13.4 North Carolina - *Comparison of Biological Metrics Derived From Ponar, Epibenthic Trawl, and Sweep Net Samples: A North Carolina Pilot Study*

13.4.1 Study Objectives

A test was designed to compare biological metrics derived from three sampling methods, to determine which methods and metrics best demonstrated differences between sampling sites (Eaton 1994).

Test data consisted of benthic assemblage collection results for petite ponar, epibenthic trawl and sweep net samples taken in the vicinity of Wilmington, North Carolina (Figure 13-1). The data set included February and May 1993 ponar samples, November 1993 trawl and sweep net samples, and February 1994 samples using each of the three collection methods.

13.4.2 Study Location

Three sampling sites were located in polyhaline (>20-ppt) waters in the Wilmington vicinity. Howe Creek, a primary nursery area north of Wilmington, was selected as a reference site. Development in the Howe Creek area was sparse residential on the north side of the creek with a new development on the south side. Samples were collected on the north side of the creek, which placed a large saltmarsh between the collection site and the development to reduce possible impacts. The Howe Creek sampling location was characterized by sand and shell substrata, abundant sponge and oyster populations, and seasonally abundant macroalgae (*Ectocarpus* and *Cladophora*).

A second sampling station (Hewletts Creek) was chosen as a test site for the assessment of nonpoint impacts. Hewletts Creek receives runoff from central Wilmington. It has occasionally received pump station overflows, and its shoreline is heavily developed with single family residences. The large quantities of macroalgae (*Enteromorpha*, *Ectocarpus*, and *Porphyra*) that have been flushed out of the creek could indicate potential excess nutrients. The Hewletts Creek station was characterized by hard-packed medium sand and shell substrates, intertidal oyster bars and saltmarsh.

A sampling station located in Bradley Creek was selected as a representative impaired area. Most of this watershed has been heavily developed, and the lower portion of the creek supports two marinas. Sampling was conducted just upstream from one large marina and immediately downstream from the U.S. Route 76 bridge. The Bradley Creek station was characterized by mud and muddy sand substrate, intertidal oyster bars, and seasonally common macroalgae (*Ectocarpus*).

13.4.3 Study Methods

Three types of gear were employed to sample the benthic assemblages at each station. A petite ponar was used to collect three replicates of 1-3 grabs each (depending on faunal density), thereby sampling the infauna in a 0.04-0.13-m^2 area at each station. An epibenthic trawl (1.25-m net mouth) was pulled over 4-m of unvegetated substrate to collect the epifauna and obligate infauna in a 5-m^2 area at each station. This method is further described in Section 9.5. A D-frame net was swept through all available habitats for 10-minutes, collecting the epifauna and shallow infauna in a 20- to 60-m^2 area. Advantages and disadvantages noted for each collection method are listed in Table 13-10.

All samples were preserved in the field with 10% formalin with Rose Bengal dye added as a tissue stain. Samples were returned to the laboratory, where they were sorted from the detritus, then identified to the lowest practical taxonomic level (usually species).

Biological metrics taken from a wide variety of sources were tested for each sampling method. It was expected that different metrics would prove useful for different sampling methods. Test

Table 13-10. Advantages and disadvantages noted for the three benthic assemblage collection methods.

METHOD	ADVANTAGES	DISADVANTAGES
Petite Ponar	• can be used in any depth water on almost all substrates (except hard bottoms). • most previous researchers used dredges, therefore some comparisons with historic data can be made. • true replication allows for statistical treatment of the data.	• it samples a relatively small area, therefore rare and/or large taxa may not be collected. • the infauna are the most tolerant portion of the benthic community, therefore minor stresses may be easily missed. • sorting through large amounts of sediment and counting hundreds of individuals of one or two taxa can become tedious.
Epibenthic Trawl	• epifauna are generally more intolerant to stresses than infauna, therefore more subtle environmental changes can be detected than with infaunal sampling. • a larger area is sampled than with dredges, therefore more rare taxa should be collected. • when operated properly, a relatively small amount of sediment is collected, therefore sorting is not tedious.	• results are not comparable with most historic databases. • the trawl is fairly unwieldy and takes training to use properly. • it is impractical to use in depths beyond 5-10 m or in strong currents (>1.5-2 m/s).
Timed Sweep	• a large number of taxa are collected including rare, large and intolerant taxa. • since metrics are more reliable when calculated with increasing observations (taxa), change in a metric is a more reliable indicator of environmental change. • being semi-quantitative, only an estimate of abundance is required rather than having to count each individual. • all habitats are sampled, therefore loss or degradation of habitat is more readily documented.	• method is limited to wadeable areas. • large amounts of sediment are usually collected, making sorting tedious. • a higher degree of taxonomic expertise is required than needed for the other methods. • results are not comparable with most historic databases.

metrics included: Farrell Biotic Index (modified for North Carolina), number of amphipods and caridian shrimp, total taxa, percent annelid abundance, percent mollusc abundance, Shannon-Wiener diversity index, amphipod abundance, polychaete abundance, molluscan abundance, gastropod abundance, bivalve abundance, capitellid polychaete abundance, spionid polychaete abundance, Hurlbert's PIE, Keefe's TU, Simpson's D, and oligochaete and pelecypod abundance (Engle et al. 1994; Farrell, 1993b, Nelson 1990, Washington 1984, Weisberg et al. 1993). All metrics were tested using the data generated from each of the three collecting methods. A metric was deemed to work if it was able to correctly rank the stations; i.e., as reference, slightly impaired, or heavily impaired. Those metrics that correctly ranked the stations were further tested on a larger database to determine if metric ranking was a spurious coincidence or was due to the measurement of a consistent component of the biological community.

13.4.4 Results

Metrics that correctly ranked the three sites and their values, are listed in Table 13-11 by sampling method. The Biotic Index was the only metric to correctly rank the sites; i.e., as reference, slightly impaired, or impaired for each of the three collection methods. For samples collected by petite ponar, the Biotic Index correctly ranked the sites for the two February samples, but failed to correctly rank the sites in May. This may be related to seasonal fluctuations in recruitment (Holland 1985). The Biotic Index as a function of salinity at 38 sites sampled via petite ponar is presented in Figure 13-3. Diamonds represent reference sites, triangles represent impacted sites and squares represent areas of intermediate or unknown water quality. Lines in the figure represent possible break points for future criteria.

Two metrics, Biotic Index (BI) and % Oligochaete and Pelecypod abundance (% O&P), correctly ranked the three sites sampled using an epibenthic trawl (Table 13-11). In February, but not in May, the %O&P was low because two taxa made up 70% of the individuals at this site. This heavy skewness in abundance may be due to seasonal recruitment. To date, these samples are the only collections made using the modified trawl. More samples are required to adequately test the efficacy of the trawl.

The sweep method had three metrics that ranked the three sites correctly (Table 13-11): Biotic Index (BI), Total Taxa (TT), and Amphipod and Caridean Shrimp Taxa (A&C). Graphs of BI, TT, and A&C values for 63 timed sweep samples over a range of salinities are presented in Figure 13-4. Each metric appeared, in varying degrees, to be affected by salinity. At sites where salinities were above 8-ppt, there was sufficient separation between Reference sites (diamonds) and Impacted (triangles) sites to identify sites with Intermediate impact (squares) as well. This separation was smaller in intermediate salinities (8-20-ppt) than higher salinities (>20-ppt). Samples collected below 8-ppt salinity showed a limited range of metric values. Only BI was able to separate Reference from Impacted sites in these low salinities.

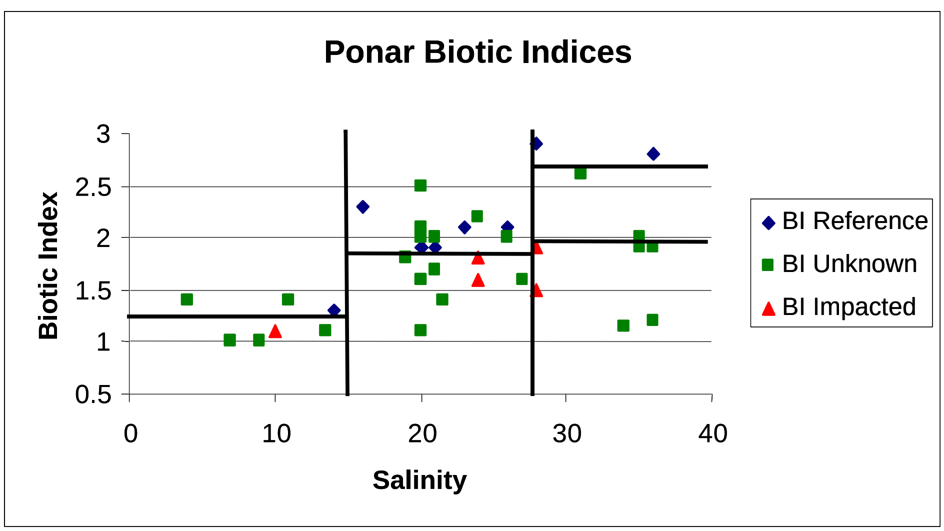
The Total Taxa metric may be related to the habitat diversity of an area; a diversity of habitats at a site would include more niches, thus allowing the survival of more taxa. This suggests that the Total Taxa metric could serve as a habitat quality measure as well as a measure of water quality.

Table 13-11. Functional metrics for the three benthic assemblage collection methods.

	Howe Creek (Reference Station)				Hewletts Creek (Nonpoint Source Impact Station)				Bradley Creek (Urban Impact Station)			
Petite Ponar												
Date	2/93	5/93	2/94	5/94	2/93	5/93	2/94	5/94	2/93	5/93	5/94	5/94
Biotic Index	2.7	2.1	2.1	1.9	2.0	1.6	2.2	1.9	1.6	1.9	1.8	1.4
Epibenthic Trawl												
Date	—	—	2/94	5/94	11/93	—	2/94	5/94	—	2/94	5/94	—
Biotic Index	—	—	2.5	2.8	2.8	—	2.4	2.7	—	1.7	2.0	—
% Oligochaeta & Pelecypoda Abundance	—	—	21	3	27	—	31	6	—	37	4	—
Timed Sweep												
Date	—	—	2/94	5/94	11/93	—	2/94	5/94	11/93	2/94	5/94	—
Biotic Index	—	—	2.4	2.5	2.2	—	2.2	2.0	1.8	1.8	1.9	—
Total taxa	—	—	109	95	94	—	91	105	45	60	68	—
Amphipoda & Caridean shrimp	—	—	17	22	9	—	9	15	7	7	9	—

Figure 13-3

Ponar samples: biotic index vs. salinity



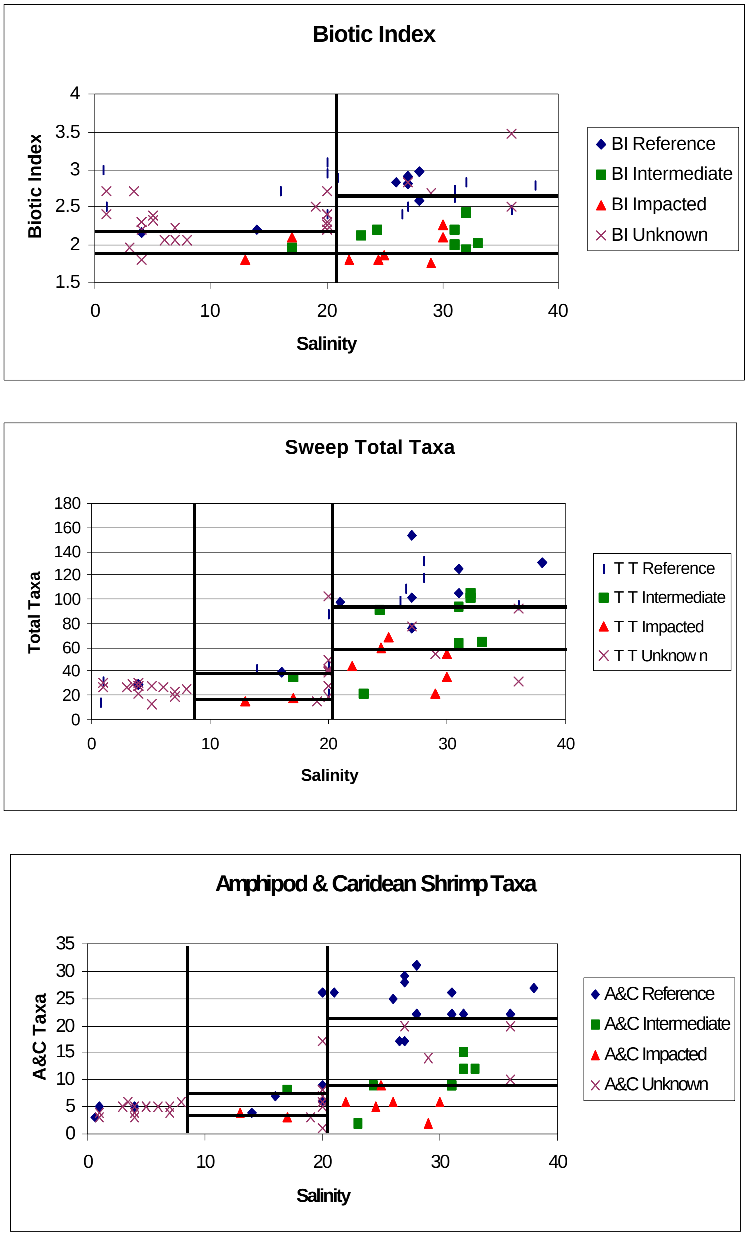


Figure 13-4

BI, total taxa and amphipod and caridean taxa by salinity.

Amphipods and caridean shrimp make up 10-15% of the total taxa at a site. This correlation explains why the graphs of the TT and A&C metrics look similar. Since the Crustacea include many of the most intolerant taxa in the estuary, the A&C metric may prove to be more sensitive to slight differences in water quality than the other metrics tested. One potential problem with the A&C metric is that it, like TT, appears to be affected by habitat quality, especially the presence or absence of seagrass and shells.

The next step, following method selection and metric determination, was biocriteria development. In this exercise, sweep samples at sites above 8-ppt were used because multiple metrics had been identified which showed a range of water qualities. For each metric, a value above the Reference/Intermediate line (Figure 13-4) was scored five points whereas a value below the Intermediate/ Impacted line was scored 1. To increase sensitivity, the Intermediate Impact area was subdivided: values in the upper 20% were scored 4 points, values in the middle 60% were scored 3 points, and values in the lower 20% were scored 2 points. Points for each of the three metrics were summed, giving each site a total score between 3 and 15 points. Water quality bioclassifications were assigned based on the number of points scored by a site (Figure 13-5).

An attempt was made, in step three of biocriteria assignment, to address natural situations where Taxa Richness was depressed at a site (little habitat diversity, wide salinity swings, or high wave action). If one or more of these situations could be identified for a site, an extra two points were awarded to the total score. While this appears to adequately correct a previously unaddressed problem in biocriteria development, assessment of the usefulness of this approach must await a validation study, which is beyond the scope of the exercise described here.

13.4.5 Summary

Test results indicated that there was no metric which consistently ranked the test stations in *a priori* order of impact based on petite ponar collections, though this may have been due to confounding by a spring peak in recruitment. The Biotic Index ranked sites correctly most often. Epibenthic trawl results correctly ranked the test sites using the Biotic Index and percent abundance of Oligochaeta and Pelecypoda metrics. Further sampling with the epibenthic trawl is required to determine whether it or the ponar will give more reliable results in non-wadable areas. The sweep method appeared to be the most versatile of the three test methods, resulting in three metrics that correctly ranked the test sites. All metrics appeared to lose sensitivity at salinities below 20-ppt. Possible seasonal effects and differences in substrate appeared to be confounding the analyses as well; therefore, these factors must be taken into account during the biocriteria development process. The Biotic Index appeared to be the most versatile tool since it was the only metric to correctly rank sites for all methods and all salinities. Initial efforts at biocriteria development in North Carolina will focus on the Biotic Index as well as on further sampling to determine the effects of seasonality, substrate, salinity, and habitat variables.

Figure 13-5

Development of biocriteria.

STEP 1: Assign points for each of three metrics from a sweep sample.

Polyhaline (21 ppt to seawater)

Points	5	4	3	2	1
BI	≥ 2.6	2.59 - 2.5	2.49 - 2.01	2.0 - 1.91	≤ 1.9
Total Taxa	≥ 95	94 - 86	85 - 69	68 - 60	< 60
Amphipods & Caridean Shrimp	≥ 21	20 - 18	17 - 13	12 - 10	9 - 0

Mesohaline (8 ppt to 20 ppt)

Points	5	4	3	2	1
BI	≥ 2.2	2.2 - 2.16	2.15 - 1.96	1.95 - 1.9	< 1.9
Total Taxa	≥ 38	37 - 32	31 - 24	23 - 18	17 - 0
Amphipods & Caridean Shrimp	≥ 8	7	6 - 5	4	3 - 0

STEP 2: Sum points. This will yield a number between 3 and 15.

STEP 3: Check for Bonus Point conditions. Add 2 points to score if one or more of the following conditions occurred: 1) Homogeneous habitat, 2) consistently high wave action, 3) very high (>26 ppt/yr) salinity fluctuations.

STEP 4: Assign Bioclassification.

Bioclassification	Points
No Impact	13-15
Slight Impact	11-12
Moderate Impact	8-10
Elevated Impact	6-7
Severe Impact	3-5

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