TECHNICAL PUBLICATION # 76-3

September, 1976

ENVIRONMENTAL RESPONSES TO MARSHLAND REFLOODING IN THE KISSIMMEE RIVER BASIN

By

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RESOURCE PLANNING DEPARTMENT

Central and Southern Florida
Flood Control District
West Palm Beach, Florida

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INTRODUCTION

The Central and Southern Florida Flood Control Project in the Kissimmee Basin consists of a network of water control structures and canals which connect the major lakes of the region. The most extensive portion of this network is Canal 38 (C-38) which was constructed through the Kissimmee River Valley. Extending from Lake Kissimmee to Lake Okeechobee, C-38 is about 52 miles (84 km) long. Five water control structures along the canal (S-65 A, B, C, D and E) act as dams allowing the water level to drop in about six foot (1.6 m) increments as the ground elevations decrease.

Stabilization of water levels in the impoundment behind each structure has had a pronounced influence on the vegetation of the river floodplain (Goodrick and Milleson, 1974) by favoring the growth of a few vegetation types, and eliminating much of the other marsh vegetation.

In addition to vegetation changes in the Kissimmee River floodplain, water level stabilization also disturbed the marshland faunal community. The marsh in the northern portions of each pool was permanently drained and was no longer capable of supporting aquatic fauna. Elimination of seasonal drawdowns prevented the concentration of those organisms produced in the marsh, and restricted their availability to larger fishes and wading birds.

This study was designed to document the effects of reflooding a previously drained marsh on the growth and distribution of marsh vegetation, aquatic macrofauna, and the fishes of an adjoining canal.

This project is part of a program designed to evaluate the effects of water level manipulation on the stabilized marshes of the Kissimmee River Valley. Information from this study will be used in conjunction with other projects investigating wetlands ecology of the Kissimmee River (Dineen, Goodrick, Hallett and Milleson, 1974) to produce beneficial water management alternatives.

LOCATION AND DESCRIPTION OF AREA

This study was conducted in an impounded marsh within Pool B of the Kissimmee River floodplain. This marsh is approximately one-half mile (0.8 km) west of water control structure S-65B in Highlands County, Florida (Figure 1).

The study area was bordered on the south by a borrow canal and the westward extension of the S-65B tieback levee (Figure 2). Smaller dikes formed the northern and eastern borders. To the west, another levee and higher elevation ground completed the boundary of the impounded area.

Water entered this marsh from rainfall and surface drainage from the west and north. Some seepage may have occurred through the eastern levee from the Kissimmee River. Outflow was controlled by a hand operated culvert, S-65BX2, located in the tieback levee.

The ground elevation in much of the impoundment area was approximately 39.5 feet (12.0 m) msl, except near the southern borrow canal, where the ground level was about 38.0 feet msl.

Although the study marsh is presently separated from the remainder of Pool B, a brief discussion of the past history of the area is warranted.

Prior to construction of C-38, the main Kissimmee River channel flowed just to the east of this marsh. The study area was within the river's floodplain and would occasionally flood when water overflowed the river channel. As early as January 1958 some of the major ditches and dikes had been constructed within the study area, but the land was still subject to flooding from the river. With the completion of C-38 and operation of S-65B in January 1969, any further flooding above 40 feet msl was eliminated. During the period from January 1969 to August 1970, the water level in the impoundment was well below 40 feet msl because of a direct connection to the next pool south.

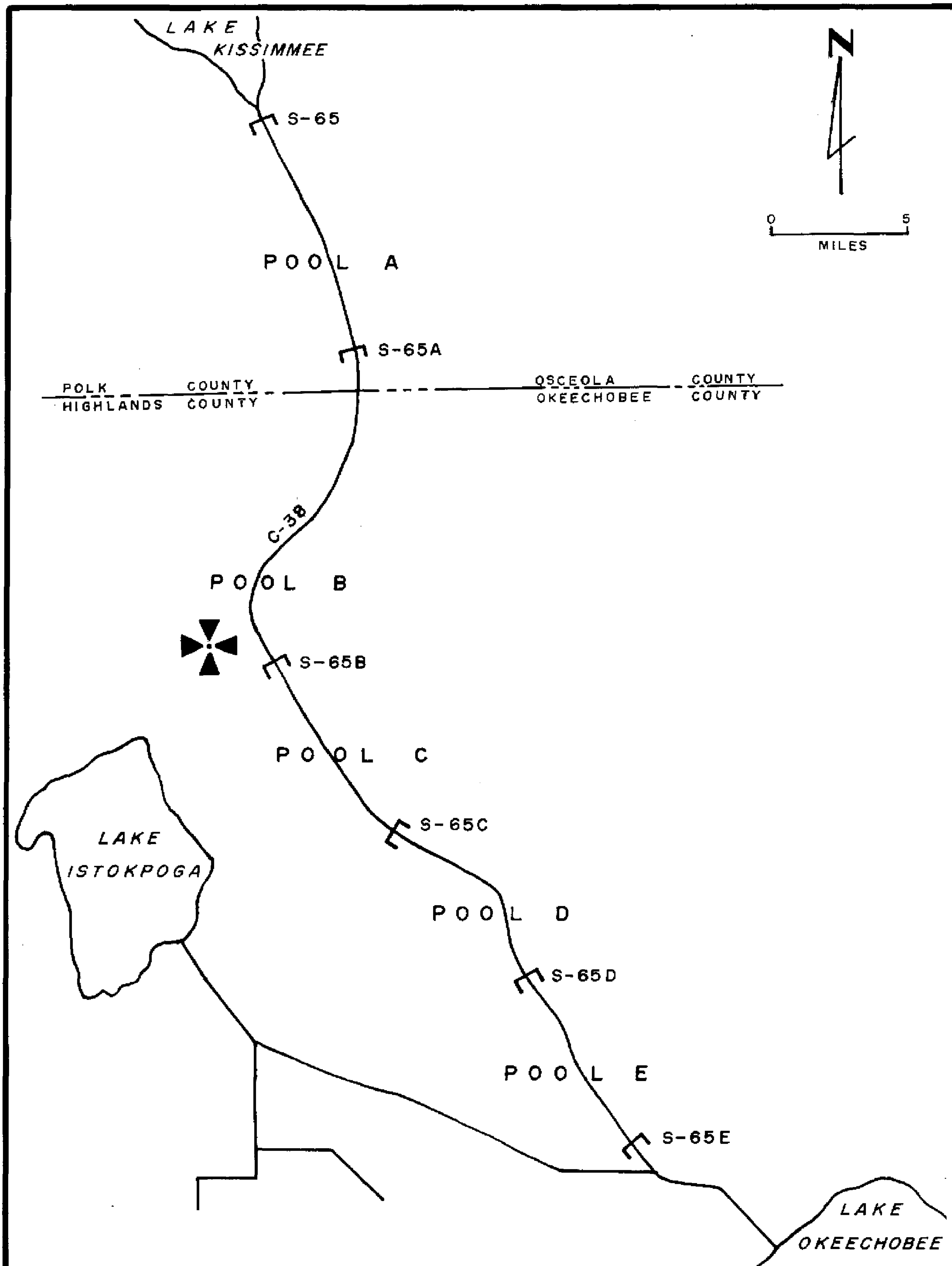

Figure I: LOCATION OF REFLOODED MARSH IN THE KISSIMMEE RIVER BASIN

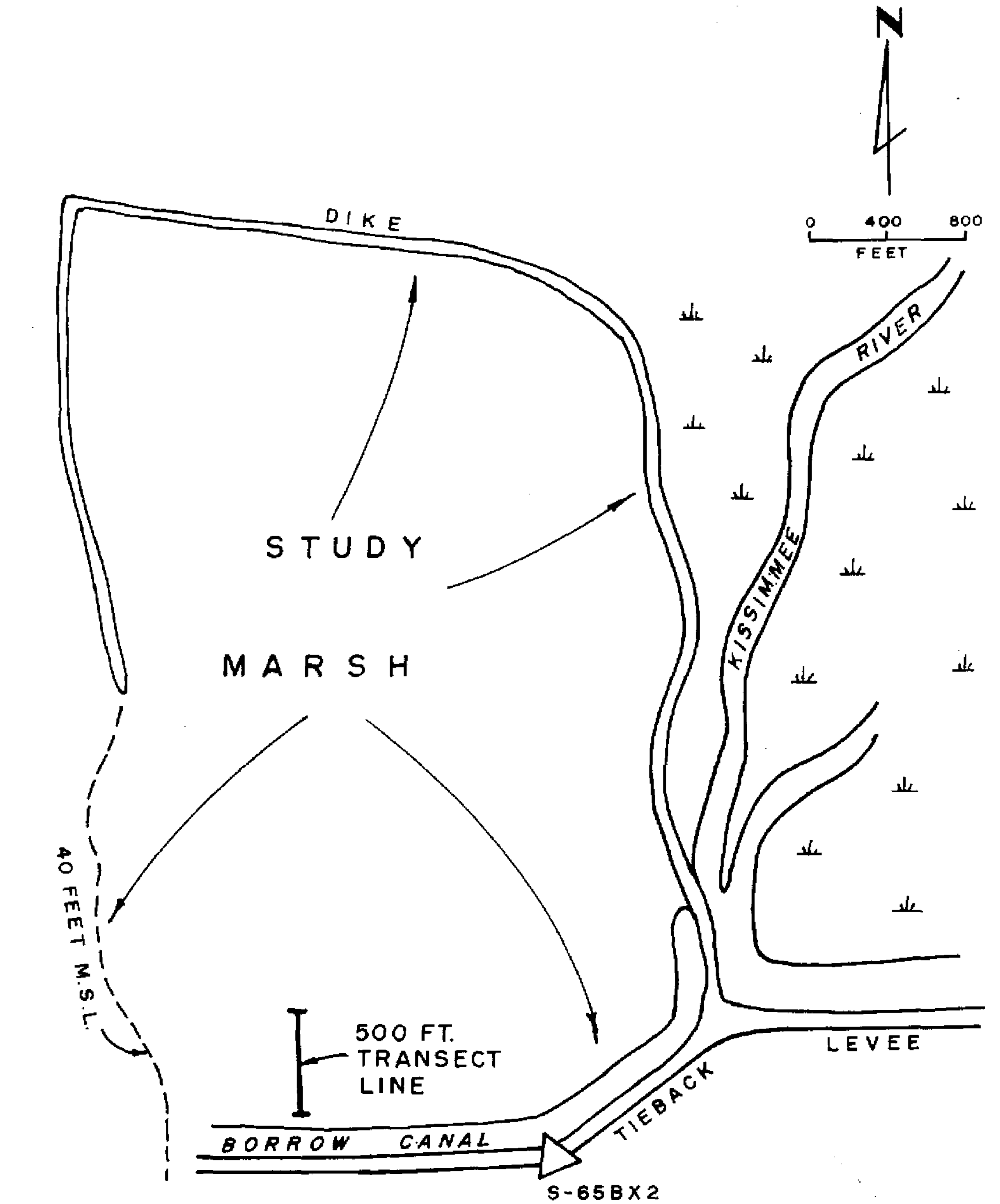

Figure 2: THE REFLOODED STUDY MARSH IN POOL B OF THE KISSIMMEE RIVER BASIN

The S-65BX2 structure maintained water levels of about 39 feet msl in the impoundment from August 19, 1970 until March 1971. The water level was lowered to 34.0 feet msl on March 4, 1971 and remained at this elevation or lower, until re-flooding was initiated in early July 1971. Water levels were then generally maintained between 39 and 40 feet msl until March 1973.

MATERIALS AND METHODS

The invertebrate and small fish population in the flooded marshland was sampled on twelve different occasions from July 28, 1971 to April 11, 1973. Duplicate samples secured on March 1, 1972 were averaged to give results for that date. Samples were obtained at 50 foot (15 m) intervals along a 500 foot (150 m) transect line extending northward from the borrow canal (Figure 2). Sample stations were designated by their position along the transect line. For example 0+00 was the initial station by the canal, 1+50 was located 150 feet north of the canal, and 4+00 was located 400 feet north of the canal. At each station a bottomless wash-tub which enclosed an area of 2.15 $feet^2$ (0.20 m^2) was quickly pushed through the water and sealed against the substrate. Vegetation inside the sample was cut at ground level and rinsed within the tub to remove any animals adhering to it. The vegetation harvested in July and December 1971, October 1972 and March 1973 was stored in plastic bags, refrigerated and returned to West Palm Beach for later analysis. Vegetation harvested on other sampling dates was discarded. A 6 x 9 inch (15 x 23 cm) dip net with 0.12 inch (0.3 cm) mesh netting was used to remove macro-organisms and any remaining debris from the water column and the top several inches of substrate within the tub. All material collected in the dip net at each station was placed into labeled plastic bags and preserved in 10% formalin solution. Upon return to the West Palm Beach laboratory, samples were washed with freshwater in a #20 U.S. Standard seive and sugar floated for separation of organisms from detritus. All organisms were identified and counted. On successive sampling dates, the transect was offset slightly to avoid sampling of a previously altered section of marsh.

The vegetation samples collected were washed free of detritus and sorted by species. When feasible, individual plants or stems were counted and length was recorded. The total wet weight of each species was measured in the laboratory.

The ground elevation at each station was calculated from the difference between the recorded water depth and the stage level in the canal on each sampling date.

The fish population was sampled from a Pool B Kissimmee River oxbow in August 1972. A one-half acre (0.20 ha) sample area was enclosed by block nets to the north and south, and the river banks to the east and west. The fish population in the canal adjacent to the south side of the marsh was sampled in August 1972 and May 1973. A one-half acre (0.20 ha) area of canal was enclosed by block nets on the east and west sides, the tieback levee on the south, and the marsh to the north. Maximum water depths were from 5 to 6 feet (1.5 to 2.0 m). Liquid rotenone (Noxifish, 5% rotenone, manufactured by Southern Mill Creek Products, Inc., Tampa, Florida) was distributed through the propeller wash of an outboard motor to yield a final concentration of approximately 2 ppm. All fish that floated to the surface within three days were collected and sorted by species. Each fish that was greater than 2.5 inches (6.35 cm) in total length was measured in the field to the nearest inch and defined as a major species. The presence of smaller fish was noted. The total weight of each major species was determined in the field.

RESULTS

A profile of elevations along the 500 foot transect is presented in Figure 3. Generally, the elevation graded from 38.05 feet msl at 0+00 to 39.14 feet msl at 5+00. The deepest station was 2+00 where the average elevation was 37.90 feet msl.

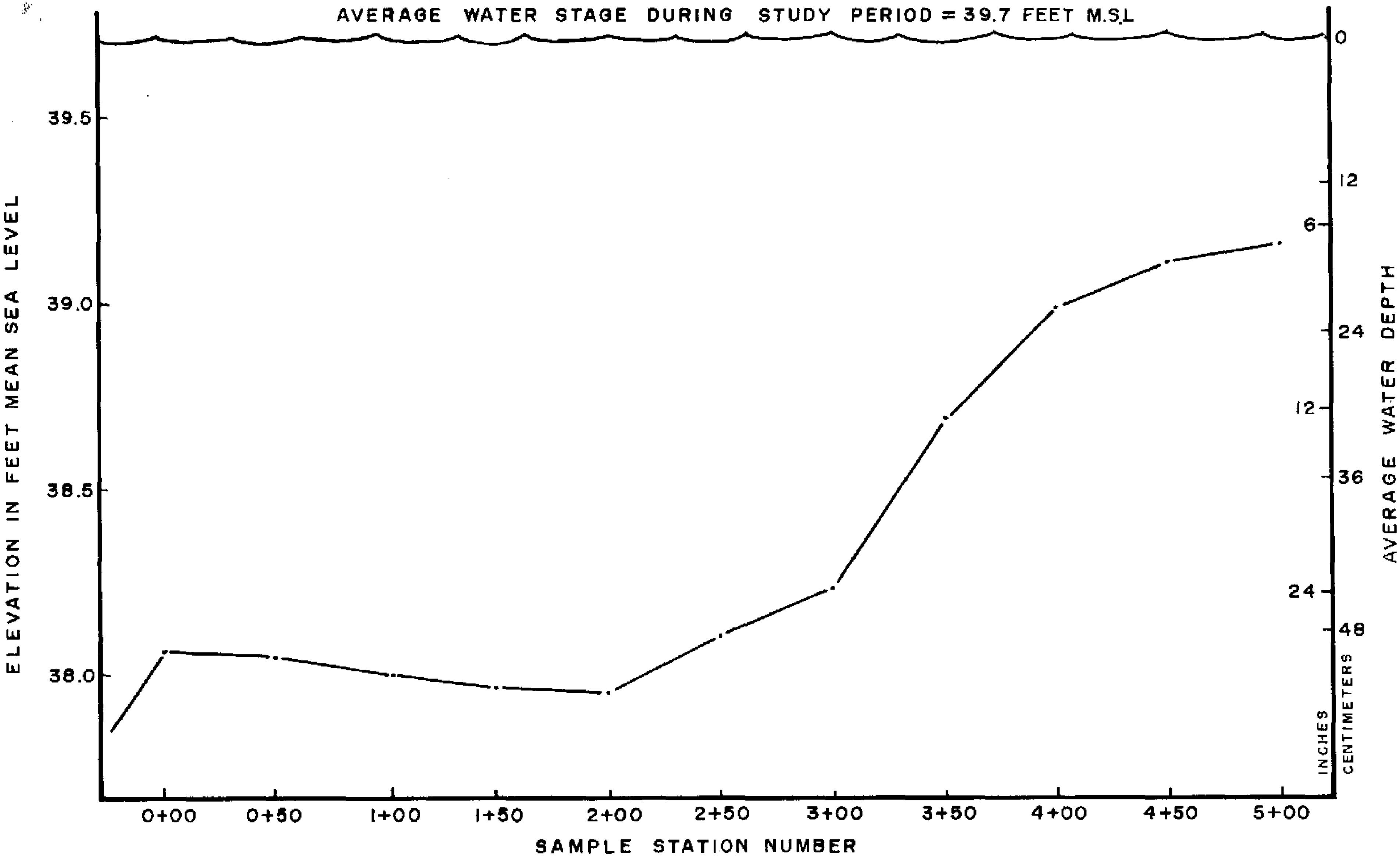

Figure 3: A COMPOSITE PROFILE OF THE ELEVATIONS ALONG THE TRANSECT IN THE REFLOODED MARSH AND AVERAGE WATER DEPTHS

At an average stage of 39.7 feet msl, water depth along the transect ranged from 20 inches (52 cm) in the southern portion to 7 inches (17 cm) at Station 5+00. During the course of the study, water stages varied from 38.7 to 40.6 feet msl. Therefore, water depths in the southern part of the marsh were approximately 31 inches (80 cm) during high stages. Conversely, some of the sampling stations were dry during lower stages.

A complete list of the aquatic macrofauna recovered from the reflooded marsh is presented in Appendix I. An analysis of population trends of each of these species was impractical. The small fishes and decapods were selected for more detailed study because these organisms occupy high levels in the marsh food chain, were easily identifiable, and were present in the marsh throughout the year.

Small Fishes

Fifteen species of fish were identified from the tub samples (Table 1). Members of the family Poeciliidae comprised 79.2% of all fish collected. *Heterandria formosa* and *Gambusia affinis* comprised 48% and 29.6%, respectively. The Centrachids and Cyprinodonts together comprised about 18% of the total. All species of fish were grouped together as "small fishes" for subsequent consideration. The numbers of fish collected during the sampling period are presented in Table 2.

Data for 11 of the sampling dates indicated a relatively uniform distribution of fishes along the transect line. Samples from August 8, 1972 and April 11, 1973 were not subjected to statistical analysis because the northern portion of the transect line was dry and hence some stations were not sampled. A total of 947 fish were recovered for a mean of 7.8 individuals per sample. The mean for each station along the transect ranged from 6.6 at station 2+50 to 9.9 at 0+00. A chi square test was employed to test the relationship between the number of small fish collected and position along the transect line. The test statistic used was:

TABLE 1. SPECIES OF FISH IDENTIFIED FROM TUB SAMPLES IN THE REFLOODED MARSH* JULY 1971 - APRIL 1973

Family	Species	Common Name
Aphredoderidae	*Aphredoderus sayanus*	Pirate perch
Centrarchidae	*Elassoma evergladei*	Everglades pigmy sunfish
	Enneacanthus gloriosus	Bluespotted sunfish
	Lepomis gulosus	Warmouth
	Lepomis macrochirus	Bluegill
	Lepomis microlophus	Redear sunfish
	Lepomis punctatus	Spotted sunfish
	Micropterus salmoides	Largemouth bass
Cyprinodontidae	*Fundulus chrysotus*	Golden topminnow
	Jordanella floridae	Flagfish
	Lucania goodei	Bluefin killifish
Percidae	*Etheostoma fusiforme*	Swamp darter
Poeciliidae	*Gambusia affinis*	Mosquito fish
	Heterandria formosa	Least killifish
	Poecilia latipinna	Sailfin molly

*Names from American Fisheries Society (1970)

TABLE 2 - NUMBERS OF SMALL FISHES COLLECTED FROM REFLOODED MARSH. JULY 28, 1971 TO APRIL 11, 1973

DATE	0+00	0+50	1+00	1+50	2+00	2+50	3+00	3+50	4+00	4+50	5+00	TOTAL	DENSITY PER METER^{2}*
July 28, 1971	2	0	0	1	0	1	0	1	1	0	0	6	2.7
October 4, 1971	10	4	3	2	8	4	12	5	4	4	7	63	28.6
October 28, 1971	7	13	5	14	8	4	4	2	11	3	1	72	32.7
December 1, 1971	7	10	8	13	10	3	9	6	3	9	5	83	37.7
January 27, 1972	13	2	3	12	8	13	11	9	9	17	15	112	50.9
March 1, 1972-A	3	8	13	1	12	7	5	5	1	5	5	65	29.6
March 1, 1972-B	3	11	6	5	13	14	8	6	8	7	8	89	40.5
May 11, 1972	27	19	26	21	15	10	15	21	12	17	8	191	86.8
August 8, 1972	17	20	7	15	6	14	26	17				122	76.3
October 17, 1972	18	5	3	8	8	10	16	14	28	26	23	159	72.3
January 16, 1973	16	5	14	3	6	6	4	2	9	2	5	72	32.7
March 1, 1973	3	2	2	1	8	1	2	2	5	4	5	35	15.9
April 11, 1973	18	24	15	28	24	24	22					155	110.7
Total **	109	79	83	81	96	73	86	73	91	94	82	947	
Mean **	9.9	7.2	7.6	7.4	8.7	6.6	7.8	6.6	8.3	8.6	7.5	7.8	

*Meter^2 = 10.76 feet^2

**Exclusive August 8, 1972 and April 11, 1973

$$x^2 = \sum_{i=1}^{K} (Ni - N/K)^2 / (N/K)$$

where K = number of stations = 11

Ni = total # fish collected at each station

N = total # fish collected = 947

$X^2_{.05} = 18.31$

The calculated x^2 for these data was 13.42 which did not exceed the critical value. The distribution of small fishes along the transect line was therefore independent of the location. Henceforth the density of small fish will be reported as an average number per square meter of marsh.

Stage levels in the marsh were recorded on a weekly basis throughout the study period. The hydrograph is plotted simultaneously with the density of fish recovered from the transect (Figure 4).

The density of fish increased from July 28, 1971 (2.7 fish/m^2) to January 27, 1972 (50.9 fish/m^2). By March 1, 1972 the density had declined to 35.0 fish/m^2, but water levels were 0.30 feet (9 cm) higher than during January 1972. The marsh stage had dropped to 39.25 feet msl by May 11, 1972 so that station 5+00 had only 1 inch (3 cm) of surface water. The average density of small fishes along the transect had increased to 86.8 fish/m^2.

During the summer of 1972, water levels in the marsh fluctuated between 38.7 feet msl and 40.0 feet msl, alternately flooding and drying much of the marsh. A stage level of 39.0 feet msl was reported on August 8, 1972. At this stage the marsh was dry from station 4+00 northward. All of the fish in the marsh were concentrated in the region below station 4+00 and the density was 76.3 fish/m^2.

More marshland was flooded on October 17, 1972 (39.5 feet msl) and density was 72.3 fish/m^2. Water stages in excess of 39.75 feet msl were accompanied by further declines in density to 32.7 fish/m^2 on January 17, 1973 and 15.9 fish/m^2 on March 1, 1973.

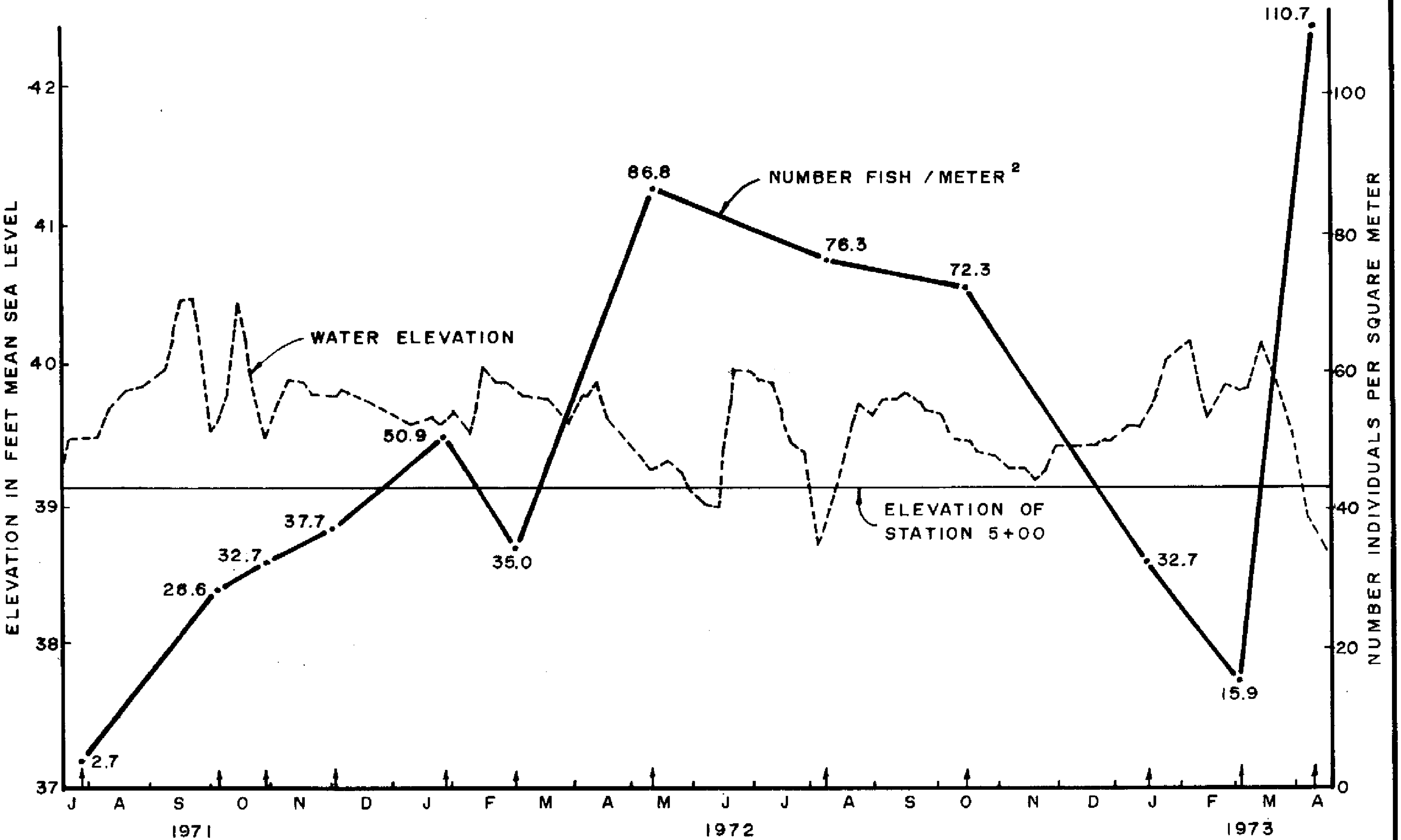

Figure 4 NUMBER OF SMALL FISH PER SQUARE METER RECOVERED FROM REFLOODED MARSH AND WATER FLUCTUATIONS, JULY 1971 TO APRIL 1973

The entire small fish population was concentrated within 300 feet of marsh by April 11, 1973 (38.8 feet msl) and the resulting density was 110.7 fish/m^2.

Freshwater Shrimp

One species of freshwater shrimp, *Palaemonetes paludosus*, was collected from the study area. The numbers of shrimp obtained per sample are presented in Table 3. The distribution of *P. paludosus* along the 500 foot transect line appeared to be dependent on sample locations. The numbers of shrimp at each station were totaled for 11 sampling dates (August 8, 1972 and May 11, 1973 samples were omitted due to low water levels) and plotted simultaneously with the transect profile (Figure 5). This figure indicates an affinity of the shrimp for the lower elevations and deeper waters. There was a sharp reduction in shrimp numbers between stations 3+00 and 3+50. The number of individuals per sample from stations 0+00 to 3+00 averaged 11, whereas those samples from stations 3+50 to 5+00 had a mean of 5.5.

To test for a relationship between the number of shrimp recovered and location along the transect line, a chi square test was employed. The calculated chi square of 156.87 exceeded the critical value at the 0.05 significance level indicating that the population of *P. paludosus* was not evenly distributed throughout the marsh.

Because of the apparent preference of the shrimp for the deeper end of the transect, water fluctuations which alternately dried and flooded the shallow, north end of the marsh would affect only a small portion of the population.

The density of the entire population of *P. paludosus* sampled along the transect is plotted with the hydrograph in Figure 6.

The population of *P. paludosus* increased steadily from 2.7 shrimp/m^2 on July 28, 1971 to 45.5 shrimp/m^2 on January 27, 1972. A slight decline to 37.1 shrimp/m^2 was reported on March 1, 1972. Very high densities of 113.2 and 146.9 shrimp/m^2 resulted on May 11, 1972 and August 8, 1972 respectively. These values

TABLE 3. NUMBERS OF FRESHWATER SHRIMP (*Palaemonetes paludosus*) COLLECTED FROM REFLOODED MARSH. JULY 28, 1971 TO APRIL 11, 1973.

Date	0+00	0+50	1+00	1+50	2+00	2+50	3+00	3+50	4+00	4+50	5+00	Total	Density per Meter^2*
July 28, 1971	0	0	1	0	3	0	2	0	0	0	0	6	2.7
October 4, 1971	8	0	4	1	1	15	4	7	1	1	0	42	19.1
October 28, 1971	4	12	8	11	0	4	10	4	10	8	3	74	33.6
December 1, 1971	12	8	14	12	15	0	7	2	2	3	0	75	34.1
January 27, 1972	11	1	2	27	9	15	21	5	2	1	6	100	45.5
March 1, 1972-A	4	11	7	10	18	4	5	1	6	5	2	73	33.2
March 1, 1972-B	4	21	10	5	12	18	4	5	3	5	3	90	40.9
May 11, 1972	49	26	37	34	31	27	25	16	4	0	0	249	113.2
August 8, 1972	165	30	2	6	0	0	4	28				235	146.9
October 17, 1972	15	4	3	1	0	4	11	15	8	14	20	95	43.2
January 16, 1973	68	22	22	6	10	7	3	11	12	8	3	172	78.2
March 1, 1973	14	5	3	9	27	2	6	11	13	9	15	114	51.8
April 11, 1973	13	6	9	4	2	19	27					80	57.1
Total **	189	110	111	116	126	96	98	77	61	54	52	1090	
Mean **	17.2	10.0	10.1	10.6	11.5	8.7	8.9	7.0	5.6	4.9	4.7	9.0	

* Meter^2 = 10.76 feet^2

**Exclusive August 8, 1972 and April 11, 1973

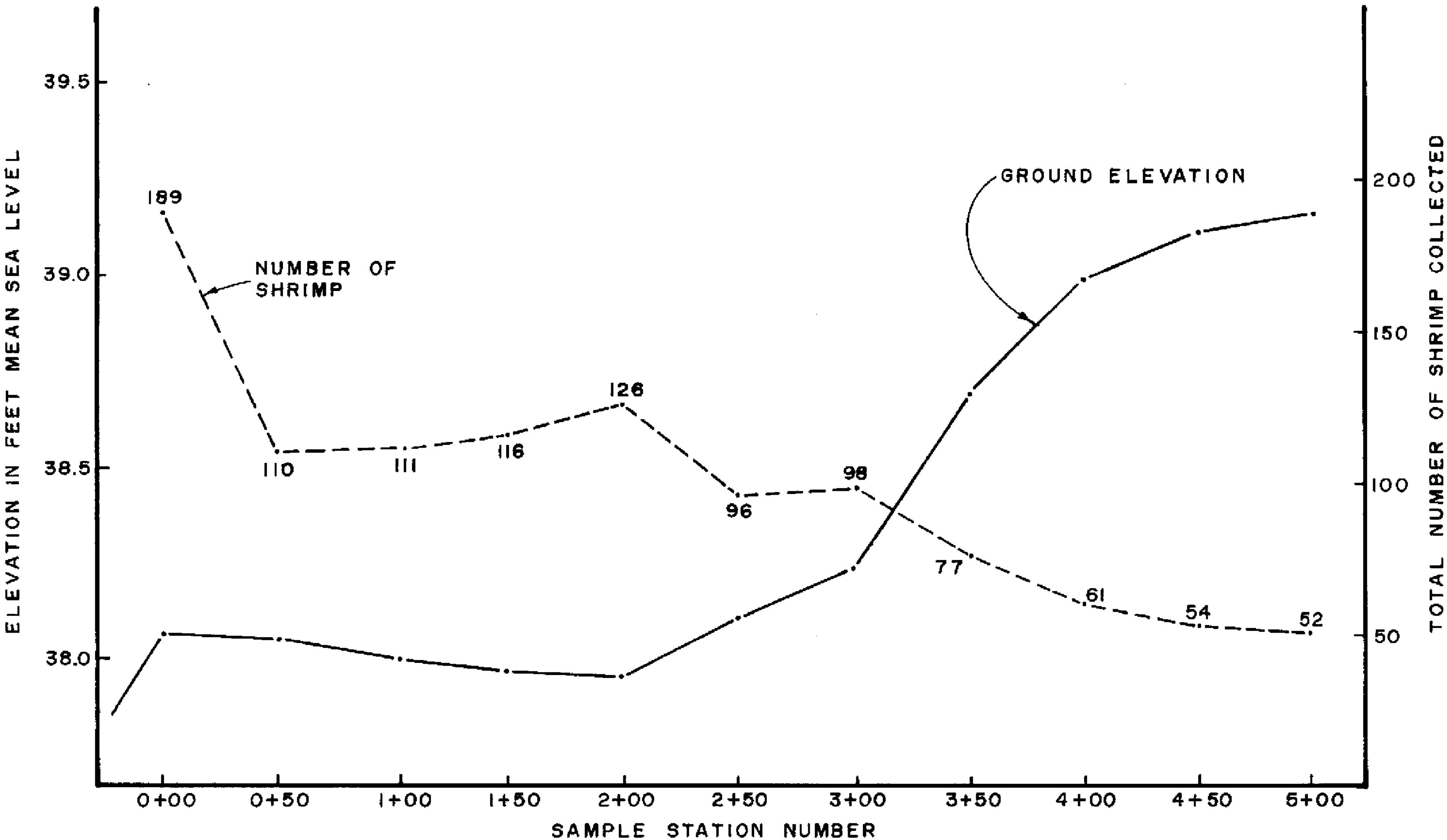

Figure 5: TOTAL NUMBER OF PALAEMONETES PALUDOSUS COLLECTED AND ELEVATION ALONG TRANSECT IN REFLOODED MARSH, JULY 1971 — MARCH 1973

TABLE 3. NUMBERS OF FRESHWATER SHRIMP (*Palaemonetes paludosus*) COLLECTED FROM REFLOODED MARSH. JULY 28, 1971 TO APRIL 11, 1973.

Date	0+00	0+50	1+00	1+50	2+00	2+50	3+00	3+50	4+00	4+50	5+00	Total	Density per Meter^2 *
July 28, 1971	0	0	1	0	3	0	2	0	0	0	0	6	2.7
October 4, 1971	8	0	4	1	1	15	4	7	1	1	0	42	19.1
October 28, 1971	4	12	8	11	0	4	10	4	10	8	3	74	33.6
December 1, 1971	12	8	14	12	15	0	7	2	2	3	0	75	34.1
January 27, 1972	11	1	2	27	9	15	21	5	2	1	6	100	45.5
March 1, 1972-A	4	11	7	10	18	4	5	1	6	5	2	73	33.2
March 1, 1972-B	4	21	10	5	12	18	4	5	3	5	3	90	40.9
May 11, 1972	49	26	37	34	31	27	25	16	4	0	0	249	113.2
August 8, 1972	165	30	2	6	0	0	4	28				235	146.9
October 17, 1972	15	4	3	1	0	4	11	15	8	14	20	95	43.2
January 16, 1973	68	22	22	6	10	7	3	11	12	8	3	172	78.2
March 1, 1973	14	5	3	9	27	2	6	11	13	9	15	114	51.8
April 11, 1973	13	6	9	4	2	19	27					80	57.1
Total **	189	110	111	116	126	96	98	77	61	54	52	1090	
Mean **	17.2	10.0	10.1	10.6	11.5	8.7	8.9	7.0	5.6	4.9	4.7	9.0	

* Meter^2 = 10.76 feet^2

**Exclusive August 8, 1972 and April 11, 1973

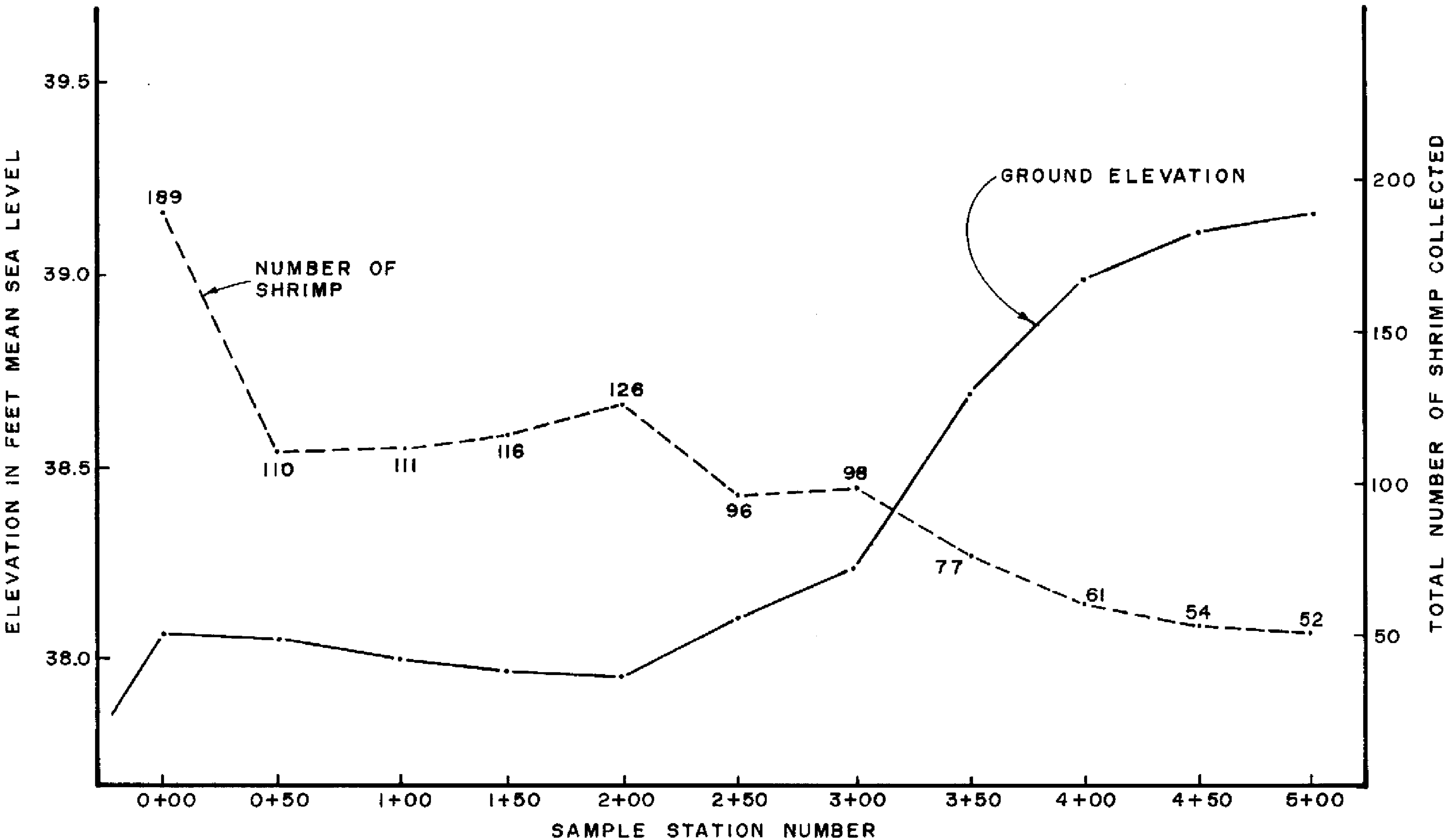

Figure 5: TOTAL NUMBER OF <u>PALAEMONETES</u> <u>PALUDOSUS</u> COLLECTED AND ELEVATION ALONG TRANSECT IN REFLOODED MARSH, JULY 1971 – MARCH 1973

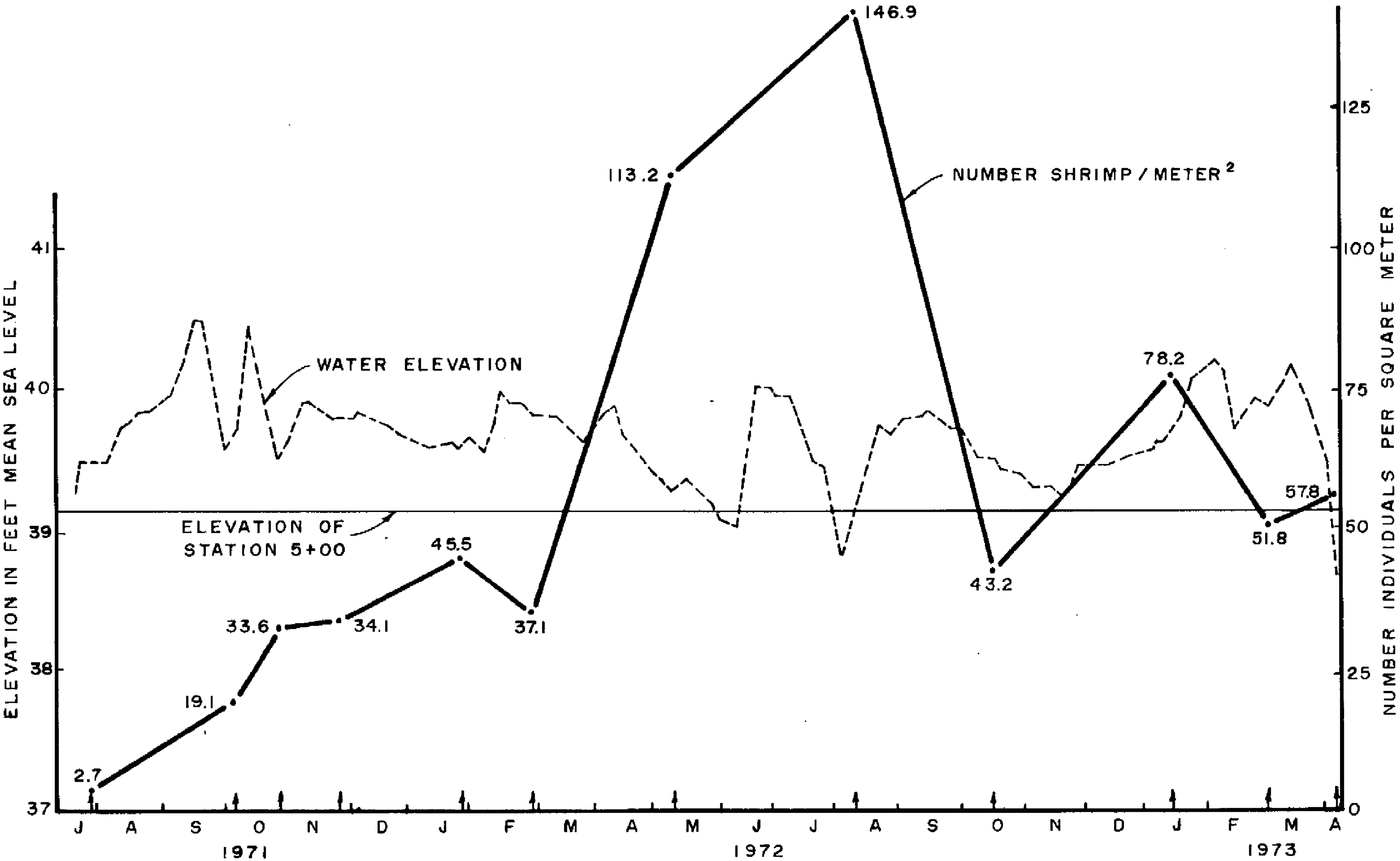

Figure 6 NUMBER OF PALAEMONETES PALUDOSUS PER SQUARE METER RECOVERED FROM REFLOODED MARSH AND WATER FLUCTUATIONS JULY 1971 TO APRIL 1973

were influenced somewhat by water level fluctuations in the marsh. Each of these samples was preceded by several weeks of declining water levels.

Following this summer peak there was a decline in density to 43.2 shrimp/m^2 by October 16, 1972. Sufficient water levels remained in the marsh through January 16, 1973 to prevent concentration of the shrimp and the density increased to 78.2 individuals/m^2.

The peak density of shrimp in January 1973 was again followed by a decline to a density of 51.8 shrimp/m^2 in March 1973. By April 11, 1973 the stage level had receded to 38.8 feet msl so that all surviving individuals were concentrated in the lower 300 feet of marsh. Samples taken along the transect indicated a density of 57.1 shrimp/m^2.

The densities of *P. paludosus* were recalculated for the deep stations (0+00 to 3+00) and the shallow stations (3+50 to 5+00). These densities were plotted simultaneously with the hydrograph on Figure 7. Density was greater at the deep stations from July 28, 1971 to August 8, 1972. The large increase in density that occurred on August 8 for the shallow stations coincided with very low water levels in the marsh. Between August and October 1972 the overall density of *P. paludosus* declined, but the greater decrease occurred in the deeper end of the transect. By January 1973, densities were again greater in the deep marsh. The increase from 27.1 to 98.6 individuals/m^2 coincided with a decrease in the shallow station density from 71.2 to 42.5 individuals/m^2.

Crayfish

One species of crayfish, *Procambarus fallax*, was collected from samples taken in the reflooded marsh. No *P. fallax* specimens were collected in July 1971. On October 28, 1971, only three individuals were collected and those crayfish measured 1.6 to 2.2 inches (42-55 mm) in length.

A large increase in density was observed on December 1, 1971 when 20.9

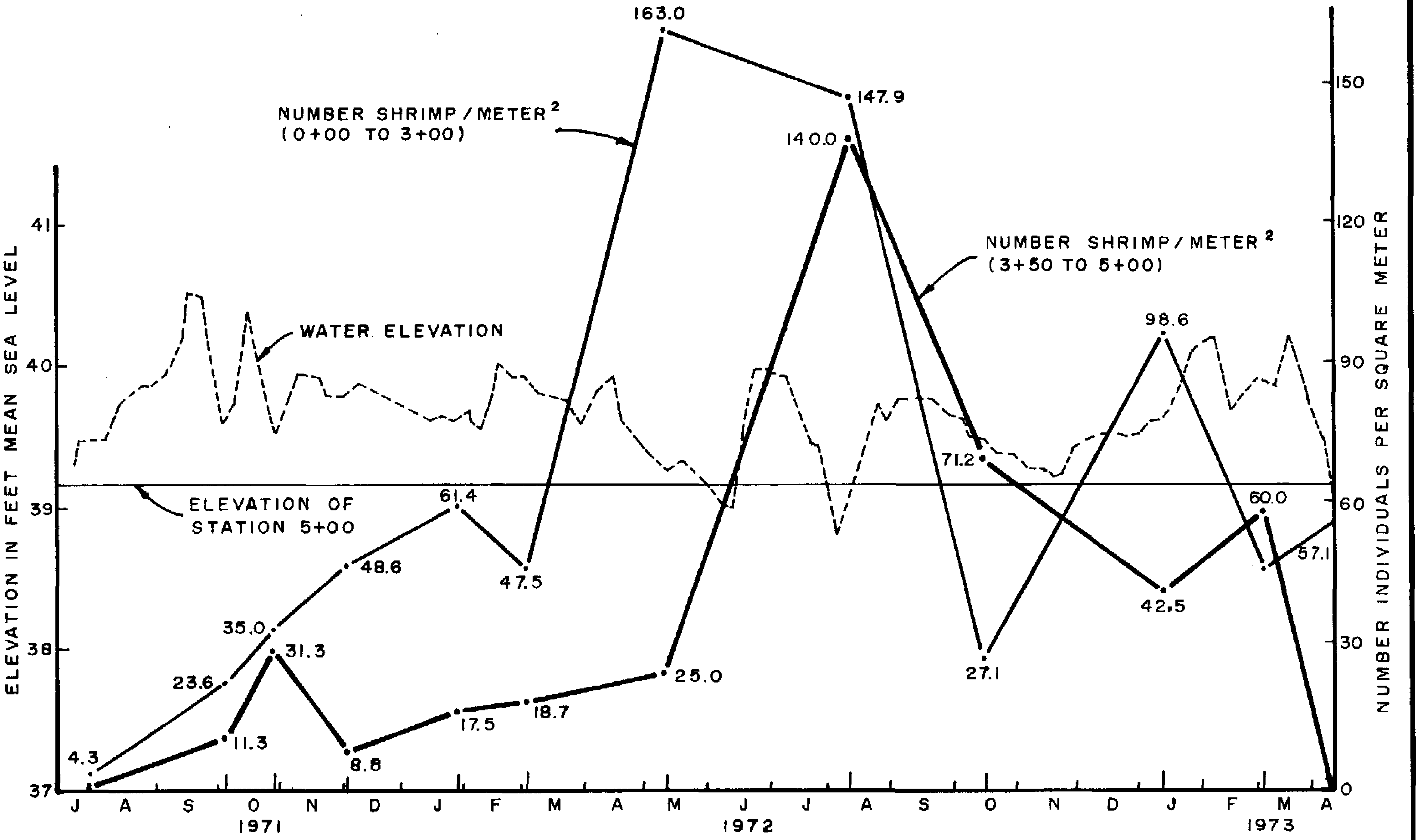

Figure 7: NUMBERS OF PALAEMONETES PALUDOSUS PER SQUARE METER RECOVERED FROM DEEP (0+00 TO 3+00) AND SHALLOW (3+50 TO 5+00) PORTIONS OF TRANSECT, JULY 1971 TO APRIL 1973

P. *fallax*/m^2 were collected. These individuals ranged in length from 0.3 to 2.2 inches (7 mm to 55 mm). Only 5% of the specimens exceeded 1.6 inches (41 mm) in length while many were considerably smaller (Table 4). The mean length of December 1971 specimens was 0.75 inches (19 mm) as compared to 1.9 inches (49 mm) in October.

The distribution of crayfish along the transect line indicated a preference for the shallower portion of the marsh. For eleven sampling periods (August 8, 1972 and April 11, 1973 were omitted), the total number of P. *fallax* collected from stations 0+00 to 3+00 averaged 9.7 compared to 19.0 for stations 3+50 to 5+00. A calculated chi square based on the total distribution was 28.79 which exceeded the critical value at the 0.05 significance level. This indicated an uneven distribution along the transect.

The eight samples taken from January 27, 1972 to March 1, 1973 indicated a relatively stable population ranging from 4.5 to 7.7 crayfish per $meter^2$.

Vegetation

Positive identification of certain plant specimens is often difficult so some plants were only identified to genera. The specific name of the closest known morphological type is included in parenthesis. Identification of some of the grasses was particularly troublesome and these were often grouped in a general category. For example, *Paspalum dissectum* was identified in July 1971, but in other samples it was unidentifiable and grouped with other grasses. Species recovered from the marsh are listed in Table 5.

The total biomass (wet weight) harvested from each of the 0.20 $meter^2$ samples is presented in Table 6. The largest increase in biomass occurred during the first four months after reflooding, from July 28, 1971 to December 1, 1971. Biomass increased at each station along the transect, with stations 0+00 - 3+00 exhibiting the greatest gains. Percentage biomass increases in the deeper portion of the marsh ranged from 85% at 2+50 to 304% at 0+00. The total percentage increase for all

TABLE 4. PERCENT OCCURRENCE OF VARIOUS LENGTH GROUPS OF *PROCAMBARUS FALLAX* FROM REFLOODED MARSH, JULY 1971 TO APRIL 1973.

	Percent of Population						
	Length* group (mm)						Total Number
Date of Sample	1-10	11-15	16-20	21-30	31-40	41+	Individuals
July 28, 1971	0						0
October 4, 1971						100	1
October 28, 1971						100	3
December 11, 1971	11	33	30	19		5	46
January 27, 1972	9	9		36	27	18	11
March 1, 1972	15	7	11	15	33	18	33
May 11, 1972		33	8	42		17	12
August 8, 1972	28	57		14			14
October 17, 1972	17	33	17	17		17	12
January 16, 1973			10	20	70		13
March 1, 1973	11			11	22	55	13
April 11, 1973	44	22	22		11		11

*Measurement from anterior end of carapace to the base of telson in mm.

1 inch = 25.4 mm

TABLE 5. PLANT SPECIES SAMPLED FROM THE REFLOODED MARSH, JULY 1971 TO MARCH 1973

Scientific Name	Common Name
Bacopa caroliniana	Water hyssop
Centella asiatica	Coinwort
Cyperus articulatus	Sweet rush
Diodia virginiana	Buttonweed
Eleocharis sp. (acicularis)	Spike-rush
Eleocharis sp. (baldwinii)	Spike-rush
Hydrochloa caroliniensis	Water grass
Leersia hexandra	Cut grass
Lippia nodiflora	Frog fruit
Ludwigia repens	False loosestrife
Panicum repens	Torpedo grass
Paspalum dissectum	-
Pontederia lanceolata	Pickerelweed
Rhynchospora inundata	Beak-rush
Rhynchospora sp.	Beak-rush
Sagittaria lancifolia	Arrowhead
Sagittaria sp. (subulata)	-
Utricularia sp.	Bladderwort
Unidentifiable grasses	-

Plant identifications from Correll and Correll (1972), Hitchcock (1935) and Long and Lakela (1971).

TABLE 6. WET WEIGHT AND PERCENTAGE CHANGE OF 0.2 METER^2 VEGETATION SAMPLES FROM REFLOODED MARSH

	July 28, 1971	December 1, 1971		October 17, 1972		March 1, 1973	
Station	Weight (g) *	Weight (g)	% Change	Weight (g)	% Change	Weight (g)	% Change
0+00	448	1809	+304	1959	+ 8	909	- 54
0+50	317	705	+122	1456	+107	1177	- 19
1+00	378	753	+ 99	1107	+ 47	1344	+ 21
1+50	385	976	+154	1312	+ 34	1459	+ 11
2+00	561	1195	+113	1263	+ 6	957	- 24
2+50	278	515	+ 85	1370	+166	961	- 30
3+00	215	469	+118	868	+ 85	880	+ 1
3+50	401	684	+ 71	1474	+116	1107	- 25
4+00	424	506	+ 19	1034	+104	550	- 47
4+50	439	450	+ 3	690	+ 53	468	- 32
5+00	251	383	+ 53	491	+ 28	387	- 21
Total	4097	8445		13024		10199	
Mean	372.4	767.7	+106	1099	+54	927	-22
0+00 to 3+00	2582	6422	+149	9335	+45	7687	-18
3+50 to 5+00	1515	2023	+ 25	3689	+82	2512	-32

* grams x (2.2 x 10^{-3}) = pounds

samples was 106%.

Total biomass increased an additional 54% during the period from December 1, 1971 to October 17, 1972. Greater increases in biomass occurred at those stations occupying the higher elevations. Biomass increased 82% at stations 3+50 to 5+00 compared to 45% for stations 0+00 to 3+00.

Biomass decreased an average of 26% during the winter months, from October 17, 1972 to March 1, 1973.

There were two general vegetation zones in the reflooded marsh related to ground elevation and water depth. The first zone extended from the canal northward for about 300 feet where ground elevations were 38.0 to 38.25 feet msl. Five species of plants, *Bacopa caroliniana*, *Hydrochloa caroliniensis*, *Leersia hexandra*, *Pontederia lanceolata* and *Sagittaria lancifolia*, usually occurred in this deeper portion of the marsh and were considered "deep marsh indicators". A submergent grass, common in the deeper marsh, was not identified and therefore not included as an indicator.

The second zone, which began about 350 feet from the canal and extended northward beyond the end of the transect, was dominated by grasses and sedges. Ground elevations in this zone ranged from 38.7 to 39.5 feet msl.

The weight of all deep marsh indicators in a sample was divided by the total sample weight to determine percentage composition of indicator species (Table 7). From July 28, 1971 to October 17, 1972 the percentage of indicator species generally increased at each station between subsequent sampling dates. In the deeper portion of the marsh (stations 0+00 to 3+00), the average percentage of indicator species increased from 76% to 93%. An increase from 0.4% to 16% occurred in the shallow portion of the marsh (stations 3+50 to 5+00). An overall decline in percentage of indicator species occurred between October 17, 1972 and March 1, 1973.

The spreading of indicator species into the shallow portion of the transect was primarily represented by *Bacopa caroliniana*. Water grass, *Hydrochloa*

TABLE 7. WET WEIGHT ANALYSES OF DEEP MARSH INDICATOR SPECIES IN REFLOODED MARSH, JULY 1971 TO MARCH 1973.

	July 28, 1971			December 1, 1971			October 17, 1972			March 1, 1973		
	TW	IW	% I	TW	IW	% I	TW	IW	% I	TW	IW	% I
0+00	448	282	62.9	1809	1730	95.6	1959	1900	97.0	909	821	90.3
0+50	317	222	70.0	705	594	84.3	1456	1450	99.6	1177	1157	98.3
1+00	378	280	74.1	753	589	78.2	1107	1069	96.5	1344	1344	100.0
1+50	385	318	82.6	976	942	96.5	1312	1280	97.6	1459	1459	100.0
2+00	561	538	95.9	1195	1195	100.0	1263	1237	98.0	957	957	100.0
2+50	278	186	66.9	515	48	9.3	1370	1297	94.7	961	741	77.1
3+00	215	123	57.2	469	111	23.7	868	409	47.1	880	35	3.9
3+50	401	6	1.5	684	50	7.3	1474	148	10.0	1107	198	17.9
4+00	424	0	0	506	0	0	1034	411	39.7	550	7	1.2
4+50	439	0	0	450	7	1.6	690	16	2.3	468	0	0
5+00	251	0	0	383	0	0	491	26	5.3	387	0	0
Total	4097	1955	47.7	8445	5266	62.4	13025	9241	70.9	10197	6717	65.9
0+00 - 3+00	2582	1949	75.5	6422	5209	81.1	9335	8641	92.6	7686	6512	84.7
3+50 5+00	1515	6	0.4	2023	57	2.8	3690	600	16.3	2511	205	8.2

TW = Total wet weight in grams   IW = Wet weight of deep marsh indicator species in grams
% I = Percentage of indicator species by wet weight.
Indicator species are *Bacopa caroliniana*, *Hydrochloa caroliniensis*, *Leersia hexandra*, *Pontederia lanceolata* and *Sagittaria lancifolia*

grams x (2.2×10^{-3}) = pounds

caroliniensis occasionally occurred at the higher elevations and *Pontederia lanceolata* also increased throughout the marsh.

The average number of species per sample decreased from 6.8 in July 1971 to 4.4 in March 1973 (Table 8). The results of a t-test at the 95% confidence level indicated that the average number of species per sample on July 28, 1971 was significantly greater than the average number collected in the October 1972 and March 1973 samples.

Fishes

A fish population sample was collected from a one-half acre (0.20 ha) area of a Kissimmee River oxbow, midway between S-65A and S-65B, on August 14-15, 1972. The results for the eleven major species of fish recovered from this sample are presented in Table 9. One acre (0.4 ha) of river oxbow contained a standing crop of 562 individuals weighing collectively 64.26 pounds (29.15 kg).

The fish population in the borrow canal adjacent to the south end of the reflooded marsh was sampled on August 9-10, 1972 (Table 10). Eleven major species of fish were collected. The time lapse since reflooding of the impoundment area was one year so that most of the fish population represented the first year class. For instance, 87% of largemouth bass were 3-6 inches (7.15-15 cm) in length, 83% of warmouth were 3-5 inches (7.5-13 cm), and 82% of brown bullheads were 4-7 inches (10-18 cm). One acre (0.40 ha) of this borrow canal contained over 4000 fish weighing collectively over 341 pounds (155 kg).

To document changes in the fish population in the canal, a second sample was taken on May 1-3, 1973 at the same location (Table 10). The water level was lower than in the previous sample, so that no fish were in the marsh. Numbers of fish retrieved cannot be used as an indication of population growth, but measurements for each species represent the changes which had occurred. For example, in August 1972, 204 largemouth bass weighed 15.74 pounds (7.14 kg) to average 1.23 ounces (35.0 g) per

TABLE 8. NUMBER OF PLANT SPECIES COLLECTED AT EACH STATION IN REFLOODED MARSH.

Station	July 28, 1971	December 1, 1971	October 17, 1972	March 1, 1973
0+00	6	5	6	4
0+50	8	9	7	6
1+00	6	8	6	4
1+50	7	4	5	5
2+00	7	4	7	3
2+50	5	6	5	6
3+00	9	6	5	3
3+50	6	5	4	5
4+00	6	4	5	3
4+50	8	7	2	6
5+00	7	4	4	3
Avg. number per Station	6.8	5.6	5.1	4.4
Avg. number (0+00 - 3+00)	6.9	6.0	5.9	4.4
Avg. number (3+50 - 5+00)	6.8	5.0	3.8	4.3

TABLE 9. FISH SPECIES WITHIN A ONE-HALF ACRE (0.20 HECTARE) SAMPLE FROM A KISSIMMEE RIVER OXBOW. AUGUST 14-15, 1972.

Species	Number per sample	Weight per sample (kg)*	Avg. weight per individual (g)**
Micropterus salmoides (Largemouth bass)	16	0.62	38.8
Lepomis gulosus (Warmouth)	44	0.54	12.2
Lepomis macrochirus (Bluegill)	148	4.05	27.4
Lepomis microlophus (Redear sunfish)	42	2.89	68.8
Lepomis punctatus (Spotted sunfish)	6	0.11	18.8
Poxomis nigromaculatus (Black crappie)	13	0.08	6.3
Ictalurus punctatus (Channel catfish)	2	2.52	1261.0
Ictalurus nebulosus (Brown bullhead)	1	0.08	82.0
Lepisosteus platyrhichus (Florida gar)	2	1.10	551.0
Erimyzon succetta (Lake chubsucker)	1	0.57	567.0
Dorosoma cepedianum (Gizzard shad)	6	2.01	334.0
Total per sample	281	14.57 kg (32.13 pounds)	
Total per acre (0.40 ha)	562	29.15 kg (64.26 pounds)	

*kg x 2.2046 = pounds

**grams x 3.5 x 10^{-2} = ounces

TABLE 10. FISH SPECIES COLLECTED FROM TWO ONE-HALF ACRE (0.20 HECTARE) SAMPLES IN A BORROW CANAL ADJACENT TO REFLOODED MARSH.

Species	August 9-10, 1972			May 1-3, 1973		
	Number per Sample	Weight per Sample (kg)*	Avg. Weight per Individual (g)**	Number per Sample	Weight per Sample (kg)	Avg. Weight per Individual (g)
Micropterus salmoides (Largemouth bass)	204	7.14	35.0	50	13.32	266.4
Lepomis gulosus (Warmouth)	1206	34.35	28.5	1964	59.14	30.1
Lepomis macrochirus (Bluegill)	292	12.42	42.5	45	2.41	53.5
Lepomis microlophus (Redear sunfish)	-	-	-	21	0.65	30.9
Poxomis nigromaculatus (Black crappie)	9	0.11	12.6	2	0.11	56.7
Aphredoderus sayanus (Pirate perch)	-	-	-	7	0.08	11.7
Ictalurus nebulosus (Brown bullhead)	192	10.34	53.9	11	2.18	198.4
Ictalurus natalis (Yellow bullhead)	27	3.86	142.8	16	1.56	97.2
Ictalurus catus (White catfish)	1	0.57	567.0	-	-	-
Notemigonus crysoleucas (Golden shiner)	135	4.42	32.8	59	3.03	51.4
Erimyzon sucetta (Chubsucker)	15	0.42	28.1	84	5.70	67.8
Lepisosteus platyrhincus (Florida gar)	11	3.32	301.5	68	6.97	102.5
Amia calva (Bowfin)	4	0.93	233.5	35	12.47	356.4
Total	2096	77.88 kg		2362	107.62 kg	
		171.7 pounds			237.3 pounds	

*kg x 2.2046 = pounds

**grams x 3.5 x 10^{-2} = ounces

individual. By May 1973, 50 individuals weighed 29.4 pounds (13.32 kg) or 9.4 ounces (266.4 g) per individual. Twelve inches (30.5 cm) was the largest length recorded in August 1972 and only seven percent of the individuals were 9-12 inches (23-30.5 cm). By May 1973, the largest individuals were 17 inches (43 cm) and 20% of the bass population was 14-17 inches (35.5-43 cm) in length. Increases in both percentage of population and individual size were noted for the warmouth, chubsucker and bowfin. Bluegill, black crappie, brown bullhead and golden shiner also increased in average weight per individual from August 1972 to May 1973.

DISCUSSION

Reflooding of the isolated marsh from July 1971 to April 1973 provided the opportunity to monitor the growth and changes of several biological facets of a freshwater marsh ecosystem.

This experimental study area was once part of the original Kissimmee River floodplain and was influenced by seasonal water level fluctuations. The flora of this area, even after impoundment and water stabilization, included many typical marsh species (Florida Game and Freshwater Fish Commission, 1957; United States Fish and Wildlife Service, 1959). Aquatic invertebrates and fishes, which once had free access to this area from the nearby river and marshlands, still inhabited the ditches and canals of the study area. Reflooding of this marsh simulated the natural overflow of the river.

Due to the relatively uniform contour within most of the reflooded marsh, minor fluctuations in water levels had a profound influence on the total amount of marshland flooded. The distribution of macrofauna throughout the entire marsh and consequently the density of organisms along the transect were dependent, in part, on water fluctuations during the sampling period.

Several factors affect the populations of aquatic animals. When water levels were above 39.14 feet msl (the calculated elevation of station 5+00), some of the aquatic animals concentrated in the deeper portion of the marsh could occupy the newly flooded areas, resulting in a reduced density of animals along the transect. Declining water levels stranded some individuals when parts of the marsh dried, and concentrated the remainder in the deeper end of the marsh. Concentration increased the likelihood of predation by larger fish or wading birds. Although sampling results show an increase in density of a species due to the lower water levels, the total population size may have actually decreased.

Small Fishes

Small fish had no distinct preference for water depth along the transect line. When marsh north of the transect was inundated, some of the small fish probably migrated into this habitat. Therefore, as the water stage increased and more marshland was flooded, the density of fish in any sample along the transect decreased. The lack of an accurate survey of this marsh prevented a determination of the total amount of marshland available for small fishes at different stage levels.

There was a rapid increase in density from 2.7 fish/m^2 in July 1971 to 28.6 fish/m^2 on October 28, 1971 and 50.9 fish/m^2 at the end of January 1972. During this period, much of the marsh north of the transect was flooded. Therefore, the density increases represented overall population growth, and were not due to concentration.

A decline in density to 35.0 fish/m^2 between January 27 and March 1, 1972 was accompanied by a stage increase of 0.3 feet (9 cm). This water level increase may have allowed further dispersal of small fish in the marsh, and lowered density along the transect. For comparison, during a similar time interval from October 28, 1971 to December 1, 1971, the stage also increased about 0.3 feet (9 cm). Although more marshland was flooded, the fish density increase from 32.7 to 37.7 fish/m^2 was probably due to reproduction.

By the summer months of 1972 fluctuating water levels and perhaps predation and competition caused a decline in the population. On May 11, 1972, station 5+00 had only 1 inch (3 cm) of water. Nearly the entire poulation of fish was concentrated within about 500 feet of marsh and a density of 86.8 fish/m^2 was observed on that date. Water levels on August 8, 1972 were even lower and the entire population was forced into about only 350 feet of flooded marsh. The density reported in August was 76.2 fish/m^2. By comparing the density and the approximate area of inundation, it appeared that the overall population had declined between May and August, 1972.

Another population increase had occurred by October 17, 1972. Although the density of 72.3 individuals/m^2 was slightly lower than values in August, the marsh was flooded well beyond station 5+00, so the total fish population had increased. This population increase was probably due to reproductive increases, reduced predation and the lack of severe water fluctuations since August 1972.

In mid-November, the water level dropped to a point where most fish would be concentrated into the lower 500 feet of marsh. Although the stage later increased, the decline in density to 32.7 fish/m^2 on January 16, 1973 may also reflect mortality caused by this prior stage decrease.

Water levels remained high until March 1, 1973 and the density decrease to 15.9 fish/m^2 was probably the result of fish dispersion into the marsh.

The density of 110.7 fish/m^2 recorded on April 11, 1973 reflected the effects of concentration when all fish were forced into 300 feet of the marsh. Total population estimates on this date are comparable with those of May 1972 and August 1972 because the limits of marsh inundation are known. The estimated population size in April 1973 was greater than the population in August 1972. Suitable water conditions in the marsh after December 1972 may have enabled the small fish population to increase.

The fifteen species of fish grouped as "small fishes" were of similar sizes and all occupied a common habitat. *Heterandria formosa* and *Gambusia affinis*, which comprised the majority of the small fishes, are prolific breeders. Kushlan (1972) indicates that these two species have a bimodal spring and fall reproductive cycle in the Big Cypress Swamp. McLane (1955) indicated that in the St. Johns River *Gambusia affinis* breeds from March to October and *Heterandria formosa* breeds from February to October. During this study, however, these species apparently continued to breed through the winter months of 1971-72. In the interval from October 4, 1971 to March 1, 1972 these two species comprised from 75.3% to 94.4% of the fish in the samples. Abundant space and food supply were available in the newly flooded marshland and may have been responsible for continued reproduction.

Shrimp - *Palaemonetes paludosus*

Fluctuating water levels had less impact on the population of *Palaemonetes paludosus* than on the small fishes because of the affinity of the shrimp for the deeper portion of the marsh. The distribution of shrimp may be related to the vegetational composition of the deeper portion of the transect. Water grass, *Hydrochloa caroliniensis*, was extremely abundant in the deep portion of the marsh, and was present at every station from 0+00 to 3+00 from July 1971 to October 1972 and from 0+00 to 2+50 in March 1973. At times *Hydrochloa caroliniensis* comprised over 90% of the sample by wet weight. This plant has long mat-forming stems and many small leaves which provide an enormous surface area. The growth form of *H. caroliniensis* is similar to Southern naiad, *Najas quadalupensis*. Kushlan (1972) showed that *P. paludosus* have a preference for naiad in the Big Cypress Swamp. Stress upon *P. paludosus* caused by water fluctuation in the very shallow marsh may also have been responsible for their abundance in the deeper water.

The population of freshwater prawns in the study area increased rapidly during the first six months, from 2.7 individuals/m^2 in July 1971 to 45.5/m^2 in January 1972. A slight decrease in shrimp density in March 1972 was possibly caused by natural mortality and higher water levels. Population peaks in May 1972 and January 1973 were probably due to the spring and autumn bimodal reproductive cycle of *Palaemonetes paludosus* (Pennack, 1953; Odum, 1957; Kushlan, 1972). The larger number of *P. paludosus* recovered in August 1972 reflected the effects of concentration because the marsh was dry from station 4+00 northward. A decline in density to 43.2 shrimp/m^2 in October 1972 approximated the January 1972 density. This decline was probably due to higher water levels and natural mortality from competition and predation.

The peak in *P. paludosus* density in January 1973 was accompanied by high stages in the marsh (40.4 feet msl) so concentration was not a contributing factor.

Following the winter peak, the density of *P. paludosus* again returned to levels near those preceding earlier reproductive periods. Although all individuals were concentrated into the lower 300 feet of marsh by April 11, 1973, the resulting density was only 57.1 shrimp/m^2. Evidently the next major reproductive cycle had not begun when this sample was taken.

Palaemonetes paludosus serves as forage for the larger fish in the borrow canal and marsh. Of the 13 major species of fish recovered from the sampling of the canal, eight were reported by McLane (1955) to include *P. paludosus* in their diet. Dineen (1965) reported that *P. paludosus* was the primary food organism of largemouth bass in the 7 to 12 inch classes in Conservation Area 2.

Crayfish - *Procambarus fallax*

Procambarus fallax, like the small fishes and shrimp, exhibited initial increases in density following reflooding of the marsh. In October 1971 only 1.4 individuals/m^2 were present but by December 1971 there were 20.9 crayfish/m^2. The density of *P. fallax* recovered during the remainder of the study was fairly constant, ranging from 4.5 to 7.7 crayfish/m^2, probably indicating an optimum population.

The average size of crayfish in the December 1971 sample was considerably smaller than those present in October 1971, and together with the large number of individuals recovered, suggests a fall reproductive peak. Additionally, a large percentage of the crayfish were under 0.6 inch (15 mm) in length in August 1972 and April 1973. This represents reproductive peaks in the fall of 1971, summer of 1972 and spring of 1973. Rhoads (1975) indicated that *P. fallax* have a spring and fall bimodal reproductive cycle in South Florida.

Vegetation

The fluctuations in water level during the study period which influenced macroinvertebrate distribution had little impact on the rooted vegetation in the marsh. Rather the vegetation responded to the overall period of inundation.

A rise in ground elevation in the middle of the transect (3+00 to 3+50) divides the "deep marsh", characterized by *Bacopa caroliniana, Hydrochloa caroliniensis, Leersia hexandra, Pontederia lanceolata,* and *Sagittaria lancifolia* from the grass and sedge dominated shallow zone. Water depths, up to one foot (30 cm) greater in the deep zone, were probably responsible for the species composition difference. The water regime from August 1970 to March 1971 flooded the marsh to about 39 feet msl and stimulated aquatic plant growth. Much of this vegetation survived the March - July 1971 drawdown and responded to reflooding. The largest increase in wet weight per unit area was in the period from July 1971 to October 1971. During this period the deeper part of the transect, from 0+00 to 3+00, showed the greatest gains. Therefore, reflooding of the marsh in July 1971 served to stimulate growth of the aquatic vegetation already present. Studies on the floodplain vegetation in the St. Johns River by Davis (1975) have shown that maximum plant biomass increase occurred in the time period which included reflooding of a seasonally dry floodplain.

A prolonged period of inundation in the marsh from July 1971 until April 1973 favored the growth of "deep marsh" species. Vegetation sampled at the end of the second growing season, in October 1972, showed a continued increase in biomass. However, much of this increase was confined to a few "deep marsh indicator" species, which initially occurred only at the lower elevations on the transect. Through the course of study, some of these indicator species spread into other parts of the transect. The decline in plant diversity per sample was due largely to increases of the few species that were better adapted to prolonged flooding of the marsh. For example, in the deeper water area, *Hydrochloa caroliniensis* grew in such thick, dense mats that it probably impeded growth of most other species. Likewise *Pontederia lanceolata* and *Sagittaria lancifolia* grow rapidly and outcompete other plants.

Plant biomass decreased during the autumn and winter from October 17, 1972 to March 1, 1973 due to seasonal dieback. A similar reduction was reported for the October-January time period in the St. Johns River floodplain (Davis, 1975). This trend occurred on the floodplain regardless of whether it remained flooded, or dried.

Fishes

The fish population in the borrow canal adjacent to the marsh had free access to move into the deeper flooded areas and feed on the smaller fish, shrimp, crayfish, and numerous other invertebrates. The food supply was practically limitless, as seen by the reproductive potential of these forage species. Additionally, the slight fluctuations in water level concentrated much of this forage in the deeper marsh, where they were utilized by the larger fish.

In contrast, the density and biomass of fish in the Kissimmee River oxbow sample was substantially smaller than the amount of fish recovered from the borrow canal. This oxbow was located about midway between S-65A and S-65B, where the water level was below the surrounding land elevation and confined to the river channel. Since there was no adjacent marshland, the fish in the oxbow lacked a source of accessible and available forage from the lower trophic levels.

SUMMARY AND CONCLUSIONS

1. Reflooding of an impounded marshland after a four month drawdown simulated the natural flooding of Kissimmee River Basin marshes, and provided the opportunity to measure some of the responses of aquatic fauna and flora. The marsh remained inundated from July 1971 until April 1973.
2. Small fishes, freshwater shrimp, and crayfish were selected as indicators of the marshland macrofauna. Populations of these organisms increased rapidly during the first six months following reflooding. The density of small fishes and freshwater shrimp increased from 2.7 individuals/m^2 to 50.9 and 45.5 individuals/m^2, respectively. Crayfish density increased from 1.4 to 20.9 individuals/m^2.
3. Slight reductions in water levels later in the study reduced the amount of wet marsh habitat, and initially produced high concentrations of small fishes and freshwater shrimp in the remaining flooded portion of the marsh. A subsequent sample indicated a decrease in the total population of small fish.
4. After the initial population increases, large numbers of freshwater shrimp were recovered in the summer and winter months indicating a spring and autumn reproductive cycle. A major reproductive peak of crayfish occurred in the first autumn and subsequent reproductive peaks occurred in the summer of 1972, and the spring of 1973. Reproductive increases for small fish were most obvious during the first six months of reflooding, and less evident in the ensuing time.
5. Marshland vegetation biomass increased rapidly following reflooding. Within the initial five months, weight of marsh vegetation per unit area had doubled. Additional increases occurred by October 1972. Biomass declined by March 1973 due to winter seasonal die-back.

6. Plant diversity decreased through the study period from 6.8 species per sample in July 1971 to 4.4 species per sample in March 1973. A few species of plants, which were considered "deep marsh indicators", increased in percentage composition by weight and occurrence throughout the marsh.

7. The total biomass and number of fish collected from a sample in a Kissimmee River oxbow were considerably smaller than those collected from a similar sample in the borrow canal adjacent to the reflooded marsh. This smaller standing crop of fish in the oxbow was probably related to the lack of adjacent marshland or littoral area capable of supporting abundant forage.

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APPENDIX I

AQUATIC MACROFAUNA RECOVERED FROM REFLOODED MARSHLAND

JULY 1971 - APRIL 1973

AMPHIBIAN	AMBYSTOMIDAE	AMBYSTOMA	SP.
AMPHIBIAN	RANIDAE	RANA	PIPIENS
AMPHIBIAN	SALAMANDRIDAE	DIEMICTYLUS	SP.
AMPHIBIAN	SIRENIDAE	PSEUDOBRANCHUS	STRIATUS BELLI
AMPHIBIAN	SIRENIDAE	PSEUDOBRANCHUS	SP
AMPHIBIAN	TADPOLE	UNIDENTIFIABLE	TADPOLE
PISCES	APHREDODERIDAE	APHREDODERUS	SAYANUS
PISCES	CENTRARCHIDAE	ELASSOMA	EVERGLADEI
PISCES	CENTRARCHIDAE	ENNEACANTHUS	GLORIOSUS
PISCES	CENTRARCHIDAE	LEPOMIS	GULOSUS
PISCES	CENTRARCHIDAE	LEPOMIS	MACROCHIRUS
PISCES	CENTRARCHIDAE	LEPOMIS	MICROLOPHUS
PISCES	CENTRARCHIDAE	LEPOMIS	PUNCTATUS
PISCES	CENTRARCHIDAE	MICROPTERUS	SALMOIDES
PISCES	CYPRINODONTIDAE	FUNDULUS	CHRYSOTUS
PISCES	CYRPINODONTIDAE	JORDANELLA	FLORIDAE
PISCES	CYPRINODONTIDAE	LUCANIA	GOODEI
PISCES	POECILIIDAE	GAMBUSIA	AFFINIS
PISCES	POECILIIDAE	HETERANDRIA	FORMOSA
PISCES	POECILIIDAE	POECILIA	LATIPINNA
PISCES	PERCIDAE	ETHEOSTOMA	FUSIFORME
ANNELIDA	HIRUDINEA		
ANNELIDA	OLIGOCHAETA		
AMPHIPODA	GAMMARIDAE	GAMMARUS FASCIATUS	
AMPHIPODA	HYALELLIDAE	AMPHITOE (HYALELLA) AZTECUS	
CLADOCERA	SIDIDAE		
CONCHOSTRACA	LYNCEIDAE	LYNCEUS MUCRONATUS	
DECAPODA	ASTACIDAE	PROCAMBARUS FALLAX	
DECAPODA	PALAEMONIDAE	PALAEMONETES PALUDOSUS	
GASTROPODA	PHYSIDAE	PHYSA POMILIA	
ISOPODA	ASELLIDAE	ASELLUS MILITARIS	
OSTRACODA	CYPRIDAE	CANDONA SP	
OSTRACODA	CYPRIDAE	CYPRIDOPSIS VIDUE	
COLEOPTERA	CURCULIONIDAE	PHYTONOMUS SP	
COLEOPTERA	DYTISCIDAE	AGABUS PUNCTATUS	
COLEOPTERA	DYTISCIDAE	BIDESSUS SP	
COLEOPTERA	DYTISCIDAE	CELINA ANGUSTATA	
COLEOPTERA	DYTISCIDAE	CELINA GROSSULA	
COLEOPTERA	DYTISCIDAE	CELINA SLOSSONI	
COLEOPTERA	DYTISCIDAE	COPELATUS CAELATIPENNIS	
COLEOPTERA	DYTISCIDAE	COPELATUS CHEVROLATI	
COLEOPTERA	DYTISCIDAE	COPTOTOMUS SP	
COLEOPTERA	DYTISCIDAE	DERONECTES SP	
COLEOPTERA	DYTISCIDAE	DYTISCUS SP	

COLEOPTERA	DYTISCIDAE	GRAPHODERUS SP
COLEOPTERA	DYTISCIDAE	HYDATICUS SP
COLEOPTERA	DYTISCIDAE	HYDROPORUS AULICUS
COLEOPTERA	DYTISCIDAE	HYDROPORUS SP
COLEOPTERA	DYTISCIDAE	HYDROVATUS COMPRESSUS
COLEOPTERA	DYTISCIDAE	HYDROVATUS PENINSULARIS
COLEOPTERA	DYTISCIDAE	HYDROVATUS SP
COLEOPTERA	DYTISCIDAE	LACCOPHILUS GENTILIS
COLEOPTERA	DYTISCIDAE	LACCOPHILUS SP
COLEOPTERA	DYTISCIDAE	RANTUS CALIDUS
COLEOPTERA	DYTISCIDAE	CYBISTER SP
COLEOPTERA	GYRINIDAE	GYRINUS ELEVATUS
COLEOPTERA	HALIPLIDAE	BRYCHIUS SP
COLEOPTERA	HALIPLIDAE	HALIPLUS PUNCTATUS
COLEOPTERA	HALIPLIDAE	PELTODYTES SP
COLEOPTERA	HYDROPHILIDAE	BEROSUS EXIGUUS
COLEOPTERA	HYDROPHILIDAE	BEROSUS STRIATUS
COLEOPTERA	HYDROPHILIDAE	BEROSUS SP
COLEOPTERA	HYDROPHILIDAE	CRENITULUS SUTURALIS
COLEOPTERA	HYDROPHILIDAE	ENOCHRUS CINCTUS
COLEOPTERA	HYDROPHILIDAE	HELOCHARES MACULICOLLIS
COLEOPTERA	HYDROPHILIDAE	HYDROPHILUS TRIANGULARIS
COLEOPTERA	HYDROPHILIDAE	NEOHYDROPHILUS CASTUS
COLEOPTERA	HYDROPHILIDAE	TROPISTERNUS LATERALIS NIMBATUS
COLEOPTERA	HYDROPHILIDAE	TROPISTERNUS SP
COLEOPTERA	NOTERIDAE	COLPIUS INFLATUS
COLEOPTERA	NOTERIDAE	HYDROCANTHUS OBLONGUS
COLEOPTERA	NOTERIDAE	HYDROCANTHUS REGIUS
COLEOPTERA	NOTERIDAE	SUPHISELLUS FLORIDANUS
COLEOPTERA	NOTERIDAE	SUPHISELLUS PUNCTICOLLIS
COLLEMBOLA	ISOTOMIDAE	ISOTOMURUS PALUSTRIS
DIPTERA	CERATOPOGONIDAE	BEZZIA SP
DIPTERA	CERATOPOGONIDAE	CULICOIDES SP
DIPTERA	CHIRONOMIDAE	CHIRONOMUS SP
DIPTERA	CHIRONOMIDAE	CRYPTOCHIRONOMUS PECTINATELLAE
DIPTERA	CHIRONOMIDAE	CRYPTOCHIRONOMUS SP
DIPTERA	CHIRONOMIDAE	EINFELDIA SP
DIPTERA	CHIRONOMIDAE	CHIRONOMUS MODESTUS
DIPTERA	CHIRONOMIDAE	GOELDICHIRONOMUS HOLOPRASINUS
DIPTERA	CHIRONOMIDAE	PENTANEURINI SP
DIPTERA	CHIRONOMIDAE	TANYTARSUS SP
DIPTERA	CULICIDAE	ANOPHELES QUADRIMACULATUS
DIPTERA	CULICIDAE	CHAOBORUS PUNCTIPENNIS
DIPTERA	CULICIDAE	MANSONIA PERTURBANS
DIPTERA	CULICIDAE	URANOTAENIA SP
DIPTERA	STRATIOMYIIDAE	ODONTOMYIA SP
DIPTERA	TABANIDAE	CHRYSOPS SP
DIPTERA	TABANIDAE	TABANUS SP
DIPTERA	TETANOCERIDAE	SEPEDON SP
DIPTERA	TIPULIDAE	HEXATOMA SP
DIPTERA	TIPULIDAE	LIMONIA SP

EPHEMEROPTERA	BAETIDAE	CALLIBAETIS FLORIDANUS
EPHEMEROPTERA	CAENIDAE	CAENIS DIMINUTA
HEMIPTERA	BELOSTOMATIDAE	BELOSTOMA SP
HEMIPTERA	CORIXIDAE	GRAPTOCORIXA SP
HEMIPTERA	CORIXIDAE	TRICHOCORIXA SP
HEMIPTERA	GERRIDAE	GERRIS SP
HEMIPTERA	NAUCORIDAE	CRYPHOCRICOS SP
HEMIPTERA	NAUCORIDAE	PELOCORIS FEMORATUS
HEMIPTERA	NAUCORIDAE	PELOCORIS SP
HEMIPTERA	NOTONECTIDAE	NOTONECTA SP
LEPIDOPTERA	PYRALIDIDAE	NYMPHULA SP
ODONATA	AESCHNIDAE	ANAX JUNIUS
ODONATA	AESCHNIDAE	ANAX LONGIPES LONGIPES
ODONATA	CORDULIIDAE	SOMATOCHLORA FILOSA
ODONATA	LIBELLULIDAE	ERYTHRODIPLAX UMBRATA
ODONATA	LIBELLULIDAE	LEPTHEMIS (ERYTHEMIS) SIMPLICICOLLIS
ODONATA	LIBELLULIDAE	LIBELLULA SP
ODONATA	LIBELLULIDAE	PACHYDIPLAX LONGIPENNIS
ODONATA	LIBELLULIDAE	PANTALA HYMENEA
ODONATA	COENAGRIONIDAE	ISCHNURA POSITA
ODONATA	LESTIDAE	LESTES VIGILAX
TRICOPTERA	HYDROPTILIDAE	OXYETHIRA SP
TRICOPTERA	PHILOPOTAMIDAE	WORMALDIA SP
TRICOPTERA	PSYCHOMYIIDAE	PSYCHOMYIA SP

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