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STATUS AND TRENDS IN WATER QUALITY AND LIVING RESOURCES IN THE VIRGINIA CHESAPEAKE BAY: 1985-2000

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Executive Summary

I. James River

A. Overview

1. Summary of Basin Characteristics

The James River basin is the largest river basin in Virginia covering 26,422 km^2 or nearly 25% of the Commonwealth's total area. The James River begins in the Allegheny Mountains where it is formed by the confluence of the Jackson and Cowpasture rivers. From its sources, the James River flows 547 km in a southeasterly direction to the fall-line near Richmond and for an additional 180 km to Hampton Roads where it enters Chesapeake Bay. Approximately 61% of the entire basin is covered with forests and an additional 17% of the watershed is covered by agricultural land. The population in the James River basin for 2000 is projected to be 2,522,485 people. Most of the basin's population is concentrated in approximately 11% of the watershed which consists of residential and industrial land found in the urban areas of Tidewater, Richmond, Petersburg, Lynchburg and Charlottesville. Annual mean flow rates for the James River at the fall-line is approximately 7,000 cfs (Belval et al. 1994). Annual precipitation within the James River basin is approximately 108 cm (Bishop, 1985). The James River contributes about 12% of the streamflow, 5% of the total nitrogen load, and 20% of the total phosphorus load to Chesapeake Bay. Over 50% of total nitrogen and total phosphorus loads to the river are from point sources or urban run-off.

2. Summary of Status and Long Term Trends

Improving trends in surface and bottom total nitrogen were detected in nearly all segments in the James River and status for these parameters was good in all segments but the polyhaline James River (JMSPH) where it was fair. Improving trends in surface and bottom dissolved inorganic nitrogen were detected in all segments in the James River mainstem except for the Polyhaline James River (JMSPH). No trends in dissolved inorganic nitrogen were detected in the Appomatox and Chickahominy Rivers (segments APPTF and CHKOH). Status of dissolved inorganic nitrogen was good in most segments of the James River. Improving trends in surface and bottom total phosphorus and dissolved inorganic phosphorus were detected in most segments of the James River. Status for these parameters was either good to fair in the tidal freshwater James River (JMSTF) but predominately poor in the lower segments of the river. Degrading trends in surface and bottom total suspended solids were detected in the Chickahominy River (CHKOH) and degrading trends in surface total suspended solids and bottom total suspended solids were detected in polyhaline James River (JMSPH) and the mesohaline James River (JMSMH), respectively. Status of total suspended solids was either fair or poor throughout the James River and its tributaries.

Improving trends in both total and dissolved inorganic nitrogen and phosphorus were detected in nearly all segments of the Elizabeth River; however, status of these parameters is generally poor. No trends were detected in surface and bottom total suspended solids and status of these parameters was generally fair or poor. A degrading trend in secchi depth was detected in the Polyhaline Elizabeth

River (ELIPH) and status of this parameter was poor throughout the Elizabeth River. Improving trends in bottom dissolved oxygen were detected in three of the five segments in the Elizabeth River.

The majority of long term trends in phytoplankton bioindicators suggest that conditions in the James River are improving with respect to phytoplankton communities. Improving trends in primary productivity, diatom biomass and chlorophyte biomass were detected at most or all stations within the James River. Additional improving trends in the ratio of biomass to abundance and cryptophyte biomass were detected at stations TF5.5 and RET5.2 located in the Tidal Freshwater James River (JMSTF) and the Oligohaline James River (JMSOH). Despite these improvements, degrading trends in cyanophyte abundance were detected at all stations in the James River and status for most phytoplankton parameters was either fair or poor at most stations.

Degrading trends in both copepod nauplii and rotifer abundance were detected at station LE5.5 in the Polyhaline James River (JMSPH) and in copepod nauplii in the Southern Branch of the Elizabeth River (SBEMH). Status of copepod nauplii abundance was good at all stations in the James River except at SBE5 in the Southern Branch of the Elizabeth River (SBEMH) where it was poor. Status of rotifer abundance was either fair or poor in the mainstem of the James River but status for this parameter was good in the Southern Branch of the Elizabeth River (SBEMH).

Although changes in sample processing methods precluded performing status and trend analyses on mesozooplankton bioindicators, results of analyses conducted on data collected through 1999 indicate improving trends in meszooplankton species diversity in both the Tidal Freshwater James River (JMSTF) and the Oligohaline James River (JMSOH). Degrading trends in meszooplankton diversity indices were detected in the Polyhaline James River (JMSPH) and the Southern Branch of the Elizabeth River. Degrading trends were detected in nearly all mesozooplankton bioindicators in the Polyhaline James River (JMSPH).

Improving trends in the benthic IBI were detected in the the Tidal Freshwater James River (JMSTF), the Oligohaline James River (JMSOH) and the Southern Branch of the Elizabeth River. The benthic IBI either met goals or was marginal within the main stem of the James River while status of the benthic IBI within the Elizabeth River was degraded.

3. Summary of Major Issues in the Basin

With respect to water quality, the primary concerns within the James River main stem are the fair to poor status of water clarity throughout the river and poor status in total phosphorus and dissolved inorganic phosphorus in the lower segments of the James. Nearly all segments in the James River basin had at least one parameter that did not meet the SAV habitat requirements. In addition, although many improving trends in water quality were detected in the Elizabeth River, the status of most parameters was poor. With regard to algal levels, increasing cyanobacterial abundances throughout the river are of particular concern. Degrading trends in both microzooplankton and mesozooplankton bioindicators at the mouth of the river were associated with water clarity and salinity declines. Further consideration should be given to the ecological implications of these zooplankton trends specifically as it might affect stocks of planktivorous feeding fish. Although there was a significant improving trend in the B-IBI within the oligohaline James River at one station, the status of the B-IBI at both stations in this segment was marginal. Despite a significant improving trend in the B-IBI at one station, the status of the B-IBI within the Southern Branch of the Elizabeth River remains degraded.

B. Management Recommendations

Improving trends in concentrations of nitrogen and phosphorus in this river basin are probably related primarily to reductions in point source loadings caused by the phosphate ban and the implementation of Biological Nutrient Removal at wastewater treatment plants. Despite the improvements, problems both with respect to water quality and living resources are still evident in the James River. Many of these appear to be localized primarily in the mesohaline and polyhaline segments of the James River and/or the Elizabeth River including: 1) fair relative status of nitrogen in the Polyhaline James River (JMSPH); 2) fair and poor relative status of phosphorus; 2) fair and poor relative status of secchi depth and total suspended solids; 3) degrading trends in secchi depth and total suspended solids; 4) poor status and degrading trends in microzooplankton and mesozooplankton indicators and; 5) degraded benthic community status. These segments are located in or near the largest concentration of urban land in the state of Virginia. This suggests that the environmental problems in these areas may be the result of their proximity to the point sources and urban run-off in this population center. Additional controls on point source and urban run-off should help alleviate these problems. If nutrient concentrations are not limiting in these areas, water clarity may be reduced by a high concentrations of total suspended solids and/or high phytoplankton concentrations caused by existing nutrient levels. Additional point and non-point nutrient controls could also ameliorate water clarity problems within these segments.

In contrast, problems with phytoplankton communities tended to be more widespread as exhibited by: 1) the occurrence of long-term degrading trends in cyanobacteria abundance; 2) the fair to poor status of cyanobacteria biomass and; 3) the poor status of the biomass to abundance ratio at all stations in this basin. Problems with SAV habitat requirements also tended to be widespread. All segments except the polyhaline James River and the Western Branch of the Elizabeth River had at least one parameter which failed to meet the SAV Habitat Requirements. Within the lower portions of the James River and the segments located in the Elizabeth River, these problems are most likely caused by nutrient loadings from point sources and urban run-off. In upper portions of the James River (segments JMSOH and JMSTF) the percentage of agricultural land ranges from approximately 6 to 7 times the amount of developed land suggesting that the water quality and living resource problems within these segments may be due primarily to non-point source run-off from agricultural land. The cause of water quality and living resource problems in the Appottomax and Chickahominy rivers is unclear. Percentages of developed and agricultural land within these watersheds are approximately equal. A more concerted effort should be placed on designing studies that can determine the cause of the water quality and living resource problems in these segments.

Specific recommendations should be developed for goals for phytoplankton biomass or productivity, chlorophyll *a*, nutrients, and suspended solids for each segment of the James River. Additional studies should be conducted that examine the spatial distribution of point sources and land-use types in relation to water quality concentrations and the benthic IBI. Additional resources should be used to increase the spatial coverage of other living resource monitoring components within the James River. Spatial distribution of point sources along with the magnitudes and timing of their discharges should be compared to the location of the existing plankton monitoring program stations to determine if there are potential relationships between trends and status in plankton indicators at these sites.

II. York River

A. Overview

1. Summary of Basin Characteristics

The York River watershed consists of approximately 3,269 square miles and has an estimated population of 372,488. Major population centers within the watershed include Ashland, Gloucester Point, Hampton, and West Point. Forested and agricultural lands are the most abundant in the watershed accounting for nearly 61% and 21% of the total land cover in the basin, respectively. The percent contributions of total nitrogen loadings were approximately equally divided between agricultural non-point sources (36%) and the combination of point and urban non-point sources (41%). Agricultural non-point source and urban non-point source contributions to total phosphorus loadings were approximately equal at 39% and 37%, respectively. Point sources contributions account for an additional 20% of total phosphorus loadings to this tributary. Percentage of households within this basin is nearly equally divided between urban and rural areas, at 53% and 46%, respectively.

2. Summary of Status and Long Term Trends

Improving trends in total nitrogen were detected in all segments of the York River basin except the oligohaline segments of the Pamunkey and Mattaponi Rivers (PMKOH and MPNOH). Status of both total nitrogen and dissolved inorganic nitrogen was good in the majority of segments of this tributary. In contrast, degrading trends in either total phosphorus or dissolved inorganic phosphorus were detected in all but two segments. Status of these two parameters was either fair or poor except total phosphorus in the tidal freshwater segments of the Pamunkey and Mattaponi River (PMKTF and MPNTF). Degrading trends in surface chlorophyll *a* were detected in the oligohaline Mattaponi (MPNOH) and Mesohaline York River (YRKMH). In general, status for surface chlorophyll *a*, total suspended solids, and secchi depth declined from good to poor moving downstream from the oligohaline segments of the Pamunkey and Mattaponi (PMKOH and MPNOH) to the Polyhaline York River (YRKPH). Degrading trends in surface chlorophyll *a* were detected in the oligohaline Mattaponi (MPNOH) and the Mesohaline York River (YRKOH).

Improving trends in chlorophyte biomass were detected in all segments with monitoring stations. Improving trends in picoplankton and cryptophyte biomass were detected in the tidal freshwater Pamunkey River (PMKTF) and the meoshaline York River (YRKMH). Improving trends in primary productivity were detected in the tidal freshwater Pamunkey (PMKTF) and Mobjack Bay

(MOBMH). In contrast, degrading trends in cyanobacteria abundance were detected in all segments with monitoring stations. Relative status of the majority phytoplankton bioindicators was either fair or poor.

Degrading trends in rotifer abundance were detected in the mesohaline York River (YRKMH) and polyhaline York River (YRKPH). Status of rotifer abundance was poor in both of these segments but good in the tidal freshwater Pamunkey (PMKTF). There were no trends in copepod nauplii abundance. Status of this parameter ranged from poor in the tidal freshwater Pamunkey River (PMKTF) to fair in the Mobjack Bay (MOBPH) and good in the mesohaline York River (YRKMH).

Although changes in sample processing methods precluded performing status and trend analyses on mesozooplankton bioindicators, results of analyses conducted on data collected through 1999 indicate improving trends in species diversity were detected in the tidal freshwater Pamunkey River (PMKTF) and the mesohaline York River (YRKMH). Status of both of these parameters was good in these two segments. Degrading trends in species diversity, total abundance, and several other indicators were detected in Mobjack Bay (MOBPH). Status of species diversity was fair while status for total mesozooplankton abundance was poor.

In the tidal freshwater Pamunkey River (PMKTF) benthic community status was good with improving trends in species diversity, abundance and biomass. In the mesohaline York River (YRKMH), benthic community status varied from good to degraded and degrading trends in the B-IBI, species diversity, and pollution sensitive species were detected at both stations. In the Lower York River (YRKPH), benthic community status ranged from degraded at station LE4.3B to good at station LE4.3. The degraded status at station LE4.3B was related to the short-term hypoxic events that occur at this station.

3. Summary of Major Issues in the Basin

The status of total suspended solids and water clarity was either fair or poor in most segments of the York River basin. The relative status of nearly all water quality parameters in the mesohaline and polyhaline York River (segments YRKMH and YRKPH) was either fair or poor. Degrading trends in dissolved inorganic phosphorus or total phosphorus were detected in all segments except the polyhaline York River (YRKPH) and Mobjack Bay (MOBPH). In most segments nearly all parameters either failed to meet the SAV requirements or were borderline. Degrading trends in bottom total suspended solids were detected in both the mesohaline and polyhaline York River (segments YRKMH and YRKPH) and a degrading trend in water clarity was detected in Mobjack Bay. Continued trends of increased cyanobacteria populations represent an unfavorable pattern along with the poor status of dinoflagellates; however, favorable diatom populations remain dominant in the river basin. Degrading trends in rotifer abundance were detected in Mobjack Bay and the mesohaline York River. These degrading trends are possibly related to degrading trends in water clarity as measured by secchi depth and/or a decreasing trend in salinity. Both benthic monitoring stations in the mesohaline York River showed degrading trends in the B-IBI. Status of benthic communities in the deep water areas of the polyhaline York River (YRKPH) was degraded primarily as a result of hypoxic events.

B. Management Recommendations

In general, the water quality conditions were better in the tidal freshwater segments of the Pamunkey and Mattaponi rivers and Mobjack Bay. Degrading trends and poor status of dissolved inorganic phosphorus and total phosphorus were found in the oligohaline segments of the Pamunkey and Mattaponi rivers, as well as, the mesohaline and polyhaline York River (segments YRKMH and YRKPH). Status of chlorophyll *a*, total suspended solids and secchi depth was fair or poor and most parameters either failed to meet the SAV habitat requirements or were borderline in these segments. The predominant source of total phosphorus within this tributary is estimated to be agricultural run-off. However, the percent contribution from agricultural sources has declined from 1985 to 2000 while percent contribution of point sources and urban run-off has increased. Although there was a substantial decline in point source loadings of total phosphorus following the phosphate ban, loadings for this parameter have begun to increase beginning in 1993 and continued to do so through 1999. Although a direct casual relationship between the degrading trends in phosphorus and potential sources of phosphorus cannot be clearly identified, additional controls of point source and non-point source controls may be required to alleviate the degrading trends and poor relative status of phosphorus concentrations in this tributary. Additional information will be required to develop specific strategies to reduce phosphorus concentrations in the York River. Spatial distribution of point sources along with the magnitudes and timing of their discharges should be compared to changes in concentration over time at stations within their vicinity to determine if there are potential relationships between changes in loadings and trends in ambient concentrations of phosphorus. Spatial distribution of land-use patterns could also be examined to determine those areas most in need of non-point source controls.

Another primary concern for management of the York River is extensive problem of poor water clarity throughout this tributary. As previously mentioned, relative status of secchi depth was fair in the oligohaline portions of the Pamunkey and Mattaponi rivers and poor in all segments of the York River main stem. In addition, at least one measure of water clarity either failed to meet the SAV requirements or was borderline in all segments of the York River. Water clarity problems in the York River may explain the degrading trends in microzooplankton and mesozooplankton indicators and also why SAV growth has not met the Tier I goals in the polyhaline York River and Mobjack Bay. The source of water clarity problem is unclear. It may be the result of increased sediment input from a variety of sources. Alternatively, the decrease in water clarity may be influenced by an increase in the abundance of phytoplankton in the water column. Degrading (increasing) trends in cyanobacterial abundance were detected at all stations monitored in the York River and degrading trends in surface chlorophyll *a* concentrations were also detected in two segments of the York River. A more thorough investigation of existing data sets may help to identify potential sources of the water clarity problems. An analysis of trends in both the fixed and volatile components of total suspended solids along with a statistical analysis of potential relationships between secchi depth and various environmental factors such as suspend solids concentrations, flow regime and phytoplankton concentrations is recommended.

With respect to benthic communities problems were located in the mesohaline and polyhaline York River. In the mesohaline York River benthic community status was either degraded (at station

LE4.1) or evidence suggests that benthic communities are degrading as evidenced by degrading trends in the B-IBI and other indicators at station RET4.3. Additional information is required before conclusions regarding management actions related to the benthos can be made. In the polyhaline York River degraded benthic communities were found at station LE4.3B where short-term hypoxic events occur on a regular basis. The cause of anoxic events at this station may be related excessive decomposition of organic material by bacteria, high respiration by phytoplankton, stratification of the water column due to salinity or temperature effects or a combination of these factors.

Specific recommendations should be developed for goals for phytoplankton biomass or productivity, chlorophyll *a*, nutrients, and suspended solids for each segment of the York River. Additional studies should be conducted that examine the spatial distribution of point sources and land-use types in relation to water quality concentrations and the benthic IBI. In addition, the relationship between physical stress and benthic community condition in the York River should be further clarified. Additional resources should be used to increase the spatial coverage of other living resource monitoring components within the York River particularly in the lower portions of the mesohaline York River and in the Polyhaline York River where most of the water quality problems for this tributary appear to be located.

III. Rappahannock River

A. Overview

1. Summary of Basin Characteristics

The Rappahannock River basin consists of 2,845 square miles and has an estimated population of 240,754 individuals. Major population centers in the basin include Fredericksburg, Culpeper, Falmouth, Orange, and Tappahannock. Forested and agricultural lands are the most abundant in the watershed accounting for nearly 61% and 33% of the total land cover in the basin, respectively. Agricultural run-off is the primary source of total nitrogen and total phosphorus to the river accounting for 53% and 66% of the loadings of these two nutrients, respectively. Point sources account for less than 10% of the total loadings for both of these nutrients. Over 66% of households were located in rural areas and most remaining households were in urban areas.

2. Summary of Water Quality Status and Long Term Trends

Improving trends in total nitrogen were detected in every segment in the Rappahannock River. Improving trends in surface and bottom dissolved inorganic nitrogen were detected in the oligohaline Rappahannock River (RPPOH). An improving trend in surface total phosphorus was detected in the tidal freshwater Rappahannock River (RPPTF). Status of all nutrients was good in nearly all segments. In contrast to the nutrients, status of chlorophyll *a*, total suspended solids and secchi depth was either fair or poor in all segments except for the Corrotoman River where status for these parameters was good. In general, nutrient and chlorophyll *a* concentrations either met the SAV habitat requirements in all segments or were borderline. Water clarity measures failed to meet the SAV habitat requirements in the tidal freshwater and oligohaline segments but were borderline in the mesohaline Rappahannock River (RPPMH) and met the SAV requirements in the Corrotoman River (CRRMH).

Improving trends in chlorophyte biomass were detected in all segments with monitoring stations while degrading trends in cyanobacteria abundance were also in all segments with monitoring stations. Improving trends in diatom biomass and cryptophyte biomass were detected in the oligohaline Rappahannock River (RPPOH) and in the upper portion of the mesohaline Rappahannock River. An improving trend and a degrading trend in dinoflagellate biomass was detected in the lower portion and upper portions of the mesohaline Rappahannock River (RPPMH), respectively. An improving trend in phytoplankton diversity was detected in the oligohaline Rappahannock River (RPPOH). Status for the majority of phytoplankton bioindicators were fair or poor in the lower portion of the mesohaline Rappahannock River (RPPMH), fair in the upper portion of the mesohaline Rappahannock River (RPPMH), and poor in the oligohaline Rappahannock River (RPPOH).

A degrading trend in rotifer abundance was detected in the lower portion of the mesohaline Rappahannock River (RPPMH) and status for this microzooplankton indicator was poor throughout the river. There were no trends in copepod nauplii abundance and status for this parameter was either good or fair.

Although changes in sample processing methods precluded performing status and trend analyses on mesozooplankton bioindicators, results of analyses conducted on data collected through 1999 indicate improving trends in mesozooplankton diversity in the oligohaline Rappahannock River (RPPOH) and the upper portion of the mesohaline Rappahannock River (RPPMH). Degrading trends in mesozooplankton diversity and several other indicators were detected in the lower portion of the mesohaline Rappahannock River (RPPMH).

A degrading trend in the B-IBI and several of its component metrics was detected in the upper portion of the mesohaline Rappahannock River (RPPMH) and status of the B-IBI ranged from degraded to severely degraded. Although benthic community status within the oligohaline Rappahannock River (RPPOH) was good, there was a degrading trends in pollution sensitive species biomass.

3. Summary of Major Issues in the Basin

Status of surface chlorophyll *a* was poor in the tidal freshwater Rappahannock River (RPPTF). Status for secchi depth and total suspended solid was poor or fair in all segments in the Rappahannock River except the Corrotoman River (CRRMH) where it was good. With regard to algal levels, degrading trends in cyanobacterial abundances throughout the river are of particular concern. Degrading trends in microzooplankton and mesozooplankton indicators were detected in the lower portion of the mesohaline Rappahannock River (RPPMH). Further consideration should be given to the ecological implications of these zooplankton trends specifically as it might affect stocks of planktivorous feeding fish. Benthic community status at all stations monitored in the mesohaline Rappahannock River (RPPMH) ranged from degraded to severely degraded and there were degrading trends in the B-IBI and nearly all of its component metrics at station RET3.1 in this segment. Benthic community status within the oligohaline Rappahannock River (RPPOH) met the Benthic Restoration goals although there was a degrading trend in pollution sensitive species biomass.

B. Management Recommendations

There do not appear to be significant problems with nutrient concentrations in this tributary. All trends in nitrogen were improving and there was only one degrading trend in bottom total phosphorus. In addition, the status of nutrients was good in most segments and SAV habitat requirements for nutrients were met in most segments. The primary concern for water quality in the main stem of Rappahannock River is water clarity. The status of secchi depth was fair to poor in the majority of segments in this tributary and in half the segments the SAV habitat requirements for water clarity measurements such as light attenuation and the percent light at the leaf surface were not met.

There is no clear cause for water clarity problems in the Rappahannock River. However, the water clarity issues may be related to high total suspended solids concentrations as indicated by the fair to poor status for this parameter throughout the river. Run-off from agricultural land constitutes the primary source of suspended sediments to the Rappahannock River. Additional non-point source controls may help to ameliorate water clarity problems in this tributary. High concentrations of phytoplankton could also adversely influence water clarity. Increasing trends in total phytoplankton abundance were found at all monitoring stations. Specific phytoplankton groups which showed increases in biomass at one or two stations were diatoms, dinoflagellates, and cryptophytes. Increasing trends in cyanobacterial and chlorophyte abundance were detected at all stations. No direct link between these factors can be made; however, a more thorough investigation of existing data sets may help to identify potential sources of the water clarity problems. An analysis of trends in both the fixed and volatile components of total suspended solids along with a statistical analysis of potential relationships between secchi depth and various environmental factors such as suspend solids concentrations, freshwater flow and phytoplankton concentrations is recommended. Without additional information, specific management recommendations for solving this problem can be made.

Degrading trends in the microzooplankton and mesozooplankton indicators in the lower portion of the mesohaline Rappahannock River (RPPMH) may be related to poor water clarity, the degrading trend in bottom total phosphorus, or perhaps changes in phytoplankton community composition. Poor status in rotifer abundance may be related to poor status in secchi depth, total suspended solids, and chlorophyll *a*.

The cause of the degrading trends and degraded status of benthic communities in the mesohaline Rappahannock River and the degrading trend in pollution sensitive species biomass in the oligohaline Rappahannock River is unknown. Without additional information, no management recommendations for solving this problem can be made.

Specific recommendations should be developed for goals for phytoplankton biomass or productivity, chlorophyll *a*, nutrients, and suspended solids for each segment of the Rappahannock River. Additional studies should be conducted that examine the spatial distribution of point sources and land-use types in relation to water quality concentrations and the benthic IBI. Additional resources should be used to increase the spatial coverage of other living resource monitoring components within the Rappahannock River.

I. Introduction

A marked decline in the water quality of the Chesapeake Bay has occurred over the past several decades. The disappearance of submerged aquatic vegetation in certain regions of the Bay, declines in the abundance of some commercially- and recreationally-important species, increases in the incidence of low dissolved oxygen events, changes in the Bay's food web, and other ecological problems have been related to the deteriorating water quality. The results of concentrated research efforts in the late 1970s and early 1980s stimulated the establishment of Federal and state directives to better manage the Chesapeake Bay watershed. By way of the Chesapeake Bay Agreements of 1983, the State of Maryland, the Commonwealths of Virginia and Pennsylvania, and the District of Columbia, agreed to share the responsibility for improving environmental conditions in the Chesapeake Bay. As part of this agreement, a long-term monitoring program in the Chesapeake Bay was established in order to: 1) track long-term trends in water quality and living resource conditions over time, 2) assess current water quality and living resource conditions, and 3) establish linkages between water quality and living resources communities. By tracking long-term trends in water quality and living resources, managers may be able to determine if changes in water quality and living resource conditions have occurred over time and if those changes are a reflection of management actions. Assessments of current status may allow managers to identify regions of concern that could benefit from the implementation of pollution abatement or management strategies. By identifying linkages between water quality and living resources it may be possible for managers to determine the impact of water quality management practices on living resource communities.

Water quality and living resource monitoring in the Virginia Mainstem and tributaries began in 1985 and has continued for 16 years. Detailed assessments of the status and long-term trends in water quality and living resources in Chesapeake Bay and its tributaries have been previously conducted (Carpenter and Lane, 1998; Dauer, 1997; Dauer et al., 1998a,1998b; Lane et al.,1998; Marshall, 1994,1996; Marshall and Burchardt, 1998; Marshall et al., 1998). An attempt was made to determine if there was concordance in current conditions of and long-term changes in water quality and living resources. The purpose of this project was to reassess the results of these studies by re-conducting the analyses after adding data collected during 2000. This report describes the status of water quality and living resource conditions for the Virginia Mainstem and tributaries, summarizes major long-term trends in water quality and measures of living resource community health.

II. Monitoring Program Descriptions

A. Water Quality

1. Sampling locations and procedures

As part of the U. S. Geological Survey's River Input Program, water quality data have been collected at five stations near the Fall Line in Virginia. Samples were taken at base-flow twice a month and during high flows whenever possible between 1988 and 2000. Water quality data have also been collected by the Virginia Department of Environmental Quality at three additional stations upstream of these River Input sites (Figure 1). These stations had a minimum of three consecutive years of samples taken between 1985 and 1996 with sampling occurring on at least a monthly basis.

Water quality conditions were regularly monitored at 28 sites in the Bay Mainstem beginning in July, 1985. From 1985 until 1995 eight stations were sampled by Old Dominion University (ODU) and 20 stations were sampled by the Virginia Institute of Marine Science (VIMS). From 1995 through the present, Mainstem water quality monitoring was conducted by ODU. Tributary water quality monitoring was conducted by the Department of Environmental Quality at 28 sites in the James, York (including Mattaponi and Pamunkey) and Rappahannock rivers (Figure 2). In addition, six permanent water quality monitoring sites were established in the Elizabeth River/Hampton Roads Harbor by ODU in February, 1989 (Figure 2).

The temporal sampling scheme for the water quality monitoring program changed several times over the 14 year period (varying from 20 to 12 sampling events per year) as a result of changes in the monitoring program budget. In general, Mainstem sampling cruises were conducted semi-monthly from March through October and monthly from November through February. Tributary sampling by the Virginia Department of Environmental Quality was generally conducted 20 times per year. The Elizabeth River stations were sampled monthly. Field sampling procedures used for ODU and VIMS water quality collections are described in detail by Alden et al., 1992a. Field sampling procedures for DEQ water quality collections are described in detail in DEQ's Quality Assurance Project Plan for the Chesapeake Bay Program (Applied Marine Research Laboratory, 1998).

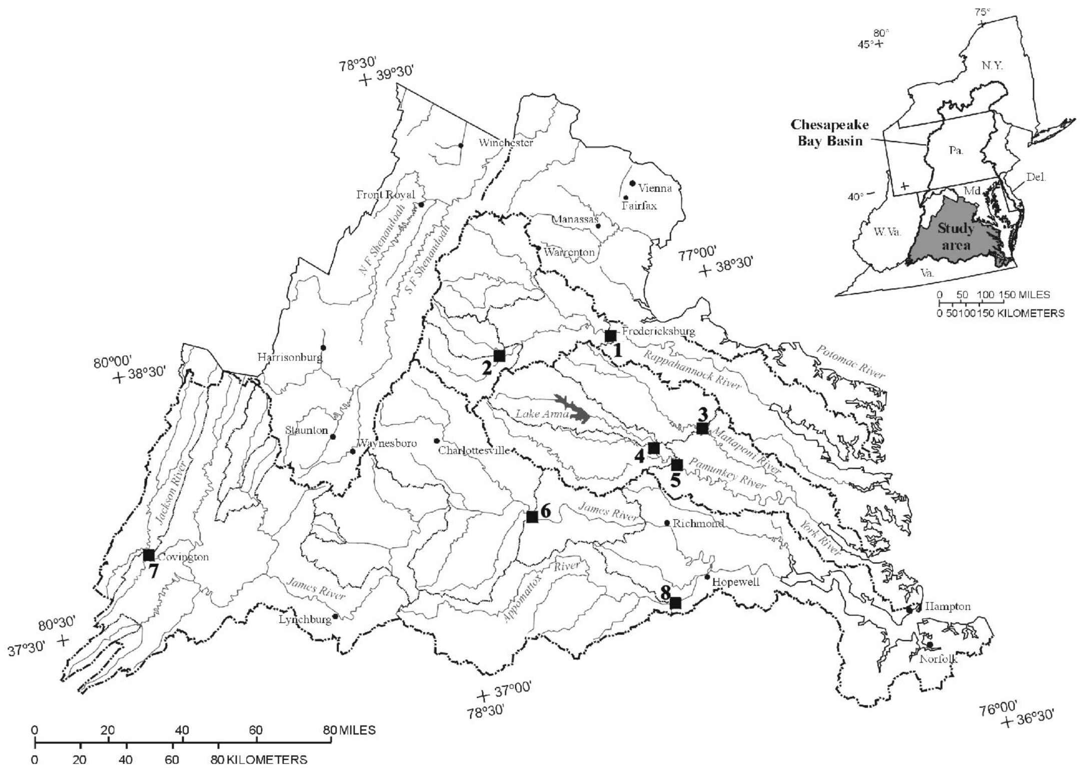
2. Laboratory sample processing

Descriptions of laboratory sample processing and standard operating procedures for all water quality parameters are found in the Chesapeake Bay Program Quality Assurance Project Plans (QAPjPs) prepared by each of the participating laboratories (Applied Marine Research Laboratory, 1998). Copies of the QAPjPs can be obtained by contacting EPA's Chesapeake Bay Program Quality Assurance Officer.

B. Phytoplankton

1. Sampling locations and procedures

Seven stations were established in Chesapeake Bay in July 1985. These were CB6.1, CB6.4, CB7.3E, CB7.4, LE5.5, WE4.2, and LE3.6 (Figure 3). From July, 1985 through September, 1990, phytoplankton collections were taken from these stations twice a month from March through October, and monthly November through February. From October, 1990, monthly samples were taken at all Bay stations. Monthly sample collections and analysis in the James (TF5.5, RET5.2), York (RET4.1, RET4.3), and Rappahannock (TF3.3, RET3.1) rivers began in March, 1986. In March, 1987, station RET4.1 in the Pamunkey River was replaced by station TF4.2, and in February,



1 Station 01668000 - Rappahannock River near Fredericksburg
2 Station 01666500 - Robinson River
3 Station 01674500 - Mattaponi River near Beulahville
4 Station 01671020 - North Anna River near Doswell
5 Station 01673000 - Pamunkey River near Hanover
6 Station 02035000 - James River at Cartersville
7 Station 02013100 - Jackson River at Covington
8 Station 02041650 - Appomattox River

Figure 1. Map showing the locations of the USGS sampling stations at and above the fall-line in each of the Virginia tributaries.

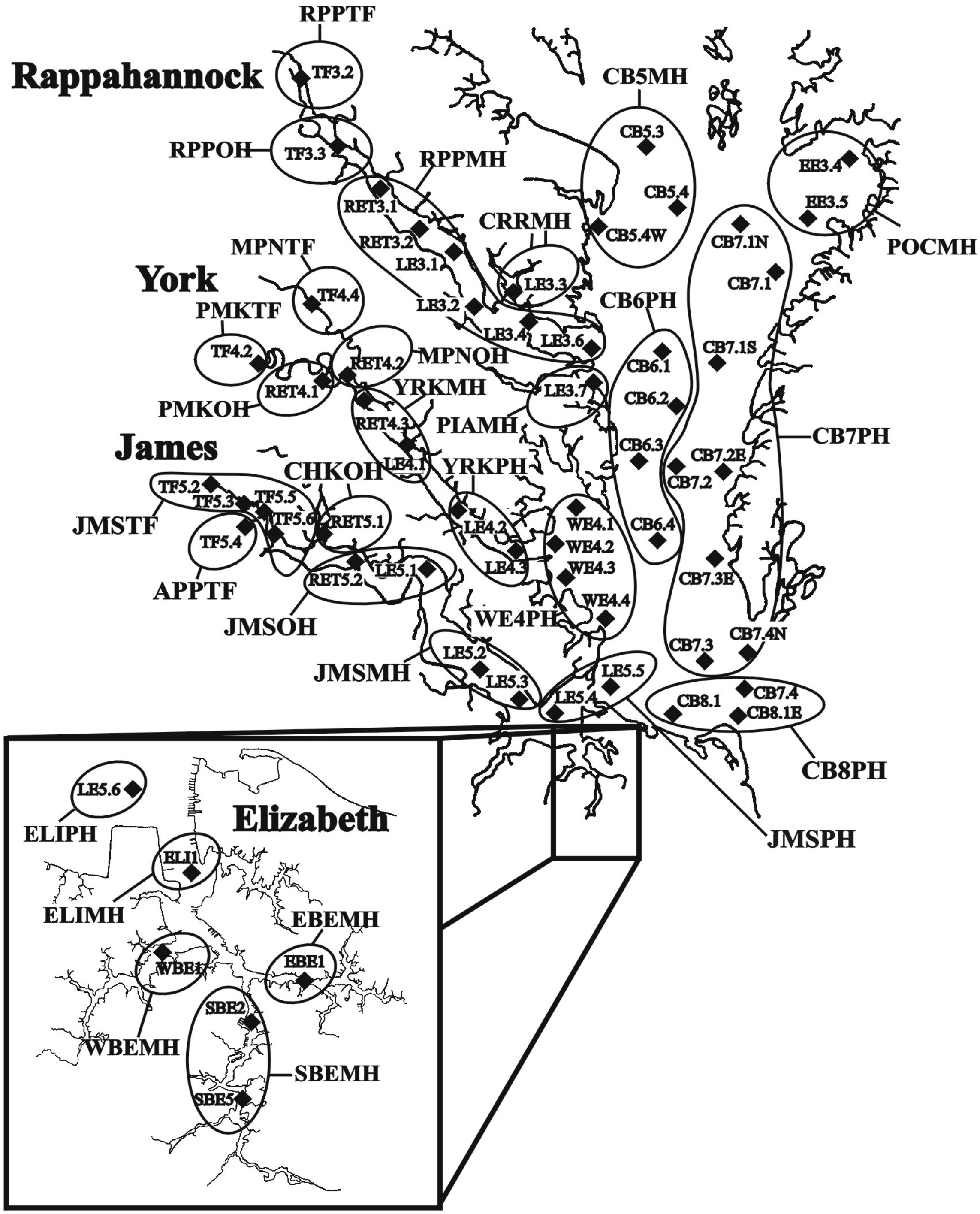


Figure 2. Map showing the locations of the water quality monitoring stations in the Virginia tributaries and the Lower Chesapeake Bay Mainstem used in the statistical analyses. Also shown are ellipses that delineate the Chesapeake Bay Program segmentation scheme.

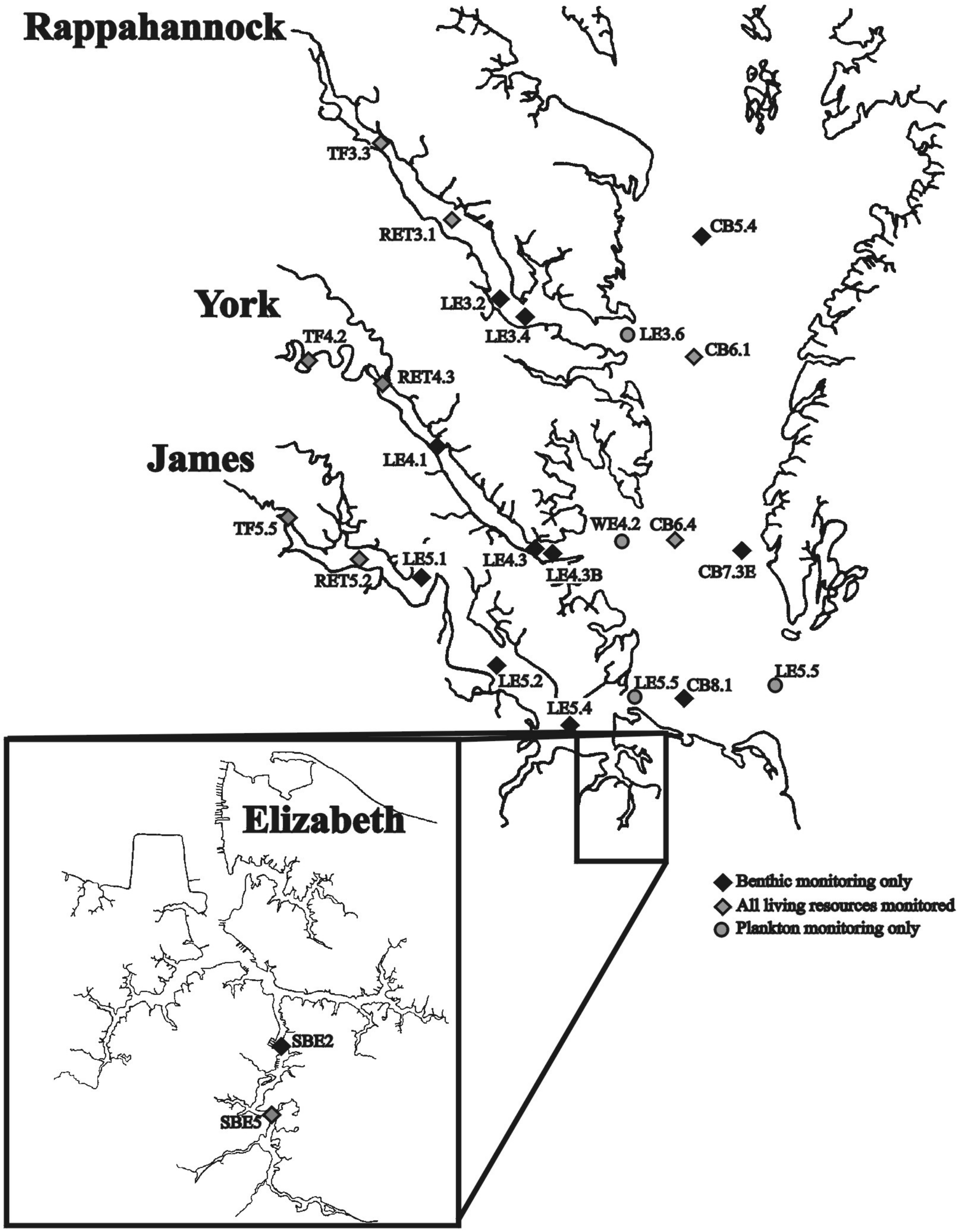


Figure 3. Map showing the locations of living resource monitoring stations in the Virginia tributaries and the Lower Chesapeake Bay Mainstem.

1989, monthly collections began at two stations (SBE2, SBE5) in the Elizabeth River. Picoplankton analysis was included at several trial stations in January, 1989, and was expanded to include all stations in July, 1989. Primary production analysis was added to all Bay and tributary stations in July 1989.

At each station, two vertical sets of three liter water samples were taken at five equidistant depths above the pycnocline and placed in two separate carboys. The process was repeated at five depths below the pycnocline. The water in each carboy was carefully mixed and replicate 500 ml sub-samples were removed from each carboy, and fixed with Lugol's solution. A second set of 125 ml sub-samples were also taken above and below the pycnocline, preserved with glutaraldehyde and placed in a cooler. These samples were taken to determine the concentrations of the autotrophic picoplankton population. An additional replicate set was also taken from the same carboy set taken above the pycnocline for primary productivity measurements.

2. Laboratory sample processing

Samples for phytoplankton analyses were passed through a series of settling and siphoning steps to produce a concentrate (or fraction of the concentrate) that was examined using a modified Utermöhl method with an inverted plankton microscope (Marshall and Alden, 1990). The analysis procedure attained an estimated precision of 85% (Venrick, 1978). The autotrophic picoplankton were processed through a protocol that included their collection on a 0.2 μ nucleopore filter, with subsequent analysis using an epifluorescent microscope, under oil at 1000x magnification, with a "green" filter set (Marshall, 1995a). Supplemental analysis with a scanning electron microscope was used in several of the species identifications. Methodology for the productivity measurements is given in Marshall and Nesius (1996). Appropriate quality assurance/quality control practices in sample collection, analysis, and data entry were employed throughout this period.

C. Zooplankton

1. Sampling locations and procedures

Microzooplankton communities were monitored monthly at seven sites in the Mainstem and six sites in the Virginia tributaries beginning in January, 1993 (Figure 3). Whole water samples were collected at all stations. Before sampling, 10 ml of modified Lugol's solution was placed into two liter (L) bottles designated for each station. The water was sampled through the use of a battery powered pump attached to a hose. Two composite water samples, each totaling 15 L, were taken from five equidistant depths above the pycnocline and collected in two carboys. Each carboy was thoroughly mixed and 1 L taken from each (Samples A and B for each station).

Mesozooplankton communities were monitored monthly at seven sites in the Mainstem beginning in July, 1985 (Figure 3). Monthly mesozooplankton monitoring was conducted at six sites in the major Virginia tributaries (Rappahannock, York/Pamunkey, and James River) beginning in March, 1986 (one site on the Pamunkey was originally sampled at RET4.1 but relocated to TF4.2 in February, 1987). In 1986 a new sampling regime began that increased frequency to two samples per month during April, May, July, and August at all the Tidal Fresh stations (TF3.3, TF4.2, TF5.5). At the same time, sampling frequency was increased to twice per month for July and August also at stations RET3.1, RET4.3, RET5.2, LE5.5, and SBE5 in order to allow better characterization of zooplankton communities during spawning periods of commercially important fish species in these areas.

Single mesozooplankton tows were conducted at each site using a bongo apparatus with 202 μ mesh nets. The nets were towed obliquely from the surface to 1 m above the bottom and back to the surface over a period of approximately five minutes. A calibrated flowmeter was attached to each net and flowmeter readings were recorded just prior to net deployment and immediately upon net retrieval. Once onboard the research vessel, the nets were "washed down" and the contents of the cod-ends were decanted into pre-labeled one liter sample containers and preserved with 7% buffered formalin. All sample numbers were recorded on a sample chain-of-custody form before departing the site.

2. Laboratory sample processing

The whole water samples taken for microzooplankton (<200μ) analysis were processed through a screen, plus a series of settling and siphoning procedures (Park and Marshall, 1993). These steps removed the larger zooplankters and debris to provide 3 sub-sets based on size to be analyzed. This method insured the collection and analysis of the small non-loricated ciliates to be included in the count.

The mesozooplankton samples were processed according to the coefficient of variation stabilizing (CVS) method described by Alden et al. (1982). This method has numerous advantages over other zooplankton enumeration techniques. The CVS method provides abundance estimates with equitable coefficients of variation for species of interest in zooplankton subsamples. It is particularly useful in increasing the precision of the estimates of numbers of large species of relatively low abundance that may be important due to their biomass, their trophic position, or their economic significance. The investigator can be quite confident that the precision of the abundance estimates is at least at the pre-determined level for all species processed by the CVS method. The method also has the advantage of allowing the investigator to set a level of precision that is consistent with cost, manpower, or time constraints. Finally, the size class data produced by the CVS method may provide information of intrinsic ecological significance.

Briefly, the CVS method involves the sieve fractionation of the samples into size classes of 2000μ, 850μ, 650μ, 300μ , and 200μ. This series was found useful for Bay mesozooplankton communities. An additional sieve size fraction between 200μ and 63μ was collected and analyzed beginning in 1998. This fraction was added to allow greater comparability with the mesozooplankton data collected in Maryland. However, these data are incomplete and the results from this additional sieve-size fraction will be reported beginning with the 1999 data set. The size classes appropriate for whole counts were transferred to labeled vials containing 7% buffered formalin and temporarily stored until counted. The size class aliquots in which the organisms were too numerous to count in their entirety were split with a Folsom plankton splitter until an appropriate sample size was achieved for statistically valid counts of the dominant species. A level of sampling error of 30% requires that each species of interest be counted to achieve a range of between 30 and 56 organisms counted in any given split. During the splitting process, reserve splits were labeled, preserved in formalin and retained until the counting procedure was completed. Those species observed in the final split were counted in the reserved splits until all had achieved the range for the 30% error level (see Alden et al., 1982 for details of CVS methodology). However, if commercially important species (e.g., blue crab zoea) were encountered, they were counted to achieve the 30% error level for the statistical models. The samples were counted under a dissecting microscope in custom-designed counting trays (60 mm tissue culture dishes). Taxonomic identifications were made under compound or inverted microscopes and reference collections and/or photographs were maintained for each taxon for documentation and QA/QC purposes.

D. Benthos

1. Fixed location sampling

Sixteen stations in the lower Chesapeake Bay were sampled quarterly (March, June, September, December) from March 1985 through December 1995 as part of the Benthic Biological Monitoring Program of the Chesapeake Bay Program. Beginning in 1996 sampling at the fixed stations occurred only in June and September and a stratified random sampling element was added to the program. Power and robustness analyses indicated that sampling during June and September would be sufficient for detecting long-term trends at the fixed locations while at the same time, allow funding resources to be reallocated to the probability-based random sampling regime (Alden et al., 1997). Stations were located within the mainstem of the bay and the major tributaries - the James, York and Rappahannock rivers (Figure 3). In the tributaries, stations were located within the tidal freshwater zone (TF5.5, TF4.2, TF3.3), turbidity maximum (transitional) zone (RET5.2, RET4.3, RET3.1), lower estuarine mesohaline muds (LE5.2, LE4.1, LE3.2) and lower estuarine polyhaline silty-sands (LE5.4, LE4.3). The tidal freshwater station within the York River estuary was located in the Pamunkey River. In the Mainstem of the Bay three stations were located off the mouths of the major tributaries (CB8.1, CB6.4, CB6.1) and two stations in the deeper channels near the bay mouth (CB7.3E) and above the Rappahannock River near the Virginia-Maryland border (CB5.4).

In 1989, five additional stations were added to the program: two stations in the Southern Branch of the Elizabeth River (SBE2, SBE5) in regions exposed to contaminated sediments, a station in the transitional region of the James River (LE5.1), a station in the lower York River exposed to low dissolved oxygen events (LE4.3B), and a station in the lower Rappahannock River exposed to low dissolved oxygen events (LE3.4).

For the fixed point stations three replicate box core samples were collected for benthic community analysis. Each replicate had a surface area of 184 cm^2, a minimum depth of penetration to 25 cm within the sediment, was sieved on a 0.5 mm screen, relaxed in dilute isopropyl alcohol and preserved with a buffered formalin-rose bengal solution.

At each station on each collection date a 50g subsample of the surface sediment was taken for sediment analysis. Salinity and temperature were measured using a Beckman RS5-3 conductive salinometer and bottom dissolved oxygen was measured using a YSI Model 57 oxygen meter. For the original 16 stations see Dauer et al. (1992) for a summary of the pattern of bottom oxygen values, Dauer et al. (1993) for a summary of the distribution of contaminants in the sediments and Dauer (1993) for a summary of salinity, water depth, and sedimentary parameters.

2. Probability-based sampling

In 1996 a probability-based sampling program was added to estimate the area of the Virginia Chesapeake Bay and its tributaries that met the Benthic Restoration Goals as indicated by the B-IBI (Ranasinghe et al., 1994; Weisberg et al., 1997). Four strata were defined and each stratum was sampled by 25 randomly allocated sites. The four strata were: 1) the James River; 2) the York River (including the Pamunkey and Mattaponi rivers); 3) the Rappahannock River; and 4) the Mainstem of the Chesapeake Bay. Each year a new set of 25 random sites was selected for each stratum.

Probability-based sampling within strata supplements data collected at fixed-point stations. Sampling design and methodologies for probability-based sampling are based upon procedures developed by EPA's Environmental Monitoring and Assessment Program (EMAP, Weisberg et al., 1993) and allow unbiased comparisons of conditions between strata (e.g., tributaries) of the Chesapeake Bay within the same collection year and within tributaries for data collected between different years. The consistency of sampling design and methodologies for probability-based sampling between the Virginia and Maryland benthic monitoring programs allows bay-wide characterizations of the condition of the benthos for the Chesapeake Bay.

Within each probability-based stratum, 25 random locations were sampled using a 0.04 m^2 Young grab. At each station one grab sample was taken for macrobenthic community analysis and a second grab sample for sediment particle size analysis and the determination of total volatile solids. All sampling processing for probability-based sampling stations were identical to those for the fixed stations. Physico-chemical measurements were also made at the random locations.

3. Laboratory sample processing

In the laboratory, each replicate was sorted and all the individuals identified to the lowest possible taxon and enumerated. Biomass was estimated for each taxon as ash-free dry weight (AFDW) by drying to constant weight at 60 ^{o}C and ashing at 550 ^{o}C for four hours. Biomass was expressed as the difference between the dry and ashed weight.

The sand fraction of each sediment sample was dry sieved and the silt-clay fraction was quantified by a pipette analysis using the techniques of Folk (1974). Total volatile solids for each sediment sample was determined as the AFDW weight of the sediment divided by the dry weight of the sediment, expressed as a percentage.

E. Statistical Analyses

In order to ensure that long-term trends in water quality and living resource data are correctly interpreted, a unified approach for conducting the statistical analyses and interpreting their results was developed. Statistical analytical procedures used in this study were based on guidelines developed by the CBP Monitoring Subcommittee's Data Analysis Workgroup.

1. Status assessments

For the tidal water quality stations, status analyses were conducted using surface and bottom water quality measurements for six parameters: total nitrogen, dissolved inorganic nitrogen, total phosphorus, dissolved inorganic phosphorus, chlorophyll *a*, and total suspended solids. Status analyses were also performed on secchi depth and bottom dissolved oxygen. All analyses were conducted using water quality data collected from all of the Chesapeake Bay Mainstem and tributary collection stations from the starting date of each monitoring program through December of 1998. Status for bottom dissolved oxygen were conducted using data collected only during the summer months of June through September. For both status and trend analyses, the stations were grouped into segments based on the segmentation scheme developed by the Data Analysis Workgroup (Figure 2).

The status of each station and segment was determined by comparison to a benchmark data set comprised of all data collected from 1985 to 1990 by both the Virginia and Maryland monitoring programs. Each station was rated as poor, fair, or good relative to the benchmark data. The ratings are obtained for data collected within each salinity zone with salinity zones being assigned using the Venice classification system (Symposium on the Classification of Brackish Waters, 1958). For each parameter in the benchmark data set, a transformation was chosen that yields a distribution that was symmetric and approximated by the logistic cumulative distribution function (CDF). In most cases, the logarithmic transformation was selected. A logistic CDF based on the mean and variance of each parameter of the benchmark data set was used to perform a probability integral transform on all data collected during the period of January, 1998 through December, 2000. This resulted in data in the interval (0,1) that follow a uniform distribution. The three year median of these transformed data was computed as an indicator of status for the period specified. The median of n observations taken from a uniform distribution follows a Beta distribution with parameters (m,m) where:

$$m = (n+1)/2$$

and n is the number of observations.

The transformed three year medians were compared to the Beta density distribution and status was determined by the placement of the transformed medians along the distribution. If the median was in the upper third of the distribution (where upper is chosen as the end of the distribution that is ecologically desirable) then the status rating is good, while a median in the middle third was rated fair, and a median in the lower third was rated poor. In most cases, serial dependence of the raw data resulted in greater than expected variance in the Beta density of the medians. To adjust for this, the variance of the Beta density was increased by a function of the ratio of among station variance to within station variance.

Because sampling regimes between monitoring programs varied with respect to the number of collection events within a given month and the number of replicate samples collected at each station varied, a uniform calculation protocol was adopted for use by both states to insure that the calculations were not inadvertently biased by these discrepancies. First, replicate values were combined by calculating a median for each station date and layer combination. Median values for each station month and year combination were calculated to combine separate cruises per month. Finally, station specific or segment specific median scores were calculated that were compared to the benchmark scale.

Status for phytoplankton, microzooplankton and mesozooplankton involved the calculation of relative status using the same technique as described for water quality relative status assessments. For phytoplankton communities the following indicators were assessed: total phytoplankton community abundance, total phytoplankton community biomass, diatom abundance, dinoflagellate abundance, cyanobacteria abundance, picoplankton abundance, and primary productivity (carbon fixation). Benchmarks for picoplankton abundance were made using data collected only in Virginia since sampling protocols for the Maryland program did not include counts of epifluorescent picoplankton. Microzooplankton parameters assessed included total microzooplankton abundance, copepod nauplii abundance and rotifer abundance. Mesozooplankton parameters assessed included the Margalef diversity index, the Shannon-Weiner diversity index, and total mesozooplankton abundance. Note that the benchmarks for mesozooplankton data were made using data collected only in Virginia since the sampling protocols for the Maryland program does not include counts of epifluorescent picoplankton. A change in laboratory sample processing for the mesozooplankton program occurred in 2000 and as a result only data collected through 1999 were used in both status and trend analyses for the mesozooplankton.

Status of benthic communities at each station was characterized using the three-year mean value (1998-2000) of the B-IBI (Weisberg et al., 1997). The B-IBI indicates whether the macrobenthic community meets the restoration goals developed for benthic habitats of the Chesapeake Bay. An index value that exceeds or equals 3.0 indicates that the macrobenthic community meets or exceeds the restoration goals developed for that habitat type while a value below 3.0 indicates that the macrobenthic community does not meet the restoration goals. Status of the benthic community was classified into four levels based on the B-IBI. Values less than or equal to 2 were classified as severely degraded, values from 2.0 to 2.6 were classified as degraded, values greater than 2.6 but less than 3.0 were classified as marginal, and values of 3.0 or more were classified as meeting goals.

2. Long-term trend analyses

Trend analyses were conducted on data collected at nine stations at and above the fall-line in the Virginia tributaries. Concentrations of water-quality constituents are often correlated with streamflow. Removal of natural flow variability allows examination of changes in water quality resulting from human activities. Flow-adjusted concentration trends were determined with a non-parametric Kendall-Theil analysis. The trend slope was the overall median of the pairwise slopes of residuals from a log-linear-regression model incorporating flow and season terms (Helsel and Hirsch, 1992). For data sets with greater than five percent censored data, a range in slope and magnitude was defined by twice computing the median slope - first, with censored data equal to zero and second, with censored data equal to the maximum detection limit (Helsel and Hirsch, 1992). For data sets with greater than twenty percent censored data, no results were reported. A p-value of 0.05 or less was considered significant for this analysis.

When considering the health of living resources, it is necessary to examine trends in concentrations that may be both flow- and human-induced. These concentrations were weighted, but not adjusted, for flow. The flow-weighting resulted in a more representative monthly concentration than the one point per month typical of many observed data sets. The volume of flow occurring between these infrequent sample dates is likely to have a pronounced effect on average concentrations in the tidal estuaries and other mixed receiving areas. Therefore trends in flow-weighted concentrations may correlate better with trends in estuarine concentrations. The linear trend in flow-weighted concentration was estimated by regressing flow-weighted concentrations with time. In most cases, the data was log-transformed in order to meet the assumptions of normality, constant variance, and linearity. A p-value of 0.01 or less was considered significant for this analysis.

The statistical tests used for the trend analyses were the Seasonal Kendall test for monotonic trends and the Van Belle and Hughes (Gilbert, 1987) tests for homogeneity of trends between stations, seasons, and station-season combinations. A p value of 0.05 was chosen as the statistical test criterion for all trend analyses. Recent studies on representative data sets from the Chesapeake Bay monitoring program have indicated that these tests are very powerful and robust, even when data violate most of the assumptions of parametric statistics (Alden et al., 1991; Alden et al., 1992b; Alden et al., 1994; Alden and Lane, 1996).

Trend analyses were conducted on the same suite of water quality parameters used for the status assessments and salinity and water temperature. Prior to the trend analyses, data were reduced to a single observation for each station month and layer combination by first calculating the median of all replicates for each layer by station and date and then calculating the median between all dates for a given station within each month. For all applicable water quality parameters, any values less then the highest detection limit were set to one half of the highest detection limit. For calculated parameters, each constituent parameter that was below the detection limit was set to one half of the detection limit and the parameter was then calculated. This protocol was used to prevent the detection of step trends resulting from changes in detection limits over time.

Increasing trends in total nitrogen, dissolved inorganic nitrogen, total phosphorus, dissolved inorganic phosphorus, chlorophyll *a* and total suspended solids should indicate increased eutrophication and as a result positive slopes in these parameters indicate degrading conditions while negative slopes indicate improving water quality conditions. Increasing trends in secchi depth and bottom dissolved oxygen indicate increasing water clarity and reduced eutrophication, respectively and as a result indicate improving water quality conditions. Decreasing trends in these two parameters indicate degrading conditions.

Trend analyses for phytoplankton communities were conducted on the following phytoplankton community indices: the phytoplankton IBI, total phytoplankton abundance (excluding picoplankton); total phytoplankton biomass (excluding picoplankton); the Margalef species diversity index, and C^{14} productivity. In addition, trend analyses were conducted on abundance and biomass values for the following taxonomic groups: diatoms; dinoflagellates; cyanobacteria; cryptomonads; chlorophytes; bloom producing species; and toxic bloom producing species.

The Margalef species diversity index was calculated as follows:

$$D = \frac{S-1}{\log_2 N}$$

where S is the number of taxa in the sample and N is the number of individuals (Margalef, 1958).

Trend analyses were conducted by station using monthly medians of microzooplankton and mesozooplankton data collected from the beginning of the respective monitoring programs through December of 2000 and December of 1999 for microzooplankton and mesozooplankton, respectively. Microzooplankton bioindicators used for the trend analyses included: total microzooplankton abundance; rotifer abundance; copepod nauplii abundance; oligotrich abundance; tintinnid abundance; sarcodinia abundance; and microzooplankton cladoceran abundance. Mesozooplankton bioindicators used for these analyses were: total mesozooplankton abundance (excluding copepod nauplii); holoplankton abundance; meroplankton abundance; indices of mesozooplankton community species diversity (including the total number of species collected, the Shannon-Weiner index, the Margalef diversity index, and Pielou's evenness); calanoid copepod abundance; cladoceran abundance; cyclopoid copepod abundance; *Acartia tonsa* abundance; *Bosmina longirostris* abundance; *Eurytemora spp.* abundance; and crab zoea abundance.

The Shannon Weiner diversity index (H') was calculated as follows:

$$H' = -\sum_{i=1}^{S} p_i \log_2 p_i$$

where p_i is the proportion of the *i*th species and S is the number of species.

Pielou's evenness index (J) was calculated using the equation:

$$J = \frac{H'}{\log_2 S}$$

where H' is the diversity index and S is the total number of species collected. Increasing trends in mesozooplankton abundance, holoplankton abundance, merozooplankton abundance and measures of species diversity indicate improving conditions while negative slopes indicate degrading conditions.

Trend analyses for benthic communities were conducted using the B-IBI (Ranasinghe et al., 1994; Weisberg et al., 1997) and on selected metrics of the B-IBI. Benthic restoration goals were developed for benthic habitats of the Chesapeake Bay based upon reference sites that were minimally impacted by low dissolved oxygen events and sediment contaminants. Goals were developed based upon data from an index period of July 15 through September 30. Therefore trends in the value of the B-IBI were based upon September cruise values for the 14 year period of 1985-1998. Selected benthic metrics were species diversity (H'), community abundance, community biomass, pollution-indicative species abundance, pollution-indicative species biomass, pollution-sensitive species abundance, and pollution-sensitive species biomass. See Weisberg et al. (1997) for a list of pollution-indicative and pollution-sensitive taxa.

III. James River

A. Basin Overview

Population in the James River basin for 2000 is projected to be 2,522,485 people. Approximately 80 percent of the housing in the basin is urban and a similar percentage of housing relies on municipal sewage treatment facilities. As a result, point sources have historically been the largest sources of nutrient loadings in the basin. Reductions have been made in point source loadings since 1985. Biological Nitrogen Removal has been implemented at 5 of the 19 active municipal sewage systems in the basin. Point sources still account for nearly half of the nitrogen and phosphorus loadings (Figure 4).

The James River's high flow rate in conjunction with its shallow waters (3.3 meters as opposed to 4.3 and 4.8 meters in the York and Rappahannock, respectively) prevent extensive nutrient related oxygen depletion. As a result, nutrient loadings and concentrations are not the most critical issue facing the James River. Water clarity impairment due to sediment loadings is a much more significant issue in this basin.

Sprague et al. (1999) described the James River Basin as follows:

"The James River Basin, at 10,200 mi^2, is the third largest tributary basin to Chesapeake Bay. The James River originates in the Appalachian Mountains near the Virginia-West Virginia border, flows through the Valley and Ridge, the Blue Ridge, the Piedmont, and the Coastal Plain physiographic provinces, and joins Chesapeake Bay near the city of Norfolk in southeastern Virginia. Two RIM stations, James River at Cartersville (02035000) and Appomattox River at Matoaca (02041650), are located in the James River Basin. The RIM station in the James River sub-basin is located approximately 40 mi upstream from the Fall Line in Cartersville, Va.. This station was selected based on the availability of a long-term discharge record; no major streams enter the river between Cartersville and the Fall Line. This monitoring station receives drainage from about 60 percent of the James River Basin.

The Appomattox River, located in another sub-basin of the James River Basin, joins the James River downstream from Richmond near the city of Hopewell, after flowing through a small area of the Coastal Plain physiographic province. The RIM station is located in Matoaca, Va. The monitoring station receives drainage from about 84 percent of the 1,600-mi^2 Appomattox River basin. The Appomattox River RIM station is located 2.8 mi downstream from the Lake Chesdin Dam, which serves to dampen and delay the hydrologic response of the Appomattox River at the RIM station during storm events.

Land use upstream of both RIM stations is dominated by forest, at 80 percent upstream from the James River station and 72 percent upstream from the Appomattox River station (table 3). Agriculture is the second largest land use, at 16 percent and 20 percent, respectively. The agricultural areas above the RIM stations are concentrated in the western part of the basin around Rockbridge, Botetourt, and Nelson Counties, and in the southeastern part of the basin around Amelia County.

Of the nine rivers monitored, the James River contributes about 12 percent of the streamflow, 5 percent of the total nitrogen load, and 20 percent of the total phosphorus load to Chesapeake Bay, making it the third largest streamflow and nutrient source to the Bay after the Susquehanna and the Potomac Rivers (Belval and Sprague, 1999). The contribution of the Appomattox River is much smaller, with 2 percent of the total streamflow and approximately 1 percent of both the total nitrogen and the total phosphorus load entering the Bay from this river."

B. Overview of Monitoring Results

Long-term trend and status analysis results for water quality are summarized for all stations in James River in Figures 5 and 6. In tidal waters, the status of surface and bottom total and dissolved inorganic nitrogen was good or fair in all segments of the James River. Improving trends in surface and/or bottom total nitrogen were detected in all segments of the James River. Improving trends in surface and bottom dissolved inorganic nitrogen were detected in all mainstem segments of the James River basin except for the James River Mouth (JMSPH). The status of surface and bottom total phosphorus varied in all portions of the James River while dissolved inorganic phosphorus

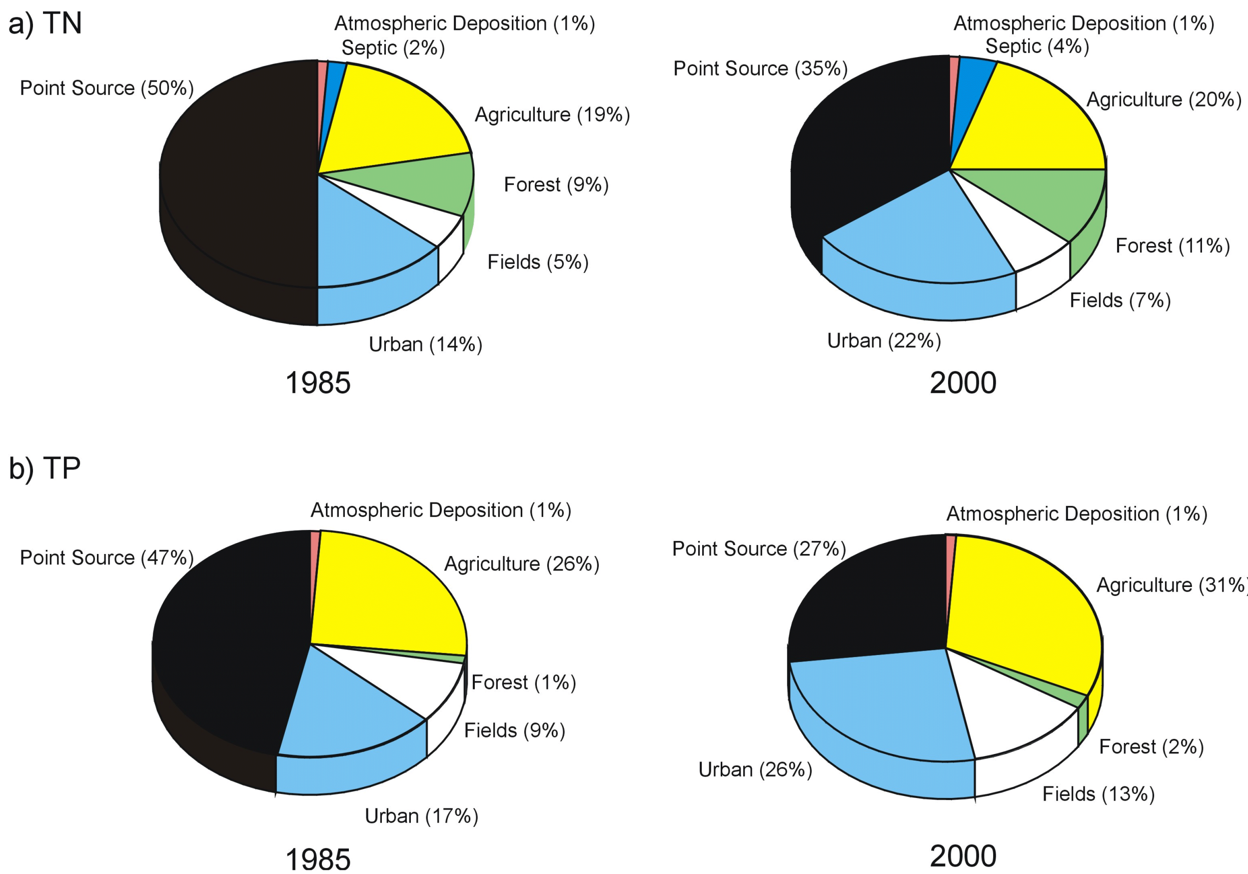


Figure 4. 1985 and 2000 a) total nitrogen and b) total phosphorus contribution to the James River by source.

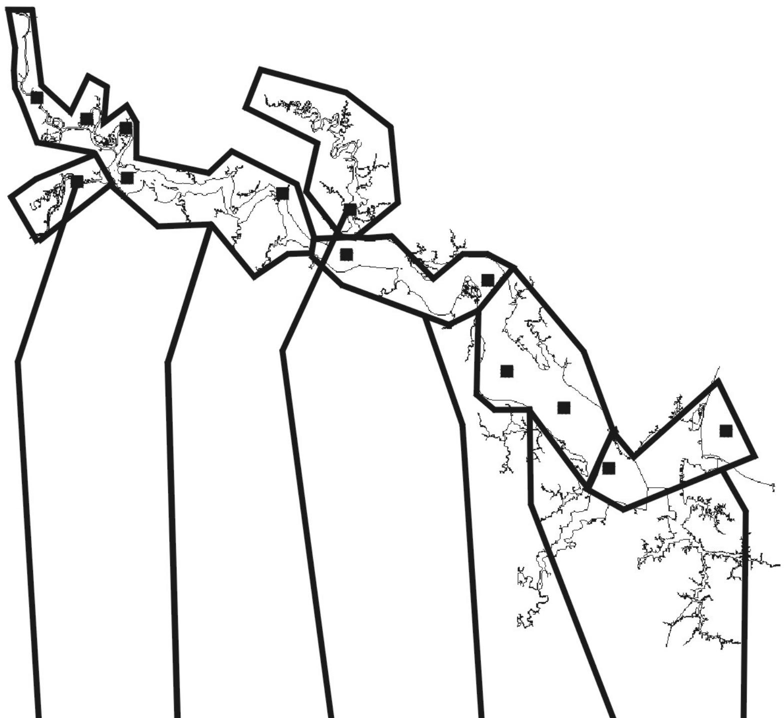
declined from good to poor along the length of the river towards the river mouth. Improving trends in either surface or surface and bottom total phosphorus were detected in all segments of the James River. Improving trends in either surface or surface and bottom dissolved inorganic phosphorus were detected in all segments of the James River except for the Chickahominy River (CHKOH) and the Middle James River (JMSOH). The status of surface chlorophyll *a* ranged from good to poor in the mainstem of the James River and was poor in both the Appomattox River (APPTF) and Chickahominy River (CHKOH). The status of surface and bottom total suspended solids was either fair or poor in all segments of the James River basin. Degrading trends in surface total suspended solids were detected in the Chickahominy River (CHKOH) and the polyhaline segment of the James River (JMSPH). Degrading trends in bottom total suspended solids were detected in the Chickahominy River (CHKOH) and in the Lower James River (JMSMH). The status for water clarity was fair in the Appomattox River and the tidal freshwater portion of the James River (JMSTF), good in the Chickahominy River (CHKOH) and the Middle James River (JMSOH) and poor in the Lower James River (JMSMH) and the James River Mouth (JMSPH).

A degrading trend in water clarity was detected at the mouth of James River (JMSPH). The status of bottom dissolved oxygen was good in all segments of the James River and an improving trend in bottom dissolved oxygen was detected in the Upper James River (JMSTF).

Long-term trend and status analysis results for water quality are summarized for all segments in the Elizabeth River in Figures 7 and 8. The status for most parameter segment combinations within the Elizabeth River basin was poor. However, the status of bottom dissolved oxygen was classified as good in all segments of the Elizabeth River basin except for the Southern Branch (segment SBEMH) for which the status was fair. Improving trends in surface and bottom total nitrogen and dissolved inorganic nitrogen were detected in nearly all segments of the Elizabeth River. Improving trends in surface and bottom total phosphorus and dissolved inorganic phosphorus were detected in all segments of the Elizabeth River. Improving trends in bottom dissolved oxygen were detected in all segments of the Elizabeth River except for the Eastern Branch and the Elizabeth River mouth (segment ELIPH). An mproving trend in surface chlorophyll *a* was detected in the Western Branch (WBEMH) of the Elizabeth River. A degrading trend in water clarity was detected in the Elizabeth River mouth (ELIPH). A decreasing trend in surface salinity was detected in the Elizabeth River Mouth (ELIPH).

Long-term trend and status analysis results for living resources are summarized for all stations in James River in Figures 9 through 12. Long term trends indicate a general pattern of increased phytoplankton abundance and biomass. Contributing to this increase are a combination of favorable and unfavorable categories of algae. In general diatoms, chlorophytes, and cryptophytes represent the more favorable components that show increased biomass, but these are accompanied by the less favorable increase of cyanobacteria abundance. Also, less favorable is the poor status associated with the dinoflagellates and cyanobacteria. However, the procaryote to eukaryote ratio shows no significant change, with improvement indicated in the biomass to abundance ratio. Within the river there were no significant changes in species diversity, with a general pattern of a decreasing trend in productivity, possibly associated with increased suspended solids in the system. The floral

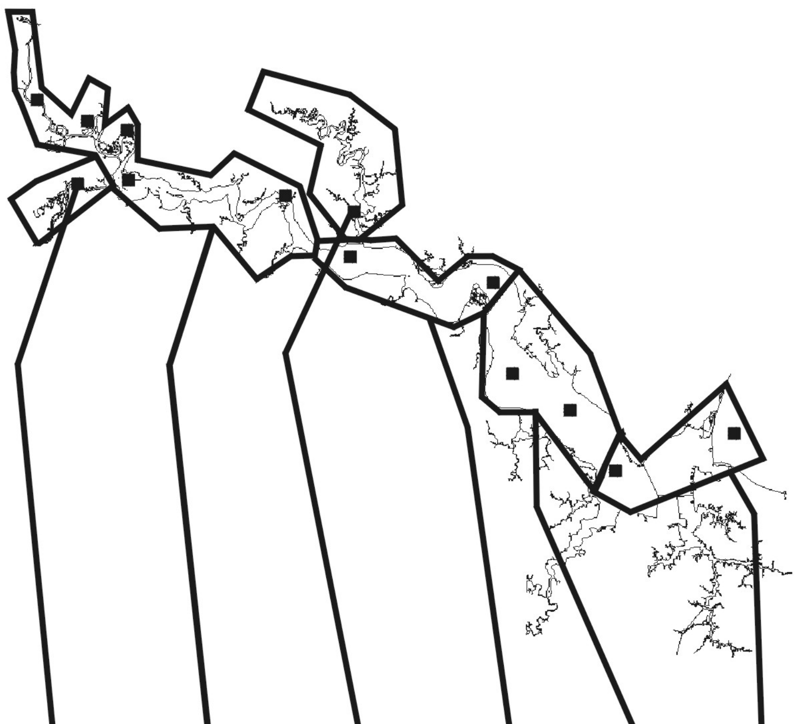
Status (1998 to 2000)	Trends (1985 to 2000)
○ Good	▲ Increasing (Degrading)
◐ Fair	△ Increasing (Improving)
● Poor	▽ Decreasing (Improving)
	▼ Decreasing (Degrading)
	NS Not significant
	* Season specific trend



Parameter	Appomatox	Upper James	Chickahominy	Middle James	Lower James	River Mouth
STN	○ ▽	○ ▽	○ ▽	○ ▽	○ ▽	◐ ▽
BTN	○ ▽	○ ▽	○ ▽	○ ▽	○ ▽	◐ NS
SDIN	○ NS	○ ▽	○ NS	○ ▽	○ ▽	◐ NS
BDIN	○ NS	○ ▽	○ NS	○ ▽	○ ▽	◐ NS
STP	◐ ▽	○ ▽	○ NS	○ ▽	● ▽	● ▽
BTP	◐ ▽	◐ ▽	○ NS	◐ NS	● NS	● ▽
SDIP	○ ▽	◐ ▽	◐ NS	● NS	● ▽	● ▽
BDIP	○ ▽	◐ ▽	◐ NS	● NS	● ▽	◐ ▽

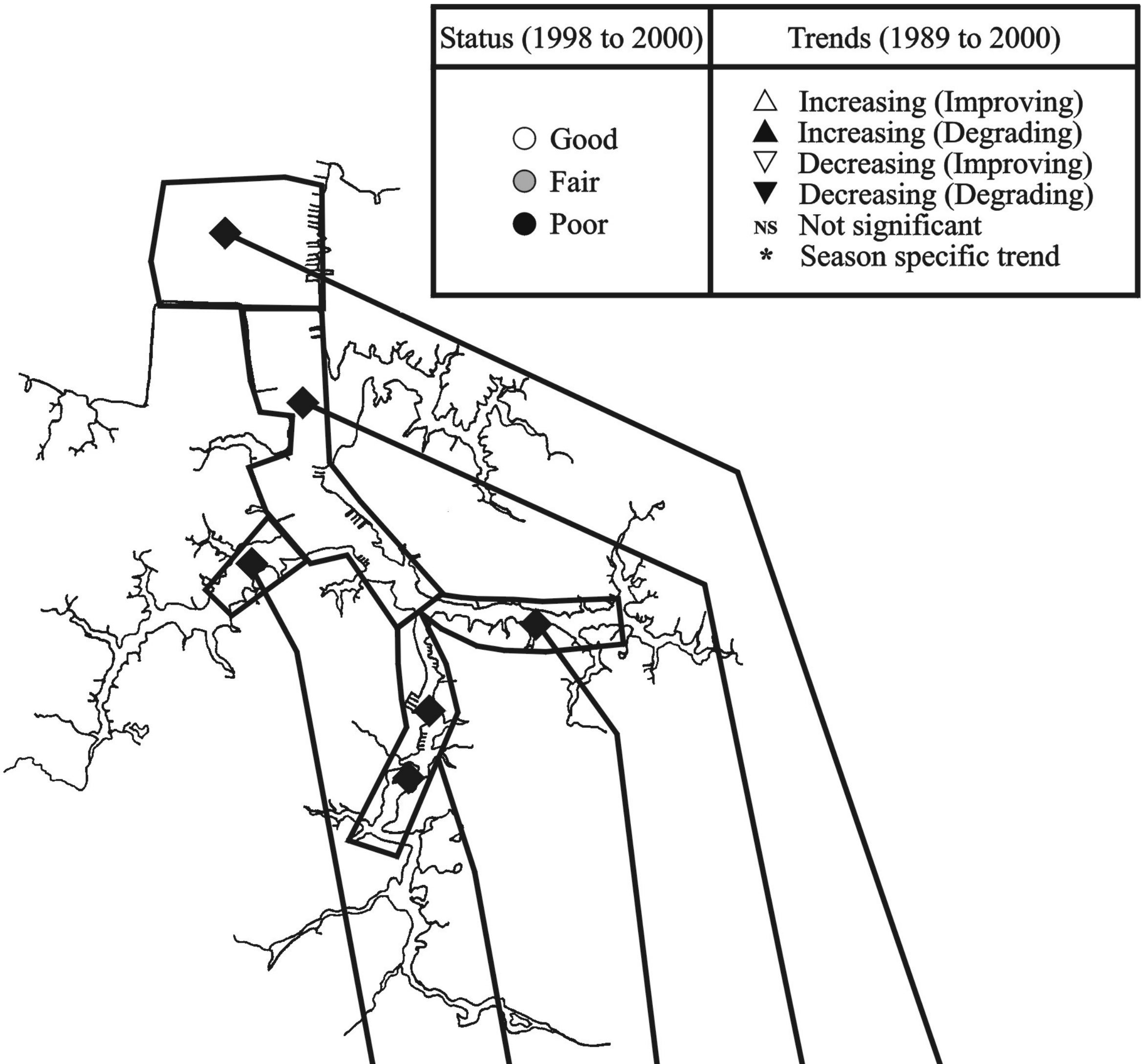
Figure 5. Map of the James River basin showing summaries of the status and trend analyses for each segment. Abbreviations for each parameter are: TN=total nitrogen: DIN=dissolved inorganic nitrogen; TP=total phosphorus; DIP=dissolved inorganic nitrogen. The prefixes S and B refer to surface and bottom measurements, respectively.

Status (1998 to 2000)	Trends (1985 to 2000)
○ Good	▲ Increasing (Degrading)
Fair	△ Increasing (Improving)
● Poor	▽ Decreasing (Improving)
	▼ Decreasing (Degrading)
	NS Not significant
	* Season specific trend



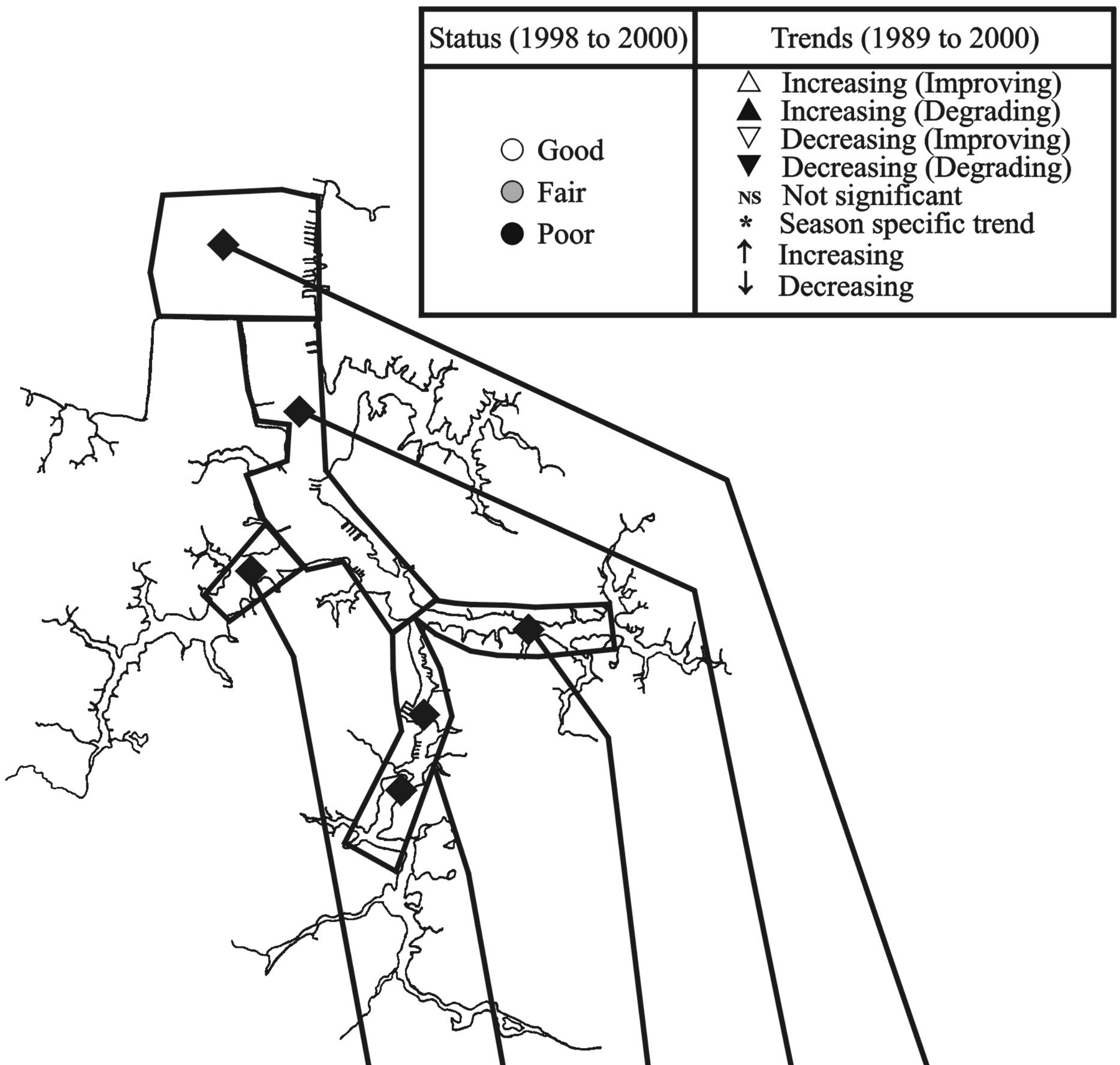
Parameter	Appomattox		Upper James		Chickahominy		Middle James		Lower James		River Mouth	
SCHLA	Poor	NS	Poor	NS	Poor	NS	Good	NS	Good	NS	Poor	NS
STSS	Poor	NS	Fair	NS	Fair	▲	Fair	▽	Poor	NS	Fair	▲
BTSS	Fair	NS	Poor	NS	Fair	▲	Poor	NS	Poor	▲	Fair	NS
SECCHI	Fair	NS	Fair	NS	Good	NS	Good	NS	Poor	NS	Poor	▼
BDO	Good	NS	Good	△	Good	NS	Good	NS	Good	NS	Good	NS
SWTEMP		NS		NS		NS		NS		NS		NS
BWTEMP		NS		NS		NS		NS		NS		NS
SSALIN		NS		NS		NS		NS		NS		NS
BSALIN		NS		NS		NS		NS		NS		↓

Figure 6. Map of the James River basin showing summaries of the status and trend analyses for each segment. Abbreviations for each parameter are: CHLA=chlorophyll a: TSS=total suspended solids; SECCHI=secchi depth; DO=dissolved oxygen; WTEMP=water temperature, SALIN=salinity. The prefixes S and B refer to surface and bottom measurements, respectively.



Parameter	Western Branch		Southern Branch		Eastern Branch		Elizabeth River Mainstem		Elizabeth River Mouth	
STN	○	▽	●	▽	◐	▽	○	NS	●	▽
BTN	○	▽	●	NS	○	▽	○	NS	●	▽
SDIN	○	▽	●	▽	●	▽	◐	▽	●	▽
BDIN	○	▽	●	▽	●	▽	○	▽	●	▽
STP	●	▽	●	▽	◐	▽	●	▽	●	▽
BTP	◐	▽	●	▽	●	▽	●	▽	●	▽
SDIP	●	▽	●	▽	●	▽	●	▽	●	▽
BDIP	●	▽	●	▽	●	▽	●	▽	●	▽

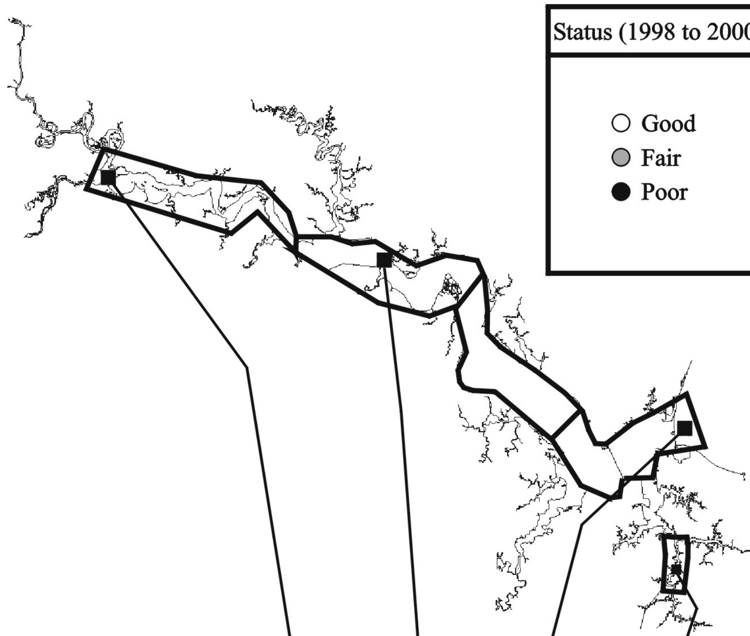
Figure 7. Map of the Elizabeth River basin showing summaries of the status and trend analyses for each segment. Abbreviations for each parameter are: TN=total nitrogen: DIN=dissolved inorganic nitrogen; TP=total phosphorus; DIP=dissolved inorganic nitrogen. The prefixes S and B refer to surface and bottom measurements, respectively.



Parameter	Western Branch		Southern Branch		Eastern Branch		Elizabeth River Mainstem		Elizabeth River Mouth	
SCHLA	◍	▽	○	NS	○	NS	○	NS	●	NS
STSS	●	NS	◍	NS	◍	NS	●	NS	◍	NS
BTSS	●	NS	○	NS	◍	NS	●	NS	●	NS
SECCHI	●	NS	●	NS	●	NS	●	NS	●	▼
BDO	○	△	◍	△	○	NS	○	△	○	NS
SWTEMP		NS		NS		NS		NS		NS
BWTEMP		NS		↑		NS		NS		NS
SSALIN		NS		NS		NS		NS		↓
BSALIN		NS		NS		NS		NS		NS

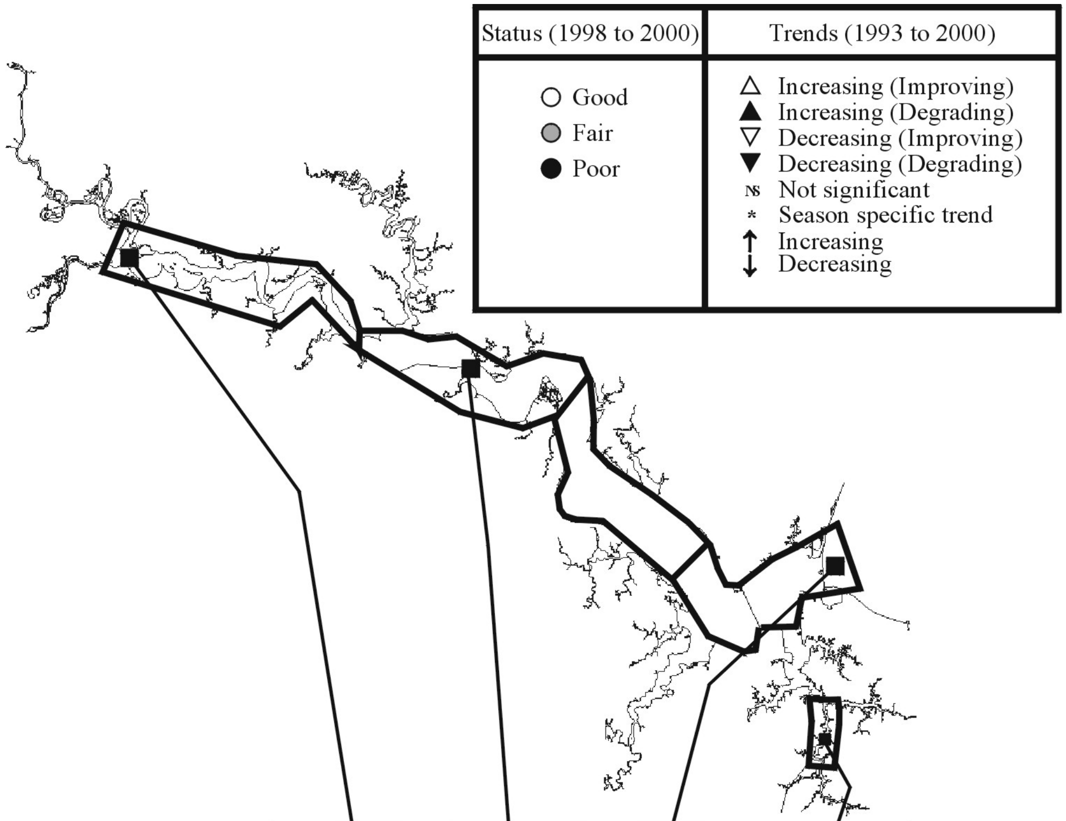
Figure 8. Map of the Elizabeth River basin showing summaries of the status and trend analyses for each segment. Abbreviations for each parameter are: CHLA=chlorophyll a: TSS=total suspended solids; SECCHI=secchi depth; DO=dissolved oxygen; WTEMP=water temperature, SALIN=salinity. The prefixes S and B refer to surface and bottom measurements, respectively.

Status (1998 to 2000)	Trends (1985 to 2000)
○ Good ◍ Fair ● Poor	△ Increasing (Improving) ▲ Increasing (Degrading) ▽ Decreasing (Improving) ▼ Decreasing (Degrading) NS Not significant * Season specific trend ↓ Decreasing ↑ Increasing



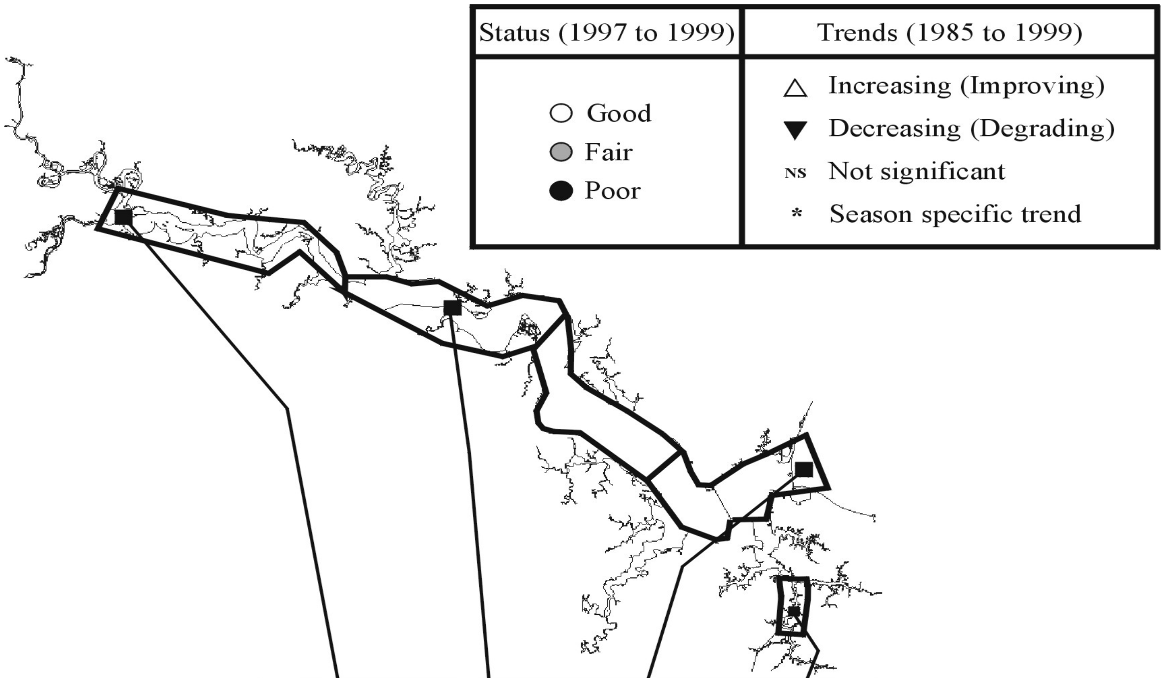
	TF5.5	RET5.2	LE5.5	SBE5
Total Abundance	↑	↑	↑*	↑
Total Biomass	◍ ↑	◍ ↑	◍ NS	● NS
Biomass to Abundance	● △	● △	● NS	● ▼
Margalef Diversity Index	○ NS	○ NS	○ NS	○ NS
Productivity	● NS	◍ ▽*	● ▽	○ ▽
Diatom Biomass	◍ △	◍ NS	◍ △*	◍ △
Dinoflagellate Biomass	● NS	● NS	● NS	○ ▽
Cyanophyte Biomass	● NS	◍ NS	● ▲	◍ ▲
Chlorophyte Biomass	○ △	○ △	○ △	○ △
Picoplankton Biomass	● NS	◍ ▽	◍ NS	○ ▽
Cryptophyte Biomass	△	△	NS	NS
Procaryote to Eucaryote Biomass	○ NS	○ NS	○ NS	○ NS
Cyanophyte Abundance	▲	▲	▲	▲

Figure 9. Map of the James River basin showing summaries of the status and trend analyses for phytoplankton bioindicators for each segment.



	TF5.5	RET5.2	LE5.5	SBE5
Total Abundance	NS	NS	NS	↓
Total Biomass	NS	NS	NS	↓
Copepod Nauplii Abundance	○ NS	○ NS	○ ▼	● ▼
Rotifer Abundance	● ▲	◍ NS	● ▲	○ NS
Oligotrich Abundance	NS	NS	NS	↓
Cladoceran Abundance	NS	NS	NS	NS
Tintinnid Abundance	NS	NS	NS	↓
Polychaeta Larvae Abundance	NS	NS	↓	↓

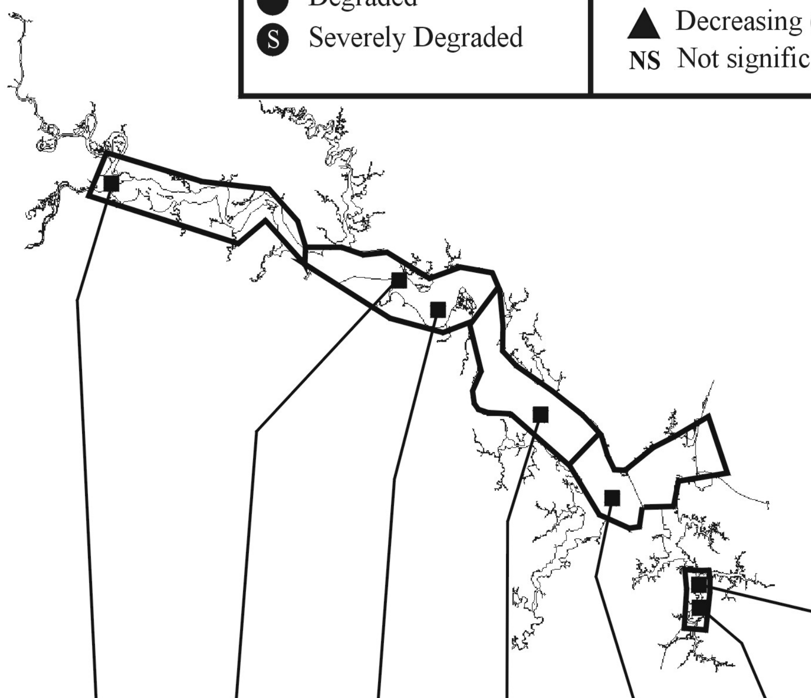
Figure 10. Map of the James River basin showing summaries of the status and trend analyses for microzooplankton bioindicators for each segment.



	TF5.5	RET5.2	LE5.5	SBE5
Total Abundance	○ **NS**	◍ **NS**	● ▼	● △
Margalef Diversity Index	○ △	○ △	○ ▼	◍ ▼
Shannon Wiener Index	○ **NS**	○ △	◍ ▼	◍ ▼
Holoplankton Abundance	**NS**	**NS**	▼	△
Meroplankton Abundance	**NS**	**NS**	▼	**NS**
Calanoid Abundance	△	**NS**	▼	△
Cyclopoid Abundance	**NS**	**NS**	▼	**NS**
Cladoceran Abundance	**NS**	**NS**	▼	**NS**
Crab Zoea Abundance	**NS**	**NS**	▼	**NS**
Acartia tonsa	▼	▼*	▼	△
Eurytemora spp.	**NS**	**NS**	**NS**	**NS**
Bosmina longirostis	**NS**	**NS**	**NS**	**NS**

Figure 11. Map of the James River basin showing summaries of the status and trend analyses for mesozooplankton bioindicators for each segment.

Status (1998 to 2000)	Trends (1985 to 2000)
○ Meets Goals	▽ Increasing (Improving)
◍ Marginal	△ Decreasing (Improving)
● Degraded	▼ Increasing (Degrading)
Ⓢ Severely Degraded	▲ Decreasing (Degrading)
	NS Not significant



	TF5.5	RET5.2	LE5.1	LE5.2	LE5.4	SBE5	SBE2
Benthic IBI	○ △	◍ △	◍ NS	○ NS	○ NS	● △	● NS
Total Abundance	△	NS	NS	NS	NS	NS	△
Total Biomass	NS	NS	NS	NS	▼	NS	NS
Pollution Sensitive Species Abundance (%)	△	△	NS	△	NS	△	△
Pollution Indicative Species Abundance (%)	▽	NS	NS	NS	▽	▽	NS
Pollution Sensitive Species Biomass (%)	△	NS	NS	NS	NS	△	△
Pollution Indicative Species Biomass (%)	NS	NS	NS	NS	▽	▽	NS
Shannon-Weiner Diversity Index	NS	△	NS	NS	NS	△	NS

Figure 12. Map of the James River basin showing summaries of the status and trend analyses for benthic bioindicators for each segment.

composition within this river goes through a transition from predominantly fresh water species to estuarine flora downstream. Upstream the composition is dominated by diatoms, with chlorophytes and cyanobacteria background species, and dinoflagellates less common. Moving downstream, estuarine diatoms (a different composition), dinoflagellates, chlorophytes, and cyanobacteria replace the fresh water forms. The Elizabeth River flora is most similar to that of the lower Chesapeake Bay. Becoming more abundant in the lower reaches of the James River and various inlets are frequent dinoflagellate blooms.

Microzooplankton trends were unchanged from last year with degrading trends in both copepod nauplii abundance and rotifer abundance at the mouth of the James with a degrading trend in rotifer abundance in the tidal fresh segment. The degrading trends in the lower part of the basin were most probably related to the water quality trends evident in the mainstem, such as degrading secchi depth, total suspended solids, and decreased salinity. Microzooplankton status was poor for rotifer abundance and good for copepod nauplii abundance throughout the James River basin. A change in methodology prevents a critical review of the status and trends in the mesozooplankton monitoring results. However, plots of raw data indicate that relative abundances and numbers of species of mesozooplankton were mostly unchanged from last year. The related water quality trends (mostly secchi depth and salinity) have not changed much from last year and therefore it is likely that the general mesozooplankton status and trends did not change much from last year. Therefore, it is likely that mesozooplankton diversity continued to decline in the lower part of the basin while the upper part of the basin should have continued to improve.

Microzooplankton trends for the Elizabeth River were degrading for copepod nauplii and decreasing for most other parameters: total abundance, oligotrich abundance, tintinnid abundance, and polychaeta larvae abundance. Although rotifer abundance status was good, the poor copepod nauplii status and decreasing trends in most microzooplankton parameters reflected the generally poor status of most water quality indices.

Benthic community status in all segments of the James River was good except for station RET5.2 in the Middle James River (JMSOH) where the status was marginal. Improving trends in the B-IBI were detected at station TF5.5 in the Upper James River (JMSTF) and station RET5.1 in the Middle James River (JMSOH). Benthic community status in the Southern Branch (SBEMH) was poor at both station SBE5 and station SBE2. An improving trend in the B-IBI was detected at station SBE5 and was related to improving trends in several metrics measuring community composition including pollution indicative and pollution sensitive species biomass and abundance.

C. Detailed Overview of Status and Trends

1. Fall Line

In the James River, improving trends in flow adjusted concentrations, flow weighted concentrations and loadings of total nitrogen were detected above the fall-line at Cartersville. Improvements in total nitrogen at this station may have been related to improving trends in flow-adjusted concentrations, flow weighted concentrations, and loadings of nitrate-nitrites (whole). Improving trends in total phosphorus and dissolved inorganic phosphorus flow adjusted concentrations and loadings were detected at this station. In addition, an improving trend in flow weighted concentrations of dissolved inorganic phosphorus was detected. Improving trends in flow adjusted concentrations, flow weighted concentrations, loadings of total suspended solids were detected at this station. At Bent Creek degrading trends in flow adjusted and flow weighted concentrations of total Kjeldahl nitrogen were detected while improving trends in flow adjusted concentrations, flow weighted concentrations and loadings of nitrates (whole) and nitrate-nitrites (whole) were detected. Improving trends in flow weighted concentrations and loadings of ammonia (filtered) were detected at this station. In addition, flow adjusted and flow weighted concentrations of total phosphorus were also detected. At Scottsville, improving trends in flow adjusted concentrations, flow weighted concentrations and loadings of nitrates were detected, as well as, flow weighted concentrations and loadings of nitrate-nitrites. Improving trends in loadings of ammonia (filtered) and flow adjusted concentrations of total phosphorus were also detected at this station (Table 1).

In the Appomattox River, improving trends in flow-weighted concentrations of total nitrogen were detected above the fall-line as well as flow weighted and flow adjusted concentrations of nitrate-nitrites (filtered) and dissolved inorganic phosphorus (Table 1).

2. Polyhaline James River (JMSPH - River Mouth)

Water Quality for Living Resources

Degrading trends in surface bottom total suspended solids and water clarity were detected in this segment (Table 2). A decreasing trend in bottom salinity was also detected. Status of all parameters was either fair or poor except for bottom dissolved oxygen which was good. Improving trends were detected in surface total nitrogen, surface and bottom total phosphorus and surface and bottom dissolved inorganic phosphorus (Table 3).

Water Quality for SAV

An improving trend in surface total phosphorus was detected in this segment while degrading trends in surface total suspended solids and secchi depth were also detected (Table 4). Status for all parameters ranged from fair to poor. Although SAV habitat requirements were met for surface dissolved inorganic nitrogen, surface dissolved inorganic phosphorus, and surface chlorophyll *a*, surface total suspended solids and all measures of water clarity (light attenuation and percentage of light at the leaf surface for both 0.5 meters and 1.0 meters) failed to meet the SAV habitat requirements (Table J5).

SAV

SAV area in JMSPH increased from 31.35 ha to 38.13 ha in 2000 and the Tier I goal was achieved.

Living Resources

The trend of increased phytoplankton biomass noted in the 1999 data set was not indicated; however, there was a trend for increased total abundance. This change in the biomass trend was accompanied by a status change for the category from poor to fair, with the biomass to abundance ratio remaining poor. The diatom and chlorophyte biomass showed favorable increasing trends, but these were countered by increased trends in the biomass and abundance of the cyanobacteria. The diatom status remained fair, and the dinoflagellates still had poor status.

Uniform degrading trends continued for this segment for the two major microzooplankton parameters with decreasing copepod nauplii abundance and increasing rotifer abundance. This was probably reflective of degrading trends in water quality parameters.

Benthic community status was good with no trend in the B-IBI.

Table 1 - Water quality trends at James RIM stations 2026000 (James River at Bent Creek) 2029000 (James River at Scottsville), 2035000 (James River at Cartersville), 2041650 (Appomattox River at Matoaca). A "*" next to the parameter name indicates the parameter was not log-transformed prior to analysis. In the Data Type column, FAC refers to flow adjusted concentrations, FWC refers to flow weighted concentrations, and LOAD refers to loadings.

Station Name	Parameter	Data Type	Baseline	Status	Slope	%Change	pValue	Direction
James River at Cartersville	TN	FAC	--	--	-0.016	-18.00	0.0014	IMPROVING
James River at Cartersville	TN	FWC	0.577	1.209	-0.034	-31.24	0.0001	IMPROVING
James River at Cartersville	TN	LOAD	1.500	0.882	-0.074	-55.82	0.0008	IMPROVING
James River at Cartersville	NO23F	FAC	--	--	-0.039	-39.00	0.0000	IMPROVING
James River at Cartersville	NO23F*	FWC	0.236	1.111	-0.382	-39.36	0.0001	IMPROVING
James River at Cartersville	NO23F	LOAD	0.620	0.279	-0.111	-70.59	0.0001	IMPROVING
James River at Cartersville	TP	FAC	--	--	-0.056	-50.00	0.0000	IMPROVING
James River at Cartersville	TP	LOAD	0.390	0.147	-0.111	-70.65	0.0001	IMPROVING
James River at Cartersville	DIP	FAC	--	--	-0.091	-68.00	0.0000	IMPROVING
James River at Cartersville	DIP*	FWC	0.139	0.074	-0.107	-46.30	0.0001	IMPROVING
James River at Cartersville	DIP	LOAD	0.300	0.063	-0.112	-70.89	0.0001	IMPROVING
James River at Cartersville	TSS	FAC	--	--	-0.03	-28.00	0.0075	IMPROVING
James River at Cartersville	TSS	FWC	15.48	29.43	-0.11	-69.28	0.0009	IMPROVING
James River at Cartersville	TSS	LOAD	41.30	19.85	-0.15	-80.26	0.0015	IMPROVING
James River at Cartersville	FLOW	FLOW	5060.00	4341.50	-0.04	-35.75	0.0065	IMPROVING
James River at Bent Creek	TKNW	FAC	--	--	0.027	53.00	0.0000	DEGRADING
James River at Bent Creek	TKNW	FWC	0.237	0.387	0.026	48.05	0.0001	DEGRADING
James River at Bent Creek	TNH4F	FWC	0.113	0.036	-0.042	-46.61	0.0001	IMPROVING
James River at Bent Creek	TNH4F	LOAD	0.252	0.068	-0.047	-50.58	0.0001	IMPROVING
James River at Bent Creek	NO3W	FAC	--	--	-0.065	-64.00	0.0000	IMPROVING
James River at Bent Creek	NO3W	FWC	0.312	0.161	-0.066	-62.87	0.0001	IMPROVING
James River at Bent Creek	NO3W	LOAD	0.623	0.268	-0.071	-65.63	0.0001	IMPROVING
James River at Bent Creek	NO23W	FAC	--	--	-0.065	-65.00	0.0000	IMPROVING
James River at Bent Creek	NO23W	FWC	0.242	0.125	-0.066	-62.79	0.0001	IMPROVING
James River at Bent Creek	NO23W	LOAD	0.436	0.232	-0.071	-65.55	0.0001	IMPROVING
James River at Bent Creek	TP	FAC	--	--	-0.075	-70.00	0.0000	IMPROVING
James River at Bent Creek	TP	FWC	0.229	0.095	-0.075	-67.74	0.0001	IMPROVING
James River at Scottsville	TNH4F	LOAD	0.230	0.053	-0.074	-67.05	0.0001	IMPROVING
James River at Scottsville	NO3W	FAC	--	--	-0.043	-50.00	0.0001	IMPROVING
James River at Scottsville	NO3W	FWC	0.337	0.184	-0.044	-48.67	0.0001	IMPROVING
James River at Scottsville	NO3W	LOAD	0.733	0.374	-0.047	-50.69	0.0014	IMPROVING
James River at Scottsville	NO23W	FWC	0.345	0.122	-0.043	-47.43	0.0001	IMPROVING
James River at Scottsville	NO23W	LOAD	0.748	0.256	-0.046	-49.50	0.0085	IMPROVING
James River at Scottsville	TP	FAC	--	--	-0.065	-65.00	0.0000	IMPROVING
Appomattox River at Matoaca	TN*	FWC	0.593	1.404	-0.133	-7.09	0.0009	IMPROVING
Appomattox River at Matoaca	NO23F	FAC	--	--	-0.019	-20.00	0.0222	IMPROVING
Appomattox River at Matoaca	NO23F	FWC	0.179	0.395	-0.018	-16.20	0.0002	IMPROVING
Appomattox River at Matoaca	DIP	FAC	--	--	-0.021	-21.00	0.0047	IMPROVING
Appomattox River at Matoaca	DIP*	FWC	0.013	0.083	-0.007	-15.81	0.0003	IMPROVING

Table 2 -Water quality trends in segment JMSPH (only significant trends are displayed).

Segment	Parameter	Season	Layer	Slope	%Change	pValue	Direction
JMSPH	TN	ANNUAL	S	-0.0053	-0.180	0.002	IMPROVING
JMSPH	TP	SUMMER2	S	-0.0014	-0.367	0.002	IMPROVING
JMSPH	TP	SUMMER1	S	-0.0011	-0.307	0.001	IMPROVING
JMSPH	TP	ANNUAL	S	-0.0012	-0.366	<0.001	IMPROVING
JMSPH	TP	ANNUAL	B	-0.0013	-0.331	<0.001	IMPROVING
JMSPH	TP	SUMMER1	B	-0.0014	-0.346	<0.001	IMPROVING
JMSPH	TP	SUMMER2	B	-0.0016	-0.395	0.001	IMPROVING
JMSPH	PO4F	ANNUAL	S	-<0.0015	.	<0.001	IMPROVING
JMSPH	PO4F	SUMMER1	S	-0.0013	-0.904	<0.001	IMPROVING
JMSPH	PO4F	SUMMER2	S	-0.0016	-0.975	<0.001	IMPROVING
JMSPH	PO4F	SUMMER2	B	-0.0016	-0.861	<0.001	IMPROVING
JMSPH	PO4F	ANNUAL	B	-<0.0013	.	<0.001	IMPROVING
JMSPH	PO4F	SUMMER1	B	-0.0013	-0.770	<0.001	IMPROVING
JMSPH	CHLA	SUMMER1	S	0.4132	1.668	<0.001	DEGRADING
JMSPH	CHLA	SUMMER2	S	0.4807	1.998	<0.001	DEGRADING
JMSPH	CHLA	ANNUAL	B	0.1823	0.430	0.009	DEGRADING
JMSPH	CHLA	SUMMER2	B	0.4979	1.879	<0.001	DEGRADING
JMSPH	CHLA	SUMMER1	B	0.4660	1.383	<0.001	DEGRADING
JMSPH	SECCHI	SPRING2	S	-0.0200	-0.267	0.009	DEGRADING
JMSPH	SECCHI	ANNUAL	S	-0.0200	-0.249	<0.001	DEGRADING
JMSPH	SECCHI	SUMMER2	S	-0.0250	-0.323	<0.001	DEGRADING
JMSPH	SECCHI	SUMMER1	S	-0.0250	-0.323	<0.001	DEGRADING
JMSPH	TSS	ANNUAL	S	0.2040	0.396	<0.001	DEGRADING
JMSPH	TSS	SPRING2	S	0.4181	0.693	0.010	DEGRADING
JMSPH	PLL05	SUMMER1	S	-0.0055	-0.304	0.003	DEGRADING
JMSPH	PLL05	SPRING2	S	-0.0067	-0.352	0.004	DEGRADING
JMSPH	PLL10	SUMMER2	S	-0.0042	-0.415	0.009	DEGRADING
JMSPH	PLL10	SUMMER1	S	-0.0055	-0.541	<0.001	DEGRADING
JMSPH	PLL10	SPRING2	S	-0.0055	-0.480	0.002	DEGRADING
JMSPH	SALINITY	SUMMER2	S	-0.2199	-0.146	0.005	DECREASING
JMSPH	SALINITY	SUMMER1	S	-0.2176	-0.149	0.002	DECREASING
JMSPH	SALINITY	SUMMER1	B	-0.2038	-0.129	0.006	DECREASING
JMSPH	SALINITY	SUMMER2	B	-0.2260	-0.140	0.009	DECREASING
JMSPH	SALINITY	ANNUAL	B	-0.1910	-0.123	<0.001	DECREASING

Table 3 - Water quality status in segment JMSPH (value is the median concentration, secchi in meters, chlorophyll *a* in μg per l, all other parameters in mg per l.).

Segment	Parameter	Season	S Value	S Score	S Status	B Value	B Score	B Status
JMSPH	CHLA	ANNUAL	8.73	64.2	POOR	-	-	-
JMSPH	CHLA	SPRING1	7.89	39.2	GOOD	-	-	-
JMSPH	CHLA	SPRING2	9.05	58.6	POOR	-	-	-
JMSPH	CHLA	SUMMER1	12.43	83.5	POOR	-	-	-
JMSPH	CHLA	SUMMER2	12.49	81.0	POOR	-	-	-
JMSPH	DIN	ANNUAL	0.050	55.4	FAIR	0.043	42.1	FAIR
JMSPH	DIN	SPRING1	0.050	66.2	POOR	0.049	70.9	POOR
JMSPH	DIN	SPRING2	0.036	67.3	POOR	0.049	63.3	POOR
JMSPH	DIN	SUMMER1	0.033	48.0	FAIR	0.035	15.6	GOOD
JMSPH	DIN	SUMMER2	0.033	65.3	POOR	0.040	10.7	GOOD
JMSPH	DO	SPRING1	-	-	-	8.27	-	GOOD
JMSPH	DO	SPRING2	-	-	-	7.77	-	GOOD
JMSPH	DO	SUMMER1	-	-	-	6.32	-	GOOD
JMSPH	DO	SUMMER2	-	-	-	6.24	-	GOOD
JMSPH	PO4F	ANNUAL	0.009	72.1	POOR	0.009	60.0	FAIR
JMSPH	PO4F	SPRING1	0.008	49.5	FAIR	0.007	52.1	FAIR
JMSPH	PO4F	SPRING2	0.008	48.3	FAIR	0.008	46.1	FAIR
JMSPH	PO4F	SUMMER1	0.012	67.5	POOR	0.016	41.6	FAIR
JMSPH	PO4F	SUMMER2	0.017	69.5	POOR	0.018	32.7	GOOD
JMSPH	SECCHI	ANNUAL	1.05	12.9	POOR	-	-	-
JMSPH	SECCHI	SPRING1	1.05	8.3	POOR	-	-	-
JMSPH	SECCHI	SPRING2	1.00	5.0	POOR	-	-	-
JMSPH	SECCHI	SUMMER1	0.98	10.7	POOR	-	-	-
JMSPH	SECCHI	SUMMER2	1.05	11.6	POOR	-	-	-
JMSPH	TN	ANNUAL	0.431	41.7	FAIR	0.451	48.1	FAIR
JMSPH	TN	SPRING1	0.436	44.4	FAIR	0.462	48.5	FAIR
JMSPH	TN	SPRING2	0.436	43.2	FAIR	0.414	48.0	FAIR
JMSPH	TN	SUMMER1	0.448	42.5	FAIR	0.471	47.8	FAIR
JMSPH	TN	SUMMER2	0.447	42.2	FAIR	0.478	45.8	FAIR
JMSPH	TP	ANNUAL	0.041	77.5	POOR	0.048	62.1	POOR
JMSPH	TP	SPRING1	0.036	80.9	POOR	0.047	63.8	POOR
JMSPH	TP	SPRING2	0.041	85.7	POOR	0.047	73.8	POOR
JMSPH	TP	SUMMER1	0.052	78.1	POOR	0.060	67.0	POOR
JMSPH	TP	SUMMER2	0.055	76.8	POOR	0.062	62.6	POOR
JMSPH	TSS	ANNUAL	10.81	58.3	FAIR	22.37	50.1	FAIR
JMSPH	TSS	SPRING1	15.13	73.0	POOR	23.02	67.9	POOR
JMSPH	TSS	SPRING2	15.13	71.8	POOR	24.90	70.6	POOR
JMSPH	TSS	SUMMER1	11.89	61.8	POOR	25.48	52.2	FAIR
JMSPH	TSS	SUMMER2	10.78	60.9	POOR	26.05	46.5	FAIR

Table 4 - SAV Season Water quality trends in segment JMSPH (only significant trends are displayed).

Segment	Parameter	Season	Layer	Slope	%Change	pValue	Direction
JMSPH	TP	SAV2	S	-0.0010	-0.317	0.000	**IMPROVING**
JMSPH	TSS	SAV2	S	0.3668	0.857	0.001	**DEGRADING**
JMSPH	SECCHI	SAV2	S	-0.0211	-0.250	0.001	**DEGRADING**

Table 5 - SAV season water quality status in segment JMSPH (value is the median concentration; secchi in meters, chlorophyll *a* in μg per l, all other parameters in mg per l.).

Segment	Parameter	Status Value	Score	Status	SAV Goal Value	Habitat Requirement
JMSPH	TN	0.4465	44.3	**FAIR**	-	-
JMSPH	DIN	0.0812	70.8	**POOR**	0.0850	**MEETS**
JMSPH	TP	0.0432	78.4	**POOR**	-	-
JMSPH	PO4F	0.0112	80.7	**POOR**	0.0140	**MEETS**
JMSPH	CHLA	7.1389	45.5	**FAIR**	6.2	**MEETS**
JMSPH	SECCHI	1.05	11.5	**POOR**	-	-
JMSPH	TSS	12.925	64.4	**POOR**	11.0	**BORDERLINE**
JMSPH	KD	-	-	-	1.30	**BORDERLINE**
JMSPH	PLL05	-	-	-	0.211	**BORDERLINE**
JMSPH	PLL10	-	-	-	0.114	**BORDERLINE**

3. Mesohaline James River (JMSMH - Lower James)

Water Quality for Living Resources

Improving trends in surface and bottom total nitrogen and dissolved inorganic nitrogen were detected, as were improving trends in surface total phosphorus and surface and bottom dissolved inorganic phosphorus. A degrading trend was detected for bottom total suspended solids (Table J6). Status was good for surface and bottom total nitrogen, surface and bottom dissolved inorganic nitrogen, surface chlorophyll *a* and summer bottom dissolved oxygen, and poor for surface and bottom total phosphorus, surface and bottom dissolved inorganic phosphorus, surface and bottom total suspended solids and water clarity (Table 7).

Water Quality for SAV

Improving trends in surface total nitrogen, surface dissolved inorganic nitrogen, and surface dissolved inorganic phosphorus were detected in this segment (Table 8). Status for most parameters was poor except for surface total nitrogen and surface chlorophyll *a* which was good and surface dissolved inorganic nitrogen which was fair. The SAV habtitat requirements for surface dissolved inorganic nitrogen and surface chlorophyll *a* concentrations were met while the remaining parameters either failed to meet the SAV requirements or were borderline (Table 9).

SAV

SAV area in this segment decreased from 1.15 ha in 1999 to 0.97 ha in 2000. The Tier I goal has not been established for this segment.

Living Resources

Phytoplankton and zooplankton monitoring is not conducted within this segment..

Benthic community status at station LE5.2 was good with no trend in the B-IBI.

Table 6 -Water quality trends in segment JMSMH (only significant trends are displayed).

Segment	Parameter	Season	Layer	Slope	%Change	pValue	Direction
JMSMH	TN	SUMMER1	S	-0.0159	-0.424	<0.001	IMPROVING
JMSMH	TN	SPRING2	S	-0.0167	-0.475	0.001	IMPROVING
JMSMH	TN	SPRING1	S	-0.0257	-0.605	<0.001	IMPROVING
JMSMH	TN	SUMMER2	S	-0.0169	-0.444	<0.001	IMPROVING
JMSMH	TN	ANNUAL	S	-0.0215	-0.546	<0.001	IMPROVING
JMSMH	TN	ANNUAL	B	-0.0144	-0.372	<0.001	IMPROVING
JMSMH	TN	SPRING1	B	-0.0150	-0.381	0.009	IMPROVING
JMSMH	TN	SUMMER2	B	-0.0113	-0.304	0.002	IMPROVING
JMSMH	TN	SUMMER1	B	-0.0096	-0.263	0.005	IMPROVING
JMSMH	DIN	ANNUAL	S	-0.0086	-0.734	<0.001	IMPROVING
JMSMH	DIN	ANNUAL	B	-0.0073	.	<0.001	IMPROVING
JMSMH	DIN	SUMMER1	B	-0.0031	.	0.003	IMPROVING
JMSMH	TP	ANNUAL	S	-0.0013	-0.347	<0.001	IMPROVING
JMSMH	PO4F	ANNUAL	S	-0.0012	-0.197	0.005	IMPROVING
JMSMH	PO4F	SUMMER2	S	-0.0013	-0.640	0.004	IMPROVING
JMSMH	PO4F	SUMMER2	B	-0.0010	-0.492	0.001	IMPROVING
JMSMH	PO4F	ANNUAL	B	-0.0011	.	0.002	IMPROVING
JMSMH	PO4F	SUMMER1	B	-0.0017	-0.427	0.001	IMPROVING
JMSMH	TSS	ANNUAL	B	1.1250	0.127	<0.001	DEGRADING
JMSMH	DO	SPRING1	B	-0.0581	-0.107	0.003	DEGRADING

Table 7 - Water quality status in segment JMSMH (value is the median concentration, secchi in meters, chlorophyll *a* in μg per l, all other parameters in mg per l.).

Segment	Parameter	Season	S Value	S Score	S Status	B Value	B Score	B Status
JMSMH	CHLA	ANNUAL	5.18	22.1	GOOD	-	-	-
JMSMH	CHLA	SPRING1	4.54	24.7	GOOD	-	-	-
JMSMH	CHLA	SPRING2	5.18	15.6	GOOD	-	-	-
JMSMH	CHLA	SUMMER1	7.00	18.0	GOOD	-	-	-
JMSMH	CHLA	SUMMER2	7.27	17.0	GOOD	-	-	-
JMSMH	DIN	ANNUAL	0.102	38.4	GOOD	0.079	18.8	GOOD
JMSMH	DIN	SPRING1	0.147	24.6	GOOD	0.144	29.0	GOOD
JMSMH	DIN	SPRING2	0.113	33.4	GOOD	0.102	25.3	GOOD
JMSMH	DIN	SUMMER1	0.072	38.5	GOOD	0.052	9.6	GOOD
JMSMH	DIN	SUMMER2	0.043	29.3	GOOD	0.056	9.9	GOOD
JMSMH	DO	SPRING1	-	-	-	8.03	-	GOOD
JMSMH	DO	SPRING2	-	-	-	6.90	-	GOOD
JMSMH	DO	SUMMER1	-	-	-	6.18	-	GOOD
JMSMH	DO	SUMMER2	-	-	-	6.15	-	GOOD
JMSMH	PO4F	ANNUAL	0.020	92.6	POOR	0.018	84.0	POOR
JMSMH	PO4F	SPRING1	0.019	96.2	POOR	0.014	93.9	POOR
JMSMH	PO4F	SPRING2	0.020	95.1	POOR	0.018	90.9	POOR
JMSMH	PO4F	SUMMER1	0.024	92.1	POOR	0.027	77.6	POOR
JMSMH	PO4F	SUMMER2	0.030	91.7	POOR	0.031	76.9	POOR
JMSMH	SECCHI	ANNUAL	0.90	25.9	POOR	-	-	-
JMSMH	SECCHI	SPRING1	0.70	11.0	POOR	-	-	-
JMSMH	SECCHI	SPRING2	0.60	10.7	POOR	-	-	-
JMSMH	SECCHI	SUMMER1	0.95	35.4	POOR	-	-	-
JMSMH	SECCHI	SUMMER2	0.95	41.2	FAIR	-	-	-
JMSMH	TN	ANNUAL	0.471	10.1	GOOD	0.513	13.6	GOOD
JMSMH	TN	SPRING1	0.530	7.7	GOOD	0.590	13.5	GOOD
JMSMH	TN	SPRING2	0.441	5.5	GOOD	0.551	12.6	GOOD
JMSMH	TN	SUMMER1	0.452	7.3	GOOD	0.519	12.3	GOOD
JMSMH	TN	SUMMER2	0.475	9.7	GOOD	0.526	13.3	GOOD
JMSMH	TP	ANNUAL	0.057	68.9	POOR	0.070	72.4	POOR
JMSMH	TP	SPRING1	0.061	79.9	POOR	0.073	80.1	POOR
JMSMH	TP	SPRING2	0.056	72.1	POOR	0.073	79.6	POOR
JMSMH	TP	SUMMER1	0.064	56.9	FAIR	0.078	77.0	POOR
JMSMH	TP	SUMMER2	0.065	57.4	FAIR	0.078	74.6	POOR
JMSMH	TSS	ANNUAL	12.75	70.0	POOR	31.00	83.7	POOR
JMSMH	TSS	SPRING1	20.00	89.5	POOR	52.00	93.9	POOR
JMSMH	TSS	SPRING2	18.25	85.9	POOR	59.50	94.1	POOR
JMSMH	TSS	SUMMER1	11.50	61.1	POOR	31.25	85.2	POOR
JMSMH	TSS	SUMMER2	11.75	58.8	POOR	31.50	84.7	POOR

Table 8 - SAV Season Water quality trends in segment JMSMH (only significant trends are displayed).

Segment	Parameter	Season	Layer	Slope	%Change	pValue	Direction
JMSMH	TN	SAV1	S	-0.0165	-0.435	0.000	IMPROVING
JMSMH	DIN	SAV1	S	-0.0053	-0.590	0.002	IMPROVING
JMSMH	PO4F	SAV1	S	-0.0005	-0.346	0.007	IMPROVING

Table 9 - SAV season water quality status in segment JMSMH (value is the median concentration; secchi in meters, chlorophyll *a* in μg per l, all other parameters in mg per l.).

Segment	Parameter	Status Value	Score	Status	SAV Goal Value	Habitat Requirement
JMSMH	TN	0.4425	7.8	GOOD	-	-
JMSMH	DIN	0.0913	48.9	FAIR	0.1130	MEETS
JMSMH	TP	0.0615	66.3	POOR	-	-
JMSMH	PO4F	0.022	93.2	POOR	0.0245	FAILS
JMSMH	CHLA	5.9	16	GOOD	5.7	MEETS
JMSMH	SECCHI	0.9	22.7	POOR	-	-
JMSMH	TSS	13.25	71.1	POOR	14.0	BORDERLINE
JMSMH	KD	-	-	-	1.80	FAILS
JMSMH	PLL05	-	-	-	0.136	BORDERLINE
JMSMH	PLL10	-	-	-	0.054	FAILS

4. Oligohaline James River (JMSOH - Middle James)

Water Quality for Living Resources

Improving trends were detected in surface and bottom total nitrogen and dissolved inorganic nitrogen, as well as surface total phosphorus and surface total suspended solids (Table 10). The status was good for surface and bottom total nitrogen, surface and bottom dissolved inorganic nitrogen and surface total phosphorus. The status of surface and bottom dissolved inorganic phosphorus and bottom total suspended solids was poor. The status of water clarity, bottom dissolved oxygen, surface chlorophyll *a* was good. The status of surface total suspended solids and bottom total phosphorus was fair (Table 11).

Water Quality for SAV

Improving trends in surface total nitrogen and surface dissolved inorganic nitrogen were detected in this segment (Table 12). Status of most parameters was good except for surface dissolved inorganic phosphorus for which status was poor and total suspended solids for which status was fair. SAV habitat requirements were met for surface chlorophyll *a*, borderline for surface dissolved inorganic phosphorus but not met for surface total suspended solids and all measures of water clarity (Table 13).

SAV

No SAV were mapped in this segment during 1999 as a result of the combination of delayed surveys and a salinity-related die-off of freshwater SAV species. There were 3.97 ha of SAV in 2000. The Tier I goal has not been established for this segment.

Living Resources

In comparison to the 1999 survey, there was evidence of improvement among several phytoplankton categories. The status of the total floral biomass and diatom biomass changed from poor to fair, and the chlorophytes from poor to good status. However, the status of the dinoflagellates remained poor, with the cyanobacteria biomass status degrading from good to fair. There were overall trends of increasing total phytoplankton biomass and abundance, along with increasing biomass of cryptophytes and chlorophytes (both favorable), plus cyanobacteria abundance (unfavorable). There were no significant trends in diversity, but a seasonal trend of decreasing productivity.

There were no significant microzooplankton trends for this part of the basin. The status of the major indicators was mixed with poor rotifer abundance and good copepod nauplii abundance. This may reflect the generally poor to fair suspended solid status but good to fair nutrient status of this segment.

Benthic community status was marginal with an improving trend B-IBI at station (RET5.2).

Table 10 -Water quality trends in segment JMSOH (only significant trends are displayed).

Segment	Parameter	Season	Layer	Slope	%Change	pValue	Direction
JMSOH	TN	SPRING2	S	-0.0325	-0.560	<0.001	IMPROVING
JMSOH	TN	SUMMER2	S	-0.0267	-0.527	<0.001	IMPROVING
JMSOH	TN	SPRING1	S	-0.0330	-0.514	<0.001	IMPROVING
JMSOH	TN	ANNUAL	S	-0.0325	-0.523	<0.001	IMPROVING
JMSOH	TN	SUMMER1	S	-0.0290	-0.553	<0.001	IMPROVING
JMSOH	TN	ANNUAL	B	-0.0208	-0.342	<0.001	IMPROVING
JMSOH	DIN	SPRING2	S	-0.0244	-1.111	<0.001	IMPROVING
JMSOH	DIN	SUMMER1	S	-0.0088	.	<0.001	IMPROVING
JMSOH	DIN	SPRING1	S	-0.0226	-0.921	<0.001	IMPROVING
JMSOH	DIN	SUMMER2	S	-0.0045	.	0.008	IMPROVING
JMSOH	DIN	ANNUAL	S	-0.0170	-0.636	<0.001	IMPROVING
JMSOH	DIN	ANNUAL	B	-0.0169	-0.659	<0.001	IMPROVING
JMSOH	DIN	SPRING2	B	-0.0202	-0.912	<0.001	IMPROVING
JMSOH	DIN	SUMMER2	B	-0.0057	.	0.001	IMPROVING
JMSOH	DIN	SUMMER1	B	-0.0091	.	<0.001	IMPROVING
JMSOH	DIN	SPRING1	B	-0.0215	-0.838	<0.001	IMPROVING
JMSOH	TP	ANNUAL	S	-0.0017	-0.357	0.001	IMPROVING
JMSOH	TSS	ANNUAL	S	-0.8000	-0.019	0.010	IMPROVING

Table 11 - Water quality status in segment JMSOH (value is the median concentration, secchi in meters, chlorophyll *a* in μg per l, all other parameters in mg per l.).

Segment	Parameter	Season	S Value	S Score	S Status	B Value	B Score	B Status
JMSOH	CHLA	ANNUAL	8.62	42.3	GOOD	-	-	-
JMSOH	CHLA	SPRING1	17.75	56.2	FAIR	-	-	-
JMSOH	CHLA	SPRING2	8.60	45.3	FAIR	-	-	-
JMSOH	CHLA	SUMMER1	9.30	34.1	GOOD	-	-	-
JMSOH	CHLA	SUMMER2	10.31	31.9	GOOD	-	-	-
JMSOH	DIN	ANNUAL	0.188	19.3	GOOD	0.180	17.3	GOOD
JMSOH	DIN	SPRING1	0.171	4.9	GOOD	0.180	4.9	GOOD
JMSOH	DIN	SPRING2	0.140	8.5	GOOD	0.160	8.8	GOOD
JMSOH	DIN	SUMMER1	0.078	22.0	GOOD	0.108	24.4	GOOD
JMSOH	DIN	SUMMER2	0.059	13.0	GOOD	0.084	19.6	GOOD
JMSOH	DO	SPRING1	-	-	-	9.10	-	GOOD
JMSOH	DO	SPRING2	-	-	-	7.12	-	GOOD
JMSOH	DO	SUMMER1	-	-	-	6.55	-	GOOD
JMSOH	DO	SUMMER2	-	-	-	6.45	-	GOOD
JMSOH	PO4F	ANNUAL	0.021	71.4	POOR	0.021	72.4	POOR
JMSOH	PO4F	SPRING1	0.014	57.1	FAIR	0.013	59.6	POOR
JMSOH	PO4F	SPRING2	0.016	63.8	POOR	0.017	66.7	POOR
JMSOH	PO4F	SUMMER1	0.026	74.5	POOR	0.027	74.8	POOR
JMSOH	PO4F	SUMMER2	0.027	77.2	POOR	0.028	75.7	POOR
JMSOH	SECCHI	ANNUAL	0.55	63.4	GOOD	-	-	-
JMSOH	SECCHI	SPRING1	0.50	63.9	GOOD	-	-	-
JMSOH	SECCHI	SPRING2	0.50	79.2	GOOD	-	-	-
JMSOH	SECCHI	SUMMER1	0.60	74.4	GOOD	-	-	-
JMSOH	SECCHI	SUMMER2	0.60	70.2	GOOD	-	-	-
JMSOH	TN	ANNUAL	0.565	4.5	GOOD	0.757	7.8	GOOD
JMSOH	TN	SPRING1	0.595	2.9	GOOD	0.782	4.1	GOOD
JMSOH	TN	SPRING2	0.534	3.5	GOOD	0.782	5.0	GOOD
JMSOH	TN	SUMMER1	0.506	3.6	GOOD	0.636	6.6	GOOD
JMSOH	TN	SUMMER2	0.498	3.8	GOOD	0.621	7.3	GOOD
JMSOH	TP	ANNUAL	0.070	30.5	GOOD	0.108	40.9	FAIR
JMSOH	TP	SPRING1	0.073	32.2	GOOD	0.122	46.8	FAIR
JMSOH	TP	SPRING2	0.070	24.2	GOOD	0.160	40.9	GOOD
JMSOH	TP	SUMMER1	0.069	23.8	GOOD	0.119	34.5	GOOD
JMSOH	TP	SUMMER2	0.069	24.8	GOOD	0.107	35.5	GOOD
JMSOH	TSS	ANNUAL	25.50	52.6	FAIR	65.50	72.0	POOR
JMSOH	TSS	SPRING1	39.00	64.6	POOR	91.75	81.1	POOR
JMSOH	TSS	SPRING2	27.75	49.3	FAIR	112.00	77.6	POOR
JMSOH	TSS	SUMMER1	21.00	44.3	FAIR	60.75	70.3	POOR
JMSOH	TSS	SUMMER2	17.75	37.9	GOOD	56.00	70.5	POOR

Table 12 - SAV Season Water quality trends in segment JMSOH (only significant trends are displayed).

Segment	Parameter	Season	Layer	Slope	%Change	pValue	Direction
JMSOH	TN	SAV1	S	-0.0292	-0.548	0.000	**IMPROVING**
JMSOH	DIN	SAV1	S	-0.0125	.	0.000	**IMPROVING**

Table 13 - SAV season water quality status in segment JMSOH (value is the median concentration; secchi in meters, chlorophyll *a* in μg per l, all other parameters in mg per l.).

Segment	Parameter	Status Value	Score	Status	SAV Goal Value	Habitat Requirement
JMSOH	TN	0.5195	4.6	**GOOD**	-	-
JMSOH	DIN	0.1105	17.1	**GOOD**	0.1065	-
JMSOH	TP	0.0699	25	**GOOD**	-	-
JMSOH	PO4F	0.0255	74.4	**POOR**	0.0225	**BORDERLINE**
JMSOH	CHLA	8.94	35.8	**GOOD**	9.9	**MEETS**
JMSOH	SECCHI	0.55	63.4	**GOOD**	-	-
JMSOH	TSS	23.75	49.3	**FAIR**	23.5	**FAILS**
JMSOH	KD	-	-	-	2.90	**FAILS**
JMSOH	PLL05	-	-	-	0.060	**FAILS**
JMSOH	PLL10	-	-	-	0.015	**FAILS**

5. Tidal Fresh James River (JMSTF - Upper James)

Water Quality for Living Resources

Improving trends in surface and bottom total nitrogen, dissolved inorganic nitrogen, total phosphorus, dissolved inorganic phosphorus and bottom dissolved oxygen were detected (Table 14). The water quality status in this segment was good for surface and bottom total nitrogen and dissolved inorganic nitrogen, surface total phosphorus and bottom dissolved oxygen. Status was fair for bottom total phosphorus, surface and bottom dissolved inorganic phosphorus, surface total suspended solids and secchi depth. Status for surface chlorophyll *a* and bottom total suspended solids was poor (Table 15).

Water Quality for SAV

Improving trends in surface total nitrogen, surface dissolved inorganic nitrogen, surface total phosphorus, and surface dissolved inorganic phosphorus were detected in this segment (Table 16). Status was good for surface total nitrogen, surface dissolved inorganic nitrogen and surface total phosphorus and fair for the remaining parameters. All parameters either failed to meet the SAV habitat requirements or were borderline (Table 17).

SAV

This segment was mapped for the first time in 1998 and 36.00 ha of SAV were reported during this survey. No SAV were mapped in this segment during 1999 as a result delayed surveys. A total of 26.84 ha were reported during 2000. A Tier I goal has not been established for JMSTF.

Table 14 -Water quality trends in segment JMSTF (only significant trends are displayed).

Segment	Parameter	Season	Layer	Slope	%Change	pValue	Direction
JMSTF	TN	SUMMER2	S	-0.0432	-0.501	<0.001	IMPROVING
JMSTF	TN	SUMMER1	S	-0.0415	-0.481	<0.001	IMPROVING
JMSTF	TN	ANNUAL	S	-0.0345	-0.497	<0.001	IMPROVING
JMSTF	TN	SPRING2	S	-0.0262	-0.404	<0.001	IMPROVING
JMSTF	TN	SPRING1	S	-0.0224	-0.380	<0.001	IMPROVING
JMSTF	TN	SUMMER1	B	-0.0442	-0.456	<0.001	IMPROVING
JMSTF	TN	SPRING1	B	-0.0187	-0.272	0.001	IMPROVING
JMSTF	TN	ANNUAL	B	-0.0334	-0.389	<0.001	IMPROVING
JMSTF	TN	SUMMER2	B	-0.0475	-0.467	<0.001	IMPROVING
JMSTF	TN	SPRING2	B	-0.0209	-0.284	<0.001	IMPROVING
JMSTF	DIN	SPRING1	S	-0.0166	-0.528	<0.001	IMPROVING
JMSTF	DIN	SUMMER2	S	-0.0382	-0.950	<0.001	IMPROVING
JMSTF	DIN	SUMMER1	S	-0.0350	-0.873	<0.001	IMPROVING
JMSTF	DIN	ANNUAL	S	-0.0275	-0.685	<0.001	IMPROVING
JMSTF	DIN	SPRING2	S	-0.0215	-0.590	<0.001	IMPROVING
JMSTF	DIN	SPRING2	B	-0.0255	-0.567	<0.001	IMPROVING
JMSTF	DIN	ANNUAL	B	-0.0300	-0.614	<0.001	IMPROVING
JMSTF	DIN	SUMMER1	B	-0.0381	-0.779	<0.001	IMPROVING
JMSTF	DIN	SPRING1	B	-0.0193	-0.504	<0.001	IMPROVING
JMSTF	DIN	SUMMER2	B	-0.0394	-0.836	<0.001	IMPROVING
JMSTF	TP	SPRING2	S	-0.0036	-0.490	<0.001	IMPROVING
JMSTF	TP	SPRING1	S	-0.0039	-0.552	<0.001	IMPROVING
JMSTF	TP	SUMMER1	S	-0.0040	-0.459	<0.001	IMPROVING
JMSTF	TP	SUMMER2	S	-0.0042	-0.463	<0.001	IMPROVING
JMSTF	TP	ANNUAL	S	-0.0047	-0.552	<0.001	IMPROVING
JMSTF	TP	ANNUAL	B	-0.0044	-0.412	<0.001	IMPROVING
JMSTF	TP	SPRING2	B	-0.0042	-0.418	0.001	IMPROVING
JMSTF	TP	SPRING1	B	-0.0040	-0.474	0.001	IMPROVING
JMSTF	TP	SUMMER1	B	-0.0035	-0.314	0.001	IMPROVING
JMSTF	PO4F	SUMMER2	S	-0.0027	-0.514	<0.001	IMPROVING
JMSTF	PO4F	SPRING2	S	-0.0024	-0.593	<0.001	IMPROVING
JMSTF	PO4F	SUMMER1	S	-0.0023	-0.492	<0.001	IMPROVING
JMSTF	PO4F	SPRING1	S	-0.0025	-0.593	<0.001	IMPROVING
JMSTF	PO4F	ANNUAL	S	-0.0024	-0.471	<0.001	IMPROVING
JMSTF	PO4F	SUMMER1	B	-<0.0017	-0.150	<0.001	IMPROVING
JMSTF	PO4F	SPRING1	B	-0.0023	-0.566	<0.001	IMPROVING
JMSTF	PO4F	SUMMER2	B	-<0.0017	-0.143	0.002	IMPROVING
JMSTF	PO4F	ANNUAL	B	-0.0015	-0.314	<0.001	IMPROVING
JMSTF	PO4F	SPRING2	B	-0.0014	-0.325	<0.001	IMPROVING
JMSTF	DO	SUMMER1	B	0.0667	0.167	<0.001	IMPROVING

Table 15 - Water quality status in segment JMSTF (value is the median concentration, secchi in meters, chlorophyll *a* in μg per l, all other parameters in mg per l.).

Segment	Parameter	Season	S Value	S Score	S Status	B Value	B Score	B Status
JMSTF	CHLA	ANNUAL	8.55	57.7	POOR	-	-	-
JMSTF	CHLA	SPRING1	5.75	50.0	FAIR	-	-	-
JMSTF	CHLA	SPRING2	9.00	55.7	POOR	-	-	-
JMSTF	CHLA	SUMMER1	17.42	60.9	POOR	-	-	-
JMSTF	CHLA	SUMMER2	18.90	57.5	POOR	-	-	-
JMSTF	DIN	ANNUAL	0.345	18.4	GOOD	0.372	18.6	GOOD
JMSTF	DIN	SPRING1	0.336	10.2	GOOD	0.365	9.5	GOOD
JMSTF	DIN	SPRING2	0.294	8.7	GOOD	0.338	8.0	GOOD
JMSTF	DIN	SUMMER1	0.184	15.7	GOOD	0.262	22.3	GOOD
JMSTF	DIN	SUMMER2	0.166	17.3	GOOD	0.238	29.0	GOOD
JMSTF	DO	SPRING1	-	-	-	9.22	-	GOOD
JMSTF	DO	SPRING2	-	-	-	8.21	-	GOOD
JMSTF	DO	SUMMER1	-	-	-	7.20	-	GOOD
JMSTF	DO	SUMMER2	-	-	-	7.10	-	GOOD
JMSTF	PO4F	ANNUAL	0.022	47.1	FAIR	0.021	56.2	FAIR
JMSTF	PO4F	SPRING1	0.022	46.5	FAIR	0.021	53.6	FAIR
JMSTF	PO4F	SPRING2	0.023	42.3	GOOD	0.018	49.2	FAIR
JMSTF	PO4F	SUMMER1	0.023	48.0	FAIR	0.024	58.1	FAIR
JMSTF	PO4F	SUMMER2	0.022	48.0	FAIR	0.024	60.6	POOR
JMSTF	SECCHI	ANNUAL	0.60	60.6	FAIR	-	-	-
JMSTF	SECCHI	SPRING1	0.60	59.6	GOOD	-	-	-
JMSTF	SECCHI	SPRING2	0.50	43.3	FAIR	-	-	-
JMSTF	SECCHI	SUMMER1	0.60	58.8	FAIR	-	-	-
JMSTF	SECCHI	SUMMER2	0.60	58.0	FAIR	-	-	-
JMSTF	TN	ANNUAL	0.749	8.3	GOOD	0.865	10.3	GOOD
JMSTF	TN	SPRING1	0.664	8.2	GOOD	0.750	9.1	GOOD
JMSTF	TN	SPRING2	0.674	8.1	GOOD	0.796	11.0	GOOD
JMSTF	TN	SUMMER1	0.791	9.9	GOOD	0.927	12.9	GOOD
JMSTF	TN	SUMMER2	0.803	9.2	GOOD	0.950	13.8	GOOD
JMSTF	TP	ANNUAL	0.077	35.8	GOOD	0.098	45.8	FAIR
JMSTF	TP	SPRING1	0.073	39.6	GOOD	0.096	50.7	FAIR
JMSTF	TP	SPRING2	0.078	34.8	GOOD	0.096	50.3	FAIR
JMSTF	TP	SUMMER1	0.080	31.6	GOOD	0.108	42.9	FAIR
JMSTF	TP	SUMMER2	0.078	29.8	GOOD	0.130	46.9	FAIR
JMSTF	TSS	ANNUAL	14.50	58.1	FAIR	36.00	58.5	POOR
JMSTF	TSS	SPRING1	18.00	56.2	FAIR	42.00	69.7	POOR
JMSTF	TSS	SPRING2	17.00	53.6	FAIR	35.50	47.7	FAIR
JMSTF	TSS	SUMMER1	13.50	43.1	FAIR	33.00	40.4	GOOD
JMSTF	TSS	SUMMER2	13.25	37.0	GOOD	34.50	54.4	FAIR

Table 16 - SAV Season Water quality trends in segment JMSTF (only significant trends are displayed).

Segment	Parameter	Season	Layer	Slope	%Change	pValue	Direction
JMSTF	TN	SAV1	S	-0.0356	-0.505	0.000	**IMPROVING**
JMSTF	DIN	SAV1	S	-0.0310	-0.773	0.000	**IMPROVING**
JMSTF	TP	SAV1	S	-0.0042	-0.502	0.000	**IMPROVING**
JMSTF	PO4F	SAV1	S	-0.0024	-0.484	0.000	**IMPROVING**

Table 17 - SAV season water quality status in segment JMSTF (value is the median concentration; secchi in meters, chlorophyll *a* in μg per l, all other parameters in mg per l.).

Segment	Parameter	Status Value	Score	Status	SAV Goal Value	Habitat Requirement
JMSTF	TN	0.7563	8.5	**GOOD**	-	-
JMSTF	DIN	0.2385	16.6	**GOOD**	0.2610	-
JMSTF	TP	0.0775	30.3	**GOOD**	-	-
JMSTF	PO4F	0.021	45	**FAIR**	0.0200	BORDERLINE
JMSTF	CHLA	10.68	52.5	**FAIR**	10.7	BORDERLINE
JMSTF	SECCHI	0.6	58.9	**FAIR**	-	-
JMSTF	TSS	14.5	51.1	**FAIR**	16.0	BORDERLINE
JMSTF	KD	-	-	-	2.40	**FAILS**
JMSTF	PLL05	-	-	-	0.086	BORDERLINE
JMSTF	PLL10	-	-	-	0.029	**FAILS**

Living Resources

There were several significant changes in the status and trends within the phytoplankton community compared to trends through 1999. These included an increase trend in total phytoplankton abundance along with increased and favorable trends in the presence of diatoms, chlorophytes, and cryptophytes, in addition to the increased abundance of cyanophytes (unfavorable). Concerns were associated with the changing status of dinoflagellates and cyanobacteria to poor, along with the continuing status of poor for the autotrophic picoplankton. However, there were no significant trends in cyanobacteria biomass. There was improvement of status with the background category of chlorophytes from poor to good. There were no significant trends associated with productivity.

Microzooplankton indicated a degrading trend and poor status in rotifer abundance. This may relate to the generally fair to poor status of chlorophyl a, suspended solids, and secchi depth for this segment. However, the good status of copepod nauplii abundance may have reflected the generally good to fair status of the major nutrients.

Benthic community status was good with a strongly improving trend in the B-IBI and most of the benthic metrics of the B-IBI.

6. Tidal Fresh Appomattox (APPTF - Appomattox)

Water quality for living resources

Improving trends in surface and bottom total nitrogen, total phosphorus, and dissolved inorganic phosphorus were detected (Table 18). Status was good for surface and bottom total nitrogen, dissolved inorganic nitrogen, dissolved inorganic phosphorus and bottom dissolved oxygen. While status was fair for surface and bottom total phosphorus, bottom total suspended solids and water clarity, status was poor for surface chlorophyll *a* and surface total suspended solids (Table 19).

Water quality for SAV

Improving trends in surface total nitrogen and surface total phosphorus were detected in this segment (Table 20). Status of surface total nitrogen, surface dissolved inorganic nitrogen and surface dissolved inorganic phosphorus was good while status of surface chlorophyll *a*, secchi depth and surface total suspended solids was poor. Although surface dissolved inorganic phosphorus met the SAV habitat requirements and surface chlorophyll *a* was borderline, surface total suspended solids and all measures of water clarity failed to met the SAV habitat requirements (Table 21).

SAV

SAV was not mapped and ground survey data was not reported for APPTF in 2000. The Tier I goal has not been established for this segment.

Living Resources

Living resource monitoring is not conducted within this segment.

Table 18 -Water quality trends in segment APPTF (only significant trends are displayed).

Segment	Parameter	Season	Layer	Slope	%Change	pValue	Direction
APPTF	TN	ANNUAL	S	-0.0119	-0.199	<0.001	IMPROVING
APPTF	TN	SPRING1	B	-0.0100	-0.190	0.006	IMPROVING
APPTF	TN	ANNUAL	B	-0.0154	-0.253	<0.001	IMPROVING
APPTF	TN	SUMMER1	B	-0.0219	-0.261	0.002	IMPROVING
APPTF	TN	SPRING2	B	-0.0136	-0.221	0.001	IMPROVING
APPTF	DIN	SPRING1	B	-0.0087	-0.592	0.002	IMPROVING
APPTF	TP	SUMMER1	S	-0.0021	-0.258	0.005	IMPROVING
APPTF	TP	SPRING2	S	-0.0033	-0.384	<0.001	IMPROVING
APPTF	TP	SPRING1	S	-0.0033	-0.422	<0.001	IMPROVING
APPTF	TP	ANNUAL	S	-0.0025	-0.333	<0.001	IMPROVING
APPTF	TP	ANNUAL	B	-0.0027	-0.346	<0.001	IMPROVING
APPTF	TP	SPRING1	B	-0.0033	-0.515	<0.001	IMPROVING
APPTF	TP	SPRING2	B	-0.0034	-0.389	<0.001	IMPROVING
APPTF	PO4F	ANNUAL	S	-<0.0012	.	0.007	IMPROVING
APPTF	PO4F	ANNUAL	B	-<0.0014	.	0.005	IMPROVING

Table 19 - Water quality status in segment APPTF (value is the median concentration, secchi in meters, chlorophyll *a* in μg per l, all other parameters in mg per l.).

Segment	Parameter	Season	S Value	S Score	S Status	B Value	B Score	B Status
APPTF	CHLA	ANNUAL	14.10	74.8	POOR	-	-	-
APPTF	CHLA	SPRING1	7.40	61.1	POOR	-	-	-
APPTF	CHLA	SPRING2	13.70	74.0	POOR	-	-	-
APPTF	CHLA	SUMMER1	45.60	89.0	POOR	-	-	-
APPTF	CHLA	SUMMER2	49.56	89.2	POOR	-	-	-
APPTF	DIN	ANNUAL	0.251	11.7	GOOD	0.243	9.3	GOOD
APPTF	DIN	SPRING1	0.217	4.6	GOOD	0.196	2.8	GOOD
APPTF	DIN	SPRING2	0.197	4.7	GOOD	0.194	3.0	GOOD
APPTF	DIN	SUMMER1	0.212	14.9	GOOD	0.185	11.9	GOOD
APPTF	DIN	SUMMER2	0.203	16.7	GOOD	0.184	15.2	GOOD
APPTF	DO	SPRING1	-	-	-	9.20	-	GOOD
APPTF	DO	SPRING2	-	-	-	8.40	-	GOOD
APPTF	DO	SUMMER1	-	-	-	8.66	-	GOOD
APPTF	DO	SUMMER2	-	-	-	8.71	-	GOOD
APPTF	PO4F	ANNUAL	0.014	30.7	GOOD	0.014	36.7	GOOD
APPTF	PO4F	SPRING1	0.014	31.4	GOOD	0.016	44.9	FAIR
APPTF	PO4F	SPRING2	0.014	29.7	GOOD	0.013	34.0	GOOD
APPTF	PO4F	SUMMER1	0.014	30.4	GOOD	0.013	34.8	GOOD
APPTF	PO4F	SUMMER2	0.014	30.9	GOOD	0.015	41.4	FAIR
APPTF	SECCHI	ANNUAL	0.50	44.1	FAIR	-	-	-
APPTF	SECCHI	SPRING1	0.50	43.4	FAIR	-	-	-
APPTF	SECCHI	SPRING2	0.50	43.3	FAIR	-	-	-
APPTF	SECCHI	SUMMER1	0.40	22.0	POOR	-	-	-
APPTF	SECCHI	SUMMER2	0.40	21.9	POOR	-	-	-
APPTF	TN	ANNUAL	0.880	15.3	GOOD	0.894	11.7	GOOD
APPTF	TN	SPRING1	0.663	7.6	GOOD	0.699	6.3	GOOD
APPTF	TN	SPRING2	0.799	12.8	GOOD	0.815	9.5	GOOD
APPTF	TN	SUMMER1	1.043	22.8	GOOD	0.949	13.5	GOOD
APPTF	TN	SUMMER2	0.989	19.4	GOOD	1.009	16.9	GOOD
APPTF	TP	ANNUAL	0.087	45.2	FAIR	0.096	42.8	FAIR
APPTF	TP	SPRING1	0.072	37.7	GOOD	0.068	25.0	GOOD
APPTF	TP	SPRING2	0.080	38.9	GOOD	0.076	24.7	GOOD
APPTF	TP	SUMMER1	0.101	47.2	FAIR	0.118	50.6	FAIR
APPTF	TP	SUMMER2	0.100	43.8	FAIR	0.114	46.5	FAIR
APPTF	TSS	ANNUAL	23.00	72.8	POOR	29.00	52.1	FAIR
APPTF	TSS	SPRING1	20.00	62.9	POOR	23.00	37.7	GOOD
APPTF	TSS	SPRING2	30.00	82.6	POOR	32.50	52.8	FAIR
APPTF	TSS	SUMMER1	30.00	85.0	POOR	33.00	55.1	FAIR
APPTF	TSS	SUMMER2	29.00	83.2	POOR	30.50	50.5	FAIR

Table 20 - SAV Season Water quality trends in segment APPTF (only significant trends are displayed).

Segment	Parameter	Season	Layer	Slope	%Change	pValue	Direction
APPTF	TN	SAV1	S	-0.0129	-0.165	0.007	IMPROVING
APPTF	TP	SAV1	S	-0.0028	-0.332	0.000	IMPROVING

Table 21 - SAV season water quality status in segment APPTF (value is the median concentration; secchi in meters, chlorophyll *a* in μg per l, all other parameters in mg per l.).

Segment	Parameter	Status Value	Score	Status	SAV Goal Value	Habitat Requirement
APPTF	TN	0.934	18.7	GOOD	-	-
APPTF	DIN	0.217	12.5	GOOD	0.2170	-
APPTF	TP	0.0932	46.1	FAIR	-	-
APPTF	PO4F	0.012	25.1	GOOD	0.0120	MEETS
APPTF	CHLA	36.46	88.9	POOR	36.5	BORDERLINE
APPTF	SECCHI	0.45	32.3	POOR	-	-
APPTF	TSS	29	82	POOR	29.0	FAILS
APPTF	KD	-	-	-	3.25	FAILS
APPTF	PLL05	-	-	-	0.021	FAILS
APPTF	PLL10	-	-	-	0.003	FAILS

7. Oligohaline Chickahominy River (CHKOH - Chickahominy)

Water Quality for Living Resources

Improving trends were detected in surface and bottom total nitrogen and degrading trends were detected in surface and bottom total suspended solids (Table 22). Status of surface and bottom total nitrogen, dissolved inorganic nitrogen and total phosphorus was good as was the status of water clarity and bottom dissolved oxygen. Status of surface and bottom dissolved inorganic phosphorus and total suspended solids was fair while the status of surface chlorophyll *a* was poor (Table 23).

Table 22 -Water quality trends in segment CHKOH (only significant trends are displayed).

Segment	Parameter	Season	Layer	Slope	%Change	pValue	Direction
CHKOH	TN	SPRING2	S	-0.0172	-0.272	<0.001	IMPROVING
CHKOH	TN	ANNUAL	S	-0.0229	-0.405	<0.001	IMPROVING
CHKOH	TN	SUMMER1	S	-0.0261	-0.406	<0.001	IMPROVING
CHKOH	TN	SUMMER2	S	-0.0261	-0.426	0.001	IMPROVING
CHKOH	TN	SPRING1	S	-0.0193	-0.330	0.001	IMPROVING
CHKOH	TN	ANNUAL	B	-0.0217	-0.351	<0.001	IMPROVING
CHKOH	TN	SUMMER1	B	-0.0242	-0.356	0.008	IMPROVING
CHKOH	TSS	SUMMER2	S	0.8333	0.773	0.009	DEGRADING
CHKOH	TSS	ANNUAL	S	0.6364	0.582	0.005	DEGRADING
CHKOH	TSS	ANNUAL	B	1.5714	0.931	<0.001	DEGRADING

Table 23 - Water quality status in segment CHKOH (value is the median concentration, secchi in meters, chlorophyll *a* in μg per l, all other parameters in mg per l.).

Segment	Parameter	Season	S Value	S Score	S Status	B Value	B Score	B Status
CHKOH	CHLA	ANNUAL	16.88	67.3	POOR	-	-	-
CHKOH	CHLA	SPRING1	13.88	59.8	POOR	-	-	-
CHKOH	CHLA	SPRING2	17.50	66.4	POOR	-	-	-
CHKOH	CHLA	SUMMER1	17.48	56.8	FAIR	-	-	-
CHKOH	CHLA	SUMMER2	17.69	53.5	FAIR	-	-	-
CHKOH	DIN	ANNUAL	0.065	5.3	GOOD	0.065	4.8	GOOD
CHKOH	DIN	SPRING1	0.052	0.5	GOOD	0.060	0.6	GOOD
CHKOH	DIN	SPRING2	0.051	1.8	GOOD	0.049	1.5	GOOD
CHKOH	DIN	SUMMER1	0.013	2.0	GOOD	0.018	2.7	GOOD
CHKOH	DIN	SUMMER2	0.012	2.4	GOOD	0.012	2.1	GOOD
CHKOH	DO	SPRING1	-	-	-	9.00	-	GOOD
CHKOH	DO	SPRING2	-	-	-	6.70	-	GOOD
CHKOH	DO	SUMMER1	-	-	-	6.23	-	GOOD
CHKOH	DO	SUMMER2	-	-	-	6.30	-	GOOD
CHKOH	PO4F	ANNUAL	0.010	41.6	FAIR	0.010	41.3	FAIR
CHKOH	PO4F	SPRING1	0.010	46.7	FAIR	0.009	41.5	FAIR
CHKOH	PO4F	SPRING2	0.010	41.3	FAIR	0.009	36.5	GOOD
CHKOH	PO4F	SUMMER1	0.011	42.7	FAIR	0.012	41.6	FAIR
CHKOH	PO4F	SUMMER2	0.012	48.0	FAIR	0.012	43.5	FAIR
CHKOH	SECCHI	ANNUAL	0.50	63.4	GOOD	-	-	-
CHKOH	SECCHI	SPRING1	0.60	90.1	GOOD	-	-	-
CHKOH	SECCHI	SPRING2	0.60	89.4	GOOD	-	-	-
CHKOH	SECCHI	SUMMER1	0.50	58.8	FAIR	-	-	-
CHKOH	SECCHI	SUMMER2	0.50	54.0	FAIR	-	-	-
CHKOH	TN	ANNUAL	0.635	6.3	GOOD	0.690	7.1	GOOD
CHKOH	TN	SPRING1	0.618	3.7	GOOD	0.691	3.9	GOOD
CHKOH	TN	SPRING2	0.657	6.1	GOOD	0.712	6.3	GOOD
CHKOH	TN	SUMMER1	0.628	9.4	GOOD	0.712	11.8	GOOD
CHKOH	TN	SUMMER2	0.570	7.7	GOOD	0.758	16.0	GOOD
CHKOH	TP	ANNUAL	0.075	34.9	GOOD	0.093	34.8	GOOD
CHKOH	TP	SPRING1	0.082	37.5	GOOD	0.093	30.3	GOOD
CHKOH	TP	SPRING2	0.079	30.9	GOOD	0.092	25.5	GOOD
CHKOH	TP	SUMMER1	0.072	26.2	GOOD	0.091	26.8	GOOD
CHKOH	TP	SUMMER2	0.085	37.5	GOOD	0.098	32.1	GOOD
CHKOH	TSS	ANNUAL	22.00	47.8	FAIR	35.50	49.5	FAIR
CHKOH	TSS	SPRING1	19.00	27.2	GOOD	40.00	48.4	FAIR
CHKOH	TSS	SPRING2	19.00	25.6	GOOD	40.00	45.4	FAIR
CHKOH	TSS	SUMMER1	21.00	44.4	FAIR	33.00	39.2	GOOD
CHKOH	TSS	SUMMER2	22.00	50.9	FAIR	47.00	56.2	FAIR

Water quality for SAV

An improving trend in surface total nitrogen was detected in this segment (Table 24). Status of most parameters was good except for surface dissolved inorganic phosphorus for which status was fair and surface chlorophyll *a* for which status was poor. Most parameters either failed to meet the SAV habitat requirements or were borderline except for surface dissolved inorganic phosphorus which met the SAV habitat requirements (Table 25).

SAV

Survey data collected in 1999 were not directly comparable with those collected in 2000. A total of 216.54 ha were reported in this segment during 2000. The Tier I goal for this segment was met.

Living Resources

Living resource monitoring is not conducted within this segment.

Table 24 - SAV Season Water quality trends in segment CHKOH (only significant trends are displayed).

Segment	Parameter	Season	Layer	Slope	%Change	pValue	Direction
CHKOH	TN	SAV1	S	-0.0228	-0.361	0.000	IMPROVING

Table 25 - SAV season water quality status in segment CHKOH (value is the median concentration; secchi in meters, chlorophyll *a* in μg per l, all other parameters in mg per l.).

Segment	Parameter	Status Value	Score	Status	SAV Goal Value	Habitat Requirement
CHKOH	TN	0.632	8.1	GOOD	-	-
CHKOH	DIN	0.016	1.6	GOOD	0.0160	-
CHKOH	TP	0.0786	33.2	GOOD	-	-
CHKOH	PO4F	0.01	40.7	FAIR	0.0100	MEETS
CHKOH	CHLA	17.5	59.3	POOR	17.5	BORDERLINE
CHKOH	SECCHI	0.55	70.5	GOOD	-	-
CHKOH	TSS	20	39.2	GOOD	20.0	FAILS
CHKOH	KD	-	-	-	2.65	FAILS
CHKOH	PLL05	-	-	-	0.083	BORDERLINE
CHKOH	PLL10	-	-	-	0.024	FAILS

8. Polyhaline Elizabeth River (ELIPH - River Mouth)

Water Quality for Living Resources

A degrading trend in water clarity and improving trends in surface and bottom total nitrogen, dissolved inorganic nitrogen, total phosphorus and dissolved inorganic phosphorus were detected in this segment. A decreasing trend in surface salinity was detected in this segment (Table 26). The status of all water quality parameters in this segment was poor except for bottom dissolved oxygen for which status was good and surface total suspended solids for which status was fair (Table 27).

Table 26 -Water quality trends in segment ELIPH (only significant trends are displayed).

Segment	Parameter	Season	Layer	Slope	%Change	pValue	Direction
ELIPH	TN	SPRING1	S	-0.0215	-0.486	0.002	IMPROVING
ELIPH	TN	ANNUAL	S	-0.0221	-0.478	0.000	IMPROVING
ELIPH	TN	SUMMER2	S	-0.0200	-0.416	0.006	IMPROVING
ELIPH	TN	SPRING2	S	-0.0219	-0.502	0.001	IMPROVING
ELIPH	TN	SUMMER1	S	-0.0200	-0.432	0.001	IMPROVING
ELIPH	TN	SUMMER2	B	-0.0241	-0.466	0.000	IMPROVING
ELIPH	TN	SUMMER1	B	-0.0197	-0.393	0.000	IMPROVING
ELIPH	TN	SPRING1	B	-0.0145	-0.327	0.007	IMPROVING
ELIPH	TN	ANNUAL	B	-0.0185	-0.403	0.000	IMPROVING
ELIPH	DIN	ANNUAL	S	-0.0130	-1.040	0.000	IMPROVING
ELIPH	DIN	SPRING2	S	-0.0116	-1.108	0.003	IMPROVING
ELIPH	DIN	SUMMER1	S	-0.0145	-1.105	0.000	IMPROVING
ELIPH	DIN	SUMMER2	S	-0.0146	-1.005	0.007	IMPROVING
ELIPH	DIN	ANNUAL	B	-0.0113	-0.964	0.000	IMPROVING
ELIPH	DIN	SUMMER1	B	-0.0082	-0.719	0.006	IMPROVING
ELIPH	DIN	SPRING1	B	-0.0115	-1.067	0.004	IMPROVING
ELIPH	TP	SUMMER1	S	-0.0017	-0.311	0.001	IMPROVING
ELIPH	TP	SUMMER2	S	-0.0024	-0.415	0.001	IMPROVING
ELIPH	TP	ANNUAL	S	-0.0016	-0.394	0.000	IMPROVING
ELIPH	TP	SUMMER2	B	-0.0023	-0.377	0.007	IMPROVING
ELIPH	TP	ANNUAL	B	-0.0014	-0.345	0.000	IMPROVING
ELIPH	TP	SUMMER1	B	-0.0022	-0.440	0.001	IMPROVING
ELIPH	PO4F	SUMMER2	S	-0.0018	-0.524	0.000	IMPROVING
ELIPH	PO4F	SUMMER1	S	-0.0017	-0.573	0.000	IMPROVING
ELIPH	PO4F	ANNUAL	S	-0.0009	-0.480	0.000	IMPROVING
ELIPH	PO4F	SPRING1	B	-0.0007	-0.640	0.000	IMPROVING
ELIPH	PO4F	ANNUAL	B	-0.0008	-0.512	0.000	IMPROVING
ELIPH	SECCHI	SUMMER1	S	-0.0125	-0.182	0.003	DEGRADING
ELIPH	SECCHI	ANNUAL	S	-0.0143	-0.208	0.000	DEGRADING
ELIPH	SECCHI	SUMMER2	S	-0.0143	-0.203	0.003	DEGRADING
ELIPH	TSS	SUMMER2	S	-0.8333	-0.773	0.004	IMPROVING
ELIPH	SALINITY	SUMMER2	S	-0.2850	-0.189	0.002	DECREASING
ELIPH	SALINITY	SUMMER1	S	-0.2667	-0.182	0.001	DECREASING
ELIPH	SALINITY	ANNUAL	S	-0.1720	-0.131	0.003	DECREASING
ELIPH	SALINITY	SUMMER1	B	-0.1786	-0.113	0.009	DECREASING

Table 27 - Water quality status in segment ELIPH (value is the median concentration, secchi in meters, chlorophyll *a* in μg per l, all other parameters in mg per l.).

Segment	Parameter	Season	S Value	S Score	S Status	B Value	B Score	B Status
ELIPH	CHLA	ANNUAL	9.63	70.1	**POOR**	-	-	-
ELIPH	CHLA	SPRING1	9.40	58.5	**POOR**	-	-	-
ELIPH	CHLA	SPRING2	9.40	63.2	**POOR**	-	-	-
ELIPH	CHLA	SUMMER1	10.59	79.9	**POOR**	-	-	-
ELIPH	CHLA	SUMMER2	13.62	89.0	**POOR**	-	-	-
ELIPH	DIN	ANNUAL	0.133	85.6	**POOR**	0.119	80.7	**POOR**
ELIPH	DIN	SPRING1	0.178	89.9	**POOR**	0.124	87.2	**POOR**
ELIPH	DIN	SPRING2	0.110	86.4	**POOR**	0.119	89.2	**POOR**
ELIPH	DIN	SUMMER1	0.057	76.3	**POOR**	0.143	80.7	**POOR**
ELIPH	DIN	SUMMER2	0.155	93.5	**POOR**	0.148	77.7	**POOR**
ELIPH	DO	SPRING1	-	-	-	7.78	-	**GOOD**
ELIPH	DO	SPRING2	-	-	-	6.70	-	**GOOD**
ELIPH	DO	SUMMER1	-	-	-	5.18	-	**GOOD**
ELIPH	DO	SUMMER2	-	-	-	5.20	-	**GOOD**
ELIPH	PO4F	ANNUAL	0.016	85.3	**POOR**	0.020	82.3	**POOR**
ELIPH	PO4F	SPRING1	0.010	82.9	**POOR**	0.011	84.7	**POOR**
ELIPH	PO4F	SPRING2	0.013	89.6	**POOR**	0.015	88.0	**POOR**
ELIPH	PO4F	SUMMER1	0.021	85.2	**POOR**	0.041	88.3	**POOR**
ELIPH	PO4F	SUMMER2	0.032	90.7	**POOR**	0.043	87.2	**POOR**
ELIPH	SECCHI	ANNUAL	0.90	5.5	**POOR**	-	-	-
ELIPH	SECCHI	SPRING1	0.80	4.1	**POOR**	-	-	-
ELIPH	SECCHI	SPRING2	0.85	4.0	**POOR**	-	-	-
ELIPH	SECCHI	SUMMER1	0.90	6.8	**POOR**	-	-	-
ELIPH	SECCHI	SUMMER2	0.90	7.4	**POOR**	-	-	-
ELIPH	TN	ANNUAL	0.535	68.9	**POOR**	0.511	65.6	**POOR**
ELIPH	TN	SPRING1	0.552	73.1	**POOR**	0.511	69.7	**POOR**
ELIPH	TN	SPRING2	0.527	68.9	**POOR**	0.498	69.4	**POOR**
ELIPH	TN	SUMMER1	0.551	69.4	**POOR**	0.561	69.9	**POOR**
ELIPH	TN	SUMMER2	0.593	74.9	**POOR**	0.567	67.6	**POOR**
ELIPH	TP	ANNUAL	0.053	88.4	**POOR**	0.065	84.4	**POOR**
ELIPH	TP	SPRING1	0.049	93.0	**POOR**	0.068	94.0	**POOR**
ELIPH	TP	SPRING2	0.052	93.3	**POOR**	0.068	94.4	**POOR**
ELIPH	TP	SUMMER1	0.070	93.1	**POOR**	0.083	88.2	**POOR**
ELIPH	TP	SUMMER2	0.075	93.3	**POOR**	0.087	88.0	**POOR**
ELIPH	TSS	ANNUAL	10.00	56.9	**FAIR**	23.00	69.2	**POOR**
ELIPH	TSS	SPRING1	13.00	77.1	**POOR**	45.50	96.2	**POOR**
ELIPH	TSS	SPRING2	13.50	82.2	**POOR**	29.00	88.7	**POOR**
ELIPH	TSS	SUMMER1	12.50	69.6	**POOR**	21.00	56.9	**FAIR**
ELIPH	TSS	SUMMER2	10.00	51.2	**FAIR**	19.00	44.3	**FAIR**

Water Quality for SAV

Improving trends in surface total nitrogen, surface dissolved inorganic nitrogen, surface total phosphorus and surface dissolved inorganic phosphorus (Table 28). A degrading trend in secchi depth was detected in this segment. Status of most parameters was poor except for surface chlorophyll *a* and surface total suspended solids for which status was fair. All parameters either failed to meet the SAV habitat requirements or were borderline (Table 29).

SAV

In 2000, SAV was not mapped and ground survey information was not reported for this segment. The Tier I goal has not been established for this segment.

Living Resources

Living resource monitoring is not conducted within this segment.

Table 28 - SAV Season Water quality trends in segment ELIPH (only significant trends are displayed).

Segment	Parameter	Season	Layer	Slope	%Change	pValue	Direction
ELIPH	TN	SAV2	S	-0.0229	-0.505	0.000	IMPROVING
ELIPH	DIN	SAV2	S	-0.0121	-0.968	0.000	IMPROVING
ELIPH	TP	SAV2	S	-0.0014	-0.358	0.000	IMPROVING
ELIPH	PO4F	SAV2	S	-0.0007	-0.448	0.000	IMPROVING
ELIPH	SECCHI	SAV2	S	-0.0143	-0.199	0.003	DEGRADING

Table 29 - SAV season water quality status in segment ELIPH (value is the median concentration; secchi in meters, chlorophyll *a* in μg per l, all other parameters in mg per l.).

Segment	Parameter	Status Value	Score	Status	SAV Goal Value	Habitat Requirement
ELIPH	TN	0.548	70.6	POOR	-	-
ELIPH	DIN	0.172	89	POOR	0.0847	BORDERLINE
ELIPH	TP	0.054	89.8	POOR	-	-
ELIPH	PO4F	0.022	89.8	POOR	0.0165	BORDERLINE
ELIPH	CHLA	6.55	49.4	FAIR	11.4	BORDERLINE
ELIPH	SECCHI	0.9	4.9	POOR	-	-
ELIPH	TSS	9.5	55.1	FAIR	26.5	FAILS
ELIPH	KD	-	-	-	2.90	FAILS
ELIPH	PLL05	-	-	-	0.032	FAILS
ELIPH	PLL10	-	-	-	0.010	FAILS

9. Mesohaline Elizabeth River (ELIMH - River Mainstem)

Water Quality for Living Resources

Improving trends were detected for surface and bottom dissolved inorganic nitrogen, total phosphorus, dissolved inorganic phosphorus and bottom dissolved oxygen (Table 30). Status of surface and bottom total nitrogen, bottom dissolved inorganic nitrogen, surface chlorophyll *a* and bottom dissolved oxygen was good. However, status of all remaining parameters was poor except for surface dissolved inorganic nitrogen which was fair (Table 31).

Table 30 -Water quality trends in segment ELIMH (only significant trends are displayed).

Segment	Parameter	Season	Layer	Slope	%Change	pValue	Direction
ELIMH	DIN	ANNUAL	S	-0.0105	-0.469	0.000	IMPROVING
ELIMH	DIN	SUMMER1	S	-0.0122	-0.505	0.008	IMPROVING
ELIMH	DIN	ANNUAL	B	-0.0090	-0.665	0.000	IMPROVING
ELIMH	DIN	SUMMER1	B	-0.0090	-0.498	0.005	IMPROVING
ELIMH	TP	ANNUAL	S	-0.0019	-0.483	0.000	IMPROVING
ELIMH	TP	SUMMER2	S	-0.0027	-0.386	0.003	IMPROVING
ELIMH	TP	SUMMER1	S	-0.0022	-0.340	0.001	IMPROVING
ELIMH	TP	ANNUAL	B	-0.0014	-0.325	0.002	IMPROVING
ELIMH	PO4F	ANNUAL	S	-0.0013	-0.555	0.000	IMPROVING
ELIMH	PO4F	SUMMER1	S	-0.0025	-0.571	0.001	IMPROVING
ELIMH	PO4F	SUMMER2	S	-0.0034	-0.697	0.004	IMPROVING
ELIMH	PO4F	SUMMER1	B	-0.0032	-0.652	0.000	IMPROVING
ELIMH	PO4F	SUMMER2	B	-0.0038	-0.715	0.000	IMPROVING
ELIMH	PO4F	SPRING1	B	-0.0007	.	0.009	IMPROVING
ELIMH	PO4F	ANNUAL	B	-0.0014	-0.747	0.000	IMPROVING
ELIMH	DO	SUMMER1	B	0.1723	0.672	0.000	IMPROVING

Table 31 - Water quality status in segment ELIMH (value is the median concentration, secchi in meters, chlorophyll *a* in μg per l, all other parameters in mg per l.).

Segment	Parameter	Season	S Value	S Score	S Status	B Value	B Score	B Status
ELIMH	CHLA	ANNUAL	7.01	33.0	GOOD	-	-	-
ELIMH	CHLA	SPRING1	5.52	21.5	GOOD	-	-	-
ELIMH	CHLA	SPRING2	5.52	16.8	GOOD	-	-	-
ELIMH	CHLA	SUMMER1	6.74	18.3	GOOD	-	-	-
ELIMH	CHLA	SUMMER2	6.47	16.3	GOOD	-	-	-
ELIMH	DIN	ANNUAL	0.138	45.1	FAIR	0.130	34.5	GOOD
ELIMH	DIN	SPRING1	0.146	23.7	GOOD	0.161	34.3	GOOD
ELIMH	DIN	SPRING2	0.128	34.3	GOOD	0.154	37.0	GOOD
ELIMH	DIN	SUMMER1	0.169	78.1	POOR	0.154	49.8	FAIR
ELIMH	DIN	SUMMER2	0.256	91.9	POOR	0.237	73.3	POOR
ELIMH	DO	SPRING1	-	-	-	8.30	-	GOOD
ELIMH	DO	SPRING2	-	-	-	7.28	-	GOOD
ELIMH	DO	SUMMER1	-	-	-	5.84	-	GOOD
ELIMH	DO	SUMMER2	-	-	-	5.82	-	GOOD
ELIMH	PO4F	ANNUAL	0.014	86.0	POOR	0.019	85.1	POOR
ELIMH	PO4F	SPRING1	0.009	85.6	POOR	0.009	86.0	POOR
ELIMH	PO4F	SPRING2	0.009	81.7	POOR	0.015	89.9	POOR
ELIMH	PO4F	SUMMER1	0.031	92.4	POOR	0.034	84.3	POOR
ELIMH	PO4F	SUMMER2	0.046	96.0	POOR	0.041	84.0	POOR
ELIMH	SECCHI	ANNUAL	0.85	22.5	POOR	-	-	-
ELIMH	SECCHI	SPRING1	0.60	11.0	POOR	-	-	-
ELIMH	SECCHI	SPRING2	0.60	10.7	POOR	-	-	-
ELIMH	SECCHI	SUMMER1	0.80	25.7	POOR	-	-	-
ELIMH	SECCHI	SUMMER2	0.80	26.2	POOR	-	-	-
ELIMH	TN	ANNUAL	0.631	29.0	GOOD	0.584	24.6	GOOD
ELIMH	TN	SPRING1	0.563	12.0	GOOD	0.595	16.2	GOOD
ELIMH	TN	SPRING2	0.563	14.8	GOOD	0.576	15.1	GOOD
ELIMH	TN	SUMMER1	0.669	36.8	GOOD	0.621	31.4	GOOD
ELIMH	TN	SUMMER2	0.677	38.7	GOOD	0.634	36.4	GOOD
ELIMH	TP	ANNUAL	0.049	62.5	POOR	0.061	67.0	POOR
ELIMH	TP	SPRING1	0.050	74.5	POOR	0.060	72.6	POOR
ELIMH	TP	SPRING2	0.048	66.8	POOR	0.063	73.0	POOR
ELIMH	TP	SUMMER1	0.073	69.8	POOR	0.077	69.2	POOR
ELIMH	TP	SUMMER2	0.079	71.3	POOR	0.079	66.4	POOR
ELIMH	TSS	ANNUAL	13.35	71.2	POOR	18.75	62.6	POOR
ELIMH	TSS	SPRING1	16.40	78.4	POOR	29.60	80.3	POOR
ELIMH	TSS	SPRING2	15.63	76.7	POOR	29.60	82.1	POOR
ELIMH	TSS	SUMMER1	13.57	68.0	POOR	20.54	70.0	POOR
ELIMH	TSS	SUMMER2	13.40	65.3	POOR	21.68	71.2	POOR

Water Quality for SAV

Improving trends in surface dissolved inorganic nitrogen, surface total phosphorus, and surface dissolved inorganic phosphorus were detected in this segment (Table 32). Status of most parameters was poor except for surface total nitrogen and surface chlorophyll *a* for which status was good. SAV habitat requirements were met for surface dissolved inorganic nitrogen and surface chlorophyll *a* but the remaining parameters failed to meet the SAV habitat requirements (Table 33).

SAV

In 2000, SAV was not mapped and ground survey information was not reported for this segment. The Tier I goal has not been established for this segment.

Living Resources

Phytoplankton and zooplankton monitoring is not conducted within this segment. It is recommended that monitoring stations for these components be added to this segment.

Table 32 - SAV Season Water quality trends in segment ELIMH (only significant trends are displayed).

Segment	Parameter	Season	Layer	Slope	%Change	pValue	Direction
ELIMH	DIN	SAV1	S	-0.0109	-0.512	0.001	IMPROVING
ELIMH	TP	SAV1	S	-0.0015	-0.318	0.000	IMPROVING
ELIMH	PO4F	SAV1	S	-0.0017	-0.469	0.000	IMPROVING

Table 33 - SAV season water quality status in segment ELIMH (value is the median concentration; secchi in meters, chlorophyll *a* in μg per l, all other parameters in mg per l.).

Segment	Parameter	Status Value	Score	Status	SAV Goal Value	Habitat Requirement
ELIMH	TN	0.6536	32.9	GOOD	-	-
ELIMH	DIN	0.1722	65.3	POOR	0.4387	FAILS
ELIMH	TP	0.0634	70.5	POOR	-	-
ELIMH	PO4F	0.0204	90.7	POOR	0.0362	FAILS
ELIMH	CHLA	6.2745	19.9	GOOD	3.5	MEETS
ELIMH	SECCHI	0.8	22.7	POOR	-	-
ELIMH	TSS	14.2	71.8	POOR	9.7	MEETS
ELIMH	KD	-	-	-	1.80	FAILS
ELIMH	PLL05	-	-	-	0.095	FAILS
ELIMH	PLL10	-	-	-	0.044	FAILS

10. Western Branch of the Elizabeth River (WBEMH - Western Branch)

Water Quality for Living Resources

Improving trends were detected in surface and bottom total nitrogen, dissolved inorganic nitrogen, total phosphorus, and dissolved inorganic phosphorus, surface chlorophyll *a*, and bottom dissolved oxygen. No degrading trends were detected (Table 34). Status of surface and bottom total nitrogen, dissolved inorganic nitrogen, and bottom dissolved oxygen was good. Status of bottom total phosphorus and surface chlorophyll *a* was fair. Status of the remaining parameters was poor (Table 35).

Table 34 -Water quality trends in segment WBEMH (only significant trends are displayed).

Segment	Parameter	Season	Layer	Slope	%Change	pValue	Direction
WBEMH	TN	SPRING1	S	-0.0265	-0.475	0.006	IMPROVING
WBEMH	TN	SPRING2	S	-0.0235	-0.491	0.001	IMPROVING
WBEMH	TN	SUMMER1	S	-0.0180	-0.340	0.003	IMPROVING
WBEMH	TN	ANNUAL	S	-0.0186	-0.372	<0.001	IMPROVING
WBEMH	TN	ANNUAL	B	-0.0146	-0.295	<0.001	IMPROVING
WBEMH	TN	SPRING2	B	-0.0227	-0.439	0.002	IMPROVING
WBEMH	DIN	ANNUAL	S	-0.0065	-0.525	0.001	IMPROVING
WBEMH	DIN	ANNUAL	B	-0.0087	-0.542	0.004	IMPROVING
WBEMH	TP	SUMMER2	S	-0.0064	-0.726	<0.001	IMPROVING
WBEMH	TP	ANNUAL	S	-0.0027	-0.520	<0.001	IMPROVING
WBEMH	TP	SUMMER1	S	-0.0064	-0.734	<0.001	IMPROVING
WBEMH	TP	SPRING2	S	-0.0031	-0.624	0.001	IMPROVING
WBEMH	TP	SUMMER2	B	-0.0061	-0.610	0.002	IMPROVING
WBEMH	TP	ANNUAL	B	-0.0024	-0.483	<0.001	IMPROVING
WBEMH	TP	SUMMER1	B	-0.0060	-0.608	<0.001	IMPROVING
WBEMH	PO4F	SPRING2	S	-0.0012	.	<0.001	IMPROVING
WBEMH	PO4F	SPRING1	S	-<0.0016	.	<0.001	IMPROVING
WBEMH	PO4F	ANNUAL	S	-0.0012	-0.557	<0.001	IMPROVING
WBEMH	PO4F	SUMMER2	S	-0.0050	-1.032	<0.001	IMPROVING
WBEMH	PO4F	SUMMER1	S	-0.0038	-0.894	<0.001	IMPROVING
WBEMH	PO4F	SPRING1	B	-<0.0017	.	0.001	IMPROVING
WBEMH	PO4F	SPRING2	B	-0.0012	.	<0.001	IMPROVING
WBEMH	PO4F	SUMMER1	B	-0.0040	-0.895	<0.001	IMPROVING
WBEMH	PO4F	ANNUAL	B	-0.0015	-0.727	<0.001	IMPROVING
WBEMH	PO4F	SUMMER2	B	-0.0047	-0.934	<0.001	IMPROVING
WBEMH	CHLA	ANNUAL	S	-0.6286	-0.437	0.005	IMPROVING
WBEMH	CHLA	SPRING2	S	-1.2092	-1.198	0.006	IMPROVING
WBEMH	DO	SUMMER1	B	0.2000	0.727	0.003	IMPROVING

Table 35 - Water quality status in segment WBEMH (value is the median concentration, secchi in meters, chlorophyll *a* in μg per l, all other parameters in mg per l.).

Segment	Parameter	Season	S Value	S Score	S Status	B Value	B Score	B Status
WBEMH	CHLA	ANNUAL	9.87	52.7	FAIR	-	-	-
WBEMH	CHLA	SPRING1	6.95	31.6	GOOD	-	-	-
WBEMH	CHLA	SPRING2	12.46	59.4	POOR	-	-	-
WBEMH	CHLA	SUMMER1	11.84	49.5	FAIR	-	-	-
WBEMH	CHLA	SUMMER2	11.21	44.0	FAIR	-	-	-
WBEMH	DIN	ANNUAL	0.081	26.1	GOOD	0.112	28.0	GOOD
WBEMH	DIN	SPRING1	0.077	9.2	GOOD	0.108	19.2	GOOD
WBEMH	DIN	SPRING2	0.062	13.9	GOOD	0.084	15.6	GOOD
WBEMH	DIN	SUMMER1	0.067	42.3	FAIR	0.143	45.5	FAIR
WBEMH	DIN	SUMMER2	0.131	76.5	POOR	0.195	64.6	POOR
WBEMH	DO	SPRING1	-	-	-	8.30	-	GOOD
WBEMH	DO	SPRING2	-	-	-	8.09	-	GOOD
WBEMH	DO	SUMMER1	-	-	-	6.09	-	GOOD
WBEMH	DO	SUMMER2	-	-	-	5.88	-	GOOD
WBEMH	PO4F	ANNUAL	0.010	77.8	POOR	0.013	73.9	POOR
WBEMH	PO4F	SPRING1	0.004	55.2	FAIR	0.004	46.3	FAIR
WBEMH	PO4F	SPRING2	0.004	49.4	FAIR	0.004	37.3	GOOD
WBEMH	PO4F	SUMMER1	0.023	90.0	POOR	0.028	79.5	POOR
WBEMH	PO4F	SUMMER2	0.037	94.3	POOR	0.037	81.8	POOR
WBEMH	SECCHI	ANNUAL	0.55	6.6	POOR	-	-	-
WBEMH	SECCHI	SPRING1	0.50	6.7	POOR	-	-	-
WBEMH	SECCHI	SPRING2	0.40	3.2	POOR	-	-	-
WBEMH	SECCHI	SUMMER1	0.50	5.2	POOR	-	-	-
WBEMH	SECCHI	SUMMER2	0.50	5.2	POOR	-	-	-
WBEMH	TN	ANNUAL	0.612	26.4	GOOD	0.614	29.4	GOOD
WBEMH	TN	SPRING1	0.617	17.1	GOOD	0.626	19.8	GOOD
WBEMH	TN	SPRING2	0.617	21.0	GOOD	0.630	22.2	GOOD
WBEMH	TN	SUMMER1	0.708	43.3	FAIR	0.722	51.2	FAIR
WBEMH	TN	SUMMER2	0.771	54.3	FAIR	0.796	66.3	POOR
WBEMH	TP	ANNUAL	0.054	68.3	POOR	0.053	57.3	FAIR
WBEMH	TP	SPRING1	0.056	80.2	POOR	0.052	64.9	POOR
WBEMH	TP	SPRING2	0.056	75.4	POOR	0.065	75.3	POOR
WBEMH	TP	SUMMER1	0.090	81.7	POOR	0.098	82.3	POOR
WBEMH	TP	SUMMER2	0.097	82.5	POOR	0.109	85.9	POOR
WBEMH	TSS	ANNUAL	18.68	83.9	POOR	23.32	72.6	POOR
WBEMH	TSS	SPRING1	26.50	91.4	POOR	29.93	80.7	POOR
WBEMH	TSS	SPRING2	26.50	91.6	POOR	39.80	89.4	POOR
WBEMH	TSS	SUMMER1	27.93	92.6	POOR	38.64	89.2	POOR
WBEMH	TSS	SUMMER2	28.80	92.7	POOR	41.85	90.7	POOR

Water Quality for SAV

Improving trends in surface dissolved inorganic nitrogen, surface total phosphorus, and surface dissolved inorganic phosphorus were detected in this segment (Table 36). Although the status of most parameters was poor, status of surface total nitrogen and surface dissolved inorganic nitrogen was good and status of surface chlorophyll *a* was fair. Although surface chlorophyll *a* met the SAV habitat requirements the remaining parameters were borderline (Table 37).

SAV

In 2000, SAV was not mapped and ground survey information was not reported for this segment. The Tier I goal has not been established for this segment.

Living Resources

Phytoplankton and zooplankton monitoring is not conducted within this segment.

Table 36 - SAV Season Water quality trends in segment WBEMH (only significant trends are displayed).

Segment	Parameter	Season	Layer	Slope	%Change	pValue	Direction
WBEMH	TN	SAV1	S	-0.0200	-0.394	0.000	IMPROVING
WBEMH	DIN	SAV1	S	-0.0074	-0.482	0.004	IMPROVING
WBEMH	TP	SAV1	S	-0.0040	-0.584	0.000	IMPROVING
WBEMH	PO4F	SAV1	S	-0.0021	-0.659	0.000	IMPROVING

Table 37 - SAV season water quality status in segment WBEMH (value is the median concentration; secchi in meters, chlorophyll *a* in μg per l, all other parameters in mg per l.).

Segment	Parameter	Status Value	Score	Status	SAV Goal Value	Habitat Requirement
WBEMH	TN	0.686	38.1	GOOD	-	-
WBEMH	DIN	0.0847	37.5	GOOD	0.1720	BORDERLINE
WBEMH	TP	0.0719	77.4	POOR	-	-
WBEMH	PO4F	0.0165	87	POOR	0.0220	BORDERLINE
WBEMH	CHLA	11.392	52.5	FAIR	6.6	MEETS
WBEMH	SECCHI	0.5	5.3	POOR	-	-
WBEMH	TSS	26.5	91.9	POOR	9.5	BORDERLINE
WBEMH	KD	-	-	-	1.60	BORDERLINE
WBEMH	PLL05	-	-	-	0.160	BORDERLINE
WBEMH	PLL10	-	-	-	0.071	BORDERLINE

11. Southern Branch of the Elizabeth River (SBEMH - Southern Branch)

Water Quality for Living Resources

Improving trends were detected in surface total nitrogen, surface and bottom dissolved inorganic nitrogen, total phosphorus, dissolved inorganic phosphorus, and bottom dissolved oxygen. In addition, an increasing trend in bottom water temperature was detected in this segment (Table 38). Status of the majority of parameters was poor except surface chlorophyll *a* and bottom total suspended solids for which status was good and surface total suspended solids and bottom dissolved oxygen for which status was fair (Table 39).

Table 38 -Water quality trends in segment SBEMH (only significant trends are displayed).

Segment	Parameter	Season	Layer	Slope	%Change	pValue	Direction
SBEMH	TN	SUMMER1	S	-0.0305	-0.377	0.004	IMPROVING
SBEMH	TN	ANNUAL	S	-0.0286	-0.343	<0.001	IMPROVING
SBEMH	TN	SUMMER1	B	-0.0151	-0.211	0.006	IMPROVING
SBEMH	DIN	ANNUAL	S	-0.0271	-0.588	<0.001	IMPROVING
SBEMH	DIN	SUMMER1	S	-0.0217	-0.486	0.006	IMPROVING
SBEMH	DIN	ANNUAL	B	-0.0129	-0.353	<0.001	IMPROVING
SBEMH	DIN	SUMMER1	B	-0.0190	-0.460	0.006	IMPROVING
SBEMH	TP	SPRING2	S	-0.0016	-0.392	0.001	IMPROVING
SBEMH	TP	ANNUAL	S	-0.0023	-0.501	<0.001	IMPROVING
SBEMH	TP	SUMMER1	S	-0.0031	-0.464	<0.001	IMPROVING
SBEMH	TP	SUMMER2	S	-0.0039	-0.541	0.002	IMPROVING
SBEMH	TP	SUMMER1	B	-0.0044	-0.520	<0.001	IMPROVING
SBEMH	TP	ANNUAL	B	-0.0026	-0.528	<0.001	IMPROVING
SBEMH	TP	SPRING2	B	-0.0024	-0.489	<0.001	IMPROVING
SBEMH	TP	SUMMER2	B	-0.0050	-0.579	<0.001	IMPROVING
SBEMH	PO4F	ANNUAL	S	-0.0018	-0.603	<0.001	IMPROVING
SBEMH	PO4F	SUMMER1	S	-0.0033	-0.702	<0.001	IMPROVING
SBEMH	PO4F	SPRING2	S	-0.0015	-0.627	0.009	IMPROVING
SBEMH	PO4F	SUMMER2	S	-0.0034	-0.667	0.001	IMPROVING
SBEMH	PO4F	SPRING1	B	-0.0014	-0.700	0.002	IMPROVING
SBEMH	PO4F	SPRING2	B	-0.0024	-0.942	<0.001	IMPROVING
SBEMH	PO4F	ANNUAL	B	-0.0022	-0.737	<0.001	IMPROVING
SBEMH	PO4F	SUMMER2	B	-0.0048	-0.786	<0.001	IMPROVING
SBEMH	PO4F	SUMMER1	B	-0.0042	-0.738	<0.001	IMPROVING
SBEMH	DO	SPRING1	B	0.1700	0.467	0.002	IMPROVING
SBEMH	DO	SUMMER1	B	0.1622	0.979	0.002	IMPROVING
SBEMH	WTEMP	SPRING2	B	0.4933	0.433	<0.001	INCREASING
SBEMH	WTEMP	SPRING1	B	0.4788	0.642	<0.001	INCREASING
SBEMH	WTEMP	ANNUAL	B	0.2317	0.217	<0.001	INCREASING

Table 39 - Water quality status in segment SBEMH (value is the median concentration, secchi in meters, chlorophyll *a* in μg per l, all other parameters in mg per l.).

Segment	Parameter	Season	S Value	S Score	S Status	B Value	B Score	B Status
SBEMH	CHLA	ANNUAL	2.49	5.3	GOOD	-	-	-
SBEMH	CHLA	SPRING1	2.99	7.4	GOOD	-	-	-
SBEMH	CHLA	SPRING2	3.03	8.5	GOOD	-	-	-
SBEMH	CHLA	SUMMER1	4.09	8.1	GOOD	-	-	-
SBEMH	CHLA	SUMMER2	3.50	3.9	GOOD	-	-	-
SBEMH	DIN	ANNUAL	0.464	83.4	POOR	0.379	81.9	POOR
SBEMH	DIN	SPRING1	0.447	67.1	POOR	0.380	74.2	POOR
SBEMH	DIN	SPRING2	0.419	77.3	POOR	0.380	76.6	POOR
SBEMH	DIN	SUMMER1	0.425	96.3	POOR	0.384	87.2	POOR
SBEMH	DIN	SUMMER2	0.444	97.5	POOR	0.392	89.4	POOR
SBEMH	DO	SPRING1	-	-	-	7.57	-	GOOD
SBEMH	DO	SPRING2	-	-	-	6.40	-	GOOD
SBEMH	DO	SUMMER1	-	-	-	4.74	-	FAIR
SBEMH	DO	SUMMER2	-	-	-	4.50	-	FAIR
SBEMH	PO4F	ANNUAL	0.023	94.0	POOR	0.024	90.0	POOR
SBEMH	PO4F	SPRING1	0.019	96.0	POOR	0.017	95.9	POOR
SBEMH	PO4F	SPRING2	0.016	94.5	POOR	0.019	94.2	POOR
SBEMH	PO4F	SUMMER1	0.044	96.3	POOR	0.047	90.1	POOR
SBEMH	PO4F	SUMMER2	0.052	96.2	POOR	0.052	88.3	POOR
SBEMH	SECCHI	ANNUAL	0.83	19.2	POOR	-	-	-
SBEMH	SECCHI	SPRING1	0.70	16.3	POOR	-	-	-
SBEMH	SECCHI	SPRING2	0.70	16.5	POOR	-	-	-
SBEMH	SECCHI	SUMMER1	0.88	35.4	POOR	-	-	-
SBEMH	SECCHI	SUMMER2	0.85	36.2	POOR	-	-	-
SBEMH	TN	ANNUAL	1.001	76.6	POOR	0.855	61.3	POOR
SBEMH	TN	SPRING1	1.003	67.3	POOR	0.884	58.2	FAIR
SBEMH	TN	SPRING2	0.962	67.9	POOR	0.908	58.3	FAIR
SBEMH	TN	SUMMER1	0.934	78.4	POOR	0.873	71.0	POOR
SBEMH	TN	SUMMER2	0.975	82.8	POOR	0.893	72.7	POOR
SBEMH	TP	ANNUAL	0.050	66.3	POOR	0.055	61.4	POOR
SBEMH	TP	SPRING1	0.047	68.2	POOR	0.050	63.0	POOR
SBEMH	TP	SPRING2	0.047	67.8	POOR	0.058	68.9	POOR
SBEMH	TP	SUMMER1	0.079	76.0	POOR	0.089	76.9	POOR
SBEMH	TP	SUMMER2	0.090	76.1	POOR	0.094	79.9	POOR
SBEMH	TSS	ANNUAL	8.18	47.9	FAIR	12.60	37.9	GOOD
SBEMH	TSS	SPRING1	9.25	49.3	FAIR	14.08	32.1	GOOD
SBEMH	TSS	SPRING2	9.70	54.1	FAIR	14.10	49.4	FAIR
SBEMH	TSS	SUMMER1	9.24	47.3	FAIR	13.88	50.0	FAIR
SBEMH	TSS	SUMMER2	8.83	44.7	FAIR	13.56	45.7	FAIR

Water Quality for SAV

Improving trends in surface total nitrogen, surface dissolved inorganic nitrogen, surface total phosphorus, and surface dissolved inorganic phosphorus were detected in this segment (Table 40). Status for most parameter was poor except for surface chlorophyll *a* for which status was good and surface total suspended solids for which status was fair. Only surface chlorophyll *a* met the SAV habitat requirements (Table 41).

SAV

In 2000, SAV was not mapped and ground survey information was not reported for this segment. The Tier I goal has not been established for this segment.

Living Resources

This is one of the most polluted rivers in Virginia with a phytoplankton composition that is dominated by flora common to the Chesapeake Bay. However, the majority of the trends are favorable. The phytoplankton abundance trend was increasing, with no significant trends present for total biomass. This was accompanied by a decreasing ratio of total biomass to total floral abundance, with a unfavorable decreasing trend present. Favorable trends included an increase in diatoms and chlorophytes, with their status fair and good respectively. There were also favorable decreasing trends in dinoflagellate and picoplankton biomass. There were no significant trends in species diversity, with productivity showing good status and a favorable trend.

Microzooplankton trends for the Elizabeth River were degrading for copepod nauplii and decreasing for most other parameters. Although rotifer abundance status was good, the poor copepod nauplii status and decreasing trends in most microzooplankton parameters reflected the generally poor status of most water quality indices.

Benthic community status was degraded with an improving trend in the B-IBI at station SBE5. The improving trend in the B-IBI was the result of trends in nearly all metrics measuring the health of benthic community composition.

Table 40 - SAV Season Water quality trends in segment SBEMH (only significant trends are displayed).

Segment	Parameter	Season	Layer	Slope	%Change	pValue	Direction
SBEMH	TN	SAV1	S	-0.0259	-0.327	0.002	IMPROVING
SBEMH	DIN	SAV1	S	-0.0220	-0.501	0.000	IMPROVING
SBEMH	TP	SAV1	S	-0.0023	-0.370	0.000	IMPROVING
SBEMH	PO4F	SAV1	S	-0.0023	-0.547	0.000	IMPROVING

Table 41 - SAV season water quality status in segment SBEMH (value is the median concentration; secchi in meters, chlorophyll *a* in μg per l, all other parameters in mg per l.).

Segment	Parameter	Status Value	Score	Status	SAV Goal Value	Habitat Requirement
SBEMH	TN	0.962	77.8	POOR	-	-
SBEMH	DIN	0.4444	89.1	POOR	0.1722	BORDERLINE
SBEMH	TP	0.063	72.2	POOR	-	-
SBEMH	PO4F	0.0356	96.4	POOR	0.0204	BORDERLINE
SBEMH	CHLA	3.026	5.4	GOOD	6.3	MEETS
SBEMH	SECCHI	0.85	15.5	POOR	-	-
SBEMH	TSS	9.25	50.2	FAIR	14.2	BORDERLINE
SBEMH	KD	-	-	-	1.80	FAILS
SBEMH	PLL05	-	-	-	0.080	FAILS
SBEMH	PLL10	-	-	-	0.040	FAILS

12. Eastern Branch of the Elizabeth River (EBEMH - Eastern Branch)

Water Quality for Living Resources

Improving trends were detected in surface and bottom total nitrogen, dissolved inorganic nitrogen, total phosphorus, and dissolved inorganic phosphorus. No degrading trends were detected (Table 42). Status of bottom total nitrogen, surface chlorophyll *a*, and bottom dissolved oxygen was good. Status of surface total nitrogen, surface total phosphorus, and surface and bottom total suspended solids was fair. All other parameters were poor (Table 43).

Water Quality for SAV

Improving trends in surface total nitrogen, surface total phosphorus, and surface dissolved inorganic phosphorus were detected in this segment (Table 44). Status of most parameters was poor except for surface chlorophyll *a* for which status was fair and surface total nitrogen and surface total suspended solids for which status was good. All parameters except surface chlorophyll *a* failed to meet the SAV habitat requirements (Table 45).

SAV

In 2000, SAV was not mapped and ground survey information was not reported for this segment. The Tier I goal has not been established for this segment.

Living Resources

Phytoplankton and zooplankton monitoring is not conducted within this segment.

Table 42 -Water quality trends in segment EBEMH (only significant trends are displayed).

Segment	Parameter	Season	Layer	Slope	%Change	pValue	Direction
EBEMH	TN	ANNUAL	S	-0.0208	-0.320	<0.001	IMPROVING
EBEMH	TN	ANNUAL	B	-0.0188	-0.352	<0.001	IMPROVING
EBEMH	TN	SUMMER1	B	-0.0194	-0.287	0.006	IMPROVING
EBEMH	DIN	ANNUAL	S	-0.0175	-0.552	<0.001	IMPROVING
EBEMH	DIN	SUMMER1	S	-0.0161	-0.493	0.008	IMPROVING
EBEMH	DIN	SUMMER1	B	-0.0224	-0.630	<0.001	IMPROVING
EBEMH	DIN	ANNUAL	B	-0.0190	-0.620	<0.001	IMPROVING
EBEMH	DIN	SUMMER2	B	-0.0210	-0.590	<0.001	IMPROVING
EBEMH	TP	SUMMER2	S	-0.0028	-0.395	0.003	IMPROVING
EBEMH	TP	SPRING1	S	-0.0023	-0.553	0.001	IMPROVING
EBEMH	TP	SUMMER1	S	-0.0026	-0.370	0.001	IMPROVING
EBEMH	TP	SPRING2	S	-0.0019	-0.490	0.005	IMPROVING
EBEMH	TP	ANNUAL	S	-0.0023	-0.494	<0.001	IMPROVING
EBEMH	TP	SUMMER2	B	-0.0034	-0.435	0.001	IMPROVING
EBEMH	TP	SUMMER1	B	-0.0029	-0.382	<0.001	IMPROVING
EBEMH	TP	ANNUAL	B	-0.0022	-0.476	<0.001	IMPROVING
EBEMH	PO4F	SUMMER1	S	-0.0028	-0.567	0.005	IMPROVING
EBEMH	PO4F	ANNUAL	S	-0.0015	-0.552	<0.001	IMPROVING
EBEMH	PO4F	SPRING1	B	-<0.0019	-0.543	0.005	IMPROVING
EBEMH	PO4F	SUMMER2	B	-0.0041	-0.737	<0.001	IMPROVING
EBEMH	PO4F	ANNUAL	B	-0.0018	-0.633	<0.001	IMPROVING
EBEMH	PO4F	SPRING2	B	-0.0020	-0.790	0.003	IMPROVING
EBEMH	PO4F	SUMMER1	B	-0.0035	-0.651	<0.001	IMPROVING
EBEMH	DO	SPRING1	B	0.1714	0.409	0.002	IMPROVING

Table 43 - Water quality status in segment EBEMH (value is the median concentration, secchi in meters, chlorophyll *a* in μg per l, all other parameters in mg per l.).

Segment	Parameter	Season	S Value	S Score	S Status	B Value	B Score	B Status
EBEMH	CHLA	ANNUAL	3.56	8.9	GOOD	-	-	-
EBEMH	CHLA	SPRING1	3.38	8.4	GOOD	-	-	-
EBEMH	CHLA	SPRING2	3.38	5.8	GOOD	-	-	-
EBEMH	CHLA	SUMMER1	4.08	5.7	GOOD	-	-	-
EBEMH	CHLA	SUMMER2	4.01	5.5	GOOD	-	-	-
EBEMH	DIN	ANNUAL	0.292	73.0	POOR	0.228	62.4	POOR
EBEMH	DIN	SPRING1	0.255	45.6	FAIR	0.286	61.6	POOR
EBEMH	DIN	SPRING2	0.253	61.1	POOR	0.286	65.9	POOR
EBEMH	DIN	SUMMER1	0.254	88.5	POOR	0.289	78.3	POOR
EBEMH	DIN	SUMMER2	0.326	94.7	POOR	0.307	82.7	POOR
EBEMH	DO	SPRING1	-	-	-	7.94	-	GOOD
EBEMH	DO	SPRING2	-	-	-	7.05	-	GOOD
EBEMH	DO	SUMMER1	-	-	-	5.25	-	GOOD
EBEMH	DO	SUMMER2	-	-	-	5.19	-	GOOD
EBEMH	PO4F	ANNUAL	0.021	93.2	POOR	0.026	90.4	POOR
EBEMH	PO4F	SPRING1	0.013	93.3	POOR	0.012	91.6	POOR
EBEMH	PO4F	SPRING2	0.014	92.4	POOR	0.022	95.6	POOR
EBEMH	PO4F	SUMMER1	0.047	97.1	POOR	0.047	89.7	POOR
EBEMH	PO4F	SUMMER2	0.054	97.0	POOR	0.051	88.2	POOR
EBEMH	SECCHI	ANNUAL	0.90	25.9	POOR	-	-	-
EBEMH	SECCHI	SPRING1	0.70	16.3	POOR	-	-	-
EBEMH	SECCHI	SPRING2	0.70	16.5	POOR	-	-	-
EBEMH	SECCHI	SUMMER1	0.80	25.7	POOR	-	-	-
EBEMH	SECCHI	SUMMER2	0.80	26.2	POOR	-	-	-
EBEMH	TN	ANNUAL	0.722	42.3	FAIR	0.666	38.1	GOOD
EBEMH	TN	SPRING1	0.688	25.3	GOOD	0.677	26.6	GOOD
EBEMH	TN	SPRING2	0.688	30.4	GOOD	0.688	31.2	GOOD
EBEMH	TN	SUMMER1	0.748	49.9	FAIR	0.696	46.1	FAIR
EBEMH	TN	SUMMER2	0.749	50.7	FAIR	0.763	61.0	POOR
EBEMH	TP	ANNUAL	0.048	61.4	FAIR	0.055	60.4	POOR
EBEMH	TP	SPRING1	0.043	66.7	POOR	0.042	49.6	FAIR
EBEMH	TP	SPRING2	0.043	59.6	FAIR	0.057	67.2	POOR
EBEMH	TP	SUMMER1	0.080	75.8	POOR	0.084	74.9	POOR
EBEMH	TP	SUMMER2	0.085	75.9	POOR	0.093	77.9	POOR
EBEMH	TSS	ANNUAL	10.12	57.1	FAIR	14.40	49.0	FAIR
EBEMH	TSS	SPRING1	12.00	64.3	POOR	15.28	49.3	FAIR
EBEMH	TSS	SPRING2	12.10	64.7	POOR	17.30	60.3	POOR
EBEMH	TSS	SUMMER1	10.84	55.1	FAIR	18.05	64.2	POOR
EBEMH	TSS	SUMMER2	10.40	50.0	FAIR	19.30	65.9	POOR

Table 44 - SAV Season Water quality trends in segment EBEMH (only significant trends are displayed).

Segment	Parameter	Season	Layer	Slope	%Change	pValue	Direction
EBEMH	DIN	SAV1	S	-0.0181	-0.546	0.001	**IMPROVING**
EBEMH	TP	SAV1	S	-0.0021	-0.391	0.000	**IMPROVING**
EBEMH	PO4F	SAV1	S	-0.0021	-0.509	0.001	**IMPROVING**

Table 45 - SAV season water quality status in segment EBEMH (value is the median concentration; secchi in meters, chlorophyll *a* in μg per l, all other parameters in mg per l.).

Segment	Parameter	Status Value	Score	Status	SAV Goal Value	Habitat Requirement
EBEMH	TN	0.747	47.7	**FAIR**	-	-
EBEMH	DIN	0.3012	82.2	**POOR**	0.3012	**FAILS**
EBEMH	TP	0.074	78.8	**POOR**	-	-
EBEMH	PO4F	0.0327	95.8	**POOR**	0.0327	**FAILS**
EBEMH	CHLA	3.4132	5.1	**GOOD**	3.4	**MEETS**
EBEMH	SECCHI	0.8	22.7	**POOR**	-	-
EBEMH	TSS	10.96	57.7	**FAIR**	11.0	**MEETS**
EBEMH	KD	-	-	-	1.80	**FAILS**
EBEMH	PLL05	-	-	-	0.089	**FAILS**
EBEMH	PLL10	-	-	-	0.037	**FAILS**

IV. York River

A. Basin Overview

The York watershed encompasses 3,270 square miles. Population in the York River Basin for 2000 is projected to be 372,488. Major population centers within the watershed include Ashland, Gloucester Point, Hampton, and West Point, Va. Percentage of households within this basin is nearly equally divided between urban and rural areas, at 53% and 46%, respectively. Nutrient and sediment loadings to the York River are primarily from agricultural non-point sources (Figure11). Sprague et al. (1999) described the York River Basin as follows:

"The York River Basin, at 2400 mi^2, is the fifth largest tributary basin to Chesapeake Bay. The York River is formed by the confluence of the Pamunkey and Mattaponi Rivers near West Point, Va. Because these two sub-basins have distinct hydrogeological characteristics, they are monitored separately. The Pamunkey River begins in the eastern part of the Piedmont Physiographic Province and flows into the Coastal Plan Physiographic Province. The Pamunkey River RIM station (01673000) near Hanover, Va., receives drainage from about 45 percent of the York River Basin. The Pamunkey River sub-basin is of relatively low relief and contains Lake Anna approximately 60 miles upstream from the monitoring station. Lake Anna serves to dampen and delay the hydroponic response of the Pamunkey River at the RIM station during storm events."

"The Mattaponi River sub-basin is located north of the Pamunkey River sub-basin, in the Piedmont and Coastal Plain Physiographic provinces. Because a relatively large percentage of the sub-basin is in the Coastal Plain, is of low relief, and contains expanses of wetlands, the Mattaponi River typically experiences lower streamflows and lower concentrations and yields of nutrients relative to the Pamunkey River and the other rivers draining to Chesapeake Bay. The Mattaponi River RIM station (01674500) near Beulahville, Va., receives drainage from about 25 percent of the York River Basin."

"As with the other tributary basins in Virginia, land use in both sub-basins is dominated by forest. Forest makes up 68 percent of the land use upstream of the Pamunkey RIM station and 69 percent upstream of the Mattaponi River RIM station. Agriculture, the second largest land use at 24 percent and 19 percent respectively, is distributed sporadically throughout the sub-basins."

"Of the nine rivers monitored, the Pamunkey River contributes about 2 percent of the streamflow, less than 1 percent of the total nitrogen load, and 2 percent of the total phosphorus load delivered annually from the nontidal part of the Chesapeake Bay Watershed. The Mattaponi River contributes less than 1 percent of the total streamflow, the total nitrogen load, and the total phosphorus load entering the Bay."

B. Overview of Monitoring Results

Long-term trend and status analysis results for water quality are summarized for all stations in York River in Figures 12 and 13. In general, the status of water quality parameters in the York River basin was better in the Pamunkey and Mattaponi rivers and Mobjack Bay than in the York River mainstem. The status of surface and bottom total nitrogen and dissolved inorganic nitrogen was good throughout the Pamunkey and Mattaponi rivers and good to fair in the York River mainstem. The status of total phosphorus fell from good to fair or poor proceeding down the Pamunkey and Mattaponi rivers to the York River mainstem. From the lower Pamunkey and Mattaponi rivers throughout the York River mainstem, the status of dissolved inorganic phosphorus was poor. The status of total suspended solids was poor in the lower Pamunkey and lower Mattaponi rivers and ranged from fair to poor in the mainstem segments of the York River. Status of surface chlorophyll *a* was good in the upper Pamunkey and Mattaponi rivers and Mobjack Bay but fair to poor in the other segments of the York River system.

The majority of improving trends were detected in the Pamunkey and Mattaponi rivers. In the mainstem of the York River there were improving trends in total nitrogen, a degrading bottom total phosphorus trend in the middle York and an improving bottom phosphorus trend in the lower York, and a degrading trend in bottom total suspended solids. These results suggest that management actions within the York River Basin should be focused on the lower Pamunkey and Mattaponi rivers as well as the mainstem of the York River. As with the James River, water clarity appears to be a major problem in the York River as the majority of segments had a status of only poor or fair for both total suspended solids and secchi depth.

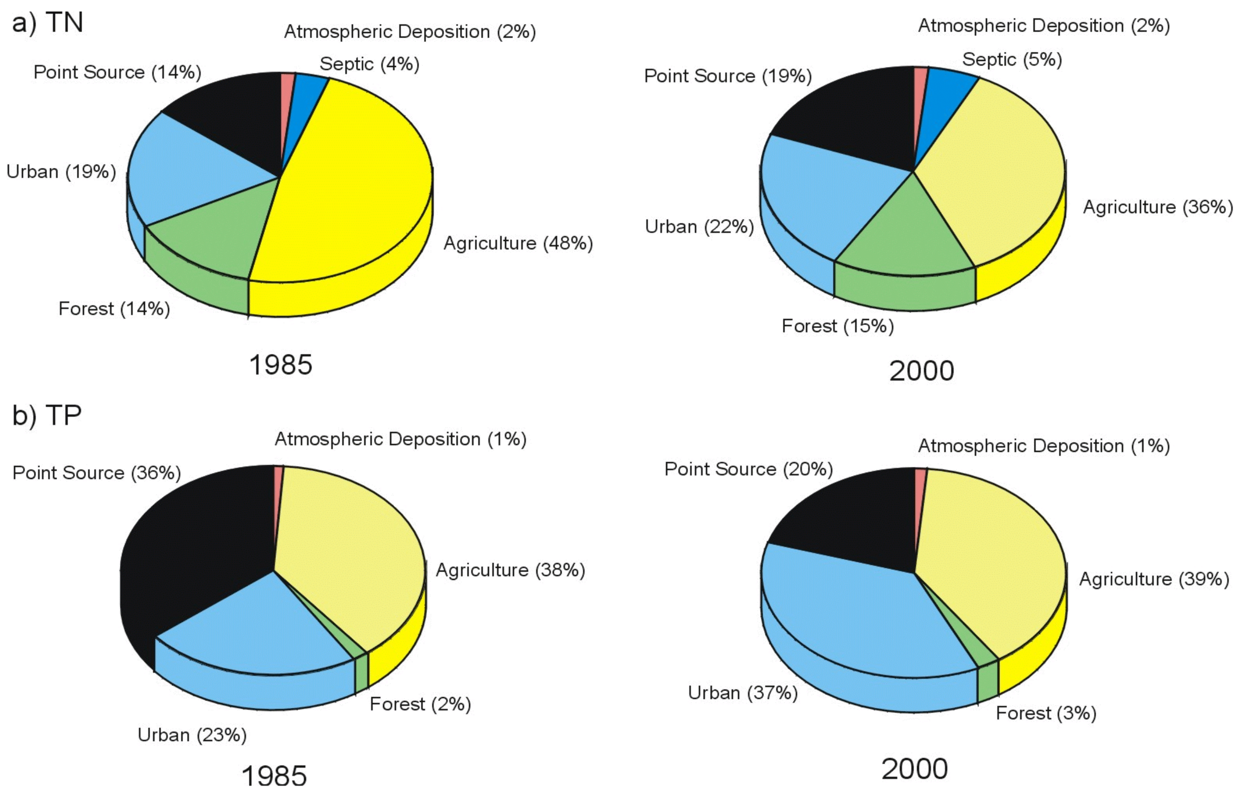
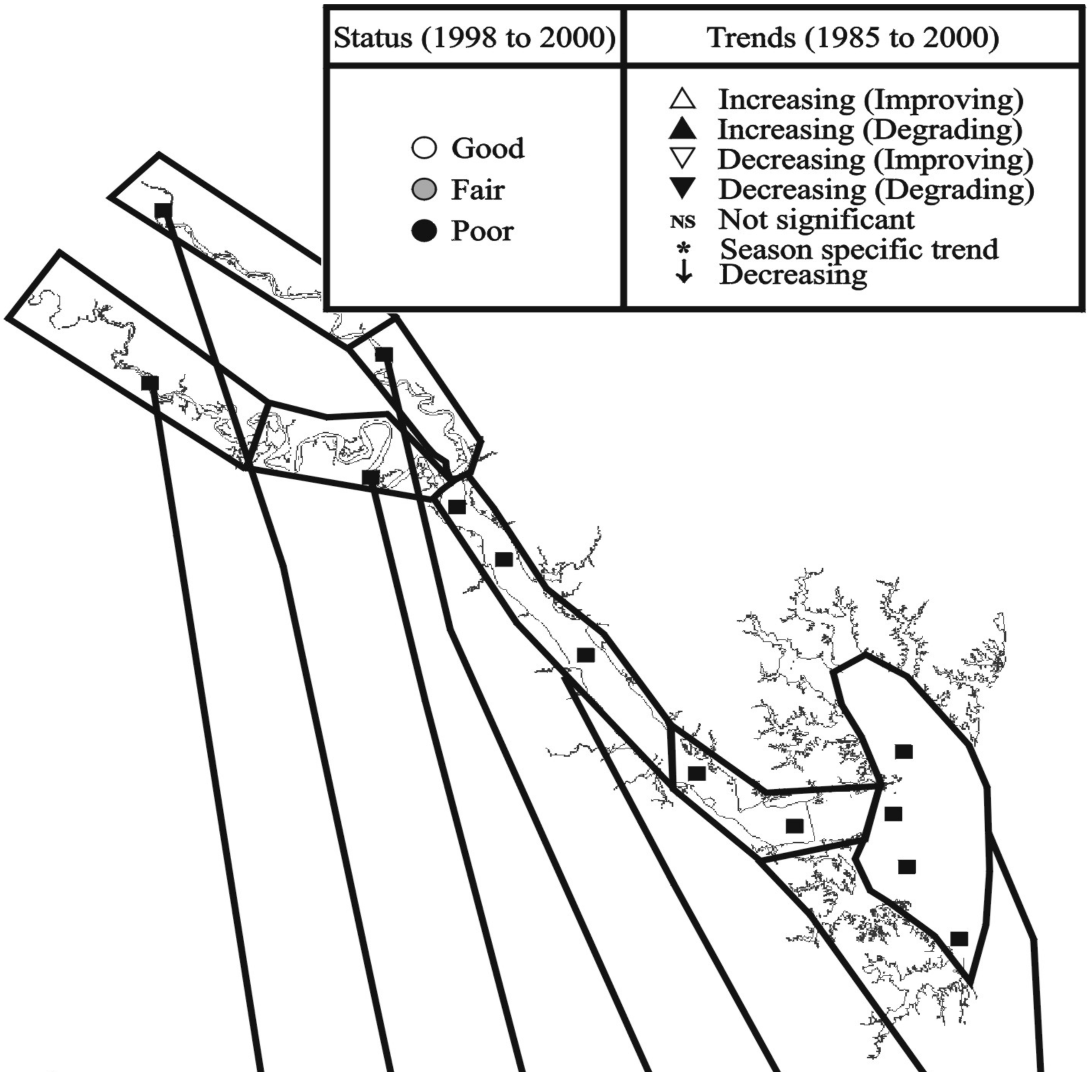
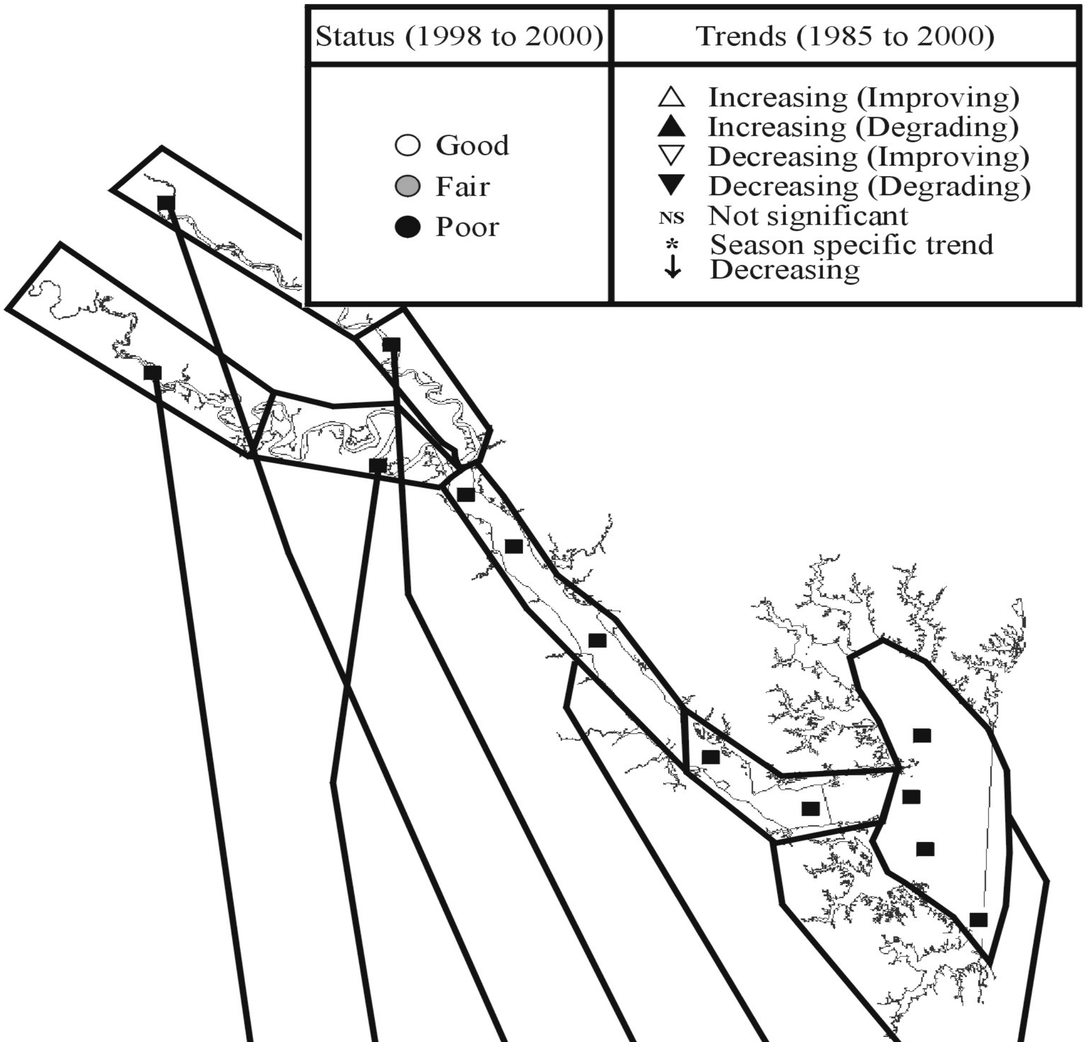


Figure 13. 1985 and 2000 a) total nitrogen and b) total phosphorus contribution to the York River by source.



Parameter	Upper Pamunkey	Lower Pamunkey	Upper Mattaponi	Lower Mattaponi	Middle York	Lower York	Mobjack Bay
STN	Good ▽	Good NS	Good ▽	Good NS	Good ▽	Fair ▽	Fair ▽
BTN	Good ▽	Good NS	Good ▽	Good NS	Fair NS	Poor NS	Fair ▽
SDIN	Good NS	Good NS	Good NS	Good NS	Good ▽	Fair NS	Good NS
BDIN	Good NS	Good NS	Good NS	Good NS	Good NS	Fair NS	Good ▽
STP	Good NS	Fair NS	Good NS	Fair NS	Poor NS	Poor NS	Fair NS
BTP	Good NS	Poor NS	Good NS	Fair NS	Poor ▲	Poor ▽	Good NS
SDIP	Fair ▲	Poor ▲	Good ▲	Poor ▲	Poor NS	Poor NS	Good NS
BDIP	Fair ▲	Poor NS	Fair ▲	Poor ▲	Poor NS	Poor NS	Good NS

Figure 14. Map of the York River basin showing summaries of the status and trend analyses for each segment. Abbreviations for each parameter are: TN= total nitrogen: DIN=dissolved inorganic nitrogen; TP=total phosphorus; DIP=dissolved inorganic nitrogen. The prefixes S and B refer to surface and bottom measurements, respectively.



Parameter	Upper Pamunkey	Lower Pamunkey	Upper Mattaponi	Lower Mattaponi	Middle York	Lower York	Mobjack Bay
SCHLA	○ NS	Fair NS	○ NS	Fair ▲	Poor ▲	Poor NS	○ NS
STSS	Fair NS	Poor NS	○ NS	Poor NS	Poor NS	Fair NS	Fair NS
BTSS	○ ▽	Poor NS	○ NS	Poor NS	Poor ▲	Poor NS	○ NS
SECCHI	○ NS	Fair NS	○ NS	Fair NS	Poor NS	Poor NS	Poor ▼
BDO	○ NS	○ NS	○ NS	○ △	○ △	Fair NS	○ △
SWTEMP	NS	NS	NS	NS	NS	NS	NS
BWTEMP	NS	NS	NS	NS	NS	NS	NS
SSALIN	NS	NS	NS	NS	NS	↓	↓
BSALIN	NS	NS	NS	NS	NS	NS	↓

Figure 15. Map of the York River basin showing summaries of the status and trend analyses for each segment. Abbreviations for each parameter are:CHLA=chlorophyll a: TSS=total suspended solids; SECCHI=secchi depth; DO=dissolved oxygen; WTEMP=water temperature, SALIN=salinity. The prefixes S and B refer to surface and bottom measurements, respectively.

Long-term trend and status analysis results for water quality are summarized for all stations in York River in Figures 14 through 17. A major concern regarding the phytoplankton composition is the poor status prevailing with the dinoflagellates and the increasing trends associated with cyanobacteria abundance. This condition is associated with the frequent summer blooms of dinoflagellates. The dominant phytoplankton throughout the river are the diatoms with the tidal fresh species also associated with increased biomass of the cyanobacteria. Downstream the freshwater diatoms are replaced by estuarine diatoms and dinoflagellates that are common to the Bay waters.

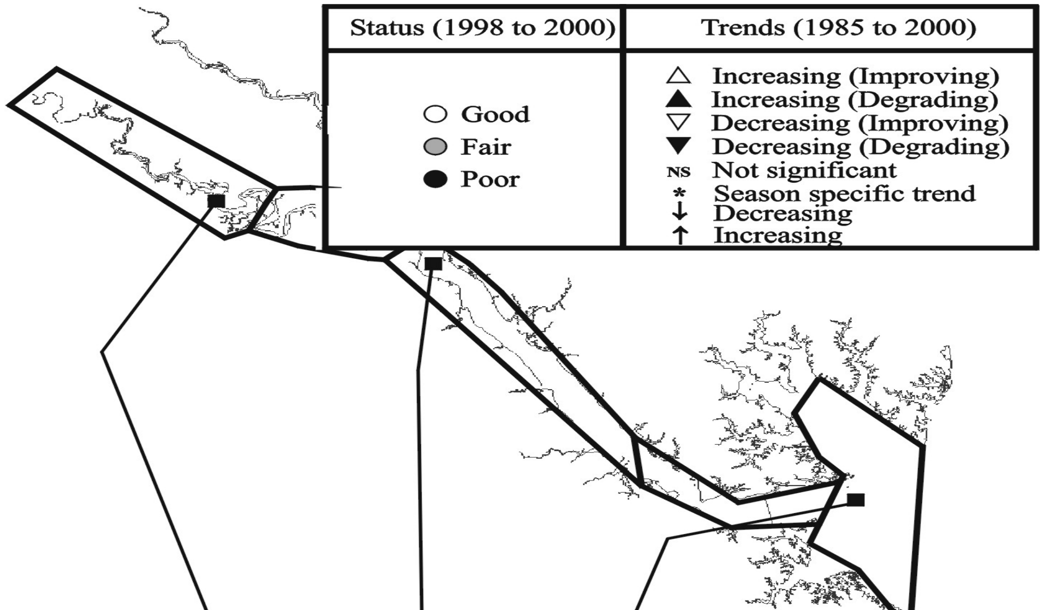
Microzooplankton monitoring results indicate a continued degradation in the middle York and mouth in terms of increasing rotifer abundance. These degrading trends are associated with continued degrading water clarity trends and decreasing salinity. However, degrading trends in copepod nauplii abundance that were evident last year in these segments have disappeared and may indicate some improvement. A change in methodology prevents a critical review of the status and trends in the mesozooplankton monitoring results. However, plots of raw data indicate that relative abundances and numbers of species of mesozooplankton are mostly unchanged from last year. The related water quality trends (mostly secchi depth and salinity) have not changed substantially from last year and therefore it is likely that the general mesozooplankton status and trends have not changed much from last year. Therefore, it is likely that mesozooplankton diversity continues to decline in the lower part of the basin while the upper part of the basin should have continued improving trends.

In the tidal freshwater Pamunkey River (PMKTF) benthic community status was good with improving trends in species diversity, abundance and biomass. In the mesohaline York River (YRKMH), benthic community status varied from good to degraded and degrading trends in the B-IBI, species diversity, and pollution sensitive species were detected at both stations. In the Lower York River (YRKPH), benthic community status ranged from degraded at station LE4.3B to good at station LE4.3. The degraded status at station LE4.3B was related to the short-term hypoxic events that occur at this station.

C. Detailed Overview of Status and Trends

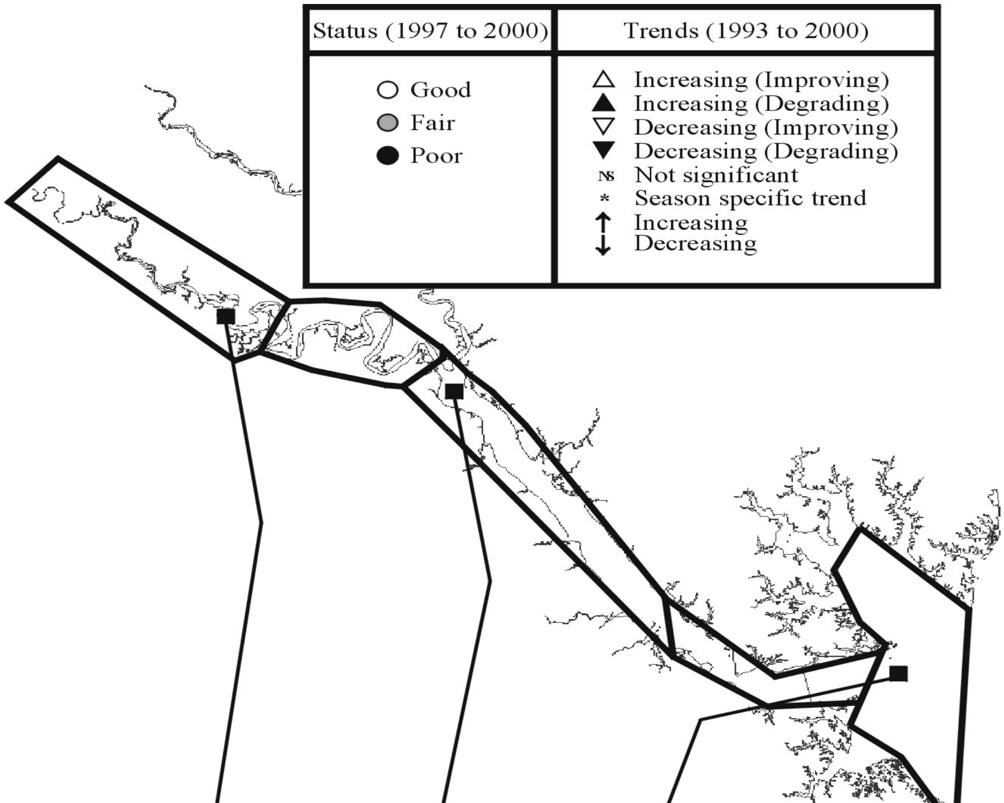
1. Fall Line

In the Pamunkey River above the fall-line, degrading trends were detected in flow adjusted concentrations of total nitrogen, nitrate-nitrites, total phosphorus, and dissolved inorganic phosphorus and total suspended solids. Degrading trends were also detected in flow weighted concentrations of total phosphorus and dissolved inorganic phosphorus. In the Mattaponi River above the fall-line, improving trends were detected in flow-adjusted and flow wieghted concentrations of total nitrogen and nitrate-nitrites (filtered). Degrading trends in flow weighted concentrations of total phosphorus and flow adjusted concentrations of dissolved inorganic phosphorus were detected; however, an improving trend in flow weighted concentrations of total phosphorus was also detected. Degrading trends in flow weighted concentrations of total nitrogen



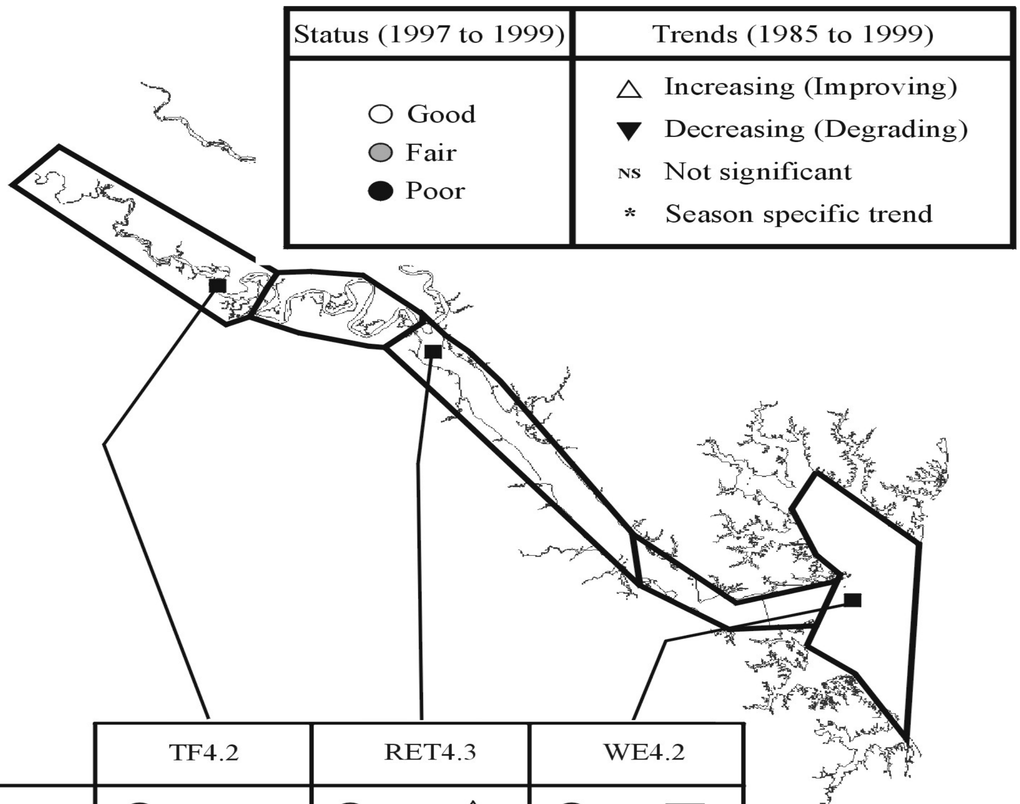
	TF4.2		RET4.3		WE4.2	
Total Abundance		↑		↑		NS
Total Biomass	Poor	↑	Poor	↑	Fair	NS
Biomass to Abundance	Poor	NS	Poor	▼	Poor	NS
Margalef Diversity Index	Fair	NS	Fair	NS	Good	NS
Productivity	Good	▽	Good	NS	Fair	▽
Diatom Biomass	Poor	NS	Fair	NS	Fair	△
Dinoflagellate Biomass	Poor	NS	Poor	NS	Poor	NS
Cyanophyte Biomass	Good	▲	Fair	NS	Poor	NS
Chlorophyte Biomass	Fair	△	Good	△	Good	△
Picoplankton Biomass	Good	▽	Poor	▽	Fair	NS
Cryptophyte Biomass		△		△		NS
Procaryote to Eucaryote Biomass	Good	NS	Good	NS	Good	NS
Cyanophyte Abundance		▲		▲		▲

Figure 16. Map of the York River basin showing summaries of the status and trend analyses for phytoplankton bioindicators for each segment.



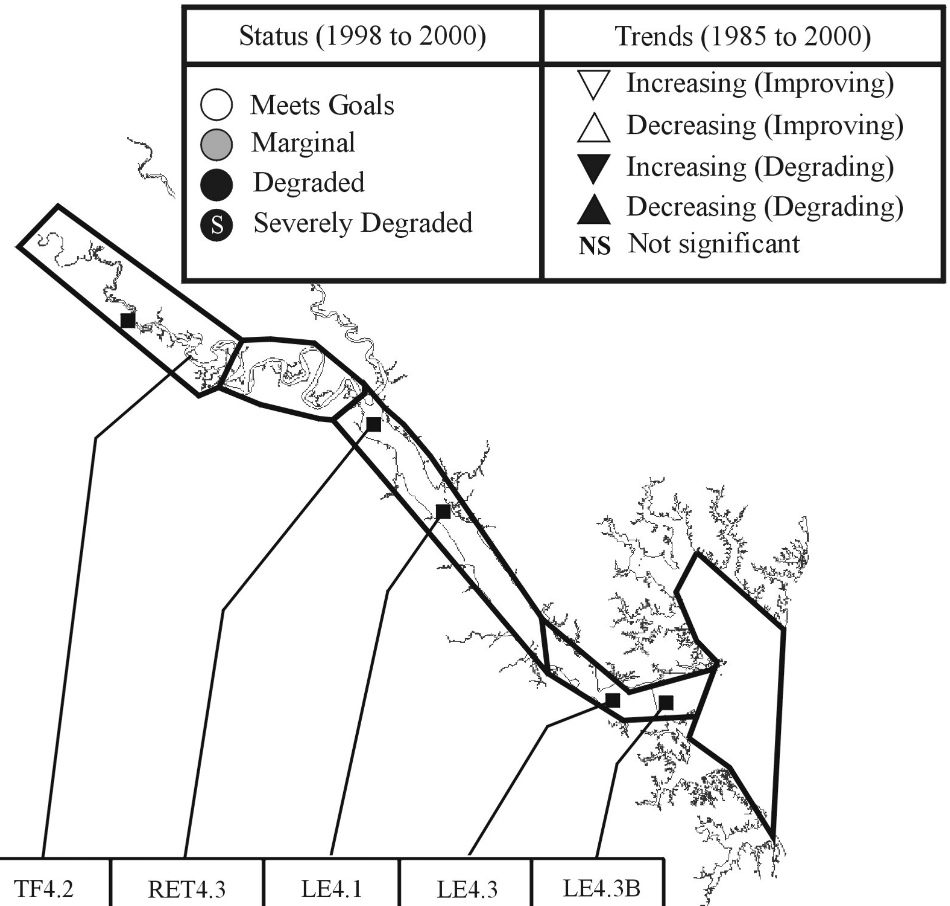
	TF4.2	RET4.3	WE4.2
Total Abundance	NS	NS	NS
Total Biomass	NS	NS	NS
Copepod Nauplii Abundance	● NS	○ NS	◐ NS
Rotifer Abundance	○ NS	● ▲	● ▲
Oligotrich Abundance	NS	NS	NS
Cladoceran Abundance	↓	NS	NS
Tintinnid Abundance	NS	NS	↓
Polychaeta Larvae Abundance	NS	NS	NS

Figure 17. Map of the York River basin showing summaries of the status and trend analyses for microzooplankton bioindicators for each segment.



	TF4.2		RET4.3		WE4.2	
Total Abundance	●	NS	○	△	●	▼
Margalef Diversity Index	○	△	○	△	◍	NS
Shannon Wiener Index	○	△	○	△	◍	▼
Holoplankton Abundance		NS		△		▼
Meroplankton Abundance		NS		△*		▼
Calanoid Abundance		NS		△		▼
Cyclopoid Abundance		NS		NS		NS
Cladoceran Abundance		NS		△		▼*
Crab Zoea Abundance		NS		NS		NS
Acartia tonsa		▼		NS		▼
Eurytemora spp.		▼		NS		NS
Bosmina longirostis		NS		△		NS

Figure 18. Map of the York River basin showing summaries of the status and trend analyses for mesozooplankton bioindicators for each segment.



	TF4.2	RET4.3	LE4.1	LE4.3	LE4.3B
Benthic IBI	○ **NS**	○ ▼	● ▼	○ **NS**	● **NS**
Total Abundance	△	**NS**	**NS**	**NS**	**NS**
Total Biomass	△	**NS**	**NS**	**NS**	**NS**
Pollution Sensitive Species Abundance (%)	**NS**	▼	**NS**	**NS**	**NS**
Pollution Indicative Species Abundance (%)	**NS**	**NS**	**NS**	**NS**	**NS**
Pollution Sensitive Species Biomass (%)	**NS**	**NS**	▼	**NS**	**NS**
Pollution Indicative Species Biomass (%)	**NS**	**NS**	**NS**	**NS**	**NS**
Shannon-Weiner Diversity Index	△	▼	**NS**	**NS**	**NS**

Figure 19. Map of the York River basin showing summaries of the status and trend analyses for benthic bioindicators for each segment.

and nitrates were detected, as well as flow adjusted and flow weighted concentrations of total Kjeldahl nitrogen were detected in the North Anna River. Improving trends in flow adjusted concentrations, flow weighted concentrations and loadings of total phosphorus were also detected (Table 46).

Table 46 - Water quality trends at York RIM stations 1674500 (Mattaponi River near Beulahville), 1673000 (Pamunkey River at Hanover), and 1671020 (North Anna River at Doswell).

Station Name	Parameter	Data Type	Baseline	Status	Slope	%Change	pValue	Direction
Pamunkey River at Hanover	TN	FAC	--	--	0.013	16.00	0.0005	DEGRADING
Pamunkey River at Hanover	NO23F	FAC	--	--	0.024	31.00	0.0000	DEGRADING
Pamunkey River at Hanover	TP	FAC	--	--	0.033	46.00	0.0000	DEGRADING
Pamunkey River at Hanover	TP*	FWC	0.082	0.131	0.099	77.80	0.0001	DEGRADING
Pamunkey River at Hanover	DIP	FAC	--	--	0.069	121.00	0.0000	DEGRADING
Pamunkey River at Hanover	DIP*	FWC	0.017	0.024	0.068	581.28	0.0001	DEGRADING
Pamunkey River at Hanover	TSS	FAC	--	--	0.04	50.00	0.0039	DEGRADING
Mattaponi River at Beulahville	TN	FAC	--	--	-0.015	-15.00	0.0000	IMPROVING
Mattaponi River at Beulahville	TN*	FWC	0.697	1.319	-0.283	-13.95	0.0001	IMPROVING
Mattaponi River at Beulahville	NO23F	FAC	--	--	- 0.029	-27.00	0.0001	IMPROVING
Mattaponi River at Beulahville	NO23F*	FWC	0.172	0.343	- 0.126	-22.52	0.0001	IMPROVING
Mattaponi River at Beulahville	TP	FAC	--	--	- 0.011	-12.00	0.0414	DEGRADING
Mattaponi River at Beulahville	TP*	FWC	0.063	0.222	- 0.027	-12.94	0.0011	IMPROVING
Mattaponi River at Beulahville	DIP	FAC	--	--	0.017	21.00	0.0099	DEGRADING
North Anna River at Doswell	TN	FWC	0.305	0.376	0.029	53.54	0.0001	DEGRADING
North Anna River at Doswell	TKNW*	FAC	--	--	0.011	20.00	0.0383	DEGRADING
North Anna River at Doswell.	TKNW	FWC	0.270	0.301	0.003	14.80	0.0001	DEGRADING
North Anna River at Doswell	NO3W	FWC	0.153	0.082	-0.024	-29.76	0.0002	IMPROVING
North Anna River at Doswell	TP	FAC	--	--	-0.106	-82.00	0.0000	IMPROVING
North Anna River at Doswell	TP	FWC	0.110	0.020	-0.109	-80.45	0.0001	IMPROVING
North Anna River at Doswell	TP	LOAD	0.158	0.016	-0.118	-82.97	0.0001	IMPROVING

2. Mobjack Bay (MOBPH)

Water quality for living resources

Improving trends were detected in surface and bottom total nitrogen, bottom dissolved nitrogen, and bottom dissolved oxygen but a degrading trend was detected in water clarity. In addition, decreasing trends in surface and bottom salinity were detected (Table 47). Status for all parameters was good or fair except for water clarity for which status was poor and degrading (Table 48).

Table 47 -Water quality trends in segment MOBPH (only significant trends are displayed).

Segment	Parameter	Season	Layer	Slope	%Change	pValue	Direction
MOBPH	TN	ANNUAL	S	-0.0045	-0.157	0.001	**IMPROVING**
MOBPH	TN	ANNUAL	B	-0.0046	-0.149	<0.001	**IMPROVING**
MOBPH	DIN	ANNUAL	B	-<0.0019	-0.238	<0.001	**IMPROVING**
MOBPH	DIN	SUMMER2	B	-0.0016	-0.470	0.004	**IMPROVING**
MOBPH	SECCHI	SPRING2	S	-0.0286	-0.333	0.004	**DEGRADING**
MOBPH	SECCHI	ANNUAL	S	-0.0208	-0.228	<0.001	**DEGRADING**
MOBPH	DO	SUMMER1	B	0.0506	0.132	0.003	**IMPROVING**
MOBPH	PLL05	SPRING2	S	-0.0070	-0.320	0.006	**DEGRADING**
MOBPH	PLL05	ANNUAL	S	-0.0039	-0.179	0.003	**DEGRADING**
MOBPH	PLL10	ANNUAL	S	-0.0038	-0.289	0.001	**DEGRADING**
MOBPH	PLL10	SPRING2	S	-0.0066	-0.513	0.005	**DEGRADING**
MOBPH	SALINITY	ANNUAL	S	-0.1467	-0.107	<0.001	**DECREASING**
MOBPH	SALINITY	SUMMER2	S	-0.1931	-0.136	0.002	**DECREASING**
MOBPH	SALINITY	SUMMER1	S	-0.2212	-0.155	<0.001	**DECREASING**
MOBPH	SALINITY	SPRING2	S	-0.2675	-0.210	0.007	**DECREASING**
MOBPH	SALINITY	ANNUAL	B	-0.1392	-0.098	<0.001	**DECREASING**
MOBPH	SALINITY	SPRING2	B	-0.1866	-0.141	0.010	**DECREASING**
MOBPH	SALINITY	SUMMER1	B	-0.1821	-0.126	<0.001	**DECREASING**
MOBPH	SALINITY	SUMMER2	B	-0.1668	-0.116	0.006	**DECREASING**

Table 48 - Water quality status in segment MOBPH (value is the median concentration, secchi in meters, chlorophyll *a* in μg per l, all other parameters in mg per l.).

Segment	Parameter	Season	S Value	S Score	S Status	B Value	B Score	B Status
MOBPH	CHLA	ANNUAL	5.64	41.4	GOOD	-	-	-
MOBPH	CHLA	SPRING1	4.41	22.1	GOOD	-	-	-
MOBPH	CHLA	SPRING2	4.87	33.2	GOOD	-	-	-
MOBPH	CHLA	SUMMER1	9.95	73.6	POOR	-	-	-
MOBPH	CHLA	SUMMER2	10.00	74.0	POOR	-	-	-
MOBPH	DIN	ANNUAL	0.012	12.1	GOOD	0.016	9.3	GOOD
MOBPH	DIN	SPRING1	0.006	8.3	GOOD	0.012	13.8	GOOD
MOBPH	DIN	SPRING2	0.010	23.1	GOOD	0.012	17.0	GOOD
MOBPH	DIN	SUMMER1	0.013	23.9	GOOD	0.025	10.1	GOOD
MOBPH	DIN	SUMMER2	0.012	20.0	GOOD	0.026	5.3	GOOD
MOBPH	DO	SPRING1	-	-	-	9.50	-	GOOD
MOBPH	DO	SPRING2	-	-	-	8.65	-	GOOD
MOBPH	DO	SUMMER1	-	-	-	6.62	-	GOOD
MOBPH	DO	SUMMER2	-	-	-	6.53	-	GOOD
MOBPH	PO4F	ANNUAL	0.002	12.8	GOOD	0.002	9.4	GOOD
MOBPH	PO4F	SPRING1	0.001	5.2	GOOD	0.001	6.5	GOOD
MOBPH	PO4F	SPRING2	0.002	17.4	GOOD	0.002	12.7	GOOD
MOBPH	PO4F	SUMMER1	0.002	16.1	GOOD	0.003	6.5	GOOD
MOBPH	PO4F	SUMMER2	0.002	16.1	GOOD	0.004	3.8	GOOD
MOBPH	SECCHI	ANNUAL	1.20	18.2	POOR	-	-	-
MOBPH	SECCHI	SPRING1	1.30	19.4	POOR	-	-	-
MOBPH	SECCHI	SPRING2	1.15	16.6	POOR	-	-	-
MOBPH	SECCHI	SUMMER1	1.03	15.7	POOR	-	-	-
MOBPH	SECCHI	SUMMER2	1.00	14.1	POOR	-	-	-
MOBPH	TN	ANNUAL	0.427	40.1	FAIR	0.432	45.9	FAIR
MOBPH	TN	SPRING1	0.382	29.4	GOOD	0.397	45.8	FAIR
MOBPH	TN	SPRING2	0.477	52.9	FAIR	0.479	62.6	POOR
MOBPH	TN	SUMMER1	0.481	55.3	FAIR	0.493	56.5	FAIR
MOBPH	TN	SUMMER2	0.490	55.7	FAIR	0.494	54.1	FAIR
MOBPH	TP	ANNUAL	0.027	41.4	FAIR	0.030	25.0	GOOD
MOBPH	TP	SPRING1	0.022	39.1	GOOD	0.026	30.2	GOOD
MOBPH	TP	SPRING2	0.027	48.3	FAIR	0.032	44.7	FAIR
MOBPH	TP	SUMMER1	0.039	55.3	FAIR	0.046	35.5	GOOD
MOBPH	TP	SUMMER2	0.040	53.0	FAIR	0.046	27.4	GOOD
MOBPH	TSS	ANNUAL	9.06	51.7	FAIR	13.43	36.6	GOOD
MOBPH	TSS	SPRING1	7.96	53.3	FAIR	15.45	53.1	FAIR
MOBPH	TSS	SPRING2	8.49	57.3	POOR	15.45	56.6	POOR
MOBPH	TSS	SUMMER1	11.55	64.7	POOR	19.59	51.2	FAIR
MOBPH	TSS	SUMMER2	12.58	60.8	POOR	19.95	48.5	FAIR

Water quality for SAV

An improving trend in surface total nitrogen and degrading trends in secchi depth and the percentage of light at the leaf surface at 1.0 m were detected in this segment (Table 49). Status for most parameters was good except for secchi depth for which status was poor and surface total suspended solids for which status was fair. Although surface dissolved inorganic nitrogen and surface chlorophyll *a* met the SAV habitat requirements, the majority of parameters were borderline (Table 50).

SAV

In 2000, SAV area in MOBPH increased to 3,693.51 ha, 3% more than in 1999 (3,584.49 ha). The Tier I goal was not achieved for MOBPH.

Table 49 - SAV Season Water quality trends in segment MOBPH (only significant trends are displayed).

Segment	Parameter	Season	Layer	Slope	%Change	pValue	Direction
MOBPH	TN	SAV2	S	-0.0052	-0.183	0.010	**IMPROVING**
MOBPH	SECCHI	SAV2	S	-0.0267	-0.238	0.001	**DEGRADING**
MOBPH	PLL10	SAV2	S	-0.0049	-0.296	0.004	**DEGRADING**
MOBPH	SALINITY	SAV2	S	-0.1613	-0.120	0.003	**DECREASING**

Table 50 - SAV season water quality status in segment MOBPH (value is the median concentration; secchi in meters, chlorophyll *a* in μg per l, all other parameters in mg per l.).

Segment	Parameter	Status Value	Score	Status	SAV Goal Value	Habitat Requirement
MOBPH	TN	0.3943	34	**GOOD**	-	-
MOBPH	DIN	0.0112	8.3	**GOOD**	0.0815	**MEETS**
MOBPH	TP	0.0252	37.1	**GOOD**	-	-
MOBPH	PO4F	0.0015	11.1	**GOOD**	0.0090	**BORDERLINE**
MOBPH	CHLA	5.3567	40.2	**GOOD**	6.4	**MEETS**
MOBPH	SECCHI	1.2	16.2	**POOR**	-	-
MOBPH	TSS	8	51.2	**FAIR**	10.5	**BORDERLINE**
MOBPH	KD	-	-	-	1.50	**BORDERLINE**
MOBPH	PLL05	-	-	-	0.229	**BORDERLINE**
MOBPH	PLL10	-	-	-	0.114	**BORDERLINE**

Living Resources

Although there were no significant trends in total phytoplankton biomass or abundance, there were increases in diatoms and chlorophytes biomass, and cyanobacteria abundance. The dinoflagellate biomass and cyanobacteria biomass both had poor status, without any trends. The procaryote:eucaryote ratio status remains fair, showing no significant trends in the balance between these categories. Species diversity did not indicate any change, with productivity rates with a declining trend.

Degrading annual trends are evident in microzooplankton parameters as an increase in rotifer abundance. This parameter also had poor status. This is likely associated with continued poor water clarity parameters and declining salinity. However, copepod nauplii abundance was good and a degrading trend in this parameter that appeared last year has disappeared this year indicating that there may be some improvement in this region.

Benthic monitoring is not conducted within this segment and it is recommended that monitoring of benthic communities be conducted within this segment.

3. Polyhaline York River (YRKPH- Lower York)

Water quality for living resources

An improving trend was detected in surface total nitrogen while a degrading trend in surface total phosphorus was also detected (Table 51). The status of most parameters was either fair or poor. Phosphorus parameters were poor at all depths (Table 52).

Table 51 - Water quality trends in segment YRKPH (only significant trends are displayed).

Segment	Parameter	Season	Layer	Slope	% Change	pValue	Direction
YRKPH	TN	ANNUAL	S	-0.0096	-0.272	<0.001	IMPROVING
YRKPH	TN	SUMMER1	S	-0.0091	-0.270	0.005	IMPROVING
YRKPH	TP	ANNUAL	B	0.0011	0.335	0.001	DEGRADING
YRKPH	PLL05	SPRING1	S	-0.0177	-0.704	<0.001	DEGRADING
YRKPH	PLL05	SPRING2	S	-0.0147	-0.504	0.003	DEGRADING
YRKPH	PLL10	SPRING2	S	-0.0108	-0.530	0.003	DEGRADING
YRKPH	PLL10	SPRING1	S	-0.0131	-0.783	<0.001	DEGRADING
YRKPH	SALINITY	ANNUAL	S	-0.1429	-0.111	0.002	DECREASING
YRKPH	SALINITY	SUMMER1	S	-0.2500	-0.176	0.001	DECREASING
YRKPH	SALINITY	SUMMER2	S	-0.2650	-0.185	0.002	DECREASING
YRKPH	SALINITY	SUMMER1	B	-0.2187	-0.146	0.002	DECREASING
YRKPH	SALINITY	SUMMER2	B	-0.1907	-0.126	0.010	DECREASING
YRKPH	WTEMP	SPRING2	B	-0.1354	-0.115	0.009	DECREASING

Water quality for SAV

No trends in water quality parameters were detected in this segment during the SAV growing season. Status for all parameters was either fair or poor. Only surface dissolved inorganic nitrogen met the SAV habitat requirements (Table 53).

SAV

In 2000, SAV area in YRKPH increased to 308.39 ha, 17% more than in 1999 (264.55 ha). The Tier I goal was not met for YRKPH.

Table 52 - Water quality status in segment YRKPH (value is the median concentration, secchi in meters, chlorophyll *a* in μg per l, all other parameters in mg per l.).

Segment	Parameter	Season	S Value	S Score	S Status	B Value	B Score	B Status
YRKPH	CHLA	ANNUAL	7.75	61.0	POOR	-	-	-
YRKPH	CHLA	SPRING1	6.52	36.3	GOOD	-	-	-
YRKPH	CHLA	SPRING2	7.00	47.3	FAIR	-	-	-
YRKPH	CHLA	SUMMER1	9.93	76.3	POOR	-	-	-
YRKPH	CHLA	SUMMER2	9.95	77.9	POOR	-	-	-
YRKPH	DIN	ANNUAL	0.046	52.1	FAIR	0.048	43.2	FAIR
YRKPH	DIN	SPRING1	0.017	26.1	GOOD	0.030	57.3	FAIR
YRKPH	DIN	SPRING2	0.043	62.2	POOR	0.036	58.8	FAIR
YRKPH	DIN	SUMMER1	0.066	83.3	POOR	0.102	48.0	FAIR
YRKPH	DIN	SUMMER2	0.067	77.7	POOR	0.148	51.7	FAIR
YRKPH	DO	SPRING1	-	-	-	7.85	-	GOOD
YRKPH	DO	SPRING2	-	-	-	7.08	-	GOOD
YRKPH	DO	SUMMER1	-	-	-	3.88	-	FAIR
YRKPH	DO	SUMMER2	-	-	-	3.90	-	FAIR
YRKPH	PO4F	ANNUAL	0.012	74.4	POOR	0.015	72.1	POOR
YRKPH	PO4F	SPRING1	0.007	68.2	POOR	0.006	52.1	FAIR
YRKPH	PO4F	SPRING2	0.007	72.6	POOR	0.008	68.1	POOR
YRKPH	PO4F	SUMMER1	0.018	81.3	POOR	0.033	83.5	POOR
YRKPH	PO4F	SUMMER2	0.024	85.1	POOR	0.041	83.8	POOR
YRKPH	SECCHI	ANNUAL	1.10	12.9	POOR	-	-	-
YRKPH	SECCHI	SPRING1	0.90	6.6	POOR	-	-	-
YRKPH	SECCHI	SPRING2	0.90	7.9	POOR	-	-	-
YRKPH	SECCHI	SUMMER1	1.00	10.7	POOR	-	-	-
YRKPH	SECCHI	SUMMER2	1.00	14.2	POOR	-	-	-
YRKPH	TN	ANNUAL	0.459	44.7	FAIR	0.530	62.9	POOR
YRKPH	TN	SPRING1	0.444	44.8	FAIR	0.585	69.5	POOR
YRKPH	TN	SPRING2	0.444	48.5	FAIR	0.585	75.4	POOR
YRKPH	TN	SUMMER1	0.497	53.6	FAIR	0.582	70.9	POOR
YRKPH	TN	SUMMER2	0.523	63.7	POOR	0.586	71.7	POOR
YRKPH	TP	ANNUAL	0.047	83.7	POOR	0.069	83.4	POOR
YRKPH	TP	SPRING1	0.039	84.1	POOR	0.050	84.8	POOR
YRKPH	TP	SPRING2	0.043	86.8	POOR	0.054	86.9	POOR
YRKPH	TP	SUMMER1	0.072	92.4	POOR	0.087	89.4	POOR
YRKPH	TP	SUMMER2	0.077	92.0	POOR	0.091	89.6	POOR
YRKPH	TSS	ANNUAL	12.25	56.9	FAIR	25.75	74.7	POOR
YRKPH	TSS	SPRING1	18.00	84.2	POOR	29.00	82.2	POOR
YRKPH	TSS	SPRING2	13.50	78.6	POOR	29.00	93.9	POOR
YRKPH	TSS	SUMMER1	11.50	55.4	FAIR	26.50	83.4	POOR
YRKPH	TSS	SUMMER2	10.50	51.2	FAIR	23.50	69.3	POOR

Table 53 - SAV season water quality status in segment YRKPH (value is the median concentration; secchi in meters, chlorophyll *a* in μg per l, all other parameters in mg per l.).

Segment	Parameter	Status Value	Score	Status	SAV Goal Value	Habitat Requirement
YRKPH	TN	0.4695	49.1	**FAIR**	-	-
YRKPH	DIN	0.0705	69.3	**POOR**	0.0830	**MEETS**
YRKPH	TP	0.0462	81.6	**POOR**	-	-
YRKPH	PO4F	0.0113	66.6	**POOR**	0.0210	**FAILS**
YRKPH	CHLA	6.515	47.7	**FAIR**	16.1	**BORDERLINE**
YRKPH	SECCHI	1	7.8	**POOR**	-	-
YRKPH	TSS	12	60.6	**POOR**	25.0	**FAILS**
YRKPH	KD	-	-	-	2.90	**FAILS**
YRKPH	PLL05	-	-	-	0.055	**FAILS**
YRKPH	PLL10	-	-	-	0.013	**FAILS**

Living Resources

Phytoplankton and zooplankton monitoring is not conducted within this segment. It is recommended that additional monitoring stations for these programs be added to this segment.

Benthic community status was degraded. The degraded status was found at the station in the channel subjected to short-term hypoxia while the station with good status was located on the shoal.

4. Mesohaline York River (YRKMH - Middle York)

Water quality for living resources

Improving trends in surface total nitrogen, surface dissolved inorganic nitrogen, and bottom dissolved oxygen were detected. Degrading trends in bottom total phosphorus, surface chlorophyll *a*, and bottom total suspended solids were detected (Table 54). Status of surface total nitrogen, surface and bottom dissolved inorganic nitrogen, and bottom dissolved oxygen was good. Status of bottom total nitrogen was fair. Status of surface and bottom total phosphorus, dissolved inorganic phosphorus and total suspended solids along with surface chlorophyll *a* and secchi depth was poor (Table 55).

Water quality for SAV

No trends in water quality parameters were detected in this segment (Table 56). Status for most parameters was poor except surface total nitrogen and surface dissolved inorganic nitrogen for which status was good. No parameters met the SAV habitat requirements (Table 57).

SAV

No SAV has been mapped by the aerial survey for YRKMH since 1974.

Living Resources

There are increasing trends in the total phytoplankton biomass and abundance, with both having a poor status. Compared to 1999, improved status was associated with diatoms (poor to fair status), with negative patterns associated with cyanobacteria (good to fair) and autotrophic picoplankton (good to fair). The dinoflagellate biomass remained poor. However, there were no significant trends with the biomass:abundance and procaryote:eukaryote ratios. There were no significant trends associated with species diversity or productivity rates.

Annual trends are degrading for microzooplankton as seen in an increase in rotifer abundance and poor rotifer abundance status. However, a degrading trend in copepod nauplii abundance that was evident from last year has disappeared, and copepod nauplii abundance status is good indicating some improvement for this region.

Benthic community status varied from good to degraded and both benthic monitoring stations showed degrading trends in the B-IBI, species diversity and pollution sensitive species.

Table 54 -Water quality trends in segment YRKMH (only significant trends are displayed).

Segment	Parameter	Season	Layer	Slope	%Change	pValue	Direction
YRKMH	TN	ANNUAL	S	-0.0075	-0.178	0.001	IMPROVING
YRKMH	TN	SPRING2	B	0.0227	0.565	0.008	DEGRADING
YRKMH	DIN	ANNUAL	S	-0.0032	.	0.006	IMPROVING
YRKMH	TP	ANNUAL	B	0.0024	0.452	<0.001	DEGRADING
YRKMH	TP	SPRING2	B	0.0043	0.809	0.010	DEGRADING
YRKMH	CHLA	ANNUAL	S	0.2795	0.469	0.010	DEGRADING
YRKMH	TSS	ANNUAL	B	2.3939	0.909	0.001	DEGRADING

Table 55 - Water quality status in segment YRKMH (value is the median concentration, secchi in meters, chlorophyll *a* in μg per l, all other parameters in mg per l.).

Segment	**Parameter**	**Season**	**S Value**	**S Score**	**S Status**	**B Value**	**B Score**	**B Status**
YRKMH	CHLA	ANNUAL	15.98	76.6	POOR	-	-	-
YRKMH	CHLA	SPRING1	15.45	79.2	POOR	-	-	-
YRKMH	CHLA	SPRING2	17.09	75.4	POOR	-	-	-
YRKMH	CHLA	SUMMER1	18.27	71.2	POOR	-	-	-
YRKMH	CHLA	SUMMER2	19.43	69.0	POOR	-	-	-
YRKMH	DIN	ANNUAL	0.081	30.0	GOOD	0.090	17.4	GOOD
YRKMH	DIN	SPRING1	0.071	16.3	GOOD	0.058	2.7	GOOD
YRKMH	DIN	SPRING2	0.063	18.9	GOOD	0.051	12.1	GOOD
YRKMH	DIN	SUMMER1	0.067	41.9	FAIR	0.083	23.4	GOOD
YRKMH	DIN	SUMMER2	0.079	46.3	FAIR	0.083	25.5	GOOD
YRKMH	DO	SPRING1	-	-	-	8.20	-	GOOD
YRKMH	DO	SPRING2	-	-	-	6.15	-	GOOD
YRKMH	DO	SUMMER1	-	-	-	5.07	-	GOOD
YRKMH	DO	SUMMER2	-	-	-	4.85	-	FAIR
YRKMH	PO4F	ANNUAL	0.019	92.0	POOR	0.019	84.6	POOR
YRKMH	PO4F	SPRING1	0.009	83.9	POOR	0.008	83.7	POOR
YRKMH	PO4F	SPRING2	0.011	87.0	POOR	0.011	79.7	POOR
YRKMH	PO4F	SUMMER1	0.026	91.0	POOR	0.027	76.5	POOR
YRKMH	PO4F	SUMMER2	0.034	92.3	POOR	0.032	77.6	POOR
YRKMH	SECCHI	ANNUAL	0.58	8.4	POOR	-	-	-
YRKMH	SECCHI	SPRING1	0.50	5.1	POOR	-	-	-
YRKMH	SECCHI	SPRING2	0.50	6.3	POOR	-	-	-
YRKMH	SECCHI	SUMMER1	0.55	7.6	POOR	-	-	-
YRKMH	SECCHI	SUMMER2	0.55	7.7	POOR	-	-	-
YRKMH	TN	ANNUAL	0.654	31.0	GOOD	0.821	52.5	FAIR
YRKMH	TN	SPRING1	0.714	24.8	GOOD	0.889	57.3	FAIR
YRKMH	TN	SPRING2	0.714	28.4	GOOD	1.018	73.6	POOR
YRKMH	TN	SUMMER1	0.618	28.0	GOOD	0.880	62.2	POOR
YRKMH	TN	SUMMER2	0.636	36.1	GOOD	0.819	53.5	FAIR
YRKMH	TP	ANNUAL	0.091	88.1	POOR	0.124	92.9	POOR
YRKMH	TP	SPRING1	0.097	90.2	POOR	0.146	96.7	POOR
YRKMH	TP	SPRING2	0.087	90.6	POOR	0.179	97.2	POOR
YRKMH	TP	SUMMER1	0.092	83.3	POOR	0.138	92.1	POOR
YRKMH	TP	SUMMER2	0.104	82.8	POOR	0.124	89.2	POOR
YRKMH	TSS	ANNUAL	25.25	90.9	POOR	78.00	95.8	POOR
YRKMH	TSS	SPRING1	24.50	91.6	POOR	97.50	97.8	POOR
YRKMH	TSS	SPRING2	24.00	91.3	POOR	98.00	97.9	POOR
YRKMH	TSS	SUMMER1	26.50	92.1	POOR	88.25	96.9	POOR
YRKMH	TSS	SUMMER2	27.00	91.5	POOR	77.00	95.6	POOR

Table 56 - SAV season water quality status in segment YRKMH (value is the median concentration; secchi in meters, chlorophyll *a* in μg per l, all other parameters in mg per l.).

Segment	Parameter	Status Value	Score	Status	SAV Goal Value	Habitat Requirement
YRKMH	TN	0.6285	28.8	**GOOD**	-	-
YRKMH	DIN	0.071	36.7	**GOOD**	0.2205	-
YRKMH	TP	0.0905	86.1	**POOR**	-	-
YRKMH	PO4F	0.02	91.2	**POOR**	0.0240	**FAILS**
YRKMH	CHLA	16.1	72.4	**POOR**	10.7	**BORDERLINE**
YRKMH	SECCHI	0.6	7.4	**POOR**	-	-
YRKMH	TSS	25	90.8	**POOR**	48.0	**FAILS**
YRKMH	KD	-	-	-	3.60	**FAILS**
YRKMH	PLL05	-	-	-	0.008	**FAILS**
YRKMH	PLL10	-	-	-	0.001	**FAILS**

5. Oligohaline Pamunkey River (PMKOH - Lower Pamunkey)

Water quality for living resources

No improving trends were detected, while a degrading trend was detected in surface dissolved inorganic phosphorus (Table 58). Status for surface and bottom total nitrogen, surface and bottom dissolved inorganic nitrogen and bottom dissolved oxygen was good. Status for surface total phosphorus, surface chlorophyll *a* and water clarity was fair. Status for surface and bottom dissolved inorganic phosphorus, bottom total phosphorus and total suspended solids was poor (Table 59).

Water quality for SAV

A degrading trend in surface dissolved inorganic phosphorus was detected in this segment (Table 60). Status of surface total nitrogen, surface dissolved inorganic nitrogen and surface chlorophyll *a* was good while status of surface dissolved inorganic phosphorus and surface total suspended solids was poor. Status of surface total phosphorus and secchi depth was fair. SAV habitat requirements were met for chlorophyll *a* but not met for the percentage of light at the leaf surface at 1.0 m while the remaining parameters were borderline (Table 60).

SAV

This segment was not surveyed during 1999 and 2000 due to poor weather conditions. The Tier I goal has not been established for this segment.

Living Resources

Living resource monitoring is not conducted within this segment.

Table 57 -Water quality trends in segment PMKOH (only significant trends are displayed).

Segment	Parameter	Season	Layer	Slope	%Change	pValue	Direction
PMKOH	PO4F	ANNUAL	S	<0.0013	.	0.001	DEGRADING

Table 58 - Water quality status in segment PMKOH (value is the median concentration, secchi in meters, chlorophyll *a* in μg per l, all other parameters in mg per l.).

Segment	Parameter	Season	S Value	S Score	S Status	B Value	B Score	B Status
PMKOH	CHLA	ANNUAL	9.29	44.6	FAIR	-	-	-
PMKOH	CHLA	SPRING1	4.40	17.6	GOOD	-	-	-
PMKOH	CHLA	SPRING2	5.50	21.9	GOOD	-	-	-
PMKOH	CHLA	SUMMER1	12.30	41.5	FAIR	-	-	-
PMKOH	CHLA	SUMMER2	12.70	39.1	GOOD	-	-	-
PMKOH	DIN	ANNUAL	0.223	24.0	GOOD	0.211	21.7	GOOD
PMKOH	DIN	SPRING1	0.261	10.0	GOOD	0.251	9.0	GOOD
PMKOH	DIN	SPRING2	0.251	19.4	GOOD	0.232	16.9	GOOD
PMKOH	DIN	SUMMER1	0.197	44.3	FAIR	0.193	41.6	FAIR
PMKOH	DIN	SUMMER2	0.185	48.4	FAIR	0.190	47.1	FAIR
PMKOH	DO	SPRING1	-	-	-	8.15	-	GOOD
PMKOH	DO	SPRING2	-	-	-	7.00	-	GOOD
PMKOH	DO	SUMMER1	-	-	-	5.05	-	GOOD
PMKOH	DO	SUMMER2	-	-	-	4.93	-	FAIR
PMKOH	PO4F	ANNUAL	0.023	76.3	POOR	0.023	74.7	POOR
PMKOH	PO4F	SPRING1	0.018	71.6	POOR	0.018	71.3	POOR
PMKOH	PO4F	SPRING2	0.018	67.7	POOR	0.018	66.8	POOR
PMKOH	PO4F	SUMMER1	0.024	74.5	POOR	0.024	70.9	POOR
PMKOH	PO4F	SUMMER2	0.025	76.7	POOR	0.024	70.7	POOR
PMKOH	SECCHI	ANNUAL	0.40	44.7	FAIR	-	-	-
PMKOH	SECCHI	SPRING1	0.25	22.6	POOR	-	-	-
PMKOH	SECCHI	SPRING2	0.25	17.9	POOR	-	-	-
PMKOH	SECCHI	SUMMER1	0.50	58.8	FAIR	-	-	-
PMKOH	SECCHI	SUMMER2	0.50	54.0	FAIR	-	-	-
PMKOH	TN	ANNUAL	0.751	10.4	GOOD	1.014	21.4	GOOD
PMKOH	TN	SPRING1	0.848	9.7	GOOD	1.301	25.6	GOOD
PMKOH	TN	SPRING2	0.822	12.0	GOOD	1.216	29.0	GOOD
PMKOH	TN	SUMMER1	0.696	13.0	GOOD	0.974	29.4	GOOD
PMKOH	TN	SUMMER2	0.688	13.9	GOOD	0.946	30.0	GOOD
PMKOH	TP	ANNUAL	0.099	54.0	FAIR	0.172	72.5	POOR
PMKOH	TP	SPRING1	0.123	64.3	POOR	0.176	69.2	POOR
PMKOH	TP	SPRING2	0.124	64.7	POOR	0.190	72.4	POOR
PMKOH	TP	SUMMER1	0.099	49.3	FAIR	0.187	73.8	POOR
PMKOH	TP	SUMMER2	0.091	42.7	FAIR	0.183	72.5	POOR
PMKOH	TSS	ANNUAL	48.00	83.6	POOR	93.00	86.7	POOR
PMKOH	TSS	SPRING1	73.00	90.8	POOR	115.50	86.0	POOR
PMKOH	TSS	SPRING2	76.00	93.4	POOR	148.00	93.1	POOR
PMKOH	TSS	SUMMER1	34.00	75.1	POOR	97.50	88.3	POOR
PMKOH	TSS	SUMMER2	35.00	78.3	POOR	93.00	87.1	POOR

Table 59 - SAV Season Water quality trends in segment PMKOH (only significant trends are displayed).

Segment	Parameter	Season	Layer	Slope	%Change	pValue	Direction
PMKOH	PO4F	SAV1	S	0.0005	0.914	0.004	DEGRADING

Table 60 - SAV season water quality status in segment PMKOH (value is the median concentration; secchi in meters, chlorophyll *a* in μg per l, all other parameters in mg per l.).

Segment	Parameter	Status Value	Score	Status	SAV Goal Value	Habitat Requirement
PMKOH	TN	0.728	12.4	GOOD	-	-
PMKOH	DIN	0.2205	35.4	GOOD	0.2330	-
PMKOH	TP	0.1092	58.1	FAIR	-	-
PMKOH	PO4F	0.024	76.5	POOR	0.0230	BORDERLINE
PMKOH	CHLA	10.72	39	GOOD	3.2	MEETS
PMKOH	SECCHI	0.4	42.6	FAIR	-	-
PMKOH	TSS	48	85.5	POOR	16.0	BORDERLINE
PMKOH	KD	-	-	-	2.40	BORDERLINE
PMKOH	PLL05	-	-	-	0.084	BORDERLINE
PMKOH	PLL10	-	-	-	0.032	FAILS

6. Tidal Freshwater Pamunkey River (PMKTF - Upper Pamunkey)

Water quality for living resources

Improving trends were detected for surface and bottom total nitrogen and bottom total suspended solids, while degrading trends were detected for surface and bottom dissolved inorganic phosphorus (Table 61). Status for all parameters was good except for surface and bottom dissolved inorganic phosphorus and surface total suspended solids which were fair (Table 62).

Water quality for SAV

An improving trend in surface total nitrogen and a degrading trend in surface dissolved inorganic phosphorus were detected in this segment (Table 63). Status of all parameters was good except for surface dissolved inorganic phosphorus and surface total suspended solids for which status was fair. All parameters failed to meet the SAV habitat requirements except for surface dissolved inorganic phosphorus and surface chlorophyll *a* which were borderline (Table 64).

SAV

This segment was not mapped during 1999 due to poor weather conditions; however, a total of 70.43 ha were reported for this segment in 2000. The Tier I goal has not been established for this segment.

Living Resources

Total phytoplankton abundance and biomass had increasing trends, with the biomass and abundance of cyanobacteria also having increasing trends, along with chlorophyte and cryptophyte biomass. A decreasing trend in the autotrophic picoplankton was also present, producing a combination of favorable and unfavorable trends overall. There were no significant trends among the diatoms or dinoflagellates, with both having poor status. The production rates showed a decreasing trend, with no significant change in species diversity, nor in the procaryote:eukaryote ratio.

No significant annual trends in microzooplankton were evident for this region, as in the past few years. Rotifer abundance status is good while copepod nauplii abundance status is poor. These mixed monitoring results may reflect the mixed degrading and improving trends evident for water quality parameters for this region.

The general improving zooplankton trends are perhaps related to improvements in water quality such as nitrogen concentrations.

Benthic community status was good with improving trends in species diversity, abundance and biomass.

Table 61 -Water quality trends in segment PMKTF (only significant trends are displayed).

Segment	Parameter	Season	Layer	Slope	%Change	pValue	Direction
PMKTF	TN	SUMMER2	S	-0.0150	-0.272	0.004	**IMPROVING**
PMKTF	TN	ANNUAL	S	-0.0095	-0.201	<0.001	**IMPROVING**
PMKTF	TN	SUMMER1	S	-0.0127	-0.230	0.005	**IMPROVING**
PMKTF	TN	ANNUAL	B	-0.0102	-0.205	<0.001	**IMPROVING**
PMKTF	PO4F	ANNUAL	S	<0.0017	.	<0.001	**DEGRADING**
PMKTF	PO4F	SPRING1	S	0.0010	.	<0.001	**DEGRADING**
PMKTF	PO4F	SPRING2	S	<0.0019	0.720	0.001	**DEGRADING**
PMKTF	PO4F	ANNUAL	B	<0.0017	.	<0.001	**DEGRADING**
PMKTF	PO4F	SPRING1	B	0.0011	.	<0.001	**DEGRADING**
PMKTF	PO4F	SPRING2	B	0.0012	1.536	<0.001	**DEGRADING**
PMKTF	TSS	ANNUAL	B	-0.6667	-0.520	0.005	**IMPROVING**
PMKTF	WTEMP	SUMMER2	S	0.1601	0.100	0.001	**INCREASING**
PMKTF	WTEMP	SUMMER2	B	0.1450	0.089	0.007	**INCREASING**

Table 62 - Water quality status in segment PMKTF (value is the median concentration, secchi in meters, chlorophyll *a* in μg per l, all other parameters in mg per l.).

Segment	Parameter	Season	S Value	S Score	S Status	B Value	B Score	B Status
PMKTF	CHLA	ANNUAL	2.35	15.9	GOOD	-	-	-
PMKTF	CHLA	SPRING1	1.16	4.0	GOOD	-	-	-
PMKTF	CHLA	SPRING2	2.53	12.1	GOOD	-	-	-
PMKTF	CHLA	SUMMER1	5.60	19.8	GOOD	-	-	-
PMKTF	CHLA	SUMMER2	6.70	22.3	GOOD	-	-	-
PMKTF	DIN	ANNUAL	0.315	16.6	GOOD	0.309	14.0	GOOD
PMKTF	DIN	SPRING1	0.368	13.5	GOOD	0.349	10.2	GOOD
PMKTF	DIN	SPRING2	0.342	14.6	GOOD	0.338	11.1	GOOD
PMKTF	DIN	SUMMER1	0.151	9.0	GOOD	0.152	8.7	GOOD
PMKTF	DIN	SUMMER2	0.126	8.5	GOOD	0.140	10.3	GOOD
PMKTF	DO	SPRING1	-	-	-	8.60	-	GOOD
PMKTF	DO	SPRING2	-	-	-	7.20	-	GOOD
PMKTF	DO	SUMMER1	-	-	-	5.27	-	GOOD
PMKTF	DO	SUMMER2	-	-	-	5.08	-	GOOD
PMKTF	PO4F	ANNUAL	0.021	46.1	FAIR	0.021	54.2	FAIR
PMKTF	PO4F	SPRING1	0.023	54.5	FAIR	0.023	62.9	POOR
PMKTF	PO4F	SPRING2	0.024	55.2	FAIR	0.025	64.8	POOR
PMKTF	PO4F	SUMMER1	0.018	39.8	FAIR	0.022	55.0	FAIR
PMKTF	PO4F	SUMMER2	0.019	42.2	FAIR	0.019	51.1	FAIR
PMKTF	SECCHI	ANNUAL	0.63	64.0	GOOD	-	-	-
PMKTF	SECCHI	SPRING1	0.70	72.0	GOOD	-	-	-
PMKTF	SECCHI	SPRING2	0.63	64.3	GOOD	-	-	-
PMKTF	SECCHI	SUMMER1	0.60	58.8	FAIR	-	-	-
PMKTF	SECCHI	SUMMER2	0.70	69.5	GOOD	-	-	-
PMKTF	TN	ANNUAL	0.685	7.6	GOOD	0.742	6.3	GOOD
PMKTF	TN	SPRING1	0.636	6.7	GOOD	0.669	5.4	GOOD
PMKTF	TN	SPRING2	0.705	8.4	GOOD	0.712	5.9	GOOD
PMKTF	TN	SUMMER1	0.669	6.0	GOOD	0.800	7.2	GOOD
PMKTF	TN	SUMMER2	0.638	5.0	GOOD	0.754	6.3	GOOD
PMKTF	TP	ANNUAL	0.067	28.0	GOOD	0.071	22.5	GOOD
PMKTF	TP	SPRING1	0.062	27.2	GOOD	0.068	24.8	GOOD
PMKTF	TP	SPRING2	0.074	32.0	GOOD	0.083	31.1	GOOD
PMKTF	TP	SUMMER1	0.076	25.5	GOOD	0.082	24.1	GOOD
PMKTF	TP	SUMMER2	0.076	23.7	GOOD	0.079	21.0	GOOD
PMKTF	TSS	ANNUAL	16.00	54.8	FAIR	19.00	29.3	GOOD
PMKTF	TSS	SPRING1	18.00	56.2	FAIR	21.00	32.7	GOOD
PMKTF	TSS	SPRING2	18.00	53.6	FAIR	21.00	26.7	GOOD
PMKTF	TSS	SUMMER1	16.50	53.9	FAIR	20.00	26.0	GOOD
PMKTF	TSS	SUMMER2	17.00	56.3	FAIR	21.00	29.0	GOOD

Table 63 - SAV Season Water quality trends in segment PMKTF (only significant trends are displayed).

Segment	Parameter	Season	Layer	Slope	%Change	pValue	Direction
PMKTF	TN	SAV1	S	-0.0095	-0.208	0.002	IMPROVING
PMKTF	PO4F	SAV1	S	0.0007	0.560	0.001	DEGRADING

Table 64 - SAV season water quality status in segment PMKTF (value is the median concentration; secchi in meters, chlorophyll *a* in μg per l, all other parameters in mg per l.).

Segment	Parameter	Status Value	Score	Status	SAV Goal Value	Habitat Requirement
PMKTF	TN	0.674	7.2	GOOD	-	-
PMKTF	DIN	0.233	14	GOOD	0.1705	-
PMKTF	TP	0.0759	29.9	GOOD	-	-
PMKTF	PO4F	0.023	51.2	FAIR	0.0250	BORDERLINE
PMKTF	CHLA	3.13	13.4	GOOD	11.9	BORDERLINE
PMKTF	SECCHI	0.65	66.1	GOOD	-	-
PMKTF	TSS	16	51.1	FAIR	37.0	FAILS
PMKTF	KD	-	-	-	3.60	FAILS
PMKTF	PLL05	-	-	-	0.016	FAILS
PMKTF	PLL10	-	-	-	0.003	FAILS

7. Oligohaline Mattaponi River (MPNOH - Lower Mattaponi)

Water quality for living resources

An improving trend was detected in bottom dissolved oxygen while degrading trends in surface and bottom dissolved inorganic phosphorus and surface chlorophyll a were detected (Table 65). Status of surface and bottom total nitrogen, dissolved inorganic nitrogen and bottom dissolved oxygen was good. Status of water clarity was fair. Status of surface and bottom dissolved inorganic phosphorus and surface chlorophyll *a* degraded. Status of surface and bottom total suspended solids was poor (Table 66).

Table 65 - Water quality trends in segment MPNOH (only significant trends are displayed).

Segment	Parameter	Season	Layer	Slope	%Change	pValue	Direction
MPNOH	PO4F	ANNUAL	S	<0.0011	.	<0.001	DEGRADING
MPNOH	PO4F	SUMMER2	S	0.0014	4.480	<0.001	DEGRADING
MPNOH	PO4F	SPRING1	S	<0.0016	.	0.004	DEGRADING
MPNOH	PO4F	SUMMER2	B	0.0015	4.800	<0.001	DEGRADING
MPNOH	PO4F	ANNUAL	B	<0.0013	.	0.001	DEGRADING
MPNOH	CHLA	ANNUAL	S	0.0550	.	<0.001	DEGRADING
MPNOH	DO	SUMMER1	B	0.0529	0.168	0.009	IMPROVING

Table 66 - Water quality status in segment MPNOH (value is the median concentration, secchi in meters, chlorophyll *a* in μg per l, all other parameters in mg per l.).

Segment	Parameter	Season	S Value	S Score	S Status	B Value	B Score	B Status
MPNOH	CHLA	ANNUAL	9.88	47.0	FAIR	-	-	-
MPNOH	CHLA	SPRING1	4.70	19.3	GOOD	-	-	-
MPNOH	CHLA	SPRING2	6.98	29.5	GOOD	-	-	-
MPNOH	CHLA	SUMMER1	17.46	56.8	FAIR	-	-	-
MPNOH	CHLA	SUMMER2	15.69	47.9	FAIR	-	-	-
MPNOH	DIN	ANNUAL	0.171	17.9	GOOD	0.159	15.5	GOOD
MPNOH	DIN	SPRING1	0.200	6.3	GOOD	0.194	5.7	GOOD
MPNOH	DIN	SPRING2	0.194	13.7	GOOD	0.194	13.1	GOOD
MPNOH	DIN	SUMMER1	0.167	38.9	GOOD	0.135	30.4	GOOD
MPNOH	DIN	SUMMER2	0.158	42.9	FAIR	0.143	37.5	GOOD
MPNOH	DO	SPRING1	-	-	-	8.37	-	GOOD
MPNOH	DO	SPRING2	-	-	-	7.20	-	GOOD
MPNOH	DO	SUMMER1	-	-	-	5.41	-	GOOD
MPNOH	DO	SUMMER2	-	-	-	5.40	-	GOOD
MPNOH	PO4F	ANNUAL	0.020	71.4	POOR	0.018	65.9	POOR
MPNOH	PO4F	SPRING1	0.019	74.6	POOR	0.018	71.3	POOR
MPNOH	PO4F	SPRING2	0.020	71.8	POOR	0.018	66.8	POOR
MPNOH	PO4F	SUMMER1	0.024	73.7	POOR	0.026	72.9	POOR
MPNOH	PO4F	SUMMER2	0.028	80.1	POOR	0.027	74.6	POOR
MPNOH	SECCHI	ANNUAL	0.40	44.7	FAIR	-	-	-
MPNOH	SECCHI	SPRING1	0.40	63.9	GOOD	-	-	-
MPNOH	SECCHI	SPRING2	0.40	59.1	FAIR	-	-	-
MPNOH	SECCHI	SUMMER1	0.45	48.1	FAIR	-	-	-
MPNOH	SECCHI	SUMMER2	0.40	34.2	POOR	-	-	-
MPNOH	TN	ANNUAL	0.703	8.5	GOOD	0.860	13.6	GOOD
MPNOH	TN	SPRING1	0.620	3.7	GOOD	0.831	7.0	GOOD
MPNOH	TN	SPRING2	0.703	7.5	GOOD	0.837	10.4	GOOD
MPNOH	TN	SUMMER1	0.753	16.7	GOOD	0.936	26.5	GOOD
MPNOH	TN	SUMMER2	0.795	21.5	GOOD	1.123	44.6	FAIR
MPNOH	TP	ANNUAL	0.093	49.9	FAIR	0.123	52.5	FAIR
MPNOH	TP	SPRING1	0.101	51.5	FAIR	0.117	44.2	FAIR
MPNOH	TP	SPRING2	0.101	49.2	FAIR	0.158	60.8	POOR
MPNOH	TP	SUMMER1	0.110	58.5	FAIR	0.149	59.0	POOR
MPNOH	TP	SUMMER2	0.113	60.3	FAIR	0.135	53.3	FAIR
MPNOH	TSS	ANNUAL	32.50	68.4	POOR	59.50	73.0	POOR
MPNOH	TSS	SPRING1	43.00	73.2	POOR	61.00	68.2	POOR
MPNOH	TSS	SPRING2	37.00	67.3	POOR	75.00	76.0	POOR
MPNOH	TSS	SUMMER1	29.50	67.1	POOR	64.00	74.2	POOR
MPNOH	TSS	SUMMER2	30.00	70.5	POOR	54.00	66.7	POOR

Water quality for SAV

Degrading trends in surface total phosphorus, surface dissolved inorganic phosphorus and surface chlorophyll *a* were detected in this segment (Table 67). Status was good for surface total nitrogen and surface dissolved inorganic nitrogen but poor for surface dissolved inorganic phosphorus and surface total suspended solids. Surface chlorophyll *a* and surface total suspended solids met the SAV habitat requirements while the remaining parameters were borderline (Table 68).

SAV

Surveys were not conducted in this segment during 2000 due to poor weather conditions.. The Tier I goal has not been established for this segment.

Living Resources

Living resource monitoring is not conducted within this segment.

Table 67 - SAV Season Water quality trends in segment MPNOH (only significant trends are displayed).

Segment	Parameter	Season	Layer	Slope	%Change	pValue	Direction
MPNOH	TP	SAV1	S	0.0031	0.827	0.001	**DEGRADING**
MPNOH	PO4F	SAV1	S	0.0007	2.240	0.001	**DEGRADING**
MPNOH	CHLA	SAV1	S	0.2323	0.501	0.005	**DEGRADING**

Table 68 - SAV season water quality status in segment MPNOH (value is the median concentration; secchi in meters, chlorophyll *a* in μg per l, all other parameters in mg per l.).

Segment	Parameter	Status Value	Score	Status	SAV Goal Value	Habitat Requirement
MPNOH	TN	0.727	12.4	**GOOD**	-	-
MPNOH	DIN	0.1705	28	**GOOD**	0.1600	-
MPNOH	TP	0.113	60.7	**FAIR**	-	-
MPNOH	PO4F	0.025	77.8	**POOR**	0.0220	**BORDERLINE**
MPNOH	CHLA	11.865	43	**FAIR**	2.9	**MEETS**
MPNOH	SECCHI	0.4	42.6	**FAIR**	-	-
MPNOH	TSS	37	75.4	**POOR**	6.0	**MEETS**
MPNOH	KD	-	-	-	1.50	**BORDERLINE**
MPNOH	PLL05	-	-	-	0.138	**BORDERLINE**
MPNOH	PLL10	-	-	-	0.065	**BORDERLINE**

8. Tidal Freshwater Mattaponi River (MPNTF - Upper Mattaponi)

Water quality for living resources

Degrading trends were detected in surface and bottom dissolved inorganic nitrogen (Table 69). Status of all parameters was good except for bottom dissolved inorganic phosphorus, which was fair (Table 70).

Water quality for SAV

An improving trend in surface total nitrogen and a degrading trend in surface dissolved inorganic phosphorus was detected in this segment (Table 71). Status of all parameters was good except for surface chlorophyll *a* for which status was fair. All parameters met the SAV habitat requirements except for the percentage of light at the leaf surface at 1.0 m which was borderline (Table 72).

SAV

Surveys were not conducted in this segment during 2000 due to poor weather conditions. The Tier I goal has not been established for this segment.

Living Resources

Living resource monitoring is not conducted within this segment.

Table 69 - Water quality trends in segment MPNTF (only significant trends are displayed).

Segment	Parameter	Season	Layer	Slope	%Change	pValue	Direction
MPNTF	TN	SUMMER2	S	-0.0196	-0.356	<0.001	**IMPROVING**
MPNTF	TN	ANNUAL	S	-0.0122	-0.263	<0.001	**IMPROVING**
MPNTF	TN	SUMMER1	S	-0.0162	-0.317	<0.001	**IMPROVING**
MPNTF	TN	SPRING2	B	-0.0115	-0.229	0.009	**IMPROVING**
MPNTF	TN	SUMMER1	B	-0.0125	-0.233	0.003	**IMPROVING**
MPNTF	TN	SPRING1	B	-0.0105	-0.216	0.009	**IMPROVING**
MPNTF	TN	ANNUAL	B	-0.0124	-0.261	<0.001	**IMPROVING**
MPNTF	PO4F	SPRING1	S	0.0010	.	<0.001	**DEGRADING**
MPNTF	PO4F	ANNUAL	S	<0.0016	.	<0.001	**DEGRADING**
MPNTF	PO4F	SPRING2	S	0.0016	5.120	<0.001	**DEGRADING**
MPNTF	PO4F	ANNUAL	B	<0.0011	.	<0.001	**DEGRADING**
MPNTF	PO4F	SPRING2	B	0.0011	1.408	0.002	**DEGRADING**
MPNTF	PO4F	SPRING1	B	<0.0016	.	0.001	**DEGRADING**
MPNTF	WTEMP	SUMMER2	S	0.2053	0.128	0.001	**INCREASING**
MPNTF	WTEMP	SUMMER1	S	0.1927	0.120	0.005	**INCREASING**
MPNTF	WTEMP	SUMMER2	B	0.2119	0.128	0.001	**INCREASING**

Table 70 - Water quality status in segment MPNTF (value is the median concentration, secchi in meters, chlorophyll *a* in μg per l, all other parameters in mg per l.).

Segment	Parameter	Season	S Value	S Score	S Status	B Value	B Score	B Status
MPNTF	CHLA	ANNUAL	1.90	12.1	GOOD	-	-	-
MPNTF	CHLA	SPRING1	0.65	1.4	GOOD	-	-	-
MPNTF	CHLA	SPRING2	2.63	12.8	GOOD	-	-	-
MPNTF	CHLA	SUMMER1	5.00	16.9	GOOD	-	-	-
MPNTF	CHLA	SUMMER2	4.79	14.1	GOOD	-	-	-
MPNTF	DIN	ANNUAL	0.185	7.1	GOOD	0.188	5.8	GOOD
MPNTF	DIN	SPRING1	0.206	4.1	GOOD	0.198	2.8	GOOD
MPNTF	DIN	SPRING2	0.206	5.2	GOOD	0.207	3.5	GOOD
MPNTF	DIN	SUMMER1	0.113	5.6	GOOD	0.142	7.9	GOOD
MPNTF	DIN	SUMMER2	0.107	6.6	GOOD	0.111	7.2	GOOD
MPNTF	DO	SPRING1	-	-	-	8.70	-	GOOD
MPNTF	DO	SPRING2	-	-	-	7.80	-	GOOD
MPNTF	DO	SUMMER1	-	-	-	5.90	-	GOOD
MPNTF	DO	SUMMER2	-	-	-	5.50	-	GOOD
MPNTF	PO4F	ANNUAL	0.016	35.8	GOOD	0.018	47.4	FAIR
MPNTF	PO4F	SPRING1	0.020	47.8	FAIR	0.024	64.9	POOR
MPNTF	PO4F	SPRING2	0.027	60.9	POOR	0.027	68.1	POOR
MPNTF	PO4F	SUMMER1	0.021	45.0	FAIR	0.022	55.3	FAIR
MPNTF	PO4F	SUMMER2	0.019	42.2	FAIR	0.021	55.2	FAIR
MPNTF	SECCHI	ANNUAL	0.90	87.3	GOOD	-	-	-
MPNTF	SECCHI	SPRING1	1.00	90.2	GOOD	-	-	-
MPNTF	SECCHI	SPRING2	1.05	93.0	GOOD	-	-	-
MPNTF	SECCHI	SUMMER1	1.00	91.0	GOOD	-	-	-
MPNTF	SECCHI	SUMMER2	1.00	90.4	GOOD	-	-	-
MPNTF	TN	ANNUAL	0.560	4.2	GOOD	0.632	3.6	GOOD
MPNTF	TN	SPRING1	0.529	3.8	GOOD	0.638	4.6	GOOD
MPNTF	TN	SPRING2	0.623	5.6	GOOD	0.676	4.9	GOOD
MPNTF	TN	SUMMER1	0.652	5.6	GOOD	0.666	3.6	GOOD
MPNTF	TN	SUMMER2	0.597	4.0	GOOD	0.754	5.7	GOOD
MPNTF	TP	ANNUAL	0.059	20.6	GOOD	0.065	18.3	GOOD
MPNTF	TP	SPRING1	0.053	19.1	GOOD	0.053	13.1	GOOD
MPNTF	TP	SPRING2	0.069	27.4	GOOD	0.068	18.0	GOOD
MPNTF	TP	SUMMER1	0.076	25.4	GOOD	0.079	22.2	GOOD
MPNTF	TP	SUMMER2	0.079	26.3	GOOD	0.080	21.8	GOOD
MPNTF	TSS	ANNUAL	8.00	21.2	GOOD	9.00	7.0	GOOD
MPNTF	TSS	SPRING1	8.00	13.2	GOOD	10.00	7.5	GOOD
MPNTF	TSS	SPRING2	5.00	3.2	GOOD	8.00	3.0	GOOD
MPNTF	TSS	SUMMER1	6.50	9.2	GOOD	8.00	3.4	GOOD
MPNTF	TSS	SUMMER2	7.00	12.0	GOOD	8.00	3.7	GOOD

Table 71 - SAV Season Water quality trends in segment MPNTF (only significant trends are displayed).

Segment	Parameter	Season	Layer	Slope	%Change	pValue	Direction
MPNTF	TN	SAV1	S	-0.0129	-0.265	0.000	IMPROVING
MPNTF	PO4F	SAV1	S	0.0009	1.152	0.000	DEGRADING

Table 72 - SAV season water quality status in segment MPNTF (value is the median concentration; secchi in meters, chlorophyll *a* in μg per l, all other parameters in mg per l.).

Segment	Parameter	Status Value	Score	Status	SAV Goal Value	Habitat Requirement
MPNTF	TN	0.601	5	GOOD	-	-
MPNTF	DIN	0.16	7.7	GOOD	0.0126	MEETS
MPNTF	TP	0.0693	23.9	GOOD	-	-
MPNTF	PO4F	0.022	49.2	FAIR	0.0017	MEETS
MPNTF	CHLA	2.8957	12	GOOD	5.6	MEETS
MPNTF	SECCHI	1	91.1	GOOD	-	-
MPNTF	TSS	6	8.3	GOOD	8.9	MEETS
MPNTF	KD	-	-	-	1.20	MEETS
MPNTF	PLL05	-	-	-	0.317	MEETS
MPNTF	PLL10	-	-	-	0.173	BORDERLINE

V. Rappahannock River

A. Basin Overview

The Rappahannock watershed encompasses 2,845 square miles. Human population of the watershed for the year 2000 is estimated to be 240,754 individuals. Approximately 66% of the housing in the region is rural. Major population centers within the watershed include Culpeper, Falmouth, Fredericksburg, Orange and Tappahannock, Virginia. Nutrient and sediment loadings to the Rappahannock River are primarily from agricultural non-point sources (Figure 18). Belval and Sprague (1999) described the Rappahannock River Basin as follows:

"The Rappahannock River Basin, at 2,800 mi^2, is the fourth largest tributary basin in the Chesapeake Bay Watershed. The Rappahannock River originates near the eastern edge of the Blue Ridge Physiographic Province and extends eastward through the Piedmont and Coastal Plain Physiographic Provinces. The RIM station (01668000) is located at the Fall Line just upstream of Fredericksburg, Va. The monitoring station receives drainage from about 57% of the Rappahannock River Basin. Upstream from the monitoring station, the Rappahannock River Basin is of high relief, and the steep slopes cause the river to rapidly respond to storm events.

Land upstream of the monitoring station is dominated by forest, at 61 percent, and agriculture, at 36 percent (table 3). The Rappahannock River Basin contains the highest percentage of agricultural land above the Fall Line of the five tributary basins in Virginia. The agricultural areas above the

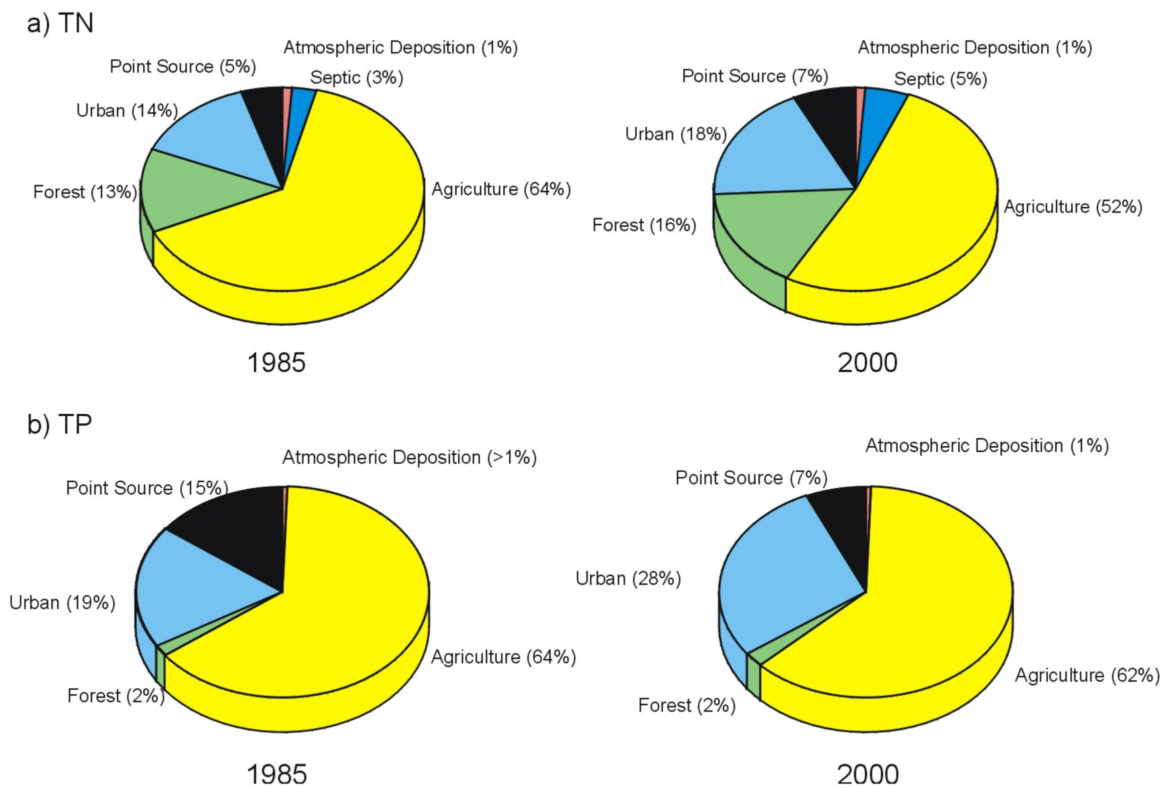


Figure 20. 1985 and 2000 a) total nitrogen and b) total phosphorus contribution to the Rappahannock River by source.

monitoring station are generally located in the central part of the basin, in Fauquier, Culpeper, Madison, and Orange Counties. Of the nine rivers monitored in the RIM Program, the Rappahannock River contributes 3 percent of the streamflow, 2 percent of the total nitrogen load, and 8 percent of the total phosphorus load delivered annually from the nontidal part of the Chesapeake Bay Watershed."

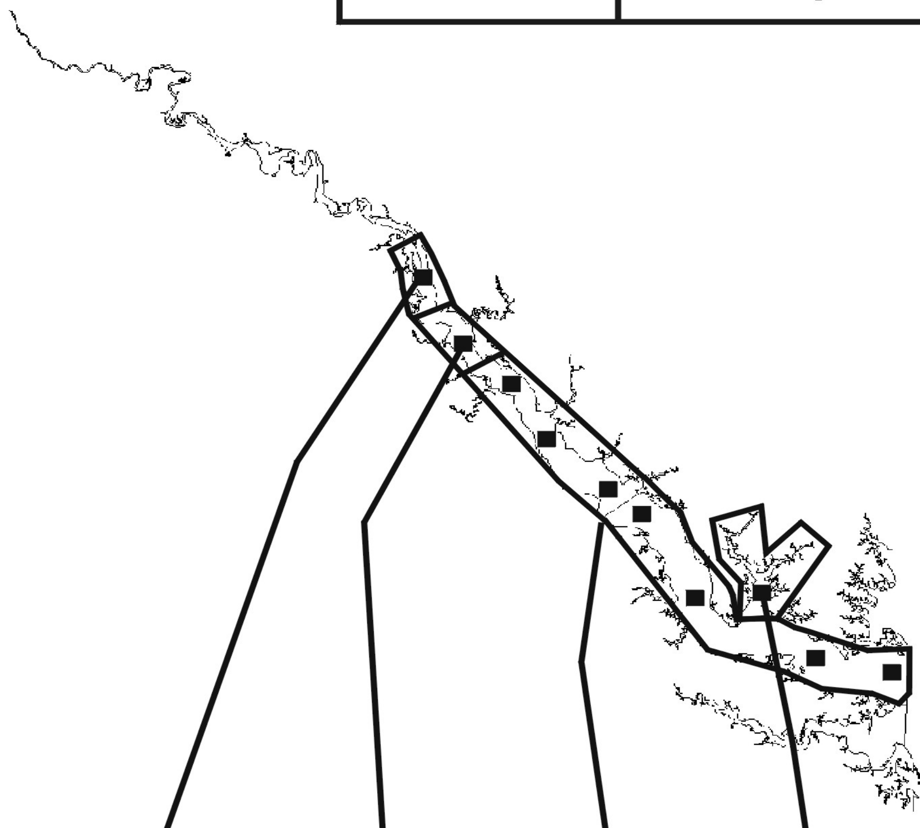
B. Overview of Monitoring Results

Long-term trend and status analysis results for water quality are summarized for all stations in York River in Figures 19 and 20. In tidal waters, status of total nitrogen and dissolved inorganic nitrogen was good in all segments. With respect to nitrogen, water quality conditions in the Rappahannock River basin are improving as indicated by the decreasing annual or season specific trends detected in total nitrogen in all segments of the Rappahannock. Status of total phosphorus and dissolved inorganic phosphorus was fair or good in all segments. Improving trends in surface and bottom total phosphorus were detected in the Upper Rappahannock River (RPPTF). Status of surface chlorophyll *a* was good in the Corrotoman River (CRRMH), fair in the lower Rappahannock River (RPPMH) and poor in the upper and middle Rappahannock River (RPPTF and RPPOH). The status of total suspended solids was poor or fair in the segments within this tributary except the Corrotoman River (CRRMH) where it was good. Status of dissolved oxygen was good in all segments except the Corrotoman River (CRRMH) where it was fair. An improving trend in bottom dissolved oxygen was detected in the middle Rappahannock River (RPPOH). Decreasing trends in salinity were detected in the Lower Rappahannock (RPPMH) and the Corrotoman River (CRRMH).

Long-term trend and status analysis results for living resources are summarized for all stations in York River in Figures 21 through 24. There was a general trend of increased biomass and abundance for the total phytoplankton which was associated with a pattern of increased diatoms as the dominant floral component, and the chlorophytes, cyanophytes, and cryptophytes as prominent background categories. Areas of floral concern within this river system would be the increasing abundance of the cyanobacteria with additional increases associated with dinoflagellates. Although there was no increased trends associated with the autotrophic picoplankton, their status within this system was poor. Yet, there was no significant trends in the procaryote:eukaryote ratio, In addition, there mainly no significant trends associated with species diversity and productivity. Throughout the river the diatoms were the major floral component, with cyanobacteria the dominant background category. Downstream the flora changed from fresh water species to dominant estuarine species, with the diatoms still the dominant flora, with dinoflagellates and cyanobacteria increasing in abundance. The lower reach of this river is also the site for increased presence of dinoflagellate blooms.

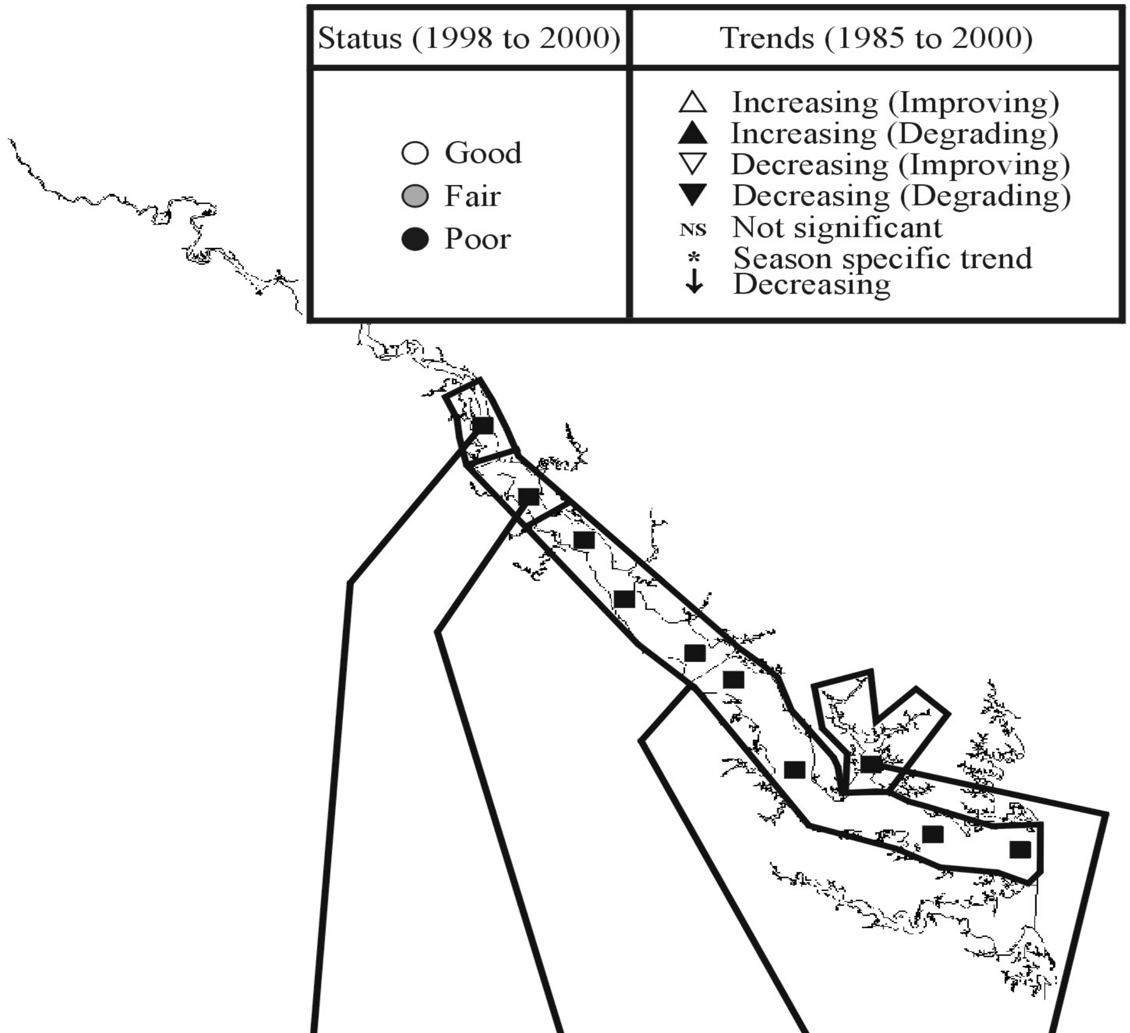
Zooplankton parameters continue the same degrading trend with respect to rotifer abundance at the mouth with poor status for this parameter in all segments monitored. However, copepod nauplii abundance was good in the upper regions of the bay and fair at the mouth. A change in methodology prevents a critical review of the status and trends in the mesozooplankton monitoring results. However, plots of raw data indicate that relative abundances and numbers of species of mesozooplankton are mostly unchanged from last year. The related water quality trends of the

Status (1998 to 2000)	Trends (1985 to 2000)
○ Good ◍ Fair ● Poor Ⓥ Very Poor	△ Increasing (Improving) ▲ Increasing (Degrading) ▽ Decreasing (Improving) ▼ Decreasing (Degrading) NS Not significant * Season specific trend



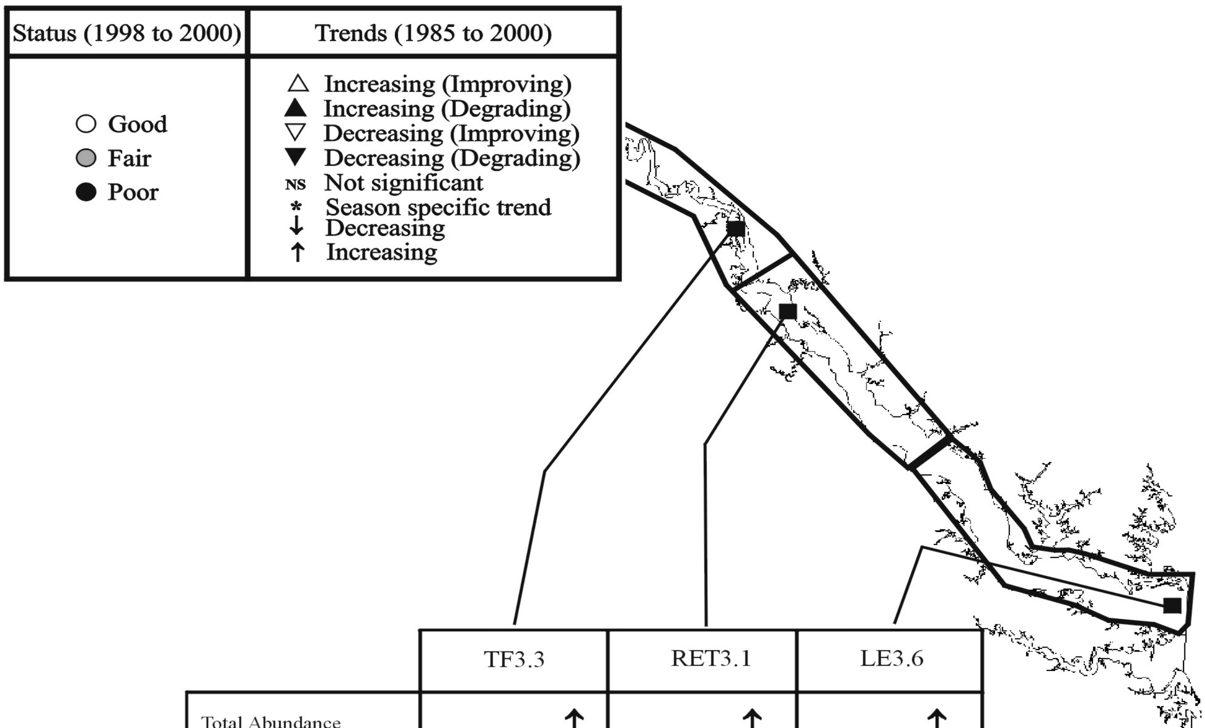
Parameter	Upper Rappahannock	Middle Rappahannock	Lower Rappahannock	Corrotoman River
STN	○ ▽	○ ▽	○ ▽	○ ▽
BTN	○ ▽	○ NS	○ ▽	○ NS
SDIN	○ NS	○ ▽	○ NS	○ NS
BDIN	○ NS	○ ▽	○ NS	○ NS
STP	○ NS	○ NS	◍ NS	◍ NS
BTP	○ ▽	○ NS	◍ NS	○ ▲
SDIP	○ NS	○ NS	◍ NS	○ NS
BDIP	○ NS	○ NS	○ NS	○ NS

Figure 21. Map of the Rappahannock River basin showing summaries of the status and trend analyses for each segment. Abbreviations for each parameter are: TN= total nitrogen: DIN=dissolved inorganic nitrogen; TP=total phosphorus; DIP= dissolved inorganic nitrogen. The prefixes S and B refer to surface and bottom measurements, respectively.



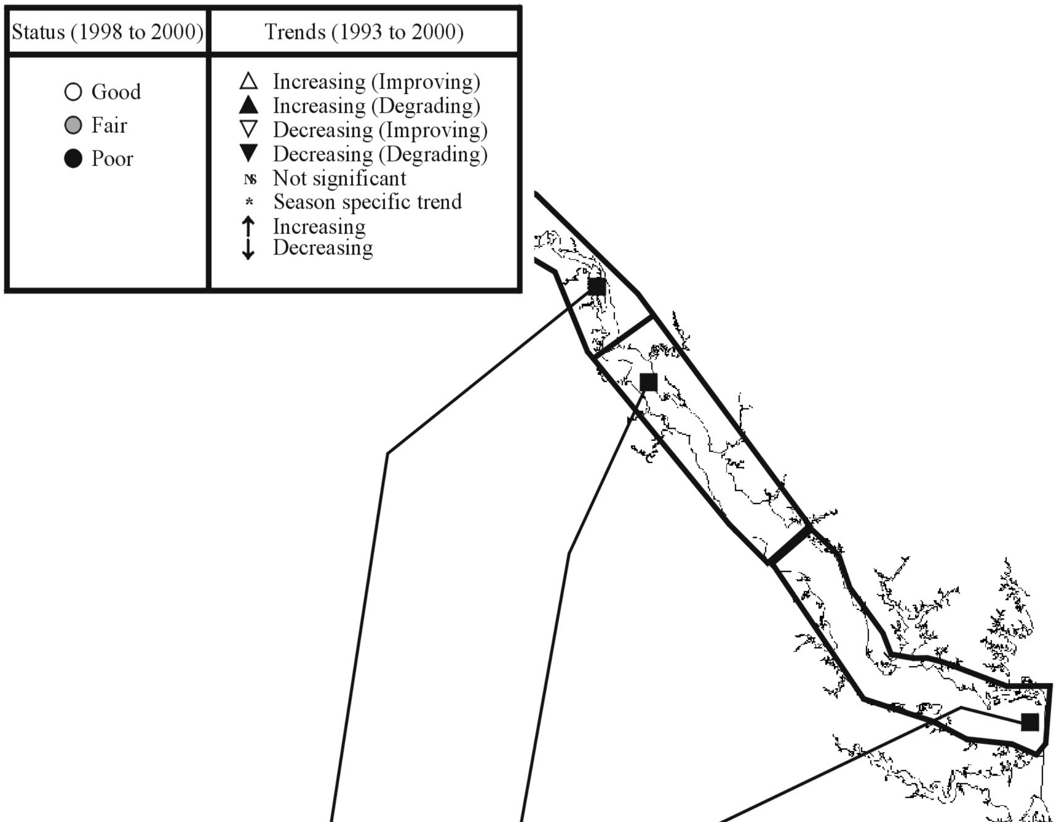
Parameter	Upper Rappahannock	Middle Rappahannock	Lower Rappahannock	Corrotoman River
SCHLA	● NS	● ▲	◍ NS	○ NS
STSS	● NS	◍ NS	◍ NS	○ NS
BTSS	◍ NS	● NS	● NS	○ NS
SECCHI	◍ △	◍ NS	◍ NS	○ ▼
BDO	○ NS	○ △	○ NS	◍ NS
SWTEMP	NS	NS	NS	NS
BWTEMP	NS	NS	NS	NS
SSALIN	NS	NS	↓	↓
BSALIN	NS	NS	↓	↓

Figure 22. Map of the Rappahannock River basin showing summaries of the status and trend analyses for each segment. Abbreviations for each parameter are: CHLA=chlorophyll a: TSS=total suspended solids; SECCHI=secchi depth; DO= dissolved oxygen; WTEMP=water temperature, SALIN=salinity. The prefixes S and B refer to surface and bottom measurements, respectively.



	TF3.3	RET3.1	LE3.6
Total Abundance	↑	↑	↑
Total Biomass	◍ ↑	● ↑	● NS
Biomass to Abundance	● NS	● ▼	◍ NS
Margalef Diversity Index	○ △	○ NS	○ NS
Productivity	◍ NS	◍ NS	○ ▽
Diatom Biomass	○ △	◍ △	◍ NS
Dinoflagellate Biomass	● NS	◍ ▽	● ▲
Cyanophyte Biomass	● ▲	◍ NS	◍ NS
Chlorophyte Biomass	○ △	○ △	○ △
Picoplankton Biomass	● NS	● NS	● NS
Cryptophyte Biomass	△	△	NS
Procaryote to Eucaryote Biomass	○ NS	○ NS	○ NS
Cyanophyte Abundance	▲	▲	▲

Figure 23. Map of the Rappahannock River basin showing summaries of the status and trend analyses for phytoplankton bioindicators for each segment.



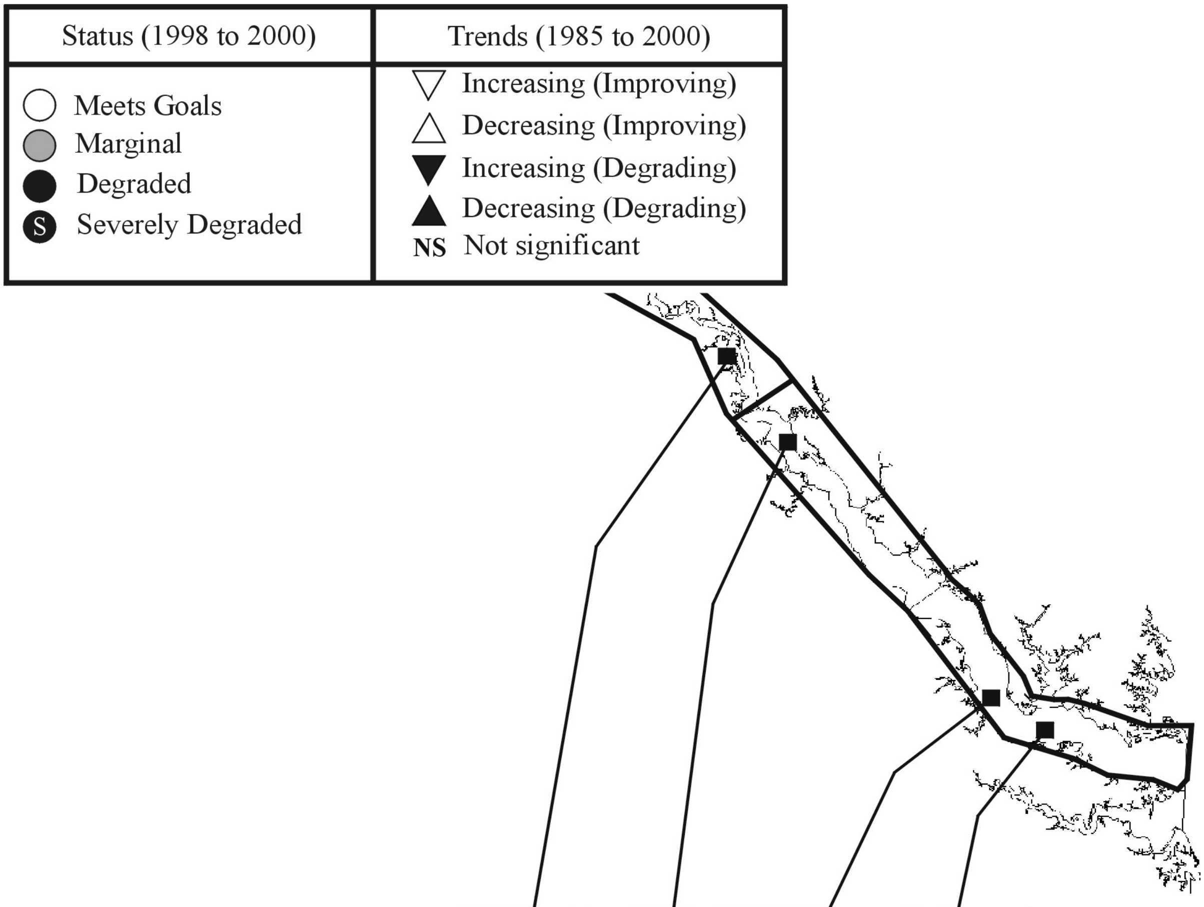
	TF3.3	RET3.1	LE3.6
Total Abundance	NS	NS	NS
Total Biomass	NS	NS	↑
Copepod Nauplii Abundance	○ NS	○ NS	◐ NS
Rotifer Abundance	● NS	● NS	● ▲
Oligotrich Abundance	NS	NS	NS
Cladoceran Abundance	↓	NS	NS
Tintinnid Abundance	NS	NS	↓
Polychaeta Larvae Abundance	NS	NS	NS

Figure 24. Map of the Rappahannock River basin showing summaries of the status and trend analyses for microzooplankton bioindicators for each segment.

Status (1997 to 1999)	Trends (1985 to 1999)
○ Good ◍ Fair ● Poor	△ Increasing (Improving) ▼ Decreasing (Degrading) NS Not significant * Season specific trend

	TF3.3	RET3.1	LE3.6
Total Abundance	○ NS	● NS	● ▼
Margalef Diversity Index	○ △	○ △	◍ NS
Shannon Wiener Index	○ △	○ △	◍ ▼
Holoplankton Abundance	NS	NS	▼
Meroplankton Abundance	NS	△	NS
Calanoid Abundance	NS	NS	▼
Cyclopoid Abundance	△	NS	NS
Cladoceran Abundance	NS	△	▼
Crab Zoea Abundance	NS	△	NS
Acartia tonsa	▼	NS	▼
Eurytemora spp.	NS	NS	NS
Bosmina longirostis	NS	NS	NS

Figure 25. Map of the Rappahannock River basin showing summaries of the status and trend analyses for mesozooplankton bioindicators for each segment.



	TF3.3	RET3.1	LE3.2	LE3.4
Benthic IBI	○ NS	● ▼	Ⓢ NS	Ⓢ NS
Total Abundance	NS	NS	△	△
Total Biomass	NS	▼	NS	△
Pollution Sensitive Species Abundance (%)	NS	▼	NS	NS
Pollution Indicative Species Abundance (%)	NS	NS	NS	NS
Pollution Sensitive Species Biomass (%)	▼	NS	NS	NS
Pollution Indicative Species Biomass (%)	NS	NS	NS	NS
Shannon-Weiner Diversity Index	NS	▼	NS	△

Figure 26. Map of the Rappahannock River basin showing summaries of the status and trend analyses for benthic bioindicators for each segment.

adjacent mainstem(mostly secchi depth and salinity) have not changed substantially from last year and therefore it is likely that the general mesozooplankton status and trends have not changed much from last year. Therefore, it is likely that mesozooplankton diversity continues to decline at the mouth of the river which is associated with generally poor clarity trends in the mainstem and declining salinity. The upper part of the basin should have continued improving trends associated with continued improvement in nutrient trends.

Benthic community status was degraded or severely degraded at all stations in the Lower Rappahannock River (RPPMH). The status observed at these stations is related to the frequency of low dissolved oxygen events that occur in this segment. A degrading trend in the B-IBI was detected at station RET3.1 in the upper portion of this segment. Benthic community status was good in the Middle Rappahannock (RPPOH) but a degrading trend in pollution sensitive species biomass was detected in this segment.

C. Detailed Overview of Status and Trends

1. Fall Line

Improving trends in flow adjusted concentrations of total nitrogen, total phosphorus and total suspended solids were detected above the fall-line near Fredericksburg. Improving trends in flow weighted and flow adjusted concentrations of total nitrogen and total phosphorus were detected in the Robinson River near Locust Dale (Table 73).

Table 73 - Water quality trends at Rappahannock River RIM stations 1668000 (Fredericksburg) and 1666500 (Robinson River at Locust Dale).

Station Name	Parameter	Data Type	Baseline	Status	Slope	%Change	pValue	Direction
Rappahannock River at Fredericksburg	TN	FAC	--	--	-0.018	-20.00	0.0020	IMPROVING
Rappahannock River at Fredericksburg	NO23F*	FAC	--	--	-0.027	-29.00	0.0099	IMPROVING
Rappahannock River at Fredericksburg	TP	FAC	--	--	-0.039	-38.00	0.0001	IMPROVING
Rappahannock River at Fredericksburg	DIP	FAC	--	--	-0.023	-25.00	0.0063	IMPROVING
Rappahannock River at Fredericksburg	DIP	FWC	0.015	0.021	-0.034	-34.00	0.0001	IMPROVING
Robinson River at Locust Dale	NO3W	FAC	--	--	-0.043	-50.00	0.0000	IMPROVING
Robinson River at Locust Dale	NO3W	FWC	0.579	0.340	-0.039	-44.02	0.0001	IMPROVING
Robinson River at Locust Dale	NO23W	FWC	0.500	0.291	-0.026	-32.35	0.0001	IMPROVING
Robinson River at Locust Dale	TP	FWC	0.086	0.052	-0.032	-38.13	0.0001	IMPROVING

2. Mesohaline Rappahannock River (RPPMH - Lower Rappahannock)

Water Quality for Living Resources

Improving trends were detected in surface and bottom total nitrogen. Decreasing trends were detected in surface and bottom salinity (Table 74). Status of surface and bottom total nitrogen, dissolved inorganic nitrogen, bottom dissolved inorganic phosphorus and bottom dissolved oxygen was good. Status of surface and bottom total phosphorus, surface dissolved inorganic phosphorus, surface chlorophyll *a*, surface total suspended solids, and water clarity was fair. Status of bottom total suspended solids was poor (Table 75).

Table 74 - Water quality trends in segment RPPMH (only significant trends are displayed).

Segment	Parameter	Season	Layer	Slope	%Change	pValue	Direction
RPPMH	TN	SUMMER2	S	-0.0114	-0.301	0.001	IMPROVING
RPPMH	TN	SUMMER1	S	-0.0104	-0.283	0.001	IMPROVING
RPPMH	TN	ANNUAL	S	-0.0100	-0.278	<0.001	IMPROVING
RPPMH	TN	SUMMER2	B	-0.0112	-0.301	0.002	IMPROVING
RPPMH	TN	ANNUAL	B	-0.0076	-0.197	0.001	IMPROVING
RPPMH	TN	SUMMER1	B	-0.0089	-0.251	0.008	IMPROVING
RPPMH	TSS	SPRING2	B	1.2926	2.686	0.004	DEGRADING
RPPMH	TSS	SPRING1	B	1.3444	2.656	0.002	DEGRADING
RPPMH	PLL05	SPRING2	S	-0.0127	-0.448	0.001	DEGRADING
RPPMH	PLL05	SPRING1	S	-0.0122	-0.445	0.010	DEGRADING
RPPMH	PLL10	SPRING1	S	-0.0108	-0.588	0.009	DEGRADING
RPPMH	PLL10	SPRING2	S	-0.0110	-0.599	0.001	DEGRADING
RPPMH	SALINITY	ANNUAL	S	-0.2000	-0.214	<0.001	DECREASING
RPPMH	SALINITY	SUMMER1	S	-0.2330	-0.217	0.001	DECREASING
RPPMH	SALINITY	SUMMER2	S	-0.2491	-0.227	0.001	DECREASING
RPPMH	SALINITY	ANNUAL	B	-0.1313	-0.127	<0.001	DECREASING
RPPMH	WTEMP	SUMMER1	B	-0.0667	-0.043	0.009	DECREASING

Water Quality for SAV

An improving trend was detected in surface total nitrogen while degrading trends in the percentage of light at leaf surface at both 0.5 and 1.0 m were detected (Table 76). Status of most parameters was fair except for surface total nitrogen and surface dissolved inorganic nitrogen for which status was good. All parameters met the SAV goals except for light attenuation and percentage of light at the leaf surface which were borderline (Table 77).

SAV

In 2000, SAV area in RPPMH increased to 72.87 ha, 120% more than in 1999 (33.12 ha); however, the Tier I goal (999.92 ha) was not met for RPPMH.

Living Resources

Increased trends in total phytoplankton abundance and biomass characterized the flora, and was associated with increased biomass trends in diatoms, chlorophytes, and cryptophytes, plus decreasing biomass for the dinoflagellates (all favorable), plus the more unfavorable increased trend of cyanobacteria abundance. The cyanobacteria status was degraded from good to fair in comparison to 1999 status. In addition, the biomass:abundance ratio remains with poor status, with an increasing unfavorable trend. Associated with this pattern, there was no significant change in the procaryote:eucaryote ratio. Neither were there any significant trends in species diversity or productivity.

At station LE3.6 in the lower portion of this segment total phytoplankton abundance showed an increasing trend, but this was not accompanied by significant changes in total phytoplankton biomass. The floral components with increased biomass trends included the chlorophytes, a background component of the floral assemblage, plus two unfavorable trends. These were the dinoflagellates and the cyanobacteria. The diatom and cyanobacteria status was fair, with the status of dinoflagellates and the autotrophic picoplankton poor (none of these are favorable conditions). The productivity trends were decreasing, with no significant changes regarding species diversity.

At station RET3.1 in the upper portion of this segment, there were no significant annual trends in the microzooplankton parameters. Status for copepod nauplii abundance was good while status for rotifer abundance was poor. This mixed status is associated with the mixed status of water quality parameters that are good for nutrients but poor to fair for water clarity and chlorophyll *a* parameters.

At station LE3.6 at the lowermost portion of this segment at the mouth of the river, a degrading trend in micozooplankton was detected as seen in an increase in rotifer abundance. This is the same degrading trend detected last year and is associated with generally degrading trends in water quality in the mainstem and declining salinity. The water quality at this station is probably best judged by adjacent mainstem results since this station is averaged in with the other mesohaline stations of this segment. Copepod nauplii abundance status was fair while rotifer abundance status was poor.

At station RET3.1 in the upper portion of this segment, benthic community status was degraded. There were degrading trends in the B-IBI and several metrics of the IBI. In the lower portion of this segment (stations LE3.2 and LE3.4), benthic community status was severely degraded. Both stations are strongly impacted by low dissolved oxygen events.

Table 75 - Water quality status in segment RPPMH (value is the median concentration, secchi in meters, chlorophyll *a* in μg per l, all other parameters in mg per l.).

Segment	Parameter	Season	S Value	S Score	S Status	B Value	B Score	B Status
RPPMH	CHLA	ANNUAL	9.44	51.0	FAIR	-	-	-
RPPMH	CHLA	SPRING1	9.85	52.9	FAIR	-	-	-
RPPMH	CHLA	SPRING2	11.17	55.5	POOR	-	-	-
RPPMH	CHLA	SUMMER1	12.34	50.3	FAIR	-	-	-
RPPMH	CHLA	SUMMER2	12.19	48.8	FAIR	-	-	-
RPPMH	DIN	ANNUAL	0.016	2.4	GOOD	0.033	4.1	GOOD
RPPMH	DIN	SPRING1	0.014	1.0	GOOD	0.043	4.9	GOOD
RPPMH	DIN	SPRING2	0.013	2.1	GOOD	0.043	6.1	GOOD
RPPMH	DIN	SUMMER1	0.009	2.4	GOOD	0.023	3.1	GOOD
RPPMH	DIN	SUMMER2	0.008	2.2	GOOD	0.024	3.0	GOOD
RPPMH	DO	SPRING1	-	-	-	8.91	-	GOOD
RPPMH	DO	SPRING2	-	-	-	6.74	-	GOOD
RPPMH	DO	SUMMER1	-	-	-	5.20	-	GOOD
RPPMH	DO	SUMMER2	-	-	-	4.70	-	FAIR
RPPMH	PO4F	ANNUAL	0.005	49.5	FAIR	0.006	37.9	GOOD
RPPMH	PO4F	SPRING1	0.004	50.0	FAIR	0.005	51.7	FAIR
RPPMH	PO4F	SPRING2	0.005	44.4	FAIR	0.005	47.5	FAIR
RPPMH	PO4F	SUMMER1	0.006	38.6	GOOD	0.010	34.8	GOOD
RPPMH	PO4F	SUMMER2	0.006	42.8	FAIR	0.011	36.4	GOOD
RPPMH	SECCHI	ANNUAL	1.15	40.3	FAIR	-	-	-
RPPMH	SECCHI	SPRING1	0.95	35.9	POOR	-	-	-
RPPMH	SECCHI	SPRING2	1.10	38.2	POOR	-	-	-
RPPMH	SECCHI	SUMMER1	1.15	54.7	FAIR	-	-	-
RPPMH	SECCHI	SUMMER2	1.15	55.7	FAIR	-	-	-
RPPMH	TN	ANNUAL	0.507	13.8	GOOD	0.528	18.0	GOOD
RPPMH	TN	SPRING1	0.567	11.6	GOOD	0.649	23.4	GOOD
RPPMH	TN	SPRING2	0.530	12.4	GOOD	0.623	22.2	GOOD
RPPMH	TN	SUMMER1	0.520	15.7	GOOD	0.558	20.1	GOOD
RPPMH	TN	SUMMER2	0.521	15.8	GOOD	0.553	18.0	GOOD
RPPMH	TP	ANNUAL	0.042	50.1	FAIR	0.054	53.5	FAIR
RPPMH	TP	SPRING1	0.038	60.1	POOR	0.054	59.6	POOR
RPPMH	TP	SPRING2	0.046	60.8	POOR	0.056	67.2	POOR
RPPMH	TP	SUMMER1	0.050	41.4	FAIR	0.064	52.5	FAIR
RPPMH	TP	SUMMER2	0.050	36.9	GOOD	0.065	44.1	FAIR
RPPMH	TSS	ANNUAL	9.00	50.6	FAIR	20.50	68.0	POOR
RPPMH	TSS	SPRING1	15.50	71.8	POOR	30.50	82.8	POOR
RPPMH	TSS	SPRING2	14.50	76.3	POOR	30.50	84.3	POOR
RPPMH	TSS	SUMMER1	9.51	41.4	GOOD	19.00	61.6	POOR
RPPMH	TSS	SUMMER2	7.63	36.5	GOOD	18.50	59.8	POOR

Table 76 - SAV Season Water quality trends in segment RPPMH (only significant trends are displayed).

Segment	Parameter	Season	Layer	Slope	%Change	pValue	Direction
RPPMH	TN	SAV1	S	-0.0100	-0.279	0.000	**IMPROVING**
RPPMH	PLL05	SAV1	S	-0.0073	-0.271	0.001	**DEGRADING**
RPPMH	PLL10	SAV1	S	-0.0067	-0.388	0.000	**DEGRADING**
RPPMH	SALINITY	SAV1	S	-0.2267	-0.226	0.000	**DECREASING**

Table 77 - SAV season water quality status in segment RPPMH (value is the median concentration; secchi in meters, chlorophyll *a* in μg per l, all other parameters in mg per l.).

Segment	Parameter	Status Value	Score	Status	SAV Goal Value	Habitat Requirement
RPPMH	TN	0.5206	15.4	**GOOD**	-	-
RPPMH	DIN	0.012	3.2	**GOOD**	0.0130	**MEETS**
RPPMH	TP	0.047	51.8	**FAIR**	-	-
RPPMH	PO4F	0.005	43.7	**FAIR**	0.0050	**MEETS**
RPPMH	CHLA	11.3664	53.5	**FAIR**	11.6	**MEETS**
RPPMH	SECCHI	1.15	47.6	**FAIR**	-	-
RPPMH	TSS	10.7063	46.5	**FAIR**	9.1	**MEETS**
RPPMH	KD	-	-	-	1.30	**BORDERLINE**
RPPMH	PLL05	-	-	-	0.341	**MEETS**
RPPMH	PLL10	-	-	-	0.178	**BORDERLINE**

3. Oligohaline Rappahannock River (RPPOH - Middle Rappahannock)

Water Quality for Living Resources

Improving trends were detected in surface total nitrogen, dissolved inorganic nitrogen, and bottom dissolved oxygen. A degrading trend surface chlorophyll *a* was detected (Table 78). Status of surface and bottom total nitrogen, dissolved inorganic nitrogen, total phosphorus, dissolved inorganic phosphorus, and bottom dissolved oxygen was good. Status of surface total suspended solids and water clarity was fair. Status of surface chlorophyll *a* and bottom total suspended solids was poor (Table 79).

Water Quality for SAV

An improving trend in surface chlorophyll *a* was detected (Table 80). Status was good for all nutrients but poor for surface chlorophyll *a* and fair for secchi depth and surface total suspended solids. Only surface dissolved inorganic phosphorus met the SAV requirements (Table 81).

SAV

SAV coverage has never been assessed and a Tier I goal has not been established for this segment.

Living Resources

Compared to the 1999 trend and status conditions, the total phytoplankton biomass and abundance continue to increase. This pattern is accompanied by increased biomass trends for diatoms, chlorophytes, and cryptophytes (all favorable), plus increased abundance and biomass for the cyanobacteria (unfavorable trends), with no significant trends for the autotrophic picoplankton which are composed of mainly the smallest cyanobacteria. There were several status changes among the floral biomass categories from 1999, with diatoms improving from poor to good, and chlorophytes from fair to good. In contrast, degrading status was associated with dinoflagellates going from fair to poor, and cyanobacteria from good to poor status. The negative trend associated with the procaryote:eucaryote ratio of 1999 was not indicated at this time. There was no significant trends in productivity rates.

There were no significant annual trends in the microzooplankton parameters. Status for copepod nauplii abundance was good while status for rotifer abundance was poor. This mixed status is associated with the mixed status of water quality parameters that are good for nutrients but poor to fair for water clarity and chlorophyl *a* parameters.

Benthic community status was good. There was a degrading trend in pollution sensitive species biomass.

Table 78 - Water quality trends in segment RPPOH (only significant trends are displayed).

Segment	Parameter	Season	Layer	Slope	%Change	pValue	Direction
RPPOH	TN	SPRING1	S	-0.0189	-0.277	0.002	IMPROVING
RPPOH	TN	ANNUAL	S	-0.0108	-0.238	0.001	IMPROVING
RPPOH	TN	SPRING1	B	-0.0201	-0.281	0.002	IMPROVING
RPPOH	DIN	SPRING1	S	-0.0149	-0.375	0.003	IMPROVING
RPPOH	DIN	ANNUAL	S	-<0.0014	.	<0.001	IMPROVING
RPPOH	DIN	SPRING1	B	-0.0175	-0.491	0.001	IMPROVING
RPPOH	DIN	SPRING2	B	-0.0121	-0.582	0.009	IMPROVING
RPPOH	DIN	ANNUAL	B	-0.0025	.	<0.001	IMPROVING
RPPOH	CHLA	SPRING2	S	0.5778	2.477	0.010	DEGRADING
RPPOH	CHLA	SUMMER2	S	0.6245	1.009	0.005	DEGRADING
RPPOH	CHLA	SUMMER1	S	0.6094	1.019	0.001	DEGRADING
RPPOH	CHLA	ANNUAL	S	0.3799	.	<0.001	DEGRADING
RPPOH	DO	SUMMER1	B	0.0694	0.178	0.001	IMPROVING

Table 79 - Water quality status in segment RPPOH (value is the median concentration, secchi in meters, chlorophyll *a* in μg per l, all other parameters in mg per l.).

Segment	Parameter	Season	S Value	S Score	S Status	B Value	B Score	B Status
RPPOH	CHLA	ANNUAL	13.46	59.0	POOR	-	-	-
RPPOH	CHLA	SPRING1	7.32	33.3	GOOD	-	-	-
RPPOH	CHLA	SPRING2	15.01	60.1	POOR	-	-	-
RPPOH	CHLA	SUMMER1	18.03	58.1	FAIR	-	-	-
RPPOH	CHLA	SUMMER2	18.26	54.9	FAIR	-	-	-
RPPOH	DIN	ANNUAL	0.135	13.5	GOOD	0.171	17.0	GOOD
RPPOH	DIN	SPRING1	0.439	22.7	GOOD	0.444	22.8	GOOD
RPPOH	DIN	SPRING2	0.168	11.2	GOOD	0.175	11.2	GOOD
RPPOH	DIN	SUMMER1	0.008	1.1	GOOD	0.010	1.2	GOOD
RPPOH	DIN	SUMMER2	0.004	0.6	GOOD	0.009	1.4	GOOD
RPPOH	DO	SPRING1	-	-	-	9.90	-	GOOD
RPPOH	DO	SPRING2	-	-	-	8.37	-	GOOD
RPPOH	DO	SUMMER1	-	-	-	6.92	-	GOOD
RPPOH	DO	SUMMER2	-	-	-	7.00	-	GOOD
RPPOH	PO4F	ANNUAL	0.009	37.1	GOOD	0.010	39.2	GOOD
RPPOH	PO4F	SPRING1	0.013	59.0	FAIR	0.011	50.5	FAIR
RPPOH	PO4F	SPRING2	0.010	41.3	FAIR	0.011	45.2	FAIR
RPPOH	PO4F	SUMMER1	0.009	34.6	GOOD	0.011	37.9	GOOD
RPPOH	PO4F	SUMMER2	0.009	35.9	GOOD	0.011	40.0	GOOD
RPPOH	SECCHI	ANNUAL	0.40	44.7	FAIR	-	-	-
RPPOH	SECCHI	SPRING1	0.30	35.6	POOR	-	-	-
RPPOH	SECCHI	SPRING2	0.35	44.2	FAIR	-	-	-
RPPOH	SECCHI	SUMMER1	0.49	56.4	FAIR	-	-	-
RPPOH	SECCHI	SUMMER2	0.49	51.6	FAIR	-	-	-
RPPOH	TN	ANNUAL	0.708	8.7	GOOD	0.806	11.3	GOOD
RPPOH	TN	SPRING1	0.811	8.5	GOOD	0.979	11.6	GOOD
RPPOH	TN	SPRING2	0.767	9.8	GOOD	0.808	9.4	GOOD
RPPOH	TN	SUMMER1	0.627	9.3	GOOD	0.680	10.2	GOOD
RPPOH	TN	SUMMER2	0.584	8.1	GOOD	0.656	10.1	GOOD
RPPOH	TP	ANNUAL	0.070	30.4	GOOD	0.092	33.8	GOOD
RPPOH	TP	SPRING1	0.083	38.4	GOOD	0.119	45.2	FAIR
RPPOH	TP	SPRING2	0.083	34.6	GOOD	0.092	25.3	GOOD
RPPOH	TP	SUMMER1	0.069	23.7	GOOD	0.088	25.1	GOOD
RPPOH	TP	SUMMER2	0.068	22.9	GOOD	0.097	31.4	GOOD
RPPOH	TSS	ANNUAL	27.00	59.0	FAIR	51.00	66.6	POOR
RPPOH	TSS	SPRING1	34.00	60.6	POOR	71.00	74.3	POOR
RPPOH	TSS	SPRING2	32.00	58.2	FAIR	59.00	65.6	POOR
RPPOH	TSS	SUMMER1	24.50	54.8	FAIR	42.00	51.9	FAIR
RPPOH	TSS	SUMMER2	22.00	51.0	FAIR	49.00	61.7	POOR

Table 80 - SAV Season Water quality trends in segment RPPOH (only significant trends are displayed).

Segment	Parameter	Season	Layer	Slope	%Change	pValue	Direction
RPPOH	CHLA	SAV1	S	0.6138	1.053	0.000	**DEGRADING**
RPPOH	SALINITY	SAV1	S	-0.0475	-0.190	0.009	**DECREASING**

Table 81 - SAV season water quality status in segment RPPOH (value is the median concentration; secchi in meters, chlorophyll *a* in μg per l, all other parameters in mg per l.).

Segment	Parameter	Status Value	Score	Status	SAV Goal Value	Habitat Requirement
RPPOH	TN	0.65	8.8	**GOOD**	-	-
RPPOH	DIN	0.02	2.1	**GOOD**	0.0200	-
RPPOH	TP	0.072	27.4	**GOOD**	-	-
RPPOH	PO4F	0.009	36.2	**GOOD**	0.0090	**MEETS**
RPPOH	CHLA	17.64	59.6	**POOR**	17.7	**BORDERLINE**
RPPOH	SECCHI	0.45	53.7	**FAIR**	-	-
RPPOH	TSS	26	55.6	**FAIR**	26.0	**FAILS**
RPPOH	KD	-	-	-	3.60	**FAILS**
RPPOH	PLL05	-	-	-	0.058	**BORDERLINE**
RPPOH	PLL10	-	-	-	0.010	**FAILS**

4. Tidal Freshwater (RPPTF - Upper Rappahannock)

Water Quality for Living Resources

Improving trends were detected in surface and bottom total nitrogen, bottom total phosphorus, and secchi depth. No degrading trends were detected (Table 82). Status of surface and bottom total nitrogen, dissolved inorganic nitrogen, total phosphorus, dissolved inorganic phosphorus and bottom dissolved oxygen was good. Status of bottom total suspended solids and water clarity was fair. Status of surface chlorophyll *a* and surface total suspended solids was poor (Table 83).

Water Quality for SAV

Improving trends in surface total nitrogen, secchi depth and the percentage of light at the leaf surface at 1.0 m were detected (Table 84). Status of all nutrient parameters was good while the status of surface chlorophyll *a* and surface total suspended solids was poor. All parameters except surface dissolved inorganic phosphorus either failed to meet the SAV goals or were borderline (Table 85).

SAV

SAV coverage increased from 7.42 ha in 1999 to 16.19 ha in 2000 in this segment for a total increase of 118%. The Tier I goal has not been established for RPPTF.

Living Resources

No living resources data are available for this segment.

Table 82 - Water quality trends in segment RPPTF (only significant trends are displayed).

Segment	Parameter	Season	Layer	Slope	%Change	pValue	Direction
RPPTF	TN	ANNUAL	S	-0.0165	-0.271	<0.001	IMPROVING
RPPTF	TN	SPRING1	S	-0.0171	-0.314	0.001	IMPROVING
RPPTF	TN	SPRING2	S	-0.0150	-0.288	0.003	IMPROVING
RPPTF	TN	SPRING2	B	-0.0202	-0.336	<0.001	IMPROVING
RPPTF	TN	ANNUAL	B	-0.0203	-0.311	<0.001	IMPROVING
RPPTF	TN	SUMMER1	B	-0.0143	-0.238	0.010	IMPROVING
RPPTF	TN	SPRING1	B	-0.0199	-0.331	<0.001	IMPROVING
RPPTF	TP	ANNUAL	B	-0.0014	-0.264	0.003	IMPROVING
RPPTF	SECCHI	SUMMER1	S	0.0077	0.308	0.004	IMPROVING
RPPTF	SECCHI	ANNUAL	S	0.0056	0.199	0.010	IMPROVING
RPPTF	DO	SPRING1	B	0.0800	0.148	0.003	IMPROVING
RPPTF	PLL05	SUMMER1	S	0.0028	1.005	0.008	IMPROVING
RPPTF	PLL10	SUMMER1	S	<0.0019	1.867	0.002	IMPROVING

Table 83 - Water quality status in segment RPPTF (value is the median concentration, secchi in meters, chlorophyll *a* in μg per l, all other parameters in mg per l.).

Segment	Parameter	Season	S Value	S Score	S Status	B Value	B Score	B Status
RPPTF	CHLA	ANNUAL	12.62	77.4	POOR	-	-	-
RPPTF	CHLA	SPRING1	7.84	55.6	POOR	-	-	-
RPPTF	CHLA	SPRING2	19.26	78.1	POOR	-	-	-
RPPTF	CHLA	SUMMER1	24.93	77.2	POOR	-	-	-
RPPTF	CHLA	SUMMER2	26.76	76.2	POOR	-	-	-
RPPTF	DIN	ANNUAL	0.461	29.7	GOOD	0.453	27.9	GOOD
RPPTF	DIN	SPRING1	0.499	24.0	GOOD	0.462	20.1	GOOD
RPPTF	DIN	SPRING2	0.424	23.0	GOOD	0.446	20.7	GOOD
RPPTF	DIN	SUMMER1	0.287	17.3	GOOD	0.312	20.5	GOOD
RPPTF	DIN	SUMMER2	0.119	11.8	GOOD	0.131	13.6	GOOD
RPPTF	DO	SPRING1	-	-	-	9.35	-	GOOD
RPPTF	DO	SPRING2	-	-	-	9.05	-	GOOD
RPPTF	DO	SUMMER1	-	-	-	6.98	-	GOOD
RPPTF	DO	SUMMER2	-	-	-	6.86	-	GOOD
RPPTF	PO4F	ANNUAL	0.008	14.4	GOOD	0.009	21.0	GOOD
RPPTF	PO4F	SPRING1	0.010	16.3	GOOD	0.009	25.9	GOOD
RPPTF	PO4F	SPRING2	0.007	12.2	GOOD	0.007	18.3	GOOD
RPPTF	PO4F	SUMMER1	0.006	9.7	GOOD	0.006	12.8	GOOD
RPPTF	PO4F	SUMMER2	0.004	9.1	GOOD	0.005	10.2	GOOD
RPPTF	SECCHI	ANNUAL	0.50	44.1	FAIR	-	-	-
RPPTF	SECCHI	SPRING1	0.50	43.4	FAIR	-	-	-
RPPTF	SECCHI	SPRING2	0.50	43.3	FAIR	-	-	-
RPPTF	SECCHI	SUMMER1	0.50	40.8	FAIR	-	-	-
RPPTF	SECCHI	SUMMER2	0.50	40.3	POOR	-	-	-
RPPTF	TN	ANNUAL	0.904	14.4	GOOD	0.857	10.7	GOOD
RPPTF	TN	SPRING1	0.765	13.8	GOOD	0.842	12.6	GOOD
RPPTF	TN	SPRING2	0.765	12.2	GOOD	0.795	10.7	GOOD
RPPTF	TN	SUMMER1	0.919	12.9	GOOD	0.917	9.1	GOOD
RPPTF	TN	SUMMER2	0.803	12.0	GOOD	0.848	8.9	GOOD
RPPTF	TP	ANNUAL	0.071	31.2	GOOD	0.077	30.4	GOOD
RPPTF	TP	SPRING1	0.064	27.7	GOOD	0.070	25.9	GOOD
RPPTF	TP	SPRING2	0.071	22.6	GOOD	0.076	27.2	GOOD
RPPTF	TP	SUMMER1	0.077	27.1	GOOD	0.089	28.8	GOOD
RPPTF	TP	SUMMER2	0.078	25.3	GOOD	0.089	33.1	GOOD
RPPTF	TSS	ANNUAL	22.00	68.7	POOR	29.50	52.1	FAIR
RPPTF	TSS	SPRING1	24.00	64.3	POOR	33.50	51.5	FAIR
RPPTF	TSS	SPRING2	23.50	69.3	POOR	33.50	60.1	POOR
RPPTF	TSS	SUMMER1	22.00	71.4	POOR	32.50	53.2	FAIR
RPPTF	TSS	SUMMER2	22.00	74.5	POOR	33.50	53.4	FAIR

Table 84 - SAV Season Water quality trends in segment RPPTF (only significant trends are displayed).

Segment	Parameter	Season	Layer	Slope	%Change	pValue	Direction
RPPTF	TN	SAV1	S	-0.0134	-0.258	0.000	**IMPROVING**
RPPTF	SECCHI	SAV1	S	0.0063	0.252	0.010	**IMPROVING**
RPPTF	PLL10	SAV1	S	0.0009	1.857	0.002	**IMPROVING**

Table 85 - SAV season water quality status in segment RPPTF (value is the median concentration; secchi in meters, chlorophyll *a* in μg per l, all other parameters in mg per l.).

Segment	Parameter	Status Value	Score	Status	SAV Goal Value	Habitat Requirement
RPPTF	TN	0.7745	12	**GOOD**	-	-
RPPTF	DIN	0.3355	27.4	**GOOD**	0.4390	-
RPPTF	TP	0.073	27.9	**GOOD**	-	-
RPPTF	PO4F	0.007	11.5	**GOOD**	0.0070	**MEETS**
RPPTF	CHLA	23.9	81	**POOR**	19.3	**BORDERLINE**
RPPTF	SECCHI	0.5	41.5	**FAIR**	-	-
RPPTF	TSS	23.5	73.1	**POOR**	18.0	**FAILS**
RPPTF	KD	-	-	-	2.90	**FAILS**
RPPTF	PLL05	-	-	-	0.086	**BORDERLINE**
RPPTF	PLL10	-	-	-	0.021	**FAILS**

5. Mesohaline Corrotoman River (CRRMH - Corrotoman River)

Water Quality for Living Resources

An improving season specific trend in surface total nitrogen was detected. Degrading trends in bottom total phosphorus and secchi depth were also detected. Decreasing trends in surface and bottom salinity were detected in this segment (Table 86). Status of all parameters was good except for surface total phosphorus and bottom dissolved oxygen for which the status was fair (Table 87).

Water Quality for SAV

An improving trend in surface total nitrogen was detected in this segment (Table 88). Status of all parameters was good and all parameters met the SAV habitat requirements (Table 89).

SAV

Although SAV area in CRRMH increased to 107.46 ha, 49% more than in 1999 (72.16 ha), the Tier I goal (218.56 ha) was not met for this segment.

Living Resources

No living resources data are available for this segment.

Table 86 - Water quality trends in segment CRRMH (only significant trends are displayed).

Segment	Parameter	Season	Layer	Slope	%Change	pValue	Direction
CRRMH	TN	ANNUAL	S	-0.0077	-0.196	<0.001	IMPROVING
CRRMH	TN	SUMMER1	S	-0.0167	-0.393	<0.001	IMPROVING
CRRMH	TN	SUMMER2	S	-0.0204	-0.447	<0.001	IMPROVING
CRRMH	TN	SUMMER2	B	-0.0127	-0.288	0.005	IMPROVING
CRRMH	TP	SUMMER1	B	0.0011	0.469	0.010	DEGRADING
CRRMH	TP	ANNUAL	B	<0.0016	0.349	0.001	DEGRADING
CRRMH	TP	SUMMER2	B	0.0015	0.640	0.008	DEGRADING
CRRMH	SECCHI	SPRING2	S	-0.0300	-0.259	0.002	DEGRADING
CRRMH	SECCHI	ANNUAL	S	-0.0187	-0.153	0.002	DEGRADING
CRRMH	TSS	SUMMER2	S	-0.3750	.	0.002	IMPROVING
CRRMH	SALINITY	SUMMER1	S	-0.3000	-0.264	<0.001	DECREASING
CRRMH	SALINITY	SPRING1	S	-0.2998	-0.318	0.007	DECREASING
CRRMH	SALINITY	SPRING2	S	-0.2646	-0.271	0.007	DECREASING
CRRMH	SALINITY	ANNUAL	S	-0.2200	-0.213	<0.001	DECREASING
CRRMH	SALINITY	SUMMER2	S	-0.3019	-0.257	<0.001	DECREASING
CRRMH	SALINITY	ANNUAL	B	-0.1826	-0.173	<0.001	DECREASING
CRRMH	SALINITY	SUMMER1	B	-0.2327	-0.204	<0.001	DECREASING
CRRMH	SALINITY	SPRING2	B	-0.2382	-0.241	0.009	DECREASING
CRRMH	SALINITY	SUMMER2	B	-0.2287	-0.192	0.001	DECREASING
CRRMH	WTEMP	SUMMER1	B	-0.1059	-0.066	0.003	DECREASING
CRRMH	WTEMP	SPRING2	B	-0.1358	-0.108	0.002	DECREASING

Table 87 - Water quality status in segment CRRMH (value is the median concentration, secchi in meters, chlorophyll *a* in μg per l, all other parameters in mg per l.).

Segment	Parameter	Season	S Value	S Score	S Status	B Value	B Score	B Status
CRRMH	CHLA	ANNUAL	7.12	33.8	GOOD	-	-	-
CRRMH	CHLA	SPRING1	4.77	16.5	GOOD	-	-	-
CRRMH	CHLA	SPRING2	8.35	35.6	GOOD	-	-	-
CRRMH	CHLA	SUMMER1	9.55	35.8	GOOD	-	-	-
CRRMH	CHLA	SUMMER2	8.51	28.1	GOOD	-	-	-
CRRMH	DIN	ANNUAL	0.008	0.9	GOOD	0.010	0.3	GOOD
CRRMH	DIN	SPRING1	0.008	0.2	GOOD	0.016	0.6	GOOD
CRRMH	DIN	SPRING2	0.008	0.6	GOOD	0.016	0.8	GOOD
CRRMH	DIN	SUMMER1	0.009	2.1	GOOD	0.012	0.5	GOOD
CRRMH	DIN	SUMMER2	0.009	2.2	GOOD	0.010	0.3	GOOD
CRRMH	DO	SPRING1	-	-	-	8.82	-	GOOD
CRRMH	DO	SPRING2	-	-	-	6.75	-	GOOD
CRRMH	DO	SUMMER1	-	-	-	4.23	-	FAIR
CRRMH	DO	SUMMER2	-	-	-	4.20	-	FAIR
CRRMH	PO4F	ANNUAL	0.003	27.7	GOOD	0.004	29.6	GOOD
CRRMH	PO4F	SPRING1	0.003	34.7	GOOD	0.004	44.8	FAIR
CRRMH	PO4F	SPRING2	0.004	37.3	GOOD	0.005	41.8	FAIR
CRRMH	PO4F	SUMMER1	0.004	24.4	GOOD	0.006	22.7	GOOD
CRRMH	PO4F	SUMMER2	0.004	27.2	GOOD	0.006	20.4	GOOD
CRRMH	SECCHI	ANNUAL	1.65	71.8	GOOD	-	-	-
CRRMH	SECCHI	SPRING1	1.70	73.0	GOOD	-	-	-
CRRMH	SECCHI	SPRING2	1.25	55.8	FAIR	-	-	-
CRRMH	SECCHI	SUMMER1	1.30	70.0	GOOD	-	-	-
CRRMH	SECCHI	SUMMER2	1.35	73.8	GOOD	-	-	-
CRRMH	TN	ANNUAL	0.478	11.0	GOOD	0.480	11.3	GOOD
CRRMH	TN	SPRING1	0.493	6.9	GOOD	0.508	8.2	GOOD
CRRMH	TN	SPRING2	0.501	9.2	GOOD	0.520	9.4	GOOD
CRRMH	TN	SUMMER1	0.529	16.0	GOOD	0.532	16.3	GOOD
CRRMH	TN	SUMMER2	0.513	14.1	GOOD	0.523	16.9	GOOD
CRRMH	TP	ANNUAL	0.035	40.1	FAIR	0.041	39.6	GOOD
CRRMH	TP	SPRING1	0.027	37.3	GOOD	0.037	42.1	FAIR
CRRMH	TP	SPRING2	0.035	45.2	FAIR	0.042	47.3	FAIR
CRRMH	TP	SUMMER1	0.043	31.0	GOOD	0.062	52.2	FAIR
CRRMH	TP	SUMMER2	0.043	28.3	GOOD	0.063	47.6	FAIR
CRRMH	TSS	ANNUAL	4.00	14.4	GOOD	8.00	21.9	GOOD
CRRMH	TSS	SPRING1	6.00	27.6	GOOD	12.00	36.5	GOOD
CRRMH	TSS	SPRING2	10.00	54.2	FAIR	12.00	41.6	GOOD
CRRMH	TSS	SUMMER1	5.00	15.8	GOOD	8.00	25.9	GOOD
CRRMH	TSS	SUMMER2	3.00	4.3	GOOD	8.00	23.6	GOOD

Table 88 - SAV Season Water quality trends in segment CRRMH (only significant trends are displayed).

Segment	Parameter	Season	Layer	Slope	% Change	pValue	Direction
CRRMH	TN	SAV1	S	-0.0097	-0.246	0.002	IMPROVING
CRRMH	SALINITY	SAV1	S	-0.2793	-0.256	0.000	DECREASING

Table 89 - SAV season water quality status in segment CRRMH (value is the median concentration; secchi in meters, chlorophyll *a* in μg per l, all other parameters in mg per l.).

Segment	Parameter	Status Value	Score	Status	SAV Goal Value	Habitat Requirement
CRRMH	TN	0.506	13.1	GOOD	-	-
CRRMH	DIN	0.0085	1.5	GOOD	0.0085	MEETS
CRRMH	TP	0.0389	38.1	GOOD	-	-
CRRMH	PO4F	0.004	34.2	GOOD	0.0040	MEETS
CRRMH	CHLA	9.14	38.9	GOOD	9.1	MEETS
CRRMH	SECCHI	1.3	62.2	GOOD	-	-
CRRMH	TSS	6	24.4	GOOD	6.0	MEETS
CRRMH	KD	-	-	-	1.10	MEETS
CRRMH	PLL05	-	-	-	0.441	MEETS
CRRMH	PLL10	-	-	-	0.252	MEETS

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Appendices

Appendix A. Results of Seasonal Kendall (SK) trend tests and Van Belle and Hughs test for homogeneity of trends for water quality parameters for the period of 1985 through 2000.

Chesapeake Bay Main stem Stations

Segment	Parameter	Season Homogeneity Test p Value	Station Homogeneity Test p Value	Seasonal Kendall Test p Value	Baseline	Slope	% Change	Absolute Change	% BDL
CB5MH	STN	0.000	0.033	0.040	0.621	-0.0028	ne	ne	0.000
CB5MH	BTN	0.000	0.147	0.185	0.605	-0.0016	ne	ne	0.000
CB5MH	SDIN	0.000	0.961	0.000	0.139	-0.0012	-0.138	-0.019	0.000
CB5MH	BDIN	0.000	0.334	0.007	0.140	-0.0026	-0.298	-0.042	0.000
CB5MH	STP	0.377	0.000	0.000	0.026	0.0003	0.184	0.005	0.000
CB5MH	BTP	0.054	0.000	0.317	0.038	0.0001	ne	ne	0.000
CB5MH	SPO4F	0.157	0.000	0.002	0.0052	0.0000	ne	ne	56.800
CB5MH	BPO4F	0.000	0.000	0.953	0.0069	0.0000	ne	ne	39.600
CB5MH	SCHLA	0.035	0.223	0.370	6.4	0.0579	ne	ne	0.000
CB5MH	BCHLA	0.002	0.318	0.938	4.3	-0.0044	ne	ne	0.000
CB5MH	STSS	0.024	0.000	0.304	6.7	0.0368	ne	ne	0.000
CB5MH	BTSS	0.000	0.647	0.706	12.5	-0.0179	ne	ne	0.000
CB5MH	SSECCHI	0.003	0.126	0.000	1.9	-0.0250	-0.209	-0.400	0.000
CB5MH	BDO (Summer)	0.101	0.173	0.513	3.3	0.0167	ne	ne	0.000
CB5MH	SSALINITY	0.000	0.831	0.000	16.227	-0.1337	-0.132	-2.139	0.000
CB5MH	BSALINITY	0.001	0.811	0.002	19.737	-0.0823	-0.067	-1.317	0.000
CB5MH	SWTEMP	0.204	0.982	0.523	16.111	0.0125	ne	ne	0.000
CB5MH	BWTEMP	0.000	0.796	0.845	15.818	-0.0048	ne	ne	0.000
CB6PH	STN	0.000	0.000	0.002	0.490	-0.0040	-0.131	-0.064	0.000
CB6PH	BTN	0.000	0.062	0.000	0.471	-0.0055	-0.187	-0.088	0.000
CB6PH	SDIN	0.000	0.597	0.002	0.056	-0.0003	-0.085	-0.005	12.600
CB6PH	BDIN	0.000	0.880	0.016	0.097	-0.0015	ne	ne	6.800
CB6PH	STP	0.082	0.000	0.359	0.025	0.0001	ne	ne	0.000
CB6PH	BTP	0.000	0.013	0.244	0.038	-0.0002	ne	ne	0.000
CB6PH	SPO4F	0.438	0.839	0.000	0.0064	0.0000	ne	ne	60.700
CB6PH	BPO4F	0.022	0.698	0.087	0.0100	0.0000	ne	ne	49.200
CB6PH	SCHLA	0.000	0.642	0.734	6.5	-0.0130	ne	ne	0.000
CB6PH	BCHLA	0.001	0.350	0.058	3.9	-0.0569	ne	ne	0.000
CB6PH	STSS	0.037	0.000	0.255	7.1	0.0898	ne	ne	0.000
CB6PH	BTSS	0.000	0.022	0.023	14.2	0.2458	ne	ne	0.000
CB6PH	SSECCHI	0.000	0.646	0.000	2.0	-0.0308	-0.253	-0.493	0.000
CB6PH	BDO (Summer)	0.221	0.647	0.417	4.4	0.0245	ne	ne	0.000
CB6PH	SSALINITY	0.089	0.922	0.000	20.621	-0.1296	-0.101	-2.074	0.000
CB6PH	BSALINITY	0.049	0.841	0.012	22.988	-0.0750	ne	ne	0.000
CB6PH	SWTEMP	0.016	0.699	0.685	17.479	0.0125	ne	ne	0.000
CB6PH	BWTEMP	0.002	0.858	0.591	17.025	-0.0125	ne	ne	0.000
CB7PH	STN	0.000	0.000	0.009	0.433	-0.0041	-0.152	-0.066	0.000
CB7PH	BTN	0.000	0.000	0.014	0.448	-0.0034	ne	ne	0.000
CB7PH	SDIN	0.000	0.001	0.000	0.061	0.0000	ne	ne	13.000
CB7PH	BDIN	0.000	0.066	0.013	0.075	-0.0009	ne	ne	5.200
CB7PH	STP	0.000	0.000	0.491	0.027	0.0000	ne	ne	0.000
CB7PH	BTP	0.000	0.048	0.018	0.048	-0.0003	ne	ne	0.000
CB7PH	SPO4F	0.038	0.949	0.000	0.0069	0.0000	ne	ne	44.800
CB7PH	BPO4F	0.006	0.226	0.000	0.0108	0.0000	ne	ne	32.300
CB7PH	SCHLA	0.000	0.881	0.668	5.3	0.0161	ne	ne	0.000
CB7PH	BCHLA	0.000	0.636	0.370	4.0	0.0330	ne	ne	0.000
CB7PH	STSS	0.067	0.000	0.131	8.5	0.0896	ne	ne	0.000
CB7PH	BTSS	0.000	0.000	0.027	18.8	0.3089	ne	ne	0.000
CB7PH	SSECCHI	0.000	0.642	0.000	2.1	-0.0333	-0.256	-0.533	0.000
CB7PH	BDO (Summer)	0.583	0.453	0.735	5.8	0.0049	ne	ne	0.000
CB7PH	SSALINITY	0.015	0.526	0.004	22.304	-0.1130	-0.081	-1.808	0.000
CB7PH	BSALINITY	0.249	0.839	0.113	25.368	-0.0500	ne	ne	0.000
CB7PH	SWTEMP	0.000	0.961	0.268	16.867	0.0164	ne	ne	0.000
CB7PH	BWTEMP	0.000	0.730	0.639	16.315	-0.0063	ne	ne	0.000

Appendix A. Continued.

Chesapeake Bay Main stem Stations

Segment	Parameter	Season Homogeneity Test p Value	Station Homogeneity Test p Value	Seasonal Kendall Test p Value	Baseline	Slope	% Change	Absolute Change	% BDL
CB8PH	STN	0.023	0.960	0.042	0.334	0.0025	ne	ne	0.000
CB8PH	BTN	0.034	0.105	0.146	0.341	0.0023	ne	ne	0.000
CB8PH	SDIN	0.000	0.171	0.107	0.048	0.0000	ne	ne	22.400
CB8PH	BDIN	0.000	0.456	0.019	0.040	-0.0003	ne	ne	11.500
CB8PH	BTP	0.176	0.050	0.002	0.054	-0.0006	-0.177	-0.010	0.000
CB8PH	STP	0.720	0.067	0.000	0.046	-0.0007	-0.245	-0.011	0.000
CB8PH	SPO4F	0.000	-	0.000	0.0141	0.0000	ne	ne	47.900
CB8PH	BPO4F	0.250	0.932	0.000	0.0201	-0.0002	ne	ne	27.600
CB8PH	SCHLA	0.002	0.920	0.504	5.0	0.0267	ne	ne	0.000
CB8PH	BCHLA	0.001	0.642	0.204	4.7	0.0583	ne	ne	0.500
CB8PH	STSS	0.444	0.441	0.000	7.3	0.2173	0.475	3.477	0.500
CB8PH	BTSS	0.122	0.218	0.001	12.9	0.4167	0.517	6.667	0.000
CB8PH	SSECCHI	0.736	0.914	0.000	2.2	-0.0375	-0.270	-0.600	0.000
CB8PH	BDO (Summer)	0.864	0.242	0.752	6.3	0.0046	ne	ne	0.000
CB8PH	SSALINITY	0.212	0.746	0.001	25.363	-0.1265	-0.080	-2.024	0.000
CB8PH	BSALINITY	0.125	0.611	0.135	29.513	-0.0363	ne	ne	0.000
CB8PH	SWTEMP	0.016	0.919	0.499	16.450	0.0188	ne	ne	0.000
CB8PH	BWTEMP	0.010	0.875	0.677	15.931	0.0100	ne	ne	0.000
PIAMH	STN	0.195	na	0.000	0.530	-0.0056	-0.169	-0.090	0.000
PIAMH	BTN	0.301	na	0.000	0.542	-0.0063	-0.186	-0.101	0.000
PIAMH	SDIN	0.047	na	0.000	0.055	0.0000	ne	ne	61.100
PIAMH	BDIN	0.183	na	0.002	0.084	0.0000	ne	ne	45.800
PIAMH	STP	0.129	na	0.683	0.019	0.0000	ne	ne	37.400
PIAMH	BTP	0.645	na	0.966	0.024	0.0000	ne	ne	32.100
PIAMH	SDIP	0.996	na	0.000	0.0050	0.0000	ne	ne	88.400
PIAMH	BDIP	0.989	na	0.000	0.0050	0.0000	ne	ne	87.900
PIAMH	SCHLA	0.941	na	0.434	7.7	-0.0604	ne	ne	0.500
PIAMH	BCHLA	0.830	na	0.808	8.0	-0.0200	ne	ne	0.500
PIAMH	STSS	0.442	na	0.884	6.2	0.0000	ne	ne	7.900
PIAMH	BTSS	0.859	na	0.634	12.3	-0.0354	ne	ne	0.037
PIAMH	SSECCHI	0.815	na	0.000	1.8	-0.0250	-0.222	-0.400	0.000
PIAMH	BDO (Summer)	0.645	na	0.269	6.5	0.0482	ne	ne	0.000
PIAMH	SSALINITY	0.989	na	0.000	18.173	-0.1534	-0.135	-2.454	0.000
PIAMH	BSALINITY	0.930	na	0.000	18.915	-0.1335	-0.113	-2.136	0.000
PIAMH	SWTEMP	0.353	na	0.436	17.650	0.0250	ne	ne	0.000
PIAMH	BWTEMP	0.757	na	0.751	16.875	-0.0076	ne	ne	0.000
POCMH	STN	0.134	0.001	0.002	0.647	-0.0059	-0.146	-0.094	0.000
POCMH	BTN	0.354	0.005	0.002	0.624	-0.0050	-0.128	-0.080	0.000
POCMH	SDIN	0.168	0.084	0.001	0.061	-0.0014	ne	ne	0.159
POCMH	BDIN	0.162	0.340	0.000	0.071	-0.0019	ne	ne	0.153
POCMH	STP	0.684	0.001	0.789	0.032	0.0000	ne	ne	0.000
POCMH	BTP	0.246	0.000	0.958	0.037	0.0000	ne	ne	0.000
POCMH	SPO4F	0.888	0.000	0.011	0.0050	0.0000	ne	ne	0.735
POCMH	BPO4F	0.904	0.001	0.008	0.0050	0.0000	ne	ne	0.788
POCMH	SCHLA	0.403	0.150	0.481	8.7	0.0456	ne	ne	0.005
POCMH	BCHLA	0.239	0.237	0.006	9.0	0.1286	0.227	2.058	0.000
POCMH	STSS	0.249	0.121	0.033	13.5	0.3286	ne	ne	0.000
POCMH	BTSS	0.335	0.000	0.007	17.3	0.4286	0.398	6.858	0.000
POCMH	SSECCHI	0.112	0.334	0.000	1.1	-0.0154	-0.224	-0.246	0.000
POCMH	BDO (Summer)	0.108	0.039	0.769	6.6	0.0010	ne	ne	0.000
POCMH	SSALINITY	0.969	0.832	0.000	19.050	-0.1350	-0.113	-2.160	0.000
POCMH	BSALINITY	0.778	0.590	0.001	19.000	-0.1140	-0.096	-1.824	0.000
POCMH	SWTEMP	0.680	0.633	0.264	18.800	0.0296	ne	ne	0.000
POCMH	BWTEMP	0.925	0.743	0.242	18.750	0.0327	ne	ne	0.000

Appendix A. Continued.

James River Stations

Segment	Parameter	Season Homogeneity Test p Value	Station Homogeneity Test p Value	Seasonal Kendall Test p Value	Baseline	Slope	% Change	Absolute Change	% BDL
JMSPH	STN	0.086	0.005	0.002	0.470	-0.0053	-0.180	-0.085	0.000
JMSPH	BTN	0.118	0.000	0.012	0.445	-0.0047	ne	ne	0.000
JMSPH	SDIN	0.155	0.770	0.000	0.089	0.0000	ne	ne	28.000
JMSPH	BDIN	0.006	0.076	0.001	0.064	0.0000	ne	ne	35.400
JMSPH	STP	0.065	0.023	0.000	0.053	-0.0012	-0.366	-0.019	0.000
JMSPH	BTP	0.449	0.003	0.000	0.063	-0.0013	-0.331	-0.021	0.000
JMSPH	SDIP	0.242	0.000	0.000	0.0220	-0.0005	ne	ne	23.000
JMSPH	BDIP	0.366	0.005	0.000	0.0190	-0.0003	ne	ne	27.600
JMSPH	SCHLA	0.000	0.303	0.079	8.2	0.1155	ne	ne	3.100
JMSPH	BCHLA	0.003	-	0.009	6.8	0.1823	0.430	2.917	0.000
JMSPH	STSS	0.491	0.001	0.000	8.3	0.2040	0.396	3.264	1.000
JMSPH	BTSS	0.571	0.049	0.119	18.5	0.2085	ne	ne	0.000
JMSPH	SSECCHI	0.129	0.056	0.000	1.3	-0.0200	-0.249	-0.320	0.000
JMSPH	BDO (Summer)	0.791	0.025	0.014	6.0	0.0324	ne	ne	0.000
JMSPH	SSALINITY	0.107	0.544	0.014	21.385	-0.1138	ne	ne	0.000
JMSPH	BSALINITY	0.678	0.000	0.000	24.768	-0.1910	-0.123	-3.056	0.000
JMSPH	SWTEMP	0.109	0.922	0.549	17.400	-0.0069	ne	ne	0.000
JMSPH	BWTEMP	0.124	0.003	0.032	16.950	0.0558	ne	ne	0.000
JMSMH	STN	0.982	0.468	0.000	0.630	-0.0215	-0.546	-0.344	0.000
JMSMH	BTN	0.768	0.161	0.000	0.620	-0.0144	-0.372	-0.230	0.000
JMSMH	SDIN	0.984	0.720	0.000	0.188	-0.0086	-0.734	-0.138	10.800
JMSMH	BDIN	0.570	0.577	0.000	0.124	-0.0073	ne	ne	15.600
JMSMH	STP	0.044	0.900	0.000	0.060	-0.0013	-0.347	-0.021	0.000
JMSMH	BTP	0.018	0.687	0.701	0.065	0.0000	ne	ne	0.000
JMSMH	SDIP	0.055	0.154	0.005	0.0163	-0.0002	-0.197	-0.003	14.500
JMSMH	BDIP	0.013	0.450	0.002	0.0150	-0.0001	ne	ne	17.200
JMSMH	SCHLA	0.004	0.406	0.637	4.8	0.0000	ne	ne	11.300
JMSMH	STSS	0.336	0.036	0.952	15.0	0.0000	ne	ne	2.700
JMSMH	BTSS	0.138	0.054	0.000	142.0	1.1250	0.127	18.000	0.000
JMSMH	SSECCHI	0.649	0.053	0.868	1.1	0.0000	ne	ne	0.000
JMSMH	BDO (Summer)	0.210	0.809	0.470	6.4	0.0095	ne	ne	0.000
JMSMH	SSALINITY	0.008	0.294	0.803	14.955	0.0221	ne	ne	0.000
JMSMH	BSALINITY	0.100	0.229	0.934	18.345	0.0056	ne	ne	0.000
JMSMH	SWTEMP	0.050	0.995	0.581	20.163	-0.0200	ne	ne	0.000
JMSMH	BWTEMP	0.036	0.969	0.575	19.700	0.0126	ne	ne	0.000
JMSOH	STN	0.851	0.442	0.000	0.995	-0.0325	-0.523	-0.520	0.000
JMSOH	BTN	0.586	0.827	0.000	0.973	-0.0208	-0.342	-0.333	0.000
JMSOH	SDIN	0.220	0.452	0.000	0.428	-0.0170	-0.636	-0.272	12.800
JMSOH	BDIN	0.343	0.222	0.000	0.411	-0.0169	-0.659	-0.270	9.100
JMSOH	STP	0.557	0.383	0.001	0.076	-0.0017	-0.357	-0.027	0.000
JMSOH	BTP	0.800	0.793	0.416	0.099	0.0008	ne	ne	0.000
JMSOH	SDIP	0.003	0.437	0.601	0.0213	0.0000	ne	ne	4.300
JMSOH	BDIP	0.037	0.116	0.157	0.0206	0.0000	ne	ne	3.700
JMSOH	SCHLA	0.151	0.038	0.606	7.0	0.0000	ne	ne	10.700
JMSOH	STSS	0.186	0.524	0.010	662.0	-0.8000	-0.019	-12.800	0.500
JMSOH	BTSS	0.372	0.454	0.261	290.0	1.4750	ne	ne	0.000
JMSOH	SSECCHI	0.317	0.060	0.224	0.5	0.0000	ne	ne	0.000
JMSOH	BDO (Summer)	0.175	0.975	0.946	6.8	0.0000	ne	ne	0.000
JMSOH	SSALINITY	0.237	0.418	0.211	2.844	0.0156	ne	ne	0.000
JMSOH	BSALINITY	0.246	0.441	0.079	3.755	0.0429	ne	ne	0.000
JMSOH	SWTEMP	0.026	0.565	0.951	18.400	-0.0006	ne	ne	0.000
JMSOH	BWTEMP	0.009	0.565	0.644	18.438	0.0250	ne	ne	0.000

Appendix A. Continued.

James River Stations

Segment	Parameter	Season Homogeneity Test p Value	Station Homogeneity Test p Value	Seasonal Kendall Test p Value	Baseline	Slope	% Change	Absolute Change	% BDL
JMSTF	STN	0.391	0.000	0.000	1.111	-0.0345	-0.497	-0.552	0.000
JMSTF	BTN	0.264	0.002	0.000	1.372	-0.0334	-0.389	-0.534	0.000
JMSTF	SDIN	0.031	0.000	0.000	0.642	-0.0275	-0.685	-0.440	0.000
JMSTF	BDIN	0.071	0.016	0.000	0.782	-0.0300	-0.614	-0.480	0.000
JMSTF	STP	0.922	0.023	0.000	0.136	-0.0047	-0.552	-0.075	0.000
JMSTF	BTP	0.588	0.000	0.000	0.171	-0.0044	-0.412	-0.070	0.000
JMSTF	SDIP	0.085	0.000	0.000	0.0816	-0.0024	-0.471	-0.038	0.500
JMSTF	BDIP	0.075	0.001	0.000	0.0765	-0.0015	-0.314	-0.024	0.500
JMSTF	SCHLA	0.043	0.879	0.089	12.6	0.0000	ne	ne	10.600
JMSTF	STSS	0.007	0.004	0.985	14.0	0.0000	ne	ne	0.000
JMSTF	BTSS	0.001	0.017	0.147	172.0	0.7500	ne	ne	0.000
JMSTF	SSECCHI	0.165	0.033	0.198	0.7	0.0000	ne	ne	0.000
JMSTF	BDO (Summer)	0.773	0.205	0.000	6.4	0.0667	0.167	1.067	0.000
JMSTF	SSALINITY	0.000	0.001	0.000	0.100	0.0000	ne	ne	0.000
JMSTF	BSALINITY	0.000	0.001	0.000	0.100	0.0000	ne	ne	0.000
JMSTF	SWTEMP	0.000	0.800	0.156	18.900	0.0438	ne	ne	0.000
JMSTF	BWTEMP	0.000	0.929	0.216	18.892	0.0400	ne	ne	0.000
APPTF	STN	0.887	na	0.000	0.959	-0.0119	-0.199	-0.190	0.000
APPTF	BTN	0.689	na	0.000	0.975	-0.0154	-0.253	-0.246	0.000
APPTF	SDIN	0.443	na	0.060	0.380	-0.0054	ne	ne	4.300
APPTF	BDIN	0.281	na	0.011	0.380	-0.0048	ne	ne	4.300
APPTF	STP	0.749	na	0.000	0.120	-0.0025	-0.333	-0.040	0.500
APPTF	BTP	0.631	na	0.000	0.125	-0.0027	-0.346	-0.043	0.500
APPTF	SDIP	0.611	na	0.007	0.0200	-0.0002	ne	ne	25.100
APPTF	BDIP	0.381	na	0.005	0.0225	-0.0004	ne	ne	25.700
APPTF	SCHLA	0.522	na	0.403	30.2	0.0000	ne	ne	20.300
APPTF	STSS	0.750	na	0.453	19.5	0.1000	ne	ne	0.000
APPTF	BTSS	0.624	na	0.462	27.3	-0.1847	ne	ne	0.000
APPTF	SSECCHI	0.599	na	0.438	0.5	0.0000	ne	ne	0.000
APPTF	BDO (Summer)	0.483	na	0.019	8.2	0.0714	ne	ne	0.000
APPTF	SSALINITY	0.063	na	0.088	0.000	0.0000	ne	ne	0.000
APPTF	BSALINITY	0.062	na	0.082	0.000	0.0000	ne	ne	0.000
APPTF	SWTEMP	0.429	na	0.047	19.675	0.0744	ne	ne	0.000
APPTF	BWTEMP	0.373	na	0.038	19.000	0.0809	ne	ne	0.000
CHKOH	STN	0.769	na	0.000	0.905	-0.0229	-0.405	-0.366	0.000
CHKOH	BTN	0.617	na	0.000	0.989	-0.0217	-0.351	-0.347	0.000
CHKOH	SDIN	0.646	na	0.002	0.118	0.0000	ne	ne	51.300
CHKOH	BDIN	0.557	na	0.014	0.128	0.0000	ne	ne	50.700
CHKOH	STP	0.793	na	0.692	0.078	0.0000	ne	ne	0.000
CHKOH	BTP	0.593	na	0.328	0.083	0.0007	ne	ne	0.000
CHKOH	SDIP	0.333	na	0.033	0.0050	0.0000	ne	ne	63.200
CHKOH	BDIP	0.238	na	0.557	0.0050	0.0000	ne	ne	59.900
CHKOH	SCHLA	0.697	na	0.076	22.3	-0.3313	ne	ne	5.300
CHKOH	STSS	0.478	na	0.005	17.5	0.6364	0.582	10.182	0.000
CHKOH	BTSS	0.757	na	0.000	27.0	1.5714	0.931	25.142	0.000
CHKOH	SSECCHI	0.270	na	0.043	0.6	0.0000	ne	ne	0.000
CHKOH	BDO (Summer)	0.435	na	0.315	5.8	0.0322	ne	ne	0.000
CHKOH	SSALINITY	0.945	na	0.001	0.100	0.0000	ne	ne	0.000
CHKOH	BSALINITY	0.937	na	0.001	0.100	0.0000	ne	ne	0.000
CHKOH	SWTEMP	0.070	na	0.909	16.000	0.0071	ne	ne	0.000
CHKOH	BWTEMP	0.051	na	0.708	15.600	0.0146	ne	ne	0.000

Appendix A. Continued.
Elizabeth River Stations

Segment	Parameter	Season Homogeneity Test p Value	Station Homogeneity Test p Value	Seasonal Kendall Test p Value	Baseline	Slope	% Change	Absolute Change	% BDL
ELIPH	STN	0.969	na	0.000	0.740	-0.0221	-0.478	-0.354	0.000
ELIPH	BTN	0.942	na	0.000	0.735	-0.0185	-0.403	-0.296	0.500
ELIPH	SDIN	0.889	na	0.000	0.200	-0.0130	-1.040	-0.208	2.700
ELIPH	BDIN	0.939	na	0.000	0.188	-0.0113	-0.964	-0.181	1.600
ELIPH	STP	0.858	na	0.000	0.065	-0.0016	-0.394	-0.026	0.500
ELIPH	BTP	0.422	na	0.000	0.065	-0.0014	-0.345	-0.022	0.000
ELIPH	SDIP	0.652	na	0.000	0.0300	-0.0009	-0.480	-0.014	8.100
ELIPH	BDIP	0.775	na	0.000	0.0250	-0.0008	-0.512	-0.013	3.200
ELIPH	SCHLA	0.027	na	0.852	8.6	0.0033	ne	ne	0.500
ELIPH	STSS	0.140	na	0.099	8.0	-0.2500	ne	ne	2.700
ELIPH	BTSS	0.026	na	0.622	16.0	0.0742	ne	ne	0.500
ELIPH	SSECCHI	0.215	na	0.000	1.1	-0.0143	-0.208	-0.229	0.000
ELIPH	BDO (Summer)	0.395	na	0.982	5.3	0.0000	ne	ne	0.000
ELIPH	SSALINITY	0.509	na	0.003	21.013	-0.1720	-0.131	-2.752	0.000
ELIPH	BSALINITY	0.563	na	0.170	24.390	-0.0562	ne	ne	0.000
ELIPH	SWTEMP	0.242	na	0.598	20.000	-0.0183	ne	ne	0.000
ELIPH	BWTEMP	0.236	na	0.382	17.900	-0.0207	ne	ne	0.000
ELIMH	STN	0.893	na	0.033	0.710	-0.0079	ne	ne	0.000
ELIMH	BTN	0.116	na	0.074	0.611	-0.0062	ne	ne	0.000
ELIMH	SDIN	0.763	na	0.000	0.358	-0.0105	-0.469	-0.168	2.100
ELIMH	BDIN	0.510	na	0.000	0.216	-0.0090	-0.665	-0.144	0.000
ELIMH	STP	0.687	na	0.000	0.063	-0.0019	-0.483	-0.030	0.000
ELIMH	BTP	0.036	na	0.002	0.069	-0.0014	-0.325	-0.022	0.000
ELIMH	SDIP	0.959	na	0.000	0.0375	-0.0013	-0.555	-0.021	9.900
ELIMH	BDIP	0.913	na	0.000	0.0300	-0.0014	-0.747	-0.022	8.500
ELIMH	SCHLA	0.145	na	0.769	11.3	-0.0200	ne	ne	3.500
ELIMH	BCHLA	0.830	na	0.123	3.8	0.1266	ne	ne	12.100
ELIMH	STSS	0.577	na	0.469	10.3	0.0800	ne	ne	0.700
ELIMH	BTSS	0.489	na	0.628	17.3	0.2200	ne	ne	0.000
ELIMH	SSECCHI	0.579	na	0.067	1.1	-0.0106	ne	ne	0.000
ELIMH	BDO (Summer)	0.858	na	0.000	4.1	0.1723	0.672	2.757	0.000
ELIMH	SSALINITY	0.929	na	0.109	16.800	0.1000	ne	ne	0.000
ELIMH	BSALINITY	0.585	na	0.271	20.150	-0.1100	ne	ne	0.000
ELIMH	SWTEMP	0.946	na	0.447	15.750	0.0333	ne	ne	0.000
ELIMH	BWTEMP	0.723	na	0.108	14.950	0.0850	ne	ne	0.000
EBEMH	STN	0.941	na	0.000	1.040	-0.0208	-0.320	-0.333	0.000
EBEMH	BTN	0.867	na	0.000	0.855	-0.0188	-0.352	-0.301	0.000
EBEMH	SDIN	0.962	na	0.000	0.507	-0.0175	-0.552	-0.280	0.000
EBEMH	BDIN	0.785	na	0.000	0.490	-0.0190	-0.620	-0.304	0.000
EBEMH	STP	0.768	na	0.000	0.075	-0.0023	-0.494	-0.037	0.000
EBEMH	BTP	0.802	na	0.000	0.074	-0.0022	-0.476	-0.035	0.000
EBEMH	SDIP	0.991	na	0.000	0.0435	-0.0015	-0.552	-0.024	7.800
EBEMH	BDIP	0.983	na	0.000	0.0455	-0.0018	-0.633	-0.029	7.100
EBEMH	SCHLA	0.204	na	0.571	6.6	-0.0550	ne	ne	11.300
EBEMH	BCHLA	0.810	na	0.490	3.5	0.0078	ne	ne	15.600
EBEMH	STSS	0.539	na	0.468	10.0	-0.0791	ne	ne	0.700
EBEMH	BTSS	0.973	na	0.901	12.2	0.0180	ne	ne	0.700
EBEMH	SSECCHI	0.651	na	0.355	1.0	0.0000	ne	ne	0.000
EBEMH	BDO (Summer)	0.746	na	0.012	3.3	0.1500	ne	ne	0.000
EBEMH	SSALINITY	0.832	na	0.092	16.850	0.1000	ne	ne	0.000
EBEMH	BSALINITY	0.611	na	0.783	18.400	-0.0143	ne	ne	0.000
EBEMH	SWTEMP	0.655	na	0.805	17.000	-0.0300	ne	ne	0.000
EBEMH	BWTEMP	0.194	na	0.434	15.900	0.0536	ne	ne	0.000

Appendix A. Continued.

Elizabeth River Stations

Segment	Parameter	Season Homogeneity Test p Value	Station Homogeneity Test p Value	Seasonal Kendall Test p Value	Baseline	Slope	% Change	Absolute Change	% BDL
SBEMH	STN	0.585	0.510	0.000	1.333	-0.0286	-0.343	-0.458	0.000
SBEMH	BTN	0.547	0.148	0.035	1.070	-0.0113	ne	ne	0.000
SBEMH	SDIN	0.969	0.988	0.000	0.738	-0.0271	-0.588	-0.434	0.000
SBEMH	BDIN	0.114	0.747	0.000	0.586	-0.0129	-0.353	-0.206	0.000
SBEMH	STP	0.808	0.139	0.000	0.074	-0.0023	-0.501	-0.037	0.000
SBEMH	BTP	0.136	0.748	0.000	0.079	-0.0026	-0.528	-0.042	0.000
SBEMH	SDIP	0.976	0.341	0.000	0.0478	-0.0018	-0.603	-0.029	1.400
SBEMH	BDIP	0.987	0.375	0.000	0.0478	-0.0022	-0.737	-0.035	2.100
SBEMH	SCHLA	0.721	0.085	0.055	4.1	-0.1136	ne	ne	9.900
SBEMH	BCHLA	0.286	0.897	0.057	3.4	0.0778	ne	ne	17.000
SBEMH	STSS	0.540	0.281	0.255	8.6	-0.1011	ne	ne	0.000
SBEMH	BTSS	0.840	0.878	0.247	13.1	-0.1946	ne	ne	0.000
SBEMH	SSECCHI	0.832	0.631	0.652	0.8	0.0000	ne	ne	0.000
SBEMH	BDO (Summer)	0.951	0.776	0.002	2.7	0.1622	0.979	2.595	0.000
SBEMH	SSALINITY	0.554	0.678	0.144	14.750	0.1073	ne	ne	0.000
SBEMH	BSALINITY	0.392	0.288	0.040	18.450	-0.1556	ne	ne	0.000
SBEMH	SWTEMP	0.249	0.124	0.114	18.200	0.0828	ne	ne	0.000
SBEMH	BWTEMP	0.030	0.011	0.000	17.100	0.2317	0.217	3.707	0.000
WBEMH	STN	0.987	na	0.000	0.800	-0.0186	-0.372	-0.298	0.000
WBEMH	BTN	0.947	na	0.000	0.791	-0.0146	-0.295	-0.234	0.000
WBEMH	SDIN	0.980	na	0.001	0.198	-0.0065	-0.525	-0.104	2.100
WBEMH	BDIN	0.957	na	0.004	0.257	-0.0087	-0.542	-0.139	1.400
WBEMH	STP	0.774	na	0.000	0.083	-0.0027	-0.520	-0.043	0.000
WBEMH	BTP	0.100	na	0.000	0.080	-0.0024	-0.483	-0.038	0.000
WBEMH	SDIP	0.899	na	0.000	0.0345	-0.0012	-0.557	-0.019	13.500
WBEMH	BDIP	0.989	na	0.000	0.0330	-0.0015	-0.727	-0.024	12.100
WBEMH	SCHLA	0.056	na	0.005	23.0	-0.6286	-0.437	-10.058	2.800
WBEMH	BCHLA	0.354	na	0.138	14.9	-0.2596	ne	ne	5.000
WBEMH	STSS	0.530	na	0.658	20.6	-0.1000	ne	ne	0.000
WBEMH	BTSS	0.229	na	0.710	20.5	0.2018	ne	ne	0.000
WBEMH	SSECCHI	0.731	na	0.750	0.6	0.0000	ne	ne	0.000
WBEMH	BDO (Summer)	0.885	na	0.003	4.4	0.2000	0.727	3.200	0.000
WBEMH	SSALINITY	0.992	na	0.225	15.900	0.1000	ne	ne	0.000
WBEMH	BSALINITY	0.920	na	0.626	16.700	0.0310	ne	ne	0.000
WBEMH	SWTEMP	0.902	na	0.565	17.000	-0.0250	ne	ne	0.000
WBEMH	BWTEMP	0.936	na	0.409	16.150	-0.0357	ne	ne	0.000

Appendix A. Continued.
York River Stations

Segment	Parameter	Season Homogeneity Test p Value	Station Homogeneity Test p Value	Seasonal Kendall Test p Value	Baseline	Slope	% Change	Absolute Change	% BDL
MOBPH	STN	0.008	0.410	0.001	0.460	-0.0045	-0.157	-0.072	0.000
MOBPH	BTN	0.259	0.363	0.000	0.494	-0.0046	-0.149	-0.074	0.000
MOBPH	SDIN	0.002	0.752	0.000	0.046	0.0000	ne	ne	21.400
MOBPH	BDIN	0.000	0.441	0.000	0.061	-0.0009	-0.238	-0.014	14.600
MOBPH	STP	0.000	0.764	0.048	0.028	0.0002	ne	ne	1.000
MOBPH	BTP	0.028	0.044	0.387	0.036	0.0001	ne	ne	1.000
MOBPH	BPO4F	1.000	0.266	0.000	0.0072	0.0000	ne	ne	52.600
MOBPH	SPO4F	1.000	0.286	0.000	0.0071	0.0000	ne	ne	63.500
MOBPH	SCHLA	0.114	0.511	0.697	5.9	-0.0202	ne	ne	0.000
MOBPH	BCHLA	0.001	0.519	0.866	6.4	-0.0092	ne	ne	0.000
MOBPH	BTSS	0.146	0.134	0.687	17.9	0.0444	ne	ne	0.000
MOBPH	STSS	0.452	0.563	0.687	10.8	-0.0205	ne	ne	0.500
MOBPH	SSECCHI	0.045	0.062	0.000	1.5	-0.0208	-0.228	-0.333	0.000
MOBPH	BDO (Summer)	0.709	0.066	0.003	6.2	0.0506	0.132	0.810	0.000
MOBPH	BSALINITY	0.128	0.478	0.000	22.763	-0.1392	-0.098	-2.227	0.000
MOBPH	SSALINITY	0.077	0.827	0.000	21.975	-0.1467	-0.107	-2.347	0.000
MOBPH	BWTEMP	0.246	0.948	0.585	17.500	0.0128	ne	ne	0.000
MOBPH	SWTEMP	0.615	0.984	0.668	18.413	0.0125	ne	ne	0.000
YRKPH	STN	0.035	0.719	0.000	0.565	-0.0096	-0.272	-0.154	0.000
YRKPH	BTN	0.159	0.241	0.085	0.544	-0.0040	ne	ne	0.000
YRKPH	SDIN	0.000	0.709	0.027	0.055	0.0000	ne	ne	43.900
YRKPH	BDIN	0.022	0.661	0.159	0.055	0.0000	ne	ne	32.800
YRKPH	STP	0.501	0.661	0.713	0.043	0.0000	ne	ne	0.000
YRKPH	BTP	0.300	0.129	0.001	0.053	0.0011	0.335	0.018	0.000
YRKPH	SDIP	0.038	-	0.063	0.0088	0.0000	ne	ne	41.200
YRKPH	BDIP	0.043	0.280	0.946	0.0125	0.0000	ne	ne	35.500
YRKPH	SCHLA	0.000	0.462	0.246	8.3	0.0531	ne	ne	6.400
YRKPH	STSS	0.605	0.864	0.155	6.0	0.1348	ne	ne	5.900
YRKPH	BTSS	0.101	0.062	0.024	20.0	0.6429	ne	ne	0.500
YRKPH	SSECCHI	0.374	0.659	0.049	1.3	-0.0089	ne	ne	0.000
YRKPH	BDO (Summer)	0.637	0.857	0.645	4.6	-0.0188	ne	ne	0.000
YRKPH	SSALINITY	0.050	0.101	0.002	20.558	-0.1429	-0.111	-2.286	0.000
YRKPH	BSALINITY	0.002	0.745	0.292	21.728	-0.0350	ne	ne	0.000
YRKPH	SWTEMP	0.276	0.813	0.574	19.025	-0.0148	ne	ne	0.000
YRKPH	BWTEMP	0.130	0.715	0.355	18.763	-0.0286	ne	ne	0.000
YRKMH	STN	0.100	0.947	0.001	0.675	-0.0075	-0.178	-0.120	0.000
YRKMH	BTN	0.037	0.077	0.190	0.705	0.0043	ne	ne	0.000
YRKMH	SDIN	0.007	0.756	0.006	0.130	-0.0032	ne	ne	17.600
YRKMH	BDIN	0.001	0.682	0.020	0.114	-0.0010	ne	ne	18.800
YRKMH	STP	0.021	0.493	0.300	0.073	0.0005	ne	ne	0.000
YRKMH	BTP	0.825	0.607	0.000	0.085	0.0024	0.452	0.038	0.000
YRKMH	SDIP	0.028	0.738	0.654	0.0125	0.0000	ne	ne	18.700
YRKMH	BDIP	0.138	0.490	0.405	0.0125	0.0000	ne	ne	18.800
YRKMH	SCHLA	0.051	0.169	0.010	9.5	0.2795	0.469	4.472	3.700
YRKMH	STSS	0.353	0.150	0.892	29.1	0.0000	ne	ne	0.000
YRKMH	BTSS	0.786	0.041	0.001	42.1	2.3939	0.909	38.302	0.000
YRKMH	SSECCHI	0.099	0.219	0.967	0.6	0.0000	ne	ne	0.000
YRKMH	BDO (Summer)	0.482	0.042	0.042	5.1	0.0318	ne	ne	0.000
YRKMH	SSALINITY	0.083	0.514	0.389	12.465	-0.0425	ne	ne	0.000
YRKMH	BSALINITY	0.080	0.702	0.374	13.615	-0.0505	ne	ne	0.000
YRKMH	SWTEMP	0.127	0.947	0.612	19.988	0.0150	ne	ne	0.000
YRKMH	BWTEMP	0.176	0.700	0.755	19.988	0.0079	ne	ne	0.000

Appendix A. Continued.

York River Stations

Segment	Parameter	Season Homogeneity Test p Value	Station Homogeneity Test p Value	Seasonal Kendall Test p Value	Baseline	Slope	% Change	Absolute Change	% BDL
PMKOH	STN	0.524	na	0.039	0.775	-0.0077	ne	ne	0.000
PMKOH	BTN	0.644	na	0.789	0.931	-0.0024	ne	ne	0.000
PMKOH	SDIN	0.173	na	0.249	0.155	-0.0013	ne	ne	11.500
PMKOH	BDIN	0.251	na	0.152	0.135	-0.0016	ne	ne	11.000
PMKOH	STP	0.709	na	0.918	0.090	0.0000	ne	ne	0.000
PMKOH	BTP	0.579	na	0.311	0.128	0.0018	ne	ne	0.000
PMKOH	SDIP	0.455	na	0.001	0.0050	0.0003	ne	ne	17.500
PMKOH	BDIP	0.159	na	0.036	0.0050	0.0001	ne	ne	14.800
PMKOH	SCHLA	0.401	na	0.013	6.4	0.0308	ne	ne	24.600
PMKOH	STSS	0.631	na	0.615	48.0	-0.2083	ne	ne	0.500
PMKOH	BTSS	0.525	na	0.101	102.0	-3.3333	ne	ne	0.500
PMKOH	SSECCHI	0.491	na	0.150	0.3	0.0000	ne	ne	0.000
PMKOH	BDO (Summer)	0.972	na	0.540	4.9	0.0167	ne	ne	0.000
PMKOH	SSALINITY	0.952	na	0.071	3.490	0.0417	ne	ne	0.000
PMKOH	BSALINITY	0.927	na	0.112	4.310	0.0450	ne	ne	0.000
PMKOH	SWTEMP	0.696	na	0.676	20.550	0.0156	ne	ne	0.000
PMKOH	BWTEMP	0.650	na	0.419	20.700	0.0218	ne	ne	0.000
PMKTF	STN	0.958	na	0.000	0.755	-0.0095	-0.201	-0.152	0.000
PMKTF	BTN	0.880	na	0.000	0.798	-0.0102	-0.205	-0.163	0.000
PMKTF	SDIN	0.894	na	0.410	0.300	-0.0006	ne	ne	7.500
PMKTF	BDIN	0.976	na	0.388	0.275	-0.0008	ne	ne	7.700
PMKTF	STP	0.995	na	0.989	0.070	0.0000	ne	ne	0.000
PMKTF	BTP	0.894	na	0.977	0.070	0.0000	ne	ne	0.000
PMKTF	SDIP	0.067	na	0.000	0.0150	0.0007	ne	ne	25.700
PMKTF	BDIP	0.013	na	0.000	0.0125	0.0007	ne	ne	25.100
PMKTF	SCHLA	0.565	na	0.270	1.6	0.0000	ne	ne	55.600
PMKTF	STSS	0.552	na	0.715	14.0	0.0000	ne	ne	0.500
PMKTF	BTSS	0.648	na	0.005	20.5	-0.6667	-0.520	-10.667	0.500
PMKTF	SSECCHI	0.854	na	1.000	0.7	0.0000	ne	ne	0.000
PMKTF	BDO (Summer)	0.034	na	0.150	5.4	0.0336	ne	ne	0.000
PMKTF	SSALINITY	0.291	na	0.000	0.100	0.0000	ne	ne	0.000
PMKTF	BSALINITY	0.215	na	0.000	0.100	0.0000	ne	ne	0.000
PMKTF	SWTEMP	0.254	na	0.080	18.000	0.0500	ne	ne	0.000
PMKTF	BWTEMP	0.274	na	0.044	19.100	0.0777	ne	ne	0.000
MPNOH	STN	0.119	na	0.454	0.670	-0.0016	ne	ne	0.000
MPNOH	BTN	0.281	na	0.069	0.830	0.0067	ne	ne	0.000
MPNOH	SDIN	0.300	na	0.581	0.118	0.0000	ne	ne	13.400
MPNOH	BDIN	0.158	na	0.142	0.135	-0.0012	ne	ne	13.600
MPNOH	STP	0.045	na	0.184	0.060	0.0008	ne	ne	0.000
MPNOH	BTP	0.365	na	0.120	0.110	0.0014	ne	ne	0.000
MPNOH	SDIP	0.011	na	0.000	0.0050	0.0001	ne	ne	24.700
MPNOH	BDIP	0.003	na	0.001	0.0050	0.0003	ne	ne	22.300
MPNOH	SCHLA	0.616	na	0.000	3.9	0.0550	ne	ne	31.700
MPNOH	BCHLA	-	na	-	7.8	-	ne	ne	0.000
MPNOH	STSS	0.071	na	0.556	26.0	0.1250	ne	ne	1.100
MPNOH	BTSS	0.530	na	0.458	44.0	0.4000	ne	ne	0.000
MPNOH	SSECCHI	0.234	na	0.065	0.5	0.0000	ne	ne	0.000
MPNOH	BDO (Summer)	0.846	na	0.009	5.1	0.0529	0.168	0.846	0.000
MPNOH	SSALINITY	0.657	na	0.064	3.380	0.0545	ne	ne	0.000
MPNOH	BSALINITY	0.795	na	0.133	4.310	0.0562	ne	ne	0.000
MPNOH	SWTEMP	0.629	na	0.212	20.500	0.0275	ne	ne	0.000
MPNOH	BWTEMP	0.741	na	0.187	20.325	0.0286	ne	ne	0.000

Appendix A. Continued.

York River Stations

Segment	Parameter	Season Homogeneity Test p Value	Station Homogeneity Test p Value	Seasonal Kendall Test p Value	Baseline	Slope	% Change	Absolute Change	% BDL
MPNTF	STN	0.965	na	0.000	0.743	-0.0122	-0.263	-0.195	0.000
MPNTF	BTN	0.997	na	0.000	0.760	-0.0124	-0.261	-0.198	0.000
MPNTF	SDIN	0.874	na	0.104	0.160	-0.0014	ne	ne	11.200
MPNTF	BDIN	0.955	na	0.021	0.180	-0.0020	ne	ne	10.400
MPNTF	STP	0.844	na	0.672	0.060	0.0000	ne	ne	0.000
MPNTF	BTP	0.514	na	0.050	0.070	-0.0005	ne	ne	0.000
MPNTF	SDIP	0.083	na	0.000	0.0088	0.0006	ne	ne	29.400
MPNTF	BDIP	0.573	na	0.000	0.0125	0.0001	ne	ne	29.700
MPNTF	SCHLA	0.196	na	0.731	1.6	0.0000	ne	ne	63.100
MPNTF	STSS	0.756	na	0.641	6.0	0.0000	ne	ne	17.100
MPNTF	BTSS	0.809	na	0.700	7.8	0.0000	ne	ne	11.000
MPNTF	SSECCHI	0.167	na	0.833	1.0	0.0000	ne	ne	0.000
MPNTF	BDO (Summer)	0.891	na	0.563	5.9	0.0092	ne	ne	0.000
MPNTF	SSALINITY	1.000	na	0.000	0.100	0.0000	ne	ne	0.000
MPNTF	BSALINITY	1.000	na	0.000	0.100	0.0000	ne	ne	0.000
MPNTF	SWTEMP	0.235	na	0.096	17.500	0.0750	ne	ne	0.000
MPNTF	BWTEMP	0.115	na	0.039	18.575	0.1000	ne	ne	0.000

Appendix A. Continued.

Rappahannock River Stations

Segment	Parameter	Season Homogeneity Test p Value	Station Homogeneity Test p Value	Seasonal Kendall Test p Value	Baseline	Slope	% Change	Absolute Change	% BDL
RPPMH	STN	0.001	0.946	0.000	0.575	-0.0100	-0.278	-0.160	0.000
RPPMH	BTN	0.000	0.077	0.001	0.619	-0.0076	-0.197	-0.122	0.000
RPPMH	SDIN	0.000	0.058	0.052	0.105	0.0000	ne	ne	20.800
RPPMH	BDIN	0.002	0.709	0.108	0.114	0.0000	ne	ne	8.900
RPPMH	STP	0.072	0.299	0.107	0.032	0.0001	ne	ne	0.500
RPPMH	BTP	0.198	0.001	0.058	0.048	0.0003	ne	ne	0.000
RPPMH	SDIP	0.829	0.000	0.285	0.0050	0.0000	ne	ne	46.900
RPPMH	BDIP	0.012	0.000	0.386	0.0050	0.0000	ne	ne	40.600
RPPMH	SCHLA	0.003	0.367	0.343	8.9	0.0518	ne	ne	0.000
RPPMH	BCHLA	0.544	-	0.230	8.1	-0.0797	ne	ne	0.000
RPPMH	STSS	0.000	0.024	0.498	9.8	0.0420	ne	ne	0.500
RPPMH	BTSS	0.007	0.587	0.038	10.8	0.3258	ne	ne	0.000
RPPMH	SSECCHI	0.005	0.001	0.724	1.4	0.0000	ne	ne	0.000
RPPMH	BDO (Summer)	0.000	0.246	0.753	5.2	0.0134	ne	ne	0.000
RPPMH	SSALINITY	0.008	0.461	0.000	14.955	-0.2000	-0.214	-3.200	0.000
RPPMH	BSALINITY	0.042	0.604	0.000	16.604	-0.1313	-0.127	-2.101	0.000
RPPMH	SWTEMP	0.000	0.836	0.668	17.834	-0.0111	.	.	0.000
RPPMH	BWTEMP	0.000	0.690	0.263	16.898	-0.0289	.	.	0.000
RPPOH	STN	0.647	na	0.001	0.728	-0.0108	-0.238	-0.173	0.000
RPPOH	BTN	0.623	na	0.020	0.775	-0.0077	ne	ne	0.000
RPPOH	SDIN	0.738	na	0.000	0.231	-0.0004	ne	ne	30.900
RPPOH	BDIN	0.573	na	0.000	0.245	-0.0025	ne	ne	30.900
RPPOH	STP	0.709	na	0.340	0.058	0.0005	ne	ne	0.500
RPPOH	BTP	0.154	na	0.282	0.080	0.0012	ne	ne	0.000
RPPOH	SDIP	0.927	na	0.006	0.0050	0.0000	ne	ne	65.400
RPPOH	BDIP	0.363	na	0.004	0.0050	0.0000	ne	ne	60.100
RPPOH	SCHLA	0.897	na	0.000	4.6	0.3799	ne	ne	18.100
RPPOH	STSS	0.414	na	0.615	31.0	-0.1429	ne	ne	0.500
RPPOH	BTSS	0.456	na	0.463	39.0	0.3333	ne	ne	0.000
RPPOH	SSECCHI	0.222	na	0.953	0.4	0.0000	ne	ne	0.000
RPPOH	BDO (Summer)	0.735	na	0.001	6.3	0.0694	0.178	1.110	0.000
RPPOH	SSALINITY	0.924	na	0.015	2.165	-0.0221	ne	ne	0.000
RPPOH	BSALINITY	0.820	na	0.028	2.588	-0.0163	ne	ne	0.000
RPPOH	SWTEMP	0.366	na	0.922	16.000	0.0000	ne	ne	0.000
RPPOH	BWTEMP	0.579	na	0.890	16.400	0.0000	ne	ne	0.000
RPPTF	STN	0.174	0.029	0.000	0.975	-0.0165	-0.271	-0.264	0.000
RPPTF	BTN	0.371	0.000	0.000	1.045	-0.0203	-0.311	-0.325	0.000
RPPTF	SDIN	0.423	0.406	0.077	0.448	-0.0055	ne	ne	5.300
RPPTF	BDIN	0.186	0.348	0.054	0.425	-0.0063	ne	ne	4.800
RPPTF	STP	0.297	0.032	0.016	0.065	-0.0005	ne	ne	0.000
RPPTF	BTP	0.186	0.028	0.003	0.085	-0.0014	-0.264	-0.022	0.000
RPPTF	SDIP	0.878	0.007	0.007	0.0050	0.0000	ne	ne	42.300
RPPTF	BDIP	0.840	0.322	0.115	0.0050	0.0000	ne	ne	37.800
RPPTF	SCHLA	0.850	0.027	0.784	12.4	0.0000	ne	ne	18.500
RPPTF	BCHLA	-	-	-	9.1	-	ne	ne	0.000
RPPTF	STSS	0.689	0.868	0.298	24.5	-0.2000	ne	ne	0.000
RPPTF	BTSS	0.505	0.425	0.060	37.3	-0.7000	ne	ne	0.000
RPPTF	SSECCHI	0.711	0.059	0.010	0.5	0.0056	0.199	0.090	0.000
RPPTF	BDO (Summer)	0.111	0.375	0.604	7.4	-0.0150	ne	ne	0.000
RPPTF	SSALINITY	0.505	0.042	0.001	0.100	0.0000	ne	ne	0.000
RPPTF	BSALINITY	0.317	0.035	0.001	0.100	0.0000	ne	ne	0.000
RPPTF	SWTEMP	0.125	0.641	0.306	16.325	0.0364	ne	ne	0.000
RPPTF	BWTEMP	0.318	0.875	0.284	17.750	0.0373	ne	ne	0.000

Appendix A. Continued.

Rappahannock River Stations

Segment	Parameter	Season Homogeneity Test p Value	Station Homogeneity Test p Value	Seasonal Kendall Test p Value	Baseline	Slope	% Change	Absolute Change	% BDL
CRRMH	STN	0.018	na	0.000	0.630	-0.0077	-0.196	-0.123	0.000
CRRMH	BTN	0.310	na	0.023	0.530	-0.0054	ne	ne	0.500
CRRMH	SDIN	0.178	na	0.103	0.055	0.0000	ne	ne	61.600
CRRMH	BDIN	0.282	na	0.452	0.055	0.0000	ne	ne	55.300
CRRMH	STP	0.395	na	0.408	0.025	0.0000	ne	ne	3.200
CRRMH	BTP	0.561	na	0.001	0.028	0.0006	0.349	0.010	0.500
CRRMH	SDIP	0.601	na	0.284	0.0050	0.0000	ne	ne	87.900
CRRMH	BDIP	0.699	na	0.065	0.0050	0.0000	ne	ne	80.500
CRRMH	SCHLA	0.763	na	0.795	7.3	0.0000	ne	ne	16.800
CRRMH	STSS	0.052	na	0.602	2.5	0.0000	ne	ne	43.200
CRRMH	BTSS	0.151	na	0.561	13.5	0.0000	ne	ne	25.300
CRRMH	SSECCHI	0.113	na	0.002	2.0	-0.0187	-0.153	-0.299	0.000
CRRMH	BDO (Summer)	0.431	na	0.015	5.0	-0.1000	ne	ne	0.000
CRRMH	SSALINITY	0.960	na	0.000	16.510	-0.2200	-0.213	-3.520	0.000
CRRMH	BSALINITY	0.832	na	0.000	16.840	-0.1826	-0.173	-2.922	0.000
CRRMH	SWTEMP	0.735	na	0.292	18.500	-0.0300	ne	ne	0.000
CRRMH	BWTEMP	0.041	na	0.103	17.825	-0.0426	ne	ne	0.000

Appendix B. Results of Seasonal Kendall (SK) trend tests and Van Belle and Hughs test for homogeneity of trends for phytoplankton bioindicators for the period of 1985 through 2000.

Chesapeake Bay Main stem Stations

Station	Parameter	Layer	Homogeneity Test p Value	SK Test p Value	Baseline	Slope	% Change	Absolute Change
CB6.1	Chlorophyte biomass	AP	0.9728	0.0000	140324	62458.2	667.7	936873.5
CB6.1	Cryptophyte biomass	AP	0.9035	0.6344	59359814	-317798.1	-8.0	-4766972.0
CB6.1	Cyanophyte biomass	AP	0.8102	0.0360	66266	0.0	0.0	0.0
CB6.1	Diatom biomass	AP	0.3194	0.5569	239802918	2233377.4	14.0	33500660.7
CB6.1	Dinoflagellate biomass	AP	0.0507	0.4334	118461536	1812274.3	23.0	27184114.8
CB6.1	Margalef Diversity Index	AP	0.7060	0.7583	2	0.0	0.0	0.0
CB6.1	Picoplankton biomass	AP	0.8976	0.1397	147150000	-1344000.0	-13.7	-20160000.0
CB6.1	Biomass to Abundance Ratio	AP	0.0074	0.0536	136	-2.1	-23.0	-31.4
CB6.1	Total abundance	AP	0.7947	0.0648	4790491	96088.7	30.1	1441331.0
CB6.1	Total biomass	AP	0.2785	0.6146	572858682	4644913.0	12.2	69673694.7
CB6.1	Chlorophyte biomass	BP	0.8794	0.0000	46654	71507.8	2299.1	1072616.3
CB6.1	Cryptophyte biomass	BP	0.8479	0.8888	28424560	74645.3	3.9	1119679.8
CB6.1	Cyanophyte biomass	BP	0.8566	0.0077	35191	0.0	0.0	0.0
CB6.1	Diatom biomass	BP	0.4199	0.8012	134179915	-512930.9	-5.7	-7693963.7
CB6.1	Dinoflagellate biomass	BP	0.2618	0.9554	52607857	77576.4	2.2	1163646.5
CB6.1	Margalef Diversity Index	BP	0.4828	0.6344	2	0.0	0.0	0.0
CB6.1	Picoplankton biomass	BP	0.9559	0.0325	81750000	-1807500.0	-33.2	-27112500.0
CB6.1	Biomass to Abundance Ratio	BP	0.5619	0.0067	81	-2.2	-40.3	-32.7
CB6.1	Total abundance	BP	0.6194	0.3858	2900128	44185.8	22.9	662787.2
CB6.1	Total biomass	BP	0.5158	0.2631	278852057	-5585710.6	-30.1	-83785659.0
CB6.4	Chlorophyte biomass	AP	0.8901	0.0000	82373	83764.2	1525.3	1256462.9
CB6.4	Cryptophyte biomass	AP	0.0155	0.9782	56637984	20602.1	0.6	309031.1
CB6.4	Cyanophyte biomass	AP	0.5582	0.0155	0	0.0	.	0.0
CB6.4	Diatom biomass	AP	0.8624	0.1062	138916373	4357584.0	47.1	65363760.2
CB6.4	Dinoflagellate biomass	AP	0.0467	0.4936	118968701	1121085.7	14.1	16816285.2
CB6.4	Margalef Diversity Index	AP	0.3519	0.7425	2	0.0	0.0	0.0
CB6.4	Picoplankton biomass	AP	0.8884	0.1282	101925000	-906600.0	-13.3	-13599000.0
CB6.4	Biomass to Abundance Ratio	AP	0.3009	0.2616	114	-1.3	-17.2	-19.5
CB6.4	Total abundance	AP	0.8450	0.0519	3133871	87812.3	42.0	1317184.4
CB6.4	Total biomass	AP	0.5678	0.3519	372856477	4943430.9	19.9	74151463.7
CB6.4	Chlorophyte biomass	BP	0.9932	0.0000	145800	65976.0	678.8	989639.6
CB6.4	Cryptophyte biomass	BP	0.4518	0.0305	18039149	846050.4	70.4	12690755.7
CB6.4	Cyanophyte biomass	BP	0.8046	0.0001	0	0.0	.	0.0
CB6.4	Diatom biomass	BP	0.4571	0.1981	155439172	4808223.0	46.4	72123345.5
CB6.4	Dinoflagellate biomass	BP	0.8395	0.7842	62918005	232806.0	5.6	3492090.3
CB6.4	Margalef Diversity Index	BP	0.4059	0.8480	2	0.0	0.0	0.0
CB6.4	Picoplankton biomass	BP	0.8583	0.4533	67950000	-673500.6	-14.9	-10102508.4
CB6.4	Biomass to Abundance Ratio	BP	0.9803	0.1321	88	-1.1	-19.4	-17.1
CB6.4	Total abundance	BP	0.8244	0.0016	2418072	113198.5	70.2	1697978.1
CB6.4	Total biomass	BP	0.4057	0.1321	249048406	5989120.0	36.1	89836800.6

Appendix B. Continued
Chesapeake Bay Main stem Stations

Station	Parameter	Layer	Homogeneity Test p Value	SK Test p Value	Baseline	Slope	% Change	Absolute Change
CB7.3E	Chlorophyte biomass	AP	0.5500	0.0000	3273	48091.6	22037.2	721374.0
CB7.3E	Cryptophyte biomass	AP	0.5373	0.5109	49158112	309989.9	9.5	4649848.2
CB7.3E	Cyanophyte biomass	AP	0.5945	0.0898	41808	0.0	0.0	0.0
CB7.3E	Diatom biomass	AP	0.9001	0.2081	178174254	5005556.1	42.1	75083342.1
CB7.3E	Dinoflagellate biomass	AP	0.5523	0.5199	138352514	952009.9	10.3	14280148.1
CB7.3E	Margalef Diversity Index	AP	0.9704	0.6953	3	0.0	0.0	0.0
CB7.3E	Picoplankton biomass	AP	0.6346	0.3212	122625000	-680333.3	-8.3	-10205000.0
CB7.3E	Biomass to Abundance Ratio	AP	0.9678	0.3139	156	-1.6	-14.9	-23.3
CB7.3E	Total abundance	AP	0.4600	0.0188	2976734	114719.5	57.8	1720792.5
CB7.3E	Total biomass	AP	0.4995	0.2081	508491262	7837696.8	23.1	117565452.2
CB7.3E	Chlorophyte biomass	BP	0.7497	0.0000	0	58975.6	.	884634.3
CB7.3E	Cryptophyte biomass	BP	0.0458	0.0105	26314555	1077754.6	61.4	16166319.0
CB7.3E	Cyanophyte biomass	BP	0.0415	0.9882	34553	0.0	0.0	0.0
CB7.3E	Diatom biomass	BP	0.2193	0.0056	201937296	11186481.2	83.1	167797218.0
CB7.3E	Dinoflagellate biomass	BP	0.3301	0.6953	73096885	411323.7	8.4	6169854.8
CB7.3E	Margalef Diversity Index	BP	0.6742	0.0690	3	-0.0	-5.4	-0.2
CB7.3E	Picoplankton biomass	BP	0.8381	0.4944	87975000	411428.6	7.0	6171428.6
CB7.3E	Biomass to Abundance Ratio	BP	0.3139	0.7583	114	-0.5	-6.3	-7.2
CB7.3E	Total abundance	BP	0.1732	0.0005	3198037	151318.6	71.0	2269779.5
CB7.3E	Total biomass	BP	0.4724	0.0093	398769512	14220303.1	53.5	213304546.5
CB7.4	Chlorophyte biomass	AP	0.7703	0.0000	29864	43201.0	2169.9	648014.7
CB7.4	Cryptophyte biomass	AP	0.3043	0.1596	22566519	572713.5	38.1	8590701.9
CB7.4	Cyanophyte biomass	AP	0.8786	0.0498	15299	0.0	0.0	0.0
CB7.4	Diatom biomass	AP	0.5609	0.0274	134607897	9104233.9	101.5	136563508.1
CB7.4	Dinoflagellate biomass	AP	0.1991	0.2468	47230759	1456546.0	46.3	21848189.4
CB7.4	Margalef Diversity Index	AP	0.8115	0.0075	3	-0.0	-15.0	-0.5
CB7.4	Picoplankton biomass	AP	0.6418	0.4491	76500000	-197400.0	-3.9	-2961000.0
CB7.4	Biomass to Abundance Ratio	AP	0.5097	0.6003	111	-0.6	-8.3	-9.2
CB7.4	Total abundance	AP	0.9186	0.0006	2267717	138802.9	91.8	2082043.7
CB7.4	Total biomass	AP	0.2500	0.0776	253623769	10443998.2	61.8	156659973.0
CB7.4	Chlorophyte biomass	BP	0.2509	0.0000	71359	30676.0	644.8	460139.4
CB7.4	Cryptophyte biomass	BP	0.5350	0.0570	19812486	580493.2	44.0	8707397.4
CB7.4	Cyanophyte biomass	BP	0.9277	0.1392	10782	0.0	0.0	0.0
CB7.4	Diatom biomass	BP	0.6387	0.0191	218458589	9087315.0	62.4	136309724.4
CB7.4	Dinoflagellate biomass	BP	0.1407	0.0536	60325191	-1410055.6	-35.1	-21150834.0
CB7.4	Margalef Diversity Index	BP	0.1660	0.0164	3	-0.0	-9.7	-0.3
CB7.4	Picoplankton biomass	BP	0.9519	0.7457	78300000	249000.0	4.8	3735000.0
CB7.4	Biomass to Abundance Ratio	BP	0.5474	0.0103	128	-3.5	-40.3	-51.8
CB7.4	Total abundance	BP	0.6735	0.0015	2073701	113353.3	82.0	1700299.1
CB7.4	Total biomass	BP	0.4869	0.0873	349613985	9773886.5	41.9	146608296.9

Appendix B. Continued

James River Stations

Station	Parameter	Layer	Homogeneity Test p Value	SK Test p Value	Baseline	Slope	% Change	Absolute Change
TF5.5	Chlorophyte biomass	AP	0.8969	0.0000	15818987	22634484.1	2003.2	316882777.4
TF5.5	Cryptophyte biomass	AP	0.6160	0.0000	26361323	3857094.7	204.8	53999325.8
TF5.5	Cyanophyte biomass	AP	0.2987	0.8135	19157403	-5385.5	-0.4	-75397.1
TF5.5	Diatom biomass	AP	0.0902	0.0270	230549510	8698527.7	52.8	121779387.8
TF5.5	Dinoflagellate biomass	AP	0.6423	0.2175	636182	0.0	0.0	0.0
TF5.5	Margalef Diversity Index	AP	0.9559	0.1049	2	0.0	5.9	0.1
TF5.5	Picoplankton biomass	AP	0.7421	0.0599	96600000	-717750.0	-10.4	-10048500.0
TF5.5	Biomass to Abundance Ratio	AP	0.4718	0.0000	16	1.4	121.4	19.7
TF5.5	Total abundance	AP	0.1777	0.0338	24027209	613453.2	35.7	8588345.1
TF5.5	Total biomass	AP	0.8057	0.0000	416646671	48966251.1	164.5	685527515.4
TF5.5	Chlorophyte biomass	BP	0.9487	0.0000	12671212	16234850.3	1793.7	227287904.2
TF5.5	Cryptophyte biomass	BP	0.2504	0.0000	23633526	3041774.2	180.2	42584838.7
TF5.5	Cyanophyte biomass	BP	0.9595	0.3963	20066162	-58536.6	-4.1	-819511.7
TF5.5	Diatom biomass	BP	0.4021	0.0406	401696920	9868550.8	34.4	138159711.1
TF5.5	Dinoflagellate biomass	BP	0.1542	0.1077	554138	0.0	0.0	0.0
TF5.5	Margalef Diversity Index	BP	0.1837	0.7477	2	0.0	0.0	0.0
TF5.5	Picoplankton biomass	BP	0.5564	0.0905	49200000	-522300.0	-14.9	-7312200.0
TF5.5	Biomass to Abundance Ratio	BP	0.3840	0.0000	19	1.3	94.7	18.1
TF5.5	Total abundance	BP	0.5846	0.0573	27650592	426243.2	21.6	5967404.1
TF5.5	Total biomass	BP	0.6672	0.0000	531848575	40141958.9	105.7	561987424.6
RET5.2	Chlorophyte biomass	AP	0.6367	0.0000	1127797	5119490.6	6355.1	71672868.7
RET5.2	Cryptophyte biomass	AP	0.8699	0.0001	29968112	3555244.2	166.1	49773418.2
RET5.2	Cyanophyte biomass	AP	0.0898	0.8225	3393895	-23664.4	-9.8	-331302.2
RET5.2	Diatom biomass	AP	0.8041	0.0776	142919806	5979593.5	58.6	83714309.1
RET5.2	Dinoflagellate biomass	AP	0.9577	0.0939	555383	0.0	0.0	0.0
RET5.2	Margalef Diversity Index	AP	0.6345	0.6111	2	0.0	0.0	0.0
RET5.2	Picoplankton biomass	AP	0.5269	0.0000	135750000	-3409866.7	-35.2	-47738133.8
RET5.2	Biomass to Abundance Ratio	AP	0.2216	0.0390	29	0.6	26.8	7.8
RET5.2	Total abundance	AP	0.4336	0.0420	7429901	436136.1	82.2	6105905.5
RET5.2	Total biomass	AP	0.7546	0.0005	225427404	19196870.3	119.2	268756184.2
RET5.2	Chlorophyte biomass	BP	0.7564	0.0000	3434150	7226486.2	2946.0	101170807.2
RET5.2	Cryptophyte biomass	BP	0.3709	0.0000	21067355	3251457.0	216.1	45520397.6
RET5.2	Cyanophyte biomass	BP	0.0863	0.9404	2802792	-1173.6	-0.6	-16430.4
RET5.2	Diatom biomass	BP	0.9826	0.0011	179367413	9187800.1	71.7	128629201.0
RET5.2	Dinoflagellate biomass	BP	0.2479	0.2345	1148416	0.0	0.0	0.0
RET5.2	Margalef Diversity Index	BP	0.1027	0.4368	2	0.0	8.8	0.1
RET5.2	Picoplankton biomass	BP	0.8143	0.0002	120900000	-3876785.7	-44.9	-54274999.8
RET5.2	Biomass to Abundance Ratio	BP	0.7081	0.0010	35	1.0	41.0	14.4
RET5.2	Total abundance	BP	0.9809	0.0034	12001736	566274.4	66.1	7927841.0
RET5.2	Total biomass	BP	0.8683	0.0000	328758431	26791674.4	114.1	375083441.6
LE5.5	Chlorophyte biomass	AP	0.7764	0.0000	377	129518.3	515379.4	1942774.4
LE5.5	COCCO_C	AP	.	0.7098	0	0.0	.	0.0
LE5.5	Cryptophyte biomass	AP	0.1254	0.9236	49502853	28234.6	0.9	423518.6
LE5.5	Cyanophyte biomass	AP	0.7401	0.0153	7636	324.3	63.7	4864.1
LE5.5	Diatom biomass	AP	0.0005	0.0003	125116401	9999275.7	119.9	149989135.1
LE5.5	Dinoflagellate biomass	AP	0.6109	0.3519	58693696	970577.6	24.8	14558663.7
LE5.5	Margalef Diversity Index	AP	0.2224	0.6813	2	0.0	0.0	0.0
LE5.5	Picoplankton biomass	AP	0.9005	0.3636	163200000	-355000.0	-3.3	-5325000.0
LE5.5	Biomass to Abundance Ratio	AP	0.4002	0.3662	67	-0.8	-18.1	-12.2
LE5.5	Total abundance	AP	0.0139	0.0062	4689301	156775.4	50.2	2351630.9
LE5.5	Total biomass	AP	0.0632	0.0519	363197245	10349033.6	42.7	155235504.0
LE5.5	Chlorophyte biomass	BP	0.9320	0.0000	364770	104089.0	428.0	1561335.2
LE5.5	COCCO_C	BP	0.9979	0.3708	0	0.0	.	0.0
LE5.5	Cryptophyte biomass	BP	0.9446	0.0000	30862669	1656819.6	80.5	24852294.2
LE5.5	Cyanophyte biomass	BP	0.9211	0.1004	6415	0.0	0.0	0.0
LE5.5	Diatom biomass	BP	0.0837	0.0057	185584033	12971424.1	104.8	194571361.5
LE5.5	Dinoflagellate biomass	BP	0.4025	0.0000	37760238	4253885.7	169.0	63808285.1
LE5.5	Margalef Diversity Index	BP	0.6717	0.1004	2	0.0	6.2	0.2
LE5.5	Picoplankton biomass	BP	0.0355	0.6222	88500000	-429000.0	-7.3	-6435000.0
LE5.5	Biomass to Abundance Ratio	BP	0.1614	0.3662	75	1.1	22.7	17.0
LE5.5	Total abundance	BP	0.5897	0.0001	4108135	214639.9	78.4	3219598.1
LE5.5	Total biomass	BP	0.2886	0.0005	298432511	19200284.0	96.5	288004260.0

Appendix B. Continued

Elizabeth River Stations

Station	Parameter	Layer	Homogeneity Test p Value	SK Test p Value	Baseline	Slope	% Change	Absolute Change
SBE5	Chlorophyte biomass	AP	0.9741	0.0004	222571	90108.0	445.3	991188.3
SBE5	Cryptophyte biomass	AP	0.2894	0.0668	34072213	1022156.6	33.0	11243722.3
SBE5	Cyanophyte biomass	AP	0.5679	0.0042	84341	21685.3	282.8	238538.6
SBE5	Diatom biomass	AP	0.2330	0.0074	67132283	4793271.1	78.5	52725982.0
SBE5	Dinoflagellate biomass	AP	0.7386	0.0065	20060675	-992005.5	-54.4	-10912060.7
SBE5	Margalef Diversity Index	AP	0.4174	0.9518	2	0.0	0.0	0.0
SBE5	Picoplankton biomass	AP	0.9974	0.0039	29325000	-417714.4	-15.7	-4594858.2
SBE5	Biomass to Abundance Ratio	AP	0.4724	0.0074	57	-1.7	-32.3	-18.3
SBE5	Total abundance	AP	0.4992	0.0002	2747945	240205.7	96.2	2642262.4
SBE5	Total biomass	AP	0.3066	0.3647	161664283	3705599.1	25.2	40761590.5
SBE5	Chlorophyte biomass	BP	0.8838	0.0000	34350	282000.6	9030.6	3102007.0
SBE5	Cryptophyte biomass	BP	0.9070	0.1027	15747968	881165.0	61.6	9692815.3
SBE5	Cyanophyte biomass	BP	0.4268	0.0000	9346	23136.8	2723.3	254504.8
SBE5	Diatom biomass	BP	0.8356	0.2857	74910591	2022890.4	29.7	22251794.4
SBE5	Dinoflagellate biomass	BP	0.1650	0.0040	33567816	-1790404.0	-58.7	-19694444.0
SBE5	Margalef Diversity Index	BP	0.0825	0.7019	2	-0.0	-4.8	-0.1
SBE5	Picoplankton biomass	BP	0.7549	0.0013	32625000	-543000.0	-18.3	-5973000.0
SBE5	Biomass to Abundance Ratio	BP	0.9484	0.0000	61	-2.3	-41.7	-25.3
SBE5	Total abundance	BP	0.9592	0.0051	3136272	180210.0	63.2	1982310.0
SBE5	Total biomass	BP	0.9622	0.6145	182757614	1606989.0	9.7	17676879.0

Appendix B. Continued

York River Stations

Station	Parameter	Layer	Homogeneity Test p Value	SK Test p Value	Baseline	Slope	% Change	Absolute Change
TF4.2	Chlorophyte biomass	AP	0.5997	0.0000	653485	483691.1	962.2	6287984.8
TF4.2	Cryptophyte biomass	AP	0.8163	0.0000	19395405	2657147.5	178.1	34542917.5
TF4.2	Cyanophyte biomass	AP	0.2871	0.0198	310873	16938.2	70.8	220197.1
TF4.2	Diatom biomass	AP	0.9603	0.7024	91906377	-221156.6	-3.1	-2875035.8
TF4.2	Dinoflagellate biomass	AP	0.2051	0.0761	1533926	0.0	0.0	0.0
TF4.2	Margalef Diversity Index	AP	0.4801	0.6537	2	-0.0	-7.0	-0.1
TF4.2	Picoplankton biomass	AP	0.7134	0.0134	38550000	-586000.0	-19.8	-7618000.0
TF4.2	Biomass to Abundance Ratio	AP	0.0656	0.1223	40	-0.8	-25.4	-10.3
TF4.2	Total abundance	AP	0.6527	0.0003	3514434	191701.3	70.9	2492117.3
TF4.2	Total biomass	AP	0.3320	0.0091	137350389	6615752.6	62.6	86004783.4
TF4.2	Chlorophyte biomass	BP	0.6804	0.0000	1369780	876757.8	832.1	11397850.9
TF4.2	Cryptophyte biomass	BP	0.9964	0.0000	10031312	2929602.0	379.7	38084826.0
TF4.2	Cyanophyte biomass	BP	0.6310	0.6386	1459123	2823.0	2.5	36699.5
TF4.2	Diatom biomass	BP	0.1609	0.6755	99263985	661949.9	8.7	8605348.1
TF4.2	Dinoflagellate biomass	BP	0.9098	0.0563	1439040	0.0	0.0	0.0
TF4.2	Margalef Diversity Index	BP	0.8617	0.0335	2	-0.0	-14.1	-0.3
TF4.2	Picoplankton biomass	BP	0.4808	0.0134	36075000	-396506.3	-14.3	-5154581.3
TF4.2	Biomass to Abundance Ratio	BP	0.0823	0.0027	42	-1.7	-53.2	-22.5
TF4.2	Total abundance	BP	0.8577	0.0001	3800872	223049.0	76.3	2899637.0
TF4.2	Total biomass	BP	0.9500	0.0017	158415148	6259240.4	51.4	81370125.5
RET4.3	Chlorophyte biomass	AP	0.8276	0.0000	1404	615997.0	614172.0	8623958.0
RET4.3	Cryptophyte biomass	AP	0.9238	0.0004	50000442	3011943.8	84.3	42167212.5
RET4.3	Cyanophyte biomass	AP	0.7432	0.3110	1270981	20707.1	22.8	289900.0
RET4.3	Diatom biomass	AP	0.0108	0.0571	182554512	6146075.3	47.1	86045054.5
RET4.3	Dinoflagellate biomass	AP	0.6191	0.7435	111096063	-78477.2	-1.0	-1098680.8
RET4.3	Margalef Diversity Index	AP	0.0739	0.9763	2	0.0	0.0	0.0
RET4.3	Picoplankton biomass	AP	0.9138	0.0067	85350000	-1046850.0	-17.2	-14655900.0
RET4.3	Biomass to Abundance Ratio	AP	0.9441	0.0432	52	-0.8	-22.2	-11.6
RET4.3	Total abundance	AP	0.9606	0.0002	7856296	383354.6	68.3	5366963.8
RET4.3	Total biomass	AP	0.4787	0.0403	411832773	11073578.6	37.6	155030100.4
RET4.3	Chlorophyte biomass	BP	0.5978	0.0000	384126	315063.0	1148.3	4410881.9
RET4.3	Cryptophyte biomass	BP	0.6246	0.0000	36749642	3990285.3	152.0	55863993.5
RET4.3	Cyanophyte biomass	BP	0.9635	0.1496	1533975	37611.0	34.3	526554.3
RET4.3	Diatom biomass	BP	0.6789	0.0003	362882403	15605874.4	60.2	218482241.6
RET4.3	Dinoflagellate biomass	BP	0.4919	0.0040	33172154	-269423.7	-11.4	-3771931.2
RET4.3	Margalef Diversity Index	BP	0.5716	0.0932	2	-0.0	-16.5	-0.3
RET4.3	Picoplankton biomass	BP	0.8068	0.0102	97350000	-663750.0	-9.6	-9292500.0
RET4.3	Biomass to Abundance Ratio	BP	0.3664	0.0000	49	-1.4	-39.9	-19.6
RET4.3	Total abundance	BP	0.9620	0.0000	8105578	671324.2	116.0	9398538.5
RET4.3	Total biomass	BP	0.8869	0.0006	522433928	20335092.9	54.5	284691300.6
WE4.2	Chlorophyte biomass	AP	0.8833	0.0000	71432	97773.6	2053.2	1466603.4
WE4.2	Cryptophyte biomass	AP	0.2206	0.3349	73551784	-773474.0	-15.8	-11602110.0
WE4.2	Cyanophyte biomass	AP	0.7919	0.3622	980	0.0	0.0	0.0
WE4.2	Diatom biomass	AP	0.2496	0.0037	181271336	8895191.9	73.6	133427878.8
WE4.2	Dinoflagellate biomass	AP	0.0890	0.3855	142101851	1863040.5	19.7	27945608.0
WE4.2	Margalef Diversity Index	AP	0.7621	0.8363	3	0.0	0.0	0.0
WE4.2	Picoplankton biomass	AP	0.8754	0.9656	79050000	32750.0	0.6	491250.0
WE4.2	Biomass to Abundance Ratio	AP	0.6177	0.4324	87	-0.6	-10.2	-8.9
WE4.2	Total abundance	AP	0.9426	0.1196	5389641	78208.9	21.8	1173133.4
WE4.2	Total biomass	AP	0.3468	0.0712	486448461	12576504.8	38.8	188647572.0
WE4.2	Chlorophyte biomass	BP	0.4907	0.0000	3396	48014.1	21208.6	720210.9
WE4.2	Cryptophyte biomass	BP	0.1154	0.2472	31557947	440087.8	20.9	6601317.3
WE4.2	Cyanophyte biomass	BP	0.5165	0.0309	3219	0.0	0.0	0.0
WE4.2	Diatom biomass	BP	0.0982	0.0100	232039851	7405162.6	47.9	111077438.7
WE4.2	Dinoflagellate biomass	BP	0.3552	0.4164	89921139	285900.8	4.8	4288511.9
WE4.2	Margalef Diversity Index	BP	0.9765	0.5174	3	0.0	0.0	0.0
WE4.2	Picoplankton biomass	BP	0.5063	0.7625	73350000	-117937.5	-2.4	-1769062.5
WE4.2	Biomass to Abundance Ratio	BP	0.6321	0.5174	73	-0.6	-12.3	-9.0
WE4.2	Total abundance	BP	0.1584	0.0100	5158877	126935.4	36.9	1904031.0
WE4.2	Total biomass	BP	0.2606	0.0072	359511131	12103497.7	50.5	181552465.5

Appendix B. Continued

Rappahannock River Stations

Station	Parameter	Layer	Homogeneity Test p Value	SK Test p Value	Baseline	Slope	% Change	Absolute Change
TF3.3	Chlorophyte biomass	AP	0.8800	0.0000	2031977	2529885.3	1743.1	35418393.6
TF3.3	Cryptophyte biomass	AP	0.9984	0.0000	30983199	3025672.5	136.7	42359414.4
TF3.3	Cyanophyte biomass	AP	0.6672	0.0000	1846739	321123.6	243.4	4495730.5
TF3.3	Diatom biomass	AP	0.3047	0.0000	95472700	18713822.1	274.4	261993509.4
TF3.3	Dinoflagellate biomass	AP	0.8282	0.5922	1974284	0.0	0.0	0.0
TF3.3	Margalef Diversity Index	AP	0.9178	0.0499	2	0.0	18.2	0.3
TF3.3	Picoplankton biomass	AP	0.1748	0.0702	102900000	1194428.6	16.3	16722000.0
TF3.3	Biomass to Abundance Ratio	AP	0.6087	0.7306	39	-0.1	-4.3	-1.7
TF3.3	Total abundance	AP	0.5151	0.0000	4890501	904850.0	259.0	12667900.0
TF3.3	Total biomass	AP	0.4935	0.0000	138094644	29175228.9	295.8	408453204.6
TF3.3	Chlorophyte biomass	BP	0.9887	0.0000	989670	2736337.9	3870.9	38308730.9
TF3.3	Cryptophyte biomass	BP	0.8800	0.0000	18773183	3765042.5	280.8	52710595.4
TF3.3	Cyanophyte biomass	BP	0.9312	0.0348	1820222	177311.4	136.4	2482359.6
TF3.3	Diatom biomass	BP	0.2068	0.0000	107830094	21599674.3	280.4	302395440.2
TF3.3	Dinoflagellate biomass	BP	0.7653	0.5485	1162148	0.0	0.0	0.0
TF3.3	Margalef Diversity Index	BP	0.8725	0.0173	2	0.0	16.5	0.3
TF3.3	Picoplankton biomass	BP	0.7746	0.2892	89400000	748521.4	11.7	10479300.0
TF3.3	Biomass to Abundance Ratio	BP	0.9443	0.7991	39	0.1	2.9	1.1
TF3.3	Total abundance	BP	0.9349	0.0000	4248219	1228585.2	404.9	17200192.8
TF3.3	Total biomass	BP	0.8820	0.0000	177600202	38636544.9	304.6	540911628.6
RET3.1	Chlorophyte biomass	AP	0.5953	0.0000	965711	1055600.0	1530.3	14778400.4
RET3.1	Cryptophyte biomass	AP	0.3621	0.0141	49379466	2475131.6	70.2	34651842.0
RET3.1	Cyanophyte biomass	AP	0.2732	0.0993	1777139	69206.6	54.5	968891.7
RET3.1	Diatom biomass	AP	0.4648	0.0081	134987136	9258603.7	96.0	129620451.1
RET3.1	Dinoflagellate biomass	AP	0.7396	0.0002	78201798	-798097.9	-14.3	-11173370.9
RET3.1	Margalef Diversity Index	AP	0.8607	0.3611	2	0.0	8.0	0.1
RET3.1	Picoplankton biomass	AP	0.9169	0.1576	153000000	1217237.5	11.1	17041325.0
RET3.1	Biomass to Abundance Ratio	AP	0.7788	0.0056	53	-1.1	-29.9	-16.0
RET3.1	Total abundance	AP	0.7052	0.0000	6640168	756487.7	159.5	10590827.8
RET3.1	Total biomass	AP	0.3620	0.0257	440704222	13968895.1	44.4	195564531.4
RET3.1	Chlorophyte biomass	BP	0.9040	0.0000	56621	807344.7	19962.3	11302825.7
RET3.1	Cryptophyte biomass	BP	0.4591	0.0000	28638216	4337890.8	212.1	60730471.1
RET3.1	Cyanophyte biomass	BP	0.8727	0.0118	1230414	104116.0	118.5	1457623.9
RET3.1	Diatom biomass	BP	0.1224	0.0001	172597463	15411875.9	125.0	215766262.6
RET3.1	Dinoflagellate biomass	BP	0.9971	0.2996	34797461	-69645.4	-2.8	-975035.0
RET3.1	Margalef Diversity Index	BP	0.8367	0.0278	1	0.0	21.9	0.3
RET3.1	Picoplankton biomass	BP	0.7042	0.2331	180000000	910575.0	7.1	12748050.0
RET3.1	Biomass to Abundance Ratio	BP	0.2721	0.6642	42	-0.2	-7.9	-3.4
RET3.1	Total abundance	BP	0.9430	0.0000	4932382	926321.0	262.9	12968494.0
RET3.1	Total biomass	BP	0.3795	0.0000	325417000	30403150.6	130.8	425644108.4
LE3.6	Chlorophyte biomass	AP	0.5221	0.0000	186615	54282.8	436.3	814242.6
LE3.6	Cryptophyte biomass	AP	0.1862	0.4791	63403537	-384811.9	-9.1	-5772178.4
LE3.6	Cyanophyte biomass	AP	0.3968	0.0392	13953	0.0	0.0	0.0
LE3.6	Diatom biomass	AP	0.8084	0.5695	253756066	2118415.4	12.5	31776231.2
LE3.6	Dinoflagellate biomass	AP	0.0406	0.0237	147931692	5567805.7	56.5	83517085.1
LE3.6	Margalef Diversity Index	AP	0.5471	0.4966	2	0.0	6.7	0.2
LE3.6	Picoplankton biomass	AP	0.5618	0.2223	284025000	-820582.5	-4.3	-12308737.5
LE3.6	Biomass to Abundance Ratio	AP	0.4035	0.0650	119	-1.9	-23.2	-27.8
LE3.6	Total abundance	AP	0.8016	0.0237	4510279	151026.8	50.2	2265402.3
LE3.6	Total biomass	AP	0.6551	0.5695	673771837	4148183.6	9.2	62222754.6
LE3.6	Chlorophyte biomass	BP	0.9135	0.0000	188759	24954.7	198.3	374321.1
LE3.6	Cryptophyte biomass	BP	0.9229	0.0144	38185105	918763.4	36.1	13781451.5
LE3.6	Cyanophyte biomass	BP	0.9777	0.0006	8956	1959.5	328.2	29392.5
LE3.6	Diatom biomass	BP	0.3721	0.0932	200681301	5142969.9	38.4	77144548.4
LE3.6	Dinoflagellate biomass	BP	0.5440	0.0067	108208898	4085105.9	56.6	61276588.5
LE3.6	Margalef Diversity Index	BP	0.4690	0.5382	2	-0.0	-6.3	-0.2
LE3.6	Picoplankton biomass	BP	0.7770	0.0896	122100000	-1247700.0	-15.3	-18715500.0
LE3.6	Biomass to Abundance Ratio	BP	0.3127	0.1239	134	-1.9	-21.2	-28.4
LE3.6	Total abundance	BP	0.6228	0.0002	4744595	187197.6	59.2	2807964.5
LE3.6	Total biomass	BP	0.3958	0.0359	438656027	12743919.7	43.6	191158795.5

Appendix C. Results of Seasonal Kendall (SK) trend tests and Van Belle and Hughs test for homogeneity of trends for C^{14} productivity bioindicators for the period of 1985 through 2000.

Station	Parameter	Layer	Homogeneity Test p Value	SK Test p Value	Baseline	Slope	% Change	Absolute Change
CB6.1	C^{14} Productivity	AP	0.9823	0.0184	19.0	-1.3	-77.0	-14.6
CB6.4	C^{14} Productivity	AP	0.7800	0.0017	27.6	-1.9	-76.4	-21.1
CB7.3E	C^{14} Productivity	AP	0.6438	0.0351	19.2	-1.2	-71.2	-13.6
CB7.4	C^{14} Productivity	AP	0.9120	0.2758	10.7	-0.5	-49.3	-5.3
LE3.6	C^{14} Productivity	AP	0.9767	0.0010	34.2	-2.0	-64.3	-22.0
LE5.5	C^{14} Productivity	AP	0.5660	0.0000	46.8	-3.3	-77.8	-36.4
RET3.1	C^{14} Productivity	AP	0.8915	0.3771	52.1	-0.8	-16.0	-8.4
RET4.3	C^{14} Productivity	AP	0.7834	0.1710	22.4	-0.7	-36.3	-8.1
RET5.2	C^{14} Productivity	AP	0.0327	0.0000	134.7	-5.6	-45.7	-61.5
SBE5	C^{14} Productivity	AP	0.9504	0.0000	62.7	-3.1	-44.4	-27.8
TF3.3	C^{14} Productivity	AP	0.7359	0.0850	44.9	-0.9	-22.8	-10.2
TF4.2	C^{14} Productivity	AP	0.8165	0.0027	9.1	-0.5	-59.0	-5.4
TF5.5	C^{14} Productivity	AP	0.2888	0.1048	39.9	-0.8	-22.3	-8.9
WE4.2	C^{14} Productivity	AP	0.9507	0.0004	50.8	-2.4	-51.5	-26.2

Appendix D. Results of Seasonal Kendall (SK) trend tests and Van Belle and Hughs test for homogeneity of trends for microzooplankton bioindicators for the period of 1985 through 2000.

Chesapeake Bay Main stem Stations

Station	Parameter	Layer	Homogeneity Test p Value	SK Test p Value	Baseline	Slope	% Change	Absolute Change
CB6.1	Barnacle Nauplii	AP	0.8935	0.1218	0.79	0.00	0.00	0.00
CB6.1	Copepod Nauplii	AP	0.3782	0.0100	112.35	-2.68	-16.67	-18.73
CB6.1	Cladoceran Abundance	AP	0.1309	0.6361	0.38	0.00	0.00	0.00
CB6.1	Oligotrich abundance	AP	0.6003	0.5087	2050.69	-48.75	-16.64	-341.25
CB6.1	Larval Polychaete Abundance	AP	0.5633	0.8504	4.23	0.00	0.00	0.00
CB6.1	Rotifer abundance	AP	0.3123	0.0009	80.54	4.88	42.37	34.13
CB6.1	Sarcodina abundance	AP	0.3062	0.1724	1.75	0.00	0.00	0.00
CB6.1	Tintinnid abundance	AP	0.5282	0.0474	2106.63	-72.00	-23.92	-504.00
CB6.1	Total Microzooplankton Abundance	AP	0.1360	0.3398	4357.35	-148.75	-23.90	-1041.25
CB6.1	Total Microzooplankton Biomass	AP	0.5456	0.6073	37.40	0.46	8.55	3.20
CB6.4	Barnacle Nauplii	AP	0.4830	0.5283	0.63	0.00	0.00	0.00
CB6.4	Copepod Nauplii	AP	0.2659	0.1768	96.81	-1.75	-12.65	-12.25
CB6.4	Cladoceran Abundance	AP	0.7237	0.0771	0.25	0.00	0.00	0.00
CB6.4	Oligotrich abundance	AP	0.8401	0.0724	2218.50	-160.65	-50.69	-1124.52
CB6.4	Larval Polychaete Abundance	AP	0.4864	0.3375	5.19	-0.05	-6.75	-0.35
CB6.4	Rotifer abundance	AP	0.4728	0.0023	49.38	6.63	93.92	46.38
CB6.4	Sarcodina abundance	AP	0.6322	0.1318	0.00	0.00	.	0.00
CB6.4	Tintinnid abundance	AP	0.5000	0.0033	2262.69	-124.92	-38.65	-874.42
CB6.4	Total Microzooplankton Abundance	AP	0.6323	0.0090	4633.44	-364.71	-55.10	-2552.96
CB6.4	Total Microzooplankton Biomass	AP	0.6035	0.7440	35.76	-0.19	-3.80	-1.36
CB7.4	Barnacle Nauplii	AP	0.7765	0.2295	0.25	0.00	0.00	0.00
CB7.4	Copepod Nauplii	AP	0.8984	0.0014	122.83	-6.00	-34.19	-42.00
CB7.4	Cladoceran Abundance	AP	0.0800	0.6885	2.17	0.00	0.00	0.00
CB7.4	Oligotrich abundance	AP	0.5819	0.1863	1965.08	97.04	34.57	679.29
CB7.4	Larval Polychaete Abundance	AP	0.7360	0.0432	6.75	-0.13	-13.90	-0.94
CB7.4	Rotifer abundance	AP	0.9783	0.0439	27.88	0.95	23.86	6.65
CB7.4	Sarcodina abundance	AP	0.3043	0.2396	0.21	0.00	0.00	0.00
CB7.4	Tintinnid abundance	AP	0.5110	0.1231	3055.21	-71.50	-16.38	-500.50
CB7.4	Total Microzooplankton Abundance	AP	0.0740	0.9415	5180.38	36.54	4.94	255.79
CB7.4	Total Microzooplankton Biomass	AP	0.6697	0.1231	40.17	-1.28	-22.22	-8.93

Appendix D. Continued

James River Stations

Station	Parameter	Layer	Homogeneity Test p Value	SK Test p Value	Baseline	Slope	% Change	Absolute Change
TF5.5	Barnacle Nauplii	AP	0.8364	0.0333	0.04	0.00	0.00	0.00
TF5.5	Copepod Nauplii	AP	0.3113	0.5661	58.46	0.35	4.13	2.42
TF5.5	Cladoceran abundance	AP	0.1748	0.1369	17.04	0.00	0.00	0.00
TF5.5	Oligotrich abundance	AP	0.5824	0.3914	2310.04	-55.08	-16.69	-385.58
TF5.5	Larval Polychaete Abundance	AP	0.3885	0.6169	0.25	0.00	0.00	0.00
TF5.5	Rotifer abundance	AP	0.9550	0.0414	789.13	8.94	7.93	62.57
TF5.5	Sarcodina abundancea abundance	AP	0.9809	0.0152	0.00	0.00	.	0.00
TF5.5	Tintinnid abundance	AP	0.9993	0.1861	1420.08	40.63	20.03	284.38
TF5.5	Total Microzooplankton Abundance	AP	0.9976	0.3914	4595.04	49.75	7.58	348.25
TF5.5	Total Microzooplankton Biomass	AP	0.8467	0.0538	102.75	2.34	15.95	16.39
RET5.2	Barnacle Nauplii	AP	0.9525	0.0010	0.33	0.00	0.00	0.00
RET5.2	Copepod Nauplii	AP	0.4182	0.1857	115.54	-2.13	-12.92	-14.93
RET5.2	Cladoceran Abundance	AP	0.1443	0.0002	16.67	0.00	0.00	0.00
RET5.2	Oligotrich abundance	AP	0.9244	0.8257	2005.17	-3.27	-1.14	-22.92
RET5.2	Larval Polychaete Abundance	AP	0.5830	0.0361	2.38	0.00	0.00	0.00
RET5.2	Rotifer abundance	AP	0.2599	0.2708	404.83	-9.92	-17.15	-69.42
RET5.2	Sarcodina abundance	AP	0.6806	0.2012	0.08	0.00	0.00	0.00
RET5.2	Tintinnid abundance	AP	0.2224	0.3040	3089.92	75.13	17.02	525.88
RET5.2	Total Microzooplankton Abundance	AP	0.7903	0.8833	5634.92	24.00	2.98	168.00
RET5.2	Total Microzooplankton Biomass	AP	0.0729	0.1863	81.09	-2.23	-19.21	-15.58
LE5.5	Barnacle Nauplii	AP	0.5593	0.0599	1.63	0.00	0.00	0.00
LE5.5	Copepod Nauplii	AP	0.6804	0.0290	104.48	-3.00	-20.10	-21.00
LE5.5	Cladoceran Abundance	AP	0.9961	0.0009	0.67	0.00	0.00	0.00
LE5.5	Oligotrich abundance	AP	0.7504	0.3283	2567.00	98.00	26.72	686.00
LE5.5	Larval Polychaete Abundance	AP	0.0849	0.0058	19.00	-0.70	-25.79	-4.90
LE5.5	Rotifer abundance	AP	0.2572	0.0013	94.40	13.50	100.11	94.50
LE5.5	Sarcodina abundance	AP	0.9894	0.6162	2.58	0.00	0.00	0.00
LE5.5	Tintinnid abundance	AP	0.6234	0.2322	2027.15	-66.25	-22.88	-463.75
LE5.5	Total Microzooplankton Abundance	AP	0.6237	0.6379	4816.90	61.88	8.99	433.13
LE5.5	Total Microzooplankton Biomass	AP	0.8487	0.3283	56.31	1.77	21.98	12.38

Appendix D. Continued

Elizabeth River Stations

Station	Parameter	Layer	Homogeneity Test p Value	SK Test p Value	Baseline	Slope	% Change	Absolute Change
SBE5	Barnacle Nauplii	AP	0.7464	0.0931	1.75	0.00	0.00	0.00
SBE5	Copepod Nauplii	AP	0.3266	0.0122	79.71	-3.90	-34.25	-27.30
SBE5	Cladoceran Abundance	AP	0.9385	0.1658	0.00	0.00	.	0.00
SBE5	Oligotrich abundance	AP	0.9255	0.0010	5278.79	-229.25	-30.40	-1604.75
SBE5	Larval Polychaete Abundance	AP	0.3421	0.0111	10.08	-0.50	-34.71	-3.50
SBE5	Rotifer abundance	AP	0.4613	0.8861	96.50	-0.04	-0.30	-0.29
SBE5	Sarcodina abundance	AP	0.8451	0.0097	0.29	0.00	0.00	0.00
SBE5	Tintinnid abundance	AP	0.5534	0.0137	1076.00	-49.00	-31.88	-343.00
SBE5	Total Microzooplankton Abundance	AP	0.9219	0.0001	6543.13	-337.13	-36.07	-2359.88
SBE5	Total Microzooplankton Biomass	AP	0.6935	0.0013	56.30	-3.70	-45.95	-25.87

Appendix D. Continued
York River Stations

Station	Parameter	Layer	Homogeneity Test p Value	SK Test p Value	Baseline	Slope	% Change	Absolute Change
TF4.2	Barnacle Nauplii	AP	0.2629	0.0335	0.54	0.00	0.00	0.00
TF4.2	Copepod Nauplii	AP	0.5615	0.4166	50.79	-0.35	-4.88	-2.48
TF4.2	Cladoceran Abundance	AP	0.9945	0.0000	18.46	-0.25	-9.48	-1.75
TF4.2	Oligotrich abundance	AP	0.0991	0.2708	1521.96	-52.00	-23.92	-364.00
TF4.2	Larval Polychaete Abundance	AP	0.2783	0.1293	0.50	0.00	0.00	0.00
TF4.2	Rotifer abundance	AP	0.3948	0.0908	275.21	-2.62	-6.66	-18.32
TF4.2	Sarcodina abundance	AP	0.9325	0.1439	0.00	0.00	.	0.00
TF4.2	Tintinnid abundance	AP	0.9427	0.7968	959.29	0.40	0.29	2.80
TF4.2	Total Microzooplankton Abundance	AP	0.1871	0.8257	2826.75	11.67	2.89	81.67
TF4.2	Total Microzooplankton Biomass	AP	0.6000	0.1231	56.66	-0.81	-9.95	-5.64
RET4.3	Barnacle Nauplii	AP	0.4365	0.1742	0.42	0.00	0.00	0.00
RET4.3	Copepod Nauplii	AP	0.9757	0.1020	122.58	-1.90	-10.85	-13.30
RET4.3	Cladoceran Abundance	AP	0.1407	0.0090	2.42	0.00	0.00	0.00
RET4.3	Oligotrich abundance	AP	0.7734	0.9408	3236.25	-11.92	-2.58	-83.42
RET4.3	Larval Polychaete Abundance	AP	0.3913	0.0156	3.58	0.00	0.00	0.00
RET4.3	Rotifer abundance	AP	0.7090	0.0174	142.67	14.42	70.74	100.92
RET4.3	Sarcodina abundance	AP	0.2837	0.7765	2.67	0.00	0.00	0.00
RET4.3	Tintinnid abundance	AP	0.6867	0.2350	1964.33	90.33	32.19	632.33
RET4.3	Total Microzooplankton Abundance	AP	0.2151	0.6034	5474.92	113.10	14.46	791.69
RET4.3	Total Microzooplankton Biomass	AP	0.0987	0.2350	49.96	1.66	23.20	11.59
WE4.2	Barnacle Nauplii	AP	0.2880	0.7497	1.42	0.00	0.00	0.00
WE4.2	Copepod Nauplii	AP	0.8988	0.0547	124.00	-3.00	-16.94	-21.00
WE4.2	Cladoceran abundance	AP	0.1166	0.4945	0.42	0.00	0.00	0.00
WE4.2	Oligotrich abundance	AP	0.1966	0.5383	2613.04	27.50	7.37	192.50
WE4.2	Larval Polychaete Abundance	AP	0.8062	0.1519	17.75	-0.25	-9.86	-1.75
WE4.2	Rotifer abundance	AP	0.5803	0.0007	124.17	11.14	62.82	78.00
WE4.2	Sarcodina abundancea abundance	AP	0.2683	0.1273	1.67	0.00	0.00	0.00
WE4.2	Tintinnid abundance	AP	0.8237	0.0153	2194.42	-104.75	-33.41	-733.25
WE4.2	Total Microzooplankton Abundance	AP	0.1105	0.2322	5076.88	-151.33	-20.87	-1059.33
WE4.2	Total Microzooplankton Biomass	AP	0.3176	0.2322	59.20	2.11	24.94	14.76

Appendix D. Continued

Rappahannock River Stations

Station	Parameter	Layer	Homogeneity Test p Value	SK Test p Value	Baseline	Slope	% Change	Absolute Change
TF3.3	Barnacle Nauplii	AP	0.9582	0.0048	0.19	0.00	0.00	0.00
TF3.3	Copepod Nauplii	AP	0.8179	0.0851	93.25	5.96	44.72	41.71
TF3.3	Cladoceran Abundance	AP	0.1975	0.0001	24.19	-0.20	-5.79	-1.40
TF3.3	Oligotrich abundance	AP	0.9330	0.7371	1955.50	-48.21	-17.26	-337.46
TF3.3	Larval Polychaete Abundance	AP	0.6192	0.6306	4.75	0.00	0.00	0.00
TF3.3	Rotifer abundance	AP	0.2422	0.9665	535.69	-0.25	-0.33	-1.75
TF3.3	Sarcodina abundance	AP	0.7198	0.2487	0.00	0.00	.	0.00
TF3.3	Tintinnid abundance	AP	0.5561	0.2233	3483.88	125.88	25.29	881.13
TF3.3	Total Microzooplankton Abundance	AP	0.5908	0.2401	6097.44	263.19	30.21	1842.32
TF3.3	Total Microzooplankton Biomass	AP	0.1562	0.0780	100.99	3.77	26.15	26.40
RET3.1	Barnacle Nauplii	AP	0.8094	0.0476	0.88	0.00	0.00	0.00
RET3.1	Copepod Nauplii	AP	0.8968	0.4753	162.56	-1.00	-4.31	-7.00
RET3.1	Cladoceran Abundance	AP	0.8019	0.0148	208.31	0.00	0.00	0.00
RET3.1	Oligotrich abundance	AP	0.4066	0.8337	2248.25	21.65	6.74	151.52
RET3.1	Larval Polychaete Abundance	AP	0.3720	0.0179	5.50	0.00	0.00	0.00
RET3.1	Rotifer abundance	AP	0.2341	0.8995	385.94	0.17	0.30	1.17
RET3.1	Sarcodina abundance	AP	0.7918	0.0273	0.00	0.00	.	0.00
RET3.1	Tintinnid abundance	AP	0.8257	0.5020	3684.06	94.58	17.97	662.08
RET3.1	Total Microzooplankton Abundance	AP	0.8036	0.1537	6695.50	421.83	44.10	2952.83
RET3.1	Total Microzooplankton Biomass	AP	0.1056	0.2753	281.36	3.01	7.49	21.08
LE3.6	Barnacle Nauplii	AP	0.5435	0.7354	1.38	0.00	0.00	0.00
LE3.6	Copepod Nauplii	AP	0.7858	0.8681	69.63	-0.13	-1.26	-0.88
LE3.6	Cladoceran Abundance	AP	0.3675	0.2412	0.00	0.00	.	0.00
LE3.6	Oligotrich abundance	AP	0.2452	0.8685	2205.25	-6.33	-2.01	-44.33
LE3.6	Larval Polychaete Abundance	AP	0.1522	0.1054	6.81	-0.23	-23.84	-1.62
LE3.6	Rotifer abundance	AP	0.8078	0.0003	64.75	25.14	271.82	176.00
LE3.6	Sarcodina abundance	AP	0.8474	0.0010	0.00	0.00	.	0.00
LE3.6	Tintinnid abundance	AP	0.6403	0.0164	1768.19	-86.80	-34.36	-607.60
LE3.6	Total Microzooplankton Abundance	AP	0.6064	0.4564	4116.00	-134.14	-22.81	-938.96
LE3.6	Total Microzooplankton Biomass	AP	0.4966	0.0314	35.57	3.75	73.77	26.24

Appendix E. Results of Seasonal Kendall (SK) trend tests and Van Belle and Hughs test for homogeneity of trends for benthic bioindicators for the period of 1985 through 2000.

Chesapeake Bay Mains Stem Stations

Station	Parameter	Layer	SK Test p Value	Baseline	Slope	% Change	Absolute Change
CB5.4	Benthic IBI	B	0.9211	1.81	0.011	8.586	0.16
CB5.4	Abundance of Equilibrium Species	B	0.3471	29.84	-0.727	-34.090	-10.17
CB5.4	Abundance of Opportunistic Species	B	0.5862	36.32	0.266	10.269	3.73
CB5.4	Total Infaunal Abundance	B	0.1020	333.90	50.880	213.333	712.32
CB5.4	Total Infaunal Biomass	B	1.0000	0.44	0.000	0.000	0.00
CB5.4	Biomass of Equilibrium Species	B	0.1250	29.89	-1.555	-72.824	-21.77
CB5.4	Biomass of Opportunistic Species	B	0.2987	33.95	-0.730	-30.082	-10.21
CB5.4	Shannon Weiner Diversity Index	B	0.4002	1.71	0.019	15.392	0.26
CB6.1	Benthic IBI	B	0.7281	3.58	-0.019	-7.235	-0.26
CB6.1	Abundance of Equilibrium Species	B	0.6560	34.86	-0.444	-17.827	-6.21
CB6.1	Abundance of Opportunistic Species	B	0.1025	16.08	0.848	73.866	11.88
CB6.1	Total Infaunal Abundance	B	0.0035	1488.24	131.440	123.647	1840.16
CB6.1	Total Infaunal Biomass	B	0.8046	10.82	-0.083	-10.701	-1.16
CB6.1	Biomass of Equilibrium Species	B	0.1250	43.49	-2.626	-84.531	-36.76
CB6.1	Biomass of Opportunistic Species	B	0.0425	1.70	0.773	636.424	10.82
CB6.1	Shannon Weiner Diversity Index	B	0.0260	2.64	0.036	18.826	0.50
CB6.4	Benthic IBI	B	0.6553	4.47	-0.022	-6.953	-0.31
CB6.4	Abundance of Equilibrium Species	B	0.5862	49.63	-0.402	-11.334	-5.63
CB6.4	Abundance of Opportunistic Species	B	0.5862	16.91	-0.675	-55.884	-9.45
CB6.4	Total Infaunal Abundance	B	0.0200	1640.88	265.652	226.655	3719.13
CB6.4	Total Infaunal Biomass	B	0.1372	5.35	-0.221	-57.910	-3.10
CB6.4	Biomass of Equilibrium Species	B	0.0116	83.36	-2.928	-49.175	-40.99
CB6.4	Biomass of Opportunistic Species	B	0.5200	1.39	0.173	173.741	2.42
CB6.4	Shannon Weiner Diversity Index	B	0.0536	2.94	0.045	21.333	0.63
CB7.3E	Benthic IBI	B	0.6108	4.22	0.000	0.000	0.00
CB7.3E	Abundance of Equilibrium Species	B	0.8820	50.28	-0.056	-1.559	-0.78
CB7.3E	Abundance of Opportunistic Species	B	0.0200	13.62	-0.898	-92.254	-12.57
CB7.3E	Total Infaunal Abundance	B	0.6918	5495.04	-26.712	-6.806	-373.97
CB7.3E	Total Infaunal Biomass	B	0.4879	12.91	-0.198	-21.515	-2.78
CB7.3E	Biomass of Equilibrium Species	B	0.9605	63.36	-0.016	-0.360	-0.23
CB7.3E	Biomass of Opportunistic Species	B	0.1513	1.30	-0.093	-100.585	-1.31
CB7.3E	Shannon Weiner Diversity Index	B	0.9605	3.72	-0.005	-1.769	-0.07
CB8.1	Benthic IBI	B	0.8912	4.33	0.000	0.000	0.00
CB8.1	Abundance of Equilibrium Species	B	0.7187	55.49	-0.145	-3.663	-2.03
CB8.1	Abundance of Opportunistic Species	B	0.0052	18.00	-1.062	-82.592	-14.87
CB8.1	Total Infaunal Abundance	B	0.0717	3129.12	182.850	81.809	2559.90
CB8.1	Total Infaunal Biomass	B	0.1768	12.22	0.807	92.489	11.30
CB8.1	Biomass of Equilibrium Species	B	0.0192	83.43	-2.729	-45.787	-38.20
CB8.1	Biomass of Opportunistic Species	B	0.0871	1.07	-0.078	-101.664	-1.09
CB8.1	Shannon Weiner Diversity Index	B	0.0244	3.79	0.044	16.179	0.61

Appendix E. Continued.
James River Stations

Station	Parameter	Layer	SK Test p Value	Baseline	Slope	% Change	Absolute Change
TF5.5	Benthic IBI	B	0.0027	2.13	0.107	70.131	1.49
TF5.5	Abundance of Equilibrium Species	B	0.0010	0.00	1.779	.	24.91
TF5.5	Abundance of Opportunistic Species	B	0.0871	20.14	-0.856	-59.531	-11.99
TF5.5	Total Infaunal Abundance	B	0.0586	1335.60	372.667	390.636	5217.34
TF5.5	Total Infaunal Biomass	B	0.1143	0.34	0.056	232.235	0.79
TF5.5	Biomass of Equilibrium Species	B	0.0013	0.00	3.553	.	49.75
TF5.5	Biomass of Opportunistic Species	B	0.1051	43.89	-2.279	-72.705	-31.91
TF5.5	Shannon Weiner Diversity Index	B	0.1051	1.18	0.046	55.051	0.65
RET5.2	Benthic IBI	B	0.0187	2.00	0.057	40.180	0.80
RET5.2	Abundance of Equilibrium Species	B	0.0586	10.42	0.840	112.806	11.75
RET5.2	Abundance of Opportunistic Species	B	0.1145	16.67	-0.337	-28.277	-4.71
RET5.2	Total Infaunal Abundance	B	0.2599	610.56	42.013	96.334	588.18
RET5.2	Total Infaunal Biomass	B	0.2227	7.34	-0.055	-10.548	-0.77
RET5.2	Biomass of Equilibrium Species	B	0.3679	28.04	0.897	44.806	12.56
RET5.2	Biomass of Opportunistic Species	B	0.2105	8.42	-0.090	-14.948	-1.26
RET5.2	Shannon Weiner Diversity Index	B	0.0307	1.66	0.047	39.723	0.66
LE5.1	Benthic IBI	B	0.9780	3.03	0.000	0.000	0.00
LE5.1	Abundance of Equilibrium Species	B	0.5018	5.57	-0.698	-125.332	-6.98
LE5.1	Abundance of Opportunistic Species	B	0.0541	0.00	0.000	.	0.00
LE5.1	Total Infaunal Abundance	B	0.4352	772.74	28.620	37.037	286.20
LE5.1	Total Infaunal Biomass	B	0.6504	0.94	-0.010	-10.106	-0.10
LE5.1	Biomass of Equilibrium Species	B	0.7420	11.81	0.044	3.717	0.44
LE5.1	Biomass of Opportunistic Species	B	0.1281	0.00	0.000	.	0.00
LE5.1	Shannon Weiner Diversity Index	B	0.1008	1.93	0.032	16.477	0.32
LE5.2	Benthic IBI	B	0.7187	3.33	0.022	9.165	0.31
LE5.2	Abundance of Equilibrium Species	B	0.0586	34.48	2.182	88.596	30.55
LE5.2	Abundance of Opportunistic Species	B	1.0000	17.25	-0.036	-2.889	-0.50
LE5.2	Total Infaunal Abundance	B	0.1624	1221.12	54.514	62.500	763.20
LE5.2	Total Infaunal Biomass	B	0.4990	4.58	-0.092	-28.000	-1.28
LE5.2	Biomass of Equilibrium Species	B	0.4713	40.78	1.429	49.062	20.01
LE5.2	Biomass of Opportunistic Species	B	0.4713	8.76	0.149	23.797	2.08
LE5.2	Shannon Weiner Diversity Index	B	0.7871	2.55	0.019	10.376	0.26
LE5.4	Benthic IBI	B	0.2003	3.72	0.014	5.231	0.19
LE5.4	Abundance of Equilibrium Species	B	0.7871	50.52	-0.065	-1.798	-0.91
LE5.4	Abundance of Opportunistic Species	B	0.0134	1.99	-0.155	-108.975	-2.17
LE5.4	Total Infaunal Abundance	B	0.8571	2528.10	5.565	3.082	77.91
LE5.4	Total Infaunal Biomass	B	0.0871	22.86	-2.312	-141.586	-32.37
LE5.4	Biomass of Equilibrium Species	B	0.3219	60.10	-1.306	-30.427	-18.29
LE5.4	Biomass of Opportunistic Species	B	0.0992	0.51	-0.013	-34.588	-0.18
LE5.4	Shannon Weiner Diversity Index	B	1.0000	3.69	0.000	-0.114	0.00

Appendix E. Continued.

Elizabeth River Stations

Station	Parameter	Layer	SK Test p Value	Baseline	Slope	% Change	Absolute Change
SBE2	Benthic IBI	B	0.4009	2.00	0.032	15.900	0.32
SBE2	Abundance of Equilibrium Species	B	0.0004	4.86	2.663	547.942	26.63
SBE2	Abundance of Opportunistic Species	B	0.1034	71.15	-2.205	-30.996	-22.05
SBE2	Total Infaunal Abundance	B	0.0199	1631.34	137.376	84.211	1373.76
SBE2	Total Infaunal Biomass	B	0.4752	0.89	0.015	17.191	0.15
SBE2	Biomass of Equilibrium Species	B	0.0010	6.80	3.125	459.559	31.25
SBE2	Biomass of Opportunistic Species	B	0.3369	41.37	-1.032	-24.953	-10.32
SBE2	Shannon Weiner Diversity Index	B	0.4519	1.78	0.027	15.337	0.27
SBE5	Benthic IBI	B	0.0003	1.31	0.119	90.840	1.19
SBE5	Abundance of Equilibrium Species	B	0.0000	0.00	1.819	.	18.19
SBE5	Abundance of Opportunistic Species	B	0.0001	91.62	-5.367	-58.575	-53.67
SBE5	Total Infaunal Abundance	B	0.3522	3148.20	92.625	29.421	926.25
SBE5	Total Infaunal Biomass	B	0.1975	0.60	0.022	37.000	0.22
SBE5	Biomass of Equilibrium Species	B	0.0031	0.00	2.042	.	20.42
SBE5	Biomass of Opportunistic Species	B	0.0001	81.62	-5.312	-65.085	-53.12
SBE5	Shannon Weiner Diversity Index	B	0.0329	1.14	0.074	64.737	0.74

Appendix E. Continued.

York River Stations

Station	Parameter	Layer	SK Test p Value	Baseline	Slope	% Change	Absolute Change
TF4.2	Benthic IBI	B	0.2207	3.00	0.042	19.600	0.59
TF4.2	Abundance of Equilibrium Species	B	0.2455	12.50	0.785	87.864	10.98
TF4.2	Abundance of Opportunistic Species	B	0.5804	4.17	0.026	8.561	0.36
TF4.2	Total Infaunal Abundance	B	0.0034	410.22	246.848	842.442	3455.87
TF4.2	Total Infaunal Biomass	B	0.0581	0.15	0.051	475.067	0.71
TF4.2	Biomass of Equilibrium Species	B	0.5822	19.44	0.501	36.044	7.01
TF4.2	Biomass of Opportunistic Species	B	0.6225	11.11	0.015	1.852	0.21
TF4.2	Shannon Weiner Diversity Index	B	0.0104	0.96	0.054	79.188	0.76
RET4.3	Benthic IBI	B	0.0509	3.71	-0.067	-25.208	-0.94
RET4.3	Abundance of Equilibrium Species	B	0.0876	40.89	-2.365	-80.960	-33.10
RET4.3	Abundance of Opportunistic Species	B	0.4641	12.91	-0.399	-43.225	-5.58
RET4.3	Total Infaunal Abundance	B	0.4641	1030.32	70.119	95.278	981.67
RET4.3	Total Infaunal Biomass	B	0.2721	4.43	-0.308	-97.210	-4.31
RET4.3	Biomass of Equilibrium Species	B	0.9029	83.08	-0.289	-4.877	-4.05
RET4.3	Biomass of Opportunistic Species	B	0.6255	3.23	0.105	45.641	1.47
RET4.3	Shannon Weiner Diversity Index	B	0.0509	2.74	-0.093	-47.569	-1.30
LE4.1	Benthic IBI	B	0.0321	3.10	-0.084	-38.116	-1.18
LE4.1	Abundance of Equilibrium Species	B	0.5418	37.56	-0.794	-29.592	-11.11
LE4.1	Abundance of Opportunistic Species	B	0.3930	23.71	0.641	37.855	8.98
LE4.1	Total Infaunal Abundance	B	0.8072	1535.94	-13.913	-12.681	-194.78
LE4.1	Total Infaunal Biomass	B	0.3930	27.51	-1.214	-61.781	-17.00
LE4.1	Biomass of Equilibrium Species	B	0.0147	82.49	-3.152	-53.500	-44.13
LE4.1	Biomass of Opportunistic Species	B	0.1431	8.28	0.635	107.316	8.89
LE4.1	Shannon Weiner Diversity Index	B	0.1431	2.54	-0.023	-12.677	-0.32
LE4.3	Benthic IBI	B	0.7778	2.92	0.000	0.000	0.00
LE4.3	Abundance of Equilibrium Species	B	0.2080	56.44	-0.710	-17.614	-9.94
LE4.3	Abundance of Opportunistic Species	B	0.6222	15.73	0.437	38.912	6.12
LE4.3	Total Infaunal Abundance	B	0.6222	3138.66	-51.369	-22.913	-719.17
LE4.3	Total Infaunal Biomass	B	0.1124	6.32	-0.664	-147.089	-9.30
LE4.3	Biomass of Equilibrium Species	B	0.4767	72.97	-0.943	-18.087	-13.20
LE4.3	Biomass of Opportunistic Species	B	0.4767	4.14	0.111	37.401	1.55
LE4.3	Shannon Weiner Diversity Index	B	0.7016	2.47	0.017	9.466	0.23
LE4.3B	Benthic IBI	B	0.3093	1.33	0.048	32.211	0.43
LE4.3B	Abundance of Equilibrium Species	B	0.5887	20.97	-0.215	-9.232	-1.94
LE4.3B	Abundance of Opportunistic Species	B	0.3324	66.67	-1.875	-25.311	-16.88
LE4.3B	Total Infaunal Abundance	B	0.6277	1373.76	-28.620	-18.750	-257.58
LE4.3B	Total Infaunal Biomass	B	0.6665	0.52	-0.029	-49.500	-0.26
LE4.3B	Biomass of Equilibrium Species	B	0.3394	44.44	-1.443	-29.224	-12.99
LE4.3B	Biomass of Opportunistic Species	B	0.8434	20.00	-0.167	-7.529	-1.51
LE4.3B	Shannon Weiner Diversity Index	B	0.2582	1.45	0.055	34.014	0.49

Appendix E. Continued.

Rappahannock River Stations

Station	Parameter	Layer	SK Test p Value	Baseline	Slope	% Change	Absolute Change
TF3.3	Benthic IBI	B	0.6206	3.40	-0.019	-7.947	-0.27
TF3.3	Abundance of Equilibrium Species	B	0.1124	32.36	-1.552	-67.145	-21.73
TF3.3	Abundance of Opportunistic Species	B	0.1294	0.00	0.649	.	9.09
TF3.3	Total Infaunal Abundance	B	0.3520	1001.70	34.691	48.485	485.67
TF3.3	Total Infaunal Biomass	B	0.9563	93.92	-0.009	-0.127	-0.12
TF3.3	Biomass of Equilibrium Species	B	0.0428	80.17	-2.550	-44.522	-35.69
TF3.3	Biomass of Opportunistic Species	B	0.3397	0.00	0.011	.	0.15
TF3.3	Shannon Weiner Diversity Index	B	0.8695	1.95	0.001	1.005	0.02
RET3.1	Benthic IBI	B	0.0277	3.58	-0.096	-37.385	-1.34
RET3.1	Abundance of Equilibrium Species	B	0.0073	33.99	-2.289	-94.264	-32.04
RET3.1	Abundance of Opportunistic Species	B	0.2983	1.88	0.238	177.309	3.33
RET3.1	Total Infaunal Abundance	B	0.2728	1001.70	194.616	272.000	2724.62
RET3.1	Total Infaunal Biomass	B	0.0897	9.02	-0.536	-83.162	-7.50
RET3.1	Biomass of Equilibrium Species	B	0.1394	71.23	-2.516	-49.447	-35.22
RET3.1	Biomass of Opportunistic Species	B	0.1124	1.57	0.092	81.682	1.28
RET3.1	Shannon Weiner Diversity Index	B	0.0248	2.40	-0.049	-28.700	-0.69
LE3.2	Benthic IBI	B	0.7843	2.05	0.011	7.512	0.15
LE3.2	Abundance of Equilibrium Species	B	0.4054	41.28	-0.503	-17.069	-7.05
LE3.2	Abundance of Opportunistic Species	B	0.9127	50.26	-0.114	-3.181	-1.60
LE3.2	Total Infaunal Abundance	B	0.0244	429.30	36.888	120.296	516.43
LE3.2	Total Infaunal Biomass	B	0.2066	0.27	0.014	70.519	0.19
LE3.2	Biomass of Equilibrium Species	B	0.6176	46.51	-0.089	-2.685	-1.25
LE3.2	Biomass of Opportunistic Species	B	1.0000	36.27	0.000	0.000	0.00
LE3.2	Shannon Weiner Diversity Index	B	0.3520	1.21	0.030	34.479	0.42
LE3.4	Benthic IBI	B	0.1312	1.00	0.056	50.040	0.50
LE3.4	Abundance of Equilibrium Species	B	0.2313	0.00	0.758	.	6.82
LE3.4	Abundance of Opportunistic Species	B	0.4778	100.00	-0.649	-5.845	-5.84
LE3.4	Total Infaunal Abundance	B	0.0202	57.24	57.240	900.000	515.16
LE3.4	Total Infaunal Biomass	B	0.0390	0.06	0.025	367.500	0.22
LE3.4	Biomass of Equilibrium Species	B	0.1789	0.00	2.000	.	18.00
LE3.4	Biomass of Opportunistic Species	B	0.3435	100.00	-1.020	-9.184	-9.18
LE3.4	Shannon Weiner Diversity Index	B	0.0107	0.00	0.139	.	1.25

Appendix F. Glossary of important terms.

Anoxic - condition in which the water column is characterized by a complete absence of oxygen. Anoxic conditions typically result from excessive decomposition of organic material by bacteria, high respiration by phytoplankton, stratification of the water column due to salinity or temperature effects or a combination of these factors. Anoxic conditions can result in fish kills or localized extinction of benthic communities.

Anthropogenic - resulting from or generated by human activities.

Benthos - refers to organisms that dwell on or within the bottom. Includes both hard substratum habitats (e.g. oyster reefs) and sedimentary habitats (sand and mud bottoms).

B-IBI - the benthic index of biotic integrity of Weisberg et al. (1997). The B-IBI is a multi-metric index that compares the condition of a benthic community to reference conditions.

Biological Nutrient Removal (BNR) - A temperature dependent process in which the ammonia nitrogen present in wastewater is converted by bacteria first to nitrate nitrogen and then to nitrogen gas. This technique is used to reduce the concentration of nitrogen in sewage treatment plant effluents.

Biomass - a quantitative estimate of the total mass of organisms for a particular population or community within a given area at a given time. Biomass for phytoplankton is measured as the total carbon within a liter of water. Biomass for the benthos is measured as the total ash-free dry weight per square meter of sediment habitat.

Chlorophyll *a* - a green pigment found in plant cells that functions as the receptor for energy in the form of sunlight. This energy is used in the production of cellular materials for growth and reproduction in plants. Chlorophyll *a* concentrations are measured in μg/L and are used as estimate of the total biomass of phytoplankton cells in the water column. In general, high levels of chlorophyll *a* concentrations are believed to be indicative of excessive growth of phytoplankton resulting from excess nutrients such as nitrogen and phosphorus in the water column.

Calanoid copepod - crustaceans of the subclass Copepoda and order Calanoida that are the dominant group of the mesozooplankton in marine systems. Copepods in this group (e.g. *Acartia tonsa*) are one of the most important consumers of phytoplankton in estuarine systems.

Chlorophytes - algae belonging to the division Chlorophyta often referred to as true "green algae." Chlorophytes occur in unicellular, colonial and filamentous forms and are generally more common in tidal freshwater and oligohaline portions of estuaries.

Cladocerans - crustaceans of the class Branchipoda and class Cladocera commonly referred to as "water fleas." Although cladocerans are primarily found in tidal freshwater areas in estuaries, blooms of marine cladocerans periodically occur in higher salinity areas. Some smaller species such as *Bosmina longirostris* are believed to be indicators of poor water quality conditions.

Cryptomonads -algae belonging to the division Cryptophyta that have accessory pigments in addition to chlorophyll *a* which give these small flagellated cells a red, brown or yellow color.

Cyanobacteria - algae belonging to the division Cyanophycea that are procaryotic and that occur in single-celled , filamentous and colonial forms. In general, high concentrations of cyanobacteria are considered to be indicative of poor water quality.

Cyclopoid copepod - crustaceans of the subclass Copepoda and order Cyclopoida that are the dominant group of the mesozooplankton in marine systems. Copepods in this group (e.g. *Mesocyclops edax*) are one of the most important consumers of phytoplankton in estuarine systems.

Appendix F. Glossary of important terms.

Diatoms - algae belonging to the division Bacillariophyta that have a cell wall that is composed primarily of silica and that consists of two separate halves. Most diatoms are single-celled but some are colonial and filamentous forms. Diatoms are generally considered to be indicative of good water quality and are considered to be appropriate food for many zooplankton.

Dinoflagellates - biflagellated, predominately unicellular protists which are capable of performing photosynthesis. Many dinoflagellates are covered with cellulose plates or with a series of membranes. Some dinoflagellates periodically reproduce in large numbers causing blooms that are often referred to as "red tides." Certain species produce toxins and blooms of these forms have been implicated in fish kills. High concentrations of dinoflagellates are generally considered to be indicative of poor water quality.

Dissolved oxygen (DO) - the concentration of oxygen in solution in the water column, measured in mg/L. Most organisms rely on oxygen for cellular metabolism and as a result low levels of dissolved oxygen adversely affect important living resources such as fish and the benthos. In general, dissolved oxygen levels decrease with increasing pollution.

Dissolved inorganic nitrogen (DIN) - the concentration of inorganic nitrogen compounds including ammonia (NH_4), nitrates (NO_3) and nitrites (NO_2) in the water column measured in mg/L. These dissolved inorganic forms of nitrogen are directly available for uptake by phytoplankton by diffusion without first undergoing the process of decomposition. High concentrations of dissolved inorganic nitrogen can result in excessive growth of phytoplankton which in turn can adversely effect other living resources.

Dissolved inorganic phosphorus (PO4F) - the concentration of inorganic phosphorus compounds consisting primarily of orthophosphates (PO_4), The dissolved inorganic forms of phosphorus are directly available for uptake by phytoplankton by diffusion without first undergoing the process of decomposition. High concentrations of dissolved inorganic phosphorus can result in excessive growth of phytoplankton which in turn can adversely effect other living resources.

Estuary - A semi-enclosed body of water that has a free connection with the open sea and within which seawater is diluted measurably with freshwater derived from land drainage.

Eucaryote - organisms the cells of which have discrete organelles and a nucleus separated from the cytoplasm by a membrane.

Fall-line - location of the maximum upstream extent of tidal influence in an estuary typically characterized by a waterfall.

Fixed Point Stations - stations for long-term trend analysis whose location is unchanged over time.

Flow adjusted concentration (FAC) - concentration value which has been recalculated to remove the variation caused by freshwater flow into a stream. By removing variation caused by flow, the effects of other factors such as nutrient management strategies can be assessed.

Holoplankton - zooplankton such as copepods or cladocerans that spend their entire life cycle within the water column.

Habitat - a local environment that has a community distinct from other such habitat types. For the B-IBI of Chesapeake Bay seven habitat types were defined as combinations of salinity and sedimentary types - tidal freshwater, oligohaline, low mesohaline, high mesohaline sand, high mesohaline mud, polyhaline sand and polyhaline mud.

Appendix F. Glossary of important terms.

Hypoxic - condition in which the water column is characterized by dissolved oxygen concentrations less than 2 mg/L but greater than 0 mg/L. Hypoxic conditions typically result from excessive decomposition of organic material by bacteria, high respiration by phytoplankton, stratification of the water column due to salinity or temperature effects or a combination of these factors. Hypoxic conditions can result in fish kills or localized extinction of benthic communities.

Light attenuation (KD) - Absorption, scattering, or reflection of light by dissolved or suspended material in the water column expressed as the change in light extinction per meter of depth. Light attenuation reduces the amount of light available to submerged aquatic vegetation.

Loading - the total mass of contaminant or nutrient added to a stream or river generally expressed in lbs/yr.

Macrobenthos - a size category of benthic organisms that are retained on a mesh of 0.5 mm.

Meroplankton - temporary zooplankton consisting of the larval stages of organisms whose adult stages are not planktonic.

Mesohaline - refers to waters with salinity values ranging between 0.5 and 18.0 ppt.

Mesozooplankton - zooplankton with a maximum dimension ranging between 63 μm and 2000 μm. This size category consists primarily of adults stages of copepods, cladocerans, mysid shrimp, and chaetognaths, as well as, the larval stages of a variety of invertebrates and fish.

Metric - a parameter or measurement of community structure (e.g., abundance, biomass, species diversity).

Microzooplankton - zooplankton with a maximum dimension ranging between 2 μm and 63 μm. This size category consists primarily of single-celled protozoans, rotifers and the larval stages of copepods, cladocerans and other invertebrates.

Nauplii - earliest crustacean larval stage characterized by a single simple eye and three pairs of appendages.

Non-point source - a source of pollution that is distributed widely across the landscape surrounding a water body instead of being at a fixed location (e.g. run-off from residential and agricultural land).

Oligohaline - refers to waters with salinity values ranging between 0.5 and 5.0 ppt.

Oligotrich - protists of the phylum Ciliophora and order Oligotricha. These ciliates are important predators of small phytoplankton in marine systems.

Percent of light at the leaf surface (PLL) - the percentage of light at the surface of the water column that reaches the surface of the leaves of submerged aquatic vegetation generally estimated for depths of 0.5 m and 1.0 m. Without sufficient light at the leaf surface, submerged aquatic plants cannot perform photosynthesis and hence cannot grow or reproduce.

Phytoplankton - that portion of the plankton capable of producing its own food by photosynthesis. Typical members of the phytoplankton include diatoms, dinoflagellates and chlorophytes.

Picoplankton - phytoplankton with a diameter between 0.2 and 2.0 μm in diameter. Picoplankton consists primarily of cyanobacteria and high concentrations of picoplankton are generally considered to be indicative of poor water quality conditions.

Appendix F. Glossary of important terms.

Pielou's evenness - an estimate of the distribution of proportional abundances of individual species within a community. Evenness (*J*) is calculated as follows: $J=H'/\ln S$ where H' is the Shannon - Weiner diversity index and *S* is the number of species.

Plankton - aquatic organisms that drift within and that are incapable of movement against water currents. Some plankton have limited locomotor ability that allows them to change their vertical position in the water column.

Point source - a source of pollution that is concentrated at a specific location such as the outfall of a sewage treatment plant or factory.

Polyhaline - refers to waters with salinity values ranging between 18.0 and 30 ppt.

Primary productivity - the rate of production of living material through the process of photosynthesis that for phytoplankton is typically expressed in grams of carbon per liter of water per hour. High rates of primary productivity are generally considered to be related to excessive concentrations of nutrients such as nitrogen and phosphorus in the water column.

Probability based sampling - all locations within a stratum have an equal chance of being sampled. Allows estimation of the percent of the stratum meeting or failing the benthic restoration goals.

Procaryote - organisms the cells of which do not have discrete organelles or a nucleus (e.g. Cyanobacteria).

Pycnocline - a rapid change in salinity in the water column indicating stratification of water with depth resulting from either changes in salinity or water temperature.

Random Station - a station selected randomly within a stratum. In every succeeding sampling event new random locations are selected.

Recruitment - The successful dispersal settlement and development of larval forms of plants or animal to a reproducing adult.

Reference condition - the structure of benthic communities at reference sites.

Reference sites - sites determined to be minimally impacted by anthropogenic stress. Conditions at theses sites are considered to represent goals for restoration of impacted benthic communities. Reference sites were selected by Weisberg et al. (1997) as those outside highly developed watersheds, distant from any point-source discharge, with no sediment contaminant effect, with no low dissolved oxygen effect and with a low level of organic matter in the sediment.

Restoration Goal - refers to obtaining an average B-IBI value of 3.0 for a benthic community indicating that values for metrics approximate the reference condition.

Rotifer - small multicellular planktonic animal of phylum Rotifera. These organisms are a major component of the microzooplankton and are major consumers of phytoplankton. High densities of rotifers are believed to be indicative of high densities of small phytoplankton such as cyanobacteria and as such are believed to be indicative of poor water quality.

Salinity - the concentration of dissolved salts in the water column measured in mg/L, ppt or psu. The composition and distribution of plant and animal communities is directly affected by salinity in estuarine systems. The effects of salinity on living resources must be taken into consideration when interpreting the potential effects of human activities on living resources.

Appendix F.   Glossary of important terms.

Sarcodinians - single celled protists of the subphylum Sarcodina which includes amoeba and similar forms, characterized by possession of pseudopodia. Planktonic forms of sarcodinians typically have a external shell or test constructed of detrital or sedimentary particles and are important consumers of phytoplankton.

Secchi depth - the depth of light penetration expressed in meters as measured using a secchi disk. Light penetration depth directly affects the growth and recruitment of submerge aquatic vegetation.

Shannon Weiner diversity index - a measure of the number of species within a community and the relative abundances of each species. The Shannon Weiner index is calculated as follows:

$$H' = -\sum_{i=1}^{s} p_i \log_2 p_i$$

where p_i is the proportion of the *i*th species and S is the number of species.

Stratum - a geographic region of unique ecological condition or managerial interest.

Submerged aquatic vegetation (SAV) - rooted vascular plants (e.g. eelgrass, widgeon grass, sago pondweed) that grow in shallow water areas . SAV are important in marine environments because they serve as major food source, provide refuge for juvenile crabs and fish, stabilize sediments preventing shoreline erosion and excessive suspended materials in the water column, and produce oxygen in the water column.

Threshold - a value of a metric that determines the B-IBI scoring. For all metrics except abundance and biomass, two thresholds are used - the lower 5^{th} percentile and the 50^{th} percentile (median) of the distribution of values at reference sites. Samples with metric values less than the lower 5^{th} percentile are scored as a 1. Samples with values between the 5^{th} and 50^{th} metrics are scored as 3 and values greater than the 50^{th} percentile are scored as 5. For abundance and biomass, values below the 5^{th} and above the 95^{th} percentile are scored as 1, values between the 5^{th} and 25^{th} and the 75^{th} and 95^{th} percentiles are scored as 3 and values between the 25^{th} and 75^{th} percentiles are scored as 5.

Tidal freshwater - refers to waters with salinity values ranging between 0 and 0.5 ppt which are located in the upper reaches of the estuary at or just below the maximum upstream extent of tidal influence.

Tintinnid - protists of phylum Ciliophora and order Oligotricha. These ciliates are important predators of small phytoplankton in marine systems. Tintinnids are distinguished from other members of this group because they create an exoskeleton or test made of foreign particles that have been cemented together.

Total nitrogen (TN) - the concentration of both inorganic and organic compounds in the water column which contain nitrogen measured in mg/L. Nitrogen is a required nutrient for protein synthesis. Inorganic forms of nitrogen are directly available for uptake by phytoplankton while organic compounds must first be decomposed by bacteria prior to being available for use for other organisms. High levels of total nitrogen are considered to be detrimental to living resources either as a source of nutrients for excessive phytoplankton growth or as a source of excessive bacterial decomposition that can increase the incidence and extent of anoxic or hypoxic events.

Appendix F. Glossary of important terms.

Total phosphorus (TP) - the concentration of both inorganic and organic compounds in the water column which contain phosphorus measured in mg/L. Phosphorus is a required nutrient for cellular metabolism and for the production of cell membranes. Inorganic forms of phosphorus are directly available for uptake by phytoplankton while organic compounds must first be decomposed by bacteria prior to being available for use for other organisms. High levels of total nitrogen are considered to be detrimental to living resources either as a source of nutrients for excessive phytoplankton growth or as a source of excessive bacterial decomposition that can increase the incidence and extent of anoxic or hypoxic events.

Total suspended solids (TSS) - the concentration of suspended particles in the water column, measured in mg/L. The composition of total suspended solids includes both inorganic (fixed) and organic (volatile) compounds. The fixed suspended solids component is comprised of sediment particles while the volatile suspended solids component is comprised of detrital particles and planktonic organisms. The concentration of total suspended solids directly affects water clarity which in turn affects the development and growth of submerged aquatic vegetation.

Zoea - last planktonic larval stage of crustaceans such as crabs and shrimp. Numbers of crab zoea may reflect the recruitment success of adult crabs.

Zooplankton - the animal component of the plankton which typically includes copepods, cladocerans, jellyfish and many other forms.