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# BENTHIC BIOLOGICAL MONITORING PROGRAM OF THE ELIZABETH RIVER WATERSHED (1999)

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## EXECUTIVE SUMMARY

A study of the macrobenthic communities of the Elizabeth River watershed was conducted in summer 1999. The three objectives of the Benthic Biological Monitoring Program of the Elizabeth River watershed are: (1) To characterize the health of regional areas of the tidal waters of the Elizabeth River watershed Chesapeake Bay as indicated by the structure of the benthic communities. These characterizations are based upon application of benthic restoration goals and the Benthic Index of Biotic Integrity (BIBI) developed for the Chesapeake Bay to five primary strata - the Mainstem of the river, the Lafayette River, the Southern Branch, Western Branch and Eastern Branch. Within each stratum samples were randomly allocated in a probability-based sampling design. A probability-based sampling design allows calculation of confidence intervals around estimates of condition of the benthic communities. ( 2) To conduct trend analyses on long-term data at 14 fixed-point stations to relate temporal trends in the benthic communities to changes in water and/or sediment quality. Trend analyses will be updated annually as new data are available. (3) To produce an historical data base that will allow annual evaluations of biotic impacts by comparing trends in status within probability-based strata and trends at fixed-point stations to changes in water and/or sediment quality. In addition in the 1999, sampling event two additional strata were sampled for benthic community condition: (1) Scuffletown Creek, a proposed location for sediment contaminant remediation and (2) an additional nearby small creek system - the Jones and Gilligan Creek complex.

The condition of the seven strata was compared to the results for all Virginia tidal waters for 1999 based upon the random sampling of 100 sites as part of the on-going Virginia Benthic Monitoring Program. In 1999 Virginia tidal waters averaged 30% degraded benthic bottom. All seven strata for the Elizabeth River were higher than this value - 52% for the Mainstem of the River, 64% for the Lafayette River, 64% for the Eastern Branch, 72% for the Western Branch and 92% for the Southern Branch. Scuffletown Creek and Jones-Gilligan Creek both averaged 76% area failing the Benthic Restoration Goals. In general for all Elizabeth River strata, species diversity and biomass were below reference condition levels while abundance values were within reference condition levels. Community composition was unbalanced with levels of pollution indicative species above and levels of pollution sensitive species below reference conditions. The only exceptions to these patterns was the Mainstem of the river where biomass and levels of pollution sensitive species were within reference condition levels.

## INTRODUCTION

A study of the macrobenthic communities of the Elizabeth River watershed was conducted in summer 1999. The three objectives of the Benthic Biological Monitoring Program of the Elizabeth River watershed are: (1) To characterize the health of regional areas of the tidal waters of the Elizabeth River watershed Chesapeake Bay as indicated by the structure of the benthic communities. These characterizations are based upon application of benthic restoration goals and the Benthic Index of Biotic Integrity (BIBI) developed for the Chesapeake Bay to five primary strata - the Mainstem of the River, the Lafayette River, the Southern Branch, Western Branch and Eastern Branch. Within each stratum samples are randomly allocated in a probability-based sampling design. A probability-based sampling design allows calculation of confidence intervals around estimates of condition of the benthic communities. ( 2) To conduct trend analyses on long-term data at 14 fixed-point stations to relate temporal trends in the benthic communities to changes in water and/or sediment quality. Trend analyses will be updated annually as new data are available. (3) To produce an historical data base that will allow annual evaluations of biotic impacts by comparing trends in status within probability-based strata and trends at fixed-point stations to changes in water and/or sediment quality. In addition in the 1999, sampling event two additional strata were sampled for benthic community condition: (1) Scuffletown Creek, a proposed location for sediment contaminant remediation and (2) an additional nearby small creek system - the Jones and Gilligan Creek complex.

The macrbenthic communities of the Elizabeth River have been studied since the 1969 sampling of Boesch (1973) with three stations in the Mainstem of the river. Other important studies were limited to the Southern Branch of the river including seasonal sampling at 10 sites in 1977-1978 (Hawthorne and Dauer 1983), seasonal sampling at the same 10 sites a decade later in 1987-1988 by Hunley (1993), the establishment of two long-term monitoring stations in 1989 as part of the Virginia Chesapeake Bay Benthic Monitoring Program (Dauer et al. 1999) and summarizations of the two Southern Branch long-term monitoring stations (Dauer 1993, Dauer et al. 1993).

## RATIONALE

Benthic invertebrates are used extensively as indicators of estuarine environmental status and trends because numerous studies have demonstrated that benthos respond predictably to many kinds of natural and anthropogenic stress (Pearson and Rosenberg 1978; Dauer 1993; Tapp et al. 1993; Wilson and Jeffrey 1994). Many characteristics of benthic assemblages make them useful indicators (Bilyard 1987), the most important of which are related to their exposure to stress and the diversity of their response. Exposure to hypoxia is typically greatest in near-bottom waters and anthropogenic contaminants often accumulate in sediments where benthos live. Benthic organisms generally have limited mobility and cannot avoid these adverse conditions. This immobility is advantageous in environmental assessments because, unlike most pelagic fauna, benthic assemblages reflect local environmental conditions (Gray 1979). The structure of benthic assemblages responds to many kinds of stress because these assemblages typically include

organisms with a wide range of physiological tolerances, life history strategies, feeding modes, and trophic interactions (Pearson and Rosenberg 1978; Rhoads et al. 1978; Boesch and Rosenberg 1981). Recently benthic community condition in the Chesapeake Bay has been related to water quality, sediment quality, nutrient loads, and land use patterns (Dauer et al. 2000).

# METHODS

A glossary of selected terms used in this report is found on page 40.

### *Strata Sampled*

The Elizabeth River watershed was divided into five primary strata - the Mainstem of the river, the Lafayette River, the Southern Branch, Western Branch and Eastern Branch (Fig. 1). In addition two small creeks of the Southern Branch of the river were also sampled as part of a sediment contaminant remediation effort - Scuffletown Creek and Jones-Gilligan Creek.

### *Probability-based sampling*

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.

Within each probability-based stratum, 25 random locations were sampled using a 0.04 $m^2$ Young grab. The minimum acceptable depth of penetration of the grab was 7 cm. 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. A 50 g subsample of the surface sediment was taken for sediment analysis. Salinity, temperature and dissolved oxygen were measured at the bottom and water depth was recorded.

### *Probability-Based Estimation of Degradation*

Areal estimates of degradation of benthic community condition within a stratum can be made because all locations in each stratum are randomly selected. The estimate of the proportion of a stratum failing the Benthic Restoration Goals developed for Chesapeake Bay (Ranasinghe et al. 1994; updated in Weisberg et al. 1997) is the proportion of the 25 samples with an B-IBI value of less than 3.00. The process produces a binomial distribution: the percentage of the stratum attaining goals versus the percentage not attaining the goals. With a binomial distribution the 95% confidence limits for these percentages can be calculated as:

$$95\%\ \text{Confidence Limit} = p \pm 1.96\ (\text{SQRT}(pq/N))$$

where p = percentage attaining goal, q = percentage not attaining goal and N = number of

samples.

For each stratum, 50 random points were selected using the GIS system of Versar, Inc. Decimal degree reference coordinates were used with a precision of 0.000001 degrees (approximately 1 meter) which is a smaller distance than the accuracy of positioning; therefore, no area of a stratum is excluded from sampling and every point within a stratum has a chance of being sampled. In the field the first 25 acceptable sites are sampled. Sites may be rejected because of inaccessibility by boat, inadequate water depth or inability of the grab to obtain an adequate sample (e.g., on hard bottoms).

***Fixed-Point Station sampling***

Fourteen fixed point stations were established for long-term trend analysis (Fig. 2). All field collection procedures were the same as for probability based sampling except that three replicate Young grab sample were collected for macrobenthic community analysis.

***Laboratory Analysis***

Each replicate was sieved on a 0.5 mm screen, relaxed in dilute isopropyl alcohol and preserved with a buffered formalin-rose bengal solution. 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.

Particle-size analysis was conducted using the techniques of Folk (1974). Each sediment sample is first separated into a sand fraction (> 63 $\mu$m) and a silt-clay fraction (< 63 $\mu$m). The sand fraction was dry sieved and the silt-clay fraction quantified by pipette analysis. For random stations, only the percent sand and percent silt-clay fraction were estimated. For the fixed-point stations particle-size distribution parameters were determined by the graphic and moment measures methods of Folk (1974). Total volatile solids of the sediment was estimated by the loss upon ignition method as described above and presented as percentage of the wight of the sediment.

***Benthic Index of Biotic Integrity***

**B-IBI and Benthic Community Status Designations**

The B-IBI is a multiple-metric index developed to identify the degree to which a benthic community meets the Chesapeake Bay Program's Benthic Community Restoration Goals (Ranasinghe et al. 1994; updated in Weisberg et al. 1997). The B-IBI provides a means for comparing relative condition of benthic invertebrate communities across habitat types. It also

provides a validated mechanism for integrating several benthic community attributes indicative of community health into a single number that measures overall benthic community condition.

The B-IBI is scaled from 1 to 5, and sites with values of 3 or more are considered to meet the Restoration Goals. The index is calculated by scoring each of several attributes as either 5, 3, or 1 depending on whether the value of the attribute at a site approximates, deviates slightly from, or deviates strongly from the values found at reference sites in similar habitats, and then averaging these scores across attributes. The criteria for assigning these scores are numeric and dependent on habitat type. Application of the index is limited to a summer index period from July 15th through September 30th.

Benthic community condition was classified into four levels based on the B-IBI. Values less than 2 were classified as **severely degraded**; values form 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 the goal**. Values in the marginal category do not meet the Restoration Goals, but they differ from the goals within the range of measurement error typically recorded between replicate samples. These categories are used in annual characterizations of the condition of the benthos in the Chesapeake Bay (Ranasinghe et al. 1994; Dauer et al. 1998a, 1998b; Ranasinghe et al. 1998).

## Further Information concerning the B-IBI

The analytical approach used to develop the B-IBI was similar to the one Karr et al. (1986) used to develop comparable indices for freshwater fish communities. Selection of benthic community metrics and metric scoring thresholds were habitat-dependent but by using categorical scoring comparisons between habitat types were possible. A six-step procedure was used to develop the index: (1) acquiring and standardizing data sets from a number of monitoring programs, (2) temporally and spatially stratifying data sets to identify seasons and habitat types, (3) identifying reference sites, (4) selecting benthic community metrics, (5) selecting metric thresholds for scoring, and (6) validating the index with an independent data set (Weisberg et al. 1997). The B-IBI developed for Chesapeake Bay is based upon subtidal, unvegetated, infaunal macrobenthic communities. Hard-bottom communities, e.g., oyster beds, were not sampled because the sampling gears could not obtain adequate samples to characterize the associated infaunal communities. Infaunal communities associated with submerged aquatic vegetation (SAV) were not avoided, but were rarely sampled due to the limited spatial extent of SAV in Chesapeake Bay.

Only macrobenthic data sets based on processing with a sieve of 0.5 mm mesh aperture and identified to the lowest possible taxonomic level were used. A data set of over 2,000 samples collected from 1984 through 1994 was used to develop, calibrate and validate the index (see Table 1 in Weisberg et al. 1997). Because of inherent temporal sampling limitations in some of the data sets, only data from the period of July 15 through September 30 were used to develop

the index. A multivariate cluster analysis of the biological data was performed to define habitat types. Salinity and sediment type were the two important factors defining habitat types and seven habitats were identified - tidal freshwater, oligohaline, low mesohaline, high mesohaline sand, high mesohaline mud, polyhaline sand and polyhaline mud habitats (see Table 5 in Weisberg et al. 1997).

Reference sites were selected as those sites which met all three of the following criteria: no sediment contaminant exceeded Long et al.'s (1995) effects range-median (ER-M) concentration, total organic content of the sediment was less than 2%, and bottom dissolved oxygen concentration was consistently high.

A total of 11 metrics representing measures of species diversity, community abundance and biomass, species composition, depth distribution within the sediment, and trophic composition were used to create the index (see Table 2 in Weisberg et al. 1997). The habitat-specific metrics were scored and combined into a single value of the B-IBI. Thresholds for the selected metrics were based on the distribution of values for the metric at the reference sites. Data used for validation were collected between 1992 and 1994 and were independent of data used to develop the index. The B-IBI classified 93% of the validation sites correctly (Weisberg et al. 1997).

In tables presenting B-IBI results salinity classes are as follows: 1- tidal freshwater, 2 - oligohaline, 3- low mesohaline, 4 - high mesohaline and 5 - polyhaline. The two sediment classes are as follows: 1 - silt clay content < 40% and 2 - silt clay content $\geq$ 40%. All abundance values are individuals per $m^{-2}$; biomass values are AFDW g per $m^{-2}$; and pollution indicative, pollution sensitive and cavnivore/omnivore metrics are percent of abundance or biomass as indicated in tables.

# RESULTS

## Mainstem

### Environmental Parameters

All physical, chemical and sedimentary parameters are summarized in Table 1. Water depths varied from 1-17 m reflecting shoal and channel depths. All salinity values were in the polyhaline range with values from 21.3 to 23.0 ppt and bottom dissolved oxygen was generally high with values from 4.5 to 10.4 ppm. Silt-clay content varied from 0.8 to 95.2 % and total volatile solids from 0.4 to 8.0%.

### Benthic Community

Benthic community parameters including the B-IBI value, abundance, biomass, Shannon diversity and selected metrics are summarized by station in Table 2. In general the Mainstem of the river had the best benthic community condition as indicated by the highest mean B-IBI value,

biomass and Shannon Index (Table 29). In addition the composition of the community was generally the best balanced with pollution indicative species being low and pollution sensitive species having the highest values among the strata studied (Table 29).

The Mainstem of the river had the lowest level of degraded bottom (B-IBI values less than 3.0) among the primary strata (Table 30, Fig. 3). In addition the percent of bottom with severely degraded benthos (B-IBI less than 2.0) was 4%, less than the average of 12% for all Virginia tidal waters (Table 30, Fig. 4). Table 4 summarizes the B-IBI scores for selected individual metrics. Dominant species are presented in Table 5.

## Lafayette River

### Environmental Parameters

All physical, chemical and sedimentary parameters are summarized in Table 5. Water depths are shallow and varied from 1-3 m. Salinity values were primarily in the polyhaline range with values from 17.0 to 23.2 ppt and bottom dissolved oxygen was generally high with values from 3.4 to 11.8 ppm. Silt-clay content varied from 2.2 to 99.0 % and total volatile solids from 0.0 to 12.6 %.

### Benthic Community

Benthic community parameters including the B-IBI value, abundance, biomass, Shannon diversity and selected metrics are summarized by station in Table 6. The Lafayette River benthic community condition was intermediate among the strata with the Mainstem having the highest values, the Southern Branch with the lowest values and the Lafayette River, Eastern Branch and Western Branch with intermediate values (Tables 6, 29, 30). Stations L18 to L25 tended to have the highest abundance, lowest species diversity, and less abundance of pollution sensitive species (Table 6).

The Lafayette River had intermediate level of degraded bottom (B-IBI values less than 3.0) among the primary strata (Table 29, Fig. 5). In addition the percent of bottom with severely degraded benthos (B-IBI less than 2.0) was also intermediate with a value of 12 % (Table 30, Fig. 6). The three severely degraded sites were spread throughout the river (Fig. 6). Table 7 summarizes the B-IBI scores for selected individual metrics and dominant species are presented in Table 8.

## Western Branch

### Environmental Parameters

All physical, chemical and sedimentary parameters are summarized in Table 9. Water depths are shallow and varied from 1-4 m. Salinity values were all in the polyhaline range with values

from 20.5 to 23.5 ppt and bottom dissolved oxygen was generally high with values from 5.2 to 10.4 ppm. Silt-clay content varied from 0.9 to 99.1 % and total volatile solids from 0.4 to 8.1 %.

### Benthic Community

Benthic community parameters including the B-IBI value, abundance, biomass, Shannon diversity and selected metrics are summarized by station in Table 10. The Western Branch benthic community condition was intermediate among the strata with the Mainstem having the highest values, the Southern Branch with the lowest values and the Lafayette River, Eastern Branch and Western Branch with intermediate values (Tables 10, 29, 30).

The Western Branch had intermediate level of degraded bottom (B-IBI values less than 3.0) among the primary strata (Table 30, Fig. 7). In addition the percent of bottom with severely degraded benthos (B-IBI less than 2.0) was also intermediate with a value of 20 % (Table 30, Fig.8). The five severely degraded sites were in the middle region of the river (Fig. 8). Table 11 summarizes the B-IBI scores for selected individual metrics and dominant species are presented in Table 12.

## Eastern Branch

### Environmental Parameters

All physical, chemical and sedimentary parameters are summarized in Table 13. Water depths varied greatly from channel depths of 5-9 m to 1-2 m in the shallow upper region. Salinity values were in the polyhaline range in the lower reach of this branch and in the high mesohaline range in the upper reach. Bottom dissolved oxygen was generally lower than the Mainstem, Western Branch and Lafayette River with values from 1.9 to 10.8 ppm. Fourteen sites had bottom oxygen values below 4 ppm. Silt-clay content varied from 4.6 to 98.4 % and total volatile solids from 3.8 to 14.7 %.

### Benthic Community

Benthic community parameters including the B-IBI value, abundance, biomass, Shannon diversity and selected metrics are summarized by station in Table 14. The Eastern Branch benthic community condition was intermediate among the strata with the Mainstem having the highest values, the Southern Branch with the lowest values and the Lafayette River, Eastern Branch and Western Branch with intermediate values (Tables 14, 29, 30).

The Eastern Branch had intermediate level of degraded bottom (B-IBI values less than 3.0) among the primary strata (Table 30, Fig. 9). In addition the percent of bottom with severely degraded benthos (B-IBI less than 2.0) was also intermediate with a value of 12 % (Table 30,

Fig. 10). The three severely degraded sites were in the upper region of the river (Fig. 10). Table 15 summarizes the B-IBI scores for selected individual metrics and dominant species are presented in Table 16.

## Southerm Branch

### Environmental Parameters

All physical, chemical and sedimentary parameters are summarized in Table 17. Water depths varied greatly from channel depths of 7-14 m in the lower reach of the branch to 1-2 m in the upper region. Salinity values were in the polyhaline range in the lower reach of this branch and generally in the high mesohaline range in the upper reach. Bottom dissolved oxygen was generally lowest among the primary branches with all values below 4. Silt-clay content varied from 4.6 to 97.4.4 % and total volatile solids from 1.0 to 15.1 %.

### Benthic Community

Benthic community parameters including the B-IBI value, abundance, biomass, Shannon diversity and selected metrics are summarized by station in Table 18. The Southern Branch benthic community condition was the worst among the strata with the Mainstem having the highest values, the Southern Branch with the lowest values and the Lafayette River, Eastern Branch and Western Branch with intermediate values (Tables 18, 29, 30).

The Southern Branch had the highest level of degraded bottom (B-IBI values less than 3.0) among the primary strata (Table 30, Fig. 11). In addition the percent of bottom with severely degraded benthos (B-IBI less than 2.0) was the highest among all strata with a value of 44 % (Table 30, Fig. 12). The 11 severely degraded sites were found throughout the middle and upper reaches of Southern Branch (Fig. 12). Table 19 summarizes the B-IBI scores for selected individual metrics and dominant species are presented in Table 20.

## Scuffletown Creek

### Environmental Parameters

All physical, chemical and sedimentary parameters are summarized in Table 21. Water depths were shallow ranging from 1-4 m. Salinity values were all in the polyhaline range. Bottom dissolved oxygen was generally high with all values above 4 ppm. Silt-clay content varied from 9.6 to 82.3 % and total volatile solids from 1.0 to 13.5 %.

### Benthic Community

Benthic community parameters including the B-IBI value, abundance, biomass, Shannon diversity and selected metrics are summarized by station in Table 22. The Scuffletown Creek

benthic community condition was between the worst condition in the Southern Branch and the values for the Lafayette River, Eastern Branch and Western Branch (Tables 22, 29, 30).

Scuffletown Creek had levels of degraded bottom (B-IBI values less than 3.0) between the worst condition in the Southern Branch and the values for the Lafayette River, Eastern Branch and Western Branch (Table 30, Fig. 13). The percent of bottom with severely degraded benthos (B-IBI less than 2.0) was between the worst condition in the Southern Branch and the values for the Lafayette River, Eastern Branch and Western Branch with a value of 24 % (Table 30, Fig. 14). The six severely degraded sites were found throughout the creek (Fig. 14). Table 23 summarizes the B-IBI scores for selected individual metrics and dominant species are presented in Table 24.

## Jones-Gilligan Creek

### Environmental Parameters

All physical, chemical and sedimentary parameters are summarized in Table 25. Water depths varied from channel depths of 5-9 m in the lower reach to 1 m in the upper reaches. Salinity values were generally in the polyhaline range with some mesohaline values in the upper reach. Bottom dissolved oxygen was generally high with all but one value above 4 ppm. Silt-clay content varied from 2.1 to 90.1 % and total volatile solids from 0.3 to 16.5 %.

### Benthic Community

Benthic community parameters including the B-IBI value, abundance, biomass, Shannon diversity and selected metrics are summarized by station in Table 26. The benthic community condition was similar to Scuffletown Creek being between the worst condition in the Southern Branch and the values for the Lafayette River, Eastern Branch and Western Branch (Tables 27, 29, 30).

Jones-Gilligan Creek had levels of degraded bottom (B-IBI values less than 3.0) the same as Scuffletown Creek and between the worst condition in the Southern Branch and the values for the Lafayette River, Eastern Branch and Western Branch (Table 30, Fig. 13). The percent of bottom with severely degraded benthos (B-IBI less than 2.0) was again the same as Scuffletown Creek and was between the worst condition in the Southern Branch and the values for the Lafayette River, Eastern Branch and Western Branch with a value of 24 % (Table 30, Fig. 14). The six severely degraded sites were found throughout the creek but with five of the six sites near the mouth of the creek system (Fig. 14). Table 27 summarizes the B-IBI scores for selected individual metrics and dominant species are presented in Table 28.

## Fixed Point Stations

### Environmental Parameters

All physical, chemical and sedimentary parameters are summarized in Table 31.

### Benthic Community

Benthic community parameters including the B-IBI value, abundance, biomass, Shannon diversity and selected metrics are summarized by station in Table 32. These stations will be the basis for future long-term trend analyses.

## Discussion

The condition of the macrobenthic communities of the Elizabeth River watershed was characterized for five strata consisting of the Mainstem of the River, the Lafayette River, the Southern Branch, Western Branch and Eastern Branch. The five strata can be characterized in terms of benthic community condition into three categories: (1) the best condition in the Mainstem of the river, (2) the worst condition in the Southern Branch, and (3) intermediate condition in the Eastern Branch, Western Branch and Lafayette River (Figs. 15-18). The Mainstem of the river had the highest average B-IBI value of 2.88, the Southern Branch the lowest value of 2.02 and the other branches had values between 2.45 and 2.71 (Table 29, Fig. 18). The resulting estimates of percent bottom failing the Chesapeake Bay Benthic Restoration goals were lowest in the Mainstem (52 ± 20 %), greatest in the Southern Branch (92 ± 11%) and intermediate in the other branches (ranging from 64 to 72%) (Table 30). However, the estimated level of degraded benthic habitats within the Elizabeth River is higher for all five strata compared to the average for all Virginia tidal waters of 41% (1996-1998 average value from Dauer and Rodi 1999). The 1999 average level of degraded benthic habitats was 30 % (Fig. 24 from Dauer, in preparation)

The two strata studied as part of a proposed sediment contaminant remediation study (Scuffletwon Creek and Jones-Gilligan Creek) had average B-IBI values and average levels of degraded bottom intermediate between those for the Southern Branch (Tables 29, 30; Figs. 15-18) and the Lafayette River, Western branch and Eastern Branch.

Compared to the Chesapeake Bay Benthic Restoration Goals the macrobenthic communities of the Elizabeth River can be characterized as (1) having lower than expected species diversity and biomass, (2) abundance levels not different from reference conditions and (3) species composition with levels of pollution indicative species higher than reference conditions and levels of pollution sensitive species lower than reference conditions (Fig. 19-23).

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Figures

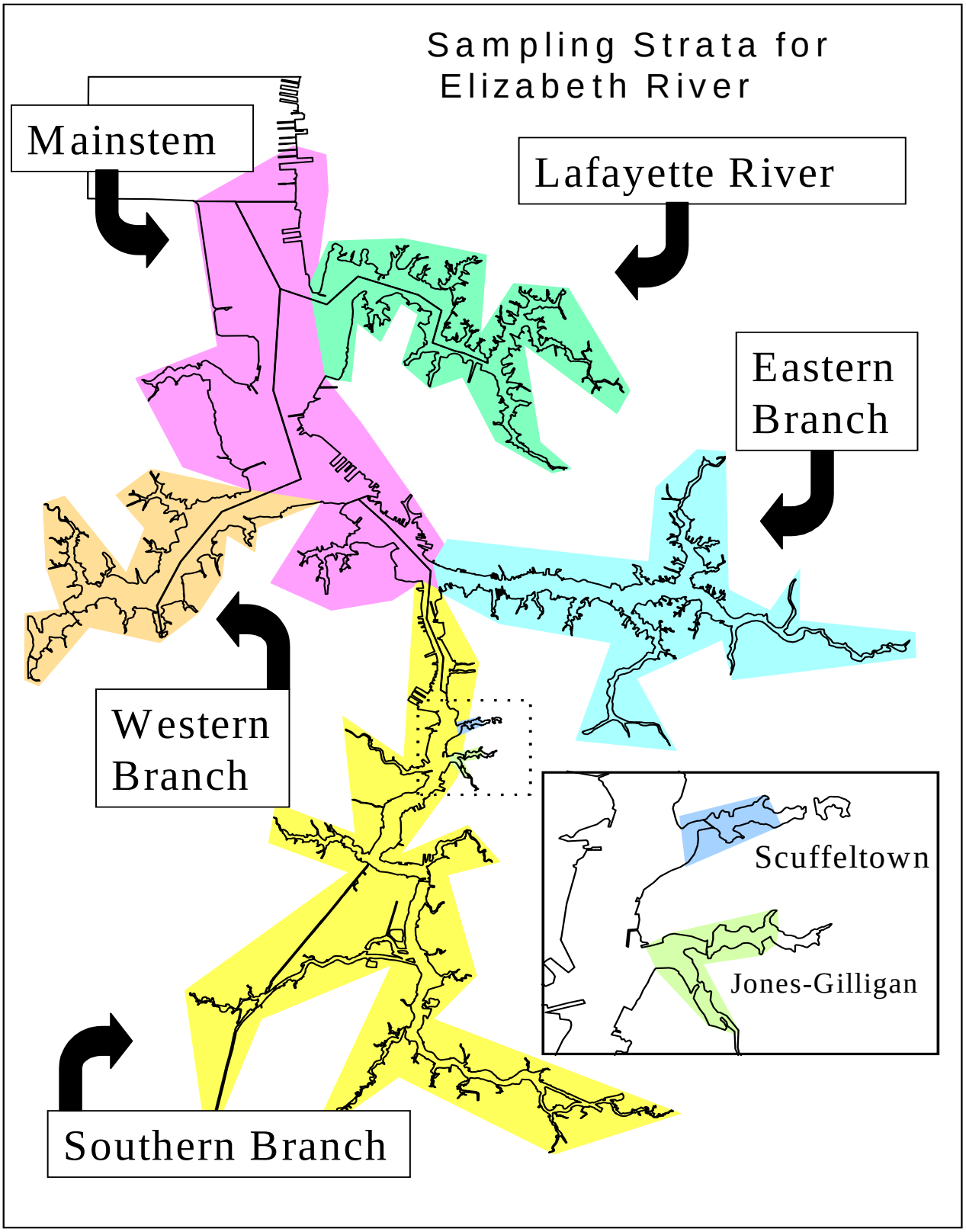


**Figure 1**. Elizabeth River watershed showing the five major segments sampled. Insert shows Scuffletown Creek and the Jones-Gilligan Creek strata.

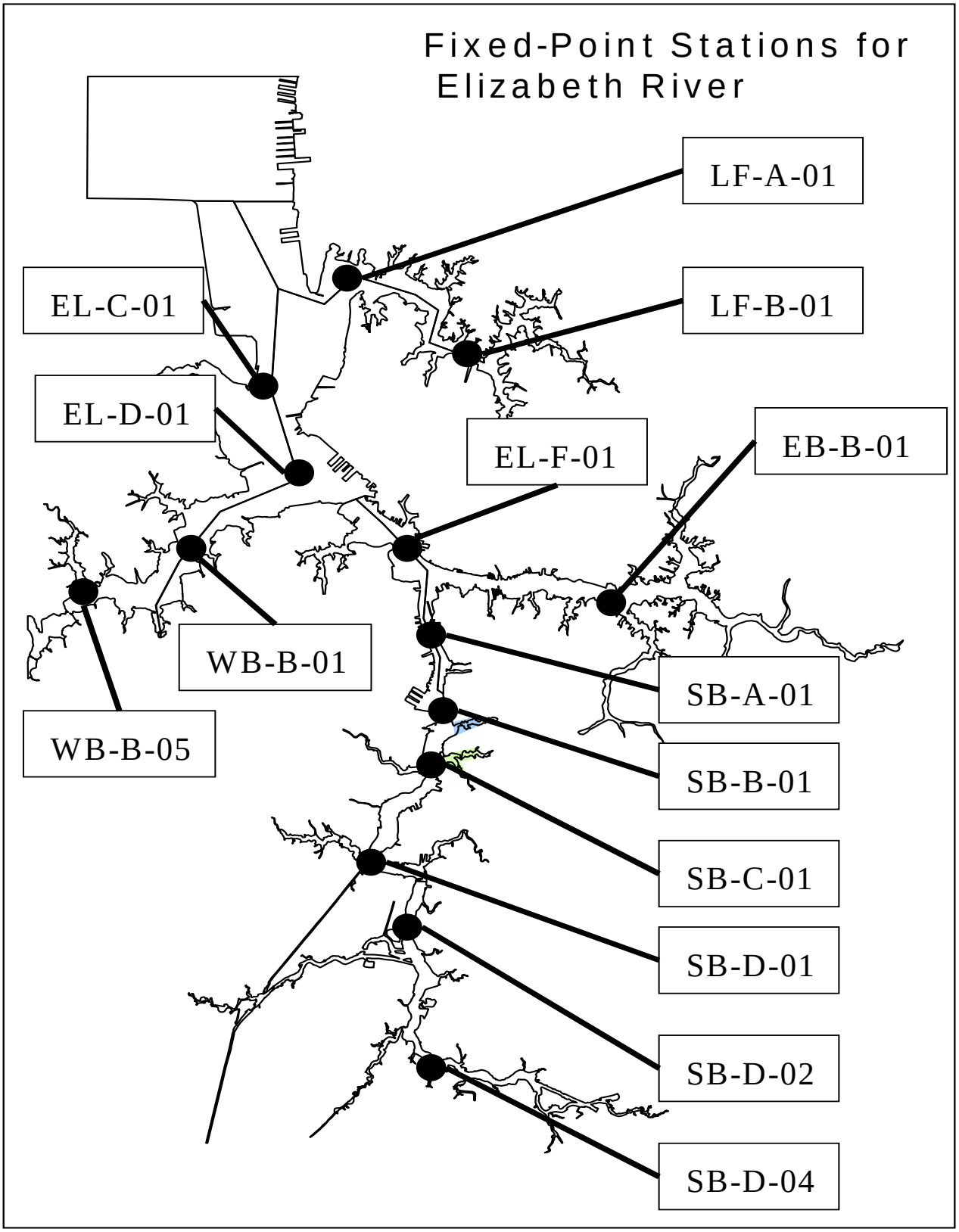


**Figure 2**. Elizabeth River watershed showing the 14 fixed-point stations for long-term trend analyses.

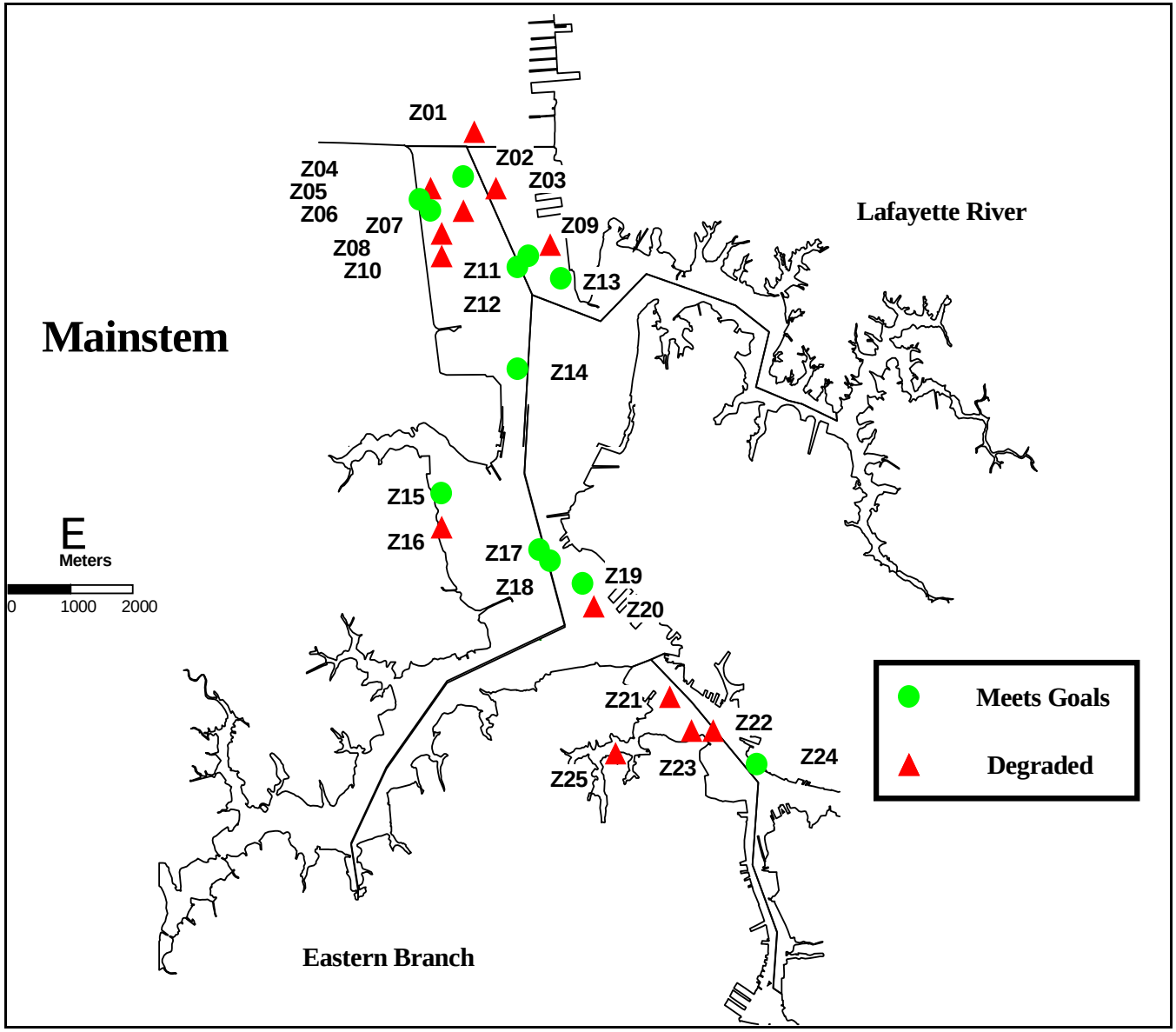


**Figure 3**. Mainstem of the Elizabeth River showing the 25 sites sampled and their designations using the B-IBI. In this figure "degraded" includes all sites with a B-IBI value less than 3.00.

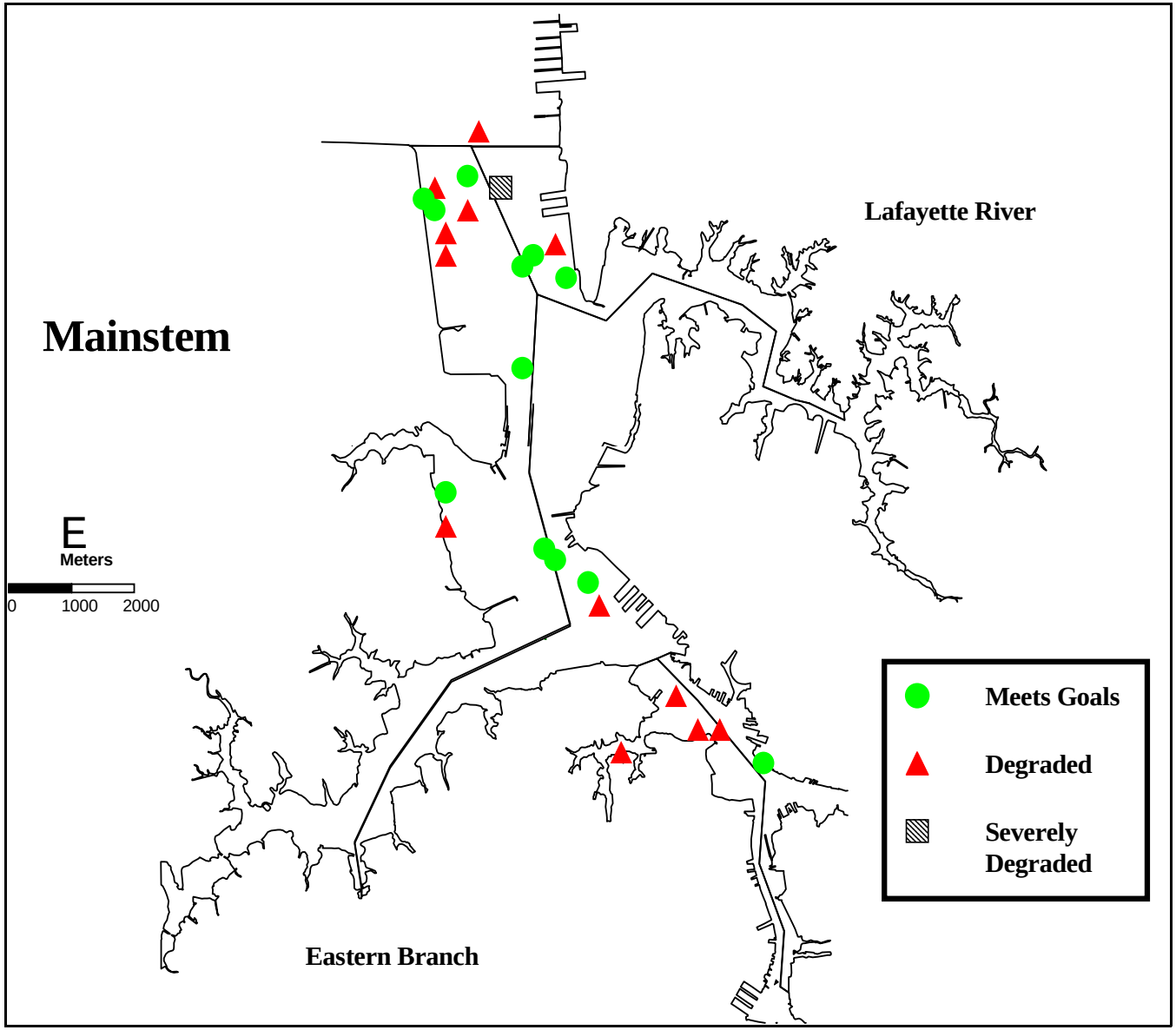


**Figure 4**. Mainstem of the Elizabeth River showing the 25 sites sampled and their designations using the B-IBI. In this figure sites with a designation of "severely degraded" are indicated.

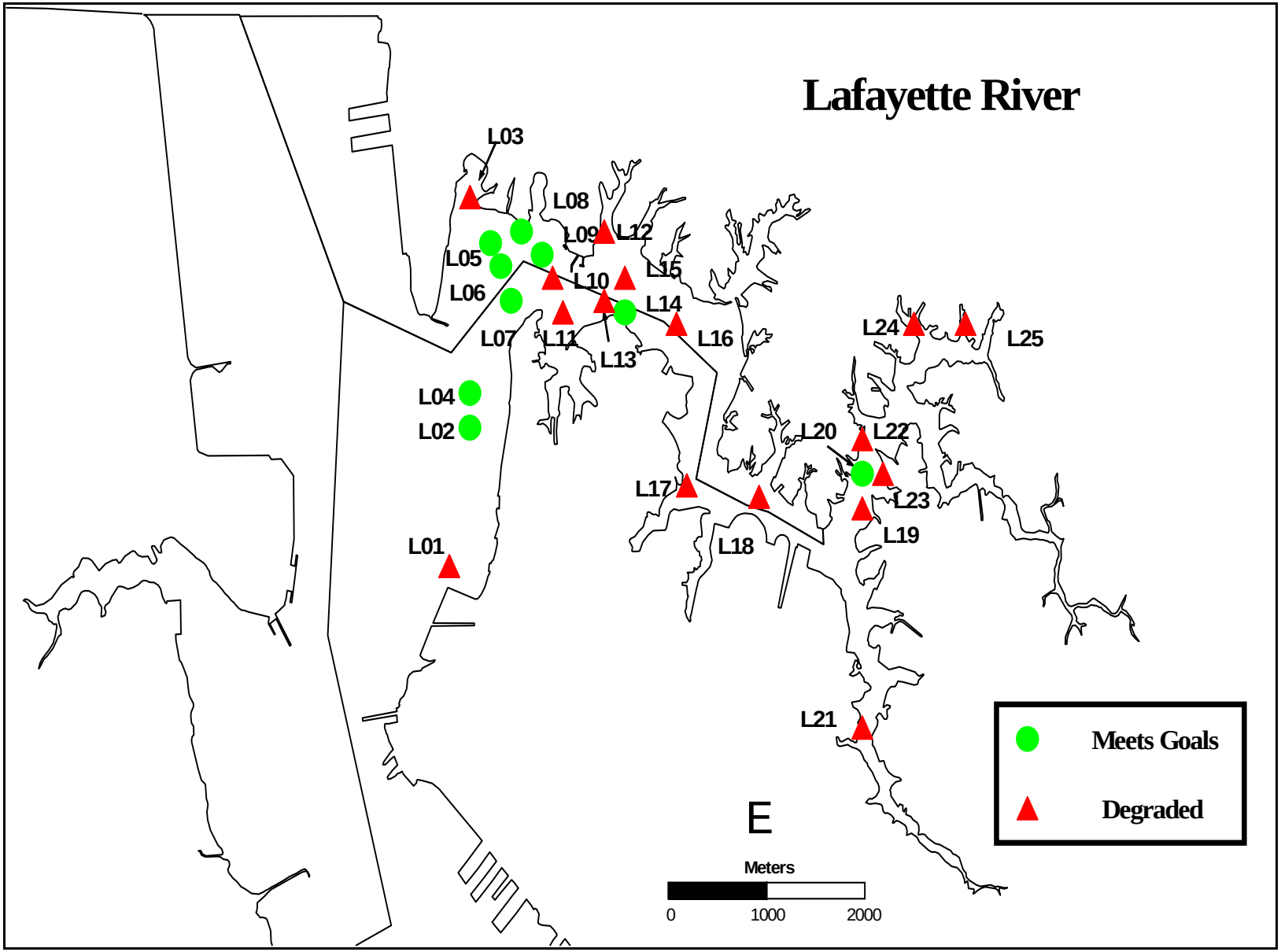


**Figure 5**. Lafayette River showing the 25 sites sampled and their designations using the B-IBI. In this figure "degraded" includes all sites with a B-IBI value less than 3.00.

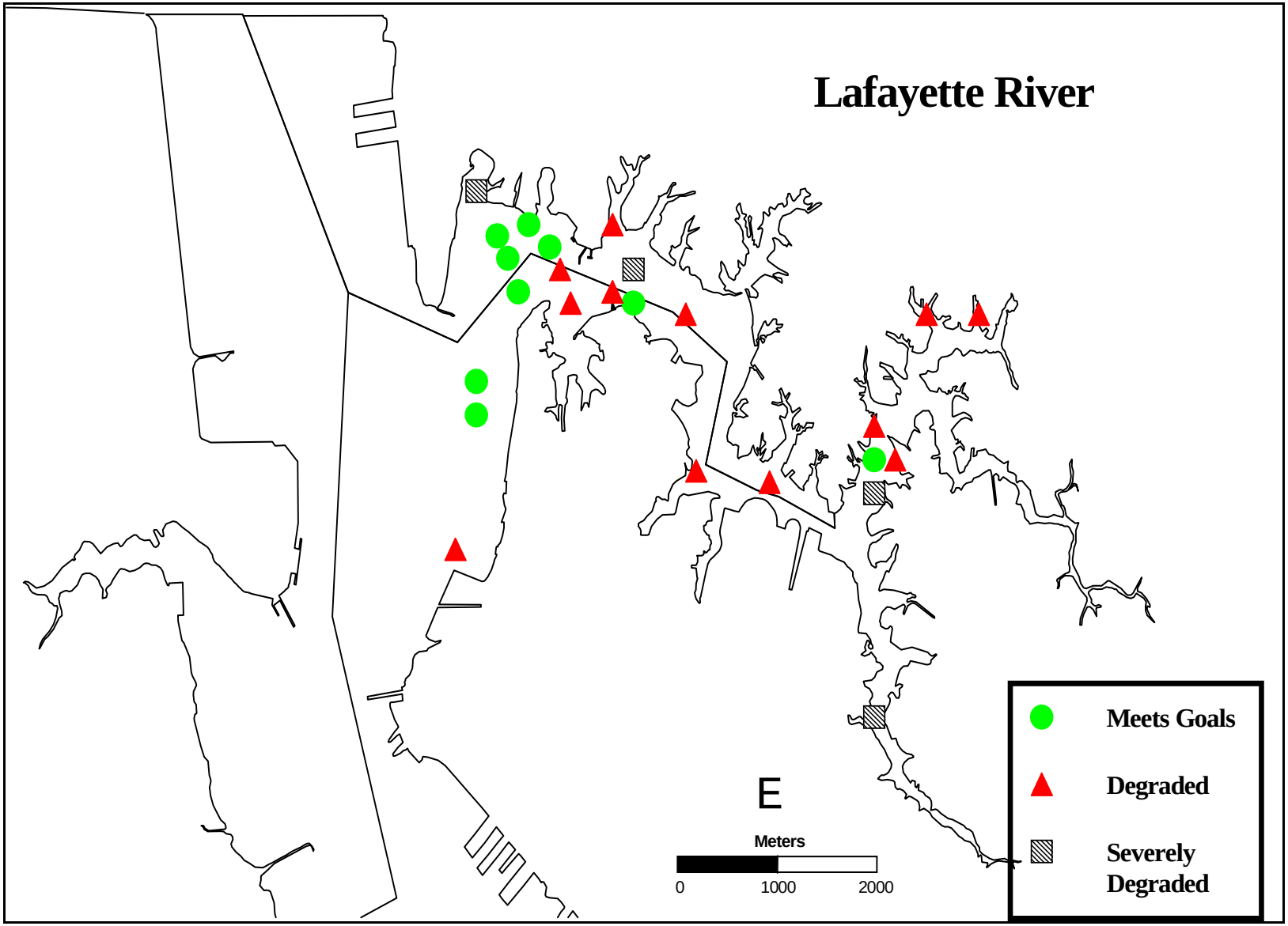


**Figure 6**. Lafayette River showing the 25 sites sampled and their designations using the B-IBI. In this figure sites with a designation of "severely degraded" are indicated.

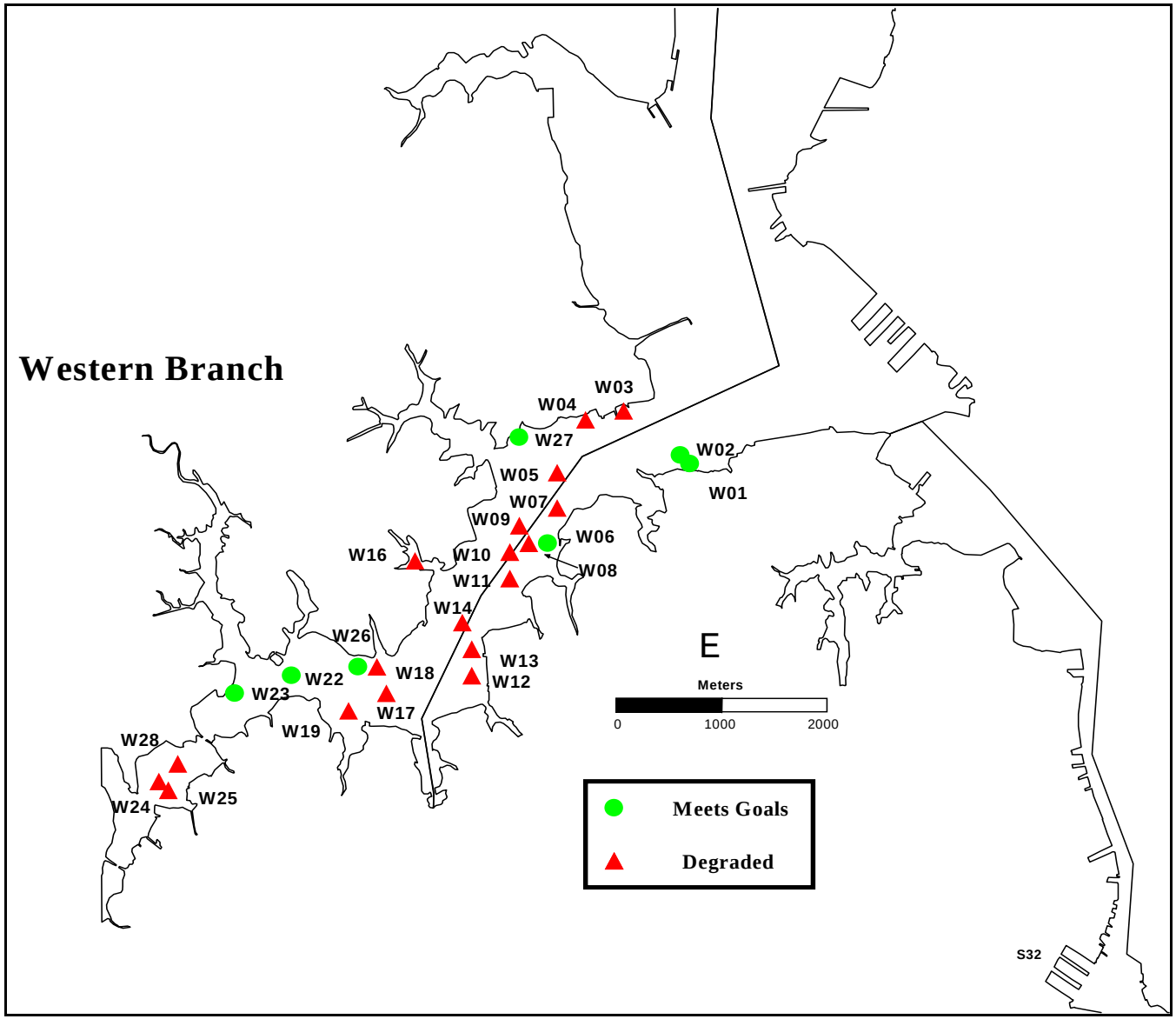


**Figure 7**. Western Branch of the Elizabeth River showing the 25 sites sampled and their designations using the B-IBI. In this figure "degraded" includes all sites with a B-IBI value less than 3.00.

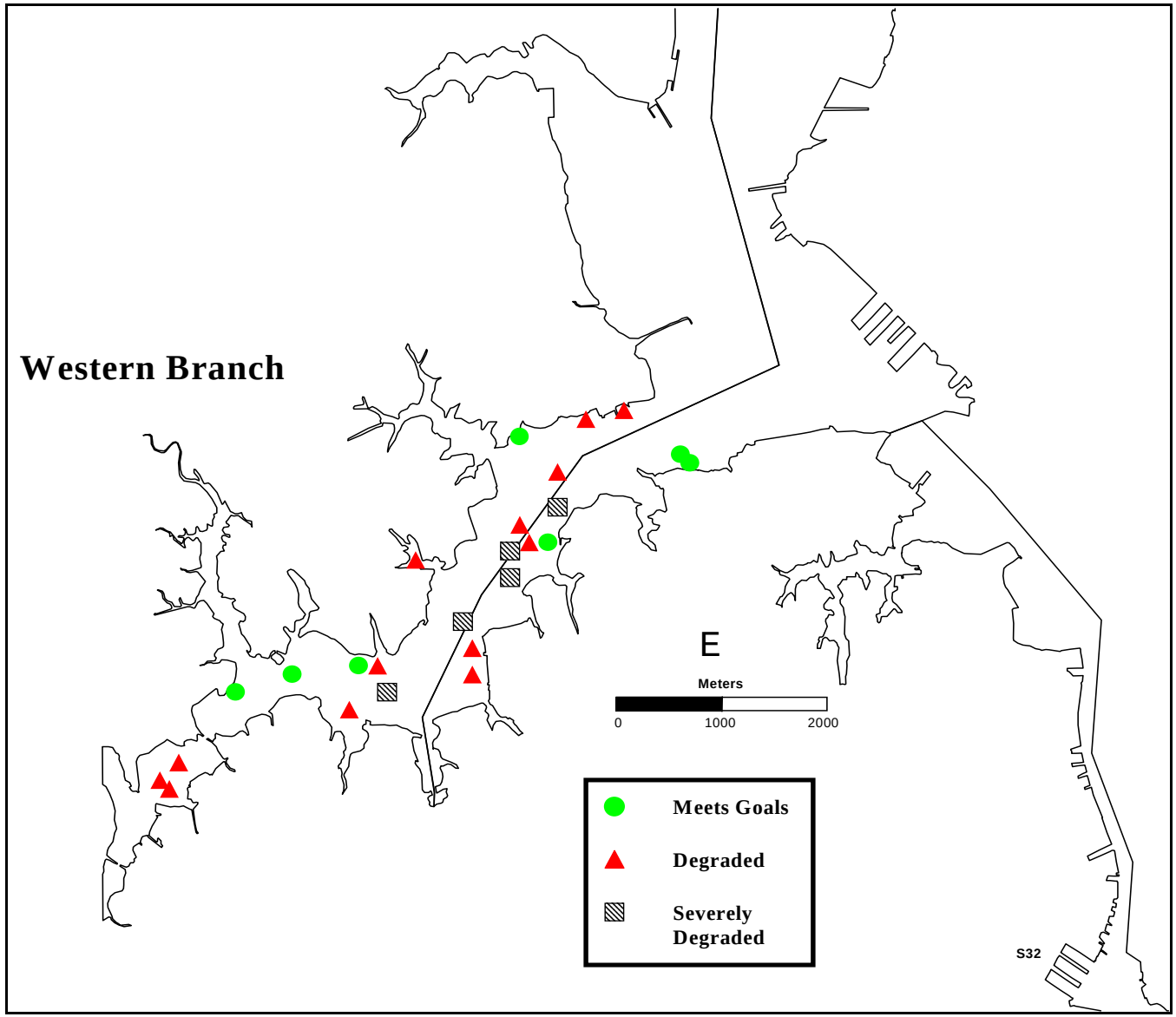


**Figure 8**. Western Branch of the Elizabeth River showing the 25 sites sampled and their designations using the B-IBI. In this figure sites with a designation of "severely degraded" are indicated.

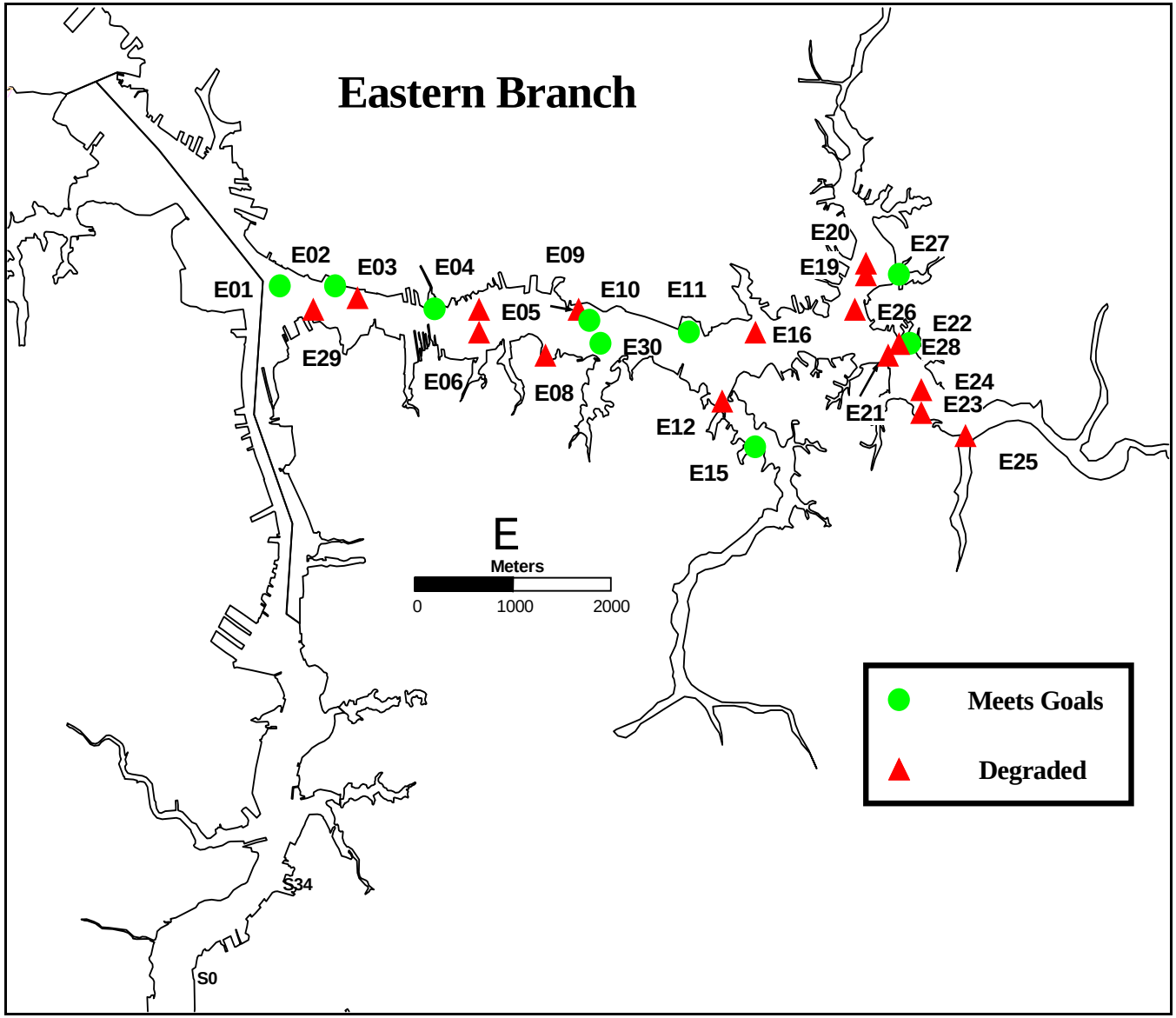


**Figure 9**. Eastern Branch of the Elizabeth River showing the 25 sites sampled and their designations using the B-IBI. In this figure "degraded" includes all sites with a B-IBI value less than 3.00.

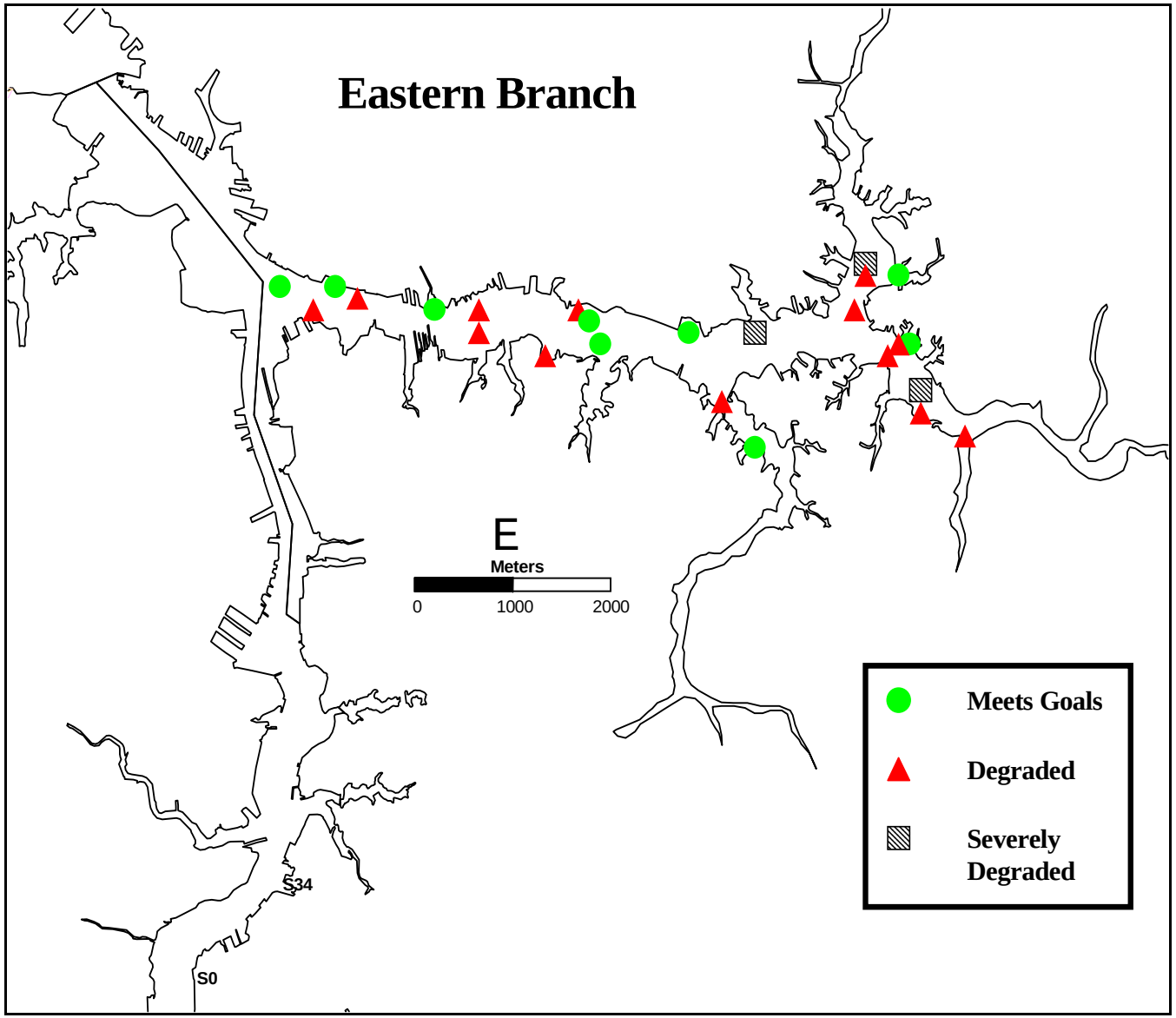


**Figure 10**. Eastern Branch of the Elizabeth River showing the 25 sites sampled and their designations using the B-IBI. In this figure sites with a designation of "severely degraded" are indicated.

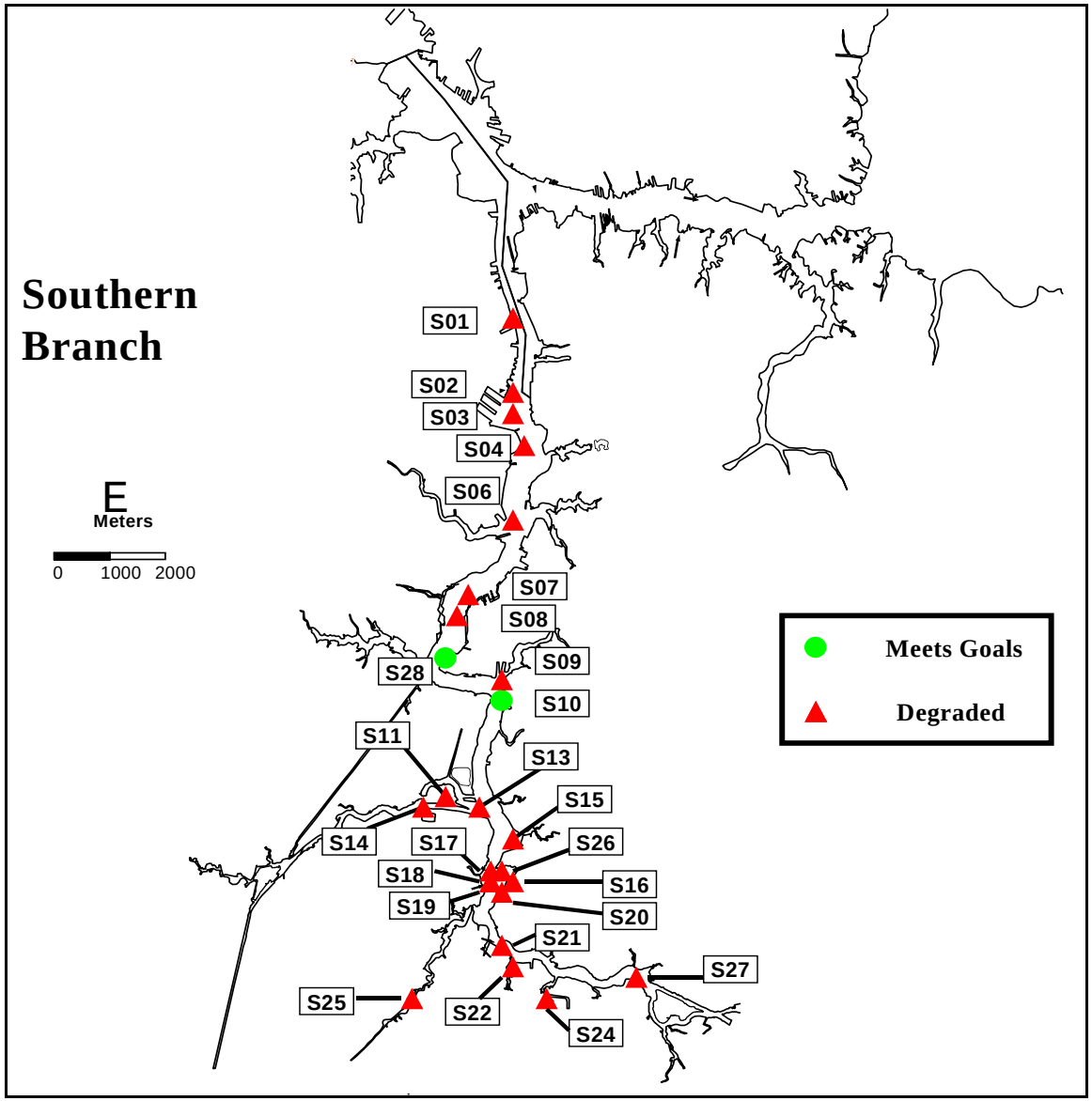


**Figure 11**. Southern Branch of the Elizabeth River showing the 25 sites sampled and their designations using the B-IBI. In this figure "degraded" includes all sites with a B-IBI value less than 3.00.

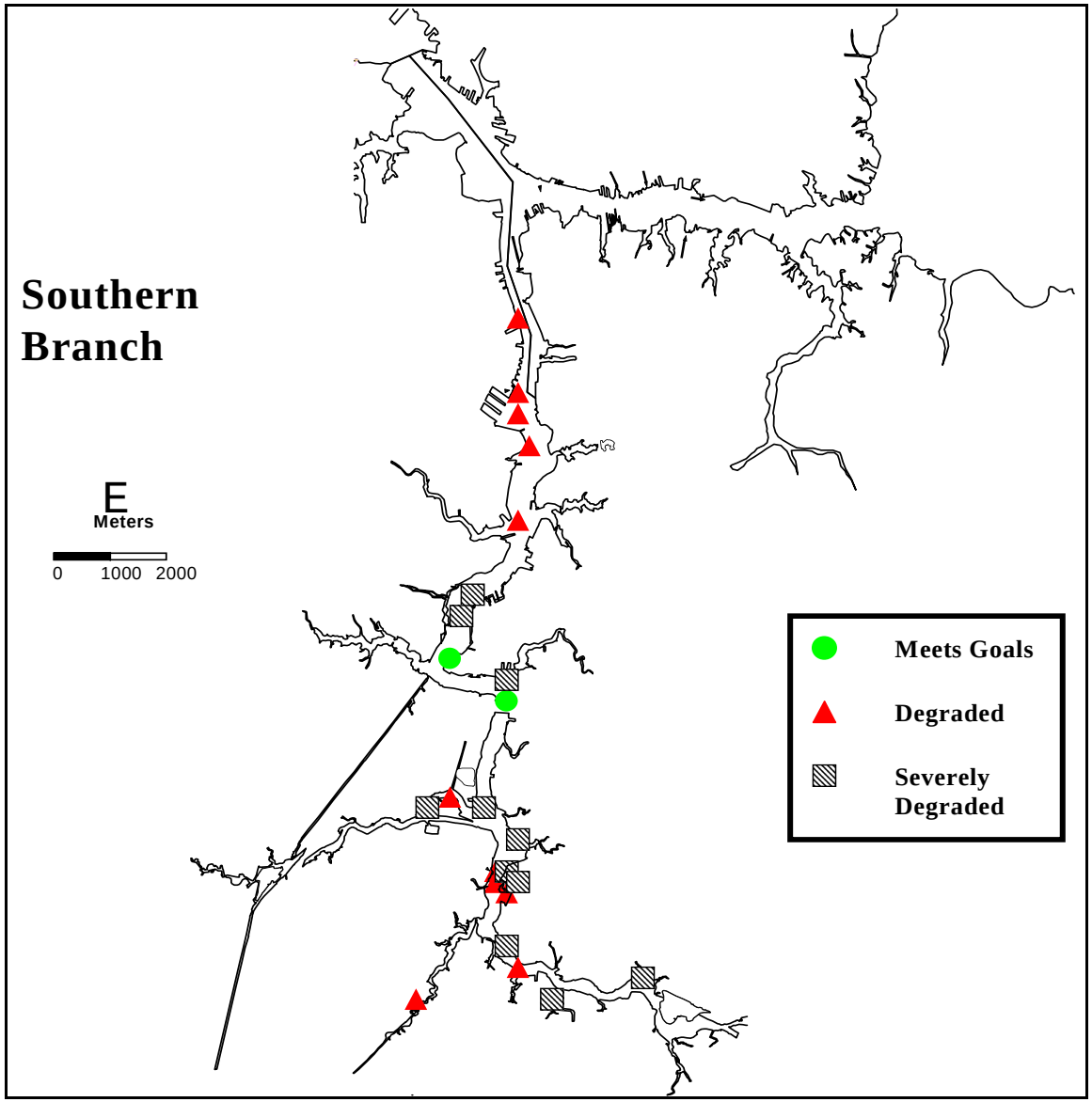


**Figure 12**. Southern Branch of the Elizabeth River showing the 25 sites sampled and their designations using the B-IBI. In this figure sites with a designation of "severely degraded" are indicated.

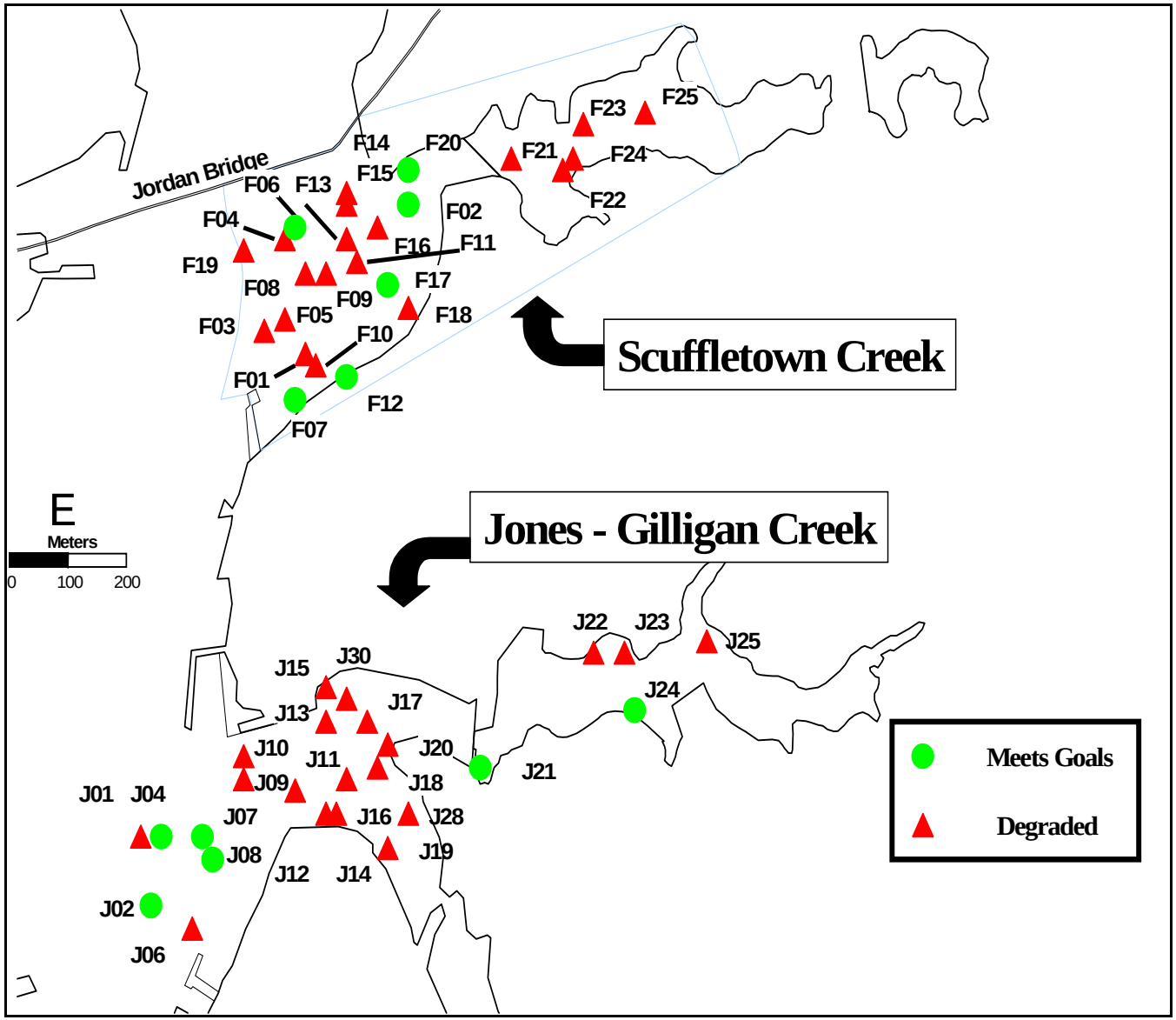


**Figure 13**. Scuffletown Creek and Jones-Giligan Creek showing the 25 sites sampled and their designations using the B-IBI. In this figure "degraded" includes all sites with a B-IBI value less than 3.00.

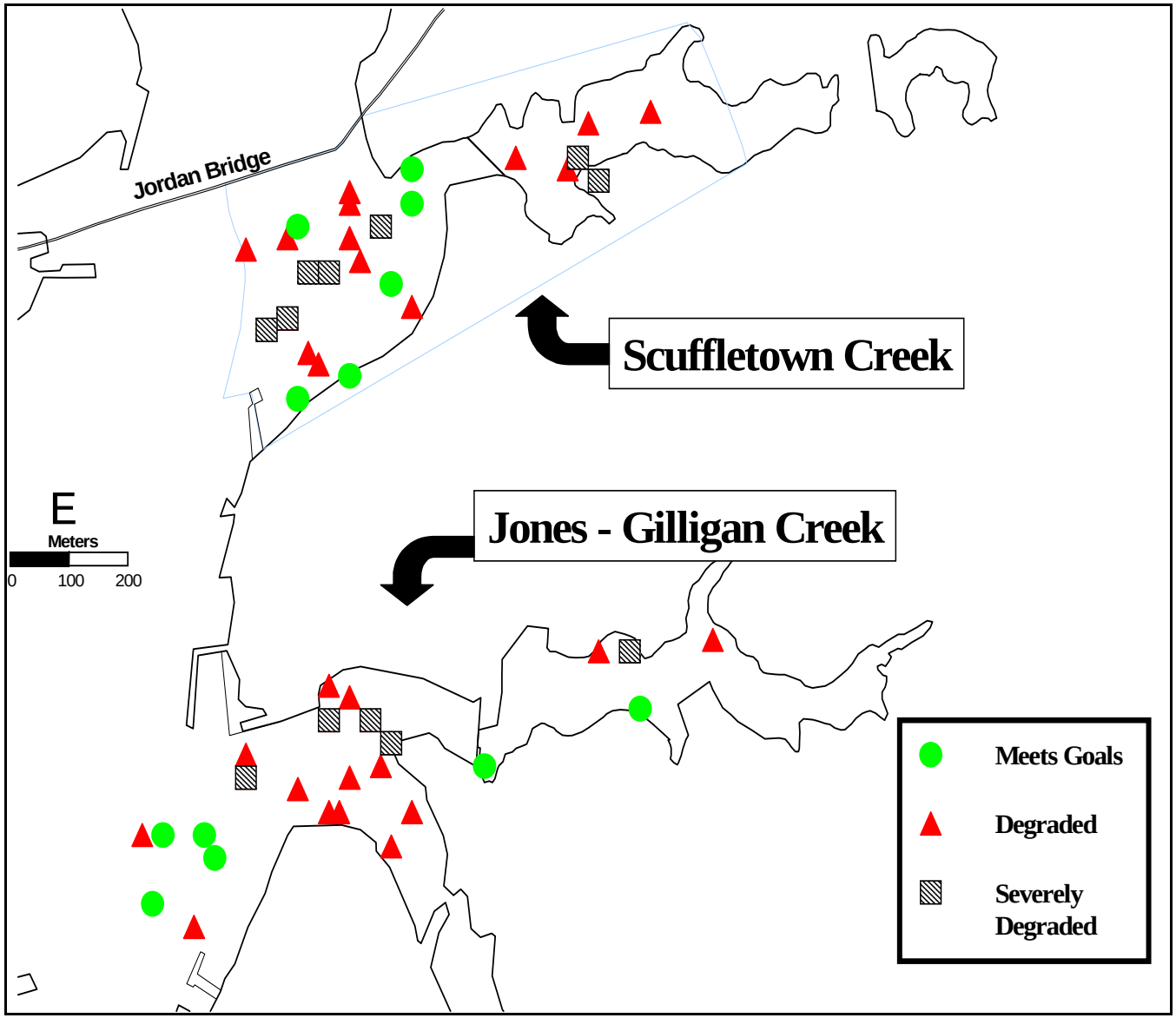


**Figure 14**. Scuffletown Creek and Jones-Giligan Creek showing the 25 sites sampled and their designations using the B-IBI. In this figure sites with a designation of "severely degraded" are indicated.

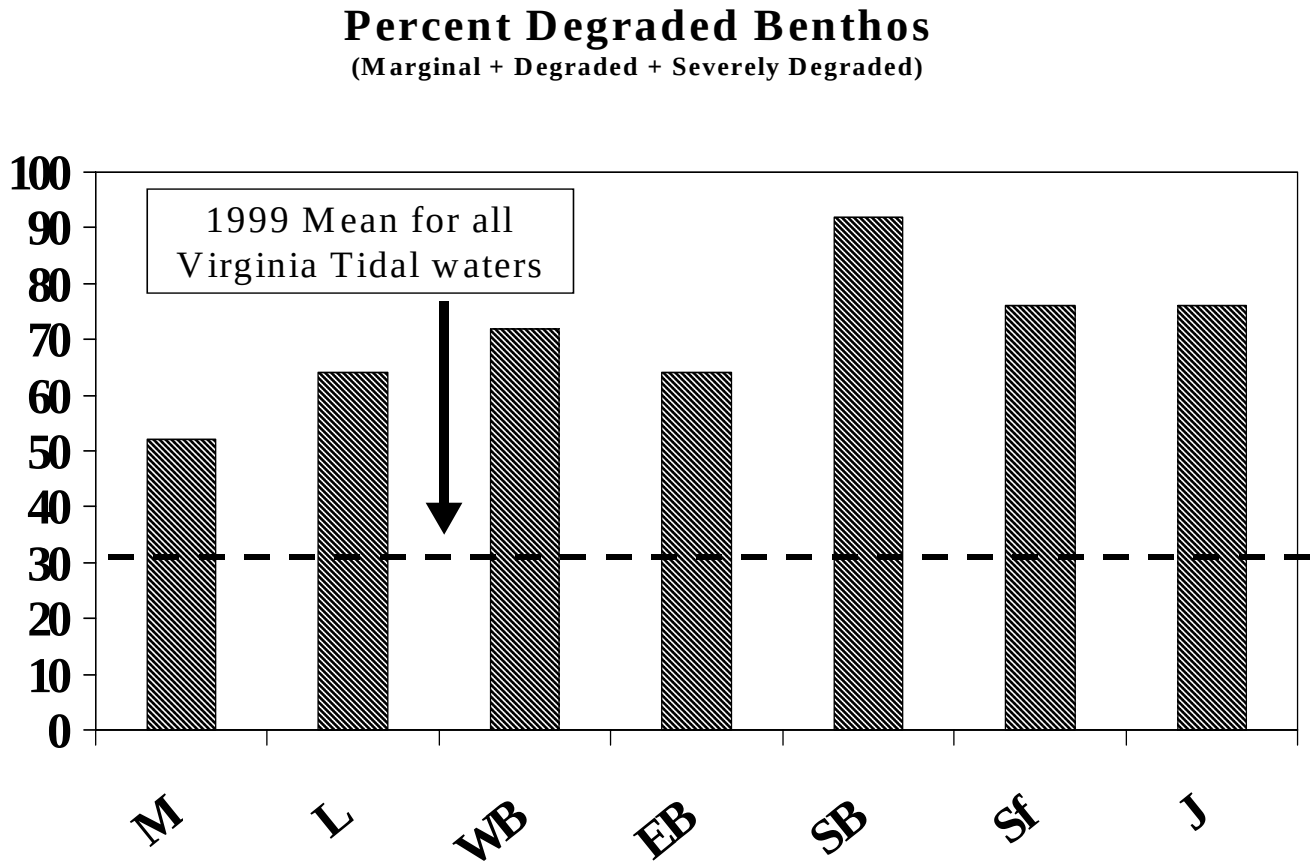


**Figure 15**. Summary of percent area of each stratum failing the Benthic Restoration Goals. Includes marginal, degraded and severely degraded categories as defined in text. Shown are the seven strata of this study and the 1999 average value for all Virginia tidal waters. Abbreviations: Bay - Mainstem of Chesapeake Bay, M - Mainstem of Elizabeth River, L - Lafayette River, WB - Western Branch, EB - Eastern Branch, SB - Southern Branch, Sf - Suffletown Creek, J - Jones-Gilligan Creek.

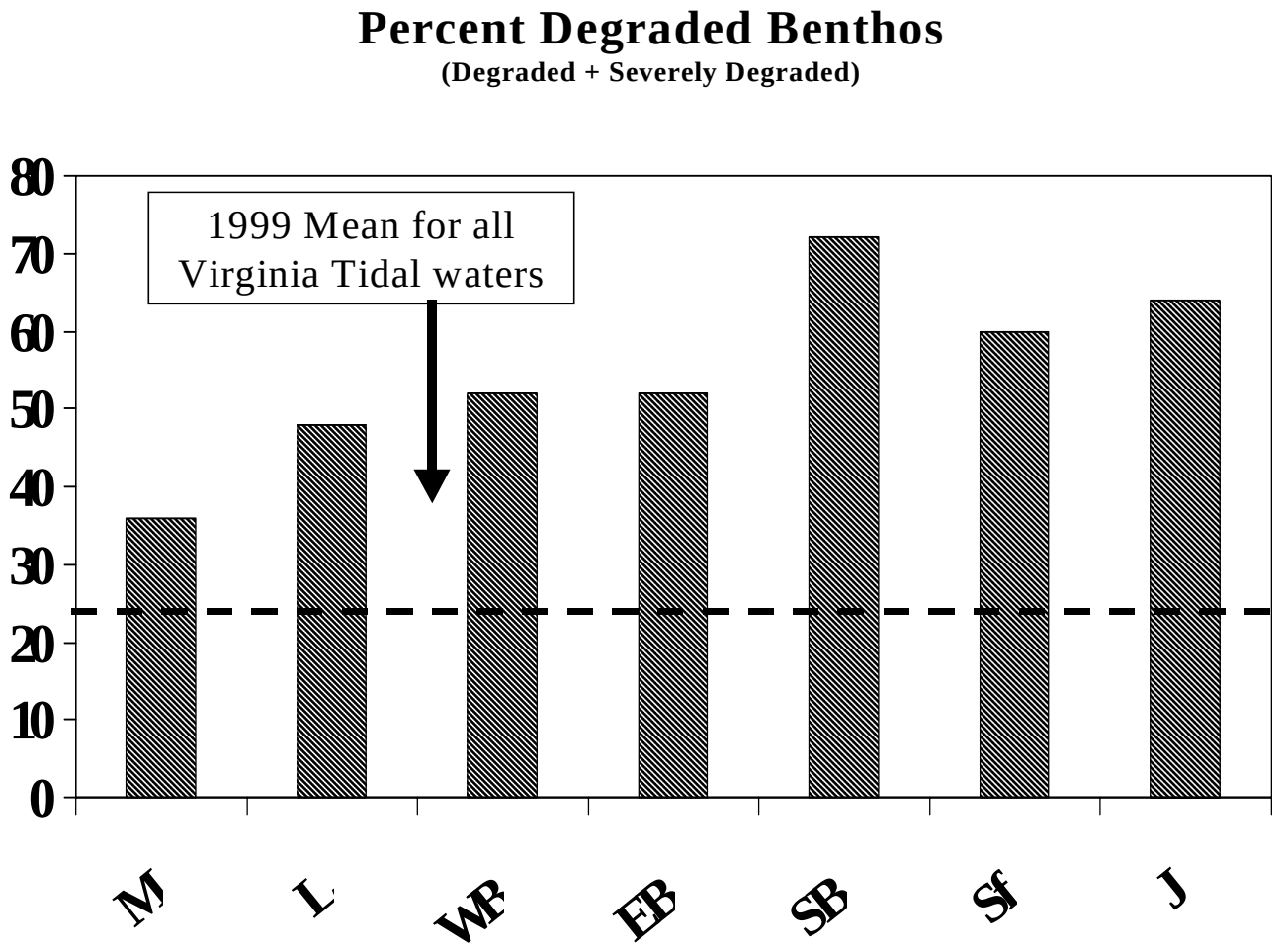


**Figure 16**. Summary of percent area of each stratum failing the Benthic Restoration Goals. Shown are degraded and severely degraded categories as defined in text. See Figure 15 for abbreviations.

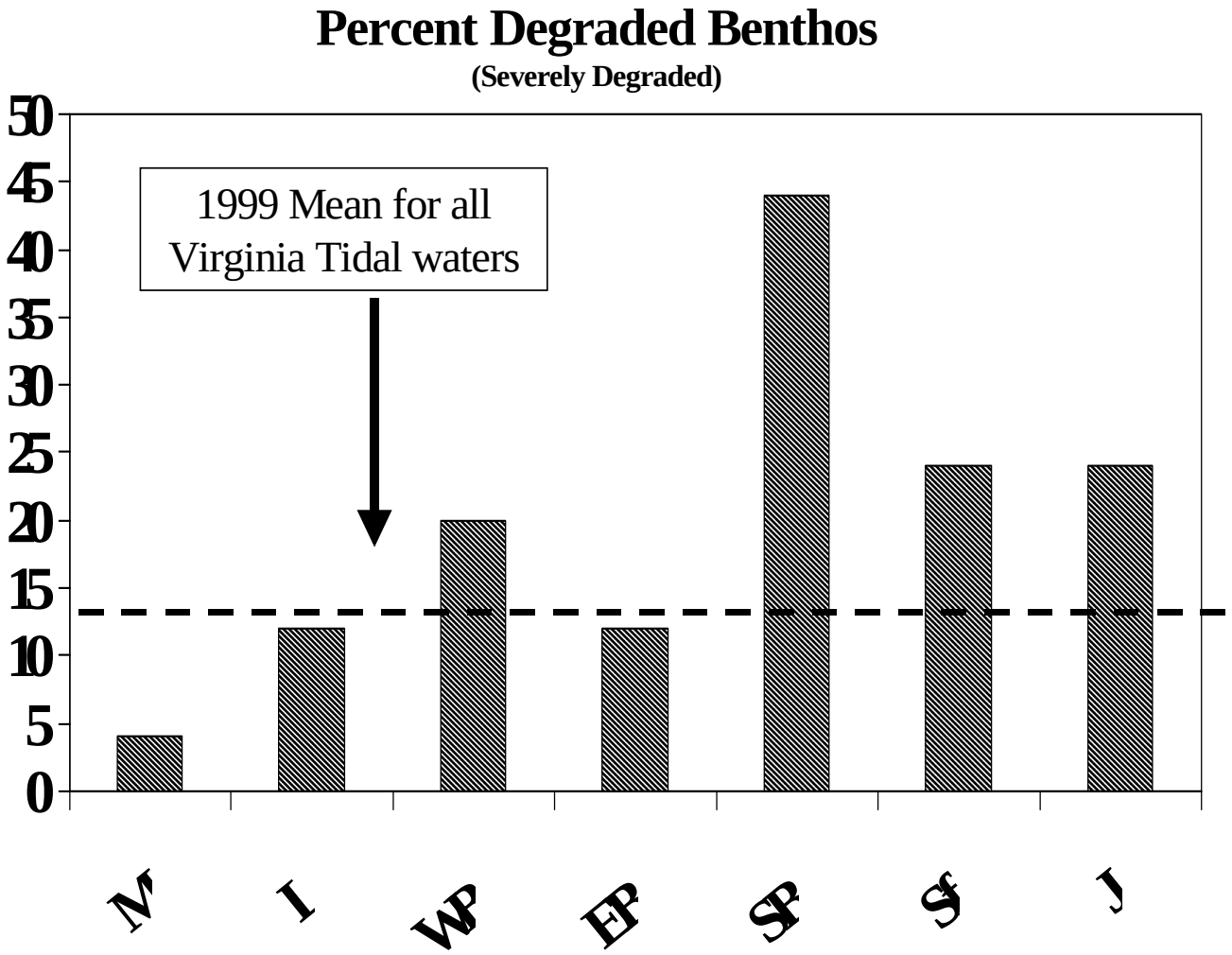


**Figure 17**. Summary of percent area of each stratum failing the Benthic Restoration Goals. Shown is only the severely degraded category as defined in text. See Figure 15 for abbreviations.

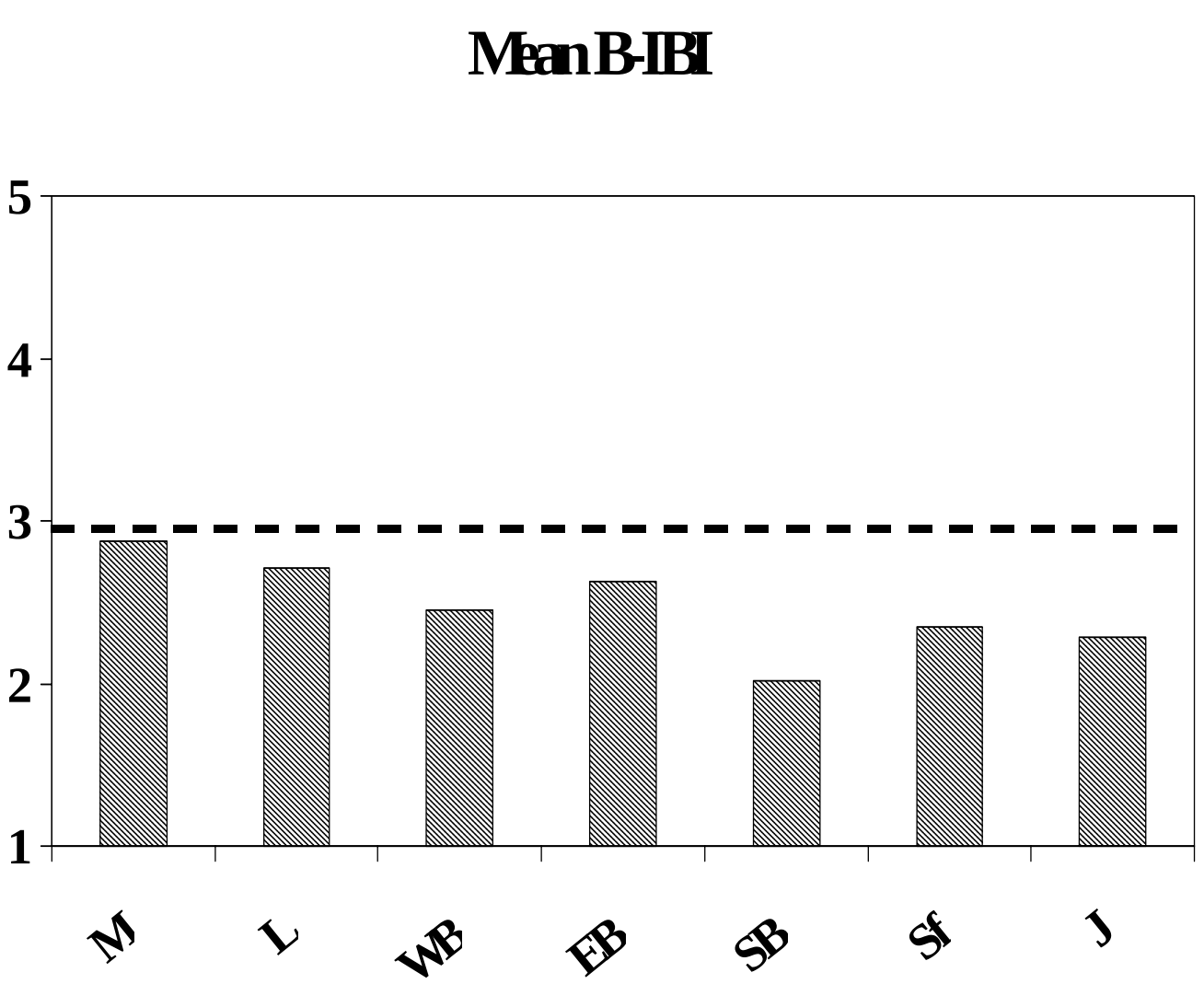


**Figure 18**. Average B-IBI values for each of the seven strata of this study. See Figure 15 for abbreviations.

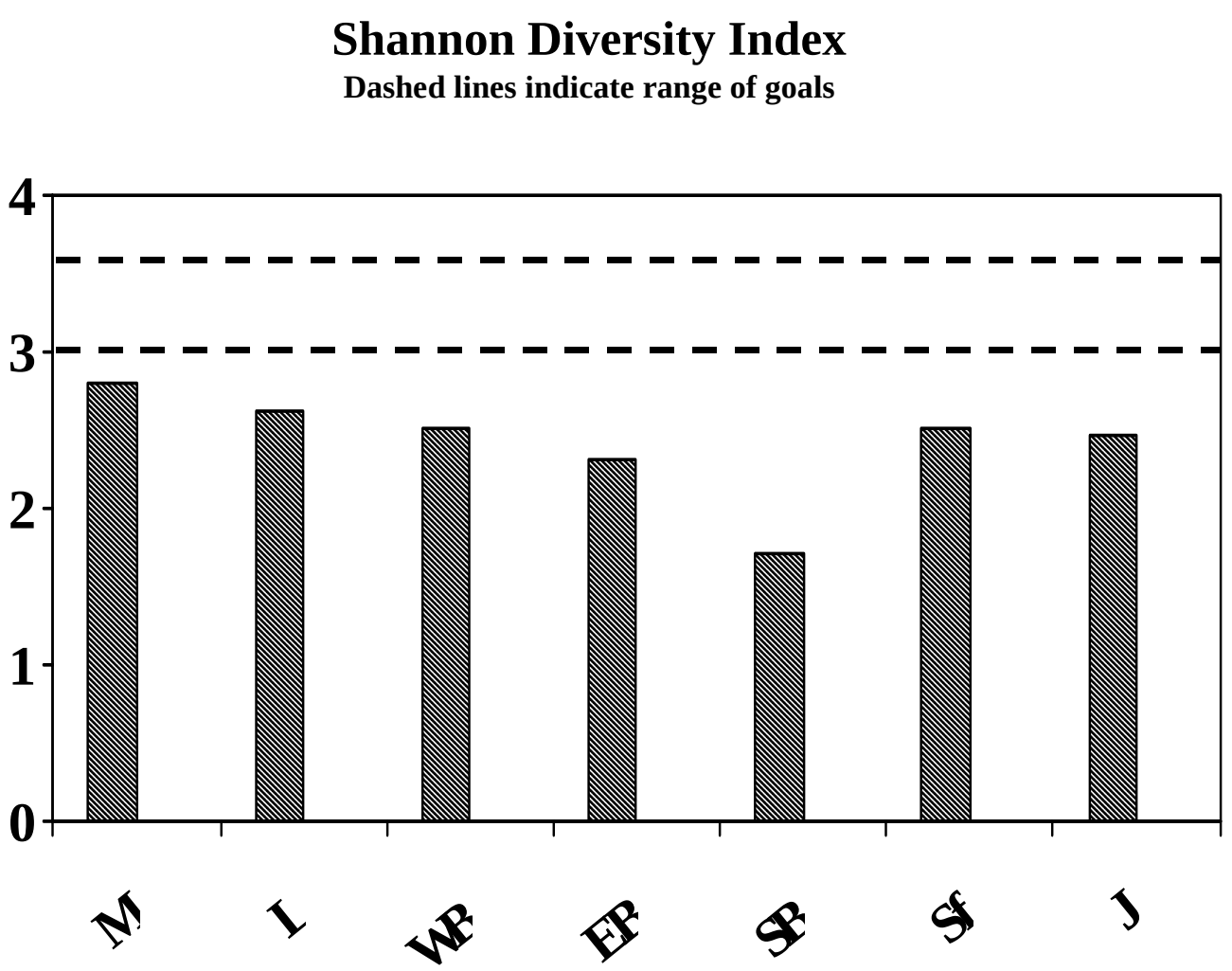


**Figure 19**. Average Shannon diversity index value for each of the seven strata of this study. Dashed lines indicate range of median values for reference conditions from Weisberg et al. (1997). See Figure 15 for abbreviations.

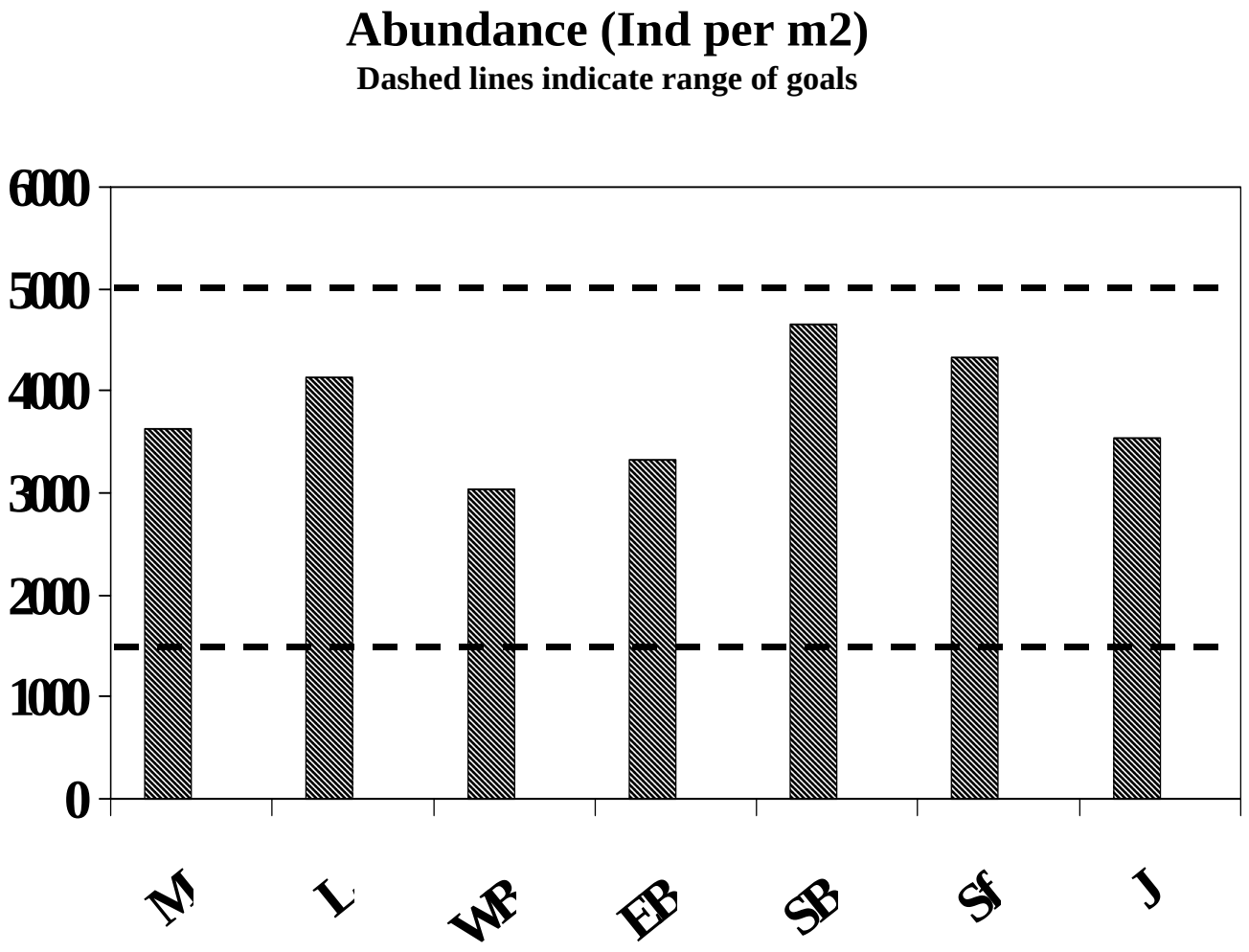


**Figure 20**. Average abundance of individuals per $m^{-2}$ for each of the seven strata of this study. Dashed lines indicate range of median values for reference conditions from Weisberg et al. (1997). See Figure 15 for abbreviations.

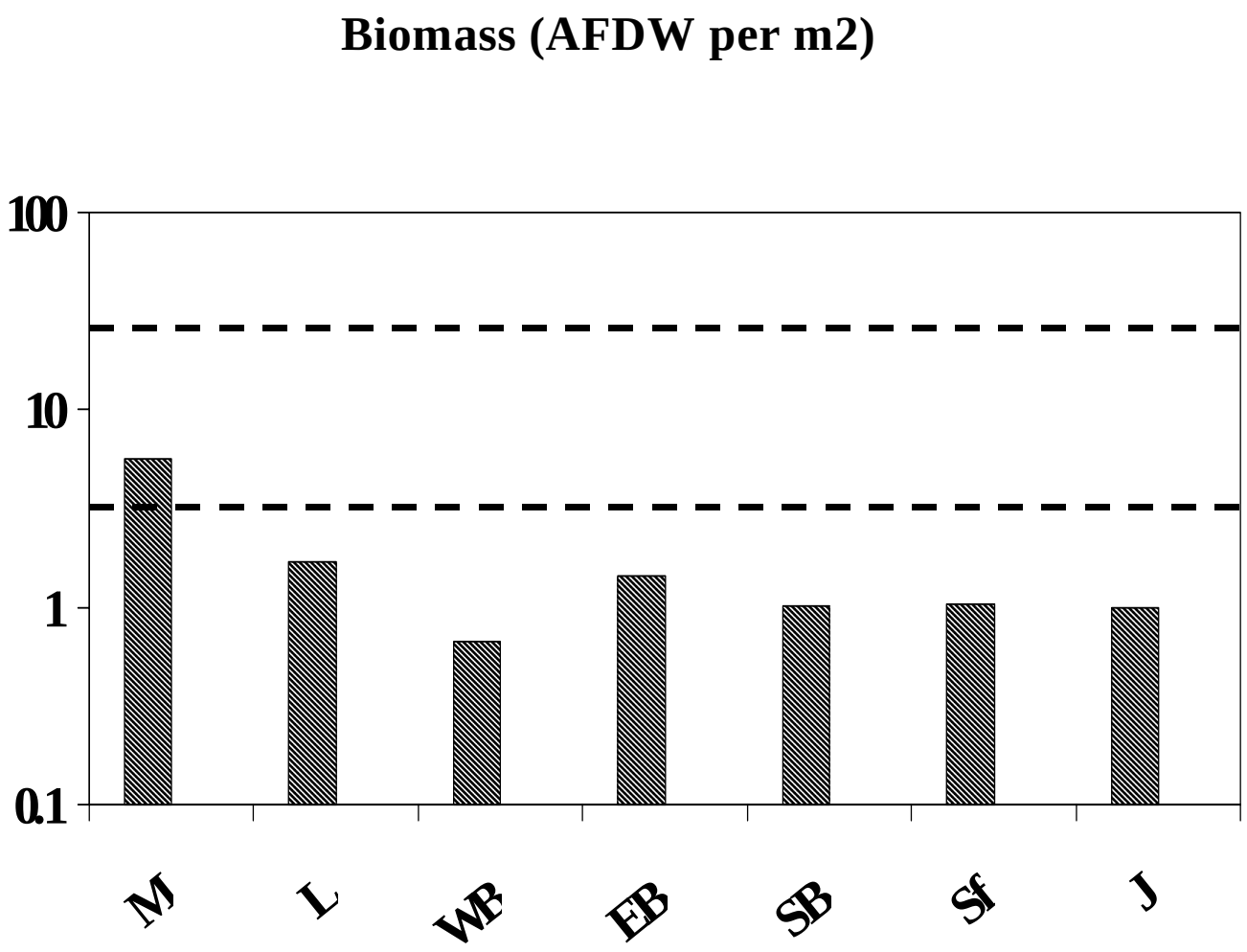


**Figure 21**. Average AFWD biomass g per $m^{-2}$ for each of the seven strata of this study. Dashed lines indicate range of median values for reference conditions from Weisberg et al. (1997). See Figure 15 for abbreviations.

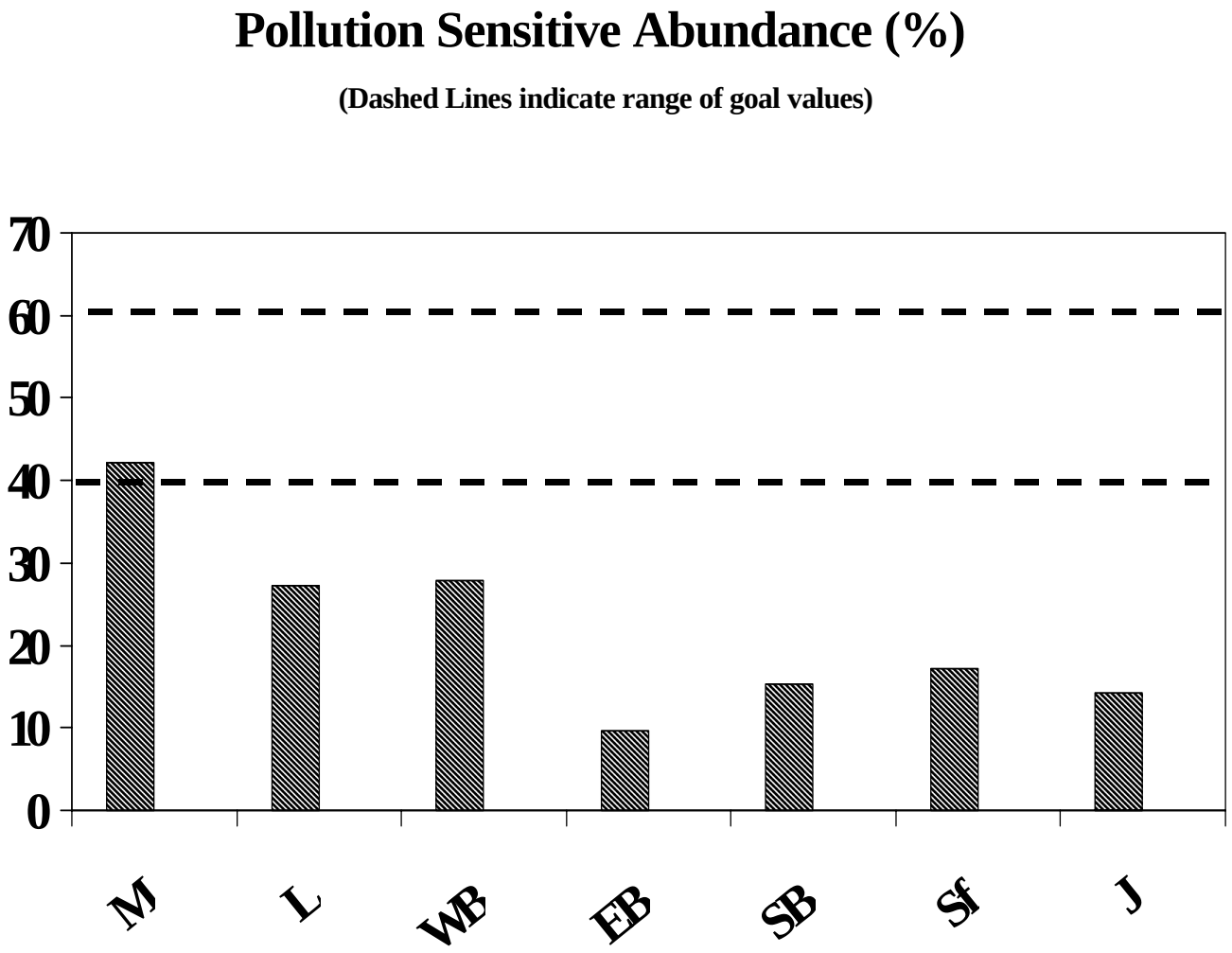


**Figure 22**. Average percentage of pollution sensitive species abundance for each of the seven strata of this study. Dashed lines indicate range of median values for reference conditions from Weisberg et al. (1997). See Figure 15 for abbreviations.

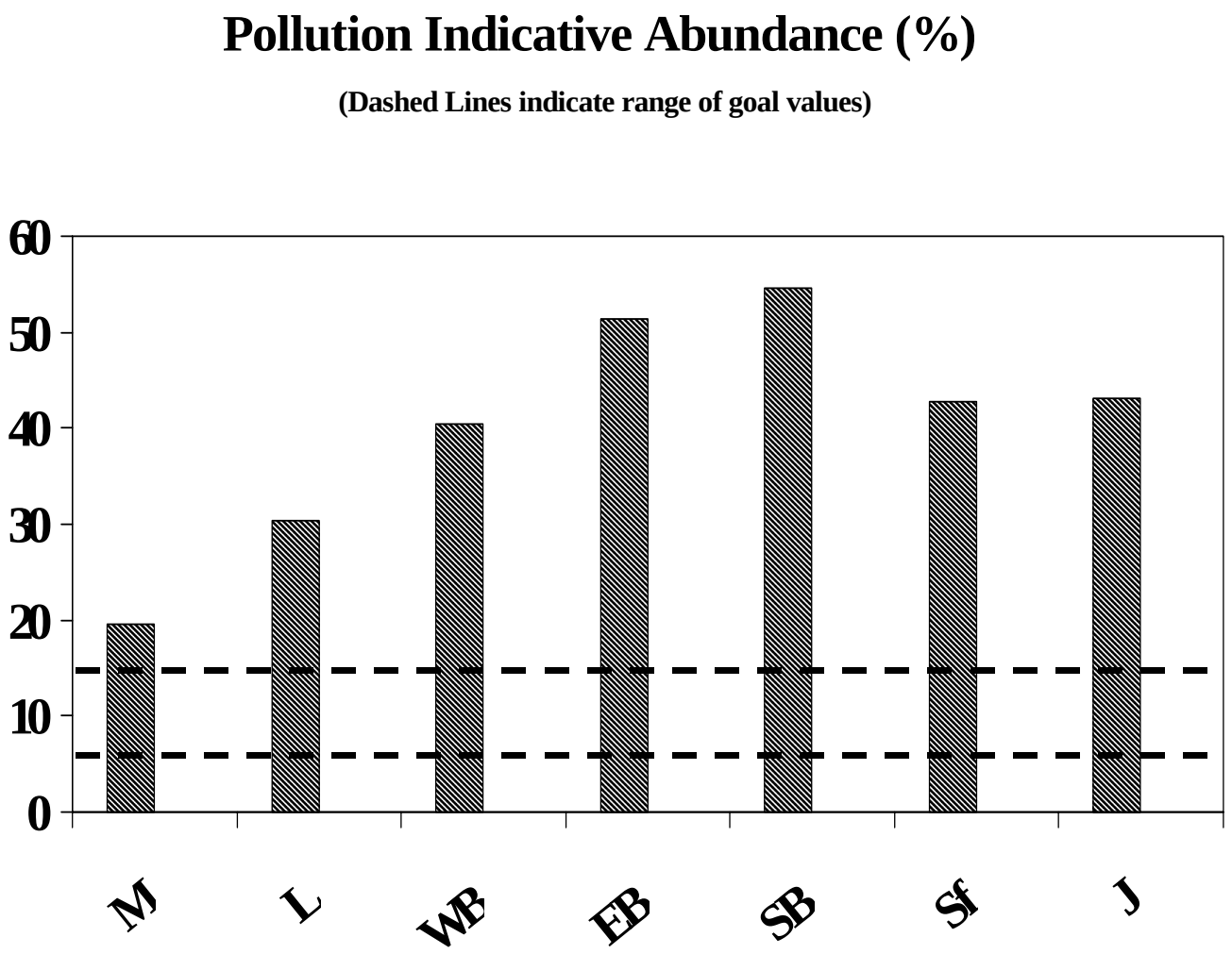


**Figure 23**. Average percentage of pollution indicative species abundance for each of the seven strata of this study. Dashed lines indicate range of median values for reference conditions from Weisberg et al. (1997). See Figure 15 for abbreviations.

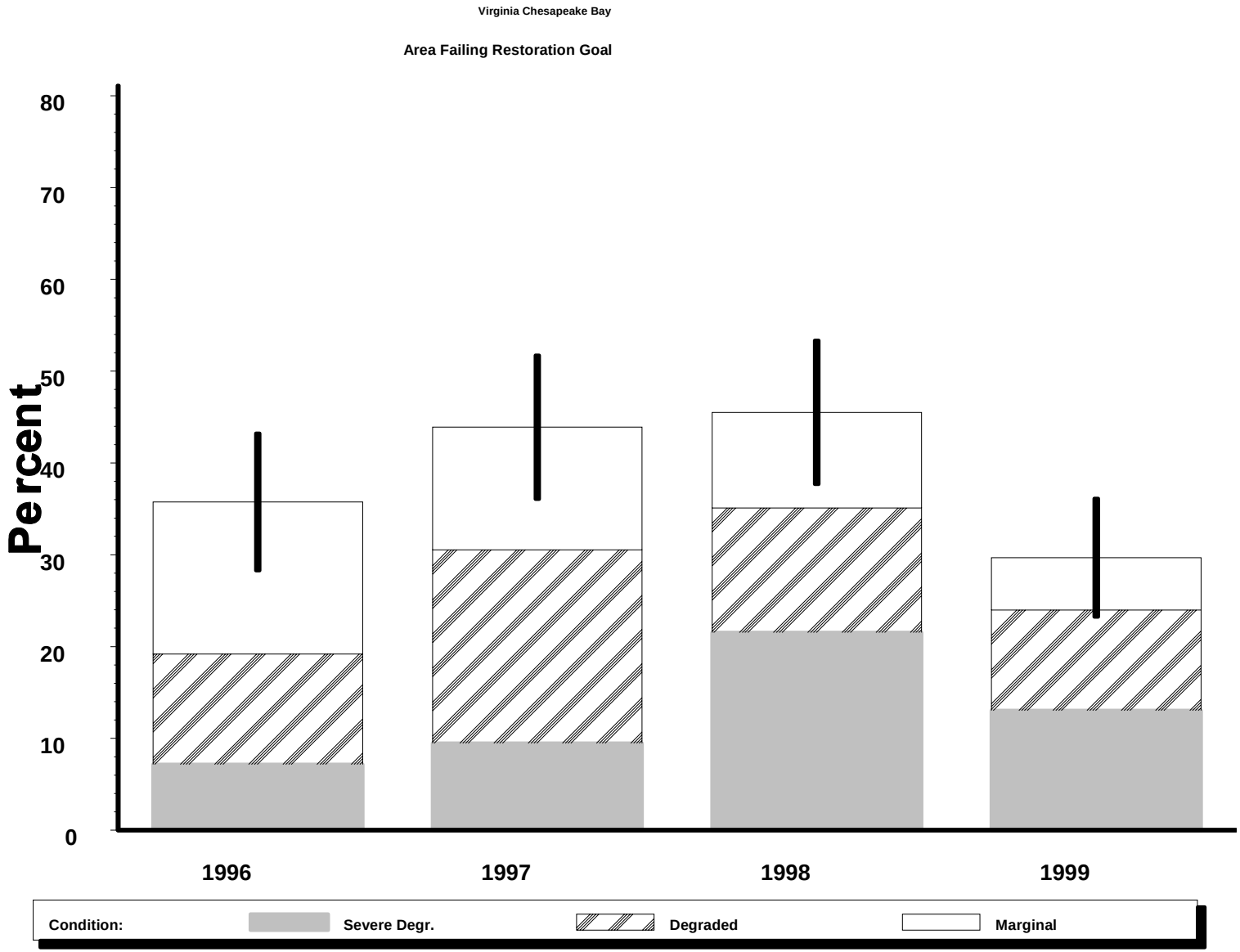


**Figure 24**. Proportion of the Virginia Bay failing the Chesapeake Bay Benthic Community Restoration Goals from 1996 - 1999. The error bars indicate ± 1 standard error.

# Glossary of selected terms

**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 is a multi-metric index that compares the condition of a benthic community to reference conditions.

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

**Habitat** - a local environment that has a benthic community distinct for 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.

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

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

**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.

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

**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.

**Stratum** - a geographic region of unique ecological condition or managerial interest. In this study the primary strata were the Mainstem of the river, the Lafayette River, the Eastern Branch, Western Branch and Southern Branch. In future years the entire Elizabeth River watershed will be sampled as a single stratum.

**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.

# Tables

| Table 1. Mainstem of the Elizabeth River. Summary of physical and chemical parameters by sample. | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Station | Date collected | Latitude | Longitude | Water Depth (m) | Salinity (ppt) | Dissolved oxygen (ppm) | Silt-Clay Content (%) | Volatile Organics (%) |
| Z01 | 8/13/99 | 36.92682 | 76.3451 | 3 | 22.2 | 6.3 | 83.2 | 5.8 |
| Z02 | 8/13/99 | 36.92065 | 76.3473 | 3 | 22.1 | 6.5 | 69.2 | 5.1 |
| Z03 | 8/13/99 | 36.91908 | 76.3404 | 14 | 23 | 6 | 93.4 | 7.5 |
| Z04 | 8/13/99 | 36.91853 | 76.3524 | 3 | 22.8 | 6.5 | 63.1 | 4.0 |
| Z05 | 8/13/99 | 36.91765 | 76.3537 | 1 | 22.7 | 6.2 | 0.8 | 0.9 |
| Z06 | 8/13/99 | 36.91682 | 76.3528 | 2 | 22.7 | 6.6 | 12.6 | 1.6 |
| Z07 | 8/13/99 | 36.9168 | 76.3486 | 3 | 22.3 | 6.3 | 85.2 | 6.7 |
| Z08 | 8/13/99 | 36.91407 | 76.3512 | 3 | 22.7 | 6.5 | 75.5 | 5.8 |
| Z09 | 8/13/99 | 36.91177 | 76.3302 | 14 | 22.8 | 5.8 | 83.4 | 7.6 |
| Z10 | 8/13/99 | 36.91151 | 76.3516 | 3 | 22.7 | 6.9 | 69.0 | 5.2 |
| Z11 | 8/13/99 | 36.91056 | 76.3354 | 3 | 22.4 | 7.2 | 3.4 | 1.0 |
| Z12 | 8/13/99 | 36.91011 | 76.3366 | 3 | 22.6 | 6.6 | 18.2 | 1.4 |
| Z13 | 8/13/99 | 36.90904 | 76.3305 | 1 | 22.5 | 7.1 | 1.0 | 0.5 |
| Z14 | 8/13/99 | 36.89668 | 76.3364 | 17 | 23 | 5.8 | 47.1 | 4.5 |
| Z15 | 8/13/99 | 36.88142 | 76.3497 | 3 | 22.3 | 7 | 5.5 | 0.9 |
| Z16 | 8/13/99 | 36.87533 | 76.3505 | 1 | 22.4 | 10.4 | 2.6 | 0.4 |
| Z17 | 8/13/99 | 36.87293 | 76.3329 | 13 | 22.8 | 5.6 | 76.5 | 6.3 |
| Z18 | 8/13/99 | 36.87147 | 76.3316 | 14 | 22.8 | 5.3 | 78.7 | 7.3 |
| Z19 | 8/13/99 | 36.86927 | 76.3258 | 3 | 22 | 5.7 | 12.4 | 5.9 |
| Z20 | 8/13/99 | 36.86645 | 76.3243 | 13 | 22.5 | 5.4 | 92.7 | 7.9 |
| Z21 | 8/13/99 | 36.85454 | 76.3101 | 9 | 22.2 | 4.5 | 87.3 | 7.7 |
| Z22 | 8/13/99 | 36.85056 | 76.3031 | 10 | 22.1 | 4.7 | 95.1 | 8.0 |
| Z23 | 8/13/99 | 36.85042 | 76.3063 | 3 | 22.1 | 5.8 | 46.9 | 5.8 |
| Z24 | 8/13/99 | 36.8476 | 76.2945 | 3 | 21.8 | 5 | 21.0 | 4.6 |
| Z25 | 8/13/99 | 36.84647 | 76.3202 | 1 | 21.3 | 9.6 | 90.2 | 7.8 |

Table 2. Mainstem of Elizabeth River. Summary of benthic community parameters by sample.

| Station | BIBI | Abundance | Biomass | Shannon Index | Pollution Indicative Abundance | Pollution Sensitive Abundance | Pollution Indicative Biomass | Pollution Sensitive Biomass | Carnivore Omnivore Abundance |
|---|---|---|---|---|---|---|---|---|---|
| Z01 | 2.667 | 4423 | 1.089 | 2.806 | 17.9 | 66.2 | 35.4 | 33.3 | 32.3 |
| Z02 | 3.333 | 1973 | 0.590 | 3.236 | 17.2 | 58.6 | 11.5 | 38.5 | 36.8 |
| Z03 | 1.667 | 3243 | 0.816 | 2.051 | 28.7 | 29.4 | 47.2 | 8.3 | 3.5 |
| Z04 | 2.333 | 3901 | 0.907 | 2.809 | 24.4 | 54.1 | 25.0 | 37.5 | 15.7 |
| Z05 | 4.000 | 5103 | 1.610 | 3.178 | 5.8 | 68.0 | 4.2 | 54.9 | 23.6 |
| Z06 | 3.000 | 7167 | 1.497 | 2.105 | 16.5 | 77.5 | 25.8 | 56.1 | 12.7 |
| Z07 | 2.000 | 1474 | 1.111 | 2.898 | 40.0 | 33.8 | 24.5 | 18.4 | 13.8 |
| Z08 | 2.000 | 1406 | 0.431 | 2.652 | 19.4 | 67.7 | 26.3 | 36.8 | 14.5 |
| Z09 | 2.667 | 2427 | 1.179 | 2.637 | 8.4 | 21.5 | 5.8 | 19.2 | 15.9 |
| Z10 | 2.333 | 2744 | 0.590 | 2.647 | 22.3 | 56.2 | 38.5 | 23.1 | 18.2 |
| Z11 | 4.333 | 4876 | 3.470 | 3.576 | 3.7 | 42.3 | 2.6 | 75.2 | 23.7 |
| Z12 | 3.333 | 12610 | 2.109 | 3.202 | 0.2 | 37.2 | 1.1 | 36.6 | 42.4 |
| Z13 | 3.333 | 1814 | 77.588 | 3.048 | 3.8 | 81.3 | 0.1 | 99.8 | 20.0 |
| Z14 | 3.667 | 2404 | 14.583 | 2.649 | 5.7 | 34.0 | 0.2 | 96.9 | 11.3 |
| Z15 | 4.000 | 3130 | 1.452 | 3.107 | 2.9 | 42.0 | 3.1 | 10.9 | 26.1 |
| Z16 | 2.000 | 2268 | 0.998 | 2.692 | 43.0 | 19.0 | 6.8 | 47.7 | 31.0 |
| Z17 | 3.000 | 953 | 19.641 | 3.650 | 9.5 | 35.7 | 0.1 | 98.8 | 14.3 |
| Z18 | 3.333 | 3016 | 2.540 | 2.643 | 9.8 | 27.8 | 3.6 | 71.4 | 6.8 |
| Z19 | 4.000 | 4445 | 2.019 | 4.115 | 15.3 | 26.0 | 5.6 | 25.8 | 16.3 |
| Z20 | 2.667 | 5647 | 1.656 | 2.454 | 9.6 | 27.3 | 9.6 | 47.9 | 8.8 |
| Z21 | 2.000 | 1950 | 0.408 | 2.584 | 26.7 | 38.4 | 27.8 | 27.8 | 12.8 |
| Z22 | 2.000 | 4559 | 1.406 | 2.354 | 16.4 | 17.4 | 17.7 | 4.8 | 3.0 |
| Z23 | 2.667 | 1656 | 0.476 | 2.122 | 60.3 | 24.7 | 14.3 | 61.9 | 5.5 |
| Z24 | 3.333 | 4717 | 0.612 | 2.813 | 24.0 | 55.8 | 18.5 | 18.5 | 9.1 |
| Z25 | 2.333 | 2994 | 1.202 | 1.975 | 55.3 | 11.4 | 7.5 | 17.0 | 6.1 |
| | | | | | | | | | |
| Mean | 2.880 | 3636 | 5.599 | 2.800 | 19.5 | 42.1 | 14.5 | 42.7 | 17.0 |
| St Error | 0.153 | 484 | 3.131 | 0.103 | 3.2 | 4.0 | 2.7 | 5.6 | 2.1 |

Table 3. Mainstem of the Elizabeth River. Summary of benthic community parameters scores of the B-IBI.

| Station | BIBI | Salinity Class | Sediment Class | Shannon Index | Abundance | Biomass | Pollution Indicative Abundance | Pollution Sensitive Abundance | Pollution Indicative Biomass | Pollution Sensitive Biomass | Carnivore Omnivore Abundance | Deep Deposit Feeders |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Z01 | 2.667 | 5 | 2 | 3 | 3 | 3 | 1 | | | 3 | 3 | |
| Z02 | 3.333 | 5 | 2 | 3 | 5 | 3 | 3 | | | 3 | 3 | |
| Z03 | 1.667 | 5 | 2 | 1 | 3 | 3 | 1 | | | 1 | 1 | |
| Z04 | 2.333 | 5 | 2 | 3 | 3 | 3 | 1 | | | 3 | 1 | |
| Z05 | 4.000 | 5 | 1 | 3 | 3 | 3 | 5 | | 5 | | | 5 |
| Z06 | 3.000 | 5 | 1 | 1 | 3 | 3 | 1 | | 5 | | | 5 |
| Z07 | 2.000 | 5 | 2 | 3 | 3 | 3 | 1 | | | 1 | 1 | |
| Z08 | 2.000 | 5 | 2 | 3 | 3 | 1 | 1 | | | 3 | 1 | |
| Z09 | 2.667 | 5 | 2 | 3 | 5 | 3 | 3 | | | 1 | 1 | |
| Z10 | 2.333 | 5 | 2 | 3 | 5 | 3 | 1 | | | 1 | 1 | |
| Z11 | 4.333 | 5 | 1 | 5 | 5 | 3 | 5 | | 3 | | | 5 |
| Z12 | 3.333 | 5 | 1 | 3 | 1 | 3 | 5 | | 3 | | | 5 |
| Z13 | 3.333 | 5 | 1 | 3 | 3 | 1 | 5 | | 5 | | | 3 |
| Z14 | 3.667 | 5 | 2 | 3 | 5 | 3 | 5 | | | 5 | 1 | |
| Z15 | 4.000 | 5 | 1 | 3 | 5 | 3 | 5 | | 3 | | | 5 |
| Z16 | 2.000 | 5 | 1 | 1 | 3 | 1 | 3 | | 1 | | | 3 |
| Z17 | 3.000 | 5 | 2 | 5 | 1 | 3 | 5 | | | 3 | 1 | |
| Z18 | 3.333 | 5 | 2 | 3 | 3 | 3 | 5 | | | 5 | 1 | |
| Z19 | 4.000 | 5 | 1 | 5 | 5 | 3 | 3 | | 3 | | | 5 |
| Z20 | 2.667 | 5 | 2 | 3 | 3 | 3 | 3 | | | 3 | 1 | |
| Z21 | 2.000 | 5 | 2 | 3 | 5 | 1 | 1 | | | 1 | 1 | |
| Z22 | 2.000 | 5 | 2 | 1 | 3 | 3 | 3 | | | 1 | 1 | |
| Z23 | 2.667 | 5 | 2 | 1 | 5 | 1 | 3 | | | 5 | 1 | |
| Z24 | 3.333 | 5 | 1 | 3 | 5 | 1 | 1 | | 5 | | | 5 |
| Z25 | 2.333 | 5 | 2 | 1 | 5 | 3 | 3 | | | 1 | 1 | |

Table 4. Mainstem of the River. Dominant Taxa by abundance. Taxon code: A- amphipod, B- bivalve, G - gastropod, H- hemichordate, I - isopod, O - oligochaete, P -polychaete, Ph - phoronid, R - rhynchocoel

| | Names | Abundance per $m^{-2}$ |
|---|---|---|
| 1 | Mediomastus ambiseta (P) | 1020 |
| 2 | Paraprionospio pinnata (P) | 431 |
| 3 | Hemichordata spp. (H) | 406 |
| 4 | Nereis succinea (P) | 240 |
| 5 | Glycinde solitaria (P) | 163 |
| 6 | Tubificoides spp. Group I (O) | 151 |
| 7 | Streblospio benedicti (P) | 129 |
| 8 | Loimia medusa (P) | 119 |
| 9 | Acteocina canaliculata (G) | 96 |
| 10 | Tubificoides wasselli (O) | 73 |
| 11 | Heteromastus filiformis (P) | 68 |
| 12 | Nemertea spp. (R) | 68 |
| 13 | Polydora ligni (P) | 68 |
| 14 | Phoronis psammophila (Ph) | 64 |
| 15 | Caulleriella killariensis (P) | 59 |

Table 5. Lafayette River. Summary of physical and chemical parameters by sample.

| Station | Date collected | Latitude | Longitude | Water Depth (m) | Salinity (ppt) | Dissolved oxygen (ppm) | Silt-Clay Content (%) | Volatile Organics (%) |
|---|---|---|---|---|---|---|---|---|
| L01 | 7/30/99 | 36.88628 | 76.32120 | 1 | 22.4 | 9.2 | 2.2 | 0 |
| L02 | 7/30/99 | 36.89632 | 76.31940 | 2 | 22.9 | 7.2 | 10.2 | 2 |
| L03 | 7/30/99 | 36.91228 | 76.31870 | 1 | 22.7 | 8.3 | 95.7 | 5.8 |
| L04 | 7/30/99 | 36.89843 | 76.31830 | 1 | 22.5 | 8.5 | 7.2 | 1.3 |
| L05 | 7/30/99 | 36.90842 | 76.31800 | 1 | 22.8 | 8.7 | 6.7 | 1.2 |
| L06 | 7/30/99 | 36.9071 | 76.31620 | 3 | 23.2 | 7.1 | 35.5 | 4 |
| L07 | 7/30/99 | 36.90484 | 76.31510 | 1 | 22.6 | 10.6 | 5.9 | 1 |
| L08 | 7/23/99 | 36.90928 | 76.31250 | 1 | 22.5 | 9.3 | 2.4 | 0 |
| L09 | 7/23/99 | 36.90795 | 76.31050 | 1 | 22.6 | 10.2 | 3.4 | 0.7 |
| L10 | 7/23/99 | 36.9059 | 76.30880 | 3 | 22.6 | 6.1 | 81.6 | 6.7 |
| L11 | 7/23/99 | 36.90355 | 76.30820 | 1 | 21.7 | 7.3 | 72.6 | 6.0 |
| L12 | 7/23/99 | 36.90952 | 76.30410 | 1 | 21.8 | 7.1 | 96.0 | 7.3 |
| L13 | 7/23/99 | 36.90471 | 76.30390 | 1 | 21.6 | 6.8 | 58.0 | 7.8 |
| L14 | 7/23/99 | 36.90408 | 76.30240 | 1 | 22.2 | 8.8 | 11.2 | 1.3 |
| L15 | 7/23/99 | 36.90577 | 76.30150 | 3 | 22.8 | 5.2 | 96.6 | 8.7 |
| L16 | 7/23/99 | 36.90329 | 76.29640 | 1 | 20.9 | 6.8 | 87.4 | 7.6 |
| L17 | 7/23/99 | 36.89195 | 76.29410 | 1 | 20.5 | 6.6 | 90.9 | 8.2 |
| L18 | 7/23/99 | 36.89103 | 76.28650 | 3 | 21.1 | 3.4 | 99.0 | 9.1 |
| L19 | 7/23/99 | 36.89165 | 76.27500 | 1 | 19.3 | 5.8 | 97.2 | 9.3 |
| L20 | 7/23/99 | 36.89321 | 76.27490 | 1 | 18.6 | 7.4 | 19.0 | 3.1 |
| L21 | 7/23/99 | 36.87608 | 76.27490 | 1 | 17.1 | 11.8 | 96.7 | 11.2 |
| L22 | 7/23/99 | 36.89476 | 76.27470 | 1 | 18.6 | 6.1 | 93.2 | 9.1 |
| L23 | 7/23/99 | 36.893 | 76.27280 | 1 | 19.6 | 6.6 | 85.6 | 8.5 |
| L24 | 7/23/99 | 36.90337 | 76.26840 | 1 | 17.5 | 4.7 | 92.5 | 12.2 |
| L25 | 7/23/99 | 36.90274 | 76.26330 | 1 | 17 | 3.5 | 95.5 | 12.6 |

Table 6. Lafayette River. Summary of benthic community parameters by sample.

| Station | BIBI | Abundance | Biomass | Shannon Index | Pollution Indicative Abundance | Pollution Sensitive Abundance | Pollution Indicative Biomass | Pollution Sensitive Biomass | Carnivore Omnivore Abundance |
|---|---|---|---|---|---|---|---|---|---|
| L01 | 2.667 | 1769 | 0.386 | 2.377 | 53.8 | 28.2 | 11.8 | 35.3 | 6.4 |
| L02 | 4.000 | 5375 | 21.228 | 3.175 | 7.2 | 67.1 | 0.3 | 97.3 | 11.0 |
| L03 | 1.667 | 839 | 0.522 | 3.103 | 40.5 | 10.8 | 43.5 | 8.7 | 10.8 |
| L04 | 4.333 | 2994 | 1.905 | 3.742 | 2.3 | 69.7 | 3.6 | 75.0 | 16.7 |
| L05 | 4.333 | 4037 | 2.268 | 3.156 | 10.1 | 52.8 | 2.0 | 30.0 | 14.6 |
| L06 | 3.667 | 3674 | 1.021 | 3.066 | 16.7 | 40.1 | 6.7 | 35.6 | 8.6 |
| L07 | 3.667 | 3674 | 1.089 | 3.081 | 19.1 | 39.5 | 4.2 | 56.3 | 21.0 |
| L08 | 3.333 | 4649 | 0.771 | 2.995 | 18.0 | 39.0 | 5.9 | 29.4 | 16.1 |
| L09 | 3.000 | 2245 | 0.635 | 3.231 | 23.2 | 27.3 | 14.3 | 21.4 | 7.1 |
| L10 | 2.333 | 2200 | 0.998 | 2.558 | 50.5 | 27.8 | 34.1 | 6.8 | 9.3 |
| L11 | 2.333 | 2631 | 1.043 | 2.730 | 41.4 | 35.3 | 58.7 | 15.2 | 8.6 |
| L12 | 2.333 | 1565 | 0.612 | 2.659 | 40.6 | 34.8 | 37.0 | 18.5 | 24.6 |
| L13 | 2.333 | 1996 | 0.408 | 2.963 | 21.6 | 37.5 | 16.7 | 16.7 | 9.1 |
| L14 | 3.000 | 5715 | 0.998 | 2.722 | 11.9 | 67.5 | 18.2 | 34.1 | 6.7 |
| L15 | 1.667 | 2948 | 0.408 | 1.884 | 52.3 | 30.8 | 38.9 | 16.7 | 0.8 |
| L16 | 2.333 | 4218 | 1.792 | 2.629 | 38.7 | 31.7 | 22.8 | 48.1 | 5.9 |
| L17 | 2.333 | 1724 | 0.340 | 2.135 | 59.2 | 22.4 | 6.7 | 53.3 | 9.2 |
| L18 | 2.000 | 5693 | 0.522 | 1.718 | 39.0 | 4.0 | 8.7 | 13.0 | 2.8 |
| L19 | 1.667 | 6963 | 0.476 | 1.891 | 43.0 | 2.6 | 14.3 | 14.3 | 2.0 |
| L20 | 3.000 | 6328 | 1.293 | 2.679 | 30.5 | 1.8 | 3.5 | 3.5 | 21.9 |
| L21 | 1.667 | 9390 | 0.522 | 1.747 | 37.9 | 1.2 | 17.4 | 13.0 | 0.7 |
| L22 | 2.667 | 5965 | 0.703 | 2.176 | 22.4 | 3.8 | 3.2 | 38.7 | 3.0 |
| L23 | 2.667 | 6464 | 1.043 | 2.084 | 30.9 | 3.2 | 4.3 | 45.7 | 2.8 |
| L24 | 2.667 | 4014 | 1.157 | 2.291 | 31.6 | 2.8 | 3.9 | 19.6 | 4.0 |
| L25 | 2.000 | 6146 | 0.590 | 2.474 | 15.1 | 1.1 | 7.7 | 7.7 | 8.5 |
| | | | | | | | | | |
| Mean | 2.707 | 4129 | 1.709 | 2.611 | 30.3 | 27.3 | 15.5 | 30.2 | 9.3 |
| St Error | 0.161 | 421 | 0.819 | 0.106 | 3.1 | 4.4 | 3.1 | 4.5 | 1.3 |

Table 7. Lafayette River. Summary of benthic community parameters scores of the B-IBI.

| Station | BIBI | Salinity Class | Sediment Class | Shannon Index | Abundance | Biomass | Pollution Indicative Abundance | Pollution Sensitive Abundance | Pollution Indicative Biomass | Pollution Sensitive Biomass | Carnivore Omnivore Abundance | Deep Deposit Feeders |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| L01 | 2.667 | 5 | 1 | 1 | 3 | 1 | 3 | | 3 | | | 5 |
| L02 | 4.000 | 5 | 1 | 3 | 3 | 3 | 5 | | 5 | | | 5 |
| L03 | 1.667 | 5 | 2 | 3 | 1 | 3 | 1 | | | 1 | 1 | |
| L04 | 4.333 | 5 | 1 | 5 | 3 | 3 | 5 | | 5 | | | 5 |
| L05 | 4.333 | 5 | 1 | 3 | 5 | 3 | 5 | | 5 | | | 5 |
| L06 | 3.667 | 5 | 1 | 3 | 5 | 3 | 3 | | 3 | | | 5 |
| L07 | 3.667 | 5 | 1 | 3 | 5 | 3 | 5 | | 3 | | | 3 |
| L08 | 3.333 | 5 | 1 | 3 | 5 | 1 | 3 | | 3 | | | 5 |
| L09 | 3.000 | 5 | 1 | 3 | 3 | 1 | 3 | | 3 | | | 5 |
| L10 | 2.333 | 5 | 2 | 3 | 5 | 3 | 1 | | | 1 | 1 | |
| L11 | 2.333 | 5 | 2 | 3 | 5 | 3 | 1 | | | 1 | 1 | |
| L12 | 2.333 | 5 | 2 | 3 | 5 | 3 | 1 | | | 1 | 1 | |
| L13 | 2.333 | 5 | 2 | 3 | 5 | 1 | 3 | | | 1 | 1 | |
| L14 | 3.000 | 5 | 1 | 3 | 3 | 1 | 1 | | 5 | | | 5 |
| L15 | 1.667 | 5 | 2 | 1 | 5 | 1 | 1 | | | 1 | 1 | |
| L16 | 2.333 | 5 | 2 | 3 | 3 | 3 | 1 | | | 3 | 1 | |
| L17 | 2.333 | 5 | 2 | 1 | 5 | 1 | 3 | | | 3 | 1 | |
| L18 | 2.000 | 5 | 2 | 1 | 3 | 3 | 3 | | | 1 | 1 | |
| L19 | 1.667 | 5 | 2 | 1 | 3 | 1 | 3 | | | 1 | 1 | |
| L20 | 3.000 | 5 | 1 | 1 | 3 | 3 | 5 | | 1 | | | 5 |
| L21 | 1.667 | 4 | 2 | 1 | 1 | 3 | 3 | | | 1 | 1 | |
| L22 | 2.667 | 5 | 2 | 1 | 3 | 3 | 5 | | | 3 | 1 | |
| L23 | 2.667 | 5 | 2 | 1 | 3 | 3 | 5 | | | 3 | 1 | |
| L24 | 2.667 | 4 | 2 | 3 | 3 | 3 | 5 | | | 1 | 1 | |
| L25 | 2.000 | 4 | 2 | 3 | 1 | 3 | 3 | | | 1 | 1 | |

Table 8. Lafayette River. Dominant Taxa by abundance. Taxon code: A- amphipod, B- bivalve, G - gastropod, H- hemichordate, I - isopod, O - oligochaete, P -polychaete, Ph - phoronid, R - rhynchocoel

| | Name | Abundance per $m^{-2}$ |
|---|---|---|
| 1 | Streblospio benedicti (P) | 1103 |
| 2 | Mediomastus ambiseta (P) | 682 |
| 3 | Leptocheirus plumulosus (A) | 631 |
| 4 | Tubificoides spp. Group I (O) | 507 |
| 5 | Tubificoides heterochaetus (O) | 171 |
| 6 | Heteromastus filiformis (P) | 129 |
| 7 | Caulleriella killariensis (P) | 107 |
| 8 | Nereis succinea (P) | 76 |
| 9 | Spiochaetopterus oculatus (P) | 64 |
| 10 | Cyathura polita (I) | 56 |
| 11 | Glycinde solitaria (P) | 49 |
| 12 | Nemertea spp. (R) | 47 |
| 13 | Leitoscoloplos spp (P). | 44 |
| 14 | Paraprionospio pinnata (P) | 44 |
| 15 | Phoronis psammophila (Ph) | 44 |

Table 9. Western Ranch. Summary of physical and chemical parameters by sample.

| Station | Date collected | Latitude | Longitude | Water Depth (m) | Salinity (ppt) | Dissolved oxygen (ppm) | Silt-Clay Content (%) | Volatile Organics (%) |
|---|---|---|---|---|---|---|---|---|
| W01 | 8/13/99 | 36.85466 | 76.33740 | 1 | 23 | 5.2 | 0.9 | 0.4 |
| W02 | 8/13/99 | 36.85529 | 76.33800 | 1 | 23.1 | 5.7 | 2.3 | 0.4 |
| W03 | 8/13/99 | 36.85929 | 76.34510 | 2 | 23.3 | 5.3 | 92.9 | 8.1 |
| W04 | 8/13/99 | 36.85765 | 76.34840 | 4 | 23.4 | 5.7 | 54.3 | 7.9 |
| W05 | 8/13/99 | 36.85365 | 76.35100 | 3 | 23.4 | 5.3 | 68.7 | 4.5 |
| W06 | 8/13/99 | 36.84847 | 76.35130 | 1 | 23.3 | 6.7 | 8.2 | 0.8 |
| W07 | 8/13/99 | 36.85135 | 76.35200 | 3 | 23.4 | 5.6 | 77.3 | 5.2 |
| W08 | 8/13/99 | 36.84844 | 76.35390 | 1 | 23.5 | 6.3 | 89.3 | 5.6 |
| W09 | 8/13/99 | 36.84975 | 76.35600 | 2 | 23.4 | 6.6 | 92.0 | 6.2 |
| W10 | 8/13/99 | 36.84776 | 76.35610 | 1 | 23.2 | 7.6 | 89.2 | 5.6 |
| W11 | 8/13/99 | 36.84592 | 76.35690 | 1 | 23.2 | 6.5 | 91.3 | 5.7 |
| W12 | 8/13/99 | 36.83785 | 76.36000 | 1 | 22.3 | 8.2 | 67.1 | 5.2 |
| W13 | 8/13/99 | 36.84065 | 76.36090 | 1 | 22.6 | 8.8 | 77.6 | 5.2 |
| W14 | 8/13/99 | 36.84179 | 76.36230 | 7 | 23.1 | 6 | 90.3 | 6.8 |
| W16 | 8/13/99 | 36.84675 | 76.36570 | 1 | 22.4 | 10.4 | 95.1 | 7.0 |
| W17 | 8/13/99 | 36.83656 | 76.36990 | 1 | 22.1 | 7.8 | 96.5 | 7.5 |
| W18 | 8/13/99 | 36.83853 | 76.37020 | 1 | 21.9 | 8.6 | 97.6 | 7.3 |
| W19 | 8/13/99 | 36.83544 | 76.37330 | 1 | 22.1 | 5.8 | 81.7 | 5.3 |
| W22 | 8/13/99 | 36.83809 | 76.37980 | 1 | 21.5 | 7.3 | 99.1 | 6.1 |
| W23 | 8/13/99 | 36.83689 | 76.38550 | 2 | 21.2 | 6.7 | 88.8 | 6.9 |
| W24 | 8/13/99 | 36.8295 | 76.39280 | 1 | 20.7 | 7.3 | 89.6 | 6.7 |
| W25 | 8/13/99 | 36.83024 | 76.39340 | 1 | 20.6 | 6.4 | 88.8 | 6.7 |
| W26 | 8/13/99 | 36.83925 | 76.37330 | 3 | 21.8 | 7.1 | 94.1 | 6.9 |
| W27 | 8/13/99 | 36.85693 | 76.35550 | 1 | 23.1 | 7 | 10.9 | 0.9 |
| W28 | 8/13/99 | 36.83096 | 76.39190 | 1 | 20.5 | 6.5 | 92.7 | 7.2 |

Table 10. Western Branch of the Elizabeth River. Summary of benthic community parameters by sample.

| Station | BIBI | Abundance | Biomass | Shannon Index | Pollution Indicative Abundance | Pollution Sensitive Abundance | Pollution Indicative Biomass | Pollution Sensitive Biomass | Carnivore Omnivore Abundance |
|---|---|---|---|---|---|---|---|---|---|
| W01 | 3.000 | 2019 | 0.544 | 2.9 | 16.9 | 28.1 | 8.3 | 33.3 | 14.6 |
| W02 | 3.000 | 2608 | 0.680 | 3.2 | 27.8 | 48.7 | 6.7 | 36.7 | 13.9 |
| W03 | 2.333 | 1905 | 0.544 | 2.6 | 58.3 | 22.6 | 20.8 | 20.8 | 20.2 |
| W04 | 2.333 | 3198 | 0.703 | 2.5 | 47.5 | 29.1 | 9.7 | 16.1 | 9.2 |
| W05 | 2.667 | 5851 | 1.520 | 3.3 | 22.5 | 19.0 | 10.4 | 3.0 | 19.8 |
| W06 | 3.667 | 4468 | 1.043 | 3.0 | 30.5 | 21.3 | 4.3 | 10.9 | 12.7 |
| W07 | 1.333 | 3583 | 0.499 | 1.9 | 51.3 | 43.7 | 50.0 | 18.2 | 2.5 |
| W08 | 2.000 | 3107 | 0.318 | 1.9 | 38.0 | 48.2 | 7.1 | 50.0 | 3.7 |
| W09 | 2.333 | 2336 | 0.612 | 1.7 | 35.9 | 61.2 | 51.9 | 33.3 | 5.8 |
| W10 | 1.667 | 2880 | 0.318 | 2.2 | 32.3 | 45.7 | 28.6 | 21.4 | 3.9 |
| W11 | 1.333 | 3153 | 0.476 | 2.1 | 39.6 | 38.8 | 33.3 | 28.6 | 4.3 |
| W12 | 2.333 | 2517 | 0.771 | 2.4 | 53.2 | 18.9 | 8.8 | 11.8 | 9.9 |
| W13 | 2.667 | 4037 | 0.998 | 2.4 | 55.6 | 31.5 | 15.9 | 50.0 | 14.6 |
| W14 | 1.667 | 2948 | 0.386 | 2.3 | 42.3 | 11.5 | 23.5 | 17.6 | 4.6 |
| W16 | 2.667 | 1769 | 0.862 | 2.9 | 29.5 | 30.8 | 5.3 | 18.4 | 15.4 |
| W17 | 1.667 | 2427 | 0.454 | 2.4 | 53.3 | 18.7 | 25.0 | 20.0 | 18.7 |
| W18 | 2.000 | 1860 | 0.454 | 2.2 | 56.1 | 24.4 | 25.0 | 55.0 | 9.8 |
| W19 | 2.333 | 2404 | 0.476 | 2.8 | 41.5 | 32.1 | 14.3 | 19.0 | 17.0 |
| W22 | 3.000 | 3107 | 0.748 | 2.4 | 43.8 | 32.1 | 3.0 | 36.4 | 12.4 |
| W23 | 3.000 | 2427 | 0.590 | 2.4 | 37.4 | 12.2 | 3.8 | 15.4 | 6.5 |
| W24 | 2.333 | 3243 | 0.680 | 2.9 | 37.8 | 9.8 | 6.7 | 20.0 | 11.9 |
| W25 | 2.667 | 3992 | 0.748 | 2.4 | 44.9 | 7.4 | 9.1 | 51.5 | 6.8 |
| W26 | 3.000 | 1973 | 0.522 | 2.6 | 48.3 | 19.5 | 8.7 | 47.8 | 12.6 |
| W27 | 3.667 | 4649 | 1.111 | 2.4 | 19.0 | 29.8 | 4.1 | 22.4 | 6.8 |
| W28 | 2.667 | 3493 | 0.544 | 2.5 | 47.4 | 13.0 | 16.7 | 50.0 | 8.4 |
| | | | | | | | | | |
| Mean | 2.453 | 3038 | 0.664 | 2.5 | 40.4 | 27.9 | 16.0 | 28.3 | 10.6 |
| St Error | 0.126 | 199 | 0.055 | 0.1 | 2.3 | 2.8 | 2.7 | 3.0 | 1.1 |

Table 11. Western Branch of the Elizabeth River. Summary of benthic community parameters scores of the B-IBI.

| Station | BIBI | Salinity Class | Sediment Class | Shannon Index | Abundance | Biomass | Pollution Indicative Abundance | Pollution Sensitive Abundance | Pollution Indicative Biomass | Pollution Sensitive Biomass | Carnivore Omnivore Abundance | Deep Deposit Feeders |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| W01 | 3.000 | 5 | 1 | 3 | 3 | 1 | 3 | | 3 | | | 5 |
| W02 | 3.000 | 5 | 1 | 3 | 3 | 1 | 3 | | 3 | | | 5 |
| W03 | 2.333 | 5 | 2 | 3 | 5 | 3 | 1 | | | 1 | 1 | |
| W04 | 2.333 | 5 | 2 | 3 | 3 | 3 | 3 | | | 1 | 1 | |
| W05 | 2.667 | 5 | 2 | 5 | 3 | 3 | 3 | | | 1 | 1 | |
| W06 | 3.667 | 5 | 1 | 3 | 5 | 3 | 5 | | 1 | | | 5 |
| W07 | 1.333 | 5 | 2 | 1 | 3 | 1 | 1 | | | 1 | 1 | |
| W08 | 2.000 | 5 | 2 | 1 | 3 | 1 | 3 | | | 3 | 1 | |
| W09 | 2.333 | 5 | 2 | 1 | 5 | 3 | 1 | | | 3 | 1 | |
| W10 | 1.667 | 5 | 2 | 1 | 5 | 1 | 1 | | | 1 | 1 | |
| W11 | 1.333 | 5 | 2 | 1 | 3 | 1 | 1 | | | 1 | 1 | |
| W12 | 2.333 | 5 | 2 | 1 | 5 | 3 | 3 | | | 1 | 1 | |
| W13 | 2.667 | 5 | 2 | 3 | 3 | 3 | 3 | | | 3 | 1 | |
| W14 | 1.667 | 5 | 2 | 1 | 5 | 1 | 1 | | | 1 | 1 | |
| W16 | 2.667 | 5 | 2 | 3 | 5 | 3 | 3 | | | 1 | 1 | |
| W17 | 1.667 | 5 | 2 | 1 | 5 | 1 | 1 | | | 1 | 1 | |
| W18 | 2.000 | 5 | 2 | 1 | 5 | 1 | 1 | | | 3 | 1 | |
| W19 | 2.333 | 5 | 2 | 3 | 5 | 1 | 3 | | | 1 | 1 | |
| W22 | 3.000 | 5 | 2 | 3 | 3 | 3 | 5 | | | 3 | 1 | |
| W23 | 3.000 | 5 | 2 | 3 | 5 | 3 | 5 | | | 1 | 1 | |
| W24 | 2.333 | 5 | 2 | 3 | 3 | 3 | 3 | | | 1 | 1 | |
| W25 | 2.667 | 5 | 2 | 3 | 3 | 3 | 3 | | | 3 | 1 | |
| W26 | 3.000 | 5 | 2 | 3 | 5 | 3 | 3 | | | 3 | 1 | |
| W27 | 3.667 | 5 | 1 | 1 | 5 | 3 | 5 | | 3 | | | 5 |
| W28 | 2.667 | 5 | 2 | 3 | 3 | 3 | 3 | | | 3 | 1 | |

Table12. Western Branch. Dominant Taxa by abundance. Taxon code: A- amphipod, B- bivalve, G - gastropod, H- hemichordate, I - isopod, O - oligochaete, P -polychaete, Ph - phoronid, R - rhynchocoel

| | Name | Abundance per $m^{-2}$ |
|---|---|---|
| 1 | Streblospio benedicti (P) | 1079 |
| 2 | Mediomastus ambiseta (P) | 631 |
| 3 | Tubificoides heterochaetus (O) | 240 |
| 4 | Heteromastus filiformis (P) | 127 |
| 5 | Tubificoides spp. Group I (O) | 124 |
| 6 | Caulleriella killariensis (P) | 122 |
| 7 | Paraprionospio pinnata (P) | 103 |
| 8 | Leptocheirus plumulosus (A) | 84 |
| 9 | Cyathura polita (I) | 82 |
| 10 | Glycinde solitaria (P) | 74 |
| 11 | Nemertea spp. (R) | 54 |
| 12 | Nereis succinea (P) | 44 |
| 13 | Leitoscoloplos spp. (P) | 35 |
| 14 | Hemichordata spp. (H) | 32 |
| 15 | Polydora ligni (P) | 29 |

Table 13. Eastern Branch of the Elizabeth River. Summary of physical and chemical parameters by sample.

| Station | Date collected | Latitude | Longitude | Water Depth (m) | Salinity (ppt) | Dissolved oxygen (ppm) | Silt-Clay Content (%) | Volatile Organics (%) |
|---|---|---|---|---|---|---|---|---|
| E01 | 8/27/99 | 36.84224 | 76.29250 | 9 | 21.5 | 2.4 | 92.68 | 7.9 |
| E02 | 8/27/99 | 36.84274 | 76.28690 | 4 | 20.5 | 2.9 | 27.1 | 6.0 |
| E03 | 8/27/99 | 36.84187 | 76.28330 | 6 | 21 | 2.4 | 45.8 | 6.0 |
| E04 | 8/27/99 | 36.84133 | 76.27530 | 4 | 19.7 | 2.5 | 4.6 | 3.8 |
| E05 | 8/27/99 | 36.84066 | 76.27000 | 5 | 19.7 | 1.9 | 45.2 | 4.7 |
| E06 | 8/27/99 | 36.83809 | 76.26970 | 1 | 19.2 | 4.4 | 76.8 | 7.4 |
| E08 | 8/23/99 | 36.83677 | 76.26220 | 2 | 18 | 4.5 | 96.6 | 8.1 |
| E09 | 8/23/99 | 36.84020 | 76.25770 | 3 | 19 | 2.7 | 82.3 | 9.0 |
| E10 | 8/23/99 | 36.84030 | 76.25730 | 2 | 17.2 | 6.4 | 57.1 | 6.3 |
| E11 | 8/23/99 | 36.83902 | 76.24490 | 2 | 16.8 | 7.5 | 88.3 | 7.7 |
| E12 | 8/23/99 | 36.83415 | 76.24200 | 2 | 17.8 | 2.5 | 82.5 | 8.2 |
| E15 | 8/23/99 | 36.83034 | 76.23850 | 1 | 14.5 | 10.8 | 75.6 | 8.1 |
| E16 | 8/23/99 | 36.83870 | 76.23760 | 3 | 16.5 | 4.3 | 97.1 | 10.5 |
| E19 | 8/23/99 | 36.84341 | 76.22650 | 1 | 15.5 | 8.1 | 94.1 | 12.9 |
| E20 | 8/23/99 | 36.84406 | 76.22600 | 1 | 14.5 | 7 | 91.4 | 14.7 |
| E21 | 8/23/99 | 36.83695 | 76.22320 | 3 | 16.8 | 3.1 | 93.0 | 9.1 |
| E22 | 8/23/99 | 36.83830 | 76.22100 | 1 | 16.8 | 3.9 | 95.6 | 9.9 |
| E23 | 8/23/99 | 36.83266 | 76.21910 | 2 | 16.5 | 3.6 | 96.6 | 10.5 |
| E24 | 8/23/99 | 36.83483 | 76.21900 | 2 | 16.5 | 3 | 85.7 | 8.3 |
| E25 | 8/23/99 | 36.83103 | 76.21360 | 2 | 16.2 | 4 | 86.9 | 8.0 |
| E26 | 8/23/99 | 36.84079 | 76.22780 | 1 | 15 | 10.1 | 95.1 | 10.7 |
| E27 | 8/23/99 | 36.84304 | 76.22110 | 1 | 15.2 | 7.5 | 98.4 | 13.9 |
| E28 | 8/23/99 | 36.83733 | 76.22260 | 3 | 16.8 | 3.6 | 83.9 | 7.9 |
| E29 | 8/27/99 | 36.84035 | 76.28870 | 7 | 21 | 2.6 | 33.3 | 4.2 |
| E30 | 8/27/99 | 36.83854 | 76.25590 | 6 | 20 | 2.4 | 49.4 | 4.6 |

Table 14. Eastern Branch of the Elizabeth River. Summary of benthic community parameters by sample.

| Station | BIBI | Abundance | Biomass | Shannon Index | Pollution Indicative Abundance | Pollution Sensitive Abundance | Pollution Indicative Biomass | Pollution Sensitive Biomass | Carnivore Omnivore Abundance |
|---|---|---|---|---|---|---|---|---|---|
| E01 | 3.000 | 1520 | 1.021 | 2.7 | 23.9 | 10.4 | 12.9 | 28.9 | 9.0 |
| E02 | 4.333 | 4309 | 3.470 | 3.4 | 7.4 | 54.7 | 4.4 | 48.4 | 17.9 |
| E03 | 2.000 | 4309 | 1.270 | 3.3 | 46.8 | 14.7 | 11.4 | 12.5 | 14.7 |
| E04 | 3.667 | 2699 | 1.837 | 4.0 | 3.4 | 17.6 | 6.3 | 11.1 | 32.8 |
| E05 | 2.667 | 703 | 1.383 | 3.3 | 12.9 | 6.5 | 18.2 | 1.6 | 16.1 |
| E06 | 2.333 | 1089 | 0.885 | 3.3 | 18.8 | 20.8 | 3.0 | 5.1 | 22.9 |
| E08 | 2.333 | 3878 | 1.043 | 1.8 | 60.2 | 7.6 | 9.1 | 43.5 | 8.8 |
| E09 | 2.000 | 4355 | 0.748 | 2.4 | 63.0 | 13.0 | 9.5 | 9.1 | 5.2 |
| E10 | 4.000 | 4355 | 2.155 | 3.3 | 35.9 | 5.7 | 3.2 | 45.3 | 15.1 |
| E11 | 3.333 | 3697 | 1.315 | 2.3 | 57.1 | 9.2 | 3.4 | 41.4 | 12.3 |
| E12 | 2.000 | 3266 | 1.111 | 1.2 | 85.4 | 1.4 | 16.3 | 4.1 | 4.9 |
| E15 | 3.667 | 2381 | 1.089 | 2.2 | 61.0 | 10.5 | 4.2 | 50.0 | 14.3 |
| E16 | 1.667 | 3856 | 0.590 | 0.8 | 92.9 | 0.6 | 46.2 | 3.8 | 3.5 |
| E19 | 2.000 | 4423 | 0.907 | 1.7 | 66.7 | 0.0 | 10.0 | 0.0 | 6.7 |
| E20 | 1.667 | 5239 | 1.429 | 2.0 | 60.2 | 0.4 | 9.5 | 1.6 | 6.1 |
| E21 | 2.333 | 2858 | 0.544 | 1.8 | 56.3 | 4.8 | 8.3 | 41.7 | 6.3 |
| E22 | 3.000 | 2177 | 1.678 | 2.3 | 52.1 | 6.3 | 2.7 | 8.1 | 9.4 |
| E23 | 2.667 | 3720 | 0.930 | 2.1 | 50.0 | 3.7 | 7.3 | 31.7 | 6.7 |
| E24 | 1.667 | 6668 | 1.066 | 1.3 | 74.2 | 0.7 | 17.0 | 2.1 | 5.8 |
| E25 | 2.000 | 4876 | 0.590 | 1.9 | 63.3 | 2.8 | 15.4 | 3.8 | 9.3 |
| E26 | 2.667 | 4037 | 0.907 | 2.0 | 56.7 | 1.1 | 12.5 | 2.5 | 10.1 |
| E27 | 3.333 | 2268 | 0.839 | 2.2 | 60.0 | 8.0 | 2.7 | 24.3 | 13.0 |
| E28 | 2.333 | 3039 | 0.703 | 1.9 | 60.4 | 3.0 | 9.7 | 9.7 | 11.9 |
| E29 | 2.000 | 1111 | 7.983 | 2.1 | 69.4 | 12.2 | 14.0 | 23.3 | 12.2 |
| E30 | 3.000 | 2472 | 0.680 | 3.3 | 45.9 | 26.6 | 17.4 | 20.0 | 15.6 |
| | | | | | | | | | |
| Mean | 2.627 | 3332 | 1.447 | 2.3 | 51.4 | 9.7 | 11.0 | 18.9 | 11.6 |
| St Error | 0.152 | 285 | 0.299 | 0.2 | 4.6 | 2.3 | 1.8 | 3.5 | 1.3 |

Table 15. Eastern Branch of the Elizabeth River. Summary of benthic community parameters scores of the B-IBI.

| Station | BIBI | Salinity Class | Sediment Class | Shannon Index | Abundance | Biomass | Pollution Indicative Abundance | Pollution Sensitive Abundance | Pollution Indicative Biomass | Pollution Sensitive Biomass | Carnivore Omnivore Abundance | Deep Deposit Feeders |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| E01 | 3.000 | 5 | 2 | 3 | 5 | 3 | 5 | | | 1 | 1 | |
| E02 | 4.333 | 5 | 1 | 3 | 5 | 3 | 5 | | 5 | | | 5 |
| E03 | 2.000 | 5 | 2 | 3 | 3 | 3 | 1 | | | 1 | 1 | |
| E04 | 3.667 | 5 | 1 | 5 | 3 | 3 | 5 | | 1 | | | 5 |
| E05 | 2.667 | 5 | 2 | 5 | 1 | 3 | 5 | | | 1 | 1 | |
| E06 | 2.333 | 5 | 2 | 3 | 3 | 3 | 3 | | | 1 | 1 | |
| E08 | 2.333 | 5 | 2 | 1 | 3 | 3 | 3 | | | 3 | 1 | |
| E09 | 2.000 | 5 | 2 | 3 | 3 | 3 | 1 | | | 1 | 1 | |
| E10 | 4.000 | 4 | 2 | 5 | 3 | 5 | 5 | | | 3 | 3 | |
| E11 | 3.333 | 4 | 2 | 3 | 3 | 3 | 5 | | | 3 | 3 | |
| E12 | 2.000 | 4 | 2 | 1 | 3 | 3 | 3 | | | 1 | 1 | |
| E15 | 3.667 | 4 | 2 | 3 | 5 | 3 | 5 | | | 3 | 3 | |
| E16 | 1.667 | 4 | 2 | 1 | 3 | 3 | 1 | | | 1 | 1 | |
| E19 | 2.000 | 4 | 2 | 1 | 3 | 3 | 3 | | | 1 | 1 | |
| E20 | 1.667 | 4 | 2 | 1 | 1 | 3 | 3 | | | 1 | 1 | |
| E21 | 2.333 | 4 | 2 | 1 | 3 | 3 | 3 | | | 3 | 1 | |
| E22 | 3.000 | 4 | 2 | 3 | 5 | 3 | 5 | | | 1 | 1 | |
| E23 | 2.667 | 4 | 2 | 3 | 3 | 3 | 3 | | | 3 | 1 | |
| E24 | 1.667 | 4 | 2 | 1 | 1 | 3 | 3 | | | 1 | 1 | |
| E25 | 2.000 | 4 | 2 | 1 | 3 | 3 | 3 | | | 1 | 1 | |
| E26 | 2.667 | 4 | 2 | 3 | 3 | 3 | 3 | | | 1 | 3 | |
| E27 | 3.333 | 4 | 2 | 3 | 5 | 3 | 5 | | | 1 | 3 | |
| E28 | 2.333 | 4 | 2 | 1 | 3 | 3 | 3 | | | 1 | 3 | |
| E29 | 2.000 | 5 | 1 | 1 | 1 | 5 | 5 | | 1 | | | 1 |
| E30 | 3.000 | 5 | 2 | 5 | 5 | 3 | 3 | | | 1 | 1 | |

Table 16. Eastern Branch. Dominant Taxa by abundance. Taxon code: A- amphipod, B- bivalve, G - gastropod, H- hemichordate, I - isopod, O - oligochaete, P -polychaete, Ph - phoronid, R - rhynchocoel

| | Name | Abundance per $m^{-2}$ |
|---|---|---|
| 1 | Streblospio benedicti (P) | 1657 |
| 2 | Leptocheirus plumulosus (A) | 288 |
| 3 | Heteromastus filiformis (P) | 228 |
| 4 | Mediomastus ambiseta (P) | 146 |
| 5 | Paraprionospio pinnata (P) | 145 |
| 6 | Tubificoides heterochaetus (O) | 116 |
| 7 | Leitoscoloplos spp. (P) | 94 |
| 8 | Tubificoides spp. Group I (O) | 76 |
| 9 | Nemertea spp. (R) | 65 |
| 10 | Cyathura polita (I) | 64 |
| 11 | Parahesione luteola (P) | 63 |
| 12 | Gyptis brevipalpa (P) | 39 |
| 13 | Nereis succinea (P) | 34 |
| 14 | Eteone heteropoda (P) | 28 |
| 15 | Hemichordata spp. (H) | 27 |

Table 17. Southern Branch. Summary of physical and chemical parameters by sample.

| Station | Date collected | Latitude | Longitude | Water Depth (m) | Salinity (ppt) | Dissolved oxygen (ppm) | Silt-Clay Content (%) | Volatile Organics (%) |
|---|---|---|---|---|---|---|---|---|
| S01 | 8/20/99 | 36.82592 | 76.29280 | 12 | 23.7 | 1.9 | 80.5 | 8.6 |
| S02 | 8/20/99 | 36.81728 | 76.29390 | 13 | 23.2 | 1.6 | 89.3 | 8.7 |
| S03 | 8/20/99 | 36.81441 | 76.29270 | 12 | 23.2 | 1.9 | 89.2 | 8.5 |
| S04 | 8/20/99 | 36.81178 | 76.29270 | 14 | 23.0 | 1.8 | 83.2 | 8.2 |
| S06 | 8/20/99 | 36.80115 | 76.29410 | 10 | 21.7 | 1.9 | 39.7 | 4.8 |
| S07 | 8/20/99 | 36.79044 | 76.30320 | 3 | 19.0 | 3.5 | 68.9 | 7.6 |
| S08 | 8/20/99 | 36.78759 | 76.30310 | 11 | 21.1 | 1.7 | 97.4 | 9.0 |
| S09 | 8/20/99 | 36.77944 | 76.29440 | 3 | 20.0 | 1.9 | 60.0 | 12.9 |
| S10 | 8/20/99 | 36.77562 | 76.29610 | 8 | 21.3 | 1.4 | 28.7 | 3.6 |
| S11 | 8/20/99 | 36.76159 | 76.30750 | 1 | 19.5 | 3.3 | 20.2 | 2.6 |
| S13 | 8/20/99 | 36.7575 | 76.30310 | 3 | 19.5 | 2.9 | 57.0 | 8.4 |
| S14 | 8/20/99 | 36.75742 | 76.31170 | 1 | 18.5 | 3.5 | 22.5 | 5.0 |
| S15 | 8/20/99 | 36.7514 | 76.29250 | 1 | 18.5 | 3.3 | 33.8 | 7.5 |
| S16 | 8/20/99 | 36.74729 | 76.29290 | 2 | 18.0 | 1.3 | 57.4 | 8.7 |
| S17 | 8/20/99 | 36.74711 | 76.29750 | 1 | 17.5 | 3.5 | 4.6 | 1.0 |
| S18 | 8/20/99 | 36.74559 | 76.29760 | 2 | 18.0 | 2.9 | 33.9 | 5.7 |
| S19 | 8/27/99 | 36.7453 | 76.29770 | 3 | 17.8 | 1.5 | 12.4 | 2.5 |
| S20 | 8/27/99 | 36.74479 | 76.29520 | 1 | 17.3 | 2.6 | 4.6 | 6.4 |
| S21 | 8/27/99 | 36.7378 | 76.29580 | 7 | 20.5 | 1.1 | 42.7 | 1.1 |
| S22 | 8/27/99 | 36.7323 | 76.29380 | 1 | 17.0 | 2.1 | 64.6 | 8.8 |
| S24 | 8/27/99 | 36.72851 | 76.28650 | 1 | 14.0 | 3.4 | 28.8 | 7.2 |
| S25 | 8/27/99 | 36.72704 | 76.31300 | 1 | 6.5 | 1.9 | 90.6 | 15.1 |
| S26 | 8/27/99 | 36.7483 | 76.29610 | 5 | 20.5 | 1.1 | 28.3 | 3.8 |
| S27 | 8/27/99 | 36.73249 | 76.26880 | 1 | 14.5 | 3.9 | 21.8 | 3.7 |
| S28 | 8/27/99 | 36.78177 | 76.30380 | 1 | 19.0 | 3 | 4.6 | 1.3 |

Table 18. Southern Branch of the Elizabeth River. Summary of benthic community parameters by sample.

| Station | BIBI | Abundance | Biomass | Shannon Index | Pollution Indicative Abundance | Pollution Sensitive Abundance | Pollution Indicative Biomass | Pollution Sensitive Biomass | Carnivore Omnivore Abundance |
|---|---|---|---|---|---|---|---|---|---|
| S01 | 2.667 | 4899 | 3.946 | 2.4 | 54.2 | 19.9 | 14.4 | 12.6 | 3.7 |
| S02 | 2.000 | 1837 | 0.975 | 1.9 | 71.6 | 6.2 | 53.5 | 20.9 | 8.6 |
| S03 | 2.000 | 2041 | 0.612 | 1.1 | 85.6 | 2.2 | 70.4 | 7.4 | 5.6 |
| S04 | 2.000 | 2563 | 0.953 | 0.9 | 83.2 | 0.9 | 83.3 | 2.4 | 4.4 |
| S06 | 2.000 | 3969 | 3.402 | 1.1 | 86.3 | 4.6 | 36.0 | 36.7 | 5.1 |
| S07 | 1.667 | 1202 | 0.680 | 2.4 | 47.2 | 20.8 | 60.0 | 10.0 | 18.9 |
| S08 | 1.667 | 1565 | 0.431 | 1.6 | 81.2 | 2.9 | 57.9 | 10.5 | 7.2 |
| S09 | 1.333 | 454 | 0.431 | 2.4 | 25.0 | 40.0 | 5.3 | 10.5 | 15.0 |
| S10 | 4.000 | 3697 | 4.831 | 3.4 | 17.8 | 31.9 | 2.3 | 76.5 | 19.6 |
| S11 | 2.333 | 68 | 0.023 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| S13 | 1.000 | 13540 | 0.499 | 0.2 | 97.5 | 1.8 | 77.3 | 13.6 | 1.8 |
| S14 | 1.333 | 5897 | 0.431 | 0.9 | 85.8 | 11.2 | 26.3 | 42.1 | 9.6 |
| S15 | 1.667 | 6509 | 0.499 | 1.8 | 68.3 | 24.0 | 9.1 | 45.5 | 19.5 |
| S16 | 1.000 | 10319 | 0.295 | 0.1 | 99.1 | 0.4 | 76.9 | 15.4 | 0.2 |
| S17 | 2.667 | 1950 | 0.363 | 2.6 | 46.5 | 33.7 | 6.3 | 43.8 | 27.9 |
| S18 | 2.667 | 1724 | 0.386 | 2.7 | 0.0 | 25.0 | 0.0 | 17.6 | 81.6 |
| S19 | 2.667 | 703 | 0.249 | 2.6 | 19.4 | 48.4 | 18.2 | 18.2 | 64.5 |
| S20 | 2.000 | 7575 | 1.520 | 2.1 | 23.1 | 11.4 | 3.0 | 28.4 | 13.5 |
| S21 | 1.333 | 6555 | 0.159 | 0.1 | 99.3 | 0.7 | 85.7 | 14.3 | 0.0 |
| S22 | 2.667 | 1678 | 0.318 | 1.7 | 67.6 | 24.3 | 7.1 | 50.0 | 13.5 |
| S24 | 1.333 | 5557 | 0.998 | 2.6 | 35.5 | 6.9 | 9.1 | 18.2 | 19.2 |
| S25 | 2.200 | 22567 | 1.542 | 0.5 | 4.3 | 0.0 | 4.4 | 0.0 | 1.8 |
| S26 | 1.667 | 907 | 0.159 | 2.4 | 57.5 | 32.5 | 42.9 | 28.6 | 30.0 |
| S27 | 1.667 | 4468 | 0.476 | 1.6 | 67.5 | 23.4 | 9.5 | 42.9 | 13.7 |
| S28 | 3.000 | 4150 | 1.315 | 2.6 | 42.6 | 12.6 | 5.2 | 36.2 | 19.1 |
| | | | | | | | | | |
| Mean | 2.021 | 4656 | 1.020 | 1.7 | 54.6 | 15.4 | 30.6 | 24.1 | 16.2 |
| St Error | 0.140 | 988 | 0.247 | 0.2 | 6.4 | 2.9 | 6.1 | 3.7 | 3.9 |

Table 19. Southern Branch of the Elizabeth Riverr. Summary of benthic community parameters scores of the B-IBI.

| Station | BIBI | Salinity Class | Sediment Class | Shannon Index | Abundance | Biomass | Pollution Indicative Abundance | Pollution Sensitive Abundance | Pollution Indicative Biomass | Pollution Sensitive Biomass | Carnivore Omnivore Abundance | Deep Deposit Feeders |
|---|---|---|---|---|---|---|---|---|---|---|---|---|

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| S01 | 2.667 | 5 | 2 | 3 | 3 | 5 | 3 | | | 1 | 1 | |
| S02 | 2.000 | 5 | 2 | 1 | 5 | 3 | 1 | | | 1 | 1 | |
| S03 | 2.000 | 5 | 2 | 1 | 5 | 3 | 1 | | | 1 | 1 | |
| S04 | 2.000 | 5 | 2 | 1 | 5 | 3 | 1 | | | 1 | 1 | |
| S06 | 2.000 | 5 | 1 | 1 | 5 | 3 | 1 | | 1 | | | 1 |
| S07 | 1.667 | 5 | 2 | 1 | 3 | 3 | 1 | | | 1 | 1 | |
| S08 | 1.667 | 5 | 2 | 1 | 5 | 1 | 1 | | | 1 | 1 | |
| S09 | 1.333 | 5 | 2 | 1 | 1 | 1 | 3 | | | 1 | 1 | |
| S10 | 4.000 | 5 | 1 | 3 | 5 | 3 | 5 | | 3 | | | 5 |
| S11 | 2.333 | 5 | 1 | 1 | 1 | 1 | 5 | | 1 | | | 5 |
| S13 | 1.000 | 5 | 2 | 1 | 1 | 1 | 1 | | | 1 | 1 | |
| S14 | 1.333 | 5 | 1 | 1 | 3 | 1 | 1 | | 1 | | | 1 |
| S15 | 1.667 | 5 | 1 | 1 | 3 | 1 | 3 | | 1 | | | 1 |
| S16 | 1.000 | 5 | 2 | 1 | 1 | 1 | 1 | | | 1 | 1 | |
| S17 | 2.667 | 4 | 1 | 3 | 5 | 1 | | 1 | 3 | | 3 | |
| S18 | 2.667 | 5 | 1 | 3 | 3 | 1 | 5 | | 1 | | | 3 |
| S19 | 2.667 | 4 | 1 | 3 | 1 | 1 | | 3 | 3 | | 5 | |
| S20 | 2.000 | 4 | 1 | 1 | 1 | 3 | | 3 | 3 | | 1 | |
| S21 | 1.333 | 5 | 2 | 1 | 3 | 1 | 1 | | | 1 | 1 | |
| S22 | 2.667 | 4 | 2 | 1 | 5 | 1 | 3 | | | 3 | 3 | |
| S24 | 1.333 | 4 | 1 | 3 | 1 | 1 | | 1 | 1 | | 1 | |
| S25 | 2.200 | 3 | | 1 | 1 | 3 | | 5 | | 1 | | |
| S26 | 1.667 | 5 | 1 | 1 | 1 | 1 | 1 | | 3 | | | 3 |
| S27 | 1.667 | 4 | 1 | 1 | 3 | 1 | | 1 | 3 | | 1 | |
| S28 | 3.000 | 5 | 1 | 1 | 5 | 3 | 3 | | 1 | | | 5.0 |

Table 20. Southern Branch. Dominant Taxa by abundance. Taxon code: A- amphipod, B- bivalve, G - gastropod, H- hemichordate, I - isopod, O - oligochaete, P -polychaete, Ph - phoronid, R - rhynchocoel

| | Name | Abundance per $m^{-2}$ |
|---|---|---|
| 1 | Streblospio benedicti (P) | 2082 |
| 2 | Oligochaeta spp. (O) | 831 |
| 3 | Paraprionospio pinnata (P) | 526 |
| 4 | Tubificoides spp. Group I (O) | 229 |
| 5 | Glycinde solitaria (P) | 153 |
| 6 | Mediomastus ambiseta (P) | 123 |
| 7 | Hemichordata spp. (H) | 96 |
| 8 | Tubificoides heterochaetus (O) | 80 |
| 9 | Heteromastus filiformis (P) | 64 |
| 10 | Cyathura polita (I) | 61 |
| 11 | Nereis succinea (P) | 57 |
| 12 | Laeonereis culveri (P) | 51 |
| 13 | Gyptis brevipalpa (P) | 37 |
| 14 | Loimia medusa (P) | 33 |
| 15 | Leitoscoloplos spp (P). | 29 |

| Table 21. Scuffletown Creek. Summary of physical and chemical parameters by sample. | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Station | Date collected | Latitude | Longitude | Water Depth (m) | Salinity (ppt) | Dissolved oxygen (ppm) | Silt-Clay Content (%) | Volatile Organics (%) |
| F01 | 7/22/99 | 36.80636 | 76.28980 | 1 | 20.2 | 5.8 | 16.1 | 2.0 |
| F02 | 7/22/99 | 36.80644 | 76.28970 | 1 | 20.1 | 5.2 | 32.7 | 4.0 |
| F03 | 7/21/99 | 36.80678 | 76.28920 | 4 | 21.6 | 5.7 | 67.6 | 7.0 |
| F04 | 7/21/99 | 36.80776 | 76.28910 | 2 | 22 | 5 | 65.4 | 7.3 |
| F05 | 7/21/99 | 36.8068 | 76.28890 | 2 | 21.1 | 6.8 | NA | 5.2 |
| F06 | 7/21/99 | 36.80778 | 76.28880 | 3 | 21.7 | 5.1 | 62.8 | 6.2 |
| F07 | 7/21/99 | 36.80586 | 76.28880 | 1 | 20 | 8.6 | 11.4 | 1.0 |
| F08 | 7/21/99 | 36.80735 | 76.28880 | 3 | 21.3 | 6.5 | 56.3 | 6.8 |
| F09 | 7/21/99 | 36.80736 | 76.28840 | 2 | 21.2 | 6.4 | 47.0 | 5.3 |
| F10 | 7/21/99 | 36.80635 | 76.28830 | 1 | 20 | 9.3 | 9.6 | 1.2 |
| F11 | 7/21/99 | 36.80746 | 76.28790 | 1 | 20 | 7.8 | 12.4 | 1.9 |
| F12 | 7/21/99 | 36.80604 | 76.28770 | 1 | 19.9 | 9.1 | 15.7 | 2.0 |
| F13 | 7/21/99 | 36.80794 | 76.28770 | 2 | 20.3 | 6.2 | 72.2 | 8.2 |
| F14 | 7/21/99 | 36.8084 | 76.28760 | 1 | 20 | 8.2 | 46.4 | 7.2 |
| F15 | 7/21/99 | 36.80826 | 76.28760 | 1 | 20.1 | 7 | 39.6 | 5.7 |
| F16 | 7/21/99 | 36.80803 | 76.28720 | 1 | 20 | 7 | 70.5 | 6.5 |
| F17 | 7/21/99 | 36.80721 | 76.28700 | 1 | 19.9 | 8.9 | 17.2 | 1.8 |
| F18 | 7/21/99 | 36.80708 | 76.28670 | 1 | 20.1 | 7.8 | 18.5 | 1.7 |
| F19 | 7/21/99 | 36.80866 | 76.28650 | 4 | 21.7 | 5.2 | 38.3 | 4.2 |
| F20 | 7/21/99 | 36.8086 | 76.28470 | 1 | 19.1 | 7.1 | 24.8 | 4.6 |
| F21 | 7/21/99 | 36.80801 | 76.28410 | 1 | 20.3 | 4.4 | 69.2 | 9.7 |
| F22 | 7/21/99 | 36.80856 | 76.28340 | 1 | 19.6 | 5.5 | 78.2 | 11.0 |
| F23 | 7/21/99 | 36.80911 | 76.28330 | 1 | 19.4 | 6.9 | 63.9 | 13.5 |
| F24 | 7/21/99 | 36.80873 | 76.28330 | 1 | 19.7 | 6.4 | 72.0 | 11.3 |
| F25 | 7/21/99 | 36.80935 | 76.28120 | 1 | 19.4 | 4.9 | 82.3 | 9.8 |

Table 22. Scuffletown Creek. Summary of benthic community parameters by sample.

| Station | BIBI | Abundance | Biomass | Shannon Index | Pollution Indicative Abundance | Pollution Sensitive Abundance | Pollution Indicative Biomass | Pollution Sensitive Biomass | Carnivore Omnivore Abundance |
|---|---|---|---|---|---|---|---|---|---|
| F01 | 2.333 | 1996 | 0.816 | 2.499 | 46.6 | 9.1 | 8.3 | 13.9 | 9.1 |
| F02 | 3.000 | 6146 | 1.950 | 2.425 | 32.1 | 3.7 | 4.7 | 9.3 | 13.7 |
| F03 | 1.333 | 4604 | 0.476 | 1.759 | 60.1 | 0.0 | 38.1 | 0.0 | 1.5 |
| F04 | 2.333 | 2019 | 0.635 | 2.739 | 42.7 | 30.3 | 28.6 | 21.4 | 13.5 |
| F05 | 1.667 | 1383 | 0.249 | 2.057 | 9.8 | 50.8 | 18.2 | 18.2 | 3.3 |
| F06 | 3.000 | 1157 | 1.338 | 2.864 | 7.8 | 31.4 | 5.1 | 42.4 | 25.5 |
| F07 | 3.000 | 6396 | 1.520 | 2.822 | 37.2 | 6.7 | 6.0 | 13.4 | 11.7 |
| F08 | 1.667 | 953 | 0.794 | 3.168 | 16.7 | 33.3 | 28.6 | 11.4 | 23.8 |
| F09 | 1.333 | 4332 | 0.476 | 2.374 | 32.5 | 38.7 | 23.8 | 14.3 | 3.7 |
| F10 | 2.333 | 2517 | 0.748 | 2.928 | 41.4 | 9.9 | 15.2 | 24.2 | 16.2 |
| F11 | 2.000 | 6486 | 0.885 | 2.024 | 64.7 | 16.4 | 25.6 | 15.4 | 3.8 |
| F12 | 3.667 | 3742 | 1.247 | 2.805 | 35.2 | 4.8 | 3.6 | 7.3 | 12.1 |
| F13 | 2.000 | 5421 | 0.998 | 2.528 | 44.4 | 25.1 | 38.6 | 15.9 | 1.3 |
| F14 | 2.667 | 4740 | 0.862 | 2.496 | 46.9 | 32.1 | 13.2 | 42.1 | 9.1 |
| F15 | 2.667 | 1814 | 1.338 | 3.258 | 38.8 | 13.8 | 20.3 | 10.2 | 12.5 |
| F16 | 1.667 | 3969 | 0.975 | 2.203 | 48.0 | 34.9 | 32.6 | 14.0 | 5.1 |
| F17 | 3.000 | 5602 | 1.656 | 2.957 | 37.7 | 7.7 | 11.0 | 16.4 | 7.3 |
| F18 | 2.667 | 5829 | 1.383 | 2.707 | 52.9 | 9.7 | 6.6 | 21.3 | 15.2 |
| F19 | 2.667 | 3856 | 0.544 | 2.479 | 45.9 | 30.0 | 29.2 | 25.0 | 3.5 |
| F20 | 3.333 | 4150 | 1.406 | 3.093 | 43.2 | 11.5 | 8.1 | 16.1 | 19.1 |
| F21 | 2.333 | 4196 | 0.748 | 2.046 | 68.1 | 6.5 | 12.1 | 42.4 | 8.1 |
| F22 | 2.333 | 11068 | 0.953 | 2.585 | 33.2 | 4.1 | 9.5 | 31.0 | 9.4 |
| F23 | 2.000 | 1043 | 0.522 | 2.292 | 52.2 | 13.0 | 8.7 | 17.4 | 13.0 |
| F24 | 1.667 | 9639 | 2.041 | 2.365 | 51.3 | 6.1 | 7.8 | 16.7 | 9.2 |
| F25 | 2.000 | 5284 | 1.383 | 1.119 | 79.8 | 0.4 | 14.8 | 1.6 | 5.6 |
| | | | | | | | | | |
| Mean | 2.347 | 4334 | 1.038 | 2.504 | 42.8 | 17.2 | 16.7 | 18.5 | 10.3 |
| St Error | 0.124 | 507 | 0.094 | 0.095 | 3.3 | 2.8 | 2.2 | 2.2 | 1.3 |

Table 23. Scuffletown Creek. Summary of benthic community parameters scores of the B-IBI.

| Station | BIBI | Salinity Class | Sediment Class | Shannon Index | Abundance | Biomass | Pollution Indicative Abundance | Pollution Sensitive Abundance | Pollution Indicative Biomass | Pollution Sensitive Biomass | Carnivore Omnivore Abundance | Deep Deposit Feeders |
|---|---|---|---|---|---|---|---|---|---|---|---|---|

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| F01 | 2.333 | 5 | 1 | 1 | 3 | 1 | 3 | | 1 | | | 5 |
| F02 | 3.000 | 5 | 1 | 1 | 3 | 3 | 5 | | 1 | | | 5 |
| F03 | 1.333 | 5 | 2 | 1 | 3 | 1 | 1 | | | 1 | 1 | |
| F04 | 2.333 | 5 | 2 | 3 | 5 | 3 | 1 | | | 1 | 1 | |
| F05 | 1.667 | 5 | 2 | 1 | 3 | 1 | 3 | | | 1 | 1 | |
| F06 | 3.000 | 5 | 2 | 3 | 3 | 3 | 3 | | | 3 | 3 | |
| F07 | 3.000 | 5 | 1 | 3 | 3 | 3 | 3 | | 1 | | | 5 |
| F08 | 1.667 | 5 | 2 | 3 | 1 | 3 | 1 | | | 1 | 1 | |
| F09 | 1.333 | 5 | 2 | 1 | 3 | 1 | 1 | | | 1 | 1 | |
| F10 | 2.333 | 5 | 1 | 3 | 3 | 1 | 1 | | 1 | | | 5 |
| F11 | 2.000 | 5 | 1 | 1 | 3 | 1 | 1 | | 1 | | | 5 |
| F12 | 3.667 | 5 | 1 | 3 | 5 | 3 | 5 | | 1 | | | 5 |
| F13 | 2.000 | 5 | 2 | 3 | 3 | 3 | 1 | | | 1 | 1 | |
| F14 | 2.667 | 5 | 2 | 3 | 3 | 3 | 3 | | | 3 | 1 | |
| F15 | 2.667 | 5 | 1 | 3 | 3 | 3 | 1 | | 1 | | | 5 |
| F16 | 1.667 | 5 | 2 | 1 | 3 | 3 | 1 | | | 1 | 1 | |
| F17 | 3.000 | 5 | 1 | 3 | 3 | 3 | 3 | | 1 | | | 5 |
| F18 | 2.667 | 5 | 1 | 3 | 3 | 3 | 3 | | 1 | | | 3 |
| F19 | 2.667 | 5 | 1 | 1 | 5 | 1 | 1 | | 3 | | | 5 |
| F20 | 3.333 | 5 | 1 | 3 | 5 | 3 | 3 | | 1 | | | 5 |
| F21 | 2.333 | 5 | 2 | 1 | 3 | 3 | 3 | | | 3 | 1 | |
| F22 | 2.333 | 5 | 2 | 3 | 1 | 3 | 3 | | | 3 | 1 | |
| F23 | 2.000 | 5 | 2 | 1 | 3 | 3 | 3 | | | 1 | 1 | |
| F24 | 1.667 | 5 | 2 | 1 | 1 | 3 | 3 | | | 1 | 1 | |
| F25 | 2.000 | 5 | 2 | 1 | 3 | 3 | 3 | | | 1 | 1 | |

Table 24. Scuffletown Creek. Dominant Taxa by abundance. Taxon code: A- amphipod, B- bivalve, C - cumacean, G - gastropod, H- hemichordate, I - isopod, O - oligochaete, P -polychaete, Ph - phoronid, R - rhynchocoel

| | Name | Abundance per $m^{-2}$ |
|---|---|---|
| 1 | Streblospio benedicti (P) | 1888 |
| 2 | Mediomastus ambiseta (P) | 370 |
| 3 | Tubificoides spp. Group I (O) | 356 |
| 4 | Leitoscoloplos spp. (P) | 298 |
| 5 | Heteromastus filiformis (P) | 281 |
| 6 | Tubificoides heterochaetus (O) | 228 |
| 7 | Capitella capitata (P) | 165 |
| 8 | Cyathura polita (I) | 109 |
| 9 | Leucon americanus (C) | 95 |
| 10 | Nemertea spp. (R) | 77 |
| 11 | Cyclaspis varians (C) | 73 |
| 12 | Glycinde solitaria (P) | 66 |
| 13 | Eteone heteropoda (P) | 64 |
| 14 | Caulleriella killariensis (P) | 40 |
| 15 | Nereis succinea (P) | 37 |

| Table 25. Jones-Giligan Creek. Summary of physical and chemical parameters by sample. | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Station | Date collected | Latitude | Longitude | Water Depth (m) | Salinity (ppt) | Dissolved oxygen (ppm) | Silt-Clay Content (%) | Volatile Organics (%) |
| G01 | 7/22/99 | 36.80036 | 76.29150 | 9 | 23.8 | 4.3 | 79.8 | 8.5 |
| G02 | 7/22/99 | 36.79953 | 76.29140 | 1 | 19.7 | 11.1 | 41.0 | 12.5 |
| G04 | 7/22/99 | 36.80038 | 76.29120 | 2 | 20.2 | 8.7 | 16.1 | 2.0 |
| G06 | 7/22/99 | 36.79919 | 76.29070 | 6 | 22.4 | 4.2 | 6.9 | 0.5 |
| G07 | 7/22/99 | 36.80044 | 76.29040 | 5 | 21.6 | 4.9 | 87.0 | 7.0 |
| G08 | 7/22/99 | 36.80014 | 76.29020 | 3 | 21.1 | 5.3 | 37.7 | 3.1 |
| G09 | 7/22/99 | 36.80106 | 76.28980 | 9 | 23.8 | 4 | 85.1 | 6.1 |
| G10 | 7/22/99 | 36.80123 | 76.28980 | 5 | 21.4 | 3.8 | 55.0 | 4.13 |
| G11 | 7/22/99 | 36.80101 | 76.28860 | 5 | 23 | 4.2 | 81.4 | 6.5 |
| G12 | 7/22/99 | 36.80044 | 76.28830 | 1 | 19.6 | 7.2 | 2.1 | 0.3 |
| G13 | 7/22/99 | 36.80175 | 76.28820 | 5 | 21 | 4.6 | 15.5 | 2.0 |
| G14 | 7/22/99 | 36.80043 | 76.28810 | 1 | 19.6 | 11.2 | 18.4 | 5.8 |
| G15 | 7/22/99 | 36.80219 | 76.28810 | 3 | 20 | 4.3 | 20.1 | 2.7 |
| G16 | 7/22/99 | 36.80106 | 76.28760 | 3 | 19.8 | 6.2 | 90.1 | 7.2 |
| G17 | 7/22/99 | 36.80184 | 76.28740 | 3 | 21.1 | 4.2 | 28.9 | 3.0 |
| G18 | 7/22/99 | 36.80121 | 76.28720 | 1 | 18.6 | 6.8 | 81.9 | 6.3 |
| G19 | 7/22/99 | 36.80021 | 76.28690 | 1 | 19.3 | 10.1 | 8.8 | 1.7 |
| G20 | 7/22/99 | 36.8015 | 76.28680 | 1 | 17 | 6.4 | 28.2 | 4.4 |
| G21 | 7/22/99 | 36.80118 | 76.28520 | 1 | 18.5 | 6.1 | 52.9 | 16.5 |
| G22 | 7/22/99 | 36.80268 | 76.28300 | 1 | 12.3 | 8.3 | 78.5 | 9.7 |
| G23 | 7/22/99 | 36.80264 | 76.28240 | 1 | 11 | 7.2 | 77.4 | 8.9 |
| G24 | 7/22/99 | 36.80205 | 76.28210 | 1 | 18.8 | 7 | 74.3 | 9.5 |
| G25 | 7/22/99 | 36.80277 | 76.28070 | 1 | 18.3 | 8.4 | 75.4 | 9.0 |
| G28 | 7/22/99 | 36.80071 | 76.28680 | 1 | 19.7 | 12.6 | 40.5 | 4.5 |
| G30 | 7/22/99 | 36.80206 | 76.28780 | 2 | 20.4 | 4.3 | 37.4 | 3.9 |

Table 26. Jones and Gilligan Creeks. Summary of benthic community parameters by sample.

| Station | BIBI | Abundance | Biomass | Shannon Index | Pollution Indicative Abundance | Pollution Sensitive Abundance | Pollution Indicative Biomass | Pollution Sensitive Biomass | Carnivore Omnivore Abundance |
|---|---|---|---|---|---|---|---|---|---|
| G01 | 2.000 | 1293 | 0.295 | 2.276 | 50.9 | 12.3 | 15.4 | 30.8 | 10.5 |
| G02 | 3.333 | 3130 | 1.928 | 3.134 | 42.8 | 15.2 | 2.4 | 63.5 | 18.1 |
| G04 | 3.000 | 3538 | 0.998 | 2.925 | 48.1 | 17.3 | 6.8 | 6.8 | 10.9 |
| G06 | 2.667 | 2926 | 0.885 | 3.228 | 27.9 | 31.8 | 25.6 | 15.4 | 7.8 |
| G07 | 3.000 | 1315 | 0.726 | 2.679 | 48.3 | 15.5 | 12.5 | 62.5 | 12.1 |
| G08 | 3.000 | 703 | 0.658 | 3.289 | 3.2 | 29.0 | 3.4 | 10.3 | 45.2 |
| G09 | 1.000 | 726 | 0.204 | 2.309 | 25.0 | 18.8 | 22.2 | 22.2 | 12.5 |
| G10 | 2.667 | 1361 | 0.454 | 3.196 | 25.0 | 41.7 | 15.0 | 30.0 | 25.0 |
| G11 | 2.333 | 522 | 0.295 | 2.941 | 17.4 | 39.1 | 23.1 | 30.8 | 43.5 |
| G12 | 2.333 | 2903 | 0.386 | 2.719 | 50.0 | 1.6 | 11.8 | 11.8 | 27.3 |
| G13 | 1.333 | 8301 | 1.111 | 1.914 | 61.2 | 6.6 | 24.5 | 26.5 | 2.7 |
| G14 | 2.333 | 3062 | 1.293 | 2.389 | 65.2 | 11.9 | 21.1 | 45.6 | 17.8 |
| G15 | 2.333 | 2472 | 0.612 | 2.557 | 48.6 | 3.7 | 7.4 | 3.7 | 6.4 |
| G16 | 2.000 | 386 | 0.318 | 2.534 | 17.6 | 23.5 | 7.1 | 57.1 | 23.5 |
| G17 | 1.667 | 1157 | 0.431 | 2.643 | 49.0 | 3.9 | 21.1 | 21.1 | 11.8 |
| G18 | 2.333 | 204 | 0.136 | 2.419 | 0.0 | 22.2 | 0.0 | 16.7 | 33.3 |
| G19 | 2.333 | 7326 | 1.45152 | 2.137 | 54.8 | 7.1 | 17.2 | 42.2 | 9.0 |
| G20 | 1.333 | 9049 | 1.5876 | 1.413 | 84.0 | 4.3 | 11.4 | 60.0 | 6.8 |
| G21 | 3.000 | 726 | 0.52164 | 3.524 | 21.9 | 25.0 | 8.7 | 39.1 | 28.1 |
| G22 | 2.000 | 5307 | 1.134 | 2.139 | 58.5 | 2.1 | 14.0 | 8.0 | 9.4 |
| G23 | 1.800 | 6486 | 1.40616 | 2.369 | 51.0 | 4.2 | 12.9 | 8.1 | 9.4 |
| G24 | 3.000 | 5557 | 3.24324 | 2.891 | 42.4 | 4.9 | 4.9 | 25.9 | 9.0 |
| G25 | 2.000 | 6600 | 2.268 | 2.351 | 45.7 | 2.4 | 8.0 | 2.0 | 14.8 |
| G28 | 2.667 | 4627 | 0.81648 | 2.464 | 60.3 | 10.8 | 11.1 | 41.7 | 17.6 |
| G30 | 1.667 | 8618 | 1.474 | 1.187 | 82.4 | 1.6 | 46.2 | 27.7 | 0.8 |
| | | | | | | | | | |
| Mean | 2.285 | 3532 | 0.985 | 2.545 | 43.2 | 14.3 | 14.1 | 28.4 | 16.5 |
| St Error | 0.122 | 572 | 0.147 | 0.111 | 4.3 | 2.4 | 2.0 | 3.8 | 2.3 |

Table 27. Jones-Gilligan Creek Creek. Summary of benthic community parameters scores of the B-IBI.

| Station | BIBI | Salinity Class | Sediment Class | Shannon Index | Abundance | Biomass | Pollution Indicative Abundance | Pollution Sensitive Abundance | Pollution Indicative Biomass | Pollution Sensitive Biomass | Carnivore Omnivore Abundance | Deep Deposit Feeders |
|---|---|---|---|---|---|---|---|---|---|---|---|---|

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| G01 | 2.000 | 5 | 2 | 1 | 3 | 1 | 3 | | | 3 | 1 | |
| G02 | 3.333 | 5 | 2 | 3 | 3 | 3 | 5 | | | 5 | 1 | |
| G04 | 3.000 | 5 | 1 | 3 | 5 | 1 | 3 | | 1 | | | 5 |
| G06 | 2.667 | 5 | 1 | 3 | 3 | 1 | 1 | | 3 | | | 5 |
| G07 | 3.000 | 5 | 2 | 3 | 3 | 3 | 3 | | | 5 | 1 | |
| G08 | 3.000 | 5 | 1 | 3 | 1 | 1 | 5 | | 3 | | | 5 |
| G09 | 1.000 | 5 | 2 | 1 | 1 | 1 | 1 | | | 1 | 1 | |
| G10 | 2.667 | 5 | 2 | 3 | 3 | 1 | 3 | | | 3 | 3 | |
| G11 | 2.333 | 5 | 2 | 3 | 1 | 1 | 1 | | | 3 | 5 | |
| G12 | 2.333 | 5 | 1 | 3 | 3 | 1 | 3 | | 1 | | | 3 |
| G13 | 1.333 | 5 | 1 | 1 | 1 | 3 | 1 | | 1 | | | 1 |
| G14 | 2.333 | 5 | 1 | 1 | 5 | 3 | 1 | | 1 | | | 3 |
| G15 | 2.333 | 5 | 1 | 1 | 3 | 1 | 3 | | 1 | | | 5 |
| G16 | 2.000 | 5 | 2 | 3 | 1 | 1 | 3 | | | 3 | 1 | |
| G17 | 1.667 | 5 | 1 | 1 | 1 | 1 | 1 | | 1 | | | 5 |
| G18 | 2.333 | 5 | 2 | 3 | 1 | 1 | 5 | | | 1 | 3 | |
| G19 | 2.333 | 5 | 1 | 1 | 3 | 3 | 1 | | 1 | | | 5 |
| G20 | 1.333 | 4 | 1 | 1 | 1 | 3 | | 1 | 1 | | 1 | |
| G21 | 3.000 | 5 | 2 | 5 | 1 | 3 | 3 | | | 3 | 3 | |
| G22 | 2.000 | 4 | 2 | 3 | 1 | 3 | 3 | | | 1 | 1 | |
| G23 | 1.800 | 3 | | 3 | 1 | 3 | | 1 | | 1 | | |
| G24 | 3.000 | 5 | 2 | 3 | 3 | 5 | 5 | | | 1 | 1 | |
| G25 | 2.000 | 5 | 2 | 1 | 3 | 3 | 3 | | | 1 | 1 | |
| G28 | 2.667 | 5 | 2 | 3 | 3 | 3 | 3 | | | 3 | 1 | |

Table 28. Jones-Gilligan Creek. Dominant Taxa by abundance. Taxon code: A- amphipod, B- bivalve, C - cumacean, G - gastropod, H- hemichordate, I - isopod, O - oligochaete, P -polychaete, Ph - phoronid, R - rhynchocoel

| | Name | Abundance per $m^{-2}$ |
|---|---|---|
| 1 | Streblospio benedicti (P) | 1921 |
| 2 | Tubificoides spp. Group I (O) | 240 |
| 3 | Tubificoides heterochaetus (O) | 158 |
| 4 | Caulleriella killariensis (P) | 134 |
| 5 | Leitoscoloplos spp. (P) | 134 |
| 6 | Mediomastus ambiseta (P) | 97 |
| 7 | Heteromastus filiformis (P) | 95 |
| 8 | Cyathura polita (I) | 92 |
| 9 | Capitella capitata (P) | 70 |
| 10 | Laeonereis culveri (P) | 65 |
| 11 | Hobsonia florida (P) | 64 |
| 12 | Glycinde solitaria (P) | 53 |
| 13 | Edotea triloba (I) | 50 |
| 14 | Cyclaspis varians (C) | 44 |
| 15 | Leucon americanusn (C) | 44 |

Table 29. Summary of benthic community parameters by stratum.

| Station | BIBI | Abundance | Biomass | Shannon Index | Pollution Indicative Abundance | Pollution Sensitive Abundance | Pollution Indicative Biomass | Pollution Sensitive Biomass | Carnivore Omnivore Abundance |
|---|---|---|---|---|---|---|---|---|---|
| Mainstem | | | | | | | | | |
| Mean | 2.880 | 3636 | 5.599 | 2.800 | 19.5 | 42.1 | 14.5 | 42.7 | 17.0 |
| St Error | 0.153 | 484 | 3.131 | 0.103 | 3.2 | 4.0 | 2.7 | 5.6 | 2.1 |
| Lafayette River | | | | | | | | | |
| Mean | 2.707 | 4129 | 1.709 | 2.611 | 30.3 | 27.3 | 15.5 | 30.2 | 9.3 |
| St Error | 0.161 | 421 | 0.819 | 0.106 | 3.1 | 4.4 | 3.1 | 4.5 | 1.3 |
| Eastern Branch | | | | | | | | | |
| Mean | 2.627 | 3332 | 1.447 | 2.3 | 51.4 | 9.7 | 11.0 | 18.9 | 11.6 |
| St Error | 0.152 | 285 | 0.299 | 0.2 | 4.6 | 2.3 | 1.8 | 3.5 | 1.3 |
| Western Branch | | | | | | | | | |
| Mean | 2.453 | 3038 | 0.664 | 2.5 | 40.4 | 27.9 | 16.0 | 28.3 | 10.6 |
| St Error | 0.126 | 199 | 0.055 | 0.1 | 2.3 | 2.8 | 2.7 | 3.0 | 1.1 |
| Southern Branch | | | | | | | | | |
| Mean | 2.021 | 4656 | 1.020 | 1.7 | 54.6 | 15.4 | 30.6 | 24.1 | 16.2 |
| St Error | 0.140 | 988 | 0.247 | 0.2 | 6.4 | 2.9 | 6.1 | 3.7 | 3.9 |
| Scuffletown Creek | | | | | | | | | |
| Mean | 2.347 | 4334 | 1.038 | 2.504 | 42.8 | 17.2 | 16.7 | 18.5 | 10.3 |
| St Error | 0.124 | 507 | 0.094 | 0.095 | 3.3 | 2.8 | 2.2 | 2.2 | 1.3 |
| Jones - Gilligan Creeks | | | | | | | | | |
| Mean | 2.285 | 3532 | 0.985 | 2.545 | 43.2 | 14.3 | 14.1 | 28.4 | 16.5 |
| St Error | 0.122 | 572 | 0.147 | 0.111 | 4.3 | 2.4 | 2.0 | 3.8 | 2.3 |

Table 30. Summary of area of each stratum (± 95% confidence interval) failing the Benthic Restoration Goals. Virginia Tidal Waters data is the average value for 1996-1998 for all regions from tidal freshwater through polyhaline from Dauer and Rodi (1999). The 1999 values is show separately for comparison with data of this study collected in 1999.

| Strata within the Elizabeth River | Percent Degraded | % Marginal | % Degraded | % Severely Degraded | % Degraded plus Severely Degraded |
|---|---|---|---|---|---|
| Mainstem of River | 52 ± 20 | 16 | 32 | 4 | 36 |
| Lafayette River | 64 ± 19 | 16 | 36 | 12 | 48 |
| Eastern Branch | 64 ± 19 | 12 | 40 | 12 | 52 |
| Western Branch | 72 ± 18 | 20 | 32 | 20 | 52 |
| Southern Branch | 92 ± 11 | 20 | 28 | 44 | 72 |
| Scuffletown Creek | 76 ± 17 | 16 | 36 | 24 | 60 |
| Jones/Gilligan Creek | 76 ± 17 | 12 | 40 | 24 | 64 |
| Virginia Chesapeake Bay | | | | | |
| Virginia Tidal Waters (1996-1998) | 41 ± 11 | 14 | 14 | 12 | 26 |
| Virginia Tidal Waters (1999) | 38 ± 11 | 16 | 12 | 9 | 21 |

| Table 31. Fixed Pont Stations of the Elizabeth River. Summary of physical and chemical parameters by sample. | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Station | Date collected | Latitude | Longitude | Water Depth (m) | Salinity (ppt) | Dissolved oxygen (ppm) | Silt-Clay Content (%) | Volatile Organics (%) |
| Mainstem | | | | | | | | |
| ELC1 | 8/20/99 | 36.87960 | 76.34755 | 2.000 | 21 | 4.1 | 25.8 | 1.7 |
| ELD1 | 8/13/99 | 36.86142 | 76.33573 | 1.000 | 21.9 | 7.6 | 3.2 | 4.1 |
| ELF1 | 8/13/99 | 36.84861 | 76.29667 | 5.000 | 21.8 | 5.4 | 34.1 | 5.2 |
| Southern Branch | | | | | | | | |
| SBA1 | 8/20/99 | 36.82549 | 76.29070 | 12.000 | 23.5 | 1.9 | 86.7 | 8.1 |
| SBB1 | 8/20/99 | 36.81167 | 76.28861 | 1.000 | 19.8 | 4.7 | 34.6 | 10.9 |
| SBC1 | 8/20/99 | 36.79935 | 76.29440 | 7.000 | 21 | 1.6 | 84.2 | 8.2 |
| SBD1 | 8/20/99 | 36.77962 | 76.31058 | 11.000 | 21.3 | 1.5 | 67.4 | 6.7 |
| SBD2 | 8/20/99 | 36.76675 | 76.29694 | 2.000 | 19 | 3.6 | 49.4 | 7.0 |
| SBD4 | 8/27/99 | 36.74021 | 76.29909 | 1.000 | 17 | 2.7 | 7.8 | 1.2 |
| Lafayette River | | | | | | | | |
| LFA1 | 7/30/99 | 36.90918 | 76.31378 | 2.000 | 23.1 | 7.3 | 63.3 | 3.6 |
| LFB1 | 7/30/99 | 36.88958 | 76.28303 | 3.000 | 21.2 | 5.5 | 99.1 | 7.8 |
| Western Branch | | | | | | | | |
| WBB1 | 8/13/99 | 36.84622 | 76.35761 | 1.000 | 23.2 | 6.9 | 92.3 | 6.0 |
| WBB5 | 8/13/99 | 36.82926 | 76.39316 | 1.000 | 20.7 | 6.9 | 87.4 | 7.1 |
| Eastern Branch | | | | | | | | |
| EBB1 | 8/23/99 | 36.83778 | 76.24222 | 1.000 | 16.5 | 9.3 | 47.3 | 5.1 |

| Table 32. Fixed Point Stations of the Elizabeth River. Summary of benthic community parameters by sample. | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Station | BIBI | Abundance | Biomass | Shannon Index | Pollution Indicative Abundance | Pollution Sensitive Abundance | Pollution Indicative Biomass | Pollution Sensitive Biomass | Carnivore Omnivore Abundance |
| Mainstem | | | | | | | | | |
| ELC1 | 3.444 | 3198 | 1.489 | 2.808 | 18.1 | 61.7 | 9.7 | 49.4 | 14.1 |
| ELD1 | 3.333 | 2291 | 0.990 | 2.781 | 4.4 | 74.9 | 6.2 | 32.9 | 15.7 |
| ELF1 | 2.556 | 2487 | 4.029 | 2.197 | 50.7 | 25.9 | 26.2 | 41.2 | 14.9 |
| Southern Branch | | | | | | | | | |
| SBA1 | 2.444 | 2328 | 2.170 | 2.275 | 28.2 | 10.7 | 8.1 | 7.1 | 3.9 |
| SBB1 | 1.333 | 1089 | 0.522 | 2.123 | 61.6 | 13.4 | 13.2 | 20.6 | 31.0 |
| SBC1 | 2.667 | 2003 | 1.603 | 2.870 | 47.5 | 22.7 | 49.7 | 32.5 | 16.8 |
| SBD1 | 2.333 | 1724 | 1.005 | 2.819 | 39.9 | 7.1 | 42.1 | 6.9 | 18.8 |
| SBD2 | 2.111 | 1225 | 0.265 | 2.141 | 43.3 | 25.6 | 8.7 | 17.1 | 43.8 |
| SBD4 | 2.556 | 2177 | 0.484 | 2.597 | 36.2 | 37.7 | 6.2 | 21.7 | 37.2 |
| Lafayette River | | | | | | | | | |
| LFA1 | 2.000 | 5065 | 1.285 | 2.249 | 29.0 | 63.5 | 34.7 | 30.8 | 5.2 |
| LFB1 | 1.889 | 3077 | 0.348 | 1.811 | 31.5 | 3.1 | 10.6 | 18.3 | 3.7 |
| Western Branch | | | | | | | | | |
| WBB1 | 2.222 | 2895 | 0.696 | 1.926 | 40.3 | 49.2 | 15.7 | 14.9 | 3.7 |
| WBB5 | 2.667 | 3001 | 0.862 | 2.846 | 39.0 | 21.0 | 5.4 | 23.7 | 17.9 |
| Eastern Branch | | | | | | | | | |
| EBB1 | 3.111 | 3160 | 1.043 | 2.213 | 52.7 | 17.0 | 5.7 | 37.2 | 17.4 |