Carolinian Province, North Carolina Benthic Community Assessment

Submitted to

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INTRODUCTION

The Pamlico-Albemarle-Currituck Sounds in North Carolina were sampled during the summer of 1996 as part of the EMAP Carolinian Province sampling program. One aspect of this evaluation was benthic community characterization, which was accomplished via sample collection by National Oceanic and Atmospheric Administration (NOAA) personnel and laboratory and data analysis by Barry A. Vittor & Associates, Inc. (BVA).

The Carolinian Province region and 1996 EMAP sampling stations are indicated in Figures 1 and 2.

METHODS

Sample Collection And Handling

A Young dredge (area = 0.04 m^2) was used to collect replicate bottom samples at each of 42 stations in Pamlico, Albemarle and Currituck Sounds, North Carolina. Macroinfaunal samples were sieved through a 0.5-mm mesh screen and preserved with 10% formalin on ship. Macroinfaunal samples were transported to the BVA laboratory in Mobile, Alabama.

Macroinfaunal Sample Analysis

In the BVA laboratory, benthic samples were inventoried, rinsed gently through a 0.5-mm mesh sieve to remove preservatives and sediment, stained with Rose Bengal, and stored in 70% isopropanol solution until processing. Sample material (sediment, detritus, organisms) was placed in white enamel trays for sorting under Wild M-5A dissecting microscopes. All macroinvertebrates were carefully removed with forceps and placed in labelled glass vials containing 70% isopropanol. Each vial represented a major taxonomic group (*e.g.* Polychaeta, Mollusca, Arthropoda). All sorted macroinvertebrates were identified to the lowest practical identification level (LPIL), which in most cases was to species level unless the specimen was a juvenile, damaged, or otherwise unidentifiable. The number of individuals of each taxon, excluding fragments, was recorded. A voucher collection was prepared, composed of representative individuals of each species not previously encountered in samples from the region.

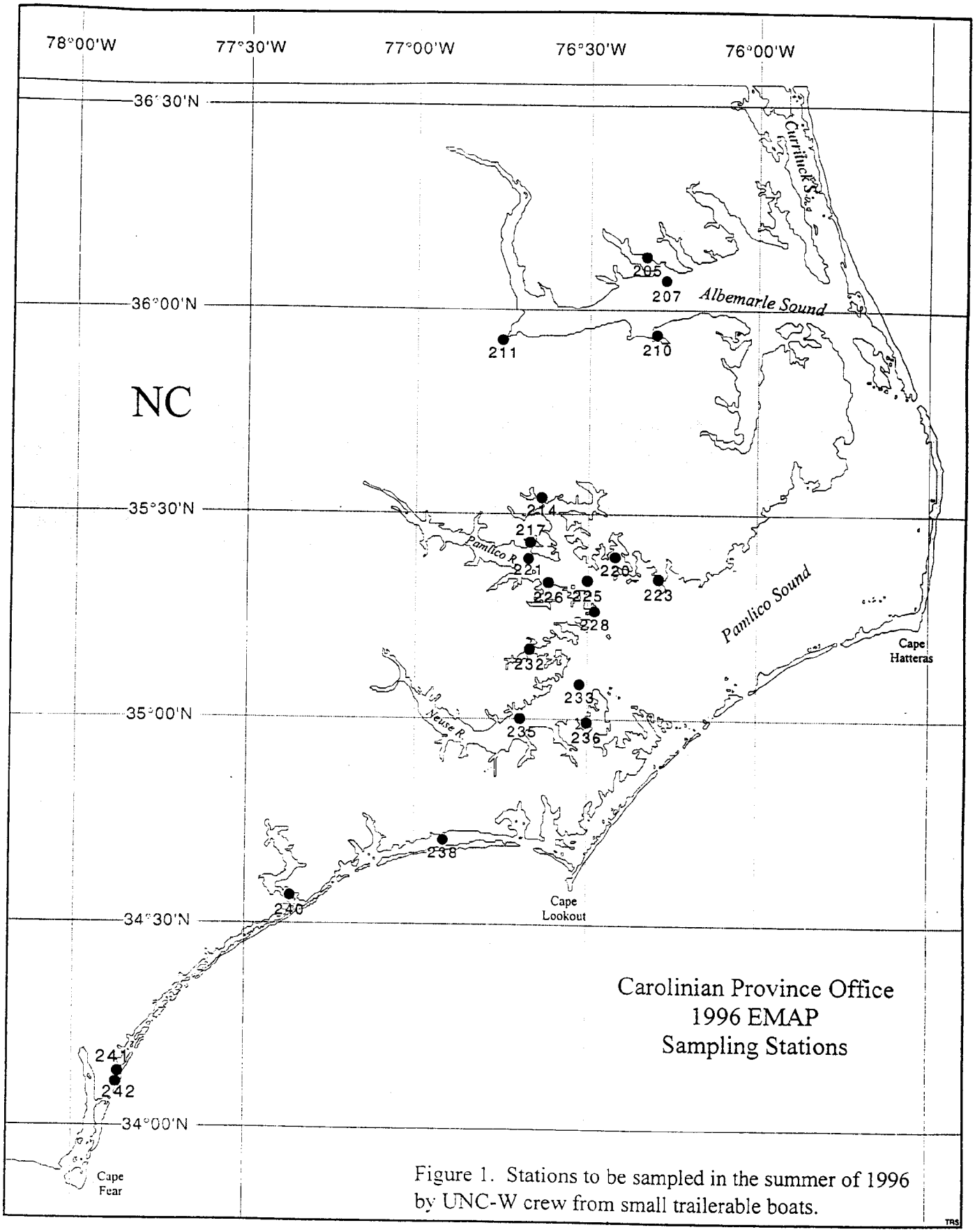


Figure 1. Stations to be sampled in the summer of 1996 by UNC-W crew from small trailerable boats.

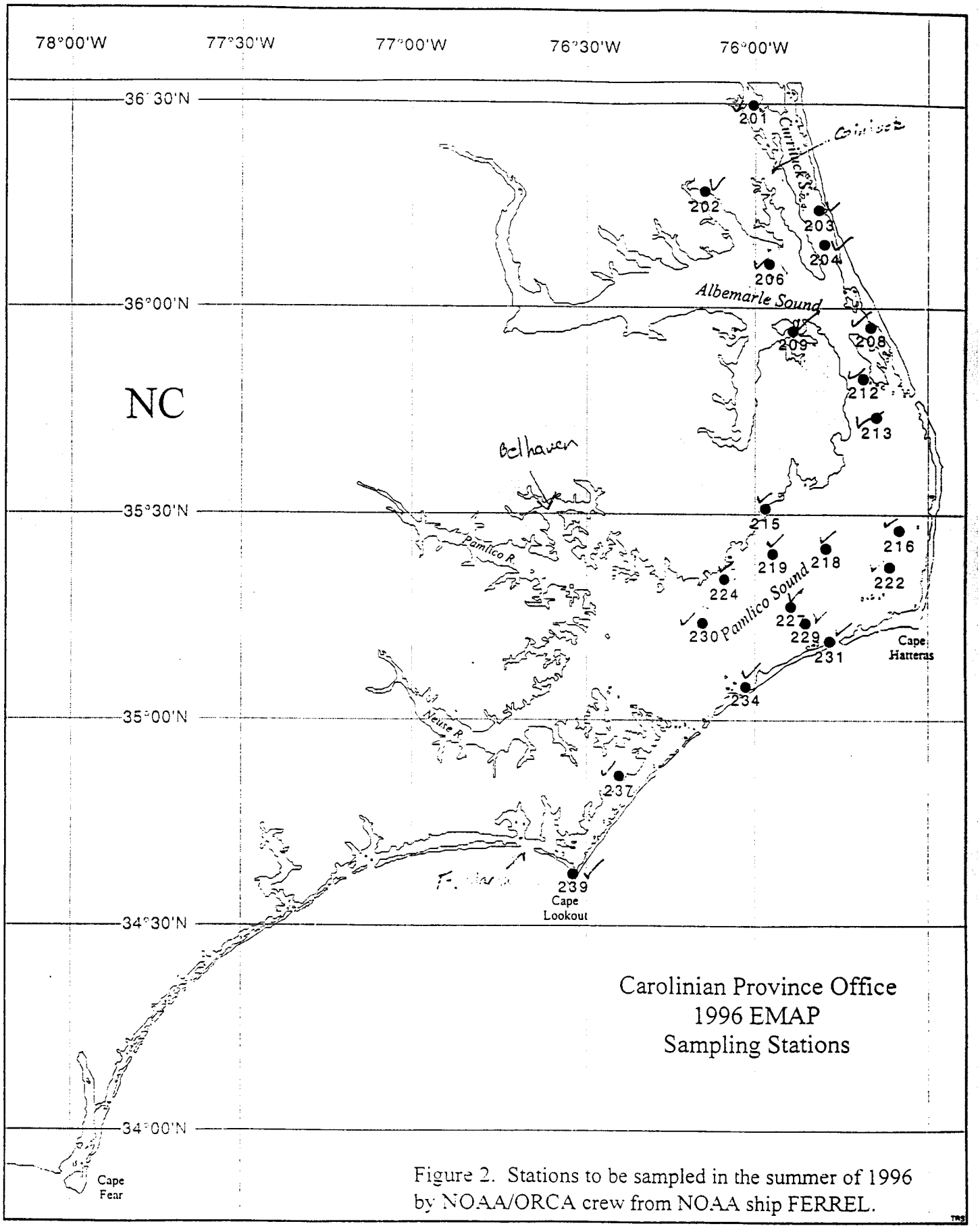


Figure 2. Stations to be sampled in the summer of 1996 by NOAA/ORCA crew from NOAA ship FERREL.

DATA ANALYSIS

All data generated as a result of laboratory analysis of macroinfauna samples were first coded on data sheets. Enumeration data were entered for each species according to station and replicate. These data were reduced to a data summary report for each station, which included a taxonomic species list and benthic community parameters information. Archive data files of species identification and enumeration were prepared.

The QA and QC reports for the Carolinian Province samples are given in the Appendix.

The analytical methodologies utilized for this study were similar to those used in similar benthic community characterization reports prepared for other state and federal agency surveys. Macroinfaunal characterization involves an evaluation of several biological community structure parameters (*e.g.*, species abundance, species composition and species diversity indices) during initial data reduction, followed by pattern and classification analysis for delineation of species assemblages. Since species are distributed along environmental gradients, there are generally no distinct boundaries between communities. However, the relationships between habitats and species assemblages often reflect the interactions of physical and biological factors and indicate major ecological trends.

Assemblage Structure

Several numerical indices were chosen for analysis and interpretation of the macroinfaunal data. Selection was based primarily on the ability of the index to provide a meaningful summary of data, as well as the applicability of the index to the characterization of the benthic community. Infaunal abundance is reported as the total number of individuals per station and the total number of individuals per square meter (= density). Species richness is reported as the total number of taxa represented in a given station collection.

Taxa diversity, which is often related to the ecological stability and environmental "quality" of the benthos, was estimated by the Pielou's Index (Pielou, 1966), according to the following

formula:

$$H' = -\sum_{i=1}^{s} p_i(\ln p_i)$$

where, S = is the number of taxa in the sample,

i = is the i'th taxa in the sample, and

p_i = is the number of individuals of the i'th taxa divided by the total number of individuals in the sample.

Taxa diversity within a given community is dependent upon the number of taxa present (taxa richness) and the distribution of all individuals among those taxa (equitability or evenness). In order to quantify and compare the equitability in the fauna to the taxa diversity for a given area, Pielou's Index J' (Pielou, 1966) was calculated as J' = H'/lnS, where $ln S = H'_{max}$, or the maximum possible diversity, when all taxa are represented by the same number of individuals; thus, $J' = H' / H'_{max}$.

Macroinfaunal data were graphically and statistically analyzed to identify any differences in density between stations. Data for total density were variously transformed and tested for normality (Shapiro-Wilk W; SAS Institute, 1995). Data could not be normalized with standard transformations [*e.g.* ln(x+1), √(x+1)], so data were analyzed using non-parametric methods [*e.g.*, Wilcoxon/Kruskal-Wallis Chi-squared (c^2) test; SAS Institute, 1995].

Faunal Similarities

Numerical classification analysis (Boesch 1977) was performed on the faunal data to examine within- and between- stations differences at the Carolinian Province sites and to compare faunal composition at each station within the site. Both normal and inverse classification analyses were used in this study. Normal analysis (sometimes called Q-analysis) treats samples as individual observations, each being composed of a number of attributes (*i.e.* the various species

from a given sample). Normal analysis is instructive in helping to ascertain community structure and to infer specific ecological conditions between sampling stations from the relative distributions of species. Inverse classification (termed R-analysis) is based on species as individuals, each of which is characterized by its relative abundance in the various samples. This type of analysis is commonly used to identify species groupings with particular habitats or environmental conditions.

Classification analysis of both station collections (normal analysis) and species (inverse analysis) was performed using the Czekanowski quantitative index of faunal similarity (Field and MacFarlane 1968). This index is computationally equivalent to the Bray-Curtis similarity measure (Bray and Curtis 1957). The value of the similarity index is 1.0 when two samples are identical and 0 when no species are in common. Hierarchical clustering of similarity values is achieved using the group-average sorting strategy (Lance and Williams 1967) and displayed in the form of dendrograms.

Both similarity classification and cluster analysis were performed using the microcomputer package, "Community Analysis System 5.0" (Bloom 1994), as modified for use in BVA's benthic data management program. Taxa used in these analyses were selected according to their percent abundance and percent frequency. Total densities for each of the selected taxa at a given station were log-transformed [x=ln(x+1)] for the analysis.

BENTHIC COMMUNITY CHARACTERIZATION

Faunal Composition, Abundance, And Community Structure

Table 1 provides a complete phylogenetic listing for all stations as well as data on taxa abundance and station occurrence. Four Microsoft ™Excel 5.0 (Macintosh version) spreadsheets are being provided separately to NOAA which include: raw data on taxa abundance and density by replicate, a complete taxonomic listing with station abundance and occurrence, a major taxa table with overall taxa abundance, and an assemblage parameter table including data on mean number of taxa, mean density, taxa diversity and taxa evenness by station.

A total of 4,386 organisms, representing 183 taxa, were identified from the 42 stations (Table 2). Polychaetes were the most numerous organisms present representing 46.6% of the total

Table 1. Abundance and distribution of taxa for the EMAP Carolinian Province, North Carolina stations, 1996. Taxa above the shaded line were included in the classification analysis.

Taxa	Phylum	Class	No. Inds.	% Total	Cumul. %	Station Occur.	% Station Occurr	Comments
Mediomastus (LPIL)	A	Poly	773	17.62	17.62	32	76.2	anterior portions only, probably *M . ambiseta* pygidium needed for species ID
Streblospio benedicti	A	Poly	253	5.77	23.39	22	52.4	
Acteocina canaliculata	M	Gast	250	5.70	29.09	18	42.9	
Lucina multilineata	M	Biva	190	4.33	33.42	12	28.6	
Acanthohaustorius millsi	Ar	Mala	182	4.15	37.57	5	11.9	
Marenzellaria viridis	A	Poly	163	3.72	41.29	10	23.8	
Heteromastus filiformis	A	Poly	155	3.53	44.82	13	31	
Mulinia lateralis	M	Biva	149	3.40	48.22	13	31	
Macoma balthica	M	Biva	148	3.37	51.59	7	16.7	
Tellinidae (LPIL)	M	Biva	108	2.46	54.05	14	33.3	crushed, and/or juvenile specimens
Macoma tenta	M	Biva	98	2.23	56.29	11	26.2	
Coelotanypus (LPIL)	Ar	Inse	85	1.94	58.23	9	21.4	4th instar, associated pupae, or adult needed for species ID
Chironomus (LPIL)	Ar	Inse	82	1.87	60.10	5	11.9	4th instar, associated pupae, or adult needed for species ID
Tubulanus (LPIL)	R		75	1.71	61.81	15	35.7	genus is lowest idetification level
Paraprionospio pinnata	A	Poly	72	1.64	63.45	16	38.1	
Cyathura polita	Ar	Isop	62	1.41	64.86	9	21.4	
Rangia cuneata	M	Biva	60	1.37	66.23	13	31	
Astarte nana	M	Biva	57	1.30	67.53	8	19	
Bivalvia (LPIL)	M	Biva	57	1.30	68.83	17	40.5	crushed, and/or juvenile specimen
Leitoscoloplos robustus	A	Poly	55	1.25	70.08	11	26.2	
Cirratulidae (LPIL)	A	Poly	46	1.05	71.13	5	11.9	anterior fragment, posterior needed for species ID
Glycinde solitaria	A	Poly	46	1.05	72.18	12	28.6	
Haustoriidae (LPIL)	Ar	Mala	45	1.03	73.21	3	7.1	damaged or missing diagnostic characters
Linopherus sp.A	A	Poly	41	0.93	74.14	9	21.4	
Phoronis (LPIL)	Ph		41	0.93	75.08	14	33.3	genus is lowest identification level
Nereis succinea	A	Poly	40	0.91	75.99	3	7.1	
Rhynchocoela (LPIL)	R		36	0.82	76.81	22	52.4	no identifible characters
Laeonereis culveri	A	Poly	33	0.75	77.56	4	9.5	
Tellina agilis	M	Biva	32	0.73	78.29	4	9.5	
Protohaustorius sp.B	Ar	Mala	30	0.68	78.97	2	4.8	
Lineidae (LPIL)	R		30	0.68	79.66	14	33.3	family is lowest identification level
Oligochaeta (LPIL)	A	Olig	29	0.66	80.32	9	21.4	marine and some estuarine specimens only identified to class
Parahaustorius longimerus	Ar	Mala	29	0.66	80.98	1	2.4	
Apoprionospio pygmaea	A	Poly	28	0.64	81.62	6	14.3	
Sigambra tentaculata	A	Poly	28	0.64	82.26	8	19	
Listriella barnardi	Ar	Mala	23	0.52	82.78	6	14.3	
Mediomastus ambiseta	A	Poly	22	0.50	83.28	6	14.3	
Tharyx acutus	A	Poly	22	0.50	83.79	6	14.3	
Cerithium (LPIL)	M	Gast	22	0.50	84.29	2	4.8	juvenile specimen
Amphicteis gunneri	A	Poly	21	0.48	84.77	2	4.8	
Leitoscoloplos (LPIL)	A	Poly	21	0.48	85.24	6	14.3	anterior segments only, abdomenal segments necessary for species ID
Caecum pulchellum	M	Gast	21	0.48	85.72	1	2.4	
Tagelus plebeius	M	Biva	20	0.46	86.18	1	2.4	
Tubificidae (LPIL)	A	Olig	19	0.43	86.61	9	21.4	sexually immature
Ampelisca sp.X	Ar	Mala	19	0.43	87.05	4	9.5	
Rictaxis punctostriatus	M	Gast	19	0.43	87.48	3	7.1	
Hydrobiidae (LPIL)	M	Gast	18	0.41	87.89	3	7.1	crushed shell and/or juvenile specimen
Actiniaria (LPIL)	Cn	Anth	17	0.39	88.28	6	14.3	order is lowest identification level
Scoloplos rubra	A	Poly	15	0.34	88.62	6	14.3	
Corophium lacustre	Ar	Mala	15	0.34	88.96	2	4.8	
Leptocheirus plumulosus	Ar	Mala	15	0.34	89.30	2	4.8	
Haminoea succinea	M	Gast	15	0.34	89.64	4	9.5	
Spionidae (LPIL)	A	Poly	14	0.32	89.96	8	19	missing identificaton characters and/or immature
Clymenella torquata	A	Poly	13	0.30	90.26	4	9.5	
Edotia triloba	Ar	Isop	12	0.27	90.53	7	16.7	
Hexagenia limbata	Ar	Inse	12	0.27	90.81	1	2.4	
Brania wellfleetensis	A	Poly	11	0.25	91.06	1	2.4	
Nephtys picta	A	Poly	11	0.25	91.31	4	9.5	
Spiochaetopterus oculatus	A	Poly	11	0.25	91.56	7	16.7	
Hargeria rapax	Ar	Mala	10	0.23	91.79	2	4.8	
Gemma gemma	M	Biva	10	0.23	92.02	1	2.4	
Macoma (LPIL)	M	Biva	10	0.23	92.24	5	11.9	
Glycera dibranchiata	A	Poly	9	0.21	92.45	6	14.3	
Spiophanes bombyx	A	Poly	9	0.21	92.65	6	14.3	
Tubificoides (LPIL)	A	Olig	9	0.21	92.86	4	9.5	
Tellina (LPIL)	M	Biva	9	0.21	93.06	4	9.5	
Magelona annulata	A	Poly	8	0.18	93.25	4	9.5	
Ampeliscidae (LPIL)	Ar	Mala	8	0.18	93.43	1	2.4	
Aoridae (LPIL)	Ar	Mala	8	0.18	93.61	2	4.8	
Gammarus sp.A	Ar	Mala	8	0.18	93.79	1	2.4	
Balanoglossus (LPIL)	He		8	0.18	93.98	4	9.5	
Mactridae (LPIL)	M	Biva	8	0.18	94.16	4	9.5	
Tellina iris	M	Biva	8	0.18	94.34	1	2.4	
Glycera americana	A	Poly	7	0.16	94.50	3	7.1	
Nereidae (LPIL)	A	Poly	7	0.16	94.66	3	7.1	
Chironomidae (LPIL)	Ar	Inse	7	0.16	94.82	2	4.8	

Table 1 continued:

Loimia medusa	A	Poly	6	0.14	94.96	4	9.5
Phyllodocidae (LPIL)	A	Poly	6	0.14	95.09	4	9.5
Polydora cornuta	A	Poly	6	0.14	95.23	3	7.1
Procladius (LPIL)	Ar	Inse	6	0.14	95.37	5	11.9
Aglaophamus verrilli	A	Poly	5	0.11	95.48	2	4.8
Dipolydora socialis	A	Poly	5	0.11	95.60	1	2.4
Nereis (LPIL)	A	Poly	5	0.11	95.71	3	7.1
Parahaustorius (LPIL)	Ar	Mala	5	0.11	95.82	1	2.4
Phascolion strombi	S		5	0.11	95.94	3	7.1
Aricidea (LPIL)	A	Poly	4	0.09	96.03	2	4.8
Armandia agilis	A	Poly	4	0.09	96.12	1	2.4
Phyllodoce mucosa	A	Poly	4	0.09	96.21	1	2.4
Scolelepis texana	A	Poly	4	0.09	96.30	3	7.1
Ampelisca (LPIL)	Ar	Mala	4	0.09	96.39	4	9.5
Corophium (LPIL)	Ar	Mala	4	0.09	96.48	1	2.4
Cyathura (LPIL)	Ar	Isop	4	0.09	96.58	4	9.5
Leptocheirus (LPIL)	Ar	Mala	4	0.09	96.67	2	4.8
Monoculodes edwardsi	Ar	Mala	4	0.09	96.76	1	2.4
Ogyrides alphaerostris	Ar	Mala	4	0.09	96.85	2	4.8
Leptosynapta tenuis	E	Holo	4	0.09	96.94	3	7.1
Ancistrosyllis hartmanae	A	Poly	3	0.07	97.01	2	4.8
Aricidea sp.E	A	Poly	3	0.07	97.08	1	2.4
Goniada littorea	A	Poly	3	0.07	97.15	1	2.4
Prionospio (LPIL)	A	Poly	3	0.07	97.21	1	2.4
Cyathura burbancki	Ar	Isop	3	0.07	97.28	1	2.4
Pinnotheridae (LPIL)	Ar	Mala	3	0.07	97.35	2	4.8
Sialis (LPIL)	Ar	Inse	3	0.07	97.42	1	2.4
Donax variabilis	M	Biva	3	0.07	97.49	1	2.4
Dosinia discus	M	Biva	3	0.07	97.56	2	4.8
Gastropoda (LPIL)	M	Gast	3	0.07	97.62	2	4.8
Nassarius vibex	M	Gast	3	0.07	97.69	2	4.8
Ancistrosyllis jonesi	A	Poly	2	0.05	97.74	2	4.8
Capitellidae (LPIL)	A	Poly	2	0.05	97.78	2	4.8
Cirrophorus lyra	A	Poly	2	0.05	97.83	1	2.4
Drilonereis longa	A	Poly	2	0.05	97.88	2	4.8
Goniada maculata	A	Poly	2	0.05	97.92	1	2.4
Leitoscoloplos acutus	A	Poly	2	0.05	97.97	2	4.8
Limnodrilus profundicola	A	Olig	2	0.05	98.01	1	2.4
Magelona (LPIL)	A	Poly	2	0.05	98.06	2	4.8
Owenia fusiformis	A	Poly	2	0.05	98.10	1	2.4
Paraonidae (LPIL)	A	Poly	2	0.05	98.15	2	4.8
Paraonis fulgens	A	Poly	2	0.05	98.19	2	4.8
Prionospio heterobranchia	A	Poly	2	0.05	98.24	1	2.4
Sigambra bassi	A	Poly	2	0.05	98.29	2	4.8
Brachiopoda (LPIL)	B		2	0.05	98.33	1	2.4
Aeginellidae (LPIL)	Ar	Mala	2	0.05	98.38	2	4.8
Oedicerotidae (LPIL)	Ar	Mala	2	0.05	98.42	2	4.8
Parahaustorius attenuatus	Ar	Mala	2	0.05	98.47	1	2.4
Ophiuroidea (LPIL)	E	Ophi	2	0.05	98.51	2	4.8
Cryptochironomus (LPIL)	Ar	Inse	2	0.05	98.56	2	4.8
Dolichopodidae (LPIL)	Ar	Inse	2	0.05	98.60	1	2.4
Tanytarsus (LPIL)	Ar	Inse	2	0.05	98.65	2	4.8
Chione cancellata	M	Biva	2	0.05	98.70	2	4.8
Lucinidae (LPIL)	M	Biva	2	0.05	98.74	2	4.8
Mitrella lunata	M	Gast	2	0.05	98.79	2	4.8
Odostomia weberi	M	Gast	2	0.05	98.83	2	4.8
Ancistrosyllis (LPIL)	A	Poly	1	0.02	98.86	1	2.4
Asychis elongatus	A	Poly	1	0.02	98.88	1	2.4
Carazziella hobsonae	A	Poly	1	0.02	98.90	1	2.4
Caulleriella (LPIL)	A	Poly	1	0.02	98.92	1	2.4
Ceratonereis irritabilis	A	Poly	1	0.02	98.95	1	2.4
Chaetopteridae (LPIL)	A	Poly	1	0.02	98.97	1	2.4
Chaetopterus variopedatus	A	Poly	1	0.02	98.99	1	2.4
Cirrophorus (LPIL)	A	Poly	1	0.02	99.02	1	2.4
Exogone rolani	A	Poly	1	0.02	99.04	1	2.4
Galathowenia oculata	A	Poly	1	0.02	99.06	1	2.4
Glyceridae (LPIL)	A	Poly	1	0.02	99.08	1	2.4
Goniadidae (LPIL)	A	Poly	1	0.02	99.11	1	2.4
Grubeosyllis clavata	A	Poly	1	0.02	99.13	1	2.4
Hirudinea (LPIL)	A	Hiru	1	0.02	99.15	1	2.4
Leitoscoloplos fragilis	A	Poly	1	0.02	99.17	1	2.4
Lumbrineridae (LPIL)	A	Poly	1	0.02	99.20	1	2.4
Magelona riojai	A	Poly	1	0.02	99.22	1	2.4
Mesochaetopterus (LPIL)	A	Poly	1	0.02	99.24	1	2.4
Nephtys bucera	A	Poly	1	0.02	99.27	1	2.4
Notomastus (LPIL)	A	Poly	1	0.02	99.29	1	2.4
Notomastus lobatus	A	Poly	1	0.02	99.31	1	2.4

Table 1 continued:

Pectinaria gouldii	A	Poly	1	0.02	99.33	1	2.4
Phyllodoce arenae	A	Poly	1	0.02	99.36	1	2.4
Pilargidae (LPIL)	A	Poly	1	0.02	99.38	1	2.4
Schistomeringos rudolphi	A	Poly	1	0.02	99.40	1	2.4
Spio pettiboneae	A	Poly	1	0.02	99.43	1	2.4
Syllidae (LPIL)	A	Poly	1	0.02	99.45	1	2.4
Acanthohaustoriu s (LPIL)	Ar	Mala	1	0.02	99.47	1	2.4
Acuminodeutopus naglei	Ar	Mala	1	0.02	99.49	1	2.4
Argulus (LPIL)	Ar	Bran	1	0.02	99.52	1	2.4
Erichsonella attenuata	Ar	Mala	1	0.02	99.54	1	2.4
Erichthonius brasiliensis	Ar	Mala	1	0.02	99.56	1	2.4
Gammarus (LPIL)	Ar	Mala	1	0.02	99.59	1	2.4
Pinnixa (LPIL)	Ar	Mala	1	0.02	99.61	1	2.4
Synchelidium americanum	Ar	Mala	1	0.02	99.63	1	2.4
Ablabesmyia annulata	Ar	Inse	1	0.02	99.65	1	2.4
Ceratopogonidae (LPIL)	Ar	Inse	1	0.02	99.68	1	2.4
Chaoborus (LPIL)	Ar	Inse	1	0.02	99.70	1	2.4
Cladotanytarsus (LPIL)	Ar	Inse	1	0.02	99.72	1	2.4
Polypedilum halterale Grou	Ar	Inse	1	0.02	99.74	1	2.4
Astarte (LPIL)	M	Biva	1	0.02	99.77	1	2.4
Mytilidae (LPIL)	M	Biva	1	0.02	99.79	1	2.4
Mytilopsis leucophaeata	M	Biva	1	0.02	99.81	1	2.4
Spisula solidissima	M	Biva	1	0.02	99.84	1	2.4
Tectonatica pusilla	M	Gast	1	0.02	99.86	1	2.4
Turbonilla (LPIL)	M	Gast	1	0.02	99.88	1	2.4
Turbonilla interrupta	M	Gast	1	0.02	99.90	1	2.4
Urosalpinx cinera	M	Gast	1	0.02	99.93	1	2.4
Veneridae (LPIL)	M	Biva	1	0.02	99.95	1	2.4
Turbellaria (LPIL)	P	Turb	1	0.02	99.97	1	2.4
Ascidiacea (LPIL)	U	Asci	1	0.02	100.00	1	2.4

TAXA KEY

Phylum
Class

A = Annelida
Hiru = Hirudinea
Olig = Oligochaeta
Poly = Polychaeta
B = Brachiopoda
Ar = Arthropoda
Bran = Branchiura
Mala = Malacostraca
Cuma = Cumacea
Deca = Decapoda
Isop = Isopoda
Lept = Leptostraca
Mysi = Mysidacea
Ostr = Ostracoda
Inse = Insecta
Tana = Tanaidacea
Ce = Cephalochordata
Cn = Cnidaria
Anth = Anthozoa
E = Echinodermata
Aste = Asteroidea
Holo = Holothuroidea
Ophi = Ophiuroidea
He = Hemichordata
M = Mollusca
Gast = Gastropoda
Biva = Bivalvia
Polyp = Polyplacophora
Scap = Scaphopoda
Ph = Phoronida
P = Platyhelminthes
Turb = Turbellaria
R = Rhynchocoela
S = Sipuncula
U = Urochordata
Asci = Ascidiacea

Table 2. Summary of abundance of major taxonomic groups for the EMAP Carolinian Province, North Carolina stations, 1996.

Taxa	Total No. Inds.	% Total	Total No. Taxa	% Total
Annelida				
Polychaeta	2045	46.6	80	43.7
Oligochaeta	59	1.3	4	2.2
Hirudinea	1	0.0	1	0.5
Mollusca				
Pelecypoda	979	22.3	24	13.1
Gastropoda	359	8.2	14	7.7
Crustacea				
Amphipoda	414	9.4	24	13.1
Other Crustacea	101	2.3	10	5.5
Insecta				
Diptera	191	4.4	12	6.6
Other Insecta	15	0.3	2	1.1
Other Taxa	222	5.1	12	6.6
TOTAL	**4386**		**183**	

assemblage, followed in abundance by bivalves (22.3%), amphipods (9.4%), gastropods (8.2%) and dipterans (4.4%). Polychaetes represented 43.7% of the total number of taxa followed by bivalves (13.1%), amphipods (13.1%), gastropods (7.7%) and dipterans (6.6%) (Table 2). The percentage abundance of the major taxa at the 42 stations is given in Figure 3.

The dominant taxon collected from the samples was the polychaete, *Mediomastus* (LPIL) representing 17.6% of the total number of individuals identified (note that *Mediomastus* (LPIL) is most probably *Mediomastus ambiseta*; Table 1). The polychaete, *Streblospio benedicti* (5.8%) and the gastropod, *Acteocina canaliculata* (5.7%) were the only other taxa representing greater that 5% of the total number of organisms identified (Table 1). *Mediomastus* (LPIL) was the most widely distributed taxon being found at 76% of the stations. *Streblospio benedicti*, rhynchocoels and *A. canaliculata* were found at 52%, 52% and 43% of the stations, respectively (Table 1). The distribution of dominant taxa representing >10% of the total assemblage at each station is given in Table 3.

Station mean density and mean number of taxa data are given in Table 4 and Figures 4 and 5. Mean densities ranged from 80 organisms!m^{-2} at Station 221 to 8350 organisms!m^{-2} at Station 214 (Table 4; Figure 4). There were significant differences in densities between stations (0^2 = 83.68, df = 41, Prob > 0^2 = 0.0001; Table 4; Figure 4). The mean number of taxa per replicate ranged from 1.5 at Station 206 to 28 at Station 239 (Table 4; Figure 5).

Taxa diversity and evenness are given in Table 4 and Figures 6 and 7. Taxa diversity (H') ranged from 0.30 at Station 206 to 3.03 at Station 227. Taxa evenness (J) ranged from 0.40 at Station 214 to 0.97 at Station 233.

Numerical Classification Analysis

Normal (stations) and inverse (species) classification analyses were performed on the Carolinian Province data set and displayed as dendrograms (Figures 8 and 9). Selection of the species included in the analyses was based on a minimum representation of 0.27% of total

Figure 3. Percent abundance of major taxa for the EMAP Carolinian Province stations, 1996.

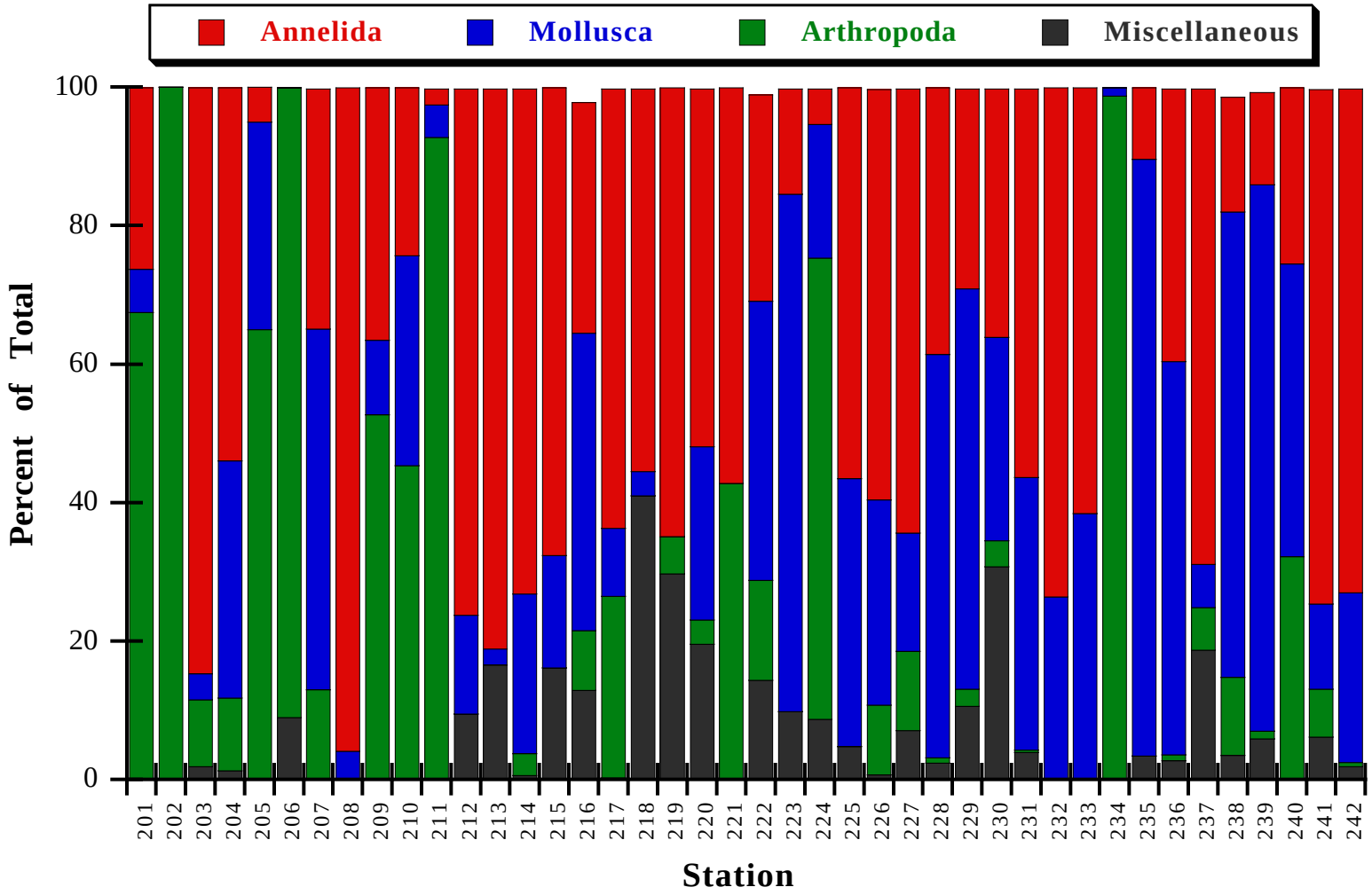


Table 3. Percent abundance of dominant taxa (> 10% of the total) for the EMAP Carolinian Province, North Carolina stations, 1996.

Taxa	201	202	203	204	205	206	207	208	209	210	211	212	213	214	215	216	217	218	219	220	221	222	223	224	225	226	227	228	229	230	231	232	233	234	235	236	237	238	239	240	241	242
Rhynchocoela (LPIL)																																					12.5					
Tubulanus (LPIL)													16.7					26.8	13.5											23.1												
Lineidae (LPIL)																			10.8																							
Oligochaeta																																										
Tubificidae (LPIL)										24.2																																
Polychaeta																																										
Amphicteis gunneri									20.3																																	
Brania wellfleetensis																											15.7															
Cirratulidae (LPIL)																																									24.8	
Glycinde solitaria																																				11.0						
Heteromastus filiformis																	33.3									27.3										11.9						
Leitoscoloplos robustus																				14.3					13.7			13.9				11.8									
Linopherus Sp. A													38.1					16.1	10.8														15.4									
Mediomastus (LPIL)							34.8	58.6				42.9		69.3				14.3	16.2	25.0	57.1				31.0							11.8										
Marenzellaria viridis	21.4		59.6	27.0													11.8																									
Nereis succinea																																										22.5
Paraprionospio pinnata																11.8		14.3	27.0														15.4									
Scoloplos rubra															24.3																											
Sigambra tentaculata													16.7																				23.1				12.5					
Streblospio benedicti				10.5				33.7				25.4	19.1		29.7																25.6	44.1					37.5					14.6
Bivalvia																																										
Astarte nana																												13.1														
Lucina multilineata															10.8	28.0						30.1					11.4		44.7	12.8												
Macoma baltica														13.5											32.3																	
Macoma tenta																										23.4																
Mulinia lateralis																												26.2			15.8	26.5	15.4		72.4	22			23.7		
Bivalvia (LPIL)																																			10.4							
Rangia cuneata					30.0		52.2			30.3																																
Tagelus plebeius																																										13.2
Tellinidae (LPIL)				32.2																																			18.6		
Tellina agilis																																				15.6						
Gastropoda																																										
Acteocina canaliculata																							38.5							10.3			15.4					37.5	37.3			
Rictaxis punctostriatus																																						10.1				
Isopoda																																										
Cyathura polita											11.9						14.1																									
Amphipoda																																										
Acanthohaustorius millsi																					14.3			63.2										60.6								
Aoridae (LPIL)					35.0																																					
Gammarus Sp. A											19.1																															
Haustoriidae (LPIL)																																		18.2								
Leptocheirus (LPIL)					15.0																																					
Leptocheirus plumulosa									13.5	15.2																																
Parahaustroius longimerus																																		12.3								
Protohaustorius Sp. B																																								27.1		
Diptera																																										
Chironomus (LPIL)	40.7																				28.6																					
Coelotanypus (LPIL)	22.8	81.8			10.0	90.9			16.2	18.2																																
Ephemeroptera																																										
Hexagenia limbata											28.6																															

Table 4. Summary of benthic macroinvertebrate data for the EMAP Carolinian Province, North Carolina stations, 1996.

Station	Total Taxa	Mean Taxa per Repl.	Total No. Inds.	Density (Mean)	Density (Std. Dev)	H'	J'
201	12	9.0	145	1813	18	1.61	0.65
202	3	2.0	11	138	53	0.60	0.55
203	13	8.0	52	650	35	1.57	0.61
204	15	11.0	152	1900	813	1.96	0.72
205	6	4.0	20	250	35	1.54	0.86
206	2	1.5	11	138	18	0.30	0.44
207	4	3.0	23	288	88	1.06	0.76
208	9	6.5	193	2413	1290	1.02	0.46
209	19	13.5	74	925	–	2.49	0.85
210	7	5.5	33	413	53	1.68	0.86
211	13	9.0	42	525	141	2.17	0.85
212	11	8.0	63	788	619	1.72	0.72
213	8	6.0	42	525	106	1.64	0.79
214	20	14.0	668	8350	2086	1.19	0.40
215	13	8.0	37	463	301	2.09	0.81
216	27	19.5	93	1163	124	2.71	0.82
217	20	15.0	255	3188	1184	2.27	0.76
218	11	8.5	56	700	636	2.09	0.87
219	11	8.0	37	463	88	2.11	0.88
220	15	11.0	56	700	212	2.39	0.88
221	3	2.0	7	88	18	0.96	0.87
222	31	20.0	104	1300	424	2.72	0.79
223	22	15.0	91	1138	88	2.35	0.76
224	14	9.0	57	713	88	1.57	0.59
225	19	13.5	124	1550	424	2.16	0.73
226	20	15.0	128	1600	601	2.36	0.79
227	29	18.5	70	875	106	3.03	0.90
228	17	13.5	122	1525	177	2.34	0.83
229	34	22.0	159	1988	124	2.40	0.68
230	18	13.0	78	975	141	2.53	0.88
231	38	24.0	203	2538	972	2.74	0.75
232	5	4.0	34	425	177	1.38	0.86
233	7	5.5	13	163	18	1.88	0.97
234	7	6.5	236	2950	460	1.18	0.61
235	6	4.0	29	363	18	1.00	0.56
236	17	13.5	109	1363	301	2.42	0.85
237	9	5.0	16	200	141	1.93	0.88
238	40	25.5	168	2100	354	2.65	0.72
239	39	28.0	252	3150	1061	2.60	0.71
240	17	10.5	59	738	265	2.12	0.75
241	31	21.0	113	1413	230	2.84	0.83
242	27	20.0	151	1888	301	2.63	0.80

Figure 4. Mean macroinvertebrate densities for the EMAP Carolinian Province stations, 1996.

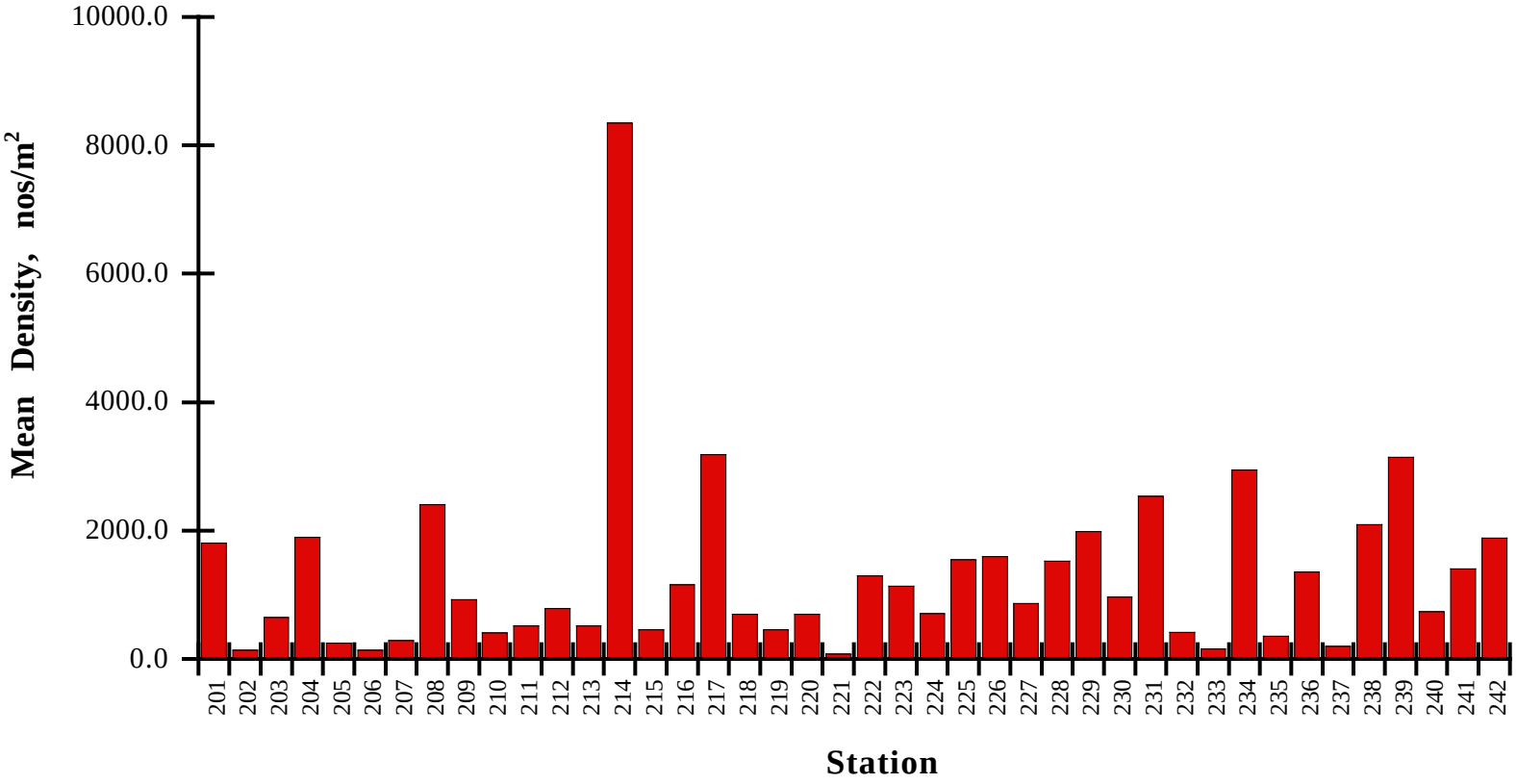


Figure 5. Mean number of macroinvertebrate taxa per relicate for the EMAP Carolinian Province stations, 1996.

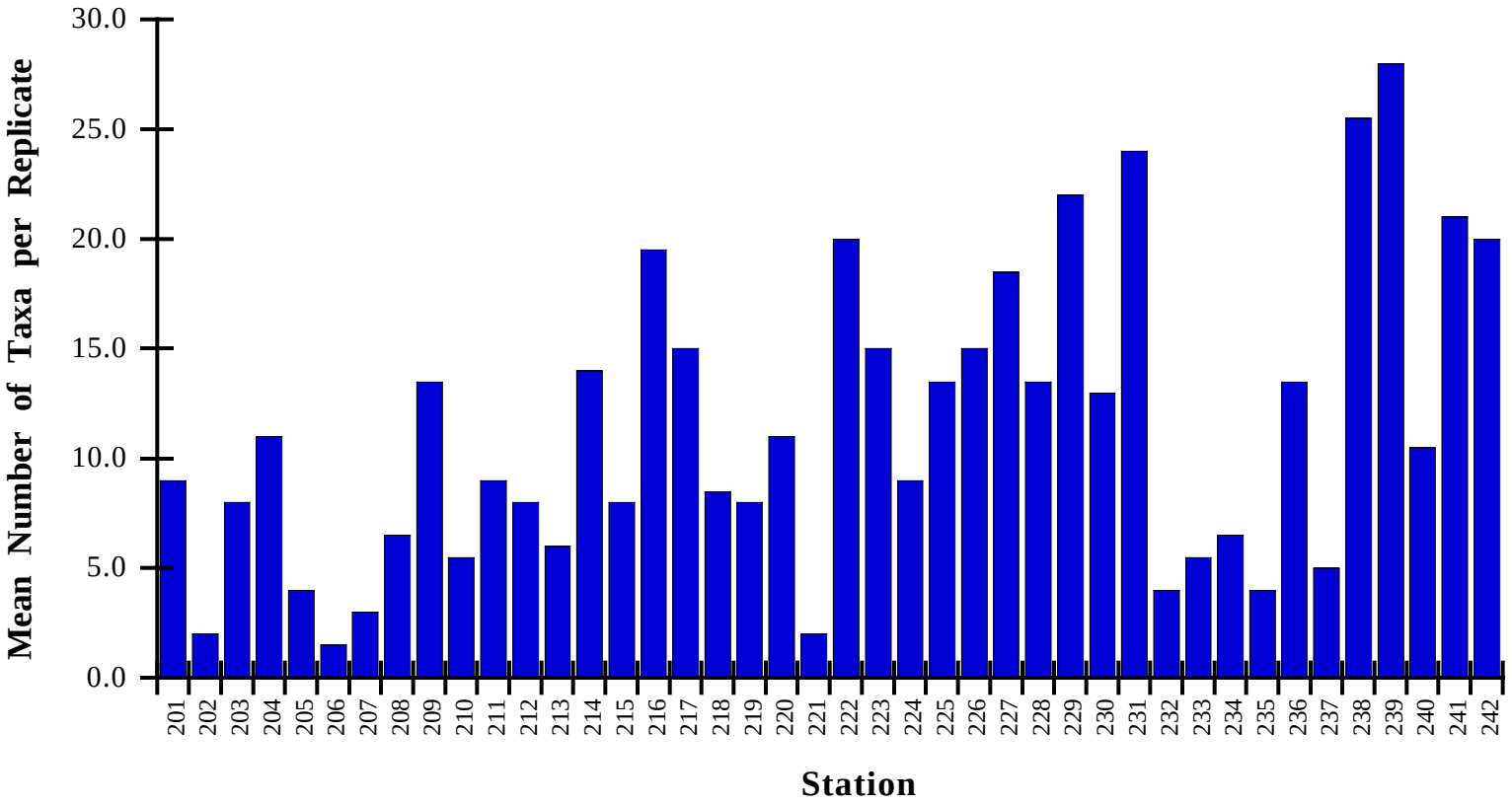


Figure 6. Taxa diversity (H') for the EMAP Carolinian Province stations, 1996.

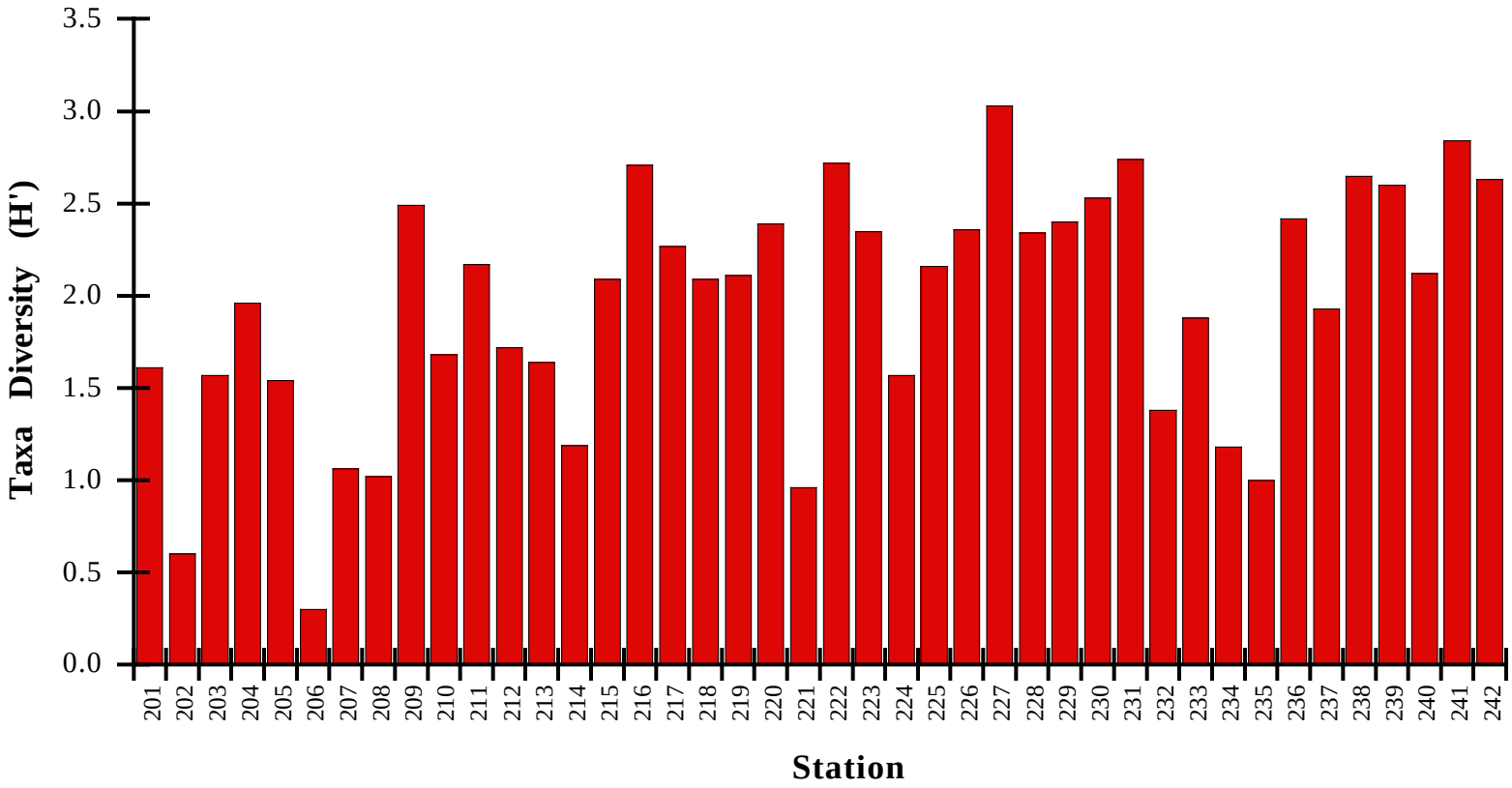
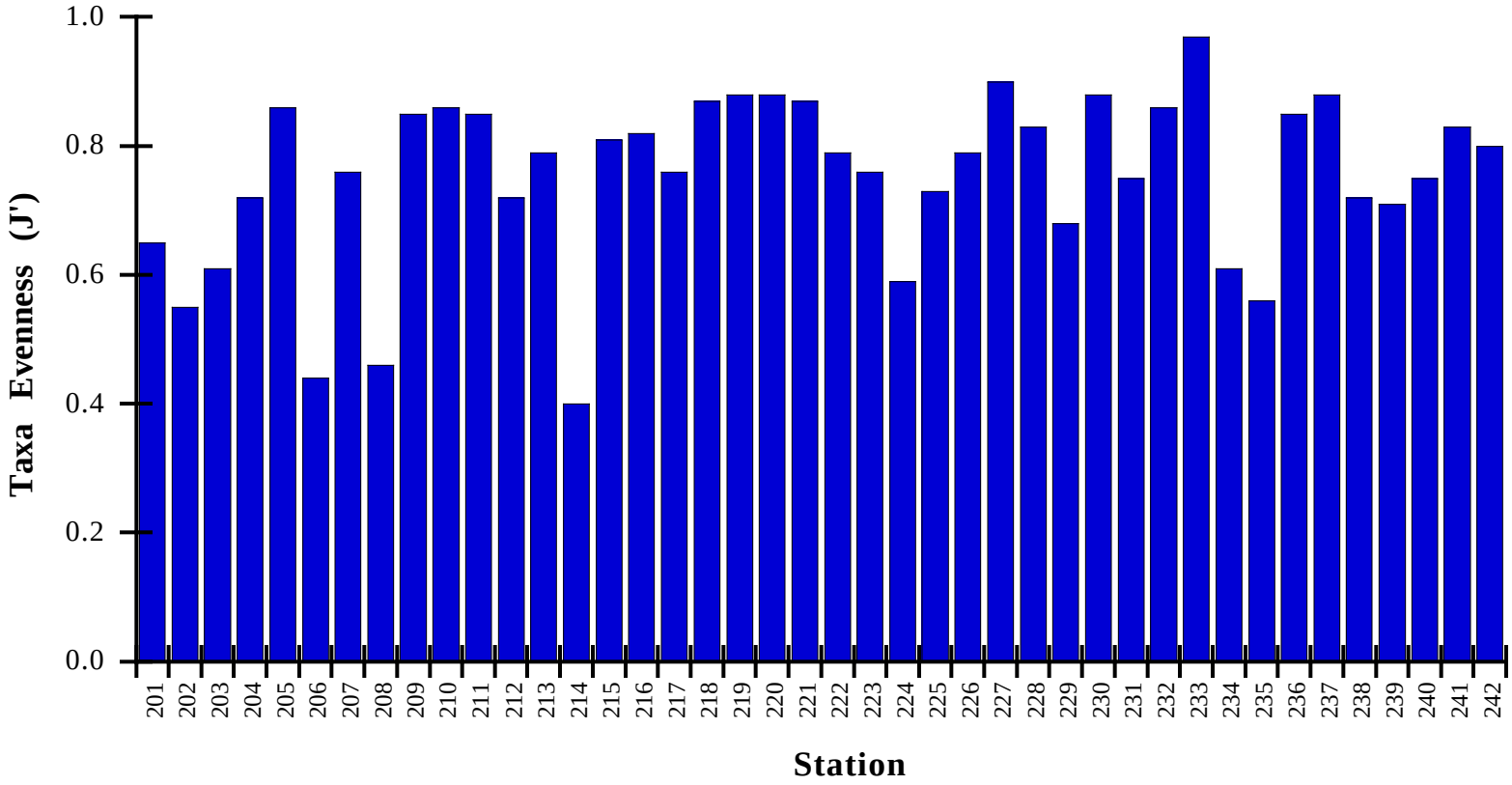


Figure 7. Taxa evenness (J') for the EMAP Carolinian Province stations, 1996.



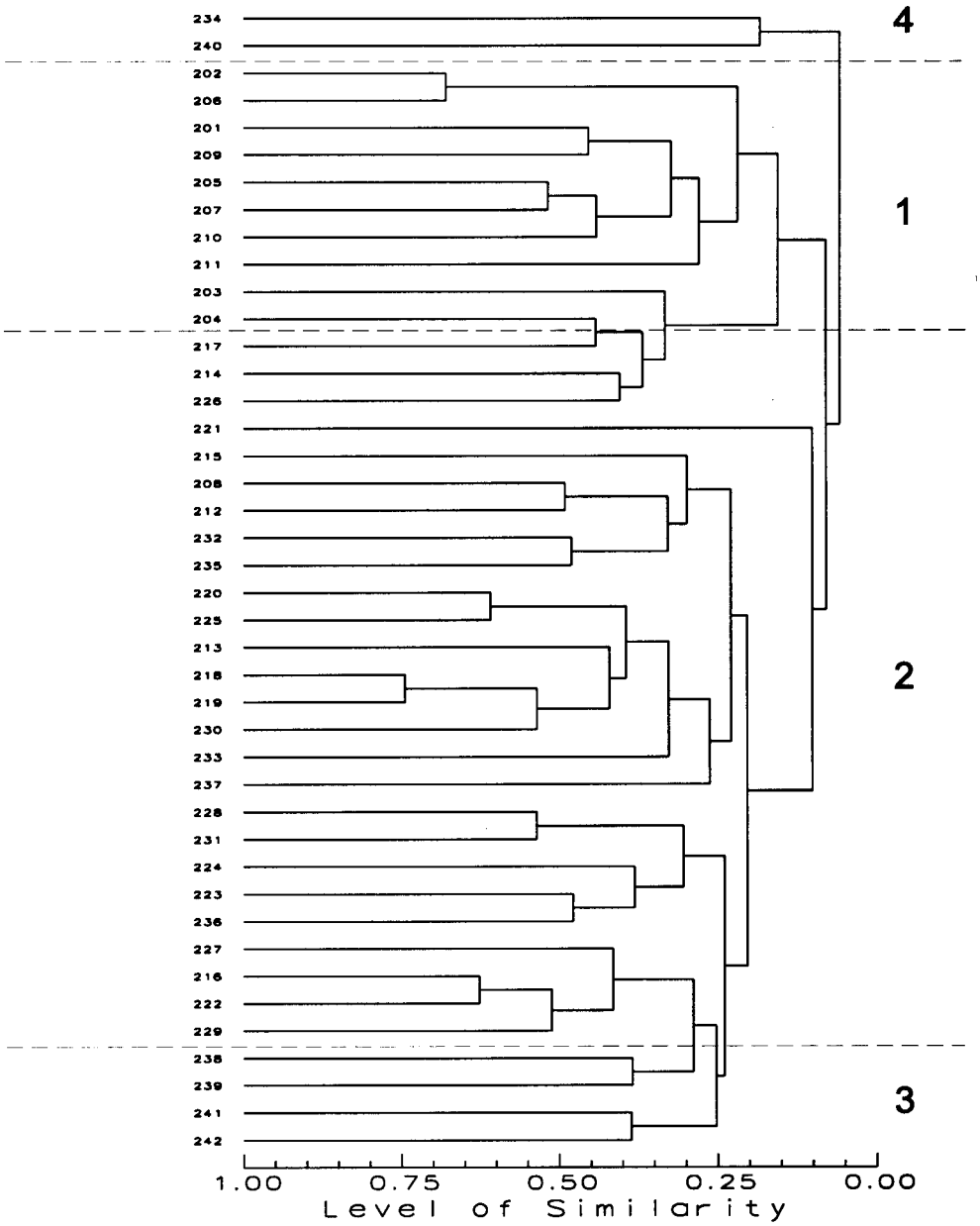


Figure 8. Normal (station) classification analysis for the EMAP Carolinian Province stations. Large, bolded numbers (1, 2, 3, 4) denote station groupings.

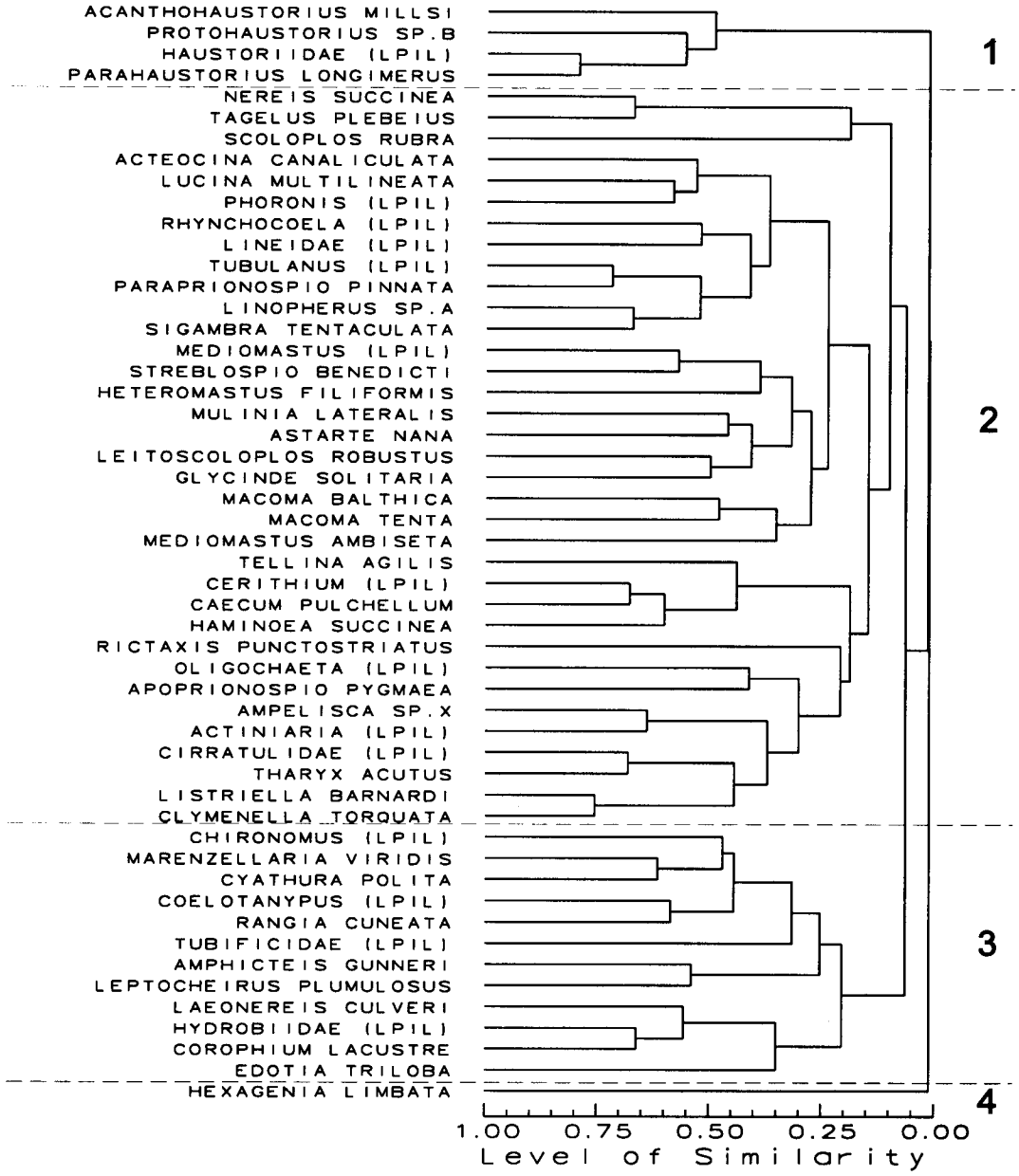


Figure 9. Inverse (taxa) classification analysis for the EMAP Carolinian Province stations. Large, bolded numbers (1, 2, 3, 4) denote taxa groupings.

individuals. Count data for the 56 taxa selected were included in a matrix of station and species groups (Table 5). These taxa accounted for 90.8% of the macroinfaunal assemblage collected.

Numerical classification of the 42 stations can be interpreted at a four-group level (7-30% level of similarity) representing the upper (group 1: North Landing River to East Lake stations), mid- (group 2: Roanoke Sound to Nelson Bay stations) and lower (group 3: Lookout Bight to Myrtle Grove stations) regions of the Carolinian Province as well as two stations (group 4: stations 234 and 240) with a distinctive faunal assemblage (Figure 8).

Classification of the 60 taxa at the 42 stations can interpreted at a four-group level (1 - 15% similarity; Table 5 and Figure 9). Group 1 includes four taxa of amphipods which are fossorial and generally inhabit clean, sandy habitats in > 20 ppt water. Group 2 includes a complex of 35 taxa found in brackish to fully marine waters. Group 3 includes 12 taxa representing freshwater species and brackish water opportunists. Group 4 includes the freshwater mayfly taxon, *Hexagenia limbata*.

Table 5. Data matrix of the EMAP Carolinian Province station and taxa groups compiled from classification analysis dendrograms.

	STATION																																									
Taxa	**234**	**240**	**202**	**206**	**201**	**209**	**205**	**207**	**210**	**211**	**203**	**204**	**217**	**214**	**226**	**221**	**215**	**208**	**212**	**232**	**235**	**220**	**225**	**213**	**218**	**219**	**230**	**233**	**237**	**228**	**231**	**224**	**223**	**236**	**227**	**216**	**222**	**229**	**238**	**239**	**241**	**242**
Acanthohaustorius millsi	143	1														1										1						36										
Protohaustorius sp.B	14	16																																								
Haustoriidae (LPIL)	43																												1			1										
Parahaustorius longimerus	29																																									
Nereis succinea															5		1																									34
Tagelus plebeius																																										20
Scoloplos rubra																	9														1		1			1					2	1
Acteocina canaliculata																	1				1	1	1		2		8	2		10	10	1	35		1	8	4	6	63	94		2
Lucina multilineata																	4										10					2	9	4	8	26	32	71		22	1	1
Phoronis (LPIL)																	3					1			2	2	1			2	1	1	3	3	4	4	6	8				
Rhynchocoela (LPIL)				1							1	1	1	4	1		1		2		1		2		3		3		2			2	1			2	1	1	1	3	1	1
Lineidae (LPIL)																	1		4			5	1		3	4	2		1	1	2		1				1	1		3		
Tubulanus (LPIL)																						4	3	7	15	5	18				1		2		1	5	4	1	1		6	2
Paraprionospio pinnata																				2		4	2	1	8	10	4	2			1		1		6	11	10	3		2	5	
Linopherus sp.A																							4	16	9	4		2							1	2	1	2				
Sigambra tentaculata																							4	7	4	2	5	3	2								1					
Mediomastus (LPIL)		1				4		8			2	12	14	463	1	4	2	113	27	4	2	14	26	1	8	6	6			8	5		1	4	3	1	6	12	2	3	8	2
Streblospio benedicti		1									1	16		1	6		11	65	16	15	1	2	5	8					6	2	52			8	1			3		1	10	22
Heteromastus filiformis												1	85	3	35			1	2				1							6				13	1			1			2	4
Mulinia lateralis		14																2		9	21		2					2		32	32	1	5	24					1		4	
Astarte nana																														16	16	2	7	2			1	1				12
Leitoscoloplos robustus															1					4		8	17					1	1	17	1				1				2		2	
Glycinde solitaria														1								1	9							9	1	3	3	12		2		2	2		1	
Macoma balthica													2	90	4							5	40										2	5								
Macoma tenta														50	30							2	2	1			4	1	1	3	3					1						
Mediomastus ambiseta												2		11			1	3					2							3												
Tellina agilis																																3	2	17						10		
Cerithium (LPIL)																																							8	14		
Caecum pulchellum																																								21		
Haminoea succinea																														1	1			1						12		
Rictaxis punctostriatus																														1	1								17			
Oligochaeta (LPIL)					2							8	3					1																	2			3	1	5		4
Apoprionospio pygmaea		1																													15				1			7	1	3		
Ampelisca sp. X																																				5	4	3	7			
Actiniaria (LPIL)																																1				1	2	6	3	4		
Cirratulidae (LPIL)																																					1	2	3		28	12
Tharyx acutus																															1						1		1	3	9	7
Listriella barnardi																																			4	2	6		2	2	7	
Clymenella torquata																																			3		6		1		3	
Chironomus (LPIL)					59	2						8		11		2																										
Marenzellaria viridis					31	5	1				31	41	30	6	11																		3	4								
Cyathura polita			1		4	5				5	1	5	36	2	3																											
Coelotanypus (LPIL)			9	10	33	12	2	2	6	3				8																												
Rangia cuneata					8	6	6	12	10	2	1	3	4	5					1																	1	1					
Tubificidae (LPIL)					1	1			8	1			1	2																					2			1			2	
Amphicteis gunneri						15							6																													
Leptocheirus plumulosus						10			5																																	
Laeonereis culveri											5		19		5																											4
Hydrobiidae (LPIL)													14	3																												1
Corophium lacustre											1		14																													
Edotia triloba												3	4	1	1															1	1			1								
Hexagenia limbata										12																																

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APPENDIX

Carolinian Province QA/QC Reports

BARRY A. VITTOR & ASSOCIATES, INC.
ENVIRONMENTAL RESEARCH & CONSULTING
8060 Cottage Hill Road Mobile, Alabama 36695
Phone (334) 633-6100 Fax (334) 633-6738

QUALITY ASSURANCE STATEMENT

Client/Project NOAA

Work Assignment Title Carolinian Province 1996

Work Assignment Number CP96 Task Number 2

Description of Data Set or Deliverable: 84 Benthic macroinvertebrate samples collected in July and September of 1996; Young Dredge grabs.

Description of audit and review activities: Judged accuracy rates were well above standard levels for sorting and taxonomy. Laboratory QC reports were completed. Copies of reports, logs, and QC results follow (see attachments.) All taxonomic data were entered into computer and printed. This list was checked for accuracy against original taxonomic data sheets.

Description of outstanding issues or deficiencies which may affect data quality: None

Carl Mabry 3/10/97

Signature of QA Officer or Reviewer Date

Marianne Hutchard 3-10-97

Signature of Project Manager Date

BARRY A. VITTOR & ASSOCIATES, INC.
ENVIRONMENTAL RESEARCH & CONSULTING
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Phone (334) 633-6100 Fax (334) 633-6738

QUALITY CONTROL REWORKS

Client/Project NOAA
Work Assignment Title Carolinian Province 1996
Work Assignment Number CP96 Task Number 2

Sorting Results:

Sample #	% Accuracy
240-2	100%
223-1	100%
238-3	100%
233-1	100%
218-1	100%
235-1	100%
208-1	98%
233-2	100%
221-1	67% (see additional QCs)

Taxonomy Results:

Sample #	Taxa	% Accuracy
227-2	Crust./Moll.	100%
218-2	Crust./Moll.	100%
220-2	Crust./Moll.	85.7% (see additional QCs)
216-2	Crust./Moll.	95%
226-1	Crust./Moll.	100%
234-2	Crust./Moll.	98%
207-1	Crust./Moll.	100%
231-1	Poly./Misc.	97%
224-1	Poly./Misc.	100%
239-2	Poly./Misc.	100%
225-2	Poly./Misc.	98%
241-2	Poly./Misc.	100%
206-2	Poly./Misc.	100%
212-1	Poly./Misc.	97%
216-2	Poly./Misc.	95%
232-2	Poly./Misc.	100%

Description of outstanding issues or deficiencies which may affect data quality: None

Carl Mahy 3/10/97

Signature of QA Officer or Reviewer Date

ADDITION QUALITY CONTROL REWORKS

Client/Project NOAA

Work Assignment Title Carolinian Province 1996

Work Assignment Number CP96 Task Number 2

Dept.: Sorting

Personnel.: SLW

Reasons requiring reworks: Accuracy rate for sample 221-1 was below acceptable rate of 95%. One crustacea was found in QCed sample. This sample only contained two individuals prior to QC, thus causing a failure. All samples sorted by this technician were reworked.

Results of reworks:

Sample #	% Accuracy
202-1	100%
208-2	100%
216-2	100%
228-1	100%
238-2	100%

Description of outstanding issues or deficiencies which may affect data quality: None

All individuals in reworks were sorted correctly.

Carl Maday 2/10/97

Signature of QA Officer or Reviewer Date

–

ADDITION QUALITY CONTROL REWORKS

Client/Project NOAA

Work Assignment Title Carolinian Province 1996

Work Assignment Number CP96 Task Number 2

Dept.: Taxonomy

Personnel.: TJH

Reasons requiring reworks: Accuracy rate for sample 220-2 was below acceptable rate of 95%. One gastropod *(Acteocina)* was erroneously assumed dead. Four more samples were randomly selected for reworks.

Results of reworks:

Sample #	% Accuracy
236-2	100%
215-1	100%
220-1	100%
224-1	100%

Description of outstanding issues or deficiencies which may affect data quality: None

All mollusc in reworks were identified correctly.

Carl M Day 3/10/97

Signature of QA Officer or Reviewer Date

–

LABORATORY QC REPORT

Client/Project NOAA CAROLINIAN PROVICE 9/96

BVA Sample Nos. STATION 231

Phase of Lab Involvement TAXONOMY (LINDA)	Phase of Lab Involvement
Date 12/23/96	Date
Incident INCORRECT TAXON NAME GIVEN TO ORGANISM RECORDED IN DATA SHEET	Incident
Cause:	Cause:
Corrective action: CORRECT NAME ENTERED IN DATA SHEET	Corrective action:

Leitoscoloplos rubra was changed to Leitoscoloplos robustus

Verification by outside scientists: N/A

QC problems N/A

Judged accuracy rates: N/A

Marianne Hirtchurst 12-20-96

Lab Manager Date

Carl Mabry 12/20/96

QA Officer Date

C:\DOCS\FORMS\QAREPORT.DOC02Feb95