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FINAL REPORT ON THE AQUATIC MACROINVERTEBRATE AND FISHERIES SAMPLING OF ROWELL CREEK NAS CECIL FIELD FL

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ENVIRONMENTAL CONSULTING & TECHNOLOGY, INC

FINAL REPORT ON THE AQUATIC MACROINVERTEBRATE AND FISHERIES SAMPLING OF ROWELL CREEK, NAVAL AIR STATION - CECIL FIELD DUVAL COUNTY, FLORIDA

PREPARED FOR:

ABB ENVIRONMENTAL SERVICES

PREPARED BY:

ECT

Environmental Consulting & Technology, Inc.

5405 Cypress Center Drive
Suite 200
Tampa, Florida 33609
(813) 289-9338

ECT NO. 92367-0400

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TABLE OF CONTENTS

Section		Page
1.0	INTRODUCTION	1-1
2.0	METHODS	2-1
	2.1 PHYSICAL AND CHEMICAL CHARACTERISTICS	2-1
	2.2 FISHERIES SAMPLING	2-1
	2.3 MACROINVERTEBRATE SAMPLING	2-2
	2.4 ANALYSES OF DATA	2-4
3.0	RESULTS	3-1
	3.1 PHYSICAL AND CHEMICAL CHARACTERISTICS	3-1
	3.1.1 STATION BIO-1	3-1
	3.1.2 STATION BIO-2	3-3
	3.1.3 STATION BIO-3	3-3
	3.1.4 STATION BIO-4	3-3
	3.1.5 STATION BIO-5	3-4
	3.1.6 STATION BIO-6	3-4
	3.2 FISHERIES SAMPLING RESULTS	3-5
	3.3 AQUATIC MACROINVERTEBRATE SAMPLING	3-8
	3.3.1 BENTHIC INFAUNA	3-8
	3.3.2 AQUATIC EPIFAUNA	3-8
4.0	DISCUSSION	4-1
5.0	CONCLUSIONS AND RECOMMENDATIONS	5-1
6.0	BIBLIOGRAPHY	6-1

LIST OF TABLES

Table		Page
3-1	Fisheries Sampling	3-6
3-2	Macroinvertebrates (Number Per Square Meter) Collected From Ponar Grab Samples, November 1991	3-9
3-3	Macroinvertebrates Collected From Artificial Substrate Samples, December 1991	3-15

LIST OF FIGURES

Figure		Page
1-1	Project Vicinity	1-2
1-2	Project Location	1-3
1-3	Site Map	1-4
3-1	Physical and Chemical Characteristics	3-2
3-2	Fisheries Density and Diversity	3-7
3-3	Benthic Infauna Density and Diversity	3-21
3-4	Aquatic Epifauna Density and Diversity	3-22

1.0 INTRODUCTION

ABB Environmental Service (ABB-ES) contracted Environmental Consulting & Technology, Inc. (ECT) to perform aquatic macroinvertebrate and fisheries sampling of Rowell Creek on Naval Air Station (NAS) Cecil Field (see Figures 1-1 and 1-2).

Six biological sampling stations were located within Rowell Creek (Figure 1-3) including two stations upstream from Lake Fretwell and four stations downstream. The investigation for each location includes a general description, measurement of physical and chemical parameters, aquatic macroinvertebrate sampling, and fisheries sampling. This report describes and discusses the methods and results of the investigation.

The investigation results will be used to support the ecological assessment for hazardous waste sites in the Rowell Creek watershed. ABB-ES is currently conducting remedial investigations and feasibility studies for the hazardous waste sites under contract to the Southern Division Naval Facilities Engineering Command.

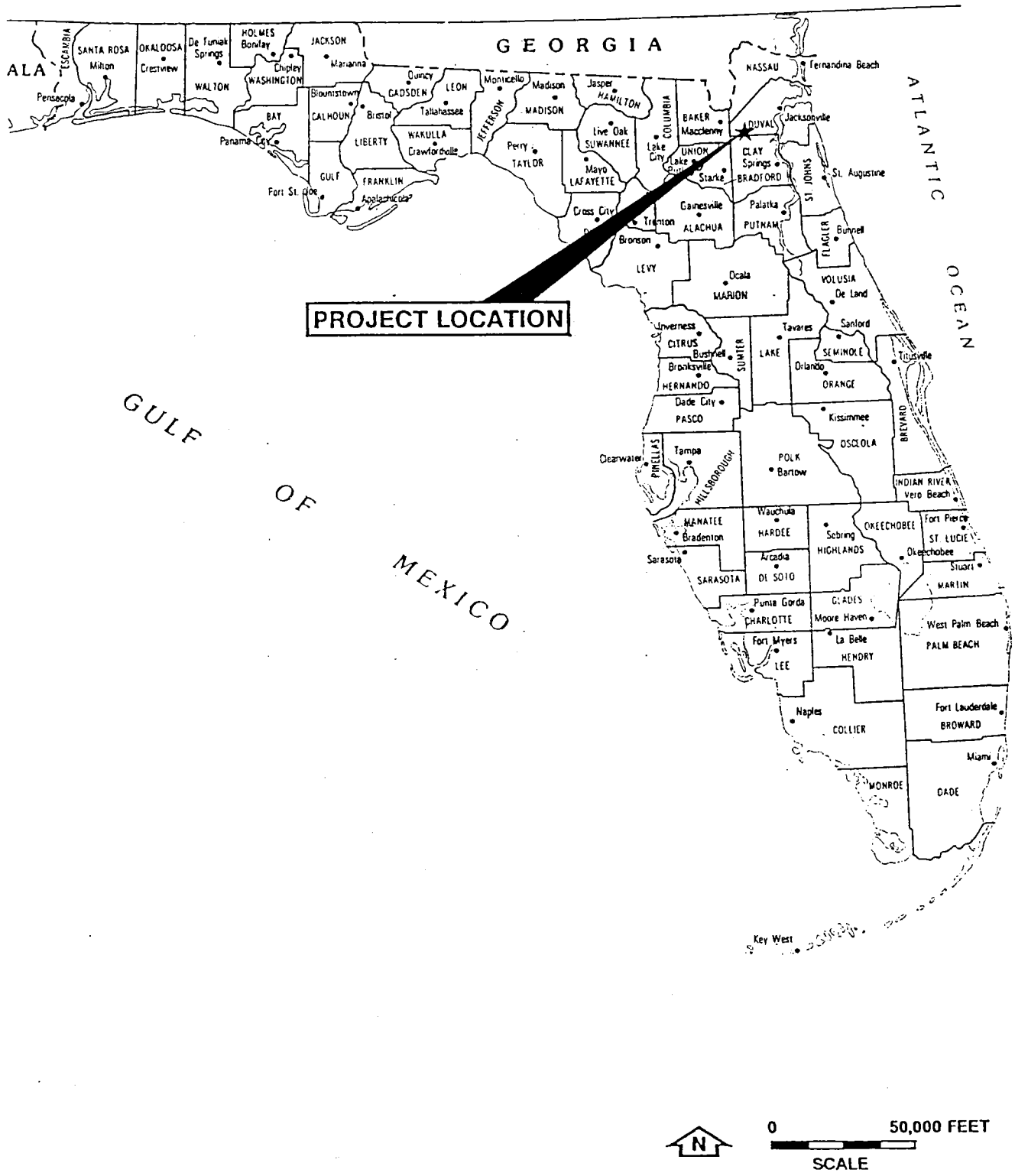

FIGURE 1-1.

PROJECT VICINITY
NAVAL AIR STATION CECIL FIELD
Source:USGS Map, 1974; ECT, 1992.

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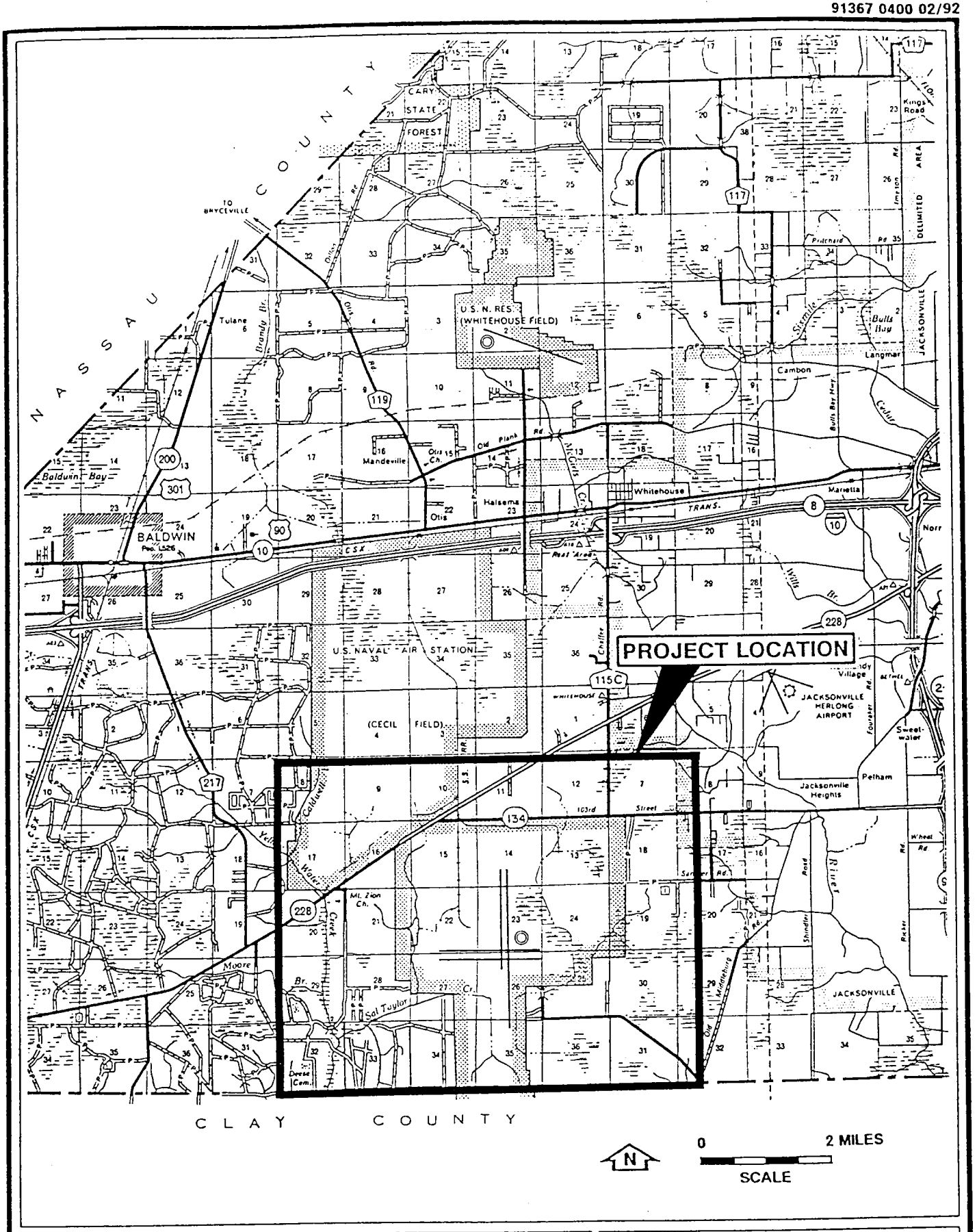

FIGURE 1-2.

PROJECT LOCATION
NAVAL AIR STATION CECIL FIELD
Source: FDOT Map, Duval County, FL, 1973; ECT, 1992.

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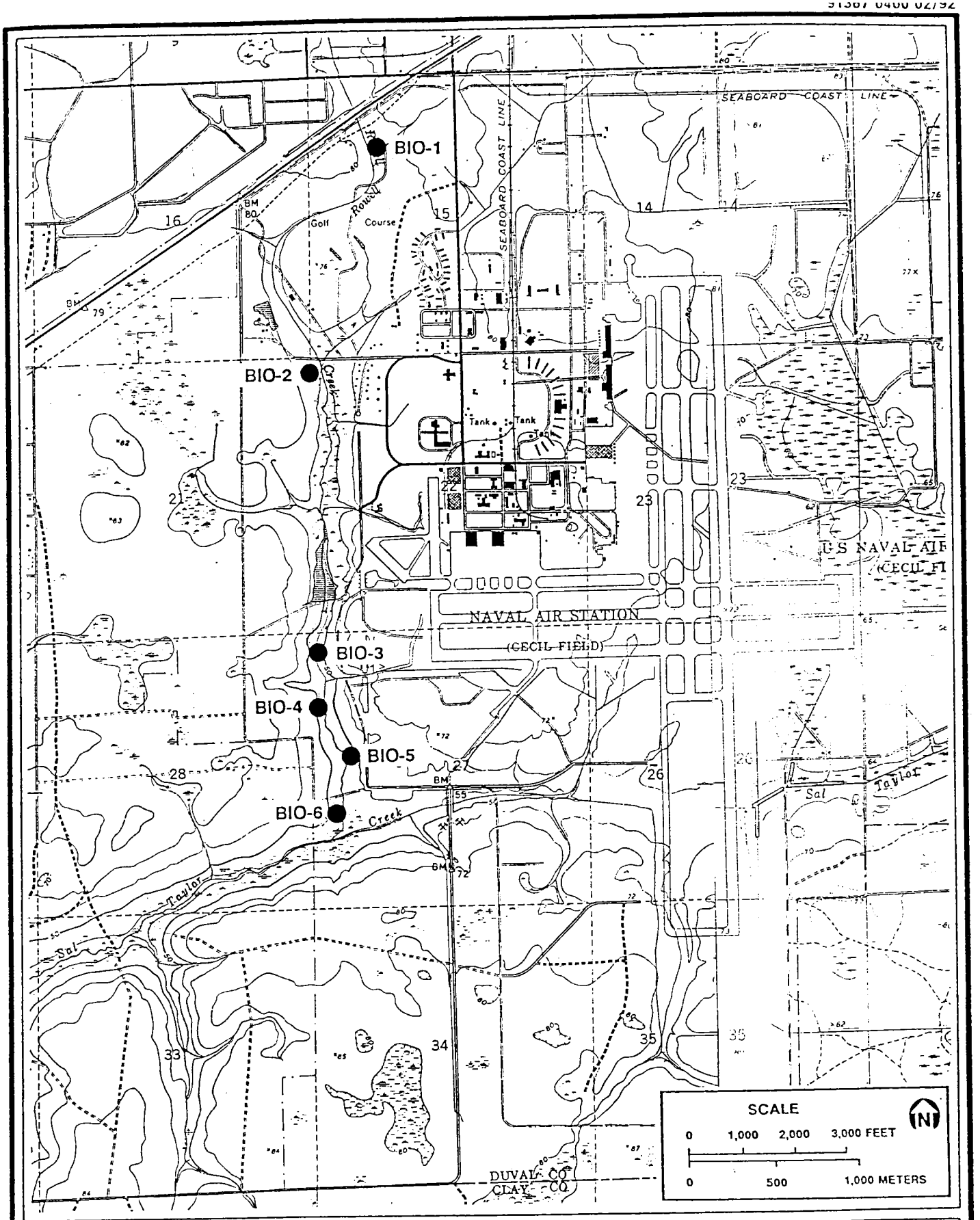

FIGURE 1-3.

SITE MAP
NAVAL AIR STATION CECIL FIELD
SourceS: USGS Quad., Fiftone, FL, Rev. 1970 and Jacksonville Heights, FL;

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2.0 METHODS

2.1 PHYSICAL AND CHEMICAL CHARACTERISTICS

A transect perpendicular to the streamflow was established at each station and marked with survey flags. The cross section of the stream was measured and the water depth was recorded at intervals across the stream. An average water depth was calculated by dividing the total of the recorded depths by the number of depth measurements. Notes were made at each station as to water clarity, vegetation, substrate composition, and relative streamflow rates.

A Teledyne-Gurley pygmy flow meter was used to measure stream current velocity at 2 foot (ft) intervals across the stream; measurements were taken at 0.6 times the total depth where the depth was less than 1.5 ft and at 0.2 and 0.8 times the depth where the depth exceeded 1.5 ft.

A Hydrolab® Surveyor II was used to record the temperature, pH, dissolved oxygen (DO), specific conductivity, oxidation-reduction potential (ORP), and salinity. Water clarity was estimated using a Secchi disk. Data gathered during the assessment of physical and chemical characteristics of the project area have been summarized graphically in Figure 3-1.

2.2 FISHERIES SAMPLING

The objectives of the fisheries surveys were to inventory the local fish fauna, develop representative species lists for the various water bodies, and characterize the diversity of resident populations. ECT performs fisheries sampling under the guidelines of the corporate comprehensive quality assurance plan (CompQAP), as approved by the Florida Department of Environmental Regulation (FDER) (QAP No. 8900083G).

Fisheries sampling was conducted by blocking the creek downstream of the station with a 0.5 centimeter (cm) mesh seine, moving overland to an upstream location, and working a second seine downstream until most fish were trapped. Fish captured were identified and tallied by species, then released immediately. At least one individual from each species group was placed in a labeled Ziploc® bag and preserved in a 10 percent buffered formalin acetate solution as a voucher specimen. Fisheries were also sampled by plunging a 0.5 cm mesh D-frame net under streambanks and working the net upward to the surface through heavily vegetated areas. This process was repeated 10 times along both streambanks at each station. In addition, a minnow trap baited with dried dog food was left at each station for 24 hours.

2.3 MACROINVERTEBRATE SAMPLING

Aquatic macroinvertebrate sampling included benthic infaunal communities and aquatic epifaunal communities. Benthic infaunal communities were sampled with a petite Ponar dredge (225 square cubic meter[cm^2] area [Edmonson and Winberg, 1971]). Five Ponar samples were collected along a transect across the stream at each station. Each Ponar sample was washed in the field through a U.S. No. 30 sieve (595 micron mesh) and preserved in a 10 percent formalin acetate/rose bengal stain solution. The samples were then double bagged and placed in prelabeled Ziploc® freezer bags. Each sample was labeled with the project name and number, station name and number, type of sample, replicate number, collection date and time, and the initials of persons collecting the samples. Accompanying field notes included information on sample location, substrate conditions, depth of sample collection, and condition of sample. All samples were stored in a cooler and returned to the laboratory for further processing.

Aquatic epifaunal communities were sampled by allowing them to colonize Hester-Dendy artificial substrate samplers (Standard Methods, 1975; Weber, 1973). Four samplers were suspended within the water column at each station, then allowed to incubate for 28 days. After the incubation period, the artificial substrate samplers were enclosed in plastic jars and carefully removed from the water. The samples were then preserved in a 10 percent formalin/rose bengal solution. These samples were labeled in the same manner as the Ponar samples, placed in coolers and delivered to the laboratory for taxonomic identification.

In the laboratory, the Ponar samples were washed of preservative and sediment through a 500 micrometer (μm) sieve and placed in white trays to remove macroinvertebrates. Organisms from the artificial substrate samplers were washed from the plates using a soft bristle brush and then sieved through a 500 μm mesh. One of each of the four artificial substrate replicates and five Ponar replicates per station were held in reserve. The additional sample was retained in the event that the other replicates did not provide an adequate sample size.

A laboratory bench sheet was prepared for each sample (replicate) during sorting. The sheet includes project name and number, client name, station name and number, sample type, replicate number, sample date, initials of persons collecting the samples, date sorted, person sorting, number of vials, place vials stored, resampled or not, group subsampled, split, and additional comments regarding appearance of sample.

In samples with extremely large numbers of certain groups of macroinvertebrates, generally chironomids or oligochaetes, the subsampling procedure as described in Weber (1973) was used to sample only those groups of excessively high densities (greater than 200 organisms). The procedure involves mixing the sample thoroughly until it is evenly distributed over the bottom of the sorting tray. The tray is divided into fourths and at least one quarter of the sample is sorted, placed in prelabeled

vials, and stored for taxonomy. If the sample is subsampled, the vial containing the split is appropriately labeled and the split is recorded on the bench sheet corresponding to that sample (replicate).

Organisms are identified to lowest practical taxonomic level using a variety of taxonomic keys and monographs. All organisms are identified by the same taxonomist. Species and their counts are listed on the same bench sheet prepared during the sorting. Slides are made of oligochaetes and chironomids and stored for identification after drying. The number of slides made per sample per replicate and their location is recorded on the bench sheet. Slides are labeled as to project name, station number, replicate number, and collection date. After identification of slides, the species and their counts are also listed on the bench sheet. Appropriate conversions due to subsampling are made on the sheets.

Data from each bench sheet is entered into the computer for calculation of number of organisms per square meter (m^2) and the Shannon Wiener species diversity index. Species collected in each replicate per station along with their converted counts, diversity per replicate, and station summaries are exhibited. Random checks using a hand calculator are made on the diversity values that were generated by the computer.

2.4 ANALYSES OF DATA

The fisheries and macroinvertebrate data were analyzed mathematically to assess species diversity. Species diversity was estimated by the Shannon-Wiener index (H′), where:

H′ = "the negative summation (from i = 1 to s) of $n_i/N \log_2({}_n i/N)$ where s is the number of species in a sample, N is the species in a sample, N is the total number of individuals in a sample, and n_i is the total number of individuals in species i. [Rule 17.302.200(23), Florida Administrative Code]."

The Shannon-Wiener Index (often mislabeled Shannon-Weaver Index), is a measure of the level of uncertainty as to the identity of the next species in a sample (Shannon, 1948; Krebs, 1978).

Density of macroinvertebrates (the number of individuals per m^2) for each of the stations was calculated based on both the Ponar (infaunal) samples and the artificial substrate (epifaunal) samples. Density of benthic infauna was calculated by summing the total number of individuals in four replicates per station and dividing the sum by the total sample area of 4 x 225 cm^2. For the artificial substrate samples, density was calculated by summing the total number of individuals in the three replicates and dividing the sum by the total sample area of 3 x 0.13 m^2.

3.0 RESULTS

3.1 PHYSICAL AND CHEMICAL CHARACTERISTICS

Physical descriptions of each of the six biological sampling stations, including substrate, water appearance, and cover are included in the following subsections. Measurements of current velocity, specific conductivity, pH, DO, and ORP are summarized in Figure 3-1. Salinity was not detected at any of the sampling stations so that parameter has been omitted. The ORP was positive at each station measured, indicating an oxidative atmosphere. The Secchi disk was observable down to the substrate at each station. The greatest depth at which the disk was observed (4.8 ft) was recorded in a deep pool near Station BIO-2. All six of the sampling stations overlay the Wesconnett fine sand soil map unit (Soil Survey of city of Jacksonville, Duval County, Florida, May 1978). This soil is a sandy, siliceous, thermic, typic haplaquod. Wesconnett fine sands range from strongly acid to extremely acid.

3.1.1 STATION BIO-1

Within the study area, Rowell Creek begins as a culverted stream, flowing from north to south under County Road (CR) 228. From this culvert, the stream is channeled through a narrow ditch across a golf course, where it enters a secondary growth forest, and reverts to a natural meander. Station BIO-1 is the northernmost station and is upstream of the hazardous waste sites. This station serves as the reference location, providing a baseline for comparison with downstream stations.

At BIO-1, the stream is approximately 14-ft wide at the top of the bank. Maximum water depth during the sampling event was approximately 1.1 ft; average water depth was approximately 0.7 ft. The streambed at Station BIO-1 was mucky-fine sand with abundant leaf litter and detritus. The stream exhibited slow flow that varied greatly with rainfall. No current was recorded during the sampling event. The water at

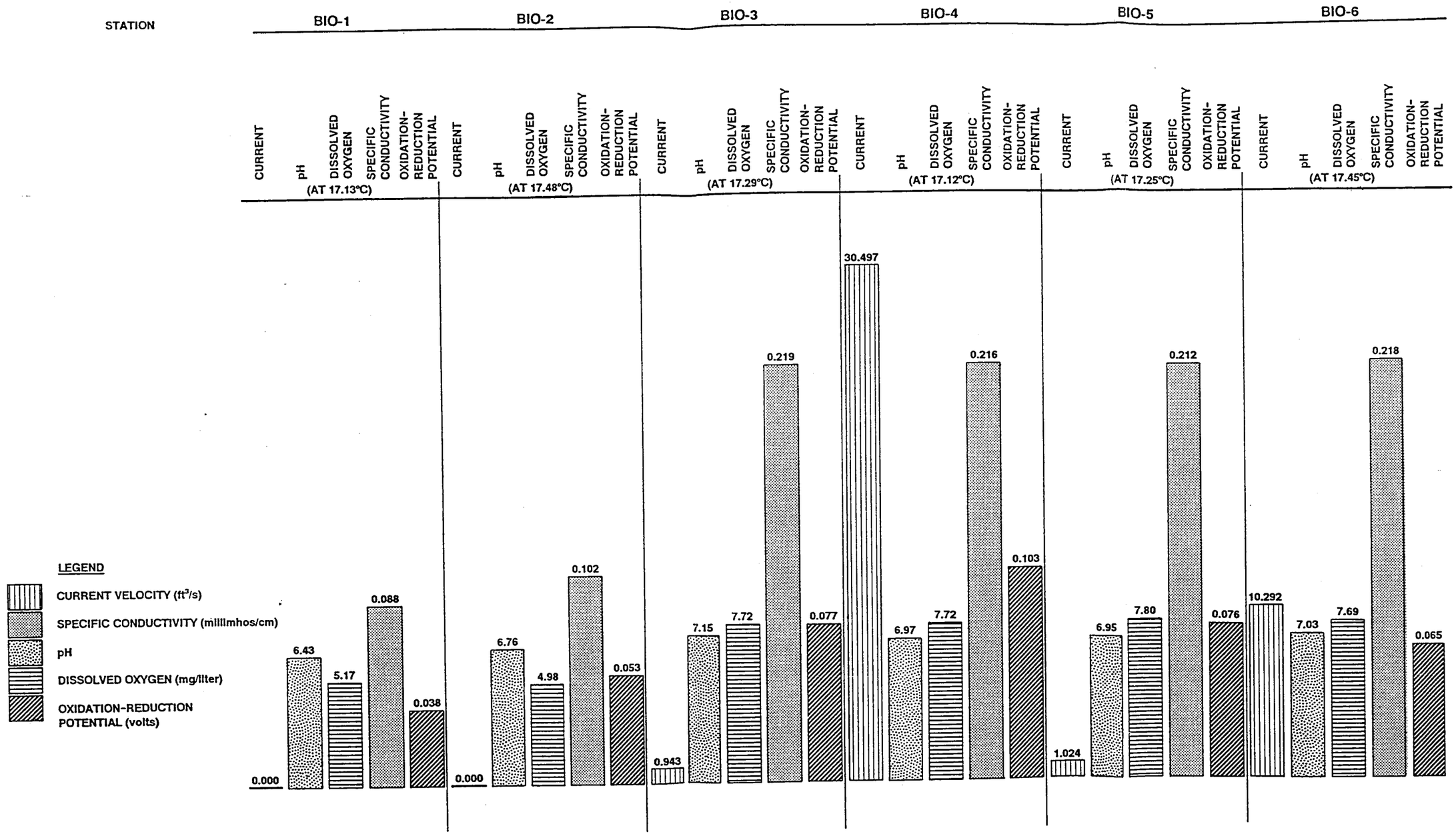

FIGURE 3-1

PHYSICAL AND CHEMICAL CHARACTERISTICS
NAVAL AIR STATION CECIL FIELD

Sources: ECT, 1992.

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Station BIO-1 was heavily stained with tannins.

3.1.2 STATION BIO-2

Station BIO-2 is situated immediately downstream of the confluence of Rowell Creek with an unnamed tributary (see Figure 1-3). The stream cross section is approximately 18 ft in width with a maximum depth of 3.4 ft; average depth during sampling was approximately 2.4 ft. Total width of the stream channel was approximately 30 ft at the top of the bank. There was no apparent streamflow during the sampling event; no flow was recorded by the current meter. The water surface was covered with a layer of scum comprised of a light brown foamy fraction and a fine, sheen layer which appeared to be immiscible with the water. This scum layer resembled sewage effluent, although no strong odor was detected. The water itself was darkly stained with tannins. The stream bottom was a very fine sand with a detrital layer up to several inches thick.

3.1.3 STATION BIO-3

Station BIO-3 is situated south of Lake Fretwell, upstream of the confluence with an unnamed tributary to Rowell Creek. The width of the stream was approximately 12 ft at the top of the bank; the maximum depth was 2.0 ft; and the average depth was approximately 1.46 ft. The streambed is comprised of fine sand, with thick layers of fine detritus in some areas and bare sand in others. The water was stained with tannins. Flow was measured at 0.94 cubic feet per second (ft^3/s).

3.1.4 STATION BIO-4

Station BIO-4 is situated downstream of an unnamed tributary to Rowell Creek and upstream of a dam/waterfall formed from discarded concrete rubble. Abundant solid waste litters the area. The stream cross section was approximately 11 ft in width with a maximum depth of 1.1 ft; average depth was approximately 0.7 ft. The streambed

is comprised of nearly bare fine sand at the sampling location, whereas abundant detritus settled out upstream of the dam. Flow was measured at 30.50 ft^3/s.

3.1.5 STATION BIO-5

Station BIO-5 is situated at a deep pool within a meander, just upstream from the southern extent of the study area. The stream cross section was approximately 12-ft wide with a maximum depth of 2.32 ft at the outside of the meander; the average depth was approximately 1.93 ft. The streambed consisted of fine sand with a thin detrital layer settling out along the outside of the meander and a thicker layer toward the inside. The lightly tannin-stained water was flowing briskly at this station; flow was recorded at 1.02 ft^3/s. The most strongly flowing portion of the stream did not coincide with a preset current measurement distance from the bank. The stream cross section had a series of current shadows formed by various obstacles which tended to reduce flow at the preset locations for current measurements (i.e., every 2 ft). This tended to reduce the average of the recorded flows. Had measurements been taken at different intervals, it is likely that flow would have been overestimated.

3.1.6 STATION BIO-6

Station BIO-6 is situated to the south of a bridge crossing for Perimeter Road, (Figure 3-1) and marks the southern, downstream limit of the study area. The stream cross section was approximately 19 ft in width with a maximum depth of 2.15 ft; the average depth was approximately 1.42 ft. The streambed was of fine sand with a thin detrital layer. The water was fairly clear and lightly stained with tannins. Flow was measured at 10.29 ft^3/s.

3.2 FISHERIES SAMPLING RESULTS

Combining the data from seining, dip-netting, and minnow trapping, a total of 12 species were identified from all stations on Rowell Creek (see Table 3-1).

Five fish species were identified at Station BIO 1 including mosquitofish (Gambusia affinis), southeastern golden shiner (Notemigonus crysoleucas), redfin pickerel (Esox americanus), and tadpole madtom (Noturus gyrinus). Species diversity and the contribution to the sample made by pollution resistant species are presented in Figure 3-2. Pollution tolerances are discussed in Section 4.0.

Three species of fish were collected at BIO-2 including the mosquitofish, the silver shiner (Notropis photogenis), and the pumpkinseed (Lepomis gibbosus). The mosquitofish and the Alabama chubsucker (Erimyzon tenuis) were collected at BIO-3.

Two fish species, the southeastern golden shiner and the bluegill (Lepomis macrochirus) were collected at BIO-4. The silver shiner, mosquitofish, bluegill, and largemouth bass (Micropterus salmoides) were collected at B10-5.

The Florida spotted gar (Lepisosteus platyrinchus), silver shiner, mosquitofish, long-ear sunfish (Lepomis megalotis), and an unidentified shiner were identified at BIO-6. The unidentified shiner was bright yellow dorsally and had a dusky brown lateral band; the ventral area was whitish and the tailfin was emarginate. These characteristics would almost certainly place the fish in the genus Notropis. However, no reference was found to a species with those characteristics which had the dorsal fin located posterior to the anal fin. Since only one individual was captured, the taxonomic uncertainty may be a result of individual variation. This specimen has been preserved and will be compared with other individuals in the future to establish the appropriate species.

Table 3-1. Fisheries Sampling

Common Name	Family	Genus Species	Number of Individuals							
			STA. BIO-1	STA. BIO-2	STA. BIO-3	STA. BIO-4	STA. BIO-5	STA. BIO-6	Pollution Tolerant	Limited Pollution Tolerance
Florida Spotted Gar	Lepisosteidae	Lepisosteus platyrinchus						1		X
Redfin Pickerel	Esocidae	Esox americanus	1							X
Alabama Chubsucker	Cyprinidae	Erimyzon tenuis			2					X
Southeastern Golden Shiner		Notemigonus crysoleucas	2			5				X
Silver Shiner		Notropis photogenis		11			2	5		X
Unidentified Shiner		Notropis sp.						1		X
Mosquitofish	Poeciliidae	Gambusia affinis	1	36	8		4	4	X	
Tadpole Madtom	Ictaluridae	Noturus gyrinus	1							X
Pumpkinseed	Centrarchidae	Lepomis gibbosus		1						X
Bluegill		Lepomis macrochirus				1	1			X
Long-ear Sunfish		Lepomis megalotis						2		X
Largemouth Bass		Micropterus salmoides					15			X
Number of Individuals per Station			5	48	10	6	22	13		
Species Diversity			1.93	0.914	0.722	0.633	1.341	2.04		

Source: ECT, 1992.

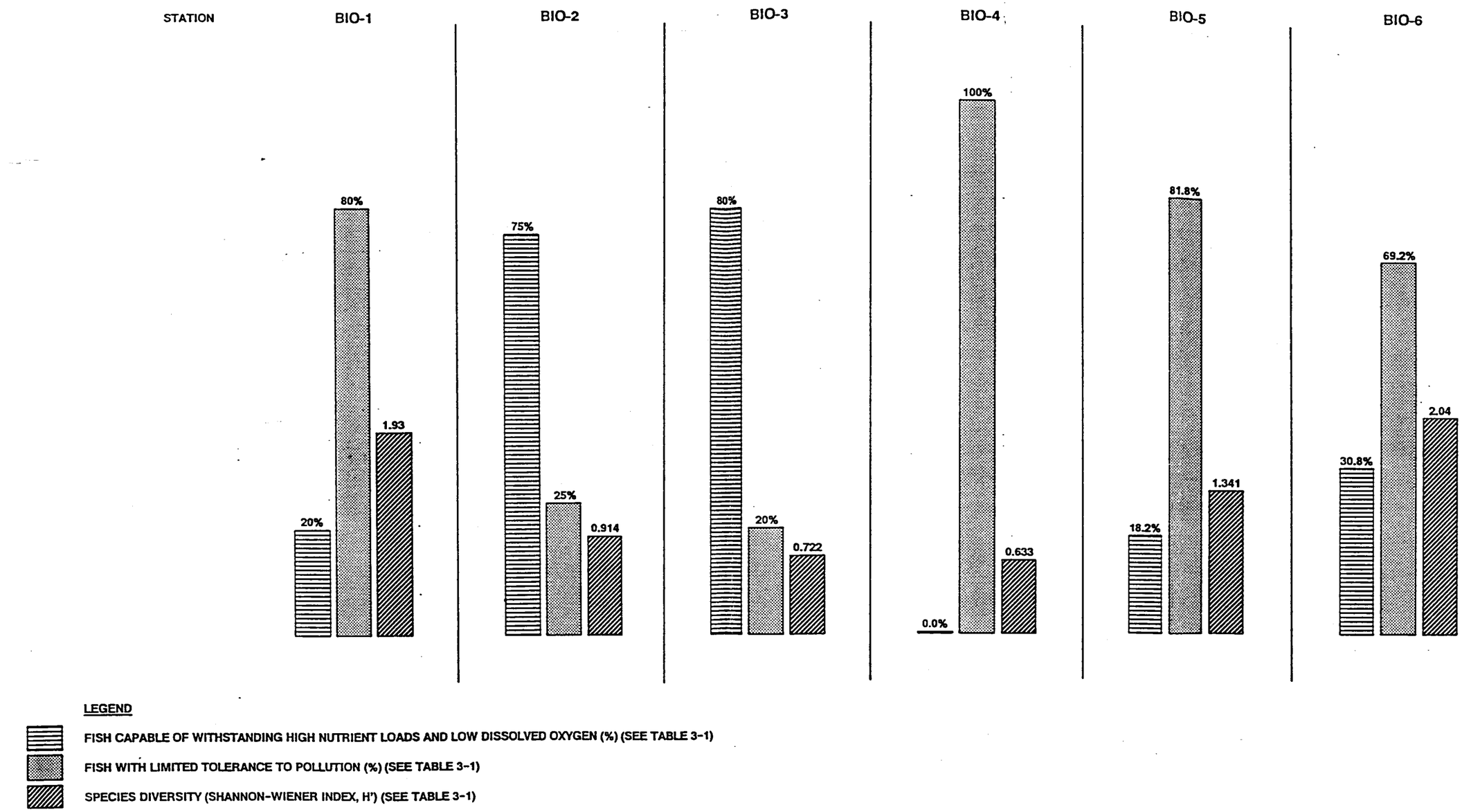

FIGURE 3-2

FISHERIES DENSITY AND DIVERSITY
NAVAL AIR STATION CECIL FIELD
Sources: ECT, 1992.

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3.3 AQUATIC MACROINVERTEBRATE SAMPLING

3.3.1 BENTHIC INFAUNA

A total of 44 benthic infaunal organisms were identified from all replicate petite Ponar samples from Station BIO-1, 21 from Station BIO-2, 13 from Station BIO-3, 14 from Station BIO-4, 25 from Station BIO-5, and 20 from Station BIO-6 (see Table 3-2, sheets 1 through 6). Each organism was classified as pollution tolerant, limited tolerance or clean water in Table 3-2 according to literature information. Pollution tolerances are discussed on Section 4.0. Density in number of individuals per m^2 and species diversity were calculated for each station and the results summarized in Figure 3-3.

3.3.2 AQUATIC EPIFAUNA

A total of 26 species of aquatic invertebrates were identified from all replicate Hester-Dendy artificial substrate samples at Station BIO-1. For Stations BIO-2, BIO-3, BIO-4, BIO-5 and BIO-6, 22, 32, 28, 28 and 32 species were identified, respectively. The species and number of individuals found in each replicate sample for each station are listed in Table 3-3. The density (number of individuals per m^2) and species diversity calculated for each station are provided in Figure 3-4.

Table 3-2. Macroinvertebrates (Number per Square Meter) Collected from Station BIO-1, Ponar Grab Samples, November 1991

Common Name	Class	Family	Genus species	Replicates A	B	C	D	Total	* Pollution Tolerant	Limited Tolerance	Clean Water
Flatworms	Turbellaria			43				43			
Oligochaetes	Oligochaeta	Lumbriculidae	Species A.	86	344	43		474	x		
		Naididae	Dero digitata			43		43	x		
			Dero nivea	172	172	43		388	x		
			Nais variabilis		86		43	129	x		
			Pristina synclites		43			43	x		
		Tubificidae	Slavena appendiculata		172		43	215	x		
			Aulodrilus piqueti	172	86	86		344	x		
			Ilyodrilus templetoni			86		86	x		
			Limnodrilus hoffmeisteri	258	43			301	x		
			Limnodrilus udekemianus				43	43	x		
			Tubificid. Immat. w/ capil. setae		689			689	x		
			Tubificid. Immat. w/o capil	646	1809	818	517	3789	x		
Amphipods	Malacostraca			86			43	129			x
Mayflies	Insecta	Baetidae	Baetis sp.	43				43			x
			Dannella simplex	86				86			x
			Paraleptophlebia volitans	258	258	258	25	1033			x
Damselflies		Coenagrionidae	Enallagma synatum	43				43			x
		Libellulidae	Tetragoneura cynocera	43				43		x	
		Gomphidae	Gomphus minutus	258				258			x
Caddisflies		Hydropsychidae	Hydropsyche decalda		43			43			x
			Phylocentropus sp.	560	172	689	172	1593			
Alderflies		Sialidae	Sialis equalis	86	86	43		215			
Riffle Beetles		Elmidae	Ancyronyx variegatus		129		86	215		x	
			Stenelmis sp.	215	517			732		x	
			Dubiraphia sp.	129	172	86	43	431		x	
Midges		Chironomidae	Ablabesmyia mallochi	86	215			301		x	
			Ablabesmyia parajanta	43	388	43	43	517		x	
			Conchapelopia sp.		43			43		x	
			Cryptochironomus blarina gr.		43			43		x	
			Cryptochironomus fulvus gr.		86			86		x	
			Demicryptochironomus sp.	43				43		x	
			Kiefferulus dux	86				86		x	
			Orthocladinae sp. C Epler	43	43	43	172	301		x	
			Paramerina sp.	43				43		x	
			Rheotanytarsus exiguus gr.		43			43		x	
			Rheotanytarsus distinctissimus gr.		43			43		x	
			Stenochironomus hilaris		43			43		x	
			Tanytarsus sp. I Cantrell	818	215		172	1206		x	
			Tanytarsus querlus				129	129		x	
			Tribelos fusicornis	344	86	86	258	775		x	
Snails	Gastropoda	Ancyliidae				43		43			x
			Ferrissia hendersoni	215	344			560			x
Mussels	Bivalvia	Sphaeriidae	Pisidium sp.	86	172			258			x
			TOTAL NUMBER OF SPECIES	27	29	14	14	44			
			TOTAL NUMBER OF INDIVIDUALS	4,995	6,588	2,411	2,024	16,018			
			DIVERSITY (d)	4.13	3.97	2.80	3.32	4.30			

Table 3-2. Macroinvertebrates (Number per Square Meter) Collected From Station BIO-2, Ponar Grab Samples, November 1991 (Page 2 of 6)

Common Name	Class	Family	Genus species	Replicates A	B	C	D	Total	* Pollution Tolerant	Limited Tolerance	Clean Water
Nematodes	Nematoda			86				86			
Oligochaetes	Oligochaeta	Lumbriculidae	Species A.	43				43			
		Naididae	Dero nivea			43		43	x		
		Tubificidae	Limnodrilus hoffmeisteri		129		172	301	x		
			Tubificid. Immat. w/o capil	861	344	43	1292	2541	x		
Amphipods	Malacostraca	Gammaridae				43		43			x
	Malacostraca	Cambarinae				43		43			x
Damselflies	Insecta	Gomphidae	Gomphus minutus			43		43			x
			Paraleptophlebia volitans			129		129			x
Caddisflies		Hydropsychidae	Hydropsyche decalda		43			43			x
			Phylocentropus	43	172	344	258	818			
Riffle Beetles		Elmidae	Dubiraphia sp.	86				86		x	
Midges		Chironomidae	Ablabesmyia mallochi	43	129	129		301		x	
			Cryptochironomus blarina gr.			43	43	86		x	
			Cryptochironomus fulvus gr.		43	172	86	301		x	
			Orthocladinae sp. C Epler			43	43	86		x	
			Polypedilum illinoense	43				43		x	
			Rheotanytarsus exiquus gr.		129			129		x	
			Stenochironomus hilaris			43	86	129		x	
			Tanytarsus sp. I Cantrell		129	129	43	301		x	
			Tribelos fusicornis	344	3832	2541	3832	10550		x	
			Tribelos jucundum		1593	172	1722	3488		x	
			TOTAL NUMBER OF SPECIES	8	9	14	9	21			
			TOTAL NUMBER OF INDIVIDUALS	1,550	4,952	3,789	5,856	16,148			
			DIVERSITY (d)	1.99	1.39	1.99	1.56	1.96			

Table 3-2. Macroinvertebrates (Number per Square Meter) Collected From Station BIO-3 In Ponar in Grab Samples, November 1991 (Page 3 of 6)

Common Name	Class	Family	Genus Species	Replicates A	B	C	D	Total	* Pollution Tolerant	Limited Tollerance	Clean Water
Flatworms		Plannaridae	Dugesia sp.	86				86	x		
Oligochaetes	Oligochaeta	Lumbriculidae		43			129	172	x		
		Tubificidae	Limnodrilus hoffmeisteri	43				43	x		
			Tubificid. Immat. w/o capil	1593		474		2067	x		
Midges		Chironomidae	Dubiraphia sp.			43		43		x	
			Ablabesmyia mallochi	86			43	129		x	
			Cryptochironomus blarina gr.	86	86	43	43	258		x	
			Cryptochironomus fulvus gr.		86			86		x	
			Paracladopelma undine	172		43	86	301		x	
			Paracladopelma scalaenum			43		43		x	
			Tribelos fusicornis			86		86		x	
			Tribelos jucundum				86	86		x	
Mussels	Bivalvia	Sphaeriidae	Pisidium sp.	301		215		517			x
			TOTAL NUMBER OF SPECIES	9	2	6	5	13			
			TOTAL NUMBER OF INDIVIDUALS	2,497	129	904	388	3,918			
			DIVERSITY (d)	1.92	0.92	1.93	2.20	2.47			

Table 3-2. Macroinvertebrates (Number per Square Meter) Collected From Station 4 in Ponar Grab Samples, November 1991 (Page 4 of 6)

Common Name	Class	Family	Genus species	Replicates A	B	C	D	Total	* Pollution Tolerant	Limited Tolerance	Clean Water
Flatworms		Plannaridae	Dugesia sp.		172		43	215			
Nematodes			Nematoda				43	43			
Oligochaetes	Oligochaeta	Tubificidae	Limnodrilus hoffmeisteri		388			388	x		
			Tubificid. Immat. w/o capil.setae	129	258	215	301	904	x		
Midges	Insecta	Chironomidae	Dubiraphia sp.			43		43		x	
			Ablabesmyia mallochi	86	215	215	129	646		x	
			Cryptochironomus blarina gr.	43			258	301		x	
			Paracladopelma undine	43			43	86		x	
			Paracladopelma scalaenum				86	86		x	
			Rheotanytarsus distinctissimus gr.				43	43		x	
			Tanytarsus sp. I Cantrell		86			86		x	
			Tribelos fusicornis		258	86		344		x	
			Tribelos jucundum		474			474		x	
Mussels	Bivalvia	Sphaeriidae	Pisidium sp.		129	43	86	258			x
			TOTAL NUMBER OF SPECIES	4	8	5	9	14			
			TOTAL NUMBER OF INDIVIDUALS	301	1,981	603	1,033	3,918			
			DIVERSITY (d)	1.84	2.83	2.01	2.76	3.27			

Table 3-2. Macroinvertebrates (Number per Square Meter) Collected From Station BIO-5 In Ponar Grab Samples, November 1991
(Page 5 of 6)

Common Name	Class	Family	Genus Species	Replicates A	B	C	D	Total	* Pollution Tolerant	Limited Tolerance	Clean Water
Oligochaetes	Oligochaeta	Lumbriculidae		43	43		258	344			
		Naididae	Dero trifida		129			129	x		
			Nais variabilis			43		43	x		
		Tubificidfae	Slavena appendiculata			86		86	x		
			Aulodrilus piqueti			43		43	x		
			Ilyodrilus templetoni		172	86	43	301	x		
			Limnodrilus hoffmeisteri		603	301	775	1679	x		
			L. udekemianus		43			43	x		
			Tubificid. Immat. w/ capil. setae			129		129	x		
			Tubificid. Immat. w/o capil.s	258	560	1722	474	3014	x		
Leeches	Hirudinea	Erpobdellidae					43	43			
Midges	Insecta	Chironomidae	Dubiraphia sp.		43			43		x	
			Ablabesmyia mallochi		43			43		x	
			Ablabesmyia parajanta	86	86		43	215		x	
			Chironomus decorus gr.				43	43		x	
			Cryptochironomus blarina gr.	129			43	172		x	
			Cryptochironomus fulvus gr.	43	43			86		x	
			Kiefferulus dux				43	43		x	
			Paralauterborniella nigrohalt	43				43		x	
			Polypedilum halterale				43	43		x	
			Tanytarsus sp. I Cantrell	129	43			172		x	
			Tanytarsus guerlus gr.			43		43		x	
			Tribelos fusicornis		43	172	86	301		x	
			Tribelos jucundum	86	86		474	646		x	
Mussels	Bivalvia	Sphaeriidae	Miciromenetus dilatus dilatus			43		43			x
			Pisidium sp.	43				43			x
		Unionae	Elliptio lanceolata	43				43			x
			TOTAL NUMBER OF SPECIES	8	13	13	10	27			
			TOTAL NUMBER OF INDIVIDUALS	732	2,024	2,799	2,282	7,880			
			DIVERSITY (d)	2.66	2.94	2.27	2.55	3.21			

Table 3-2. Macroinvertebrates (Number per Square Meter Collected From Station BIO- 6, Ponar Grab Samples, November 1991 (Page 6 of 6)

Common Name	Class	Family	Genus Species	Replicates A	B	C	D	Total	* Pollution Tolerant	Limited Tolerance	Clean Water
Oligochaetes	Oligochaeta	Naididae	Dero nivea			86		86	x		
			Dero trifida			43		43	x		
		Tubificidae	Ilyodrilus templetoni		172	86		258	x		
			Limnodrilus hoffmeisteri	86		43		129	x		
			Tubificid. Immat. w/ capil.	344			86	431	x		
			Tubificid. Immat. w/o capil	172	129	172	215	689	x		
Mayflies	Insecta	Baetidae	Baetis sp.				43	43			x
Dragonflies			Macromia sp.		43			43			x
Midges		Chironomidae	Ablabesmyia mallochi		43			43		x	
			Ablabesmyia parajanta	43				43		x	
			Chironomus decorus gr.		43			43		x	
			Cryptochironomus blarina gr	129	43	43		215		x	
			Cryptochironomus fulvus gr.		43	86		129		x	
			Paracladopelma undine			43		43		x	
			Paracladopelma halterale	43		43		86		x	
			Paracladopelma scalaenum	43		43		86		x	
			Tanytarsus guerlus gr.		86	86		172		x	
			Tribelos fusicornis	43	43	172	43	301		x	
			Tribelos jucundum	129	43	560		732		x	
Snails	Gastropoda	Ancyliidae					43	43			x
Mussels	Bivalvia	Unionae	Elliptio lanceolata				43	43			x
			TOTAL NUMBER OF SPECIES	9	10	13	5	20			
			TOTAL NUMBER OF INDIVIDUALS	1,033	689	1,507	431	3,660			
			DIVERSITY (d)	2.77	3.08	3.07	1.96	3.62			

* No listing provided where no specific poolution tolerance reference is available.

Source: ECT, 1992.

Table 3-3. Macroinvertebrates (Number per Square Meter) Collected From Station BIO-1, Artificial Substrate Samples, December 1991

Common Name	Class	Family	Genus Species	Replicates A	B	C	Total	* Pollution Tolerant	Limited Tolerance	Clean Water
Oligochaetes	Oligochaeta	Naididae	Dero digitata		15		15	x		
			Dero furcata		8		8	x		
			Dero nivea	169	54	31	254	x		
			Nais variabilis			46	46	x		
Mayflies	Insecta	Baetidae	Pristinella osborni		8		8			x
			Baetidae **		15		15			x
			Eurylophella temporalis	8			8			x
			Paraleptophlebia volitans	223	100	69	392			x
Caddisflies		Hydropsychidae	Phylocentropus sp.		8		8			
			Cryptostemma uhleri	8			8			
Water Treaders		Mesovellidae	Mesovellidae	15			15			
			Mesovelia sp.		8		8			
Diving Beetles		Dytiscidae	Hygrotus sp.		8		8		x	
Midges		Chironomidae	Ablabesmyia mallochi	231	246	246	723		x	
			Ablabesmyia parajanta			46	46		x	
			Chironomus decorus gr.	123	92	46	261		x	
			Chironomidae fulvus gr.	15			15		x	
			Dicrotendipes sp.			15	15		x	
			Kieferulus dux		23	92	115		x	
			Polypedilum fallax	15	46	261	323		x	
			Polypedilum illinoense			31	31		x	
			Tanytarsus sp. I Cantrell	92	69	154	315		x	
			Tanytarsus querlus		15		15		x	
			Tribelos fusicornis	846	1476	1738	4060		x	
			Tribelos jucundum	600	15	108	723		x	
Snails	Gastropods	Ancyliidae				15	15			x
			TOTAL NUMBER OF SPECIES	12	17	14	26			
			TOTAL NUMBER OF INDIVIDUALS	2,345	2,207	2,899	7,452			
			DIVERSITY (d)	2.56	1.95	2.25	2.50			

** damaged specimen

Table 3-3. Macroinvertebrates (Number per Square Meter) Collected From Station BIO-2, Artificial Substrate Samples, December 1991 (Page 2 of 6)

Common Name	Class	Family	Genus Species	Replicates A	B	C	Total	* Pollution Tolerant	Limited Tolerance	Clean Water
Oligochaetes	Oligochaeta	Naididae	Dero digitata	31			31	x		
			Dero furcata	15	31		46	x		
		Tubificidae	Nais variabilis		31		31	x		
Mayflies	Insecta	Baetidae	Caenis diminuta	8	31		38			x
		Ephemerellidae	Eurylophella temporalis		8		8		x	
			Stenacron flordense	8	15		23		x	
			Stenacron interpunctatum	23		23	46		x	
		Leptophlebiidae	Paraleptophlebia volitans	15		15	31		x	
Damselflies		Coenagrionidae	Enallagma sygnatum			15	15			x
		Libellulidae	Pachydiplax longipennis		8	8	15		x	
Water Treaders		Mesoveliidae	Mesovelia amoena			8	8		x	
Midges		Chironomidae	Ablabesmyia mallochi	46	400	62	508		x	
			Ablabesmyia parajanta	62	31		92		x	
			Chironomus decorus gr.	169	31		200		x	
			Kieferulus dux	108	31	31	169		x	
			Lavrumdinea pilosella	15	31		46		x	
			Phanopsectra flavipes	15			15		x	
			Polypedilum fallax		2092		2092		x	
			Polypedilum illinoense		123		123		x	
			Tanytarsus sp. I Cantrell			15	15		x	
			Tribelos fusicornis	1169	0	2445	3614		x	
			Tribelos jucundum	707	1876	169	2753		x	
			TOTAL NUMBER OF SPECIES	14	15	10	22			
			TOTAL NUMBER OF INDIVIDUALS	2,392	4,737	2,791	9,920			
			DIVERSITY (d)	2.13	1.88	0.83	2.40			

Table 3-3. Macroinvertebrates (Number per Square Meter) Collected From Station BIO-4, Artificial Substrate Samples, December 1991 (Page 4 of 6)

Common Name	Class	Family	Genus Species	Replicates A	B	C	Total	* Pollution Tolerant	Limited Tolerance	Clean Water
Flatworms	Turbellaria				246		246			
Nemerteans	Enopla		Prostoma rubrum		92		92			
Oligochaetes	Oligochaeta	Naididae	Dero nivea			31	31	x		
			Slavena appendiculata	23	31		54			
Midges	Insecta	Chironomidae	Ablabesmyia mallochi	492	554	338	1384		x	
			Ablabesmyia parajanta		123		123		x	
			Conchapelopia sp.			92	92		x	
			Corynoneura sp. II Cantrell	62			62		x	
			Dicrotendipes modestus			31	31		x	
			Dicrotendipes nervosus		62		62		x	
			Dicrotendipes thanatogratus		62		62		x	
			Kiefferulus dux		62	31	92		x	
			Labrundinia neopilosella		92		92		x	
			Labrundinia pilosella	31	31		62		x	
			Nanocladius sp.		92		92		x	
			Paratanytarsus sp.		92	400	492		x	
			Pentaneura inconspicua	46			46		x	
			Polypedilum fallax	246	185	154	584		x	
			Polypedilum illinoense	154	62		215		x	
			Rheocricotopus robacki	400		246	646		x	
			Rheotanytarsus distinctissi	1230		62	1292		x	
			Rheotanytarsus exiquus gr.			3199	3199		x	
			Tanytarsus sp. I Cantrell	800	1538	2584	4922		x	
			Tanytarsus XIII Rutter	31			31		x	
			Tanytarsus querlus		154		154		x	
			Thienemanniella nr. fusca	123	62	246	431		x	
			Thienemanniella. prob. xena	123		215	338		x	
			Tribelos fusicornis	92	92		185		x	
			TOTAL NUMBER OF SPECIES	14	18	13	28			
			TOTAL NUMBER OF INDIVIDUALS	3,853	3,630	7,628	15,111			
			DIVERSITY (d)	2.93	3.07	2.28	3.56			

Table 3-3. Macroinvertebrates (Number per Square Meter) Collected From Station BIO-5, Artificial Substrate Samples, December 1991 (Page 5 of 6)

Common Name	Class	Family	Genus Species	Replicates A	B	C	Total	* Pollution Tolerant	Limited Tolerance	Clean Water
Nematodes	Nematoda				15		15			
Oligochaetes	Oligochaeta	Naididae	Dero furcata			31	31	x		
			Dero nivea		92	62	154	x		
			Slavena appendiculata			15	15			
Midges	Insecta	Chironomidae	Ablabesmyia mallochi	123	169	77	369		x	
			Ablabesmyia parajanta	46	46	108	200		x	
			Chironomus decorus gr.	15			15		x	
			Dicrotendipes nervosus			15	15		x	
			Dicrotendipes thanatogratus	15			15		x	
			Endochironomus nigricans		15	15	31		x	
			Goeldichironomus sp.		15		15		x	
			Kiefferulus dux	15	15		31		x	
			Labrundinia neopilosella	15	15	46	77		x	
			Labrundinia pilosella			31	31		x	
			Nanocladius sp.	77	46	46	169		x	
			Paralauterborniella nigrohalteral	92	15	138	246		x	
			Paratanytarsus sp.		15		15		x	
			Phaenopsectra flavipes	46		15	62		x	
			Polypedilum fallax	169	246	215	631		x	
			Polypedilum illinoense	15	15		31		x	
			Polypedilum scalaenum	15			15		x	
			Rheocricotopus robacki	15		31	46		x	
			Rheocricotopus exiquus gr.		15	15	31		x	
			Tanytarsus sp. I Cantrell	277	508		784		x	
			Tanytarsus querlus		15		15		x	
			Thienemanniella nr. fusca	15			15		x	
			Tribelos fusicornis	77	77	92	246		x	
			Tribelos jucundum	62	15		77		x	
			TOTAL NUMBER OF SPECIES	17	18	16	28			
			TOTAL NUMBER OF INDIVIDUALS	1,092	1,353	954	3,399			
			DIVERSITY (d)	3.43	2.99	3.50	3.65			

Table 3-3. Macroinvertebrates (Number per Square Meter) Collected From Station BIO-6, Artificial Substrate Samples, December 1991 (Page 6 of 6)

Common Name	Class	Family	Genus Species	Replicates A	B	C	Total	* Pollution Tolerant	Limited Tolerance	Clean Water
Flatworms	Turbellaria			15			15			
Oligochaetes	Oligochaeta	Naididae	Dero furcata		15		15	x		
			Nais variabilis	23	15		38	x		
		Tubificidae	Immature Tubificidae w/o			8	8	x		
Mayflies	Insecta	Baetidae	Macromia sp.	8			8		x	
Riffle Beetles		Elmidae	Ancyronyx variegata	46			46		x	
			Dubiraphia sp.	62		15	77		x	
			Stenelmis sp.			8	8		x	
Midges		Chironomidae	Ablabesmyia mallochi	131	354	177	661		x	
			Ablabesmyia hauberi		246	15	261		x	
			Ablabesmyia parajanta	100		215	315		x	
			Chironomus decorus gr.	115		15	131		x	
			Dicrotendipes modestus	38	15		54		x	
			Dicrotendipes thanatogratus		15	23	38		x	
			Kieferulus dux	31	46	15	92		x	
			Labrundinea neopilosella		15	8	23		x	
			Nanocladius sp.			8	8		x	
			Paratanytarsus sp.		62		62		x	
			Phanopsectra flavipes			8	8		x	
			Polypedilum fallax	254	292	169	715		x	
			Polypedilum halterale	15			15		x	
			Polypedilum illinoense	38		23	62		x	
			Polypedilum scalaenum	38		8	46		x	
			Rheotanytarsus distinctissimus gr.			8	8		x	
			Rheotanytarsus exiguus	15			15		x	
			Tanytarsus sp 1 Cantrell	138	261		400		x	
			Tanytarsus querlus	169	538		707		x	
			Thienemanniella sp.	8			8		x	
			Tribelos fusicornis	138	261	92	492		x	
			Tribelos jucundum			69	69		x	
Mussels	Bivalvia	Sphaeriidae	Micromenetus dialatatus	8			8			x
			Pisidium sp.	8		8	15			x
			TOTAL NUMBER OF SPECIES	21	13	19	32			
			TOTAL NUMBER OF INDIVIDUALS	1,400	2,138	892	4,429			
			DIVERSITY (d)	3.75	2.95	3.21	3.71			

* damaged specimen

* No listing provided where no specific pollution tolerance reference is available.

Source: ECT, 1992.

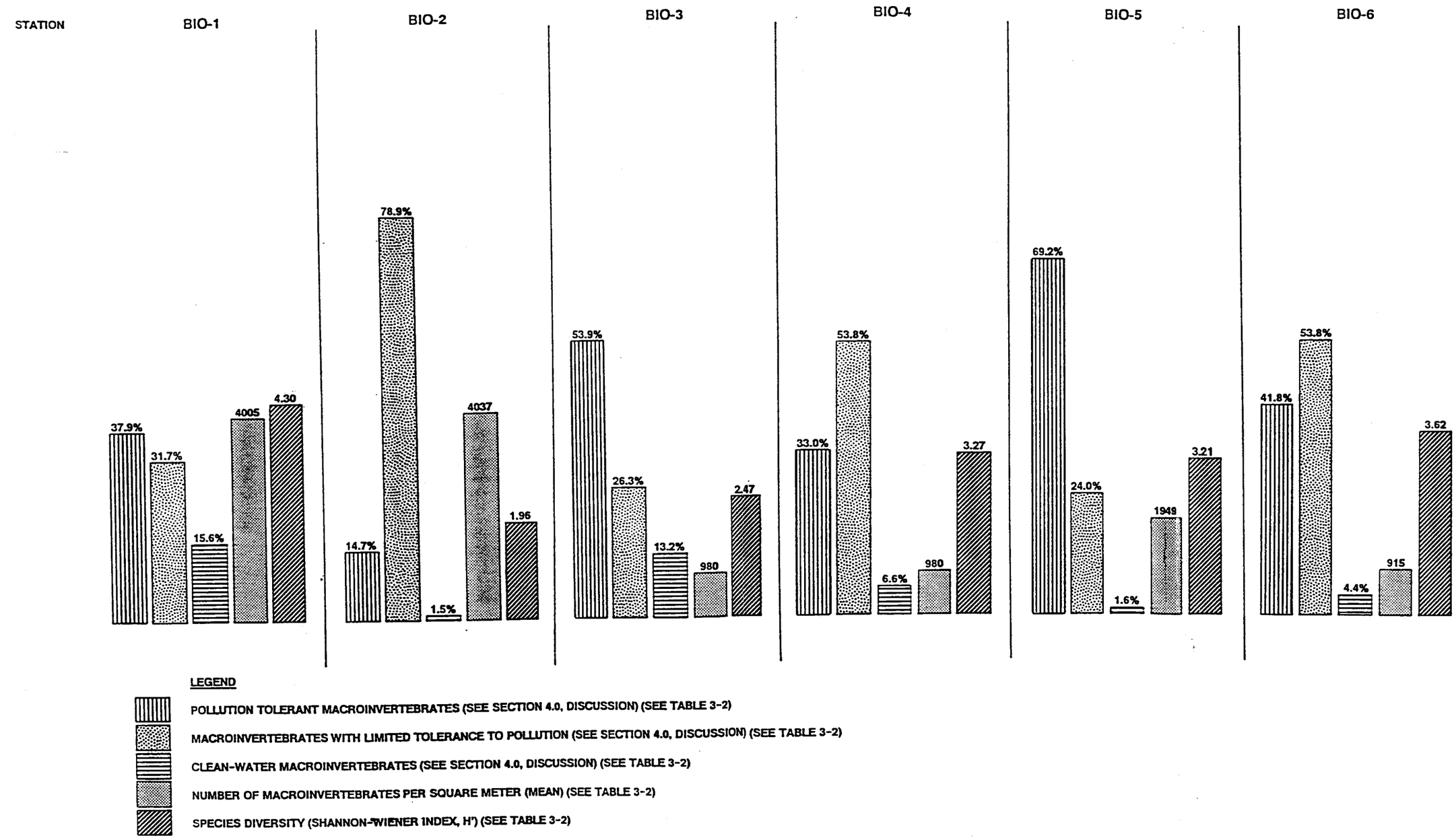

FIGURE 3-3
BENTHIC INFAUNA DENSITY AND DIVERSITY
ROWELL CREEK BIOLOGICAL SAMPLING STATIONS
NAVAL AIR STATION CECIL FIELD
Sources: ECT, 1992.

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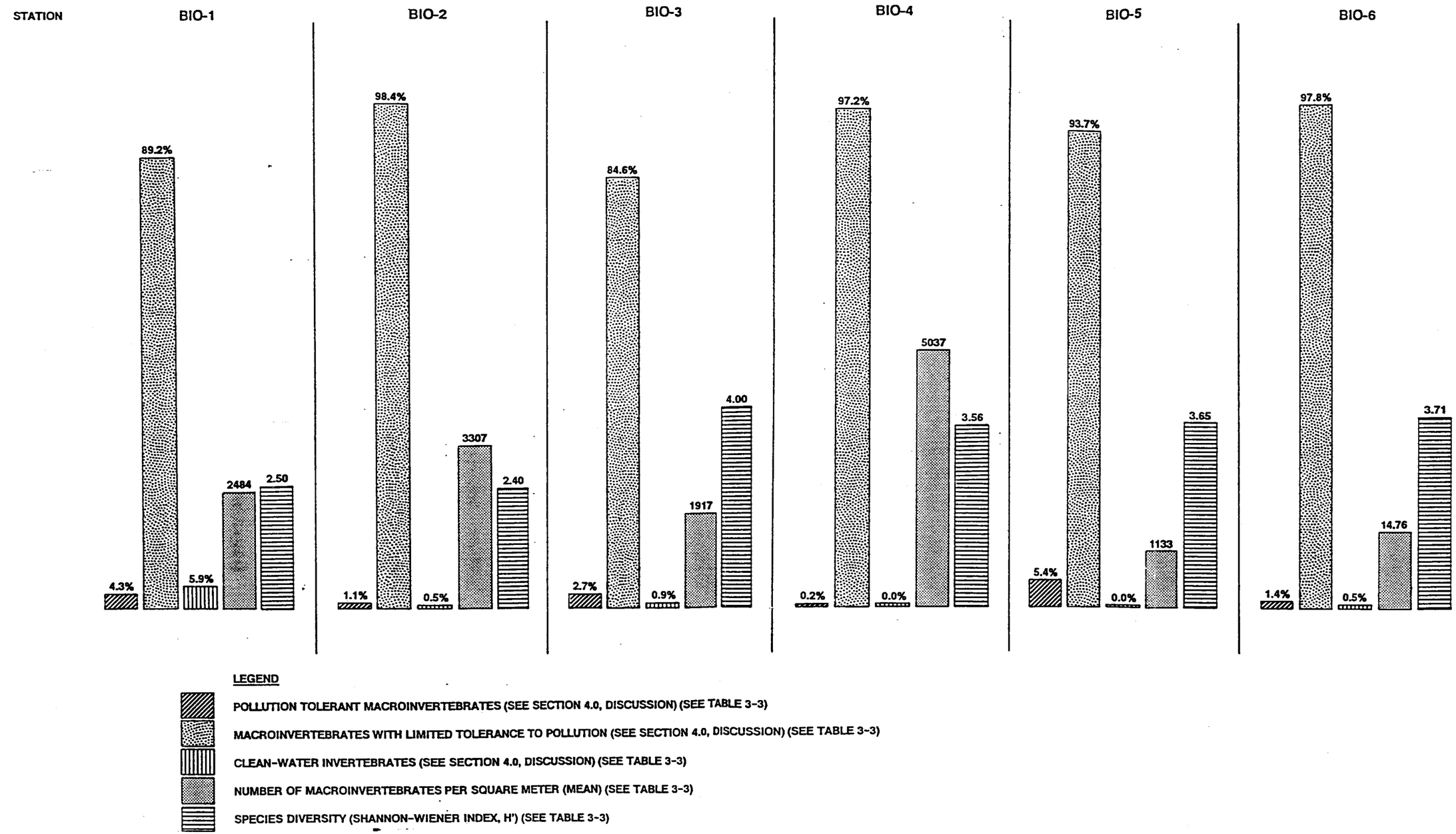

FIGURE 3-4
AQUATIC EPIFAUNA DENSITY AND DIVERSITY
ROWELL CREEK BIOLOGICAL SAMPLING STATIONS
NAVAL AIR STATION CECIL FIELD
Sources: ECT, 1992.

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4.0 DISCUSSION

An examination of the data obtained during sampling for the physical and chemical characteristics, the aquatic fisheries, and the aquatic macroinvertebrates reveals some apparent trends. The lowest aquatic macroinvertebrate biodiversity was found to occur at Station BIO-2. The fish community at this station was dominated by the mosquito-fish, fish which bear their young live and as such are resistant to high nutrient levels. The live-bearers (family Poeciliidae) are perhaps the most common and hardy of freshwater or brackish water fishes. Internal fertilization and live birth allow these species to avoid the high mortalities in the developmental stages associated with predation. In addition, developing young do not require the narrow ambient water quality tolerances that untended egg clutches do. Other examples of extremely hardy fish species are the gars in the family Lepisosteidae. In addition to surviving wide ranges of physiological parameters, some gar species have the advantage of spawning a roe which is actually poisonous (Williams, 1983). The presence of fish species from these families is predictable in Florida freshwater, and is not indicative of water quality. However, the absence of fish species less well known for their hardiness can be indicative of poor system health when comparing two systems that are otherwise similar.

The macroinvertebrate community (both epifaunal and infaunal organisms) was also dominated by organisms which are somewhat tolerant of nutrient rich waters and those which are capable of withstanding high nutrient levels and low DO (Beck, 1977; Simpson and Bode, 1980; Roback, 1974; Rudolph and Strom, 1990; Thorp and Covich, 1991). This station was observed to have low flow during the sampling event and the lowest level of DO (4.98 milligrams per liter [mg/L]) of any of the stations. Visual observation at this station suggested that the source for nutrients and organics was runoff from the golf course and perhaps sewage effluent from the upland drainage basin surrounding this station.

The opportunity for direct comparison of the data obtained at other stations is limited by differences between the stations themselves. Stations BIO-1 and BIO-2 are upstream of Lake Fretwell and cannot recruit directly from the remaining four stations downstream of the dam at Lake Fretwell. Station BIO-2 is also limited in recruiting from the upstream headwaters and the community near Station BIO-1, as ditches and shallow headwaters do not typically have diverse biota. Despite being downstream of a ditched portion of the stream, Station BIO-1 has a relatively high species diversity in the fisheries and the benthos (when compared with station BIO-2). Oxygenation of the water upstream of BIO-1 may be enhanced by the water flowing briskly through the ditch across the golf course, prior to discharging to the natural meander where flows decrease. Approximately 37.9 percent of the macroinvertebrates sampled from the benthos at Station BIO-1 are species which are often considered resistant to pollution (Brinkhurst and Cook, 1974). These organisms include the oligochaete species in the family Lumbriculidea and the species Dero, Nais, Pristina, Slavena, Aulodrilus, Ilyodrilus, and Limnodrilus. A few of these species also appear in the sampling for aquatic epifauna. In actuality, these species are generally abundant in nutrient rich waters, but can be susceptible to high levels of metallic salts (Hart, 1974). Species diversity was moderate ($H' = 2.50$) within the epifauna and relatively high ($H' = 4.30$) in the benthos. Those species which have limited pollution tolerance were predominately the arthropods within the Chironomidae or midges, and the Elmidae or riffle beetles (Thorp and Covich, 1991). Both of these groups can tolerate lowered DO utilizing adaptations such as a hemoglobin respiratory pigment or actual surface capture of air bubbles to obtain oxygen. Those organisms which are most typically associated with clean water systems included the Baetidae or mayflies, the Coenagrionidae or damselflies, and mollusks within the Ancyliidae and Sphaeriidae (Fuller, 1974; Thorp and Covich, 1991). The presence within the samples of these wide assemblages is often indicative of system health. The mollusks are most indicative of system health by their absence in polluted systems (Fuller, 1974).

As the creek meanders downstream toward Station BIO-2, flows appear to become more sluggish and the DO level decreases from 5.17 to 9.98; this may limit the recruitment of less pollution-tolerant organisms downstream from Station BIO-1. The infauna and epifauna at Station BIO-2 were low in macroinvertebrate species diversity ($H' = 1.96$ and 2.40, respectively). Furthermore, the numbers of individuals per m^2 were quite elevated in both cases, indicative of a nutrient rich system with adequate DO for opportunistic species (Beck, 1977; Simpson and Bode, 1980). Those opportunistic species were again the pollution-tolerant oligochaetes and the somewhat pollution-tolerant chironomids. Representation by clean water species was very low in both the infauna and epifauna. No mollusks were represented in either sample type despite their presence upstream.

Progressing downstream from Station BIO-1, there was a steady increase measured in both specific conductivity and ORP. These levels peaked between Stations BIO-3 and BIO-4 and leveled off downstream. The macroinvertebrates at Station BIO-3 were heavily dominated by oligochaetes in the infauna. This may be indicative of a high nutrient level in the substrate and certainly contributed to a relatively low infaunal species diversity ($H' = 2.47$). The epifauna are fairly diverse ($H' = 4.00$), and are dominated by the somewhat pollution-tolerant chironomids. These trends may imply a nutrient and electrolyte source exists upstream of Station BIO-3; the most obvious such source would be Lake Fretwell. The golf course and base housing surrounding Lake Fretwell are other likely sources for nutrients.

A known source of water which is potentially high in nutrients flows from a sewage treatment system on the base and discharges to Rowell Creek upstream of Station BIO-3. The species diversity in the fisheries community was lowest in the samples obtained from Stations BIO-3 and BIO-4. However, the limited size of the data set only allows the most general, qualitative comparisons to be made. Reasonable flow and gradual increases in the available DO indicate that any nutrient load could be

naturally and gradually reduced by uptake as the stream flows toward the southern property boundary. It should be noted that mollusks have reappeared in both samples.

The macroinvertebrate community at Station BIO-4 was reasonably diverse in both the infauna ($H' = 3.27$), and the epifauna ($H' = 3.56$). Both macroinvertebrate communities were dominated by chironomids to the near exclusion of other organisms. The nearly complete absence of oligochaetes is suspicious. The deleterious affect of heavy metal salts upon oligochaetes may be a consideration and comparisons should be made with what chemical/water quality data may be available.

At Station BIO-5, streamflow rates have increased. Species diversity within the benthos ($H' = 3.21$), and the epifauna ($H' = 3.65$) are moderate. The contribution to the diversity by organisms with dissimilar pollution tolerance levels has begun to approach a more natural mixture. In the benthos, the pollution-tolerant organisms make up approximately 69 percent, the moderately pollution-tolerant 24 percent and the remaining 7 percent consisted of mollusks and organisms with little known preferences. The epifauna at Station BIO-5 was heavily dominated by moderately pollution-tolerant chironomids.

The data from Station BIO-6 is quite similar to that of Station BIO-5. Species diversities are moderately high, the benthos is evenly mixed and the epifauna are largely consisted of chironomids. The physical and chemical characteristics of these two stations were also similar, with the exception of streamflow, and streamflow was considered to have been underestimated at Station BIO-5 during sampling.

Trends observed could be due to physical differences in sampling stations. This is especially the case since the data set only reflects conditions during one sampling

event. The data from all six sampling stations are not qualitatively different from one another if only artificial substrate sampling of the aquatic epifauna is considered. While some differences in individual species exist, the invertebrate community is dominated by the chironomids, which have some limited tolerance for enrichment and slightly depressed oxygen availability. The percentages of more pollution tolerant organisms are small, and the percentages of organisms, such as mollusks or mayflies, which are pollution intolerant are very small at each station. Artificial substrate sampling occurred over 28 days and was probably most indicative of the typical dry season aquatic macroinvertebrate community. The implication is that water quality at each of the six stations was similar over that time period.

5.0 CONCLUSIONS AND RECOMMENDATIONS

The aquatic ecological investigation has provided a baseline for the winter, dry season condition within Rowell Creek. Overall, the aquatic fauna indicates that this system is functioning adequately and supports a variety and reasonable abundance of fish and macroinvertebrates. In order to properly compare the biota and physical and chemical characteristics from one station to another, a larger sample size will be necessary. The Ponar dredge samples, in particular, need to be repeated since conditions within the soils may best reflect the long-term effects any seepage from landfills may have. The highly variable percentage of the pollutional (i.e., oligochaetes) organisms in the samples is potentially important. Although these organisms are known for their ability to tolerate enrichment and relatively low DO levels, they have been found to be susceptible to pollution associated with metals and phenols (Surber, 1953, Hart and Fuller, 1974).

The single data set only allows for qualitative comparisons between stations and the establishment of a baseline condition. Detailed comparisons of a more quantitative nature will require repeated sampling to increase the sample size. In addition, the physical and chemical characteristics of the water leaving Lake Fretwell should be measured in order to better evaluate the property for sources of enrichment. It would also be important to measure the physical and chemical characteristics upstream of Station BIO-2 and to attempt to locate a source for sewage effluent in this area. The data obtained will likely be compared with data obtained during future sampling events. This will increase the utility of the overall data set as sample size increases, seasonal variability is accounted for, and both inter- and intraspecific effects (e.g., predation by one codominant upon another which may tend to reduce the latter's contribution to numbers of individuals and species diversity) are brought into consideration.

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