1	1	5	+400.0
Hazardous Substance	2	5	10	+100.0
Other	2	2	2	0.0
Solvents	0	0	2	0.0
Total Chesapeake Bay region spills	364	333	504	+51.4
Total spills, all U.S. waters	*10,564	*10,175	10,969	+8.0
Chesapeake Bay region spills as percentage of all U.S. spills	3.45%	3.27%	4.59%	

* Revised figures

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.

Table 23.--Chesapeake Bay spills of oil, hazardous materials, and other substances by month, in gallons, pounds, and sheen, 1983.

Month	Oil		Hazardous			Other				Total			
	Spills	Gallons	Spills	Gallons	Pounds	Spills	Gallons	Pounds	Sheen	Spills	Gallons	Pounds	Sheen
January	27	11777								27	11777		
February	48	3125				2	1050			50	4175		
March	47	6126	1	100		1			1	49	6226		1
April	40	11402	4	500	12800	1	50			45	11952	12800	
May	40	5193				3	3503	5		43	8696	5	
June	52	5555	1	2		4	150007	130		57	155564	130	
July	53	2627				2	2100	2		55	4727	2	
August	56	6601	3	5	35600					59	6606	35600	
September	37	2671				1	20			38	2691		
October	39	5297								39	5297		
November	16	424				4	430			20	854		
December	22	677								22	677		
Total	477	61475	9	607	48400	19	157160	137	1	504	219242	48537	1

Table 24.--Spills of 1,000 gallons or greater, Chesapeake Bay region, 1983.

Materials	Gallons	Date	Location	Source
Residual fuel oil	3000	March 10	36°49'N 76°17'W	Miscellaneous
	5000	April 25	36°52'N 76°19'W	Unknown (suspected vessel)
Lube oil	1000	September 25	36°47'N 76°17'W	Onshore plant
	2000	August 17	38°49'N 77°00'W	Pipeline
Other material	3500	May 28	37°56'N 76°30'W	Tank truck
	2000	July 7	39°18'N 76°32'W	Land transportation
Industrial waste	1000	February 1	36°57'N 76°18'W	Onshore facility
Chemical wastes	150000	June 15	37°02'N 76°20'W	Onshore bulk storage facility
Distillate fuel oil	2500	May 3	36°57'N 76°19'W	Onshore facility
Heavy oil	3000	January 25	36°57'N 76°19'W	Combatant vessel
Gasoline	1100	June 13	37°56'N 76°30'W	Tank truck
	1200	January 7	38°55'N 77°06'W	Tank truck
	1700	August 4	38°20'N 76°28'W	Offshore fueling
	3500	April 9	37°56'N 76°30'W	Highway cargo transfer
	2800	January 10	37°56'N 76°30'W	Onshore plant
Diesel oil	1000	August 17	36°57'N 76°19'W	Unknown type

Table 24.--(continued). Spills of 1,000 gallons or greater, Chesapeake Bay region, 1983.

Materials	Gallons	Date	Location	Source
	1000	March 31	36°49'N 76°17'W	Combatant vessel
	2000	January 7	36°57'N 76°19'W	Marine facility
	2000	October 21	36°49'N 76°17'W	Tugboat
	2500	January 26	39°17'N 76°39'W	Highway vehicle liquid bulk
Residual fuel oil	1000	October 22	36°51'N 76°17'W	Tugboat

Table 25.--Spills of hazardous substances (quantity in pounds), Chesapeake Bay region, 1983.

Material	Pounds	Date	Location	Source
Sulphuric acid	5600	August 10	39°12' 76°32'	Onshore bulk storage facility
	12000	April 21	39°12' 76°32'	Onshore plant
Phenol	30000	August 31	37°18' 77°16'	Onshore refinery
Caustic soda	800	April 26	39°12' 76°32'	Onshore plant
Other material	130	June 21	36°51' 76°20'	Onshore plant
	2	July 7	36°54' 76°19'	Dry cargoship
	5	May 13	36°51' 76°20'	Onshore plant

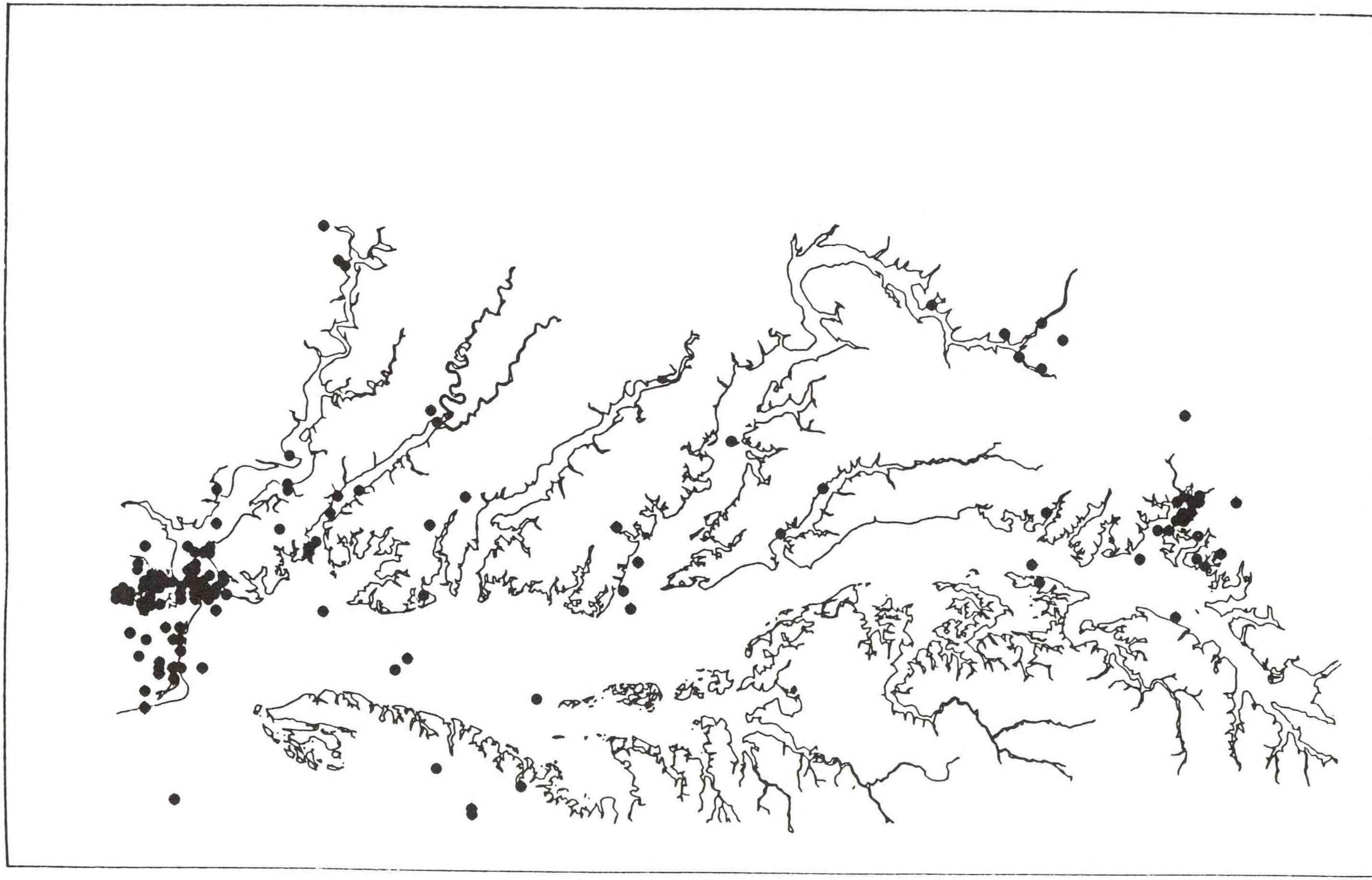


Figure 18.--Map of Chesapeake Bay showing locations of spills of oil and hazardous substances which entered navigable waters during 1982. Spill data from U.S. Coast Guard Pollution Information Reporting System (PIRS). EPA Chesapeake Bay Program map.

Figure 19.--Map of Chesapeake Bay showing locations of spills of oil and hazardous substances which entered navigable waters during 1983. Spill data from U.S. Coast Guard Pollution Information Reporting System (PIRS). EPA Chesapeake Bay Program map.

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, 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 .5 MGD represent 96 percent of total flow. Total average daily flows and capacity in MGD of twenty-two treatment facilities are listed in Table 26 for the years 1980-83. Twelve of the sewage treatment facilities showed an increase in flow in 1983.

Many treatment plants experience increased flow which can exceed their capacity during periods of heavy rainfall. The unusually high rainfall over extended periods during spring 1983 increased discharge rates at many sewage treatment facilities around the Bay.

Construction of new sewage treatment plants in the Bay region caused decreases in average daily flow at Lamberts Point, Chesapeake Elizabeth, Boat Harbor, and James River facilities. The addition of the new plants has resulted in reduction of approximately 4 million gallons of flow at the original facilities.

The increase in flow at Hopewell is due primarily to production increases at local industries and businesses. Eighty-five percent of the Hopewell flow of 34.2 MGD is from local businesses.

Table 26.--Average daily discharge of selected sewage treatment facilities, Chesapeake Bay region, 1980-1983.

Sewage Treatment Plant	Capacity (MGD)	Drainage Basin	Flow (MGD) *1980	1981	1982	1983	% change 1982-83
Blue Plains	650.0	Potomac River	317.0	324.0	332.0	*322.0	-3.0
Back River	N/A	Upper Chesapeake Bay Delmarva	80.6	64.0	76.0	90.0	18.4
Richmond	N/A	James River	61.0	63.0	63.8	N/A	
Wyoming Valley Sanitary Authority	40.0	Susquehanna River	40.0	31.5	27.5	25.8	-6.2
Hopewell	50.0	James River	33.6	31.9	28.8	34.2	+18.8
Patapsco	52.0	Upper Chesapeake Bay Delmarva	30.0	24.9	27.4	36.1	+31.8
Blue Plains Bypass	3.0	Potomac River	27.6	15.3	17.7	0	
Alexandria	54.0	Potomac River	27.0	28.9	32.1	32.9	+2.5
Upper Potomac River Commission	21.5	Potomac River	22.4	21.5	21.9	19.7	-10.1
Arlington Co.	30.0	Potomac River	22.3	22.2	25.9	25.4	-1.9
Lower Potomac	36.0	Potomac River	22.2	22.4	28.2	30.4	+7.8
Scranton Sewer Authority	28.0	Susquehanna River	21.2	20.2	16.0	14.3	-10.6
Lamberts Point	30.0	James River	20.6	21.3	25.2	23.9	-5.16
Harrisburg	30.1	Susquehanna River	20.5	19.6	22.6	25.6	+13.3
Binghamton-Johnson City	18.3	Susquehanna River	19.9	14.0	17.2	*19.5	+13.4
Chesapeake-Elizabeth	30.0	James River	19.7	19.9	25.1	22.2	-11.6
Boat Harbor	25.0	James River	17.6	17.6	18.9	18.2	-3.7
York City	26.0	Susquehanna River	16.3	16.0	16.3	18.2	+11.7
Piscataway	30.0	Potomac River	15.0	13.9	15.3	17.3	+13.1
Western Branch	30.0	Upper Chesapeake Bay Delmarva	13.9	9.9	10.4	11.3	+8.7
James River	20.0	James River	13.7	13.9	15.8	14.7	-7.0
Army Base	18.0	James River	12.4	11.5	12.9	13.4	+3.9
Total (omitting Richmond)			874.5	827.4	877.0	815.1	+84.14

* 1980 Data from EPA Chesapeake Bay Program database

ACKNOWLEDGMENTS

Thanks are expressed to Dr. Celso S. Barrientos, Kathryn A. Benkert, Jack Foreman, Karl B. Pechmann, Isobel C. Sheifer, and Dr. Kenneth W. Turgeon for review of the draft. Special thanks to Pollie A. McKinney for typing the report.

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
EPA/Chesapeake Bay Program, Annapolis
Hampton Roads Maritime Association
Maryland Department of Environmental Programs
Maryland Department of Natural Resources
    Natural Resources Marine Police
    Forest and Park Services
    Tidal Fisheries
    Licensing and Consumer Services
Maryland Highway Toll Administration
Maryland Pilots Association
Maryland Port Administration
Maryland State Climatologist
Maryland Steamship Trade Association
Metropolitan Washington Council of Governments
NASA/Goddard Space Flight Center
NOAA/National Environmental Satellite, Data, and Information Service
NOAA/NAVY Joint Ice Center
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 Field Office
    Washington Weather Service Field Office
        Ocean Services Unit
    Norfolk Weather Service Field Office
Potomac River Fisheries Commission
T. L. Courtney, Independent Commercial Fisherman
University of Maryland
    Chesapeake Biological Laboratory

Acknowledgments, continued

U.S. Coast Guard
- Group Baltimore
- Group Eastern Shore
- Group Hampton Roads
- Pollution Information Reporting System
- Baltimore Safety Office
- Public Affairs Office
- District Office - Hampton Roads

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
Weather Observers
- Aberdeen Airport
- Capitol City Airport

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

OFFICIAL BUSINESS
Penalty for Private Use. $300

AN EQUAL OPPORTUNITY EMPLOYER

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

FIRST CLASS

U.S.MAIL