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# The Aquatic Macroinvertebrates of the White River National Wildlife Refuge

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Arkansas Water Resources Research Center
University of Arkansas
Fayetteville, Arkansas 72701


**Arkansas Water Resources Research Center**

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ABSTRACT

THE AQUATIC MACROINVERTEBRATES OF THE
WHITE RIVER NATIONAL WILDLIFE REFUGE

The primary purpose of this study was to survey the diversity of the aquatic macroinvertebrates of the White River National Wildlife Refuge (WRNWR). Determining relative abundance and distributional and seasonal patterns were secondary objectives. No comprehensive investigations of the WRNWR aquatic macroinvertebrates had been conducted previously, and it was hypothesized that this relatively undisturbed area may serve as a refugium. Further, this study provides base line data by which management programs can be composed.

Thirty sampling stations were established within the WRNWR. Samples were collected from north to south at a basic rate of five stations per month. Revisit collections were made during the subsequent six month period, providing a total of 60 samples. Each station was sampled on each occasion for 1.4 man hours with a Turtox Indestructible™ dip net, and specimens were preserved in 70% ethanol. Three black light samples were taken to augment the species list.

Of the 15,083 organisms collected, 80.4% were insects while 6.4% were decapod crustaceans, 5.2% were molluscs, 4.5% were isopods and 2.1% were amphipods. Number of taxa collected per station ranged from 8-36, while numerical standing crop ranged from 8-600. Shannon-Wiener diversity values ranged from 1.056-4.717.

The most complex aquatic macroinvertebrate communities were found, in general, in the southeastern portion of the refuge. Great diversity here and at a few other stations was correlated with minimal disturbance by human activity. Parts of the WRNWR apparently function as a refugium. Four of the ten leach species collected, and an uncommon beetle, Suphis, were new state records.

S.W. Chordas, III and G.L. Harp

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Keywords: Aquatic Macroinvertebrates, National Wildlife Refuge, Arkansas

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# INTRODUCTION

The White River National Wildlife Refuge (WRNWR), located in the floodplain of the lower White River just a few km above its confluence with the Mississippi River, is the largest refuge in Arkansas (Anonymous, undated). It covers 45,750 ha of land and is traversed by 95.5 km of the White River itself. The refuge was established on 4 September 1935, primarily as a sanctuary for migratory waterfowl (Earngy, 1987). The majority of the refuge is concentrated in the eastern portion of Arkansas County, but extends into three adjoining counties. The refuge ranges from 4.4 to 14.7 km in width and contains many km of streams, bayous and sloughs in addition to its 165 natural lakes. The refuge is a bottomland area rather than a swamp area. Due to its close proximity to the White and Mississippi Rivers, the refuge is subjected to flooding several months of the year. Flooding occurs, on an average, in late winter and in spring lasting about two months (Anonymous, undated).

The refuge is dominated by thirteen different forest types containing 31 major tree species. The understory and forest floor are filled with numerous species of woody shrubs, vines and herbaceous plants. Combinations

of these plant create a diversity of good quality wildlife habitat. An active management program is conducted on the refuge to maintain and create suitable wildlife habitat conditions for all wildlife species that live in or use the refuge (Anonymous, undated).

The refuge is best noted for its large number of overwintering waterfowl. Waterfowl start arriving in early fall, but do not reach peak populations until late December. The majority of the ducks present on the refuge are mallards. Peak waterfowl populations range from 150 to 350 thousand ducks (average around 225 thousand) and approximately 10 thousand Canada geese (Anonymous, undated).

The watershed of the refuge is extremely flat bottomland of the Mississippi Alluvial Plain. Agriculture dominates the watershed outside of the refuge boundaries while varying thicknesses of forest growth dominate within its boundaries (Arkansas Department of Pollution Control and Ecology, 1975). The soil type is composed mostly of fine alluvium. Substrates include hard packed mud, sand, clay, soft mud and organic detritus.

The mean annual rainfall on the refuge is 128.30 cm,

with approximately 75% of the total rainfall occurring between the months of January and July. The mean annual temperature is 16.4°C with a mean high of 26°C and a mean low of 0.94°C (U.S. Department of Commerce National Oceanic and Atmospheric Administration, 1989 & 1990).

The refuge is open to the general public from 1 March until 31 October. There are 23 campgrounds equipped with tables and chemical toilets. Utilization of the refuge is primarily by sport fishermen, hunters and campers (Anonymous, undated).

## PURPOSE AND OBJECTIVES

The primary purpose of this study was to survey the diversity of the aquatic macroinvertebrates of the White River National Wildlife Refuge. Determining relative abundance and distributional and seasonal patterns were secondary objectives. Comprehensive investigations of the aquatic macroinvertebrate communities were previously lacking.

This survey of the aquatic macroinvertebrates of the WRNWR provides insight into the now existing and pre-existing communities. As a relatively undisturbed environment, the refuge may still support invertebrate communities similar to those of the natural environment

of the past. Further, this study provides base line data by which immediate or long term wildlife management programs can be compared. The population structure of the aquatic macroinvertebrate community is an ideal measure of the general environment health within an area (Mason, 1981). Many aquatic macroinvertebrates posess very limited means of mobility and have strict habitat requirements; thus limiting these organisms to tolerate harsh environmental changes. Therefore, the presence, absence or number of individuals of certain aquatic macroinvertebrates, within a given community, can be useful in evaluting habitat quality.

## METHODS AND MATERIALS

Thirty sampling stations were established within the boundaries of the WRNWR to effectively explore as many microhabitats as possible (Table 1). Collections were made, in general, from north to south at a rate of five stations per month, thus completing the initial samples in six months (October 1989-March 1990). Due to extensive flooding, most samples of this first series were taken toward the end of the planned sampling period, in accordance with accessibility of the sample site. Revisit collections were taken from June-September 1990, resulting in a total of 60 collections, two from each sample site. Although revisit collections were not made at precise intervals, crude seasonal distribution was derived. Each station was sampled for 1.5 man hours with a Turtox Indestructible™ dip net, and specimens were preserved in 70% ethanol. Mussel relics were collected by hand. The aquatic macroinvertebrates were identified in the laboratory, catalogued and placed in the Aquatic Macroinvertebrate Collection of the Arkansas State University Museum of Zoology (ASUMZ) as voucher specimens.

Three black light samples were taken to further

Table 1. Stations selected for sampling. (Collection numbers are in parentheses, and prime numbers denote second visit).

| Station | | Description |
|---|---|---|
| 1 | AR, Monroe Co., T3S, R1W, Sec. 29, NE¼ of NE¼, Swan Lake | |
| | (1) 14-X-89 | Collected in leaf litter and debris; small amount of aquatic vegetation and algae present; substrate semi-soft |
| | (1[1]) 30-VI-90 | Original banks flooded; water level up about 1.0m; sampled in detritus and along banks; substrate of mud. |
| 2 | AR, Monroe Co., T3S, R1W, Sec. 33, NW¼-Buck Lake | |
| | (2) 14-X-89 | Sampled along bank and around tree bases; leaf litter, sparse vegetation and algae present. |
| | (2[1]) 30-VI-90 | Original banks flooded; sampled along banks; substrate muddy; some detritus present. |
| 3 | AR, Monroe Co., T3S, R1W, Sec. 33, NW¼ of NW¼-Little Moon | |
| | (3) 14-X-89 | Substrate of mud and rocks; steep banks; sampled along edge and in leaf litter; slow curent present. |
| | (3[1]) 30-VI-90 | Water level up about 1.3m; sampled along banks in leaf litter and small wood chips and in scant root wads; slow current present. |
| 4 | AR, Monroe Co., T3S, R1W, Sec. 34, SW¼ of SW¼-Waters Bayou | |
| | (4) 13-X-89 | Sampled along steep clay-mud banks in sparse vegetation and solid detritus (twigs, bark, etc.); moderate current present. |
| | (4[1]) 30-VI-90 | Water up about 1.0m; sampled in |

Table 1 Cont.

| | | |
|---|---|---|
| | | vegetation, mud, leaf litter and root wads; slow current present. |
| 5 | AR, Monroe Co., T3S, R1W, Sec. 26-Indian Bayou | |
| | (5) 14-X-89 | Substrate of rock and mud; sampled in riffle and pool areas; sparse vegetation in pool area; swift current present. |
| | (5[1]) 30-VI-90 | Normal banks flooded; water up 2.0m; sampled along rock bank; moderate current present. |
| 6 | AR, Arkansas Co., T4S, R1W, Sec. 21, SE¼-Big Island Chute | |
| | (6) 18-XI-89 | Sampled in both pool area and main stream; vegetation, leaf litter and detritus present in pool area; hard clay banks in main stream; little debris; slow current. |
| | (6[1])22-VII-90 | Water level up about 1.0m; sampled in both the pool area and main stream: vegetation, leaf litter and solid detritus (wood chips, twigs, etc.) present in pool area; hard substrate in main stream; moderate current. |
| 7 | AR, Arkansas Co., T4S, R1W, Sec. 33, SE¼-H-Landing | |
| | (7) 18-XI-89 | Sampled along edge, in drifts, along logs and in accumulated debris; substrate of rock and mud; moderate current present. |
| | (7[1]) 22-VII-90 | Water up about 1.5m; substrate soft silty mud; banks steep; sampled along edge and in scant root wads; very swift current present. |
| 8 | AR, Arkansas Co., T4S, R1W, Sec. 14, SE¼-Little White Lake | |
| | (8) 18-XI-89 | Substrate hard; sampled along edge, in leaf litter and in organic detritus. |

Table 1 Cont.

| | | |
|---|---|---|
| | (8[1]) 22-VII-90 | Water up 1.0m; soft substrate; sampled in leaf litter and solid organic detritus areas. |
| 9 | AR, Monroe Co., T4S, R1W, Sec 1, NE¼ of NE¼-Indian Bay | |
| | (9) 18 XI-89 | Very steep banks; extremely soft muddy substrate with a few scattered rocks; no leaf litter or detritus present; swift current present. |
| | (9[1]) 22-VII-90 | Water up about 1.7m; substrate muddy; sampled along banks and in accumulated debris; moderate current present. |
| 10 | AR, Arkansas Co., T4S, R1W, Sec. 35, NE¼-Big Horseshoe Lake | |
| | (10) 18-XI-89 | Very steep banks; no aquatic vegetation; substrate of sand; sampled around tree bases, along bank and around boat ramp; slow current present. |
| | (10[1]) 29-IX-90 | Water level down about 0.5m; no aquatic vegetation, leaf litter or detritus; substrate of sand; sampled in same areas as first sample; very slow current present. |
| 11 | AR, Arkansas Co., T5S, R1W, Sec. 2, SE¼-Lake Gut | |
| | (11) 16-XII-89 | Sampled in vegetation, in leaf litter, along edge and around tree bases; soft muddy substrate; no current. |
| | (11[1]) 29-IX-90 | Water level about the same; sampled in and around rooted vegetation, along banks and in organic detritus; semi-soft substrate; no current. |
| 12 | AR, Arkansas Co., T5S, R1W, Sec. 27, SW¼ of NW¼-Burnt Lake | |

Table 1 Cont.

| | | |
|---|---|---|
| | (12) 17-XII-89 | Sampled in leaf litter, along bank and under overhanging brush and limbs; semi-soft substrate of mud. |
| | (12[1]) 30-IX-90 | Water level down about 0.7m; sampled along bank, in large amount of leaf litter present and under overhanging brush; very soft substrate of mud. |
| 13 | AR, Arkansas Co., T5S, R1W, Sec. 35, NE¼-Escrogens Lake | |
| | (13) 17-XII-89 | Sampled along bank, in solid organic detritus and in leaf litter; hard packed substrate; no aquatic vegetation. |
| | (13[1]) 30-IX-90 | Water level down approximately 0.7m; sampled along bank and in large amount of leaf litter and organic detritus present; very soft mud substrate. |
| 14 | AR, Arkansas Co., T5S, R1W, Sec. 21, SE¼-Essex Bayou | |
| | (14) 17-XII-89 | Sampled in drifts, along edge and around partly submerged brush; semi-soft muddy substrate; no aquatic vegetation; slow current present. |
| | (14[1]) 30-XI-90 | Water level down 2.0m; very steep banks; no aquatic vegetation, detritus or leaf litter present; sampled in mud banks and around brush/tree bases; slow current. |
| 15 | AR, Arkansas Co., T5S, R1W, Sec. 21, NE¼ of NW¼-(Hurricane) pond | |
| | (15) 17-XII-89 | Substrate of semi-soft black mud; sampled in abundant leaf litter, around tree bases and in solid organic detritus; no vegetation present. |

Table 1 Cont.

| | | |
|---|---|---|
| | (15[1]) 30-IX-90 | Water level down approximately 0.3m; pond slightly covered with duckweed; very soft black mud substrate; sampled in the abundance of leaf litter, muck and solid detritus present(bark and twigs); no vegetation. |
| 16 | AR, Arkansas Co., T6S, R1W, Sec. 3, SW¼-Columbus Lake | |
| | (16) 20-I-90 | Semi-hard mud clay substrate; sampled along bank and in scant debris accumulations; no vegetation. |
| | (16[1]) 4-IX-90 | Water level unchanged; semi-soft substrate; no vegetation; sampled along bank and in solid organic debris; an abundance of wood chips, twigs and seeds present. |
| 17 | AR, Arkansas Co., T6S, R1W, Sec. 10, NW¼-Prairie Bayou (Bradley Bayou Junction) | |
| | (17) 20-I-90 | Steep banks to a flat bottom; mud-clay substrate; sampled in thick vegetation, along bank and in main channel; moderate current present. |
| | (17[1]) 4-IX-90 | Water level up 1.4m; extremely soft mud substrate; sampled along bank in mud and in scant root wads; no vegetation ord detritus present; very swift current. |
| 18 | AR, Arkansas Co., T6S, R1W, Sec. 15, N½-H-Lake | |
| | (18) 20-I-90 | Very turbid water; semi-soft substrate: sampled along bank, around tree bases and in thick accumulation of organic detritus; many gutted fish carcasses floating along bank. |
| | (18[1]) 4-IX-90 | Water level unchanged; semi-soft mud substrate; sampled along bank, around tree bases and in |

Table 1 Cont.

| | | |
|---|---|---|
| | | thick accumulation of organic detritus. |
| 19 | AR, Arkansas Co., T6S, R1W Sec. 16, SE¼-Prairie Lake | |
| | (19) 20-I-90 | Slightly turbid water; small amount of detritus present; sampled along bank and in detritus; semi-hard substrate. |
| | (19[1]) 4-IX-90 | Water level unchanged; slightly turbid; sampled along banks and in detritus. |
| 20 | AR, Arkansas Co., T6S, R1W, Sec. 28, NW¼-Wolf Lake | |
| | (20) 20-I-90 | Semi-hard substrate; sampled in riparian vegetation, around brush/tree bases and in detritus. |
| | (20[1]) 4-IX-90 | Water level unchanged; substrate same as first sample; sampled along bank, in detritus and riparian vegetation. |
| 21 | AR, Arkansas Co., T7S, R2W, Sec. 2, NE¼-Wolf Bayou (at flood gate) | |
| | (21) 17-II-90 | Hard substrate; no vegetation; very little detritus; sampled along edge, in detritus and around flood gate opening; slow current present. |
| | (21[1]) 11-VIII-90 | Water level down 3.0m; soft muddy substrate; sampled in leaf litter and organic detritus; no vegetation present; no current present. |
| 22 | AR, Arkansas Co., T7S, R2W, Sec. 34, NE¼-Beaver Pond (across from flat lake) | |
| | (22) 17-II-90 | Very soft black mud substrate; no aquatic vegetation; normal banks flooded; sampled in leaf litter, in debris piles and in mud on bank; no current. |
| | (22[1]) 11-VIII-90 | Water level down 1.4m; semi-hard |

Table 1 Cont.

| | | |
|---|---|---|
| | | substrate; sampled in leaf litter, in aquatic vegetation and detritus; algae,duckweed, and cattails present; no current. |
| 23 | AR, Arkansas Co., T7S, R2W, Sec. 14 SE¼-Beaver Pond #2 | |
| | (23) 18-II-90 | Mud-clay substrate; sampled in leaf litter, solid debris and in scant aquatic vegetation; many logs and large tree limbs in water; no current. |
| | (23[1]) 11-VIII-90 | Pond almost non-existent; covering only approximately a 10m X 6m area; pond entirely capped with duckweed; soft mud substrate; sampled throughout entire site; scant organic detritus present. |
| 24 | AR Arkansas Co., T7S, R2W, Sec. 22, NW¼ of SE¼-Honey Locust Bayou | |
| | (24) 18-II-90 | Soft mud substrate; sampled in riparian vegetation, along bank and in detritus; slow current present. |
| | (24[1]) 11-VIII-90 | Water level down 1.4m; semi-soft substrate; no vegetation; sampled in leaf litter, drifts and detritus accumulations; very slow current present. |
| 25 | AR, Arkansas Co., T7S, R2W, Sec. 22, NE¼ of SW¼-Reservoir | |
| | (25) 18-II-90 | Banks composed of soft substrate, while basin composed of very hard substrate; sampled in vegetation, along banks and in scant solid detritus; no current. |
| | (25[1]) 11-VIII-90 | Water level down approximately 3.0m; heavily populated with aquatic vegetation; sampled in vegetation and around boat ramp; |

Table 1 Cont.

| | | |
|---|---|---|
| | | water somewhat stagnant. |
| 26 | AR, Desha Co., T7S, R1W, Sec. 11, SE¼-Scrubgrass Bayou #1 | |
| | (26) 21-IV-90 | Normal banks flooded; hard substrate; sampled in scant bank vegetation, leaf litter and at waters edge; slow current. |
| | (26[1]) 15-IX-90 | Water level down 1.8m; site totally covered by duckweed; hard substrate; sampled in vegetation and in detritus; slow current. |
| 27 | AR, Desha Co., T7S, R1W, Sec 11, NW¼-Scrubgrass Bayou #2 | |
| | (27) 21-IV-90 | Normal banks flooded; semi-hard substrate; sampled in detritus, around tree/brush bases and in scant bank vegetation; slow current. |
| | (27[1]) 14-IX-90 | Water level down 1.8m; site totally capped by duckweed; hard substrate; sampled along edge, in scattered detritus accumulations and in vegetation; slow current. |
| 28 | AR, Desha Co., T7S, R1W, Sec. 34, NE¼-Alligator Lake | |
| | (28) 22-IV-90 | Water level high (flooding picnic area); terrestral vegetation submerged; hard substrate; sampled along logs, at water's edge and in scant detritus. |
| | (28[1]) 14-IX-90 | Water receded back to lake; very soft substrate; waterlilies and cyprus knees abundant; sampled in vegetation, detritus, along bank and around tree/brush bases. |
| 29 | AR, Desha Co., T7S, R1W, Sec. 29, SW¼-East Moon Lake | |
| | (29) 22-IV-90 | Soft mud-clay substrate; normal |

Table 1 Cont.

| | | |
|---|---|---|
| | | banks flooded; sampled in bank vegetation, at waters edge and in detritus; an abundance of twigs and solid chips present. |
| | (29[1]) 14-IX-90 | Water down 1.1m; mud substrate; solid organic debris abundant; sampled in riparian vegetation and detritus. |
| 30 | AR, Phillips Co., T6S, R1W, Sec. 36, SE½ of SE¼-Borrow Pit-#1 | |
| | (30) 22-IV-90 | Extremely hard substrate; water up and flooding normal banks; several large fallen trunks near bank and in water; no vegetation; sampled along banks, around trunks and in solid organic debris chunks; no current. |
| 30[1] | AR, Phillips Co., T6S, R1W, Sec 36, SW½ of SE¼-Borrow Pit- #2 | |
| | (30[1]) 15-IX-90 | Soft mud substrate; thick aquatic vegetation; scant duckweed; sampled in and along edge of aquatic vegetation, along bank and in detritus; no current. |

extend the species list. The duration of each sample was one hour, starting approximately 15 minutes before dark and lasting 45 minutes after dark. Specimens were preserved in 70% ethanol. Specimens were sorted in the laboratory and sent off for identification.

General and some specific aquatic macroinvertebrate identifications were made by using keys by Holsinger (1976), Pennak(1978 and 1989), Brigham et al. (1982) and Merritt and Cummins(1984). Other specific determinations were made by usings keysby Hungerford (1933), Drake and Chapman (1953), Truxal (1953),Young (1954), Young (1956), Wilson (1958), Froeschner (1962), Wood (1962), Zimmerman (1970), M$^{c}$Cafferty (1975), Tarter (1976), Gunderson (1978), Brigham (1979), Kittle (1980), Spangler (?).

Shannon-Wiener Diversity (H'), Simpson diversity, Simpson Dominance, H'max and Evenness values were calculated at base 2 logarithm using the **AQUATIC ECOLOGY-PC** program of Oakleaf Systems, Decorah, IA. H' represents the absolute diversity and is equated with the average degree of uncertainty of predicting the species of a given individual selected at random from a population. Simpson Diversity measures the probability

that two individuals selected at random from a population of N individuals will be the same species; Simpson Dominance illustrates its relationship as one minus Simpson Diversity. The maximum possible diversity if all species occur in equal numbers is determined by H'max. Evenness is a function of the absolute diversity (H') divided by the H'max (Schemnitz, 1980).

## RESULTS

A total of 15,083 individuals representing 200+ taxa was collected from the WRNWR during 14 October 1989 to 15 September 1990 (Table 1). Of the 15,083 organisms collected, 6,504 of them were obtained during the initial visits to the sample sites while the remaining 8,579 were captured during the revisits.

Of the 15,083 organisms captured, 80.4% were insects, 6.4% were decapods, 5.2% were molluscs, 4.5% were isopods and 2.1% were amphipods. The following taxa were represented by less than one percent each: Bryozoa, Nematomorpha, Annelida, Cladocera, Copepoda, Mysidacae and Hydrocarina.

The WRNWR contains a great diversity of aquatic habitats. The types utilized in this study included: lakes, bayous (ranging from still water bayous to swift running bayous), reservoirs, borrow pits, ponds and chutes. These habitats varied markedly in substrate types and kinds and amounts of aquatic vegetation present. This in turn resulted in a large and diverse concentration of aquatic macroinvertebrates (Tables 2-8, Appendix).

The number of taxa obtained at each sample site was

greatest at stations 26-30, with a mean of 35.8 for the sample area (Table 2). Stations 6-10 contained the fewest taxa with a mean of only 19.6 for the sample area. During the initial visits, the greatest number of taxa collected at one site was 36 from both stations 26 and 5. The fewest taxa collected at one site was eight, at station 10. During the revisits, the most taxa were found at station 26, and the fewest were found at station 7.

The greatest number of individuals found at each station was at stations 26-30 with a mean of 355.8 for the sample area, but stations 1-5 were quite similar with a mean of 355.5 (Table 3). The fewest individuals were obtained at sample sites 6-10 with a mean of only 107.4. During the initial visit, the greatest number of individuals obtained at one site was 600 captured at station 1, and the fewest was 8, captured at station 10. During the second visit, the most individuals obtained at one station was 621 captured at station 19, and the fewest was 33 captured at station 9.

Simpson Diversity (Table 4) depicts a relative continuity over the entire refuge. The lowest values were calculated for sites 21-25, with a mean of 0.74720.

Table 2. Number of taxa per station per collection (A =initial visit, B=second visit, M=mean, Ave-T=average taxa per sample area)

| Station | A | B | M | Ave-T |
|---|---|---|---|---|
| 1 | 24 | 19 | 21.5 | |
| 2 | 32 | 23 | 27.5 | |
| 3 | 33 | 29 | 31.0 | |
| 4 | 26 | 36 | 31.0 | |
| 5 | 36 | 28 | 32.0 | 28.6 |
| 6 | 18 | 36 | 27.0 | |
| 7 | 27 | 11 | 19.0 | |
| 8 | 18 | 33 | 25.5 | |
| 9 | 9 | 14 | 11.5 | |
| 10 | 8 | 22 | 15.0 | 19.6 |
| 11 | 17 | 32 | 24.5 | |
| 12 | 18 | 37 | 27.5 | |
| 13 | 21 | 36 | 28.5 | |
| 14 | 10 | 20 | 15.0 | |
| 15 | 19 | 31 | 25.0 | 24.1 |
| 16 | 17 | 20 | 18.5 | |
| 17 | 18 | 14 | 16.0 | |
| 18 | 20 | 30 | 25.0 | |
| 19 | 24 | 36 | 30.0 | |
| 20 | 22 | 33 | 27.5 | 23.4 |
| 21 | 19 | 34 | 26.5 | |
| 22 | 20 | 29 | 24.5 | |
| 23 | 19 | 23 | 21.0 | |
| 24 | 24 | 21 | 22.5 | |
| 25 | 26 | 15 | 20.5 | 23.0 |
| 26 | 36 | 47 | 41.5 | |
| 27 | 32 | 44 | 38.0 | |
| 28 | 22 | 43 | 32.5 | |
| 29 | 27 | 37 | 32.0 | |
| 30 | 32 | 38 | 35.0 | 35.8 |

Table 3. Number of individuals per sample site (A=initial visit, B=second visit, M=mean, Ave-I=average # of individuals per sampled area)

| Station | A | B | M | Ave-I |
|---|---|---|---|---|
| 1 | 600 | 462 | 531.0 | |
| 2 | 243 | 446 | 344.5 | |
| 3 | 453 | 211 | 332.0 | |
| 4 | 304 | 243 | 273.5 | |
| 5 | 280 | 313 | 296.5 | 355.5 |
| 6 | 261 | 145 | 203.0 | |
| 7 | 139 | 70 | 104.5 | |
| 8 | 169 | 190 | 179.5 | |
| 9 | 22 | 33 | 27.5 | |
| 10 | 8 | 37 | 22.5 | 107.4 |
| 11 | 59 | 248 | 153.5 | |
| 12 | 146 | 244 | 195.0 | |
| 13 | 157 | 279 | 218.0 | |
| 14 | 34 | 258 | 146.0 | |
| 15 | 252 | 412 | 332.0 | 208.9 |
| 16 | 104 | 292 | 198.0 | |
| 17 | 135 | 129 | 132.0 | |
| 18 | 156 | 353 | 245.5 | |
| 19 | 329 | 621 | 475.0 | |
| 20 | 466 | 265 | 365.5 | 283.2 |
| 21 | 105 | 247 | 176.0 | |
| 22 | 124 | 132 | 128.0 | |
| 23 | 184 | 368 | 276.0 | |
| 24 | 132 | 257 | 194.5 | |
| 25 | 169 | 239 | 204.5 | 195.8 |
| 26 | 328 | 507 | 417.5 | |
| 27 | 393 | 315 | 354.0 | |
| 28 | 182 | 231 | 206.5 | |
| 29 | 372 | 589 | 480.5 | |
| 30 | 198 | 443 | 320.5 | 355.8 |
| Total | 6504 | 8579 | | |

Table 4. Simpson Diversity (A=initial visit, B=second visit, M=mean, Ave Div=average for sample area)

| Station | A | B | M | Ave. Div |
|---|---|---|---|---|
| 1 | 0.737 | 0.669 | 0.703 | |
| 2 | 0.888 | 0.778 | 0.833 | |
| 3 | 0.811 | 0.866 | 0.8385 | |
| 4 | 0.821 | 0.885 | 0.853 | |
| 5 | 0.936 | 0.868 | 0.902 | 0.82590 |
| 6 | 0.806 | 0.939 | 0.8725 | |
| 7 | 0.846 | 0.797 | 0.82165 | |
| 8 | 0.826 | 0.936 | 0.881 | |
| 9 | 0.874 | 0.933 | 0.9035 | |
| 10 | 1.000 | 0.957 | 0.9785 | 0.89143 |
| 11 | 0.892 | 0.747 | 0.8195 | |
| 12 | 0.82 | 0.914 | 0.869 | |
| 13 | 0.848 | 0.902 | 0.875 | |
| 14 | 0.809 | 0.869 | 0.839 | |
| 15 | 0.717 | 0.791 | 0.754 | 0.83130 |
| 16 | 0.778 | 0.837 | 0.8075 | |
| 17 | 0.823 | 0.804 | 0.8135 | |
| 18 | 0.898 | 0.864 | 0.881 | |
| 19 | 0.662 | 0.887 | 0.7745 | |
| 20 | 0.841 | 0.872 | 0.8565 | 0.82660 |
| 21 | 0.827 | 0.825 | 0.826 | |
| 22 | 0.866 | 0.915 | 0.8905 | |
| 23 | 0.623 | 0.713 | 0.668 | |
| 24 | 0.767 | 0.800 | 0.7835 | |
| 25 | 0.862 | 0.274 | 0.568 | 0.74720 |
| 26 | 0.885 | 0.889 | 0.887 | |
| 27 | 0.864 | 0.921 | 0.8925 | |
| 28 | 0.829 | 0.952 | 0.8905 | |
| 29 | 0.773 | 0.786 | 0.7795 | |
| 30 | 0.923 | 0.858 | 0.8905 | 0.86800 |

All other mean values for areas ranged from 0.82590-0.89143.

Simpson Dominance (Table 5), since it is a function of Simpson Diversity, shows stations 21-25 to contain a much larger dominance mean (0.2528) than all other stations. The stations, as a whole, containing the communities least dominated by a few taxa are stations 6-10.

H' values (Table 6) are very close, as a whole, between all stations except 21-25 which has a mean value of 2.9352. Stations 26-30 have the largest overall mean value at 3.7039.

H'max (Table 7) is greatest for stations 26-30 with a mean value of 5.1306 for the area as a whole. Stations 6-10 have the lowest mean values at 4.1217 for the area as a whole. For the second visit, stations 26-30 all contain H'max mean values of 5.245 or greater.

Evenness values (Table 8) are greatest for stations 6-10, as a whole, with a mean value of 0.7527. Mean values are lowest for stations 21-25 as a whole being only 0.6466.

Table 5. Simpson Dominance (A=initial visit, B=second visit, M=Memn, Ave Dom=average dominance for sample area)

| Station | A | B | M | Ave Dom |
|---|---|---|---|---|
| 1 | 0.263 | 0.331 | 0.297 | |
| 2 | 0.112 | 0.222 | 0.167 | |
| 3 | 0.189 | 0.134 | 0.1615 | |
| 4 | 0.179 | 0.115 | 0.147 | |
| 5 | 0.064 | 0.132 | 0.098 | 0.1741 |
| 6 | 0.194 | 0.061 | 0.1275 | |
| 7 | 0.154 | 0.203 | 0.1785 | |
| 8 | 0.174 | 0.064 | 0.119 | |
| 9 | 0.126 | 0.067 | 0.0965 | |
| 10 | 0.0 | 0.043 | 0.0215 | 0.1086 |
| 11 | 0.108 | 0.253 | 0.1805 | |
| 12 | 0.176 | 0.086 | 0.131 | |
| 13 | 0.152 | 0.098 | 0.125 | |
| 14 | 0.191 | 0.131 | 0.161 | |
| 15 | 0.283 | 0.209 | 0.246 | 0.1687 |
| 16 | 0.222 | 0.163 | 0.1925 | |
| 17 | 0.177 | 0.196 | 0.1865 | |
| 18 | 0.102 | 0.136 | 0.119 | |
| 19 | 0.338 | 0.113 | 0.2255 | |
| 20 | 0.159 | 0.128 | 0.1435 | 0.1734 |
| 21 | 0.173 | 0.175 | 0.174 | |
| 22 | 0.134 | 0.085 | 0.1095 | |
| 23 | 0.377 | 0.287 | 0.332 | |
| 24 | 0.233 | 0.200 | 0.2165 | |
| 25 | 0.138 | 0.726 | 0.432 | 0.2528 |
| 26 | 0.115 | 0.111 | 0.113 | |
| 27 | 0.136 | 0.079 | 0.1075 | |
| 28 | 0.171 | 0.048 | 0.1095 | |
| 29 | 0.227 | 0.214 | 0.2205 | |
| 30 | 0.077 | 0.142 | 0.1095 | 0.1320 |

Table 6. Shannon Diversity (H') (A=initial visit, B=second visit, M=mean, Ave H'=average diversity for the sample area)

| Station | A | B | M | Ave H' |
|---|---|---|---|---|
| 1 | 2.588 | 2.372 | 2.4800 | |
| 2 | 3.730 | 2.794 | 3.2620 | |
| 3 | 3.275 | 3.588 | 3.4315 | |
| 4 | 3.209 | 3.863 | 3.5360 | |
| 5 | 4.332 | 3.475 | 3.9035 | 3.3226 |
| 6 | 2.804 | 4.415 | 3.6095 | |
| 7 | 3.528 | 2.707 | 3.1175 | |
| 8 | 3.063 | 4.362 | 3.7125 | |
| 9 | 2.844 | 3.594 | 3.2190 | |
| 10 | 3.000 | 4.162 | 3.5810 | 3.4479 |
| 11 | 3.451 | 3.083 | 3.2490 | |
| 12 | 2.973 | 4.196 | 3.5845 | |
| 13 | 3.236 | 4.146 | 3.6910 | |
| 14 | 2.651 | 3.322 | 2.9865 | |
| 15 | 2.724 | 3.202 | 2.9630 | 3.2948 |
| 16 | 2.913 | 3.123 | 3.0180 | |
| 17 | 3.255 | 2.704 | 2.9795 | |
| 18 | 3.621 | 3.425 | 3.5230 | |
| 19 | 2.462 | 3.694 | 3.0780 | |
| 20 | 3.186 | 3.681 | 3.4335 | 3.2064 |
| 21 | 3.245 | 3.518 | 3.3815 | |
| 22 | 3.269 | 4.036 | 3.6525 | |
| 23 | 2.322 | 2.289 | 2.3055 | |
| 24 | 3.096 | 3.000 | 3.0480 | |
| 25 | 3.521 | 1.056 | 2.2885 | 2.9352 |
| 26 | 3.661 | 4.069 | 3.8650 | |
| 27 | 3.461 | 4.305 | 3.8830 | |
| 28 | 3.143 | 4.717 | 3.9300 | |
| 29 | 2.917 | 3.036 | 2.9765 | |
| 30 | 4.179 | 3.551 | 3.8650 | 3.7039 |

Table 7. H'max (A=initial visit, B=second visit, M=mean, Ave H'max= average H'max for the sample area)

| STATION | A | B | M | Ave H'max |
|---|---|---|---|---|
| 1 | 4.584 | 4.245 | 4.4145 | |
| 2 | 4.999 | 4.521 | 4.6700 | |
| 3 | 5.043 | 4.857 | 4.9500 | |
| 4 | 4.697 | 5.169 | 4.9330 | |
| 5 | 5.169 | 4.807 | 4.9880 | 4.8091 |
| 6 | 4.169 | 5.169 | 4.6795 | |
| 7 | 4.754 | 3.458 | 4.1060 | |
| 8 | 4.169 | 5.043 | 4.6060 | |
| 9 | 3.169 | 3.807 | 3.4880 | |
| 10 | 3.000 | 4.458 | 3.7290 | 4.1217 |
| 11 | 4.086 | 4.999 | 4.5425 | |
| 12 | 4.169 | 5.209 | 4.6890 | |
| 13 | 4.392 | 5.169 | 4.7805 | |
| 14 | 3.322 | 4.322 | 3.8220 | |
| 15 | 4.245 | 4.953 | 4.5990 | 4.4866 |
| 16 | 4.086 | 4.322 | 4.2040 | |
| 17 | 4.169 | 3.807 | 3.9880 | |
| 18 | 4.322 | 4.906 | 4.6140 | |
| 19 | 4.584 | 5.169 | 4.8765 | |
| 20 | 4.458 | 5.043 | 4.7505 | 4.4866 |
| 21 | 4.245 | 5.086 | 4.6655 | |
| 22 | 4.322 | 4.906 | 4.6140 | |
| 23 | 4.245 | 4.521 | 4.3830 | |
| 24 | 4.584 | 4.392 | 4.4880 | |
| 25 | 4.697 | 3.907 | 4.3020 | 4.4905 |
| 26 | 5.169 | 5.554 | 5.3615 | |
| 27 | 4.999 | 5.458 | 5.2285 | |
| 28 | 4.458 | 5.425 | 4.9415 | |
| 29 | 4.754 | 5.245 | 4.9995 | |
| 30 | 4.999 | 5.245 | 5.1220 | 5.1306 |

Table 8. Evenness (H'/H'max) (A=initial visit, B=second visit, M=mean, Ave Evenness=average evenness for the sample area)

| Station | A | B | M | Ave Evenness |
|---|---|---|---|---|
| 1 | 0.564 | 0.559 | 0.5615 | |
| 2 | 0.746 | 0.618 | 0.6820 | |
| 3 | 0.650 | 0.739 | 0.6945 | |
| 4 | 0.683 | 0.747 | 0.7150 | |
| 5 | 0.838 | 0.723 | 0.7805 | 0.6867 |
| 6 | 0.673 | 0.854 | 0.7635 | |
| 7 | 0.742 | 0.783 | 0.7625 | |
| 8 | 0.735 | 0.865 | 0.8000 | |
| 9 | 0.897 | 0.944 | 0.9205 | |
| 10 | 0.100 | 0.934 | 0.5170 | 0.7527 |
| 11 | 0.845 | 0.617 | 0.7310 | |
| 12 | 0.713 | 0.805 | 0.7590 | |
| 13 | 0.737 | 0.802 | 0.7695 | |
| 14 | 0.798 | 0.769 | 0.7835 | |
| 15 | 0.642 | 0.647 | 0.6450 | 0.7376 |
| 16 | 0.713 | 0.723 | 0.7180 | |
| 17 | 0.781 | 0.710 | 0.7455 | |
| 18 | 0.838 | 0.698 | 0.7680 | |
| 19 | 0.537 | 0.715 | 0.6260 | |
| 20 | 0.715 | 0.730 | 0.7225 | 0.7160 |
| 21 | 0.764 | 0.692 | 0.7280 | |
| 22 | 0.756 | 0.823 | 0.7895 | |
| 23 | 0.547 | 0.506 | 0.5265 | |
| 24 | 0.675 | 0.683 | 0.6790 | |
| 25 | 0.750 | 0.270 | 0.5100 | 0.6466 |
| 26 | 0.708 | 0.733 | 0.7205 | |
| 27 | 0.692 | 0.789 | 0.7405 | |
| 28 | 0.705 | 0.870 | 0.7875 | |
| 29 | 0.614 | 0.579 | 0.5965 | |
| 30 | 0.836 | 0.677 | 0.7565 | 0.7203 |

## DISCUSSION

The WRNWR contains distinct areas which indicate habitat degradation created by man's influence. Stations 6-15, located for the most part in the middle of the refuge, contain very few taxa or individuals. Diversity is very high, as the presence of a dominating group of organisms is characteristically lacking in these areas. This area is easily accessable and has several human inhabitants along the banks of the sampled waterways. Conversely, the areas containing stations 1-5 and 20-30 are not as easily accessable to man and have no human inhabitants even remotely close. Also, natural as well as man-made borders (thick forestation and levees) delineate these areas and block such things as agricultural runoff from the refuge.

Diversity is best represented in the refuges bayous. Ranging from the fewest taxa, 8, to the highest, 47, bayous represent a broad range of macro- as well as microhabitats. Lakes in the refuge contain a rather stable community dominated throughout the refuge by the dytiscid beetles. Although good diversity was found in several places, the dytiscids were present in extremely large numbers, comparatively. Of the three ponds

sampled, stations 15, 22 and 23, station 15 contained the best populations and most taxa, but dominance values are, for all three ponds, of the highest in the refuge and diversity values are the lowest. One reservoir and two borrow pits were sampled. These had very high diversity and low dominance values for all sites. These values are comparable to the high values associated with the best bayous. The reservoir is periodically drained or almost drained and the water is used in nearby rice fields. The second sample was, unfortunately, taken during this time of drainage, resulting in very low diversity and very high dominance. The dominant organism was Palaemonetes kadiakensis.

All things considered, the healthiest portion of the refuge is the southeastern portion. Very little habitat destruction has occurred in this area, and all aquatic situations seem to be very stable. Insight into possible past exsisting communities can be derived from this area due to the presence of rare organisms and new state records as well as the general health and stability of this area. Several of the leech species, as well as the beetle, Suphis, were new state records (Appendix).

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SPECIES LIST

Nematoda
*Pectinatella magnifica*
Gordioididae
*Paragordius*
Gastropoda
Limpet
*Ferrissia*
*Laevapex*
*Helisoma*
*Physa*
*Valvata*
*Valvata tricarinata*
*Corbicula fluminia*
*Leptodea fragilis*
*Ligumia recta*
*L. subrostrata*
*Quadrula nodulata*
*Toxolasma parvus*
*Tritogonia verrocosa*
Unionidae
Oligochaeta
*Mooreobdella microstoma*
*Desserobdella phalera* - *SR*
*Erpobdella* *imm.*
Glossiphoniid imm.
Helobdellid imm.
*Helobdella fusca* - - *SR*
*Helobdella stagnalis*
*Helobdella triseralis*
*Placobdella montifera* - *SR*
*Placobdella papillifera*
*Placobdella parasitica* - *SR*
Cladocera
*Daphnia*
*Cyclops*
*Taphromysis louisianae*
*Caecidotea*
*Lirceus*
*Crangonyx*
*Synurella bifurca*
*Gammarus sp.*
*Gammarus fasciatus*
*Hyalella azteca*
*Cambarellus shufeldti*

*C. sp.*
*C. sp.*
*Cambarus diogenes*
*C. ludovicianus*
*Fallicambarus fodiens*
*Orconectes palmeri palmeri*
*O. lancifer*
*Procambarus clarkii*
*P. zonangulus*
*P. acutus*
*P. ouchitae*
*Palaemonetes kadiakensis*
Hydracarina
*Isotoma*
*Isotomerus*
Ephemeroptera adult.
*Baetis longipalpus*
*Callibaetis fluctuans*
*Brachycercus*
*Caenis*
*Ephemerella*
*Hexegenia limbata*
*Stenacron interpunctatum*
*Stenonema exiguum*
*S. femoratum*
*Tortopus primus* - - *SR*
*Lestes inequalis*
*Argia*
*Enallagma*
*Ischnura*
*Gomphus*
*Arigomphus lentulus*
*A. submedianus*
*Dromogomphus spinosus*
*D. spoliatus*
*Stylurus plagiatus*
*Nasiaeschna pentacantha*
*Macromia*
*Epicordulia princeps*
*Tetragoneuria cynosura*
*Celithemis verna*
*Erythemis simplicicollis*
*Libellula cyanea*
*Libellula incesta*
*L. luctulosa*
*L. vibrans*

*Pachydiplax longipennis*
*Perithemis tenera*
*Acroneuria*
Belostoma nymphs
*B. fluminea*
*B. lutarium*
Corixid nymphs
*Hesperocorixa lucida*
*H. nitida*
*Palmacorixa buenoi*
*Sigara*
*Trichocorixa calva*
*T. kanza*
*T. sexcincta*
*Gelastocoris oculatus oculatus*
*Gerris nymphs*
*Gerris argenticollis*
*G. nebularis*
*Limnoporus caniculatus*
*Neogerris hesione*
*Trepobates pictus*
*Trepobates subnitidus*
*Hebrus consolidus*
*Merragata brunnea*
*Hydrometra martini*
*Mesovelia nymphs*
*M. mulsanti*
*Pelocoris nymph*
*Pelocoris femoratus*
*Ranatra australis nymph*
*R. buenoi*
*R. nigra*
*Buenoa margaritacea*
*Notonecta nymphs*
*Notonecta irrorata*
*N. raleighi*
*Neoplea striola*
*Microvelia nymphs*
*M. hinei*
*Chauliodes rastricornis*
*Corydalus cornutus*
*Sialis*
Tricoptera pupae
*Cheumatopsyche*
*Hydropsyche*
*Macrostenum*

*Potamyia flava*
*Hydroptila*
*Palaeagapetus* *adult*
Leptoceridae pupae
*Nectopsyche*
*Oecetis*
*Ironoquia*
*Neureclipsis*
*Ptilostomis*
*Archips*
Curculionidae
Dytiscidae
*Bidessonotus*
*Celina* *larvae*
*Coptotomus*
*Coptotomus* *larvae*
*Hydaticus*
*Hydroporus*
*H. 1*
*H. 2*
*H. 3*
*H. 4*
*Hydrovatus postulatus p.*
*Laccophilus fasciatus rufus*
*L. maculosus maculosus*
*Liodessus*
*Lioporius pilatei*
*L. triangularis*
*Thermonectes basillaris*
*Dubiraphia*
*Dubiraphia* *adult*
*Stenelmis* *adult*
*Dineutus* *larvae*
*Dineutus assimilus*
*D. carolinus*
*D. emarginatus*
*Gyretes*
*Gyrinus*
Heteroceridae
Histeridae
*Berosus*
*Derallus alatus*
*Enochrus consortus*
*Enochrus ochaceus*
*E. perplexus*
*E. sayi*

*Helocharus*
*Helophorus* *larvae*
*Hydrobiomorpha casta* *larvae*
*Hydrobius*
*Hydrochara*
*Hydrochus*
*Tropisternus blatchleyi blatchleyi*
*T. collaris mexicanus*
*T. c. striolatus*
*T. lateralus nimbatus*
Lampyridae
*Hydrocanthus atripennis*
*Suphis inflatus* - - *SR*
*Suphisellis bicolor bicolor*
*Haliplus*
*Peltodytes dunavani*
*P. sexmaculatus*
*Cyphon*
*Cyphon* *larvae*
*Stenus*
*Sepedon*
*Thinobius*
Tabanidae pupae
*Chlorotabanus*
*Chrysops*
*Tabanus*
*Prionocera*
*Tipula*
*Limnoia*
*Culex erraticus*
*Chaoborus*
Chironomidae
Ceratopogonidae
Stratiomyidae pupae
*Odontomyia*
*Stratiomys*