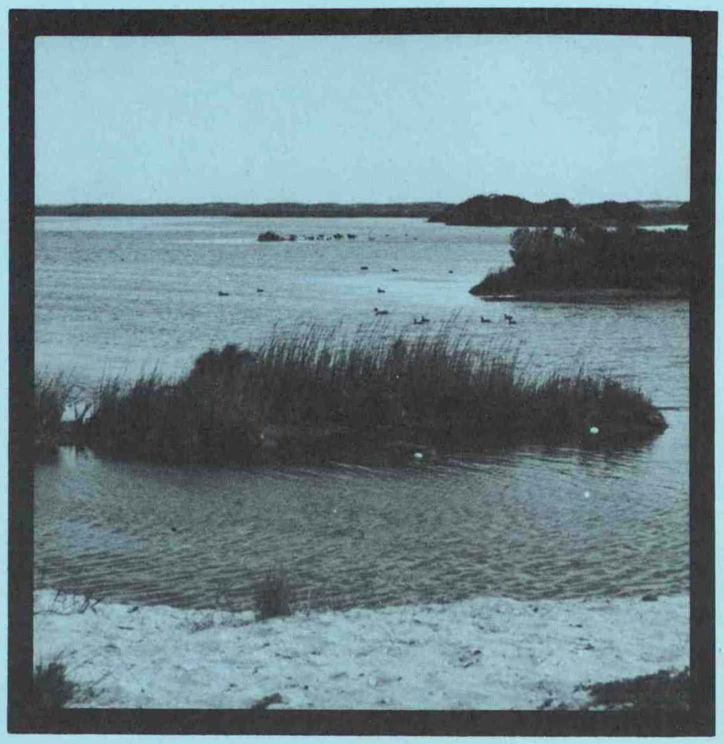
Marine Environmental Assessment
CHESAPEAKE BAY
DEC. 1984 – FEB. 1985



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.

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NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
NOAA
U.S. DEPARTMENT OF COMMERCE

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CHESAPEAKE BAY

DEC. 1984 – FEB. 1985

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Marine Environmental Assessment Division

Washington, D.C.

APRIL 1985

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CHESAPEAKE BAY MARINE ASSESSMENT

The marine ecosystem exhibits many complex interrelationships which are difficult to measure. Climatic events do not often produce an obvious immediate response in the marine environment. The extended intervals that frequently exist between a climate event and the observed impact present a problem different from the land oriented assessments Assessment and Information Services Center (AISC) produces. This difference necessitates relating changes in climatic variables to marine environmental changes on a quarterly basis. For Chesapeake Bay, June through August covers the warm, relatively stable summer months; September through November covers the dynamic fall period of decreasing temperatures and water column turnover and vertical mixing; December through February covers the cold winter period; and March through May covers the dynamic spring period of increasing temperatures and nutrient enrichment.

The AISC effort in Chesapeake Bay is a first step toward providing operational marine assessments for major water bodies within and adjacent to the United States.

Table 1. Environmental impact summary, Chesapeake Bay, December 1984 - February 1985.

	IMPACT SECTOR																		
	FISHERIES							RECREATION					TRANSPORTATION						
EVENT	Finfish harvest activities (general)	Shellfish harvest activities (general)	Blue crab December dredge harvest	Croaker 1984 year class	Finfish - Virginia rivers	Wooden hull boats		Park usage	Boating activity	Safety			Port operations	Cost to shippers					
Above-normal Dec. water temp.	+	+																	
Above-normal Dec. air temp.	+	+	+					+	+										
Ice cover	-	-				-			-	-									
Cold mid-Jan. water temp.				-	-														
Stong winds - Jan.													-	-					

+ Favorable

\- Unfavorable

☐ No identifiable effect, data unavailable, or not applicable

Chesapeake Bay Marine Environment

1. Highlights - General Events and Impacts

Icing temporarily shut down harvest activities, mostly oystering, for up to four weeks in areas of the upper Bay in January and February. In addition to missed work days, watermen experienced damage to boat hulls, propellers, and rudders.

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

Cold water temperatures in mid-January caused extensive mortalities of croaker, indicating the loss of most, or all, of the 1984 year class. Other finfish species such as eels suffered mortalities due to unusually cold temperatures.

Park usage and boating showed increased activity during periods of warm weather, especially on weekends. Several boating accidents were reported due to ice conditions in the upper Bay.

Strong winds in January resulted in excess costs to container-line shippers from crane downtime. Ice cover had little or no effect on large vessel operations, though smaller vessels were affected by horsepower and hull type restrictions during peak icing on the Bay.

2. Weather and Oceanography Summary

2.1 Weather

The winter quarter covering December 1984 through February 1985 was a period of strong contrasts in temperature, with record high temperatures in December and again in late February to the record cold temperatures of January 21. Strong winds prevailed throughout most of January and much of February. Dry conditions prevailed over most of the quarter with frequent small amounts of precipitation.

December:

Six cold fronts pushed through the area during the month. Storms affected the area on the 3rd, 6th, the 21st, 22nd, and the 25th. The storm on the 6th produced the greatest precipitation and was accompanied by strong northwest winds.

Precipitation in the month of December among the 11 stations in Figure 1 averaged 1.79 inches (45 percent below normal), ranging from 63 percent below normal at both Washington and Royal Oak to 7 percent below normal at Wilkes-Barre (Table 2). Six of the stations, from Baltimore to Richmond, had precipitation amounts 50 percent or more below normal. Precipitation occurred frequently during the month, but on most occasions ranged from a trace to less than 0.1 inches. Heaviest precipitation occurred in the Bay area over the 5th and the 6th with amounts up to one inch. Royal Oak recorded 0.97 inches on the 6th. Most of the precipitation northwest of the Appalachian mountains fell as snow.

Temperature averaged 44.0°F, 7.5°F above normal for the 11 stations in December. Temperature departures among the stations ranged from 5.0°F above normal at Williamsport to 9.8°F above normal at Aberdeen. Record highs occurred at many of the stations on the 28th and 29th when a surge of warm tropical air preceded a cold front on the 30th. Temperatures soared to the high 70's at many stations and reached 80°F at Baltimore on the 29th. It was the warmest December on record at Baltimore and Royal Oak, 3rd warmest at Wilkes-Barre, 4th warmest at Richmond, and 6th warmest at Norfolk.

Peak winds at Patuxent exceeded 23 mph nine times. Winds on the 6th and 7th reached 35 mph during and following the storm on the 6th, and on the 22nd reached 34 mph. Royal Oak reported its highest wind speed of the month, 39 mph, during the storm on the 25th.

January:

Warmer-than-normal weather continued briefly into January until a storm which developed in the Gulf of Mexico region moved through the area on the 1st and 2nd and brought cooler weather. Thereafter colder temperatures prevailed during the month, culminating in record low temperatures on the 21st. Major cold fronts pushed southeast through the area six times in January, each associated with frontal storms.

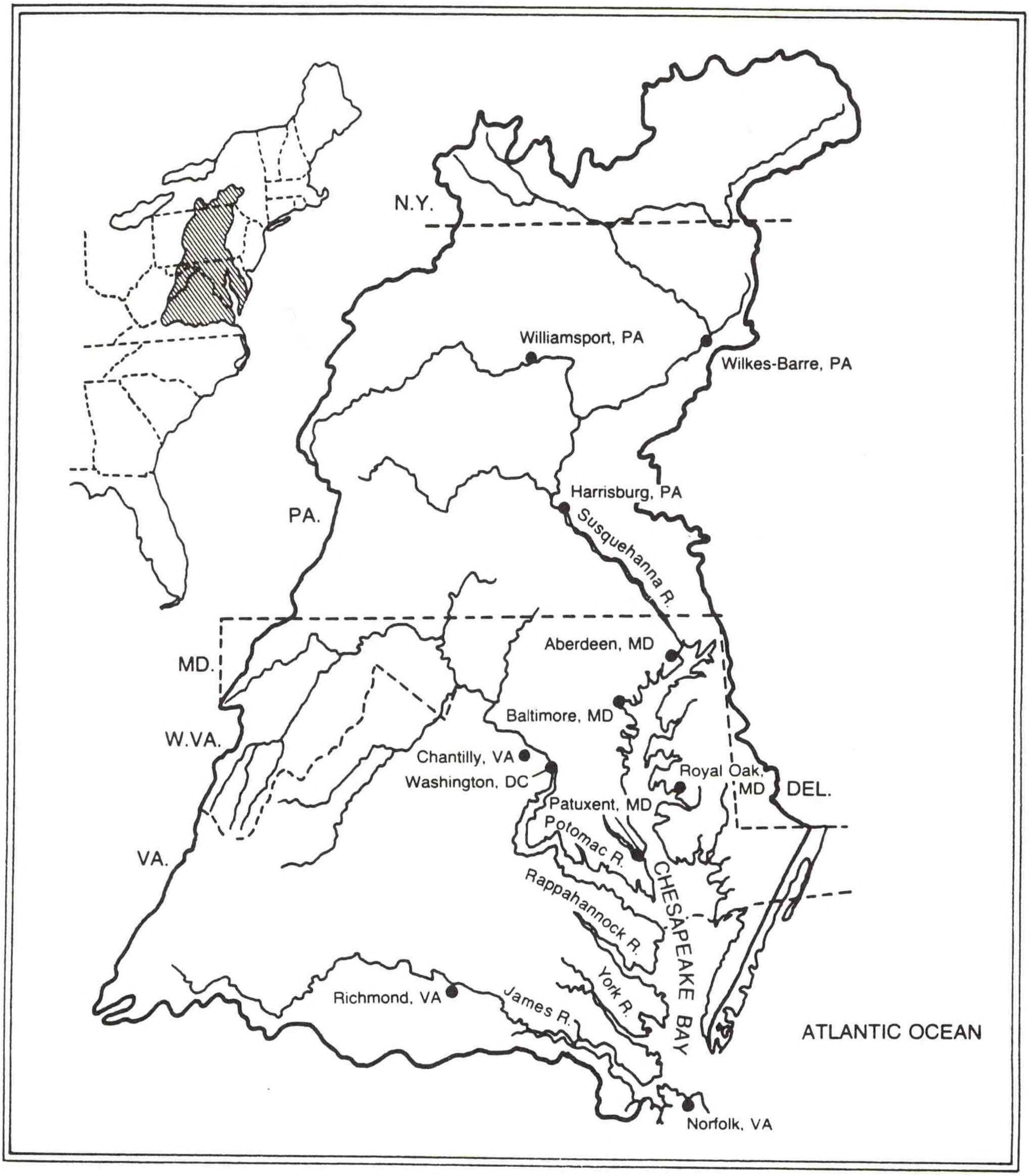


Figure 1. Selected meteorological stations, Chesapeake Bay watershed (Modified EPA map).

Table 2.--Total precipitation, mean air temperatures, and departures from normal for 11 stations, Chesapeake Bay watershed, December 1984 - February 1985.

Station	Total Precipitation (inches) and Departure from Normal Observed/*Anomaly (% of normal)			Air Temperature and Departure from Normal Observed/*Anomaly (Deg. F)		
	December	January	February	December	January	February
Williamsport, PA	2.34/-28%	0.52/-82%	1.12/-60%	35.7/+5.0	23.4/-2.8	29.9/+1.7
Wilkes-Barre, PA	2.36/-7%	0.61/-73%	1.58/-23%	37.3/+7.6	21.5/-3.7	29.8/+3.0
Harrisburg, PA	2.38/-29%	1.07/-64%	2.91/+7%	41.6/+8.2	24.9/-4.5	34.4/+2.9
Aberdeen, MD	1.79/-46%	1.32/-55%	2.63/-6%	44.8/+9.8	29.8/-3.5	38.5/+3.8
Baltimore, MD	1.71/-50%	2.03/-32%	3.03/+2%	44.1/+7.6	29.3/-3.4	38.7/+4.0
Washington, DC	1.19/-63%	2.11/-24%	3.07/+17%	45.6/+6.7	30.8/-4.4	37.8/+0.3
Chantilly, VA	1.25/-62%	2.32/-18%	3.73/+41%	43.3/+8.2	28.1/-3.3	35.8/+2.2
Royal Oak, MD	1.39/-63%	3.38/-2%	3.40/+6%	46.1/+7.2	31.5/-3.5	37.6/+0.9
Patuxent, MD	1.59/-52%	2.90/-1%	3.39/+22%	46.4/+6.8	31.7/-5.3	37.9/-0.1
Richmond, VA	1.52/-55%	3.54/+10%	3.20/+2%	47.7/+7.8	32.6/-4.0	40.2/+1.3
Norfolk, VA	2.22/-30%	3.98/+7%	3.52/+7%	50.9/+7.4	34.9/-5.0	40.4/-0.7
Average	1.79/-45%	2.16/-28%	2.87/+2%	44.0/+7.5	29.0/-4.0	36.5/+1.8

*Anomaly = departure from 30-year average for each month.

Temperatures dropped on the 21st to new record lows at all stations. The cold front of the 25th pushed through the area with lightning and thunder in the Washington, DC area (unusual for snowstorms) and with near-blizzard conditions for a brief period.

January precipitation averaged 2.16 inches among the 11 stations, 28 percent below normal, ranging from 0.52 inches at Williamsport, its lowest January amount on record, (82 percent below normal) to 3.98 inches (7 percent above normal) at Norfolk. Richmond with 3.54 inches was 10 percent above normal. Precipitation amounts were lowest in Pennsylvania and the northern part of the region, and greatest in the southern part of the region, being near normal at the lower four stations in the list (Table 2). Measurable precipitation fell on 10 occasions at Royal Oak and Patuxent, though trace amounts occurred on several more occasions. After the 3rd-4th of January, when freezing rain fell, most precipitation fell as snow. Total snowfall for the month ranged from 4.3 inches at Norfolk to 15.5 inches at Royal Oak.

January temperatures averaged 4.0°F below normal, ranging from 2.8°F below normal at Williamsport to 5.3°F below normal at Patuxent. Temperatures were well above normal during the first two days (setting record high maxima both days at Baltimore and Chantilly), but plunged to below-freezing in the mid-Bay area on the 4th. Average temperatures at Royal Oak were above-normal from the 5th to the 8th and the 14th and 25th, though daily average temperatures remained below freezing on all except four days for the remainder of January. Low temperatures reached on the morning of the 21st were record low values for the date at most of the stations. Record low temperatures also occurred on the 20th at several stations. Low temperature values ranged from -2°F at Royal Oak and Patuxent to -14°F at both Williamsport and Wilkes-Barre. The prolonged cold caused a steady formation of ice on the Bay during much of January. The Presidential Inaugural Parade in Washington, DC on the 21st was cancelled for the first time in history because of the extreme low temperature and accompanying strong winds.

Frequent strong winds occurred throughout January, gusting above 50 mph at both Royal Oak and Patuxent on the 15th. Winds exceeded 40 mph on the 25th and 26th at Patuxent, and on the 20th and 26th at Royal Oak. Wind speeds reached between 30 and 39 mph six other times at Patuxent and five other times at Royal Oak. Peak wind speeds in the range of 20 to 29 mph occurred on the Bay on 17 other occasions during the month.

February:

Storms affected the Chesapeake Bay area six times in February. A storm on the 6th-7th produced the high winds with gusts near 40 mph but little precipitation. A storm on the 12th produced both precipitation and strong wind gusts. Very warm air flowed northward over the region on the 23rd and 24th ahead of a cold front on the 24th.

Precipitation in February was greater than in January at 9 of the 11 stations, and varied over the region from well below normal (-60 percent at Williamsport) to well above noraml (+41 percent at Chantilly). The average amount for all stations was 2.87 inches, almost exactly normal. Though precipitation was only 2 percent above normal at Baltimore, February marked the first occasion since May 1984 with above-normal monthly precipitation there. As in January, precipitation in Pennsylvania was considerably less than in areas closer to the Bay, and much of the precipitation in Pennsylvania fell as snow.

A series of frontal storms over the end of January and the first two days of February dropped from one-quarter inch to two-thirds inch of precipitation (amounting to 2 to 5 inches of snow) at the end of January, and from one to one and one-half inches of additional precipitation in the first two days of February. A large storm which developed in the Gulf or Mexico region the 10th and 11th moved through the Bay area on the 12th depositing from 1.24 (Patuxent) to 1.77 (Chantilly) inches of rain over the region. Precipitation fell in low or trace amounts associated with several cold fronts during the month. Snowfalls occurred near Washington, DC on the 6th, but remained farther south and west of the Appalachian Mountains through most of the month.

Though temperatures reached record daily highs in February on the 22nd-24th at many stations, temperatures averaged only 1.8°F above normal for the month, ranging from 0.7°F below normal at Norfolk to 4.0°F above normal at Baltimore during February (Table 2). Average temperatures were below normal during the first half of the month and often below freezing in the middle portion of the Chesapeake Bay region. Temperatures showed a steady climb during the month, when temperatures reached into the low 80's in the lower part of the Bay and into the high 70's elsewhere south of Pennsylvania. The 81°F at Patuxent and the 79°F at Baltimore were new high temperatures for the month of February. Low temperature for the month occurred on the 4th, principally in the north. Wilkes-Barre's -6°F on the 4th was the coldest temperature on that date since 1918.

Winds at Patuxent gusted to 47 mph on the 8th and to 41 and 44 mph on the 7th and 9th, respectively. Winds reached from 30 to 39 mph on three other occasions at Patuxent during the month. Royal Oak reported wind gusts to 36 mph on the 3rd, and to 35 mph on the morning of the 12th. Wind gusts reached between 20 and 29 mph on ten other occasions at Royal Oak.

2.2 Icing

Maximum ice cover on Chesapeake Bay reached 20 percent during the 1984-85 winter (Table 3). NASA studies show that, in a normal winter, maximum ice cover on Chesapeake Bay is about 10 percent of the total Bay area including tributaries. Chesapeake Bay ice cover has been closer to normal during the last three winters than in the unusually cold winters which predominated during the six-year period 1977 to 1982.

Ice cover during the 1984-85 ice season was confined to the upper Bay (Figure 2). Some upper portions of tributaries in Virginia experienced limited shoreline icing. Icing was most extensive on Maryland's Eastern Shore covering many productive oystering areas. Ice formed primarily on the eastern side of Chesapeake Bay due to prevailing wind patterns, currents, and shape of land mass areas. Conditions were unusually windy in January 1985, which hindered the formation of extensive ice cover in unprotected open water areas.

Freezing weather briefly touched the Chesapeake Bay on the 7th of December, but produced no ice. Significant freezing degree-days accrued beginning January 9th when temperatures plunged well below freezing following a cold front. Freezing degree-days increased steadily over the next four days. On the 20th and 21st of January strong winds pushed subzero temperatures through the area, resulting in the steep rise in freezing degree-days (Table 4 and Figure 3). Below-freezing weather continued until February 11th when stations accumulated their peaks of freezing degree-days. Thawing proceeded rapidly after the 11th. As temperatures climbed from the 20th to the 24th, when they reached record highs throughout much of the region, ice cover dissipated rapidly. The Bay was completely free of ice by February 25 according to weather station observers.

Table 3.--Maximum ice cover of Chesapeake Bay, 1977-1985.

Winter	Estimated maximum ice cover extent (percent)	Estimated date of maximum ice cover extent
1976-77	85	February 10
1977-78	30	February 17
1978-79	60	February 20
1979-80	15	March 2
1980-81	50	January 18
1981-82	55	January 27
1982-83	<10	February 14
1983-84	30	January 23
1984-85	20	February 11

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

Figure 2.--Landsat image of icing on February 3, 1985 in upper Chesapeake Bay. Maximum ice cover occurred on or near February 11 when freezing degree-days peaked at Patuxent, MD. Maximum ice cover was about 20 percent of the total Bay area during peak icing. The Chesapeake Bay experiences ten percent ice coverage in a normal winter. Note ice cover over rivers on the Eastern Shore. Icing was more extensive in northern areas of the Western Shore while lower tributaries such as the Patuxent and Potomac rivers were relatively ice free. Loose ice is seen drifting in the Bay proper following heavy rains around February 1.

Table 4.--Number of freezing degree-days at selected Chesapeake Bay stations, winter of 1976-77 and 1981-82 to 1984-85.

	Station									
	Aberdeen					Baltimore				
Date	1976-77	1981-82	1982-83	1983-84	1984-85	1976-77	1981-82	1982-83	1983-84	1984-85
December 01-10	27.0	1.0	7.5	1.0	1.0	31.5	0.0	5.5	0.5	7.0
December 11-20	9.0	21.5	17.0	15.5	0.0	5.5	32.0	30.0	12.5	0.0
December 21-31	42.0	15.5	0.0	114.0	0.0	53.0	16.0	0.0	115.0	0.0
January 01-10	56.5	23.0	0.0	18.5	12.0	73.0	35.0	1.0	13.5	18.0
January 11-20	143.0	146.0	39.0	77.0	51.5	137.0	148.0	42.0	91.5	52.5
January 21-31	75.0	85.5	3.0	57.0	76.0	77.5	85.0	3.0	61.5	81.0
February 01-10	58.5	8.5	8.0	20.5	32.5	48.0	8.0	15.0	20.5	37.5
February 11-20	25.5	11.5	19.5	0.0	0.5	24.0	6.0	44.5	0.0	2.0
February 21-28	1.5	8.0	0.0	0.0	0.0	1.5	6.0	1.0	1.0	0.0
TOTALS	438.0	320.5	94.5	303.5	173.5	451.0	336.0	142.0	316.0	198.0

	Station									
	Royal Oak					Patuxent				
Date	1976-77	1981-82	1982-83	1983-84	1984-85	1976-77	1981-82	1982-83	1983-84	1984-85
December 01-10	19.0	0.0	5.0	0.0	2.0	12.5	0.0	0.0	0.0	5.0
December 11-20	4.5	10.5	15.5	8.0	0.0	0.0	11.5	10.0	5.0	0.0
December 21-31	25.5	10.0	0.0	88.0	0.0	13.0	7.0	0.0	71.0	0.0
January 01-10	54.5	14.0	0.0	17.5	12.0	53.0	9.0	0.0	3.0	12.0
January 11-20	112.5	115.0	25.0	59.0	31.5	140.5	106.5	23.0	53.5	36.5
January 21-31	65.0	68.5	1.5	45.5	60.0	63.0	50.5	0.0	37.0	59.5
February 01-10	42.5	5.0	7.5	12.5	37.0	41.5	3.0	2.0	10.0	30.0
February 11-20	19.5	4.0	17.0	0.0	4.0	17.5	0.0	13.0	0.0	5.5
February 21-28	0.0	5.0	0.0	0.0	0.0	0.5	2.5	0.0	0.0	0.0
TOTALS	343.0	232.0	71.5	230.5	146.5	341.5	190.0	48.0	174.5	148.5

The number of freezing degree-days (FDD) is the difference between the mean daily air temperature (°F) and 32°. Example, a mean daily air temperature of 21°F yields 11 FDDs. Freezing degree-days accumulated over periods of continuously freezing temperatures provide a measure of ice thickness through the expression: Ice Thickness (Inches) = $0.7 \sqrt{\text{Accumulated FDDs (°F)}}$. The values displayed above may be used to estimate the possible ice generation, but alternating periods of above-freezing temperatures have not been subtracted from the accumulations. Melting, rafting, and snowcover also alter the accuracy of ice thickness computed by this method.

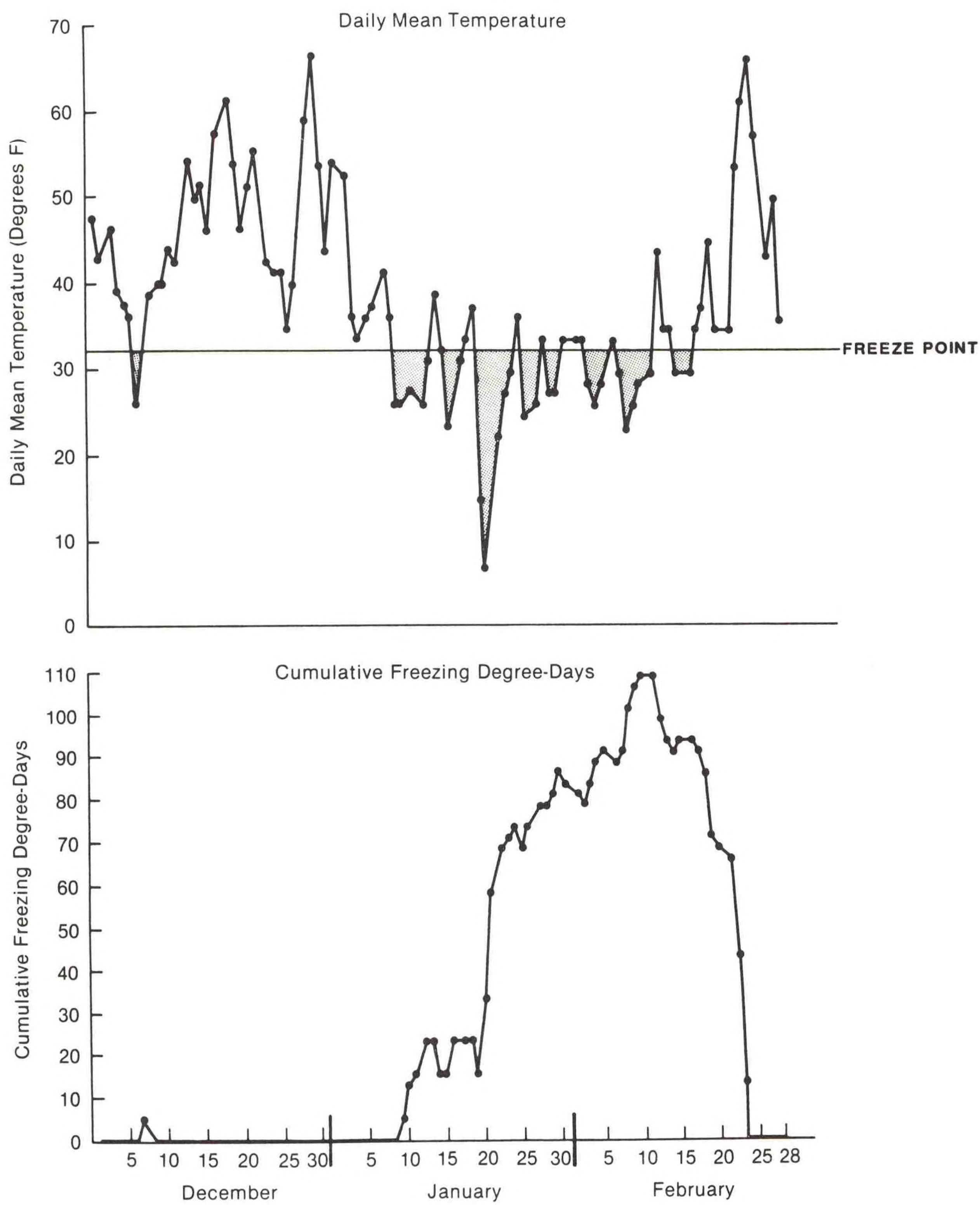


Figure 3.--Freezing degree-days and daily mean air temperature, Patuxent, MD, winter 1984-85.

2.3 Streamflow

Bay streamflow rose to slightly above-normal in December 1984 following above-normal precipitation over the region in November 1984 (Figure 4). Streamflow had been below-normal throughout the preceding fall 1984 quarter. Streamflow fell below-normal in January and February following below-normal precipitation over the area in December and January. Streamflow rose to near-normal in February as rainfall over most of the Bay drainage area was above-normal. The calendar year 1984 ended with a large streamflow excess of 5.4 trillion gallons (Figure 5). The first two months of 1985 began showing deficit streamflow.

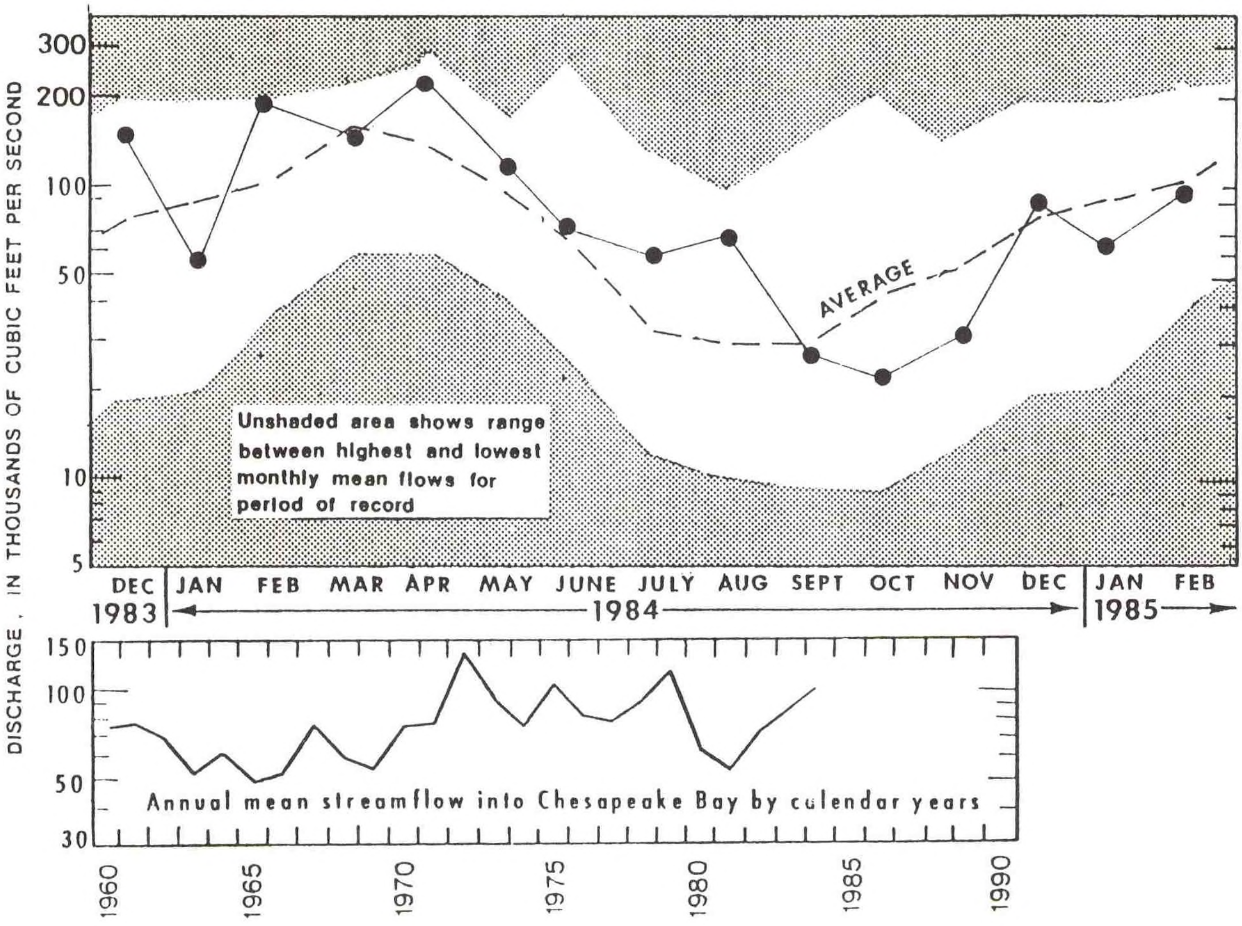
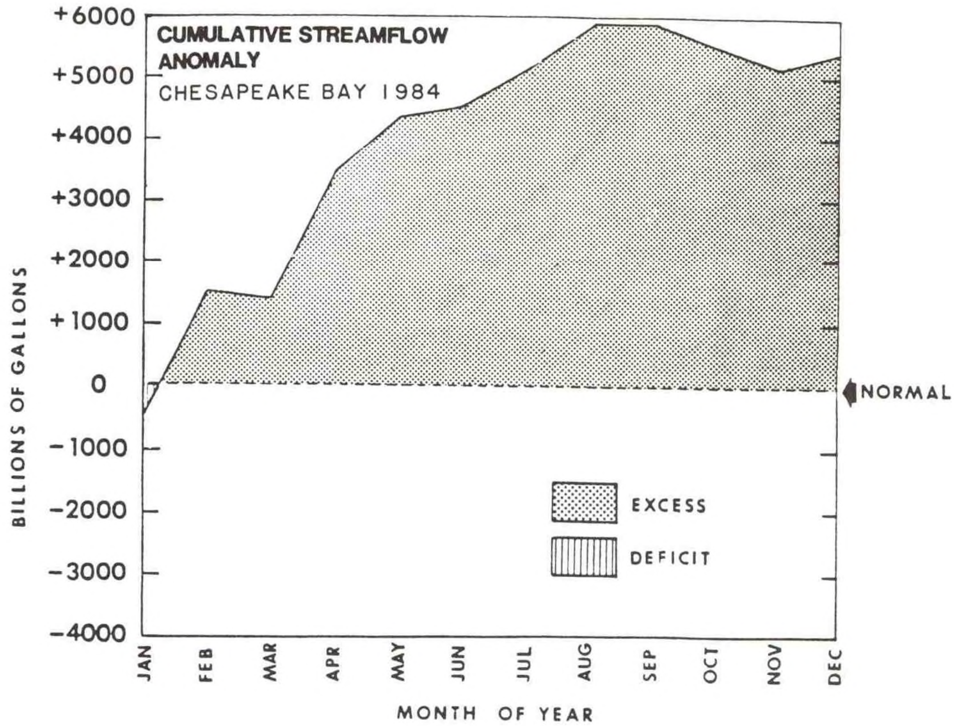


Figure 4.--Monthly streamflow into Chesapeake Bay, December 1984 - February 1985 and annual mean flow 1960-1984. Streamflow was above normal in December and below normal in January and February. Above-normal December streamflow was slightly above-normal, though streamflow had been below normal in all other months since September 1984. Data from U.S. Geological Survey.



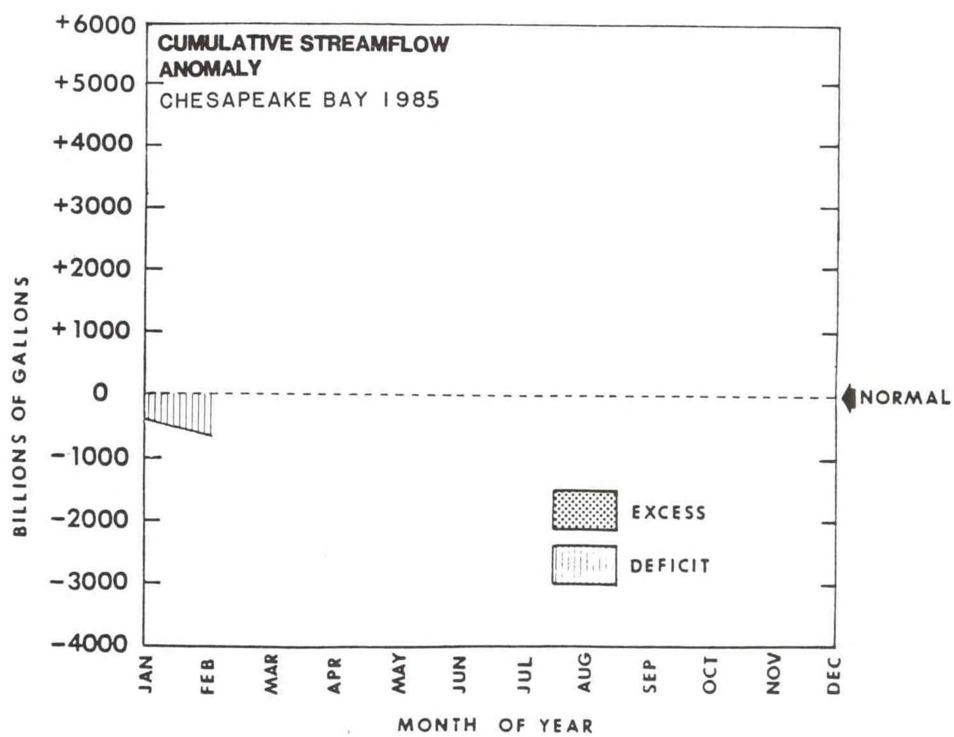


Figure 5.--Cumulative monthly streamflow anomaly, Chesapeake Bay, 1984 and 1985. The cumulative streamflow anomaly (monthly sum of negative and positive departures from normal by calendar year) for January through December 1984 was an excess of 5.4 trillion gallons. Below-normal precipitation resulted in deficit streamflows in January and February 1985. Data from U.S. Geological Survey.

2.4 Oceanography

Stations around the Bay showed slightly higher-than-normal salinities throughout the quarter (Table 5 and Figure 6). Station water temperatures averaged well above-normal for December reflecting a warm fall and warmer-than-normal December. Water temperatures decreased rapidly in mid-January and in February following arrival of very cold weather in the region.

Salinity:

Stations around the Bay began the winter quarter showing slightly higher-than-normal mean salinities but continued in a normal seasonal pattern for salinity change. December salinities averaged near normal at all stations except Bay Bridge-Tunnel which showed 2.0 ppt above normal. All stations were near or above normal in January with Bay Bridge-Tunnel exceeding normal by 2.9 ppt. All stations except Solomons were more than 1.0 ppt above normal in February. The Bay Bridge-Tunnel station showed the highest positive anomalies in all three months ranging from 2.0 to 2.9 ppt above normal. These salinities thereafter followed seasonal trends at Annapolis, Solomons, and Kiptopeke with slight increases in their respective departures, except that at Annapolis the increase between January and February was more pronounced. Salinity at Baltimore increased between December and January following below-normal rainfall, particularly in the northern portion of the Bay watershed, during this and the preceding season.

Temperature:

Surface water temperatures around the Bay were very warm during December and the first half of January. December averages reflect the warm fall and early winter with stations averaging more than four degrees above normal. Water temperatures dropped rapidly in mid-January following a period of extremely cold air temperatures. Both January and February average figures are misleading as both months were periods of approximately half a month very cold (late January and early February) and a half month very warm (early January, late February) water temperatures.

Table 5.--Bay surface salinities and surface water temperatures, December 1984 - February 1985.

Station	Surface Salinity and Departure from Normal Observed/*Anomaly (ppt)			Surface Water Temperature and Departure from Normal Observed/* (Deg. F)		
	December	January	February	December	January	February
Baltimore, MD	9.9/-0.7	11.0/+1.1	10.9/+1.1	47.4/+4.4	40.5/+3.1	37.4/+0.4
Annapolis, MD	12.5/+0.5	12.0/+0.6	12.8/+2.0	44.9/+3.2	37.5/+0.6	35.8/-0.9
Solomons, MD	16.1/+0.3	15.3/+0.3	15.0/+0.5	47.6/+4.3	39.1/+1.3	35.8/-1.6
Kiptopeke, VA	27.1/+0.6	27.3/+0.6	27.1/+1.0	48.6/+4.5	39.4/+0.7	37.6/-0.5
Bay Bridge-Tunnel, VA	24.6/+2.0	24.7/+2.9	23.0/+2.1	50.1/+5.0	43.4/+3.8	38.4/-2.8

*Anomaly = departure from long-term monthly averages.
All salinity data are provisional. Salinities are based on water densities normalized to 15°C.

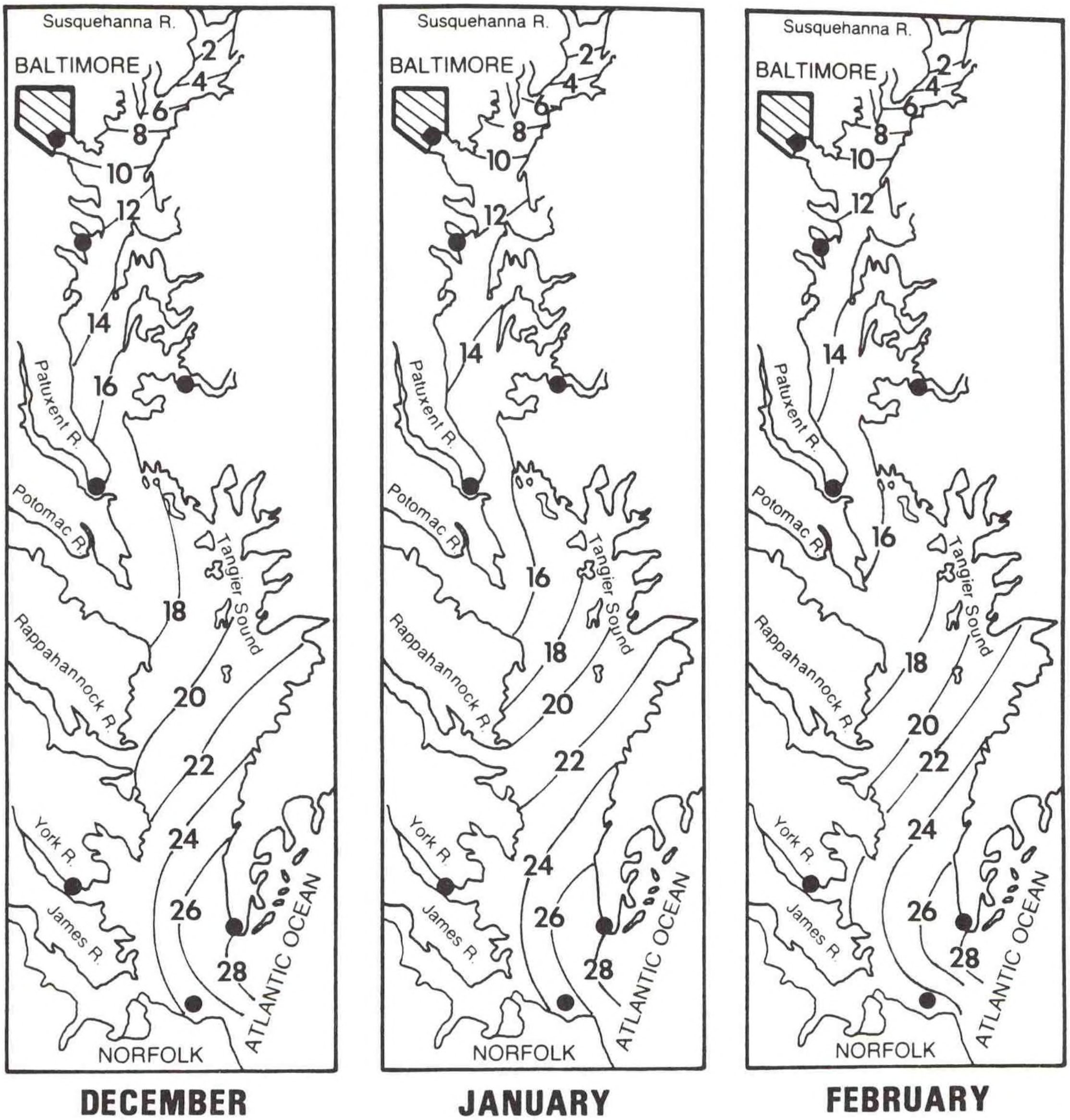


Figure 6.--Mean surface salinity distribution, Chesapeake Bay, December 1984 - February 1985. Isohalines (parts per thousand) are linearly interpolated from designated station data. All stations around the Bay except Baltimore began the winter quarter showing slightly above-normal salinities. The anomaly increased during the quarter despite seasonal decreases in salinity reflecting dry weather. Data from National Ocean Service, NOAA.

3. Impact of Climate/Weather on Bay Fisheries, Recreation, and Transportation

3.1 Fisheries

Icing temporarily shut down oystering for up to four weeks in some areas of the upper Bay from January 21 through the second week of February. Ice conditions were less severe than during the 1983-84 winter, when the oystering season was extended because of reduced landings. No extension to the oystering season was effected following the 1984-85 ice period. The blue crab dredge harvest was above average in December, and watermen in Virginia received low prices for their catch because of the high supply.

Shellfish:

Oysters

Watermen were unable to reach oyster grounds in areas of the upper Bay that had iced over in January and February. Ice hampered oystering in Maryland for approximately three to four weeks from January 21 through the second week of February.

Skim ice, which can damage wooden boat hulls, was reported on January 14, and by January 20 ice began forming solidly over many areas in upper Bay tributaries. In addition to missed workdays, watermen experienced damaged boat hulls, propellers, and rudders.

Large concentrations of boats were reported working in small areas of the upper Bay over accessible oyster beds during the ice period. Oystermen concentrated over remaining productive oyster beds in Maryland, continuing heavy fishing pressure on available stocks. Large numbers of boats were reported working in accessible, ice-free areas over oyster bars in the upper Bay. Ice completely covered upper portions of some Bay tributaries, preventing many watermen from getting out of docks.

Maryland and Virginia oyster landings and total Chesapeake Bay ice cover by winter quarter for 1976-85 are listed in Tables 6 and 7. In years such as the winter of 1976-77 when 85 percent of the total Bay was ice covered, watermen experienced extensive losses due mainly to a reduction in oyster landings. In other years since the severe 1976-77 winter, ice cover has affected watermen to lesser extents, though the effect is not as clearly evident in landings alone. The maximum ice cover of 20 percent reached during the 1984-85 winter caused interruptions in the harvest. However, the reduced accessibility caused by Maryland's ice cover kept watermen competing for already scarce oysters over more limited harvest grounds. Bay oyster stocks have shown a steady decline following years of poor reproduction in the 1970's and intense fishing pressure. Stocks were further reduced by disease-related mortalities in 1982 and more recently, by the spread of anoxic conditions in late summer 1984.

Virginia experienced minimal icing conditions and watermen reported only minor interruptions from ice cover in upper portions of northern tributaries.

Table 6.--Maryland oyster landings and total Chesapeake Bay ice cover by winter quarter for years 1976-1985.

Year	Ice Cover[1]		Maryland Oyster Landings[2]					
			Month					
			December		January		February	
Winter of	Maximum ice cover	Date of maximum ice cover	Bushels	Dollars	Bushels	Dollars	Bushels	Dollars
1984-85	20%	Feb. 11	219,963	3,480,070	96,190	1,388,986	92,642	1,329,709
1983-84	30%	Jan. 23	158,962	2,392,771	103,334	1,658,239	112,890	1,565,141
1982-83	<10%	Feb. 14	264,779	2,866,463	171,704	1,699,835	134,405	1,276,832
1981-82	55%	Jan. 27	402,127	3,898,151	123,401	1,228,415	251,778	2,319,330
1980-81	50%	Jan. 18	442,172	3,662,949	217,632	2,023,641	253,868	2,056,193
1979-80	15%	Mar. 2	363,076	3,181,805	302,390	2,554,738	194,377	1,595,119
1978-79	60%	Feb. 20	419,384	2,846,756	271,639	1,897,385	75,006	603,108
1977-78	30%	Feb. 17	411,283	2,880,563	219,352	1,616,819	198,180	1,509,357
1976-77	85%	Feb. 10	374,954	2,982,744	68,690	657,112	127,320	1,238,809

Data Sources: [1] NASA - Goddard Space Flight Center and U.S. Coast Guard.

[2] Maryland Department of Natural Resources, Tidewater Administration. Data are for total Maryland public and private ground oyster harvest. For the Potomac River, landings include the main portion and tributaries to the river on the Maryland side. Landings for 1984-85 are preliminary.

Table 7.--Virginia oyster landings and total Chesapeake Bay ice cover by winter quarter for years 1976-1985.

Year	Ice Cover[1]		Virginia Oyster Landings[2]					
			Month					
			December		January		February	
Winter of	Maximum ice cover	Date of maximum ice cover	Bushels	Dollars	Bushels	Dollars	Bushels	Dollars
1984-85	20%	Feb. 11	84,903	1,188,965	40,117	541,790	N/A[3]	N/A[3]
1983-84	30%	Jan. 23	44,507	565,395	41,108	526,660	33,640	437,634
1982-83	<10%	Feb. 14	78,130	864,971	46,799	440,687	41,118	357,329
1981-82	55%	Jan. 27	128,368	1,189,551	52,257	416,708	93,119	736,986
1980-81	50%	Jan. 18	173,933	1,159,837	51,414	606,959	62,956	454,632
1979-80	15%	Mar. 2	168,983	1,199,439	125,515	946,845	69,865	378,620
1978-79	60%	Feb. 20	183,999	972,161	120,188	780,498	38,508	240,067
1977-78	30%	Feb. 17	163,775	927,368	84,028	499,581	66,090	453,727
1976-77	85%	Feb. 10	138,698	625,590	43,796	5,890	31,078	206,780

Data Sources: [1] NASA - Goddard Space Flight Center and U.S. Coast Guard.

[2] Virginia Marine Resources Commission.
Data are for total Virginia public ground oyster harvest.
For the Virginia section of the Potomac River, landings include only tributaries to the river on the Virginia side. Landings for 1984-85 are preliminary.

[3] Not available.

Oyster prices ranged from $12 to $15 per bushel in December, rising to $15 to $17 by mid-January. Prices for oysters usually rise in early January when demand is traditionally low. Icing in early January, which reduces availability, also contributes to higher prices. In January 1985, ice cover began relatively late in mid-January, and prices remained lower in early January.

Some oyster packing houses purchased Gulf of Mexico oysters to fill orders due to the scarcity and higher prices of Chesapeake Bay oysters.

Watermen in Virginia reported improvements in landings over the 1983-84 season. December 1984 landings of oysters in Virginia were nearly double that of December 1983 in quantity and value (Table 7). Watermen reported receiving record prices in Virginia, as high as $18 to $20 per bushel during the 1984-85 winter period.

Blue crabs

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

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

Water temperature in the lower Bay reached 47°F on January 9, 1985, the latest date of any winter dredge season during the period of record 1960-85 (Table 8). Water temperatures above 47°F can keep crabs active and have some effect on the December harvest in Virginia by making dredging less efficient. In 1984, the combination of market conditions and an abundance of crabs in the lower Bay were the overriding factors contributing to the December 1984 crab landings of 4.14 million pounds, which were higher than the previous 24-year average of 4.01 million pounds.

Warmer-than-normal water temperature in late fall 1984 allowed more time for juvenile crabs to reach maturity before the winter inactivity period. Crabs had more time to shed and grow in fall 1984 than in any year during the period of record 1960-present.

Blue crabs leave creeks and rivers in late fall when 85 to 95 percent of the adult females move toward the lower Bay. When water temperature goes below 47°F early in the fall season, crabs become inactive and may settle down in the middle or even upper Bay. In 1984, more crabs probably made it to the lower Bay than would have in a cooler fall.

Virginia Institute of Marine Science (VIMS) 1984 trawl data indicated a below-average sized year class of blue crabs spawned in 1983. Crab landings

Table 8.--Virginia December commercial hard blue crab landings (millions of pounds) 1960-1984, and date when water temperature dropped to 47°F or lower.

Year	Date when water temperature dropped to 47°F or lower	Virginia December blue crab landings, millions of pounds
1960	December 9	4.448
1961	December 9	4.464
1962	December 7	4.626
1963	December 10	4.969
1964	December 16	4.746
1965	December 5	5.389
1966	December 4	6.028
1967	November 29	3.650
1968	December 6	3.358
1969	December 2	3.878
1970	December 8	3.769
1971	December 2,20	6.056
1972	December 17	4.338
1973	December 17	3.301
1974	December 10	3.580
1975	December 19	1.885
1976	November 13	3.023
1977	December 8	4.085
1978	December 18	2.510
1979	December 18	4.161
1980	November 30	4.186
1981	December 5	3.771
1982	December 19	1.837
1983	December 21	4.269
1985	January 9	4.140

Landings data from National Marine Fisheries Service, Current Fisheries Statistics, Annual Summaries, 1960-1979; Virginia Marine Resources Commission, 1980-84. Pier water temperatures from the Virginia Institute of Marine Sciences at Gloucester Point, Virginia. Data compiled by Virginia Institute of Marine Sciences. Landings primarily reflect year class strength, but other factors such as water temperature may have some influence on landings in different years.

in Virginia in September-November 1984 were lower than landings for the same period of the previous three years, reflecting the below-average strength of the 1983 year class. However, December 1984 landings were higher than the previous three years, probably a result of the extended period for growth and movement allowed by the warmer-than-normal water temperatures in 1984.

Dredging, which may be less efficient when crabs remain active because of warm water temperatures, possibly showed a decrease in catch per effort, though warm weather allowed for more boats to work and more time on the water. Even though prices remained low (at $18 per barrel), landings were above average.

Finfish:

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

Virginia Institute of Marine Sciences (VIMS) sampling showed bottom water temperatures of 32.0°F to 33.8°F in the York River in mid-January. Earlier in 1984, VIMS bottom trawling in July and August indicated the presence of a good 1984 year class; however, this year class suffered extensive cold water mortalities in winter 1984-85. Croaker of the highly successful 1982 year class survived the very mild winter of 1982-83 and have been of marketable size since summer 1984. Once the adults of the 1982 year class are depleted, croaker landings should decline until another successful year class survives a winter in Chesapeake Bay.

Mortalities of other species such as eels were noted from VIMS bottom trawling, reflecting the severity of the cold, once water temperatures dropped rapidly in mid-January.

3.2 Recreation

National Weather Service marine advisories and warnings for Chesapeake Bay are listed in Table 9. Twenty-nine small craft advisories and 11 gale warnings were issued during the quarter for the area. Strong January winds (see section 2.1) resulted in the issuance of 12 small craft advisories and eight gale warnings compared with only four advisories issued in January 1983. In February, one gale warning was issued for the mouth of the Bay, and six small craft advisories were issued for the entire Bay and Tidal Potomac River.

The U.S. Coast Guard conducted 157 Search and Rescue (SAR) operations during the quarter (Table 10). One recreational vessel sank in the upper Bay on February 1st as a result of the ice. Two persons were rescued by a Coast Guard cutter when ice in the Sassafras River gave way beneath them. In late January one vessel was stuck in ice on the Eastern Shore. In other weather related incidents, a boat went off course because of heavy fog, and a tug pulling a barge was stranded by very high winds.

Maryland Department of Natural Resources Marine Police reported a total of ten boating accidents, one injury, one death, and $116,850 property damage for recreational boating (Table 11). Property damage in winter 1984-85 far exceeded the amount in winter 1983-84, due primarily to three major boat fires. Fire caused three accidents between December and January, resulting in $37,500 property damage. One vessel capsized causing a fatality and one injury. Three vessels were grounded between December and January, but no serious injuries or accidents occurred. Four accidents occurred in February, but all were minor.

Attendance and revenue for selected Maryland and Virginia state parks are listed in Table 12. Most of the parks showed large attendance increases during periods of warm weather in December, especially on weekends. Both Maryland state parks began the quarter with large increases in attendance over December 1983. Point Lookout continued to increase from month to month while Sandy Point attendance decreased in January and increased largely in February.

All Virginia state parks, except Westmoreland, showed an increase in attenance in December 1984 over December 1983. York River and Seashore showed increases in attendance in February. Though weather was cooler in February, all parks showed increases in attendance over January.

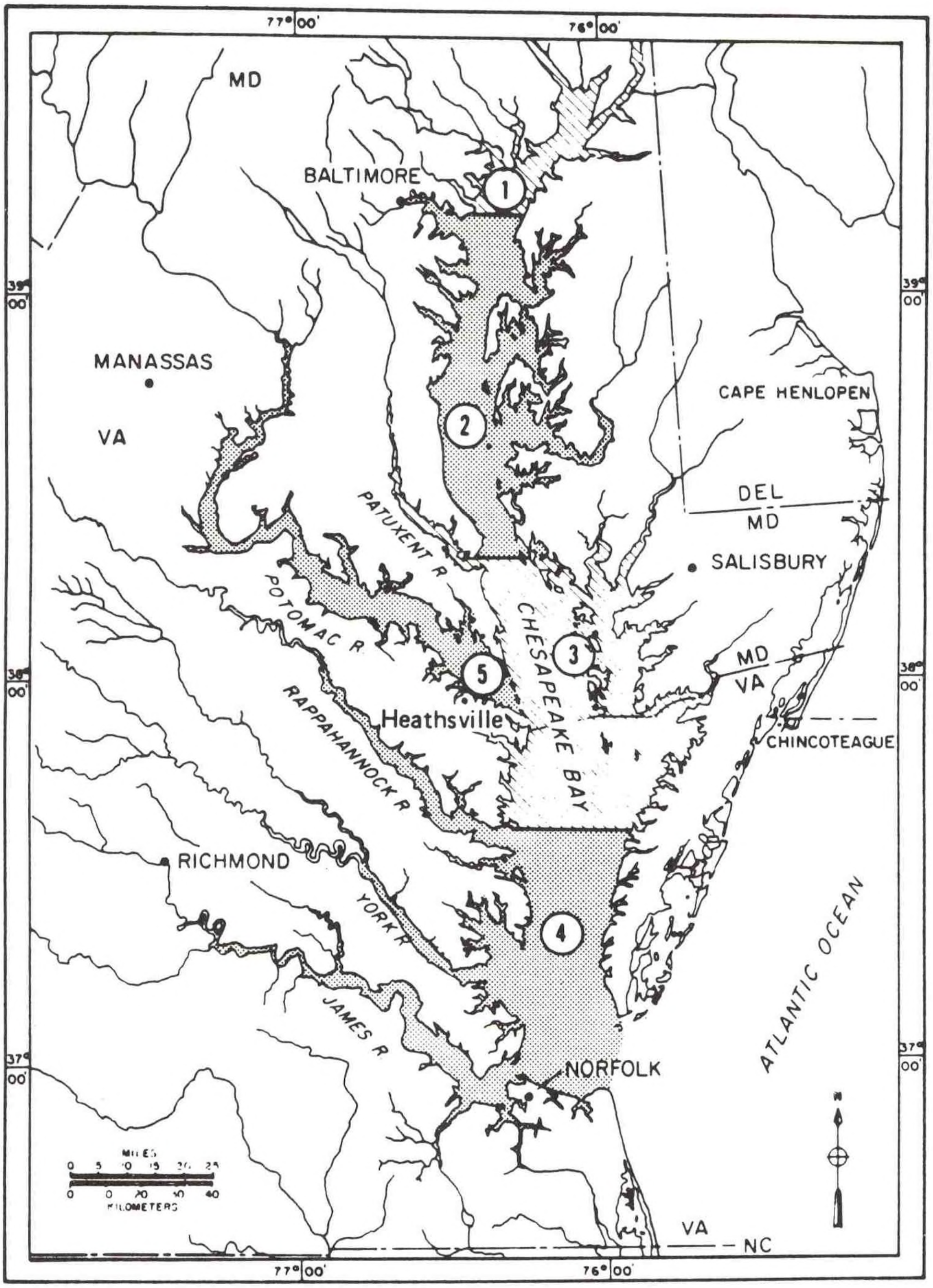


Figure 7.--National Weather Service (NWS) forecast areas for Chesapeake Bay.

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

Table 9.--Marine advisories/warnings, Chesapeake Bay, December 1984 - February 1985 (National Weather Service data). For definition of areas see Figure 7.

	Date	Condition Report[1]	Location[2]
December	3	A	Entire Bay and Tidal Potomac River
	5	A	Windmill Point to Mouth of Bay
	5	B	Windmill Point to Mouth of Bay
	5	A	Head of Bay to Windmill Point and Tidal Potomac River
	6	B	Head of Bay to Windmill Point and Tidal Potomac River
	7	A	Entire Bay and Tidal Potomac River
	15	A	Entire Bay and Tidal Potomac River
	22	A	Entire Bay and Tidal Potomac River
	24	A	Entire Bay and Tidal Potomac River
	29	A	Entire Bay and Tidal Potomac River
January	1	A	Entire Bay and Tidal Potomac River
	2	A	Entire Bay
	3	A	Head of Bay to Windmill Point and Tidal Potomac River
	3	B	Windmill Point to Mouth of Bay
	4	A	Head of Bay to Windmill Point and Tidal Potomac River
	5	B	Windmill Point to Mouth of Bay
	7	A	Windmill Point to Mouth of Bay
	7	A	Head of Bay to Windmill Point and Tidal Potomac River
	8	B	Head of Bay to Mouth of Bay
	11	B	Entire Bay and Tidal Potomac River

[1] Key to Condition Reports:

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)

[2] Windmill Point = North side of Rappahannock River

Table 9.--(Continued). Marine advisories/warnings, Chesapeake Bay, December 1985 - February 1985 (National Weather Service data). For definition of areas see Figure 7.

	Date	Condition Report[1]	Location[2]
January	15	B	Entire Bay
	15	A	Entire Bay
	17	A	Entire Bay and Tidal Potomac River
	19	A	Entire Bay and Tidal Potomac River
	20	B	South of Patuxent to Mouth of Bay
	21	A	South of Patuxent to Mouth of Bay
	25	A	Entire Bay and Tidal Potomac River
	25	B	South of Patuxent to Mouth of Bay
	26	B	Head of Bay and Tidal Potomac River
	26	A	Entire Bay and Tidal Potomac River
February	2	A	South of Patuxent to Mouth of Bay
	2	A	Head of Bay to Patuxent River and Tidal Potomac River
	7	A	Head of Bay to Patuxent River and Tidal Potomac River
	7	A	South of Patuxent to Mouth of Bay
	11	A	Entire Bay and Tidal Potomac River
	12	B	Mouth of Bay
	12	A	Mouth of Bay
	22	A	Entire Bay and Tidal Potomac River
	24	A	Entire Bay and Tidal Potomac River
	27	A	Entire Bay and Tidal Potomac River

[1] Key to Condition Reports:

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)

[2] Windmill Point = North side of Rappahannock River

Table 10.--U.S. Coast Guard Search and Rescue (SAR) caseload, December 1984 - February 1985.

Month	Number of Search and Rescues					
	Group Baltimore		Group Eastern Shore		Group Norfolk	
	1984-85	1983-84	1984-85	1983-84	1984-85	1983-84
December	28	23	4	1	32	32
January	16	14	3	1	23	29
February	18	16	6	1	27	31
TOTALS	62	53	13	3	82	92

Group Baltimore - most of Upper Bay
Group Eastern Shore - lower central portion of Eastern Shore
Group Norfolk - most of Lower Bay

Table 11.--Maryland marine accident statistics, December 1984 - February 1985.

Month	No. of Boating Accidents		No. of Injuries		No. of Deaths		Property Damage	
	1984-85	1983-84	1984-85	1983-84	1984-85	1983-84	1984-85	1983-84
December	4	1	0	0	0	1	$ 81,500	$ 0
January	2	1	1	1	1	0	$ 30,000	$450
February	4	0	0	0	0	0	$ 5,350	$ 0
TOTALS	10	2	1	1	1	1	$116,850	$450

Data Source: Maryland Department of Natural Resources Marine Police. All categories are for recreational boating. Includes Potomac River to Virginia shoreline. Data are preliminary.

Table 12.--State parks attendance and revenue, selected Maryland and Virginia facilities, December 1984 - February 1985.

Facility	December		January		February	
Maryland	Attendance	Revenue	Attendance	Revenue	Attendance	Revenue
Sandy Point	7,470	$ 0	5,068	$ 0	9,585	$ 0
Point Lookout	3,158	$486	3,835	$138	4,891	$519
Virginia						
Westmoreland	575	$2,846	882	$ 0	1630	$ 0
Chippokes	2,316	$1,010	978	$106	1,354	$ 0
York River	1,050	$ 0	2,728	$ 0	3,395	$ 0
Seashore	50,912	$ 88	34,348	$ 10	44,750	$ 62

Data from Maryland Department of Natural Resources, Forest, Park, and Wildlife Service; and Virginia Department of Conservation and Economic Development, Division of State Parks. Revenue does not always reflect usage levels. Special scheduled activities, seasonal revenue changes, and equipment breakdown influence total revenue amounts.

3.3 Transportation

Winds

Winds in excess of 40 mph shut down crane operations 15 times at the Port of Baltimore for a total of 99 hours and 24 minutes (Table 13). During the same period in winter 1983-84, winds shut down operations 3 times for a total of 34 hours and 40 minutes.

Table 13.--Number of crane shutdowns and productive time lost due to wind at Port of Baltimore, December 1984 - February 1985.

Date	Number of Shutdowns	Productive Time Lost (Hours:Minutes)
December 6	2	3:55
7	2	4:00
January 5	1	3:47
9	1	10:00
12	1	5:45
15	1	13:05
19	1	3:45
20	1	12:12
21	1	17:50
22	1	:42
25	1	4:28
26	1	17:20
February 7	1	2:35
Totals	15	99:24

Data from Maryland Port Administration.

Most of the shutdowns in the 1984-85 quarter were in January, reflecting extremely windy conditions in that month. The 1984-85 quarter contrasts sharply with conditions in the winter 1983-84 quarter, when all of the shutdowns were in February.

Losses incurred by individual container-line shippers from crane down time includes pay to stevedore crews at $1500 per hour and vessel down time at $2500 per hour. Based on the total downtime, shippers may have experienced in excess of $397,600 in costs due to excessive winds.

Icing

Ice development in Chesapeake Bay did not affect commercial ship operations into and out of the Port of Baltimore during January and February 1985; however, the Coast Guard imposed horsepower and steel hull restrictions from January 21st through February 16th and required vessels to proceed in convoys during the last ten days of January when transiting the Bay north of Baltimore.

The very rapid drop in temperature on the 20th and 21st of January caused rapid formation of ice in the Bay north of Baltimore. Heaviest ice concentration was in the Tolchester Beach area where ice thickness reached one foot. Imposition of restrictions by the Coast Guard was equally rapid, going from none to requirements of a minimum of 2500 shaft horsepower (SHP) and steel hull construction all within one day, January 21st. Convoy operations commenced January 24th and lasted through January 31st. Restrictions remained in effect through February 16th. Vessels, mostly tugs, having less than 2500 SHP were permitted to operate within convoys under waiver from the Coast Guard Captain of the Port.

Ice conditions were most severe in the Tolchester Beach area directly adjacent the principal Bay shipping lane; however, the nature of the ice (termed "oatmeal ice") made it more burdensome on available power than would have more solid ice. Solid ice formed in and around the mouths of the freshwater tributaries entering the Bay as far south as the Choptank River; however, main-channel Bay ice never reached as far south as the Bay Bridge.

Ice conditions in the Potomac did not call for convoy operations, but did result in a minimum restriction of 1500 SHP and steel hulls being required of vessels. Large vessel operations were not endangered by the ice nor operationally affected by the restrictions.

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