Environmental Study of Proposed Diversion Sites G-10 and G-14 on the Guadalupe River

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by

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1.0 EXECUTIVE SUMMARY

Studies in the West Central area of the Trans-Texas Program have considered possible alternatives for making more water available for San Antonio through diversions from the Guadalupe River near Gonzales (G-10) and at Lake Dunlap (G-14). The diversions and their implications are discussed in the West Central Study Area Phase I Interim Report (HDR, 1994). The objective of this study was to determine the possible effects of diversion of water from the two sites using Rapid Bioassessment Protocols (RBA) II and V (Plafkin et al, 1989) and develop information on fish community habitat relationships that will be utilized in the Texas Water Development Board's (TWDB) Microhabitat Assessment Technique (MAT) for flow assessment. Identification of fish species present in different habitats was conducted. Macroinvertebrates were identified to the level required for the RBA II protocol. Water analyses were conducted at each site during each sampling event. The findings of these studies are presented in the report.

2.0 INTRODUCTION

2.1 Study Area

The study area consisted of the Guadalupe River in Central Texas from Lake Dunlap (below the City of New Braunfels) to just below the City of Cuero. The study sites were selected to have the upper three for use in describing the environmental conditions associated with the G-14 diversion site and the lower three were for describing the environmental conditions associated with the G-10 diversion site. Figure 1 describes the general study area. The area near Lake Dunlap to east of Seguin is in the Blackland Prairie. Through the study area the river lies in a broad, flat valley and is characterized by meanders. In the Blackland Prairie area there are three hydropower dams that have converted the river into a series of long riverine reservoirs. These are Lakes Dunlap, McQueeny, and Placid built in 1929 and 1930. They are narrow, moderately deep, usually murky, and have heavy bottom deposits of mud. East of Sequin the river enters the sandy Post Oak Belt near its westernmost boundary. The stream appearance changes little. The valley remains broad, the water murky, and the pools long and separated by short, graveled riffles. Lake Gonzales (H-4) and Lake Wood (H-5) have converted much of the river into standing water. These lakes are similar to the three described for the area above. Near Gonzales the Guadalupe receives the San Marcos River, which increases the flow. Near Cuero the river traverses the Oak Savanna vegetative region and the river has heavily forested riparian areas. In the upper part of the study area in the Blackland prairie area primary land use in the watershed is farming dominated by corn, sorghum, and cotton production. From Gonzales down the primary use is rangeland for cattle production with many improved pastures containing Coastal Bermuda grass which may also be baled for hay production. In many areas cattle use the stream for watering.

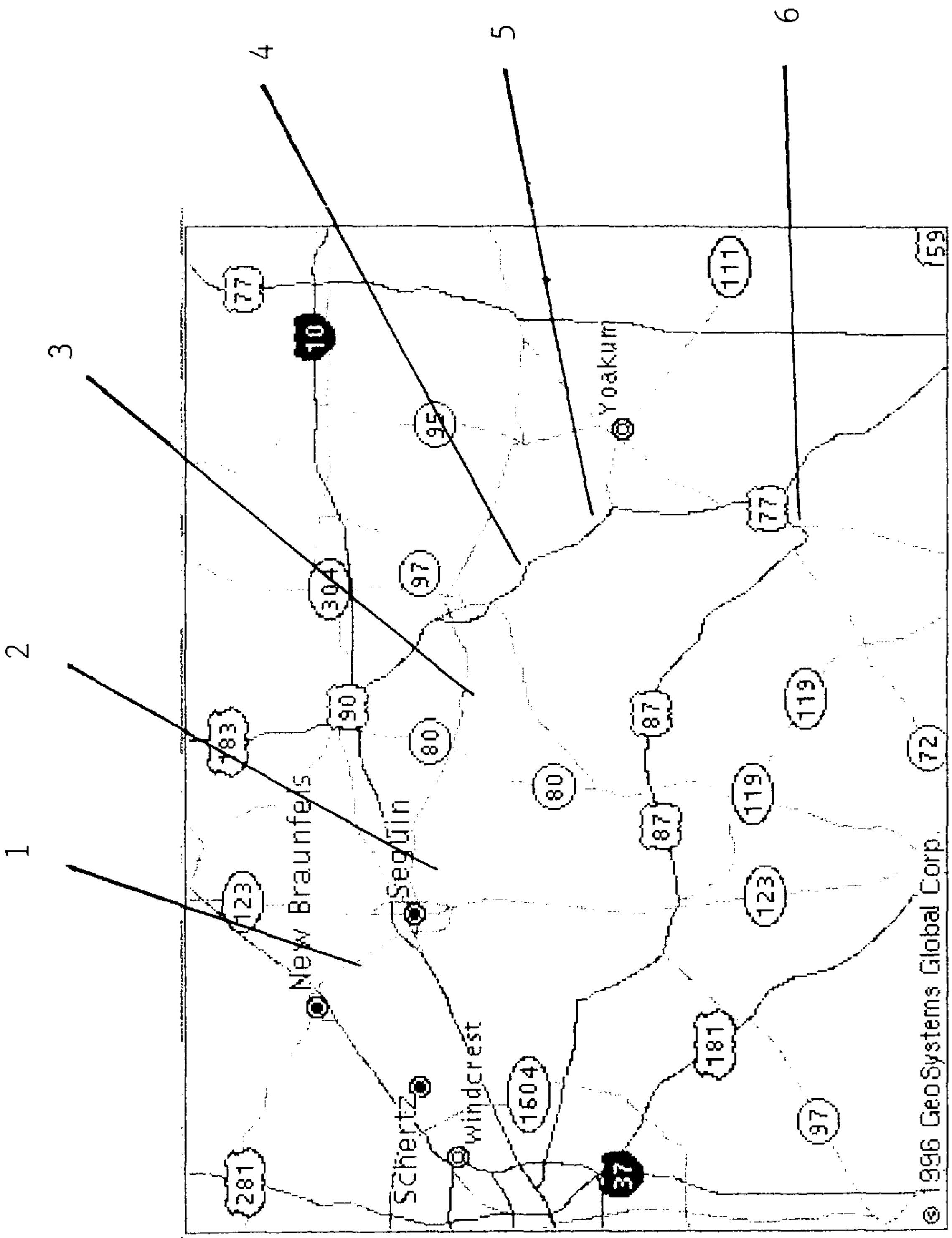

Figure 1. General study area.

2.2 Water Quality

The methods utilized to determine the existing water quality were chemical and biological. The chemical methods indicate that the stream meets the standards set by the TNRCC. The biological methods indicate that the stream at all sites non impaired to moderately impaired. A comparison of the results of this study with the TNRCC Stream standards are shown in Appendix 1.

2.3 Protected Species

The fish surveys conducted indicated that the Guadalupe Bass occurred in the area (Sites 1 and 3). Texas Parks and Wildlife Department (TPWD) has indicated the possible presence of the Blue Sucker in the area (Bauer and Spain 1991), but none were found during this study. Cagle's Map turtle a federally listed in category II is found in the study area (Killebrew 1991). No effort was made in this study to collect species other than fish and macroinvertebrates.

2.4 Climate

The study area is humid subtropical with hot summers. Rainfall averages 33 inches annually and is heaviest in May and September (Mathews and Tallent 1996). The prevailing winds are southeasterly, often pushing warm, moist air from the Gulf of Mexico during spring, summer and fall. This leads to very sporadic rainfall often from thunderstorms during these months. In the winter some Polar air gets into the area and is often stopped by warmer air off the Gulf. This results in mild winters for most of the time. Rainfall during the winter is usually distributed along frontal boundaries giving a more uniform coverage of rain than the thunderstorms that predominate during the rest of the year (Mathews and Tallent 1996).

2.5 Geology

In the upper part of the study area the surface deposits are from the Eocene. The surface deposits become progressively younger as you go down stream. In the Cuero area the surface deposits are from the Pliocene (Arbingast et al, 1976). The Guadalupe and its tributaries have cut into these deposits and have redeposited alluvium along the floodplain. This has resulted in various deposits of clay, silt, sand and gravel often carried from far upstream.

3.0 SITE SELECTION

3.1 Basic Strategy

An important step in environmental assessment of the aquatic communities is the selection of the study sites. An important consideration in the site selection was the requirement for riffle areas if possible for use in the RBA II and V protocols. Additionally staff of the TWDB wanted sites that had representative habitat and hydrological conditions which would allow them to obtain information that would be useful in their MAT protocol. Initially Natural Resource Conservation Service (NRCS) employees were contacted in the various counties within the study area. They assisted in finding cooperative landowners that would make sites available to study. They were also generally familiar with where riffles occurred along the river from their work with farmers and ranchers. TWDB staff participated in the selection of sites. Once sites were chosen the actual sampling began. Photos were made of the sites during the summer (Appendix 3).

3.2 Soil Associations

In the upper area of the study where Blackland Prairie was the general soil type, next to the river dark gray to reddish brown calcareous clay loams and clays were prevalent. The soils along the river changed to light brown to dark gray sandy loams, clay loams and some clays where sandy soils were dominant away from the river (Arbingast et al 1976).

3.3 Ecological Considerations

The G-14 area included three sampling sites. Site 1 was located below Lake Dunlap and above Lake McQueeny (Fig. 2). Site 2 was located just above the Sequin Wastewater Treatment Plant discharge and was accessed through the Gary Rainwater farm (Fig. 3). Site 3 was located near a bridge over the Guadalupe near the small community of Oak Forest below Sequin (Fig. 4). The G-10 area included three sampling sites. Site 4 was located below Gonzales and was accessed through the King Ranch (Fig. 5). Site 5 was located near the Steen community and was accessed through the Joel Steen farm (Fig. 6). Site 6 was located where Hwy 72 crosses the Guadalupe and the USGS Station 08175800 is located (Fig. 7).

3.4 Hydrological and Geomorphic Criteria

The intent of the study was to sample during the warm season (May - October) and the cool season (November - April) at three different flow regimes: 50%, 30% and 20% below median annual flow, provided the flows were available during the allotted time for the study. It was finally decided that the Cuero gage (#08175800) would be used to determine times for sampling at all sites. When it became obvious that all required flows would not occur during the study period it was decided by TWDB staff that if a needed flow did not occur during a particular month, sampling was to be done during the first week of the next month in any case. The TWDB staff monitored the sites at different flows to determine if channel morphometry, hydraulics, and habitat conditions occurred at each study site.

3.5 Field Reconnaissance

As indicated under 3.1, local NRCS staff were utilized to help locate suitable sites for study. Participating in this phase were Dr. Glenn Longley, Director of the Edwards Aquifer Research & Data Center (EARDC) at Southwest Texas State University, two graduate students Grant Phillips and John Senter. Participating TWDB staff included Raymond Mathews Jr., fisheries biologist/ecologist (Contract Manager), Greg Malstaff, geomorphologist; and James Tallent, civil engineer and hydrologist. The ecologists offered ideas for sites based on suitable habitat for USEPA - RBA protocols II and V. The hydrologist and geomorphologist looked at the sites to determine their suitability for hydrological modeling. The interdisciplinary approach assures that all aspects of the study were considered during this phase.

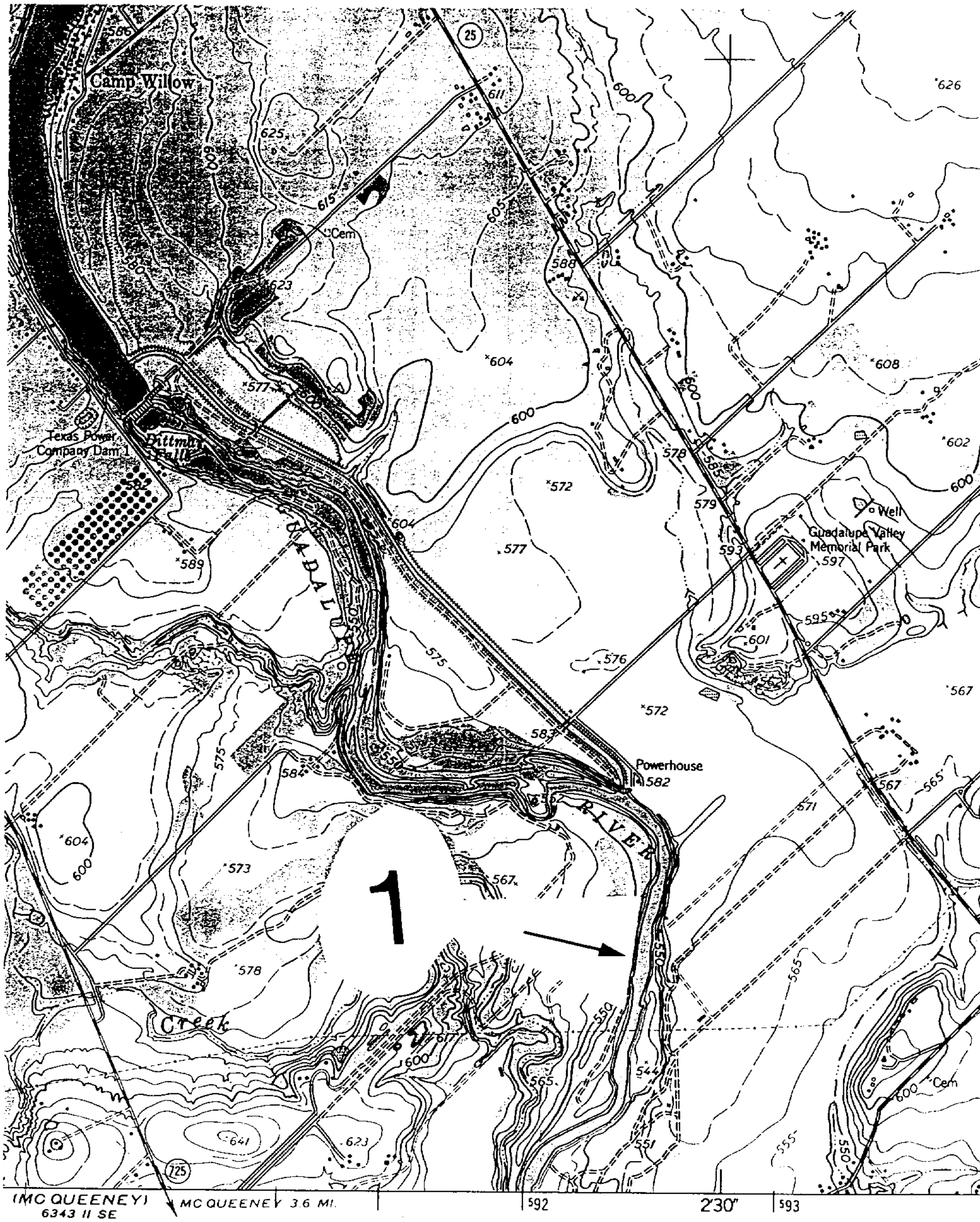

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Figure 2. Site 1.

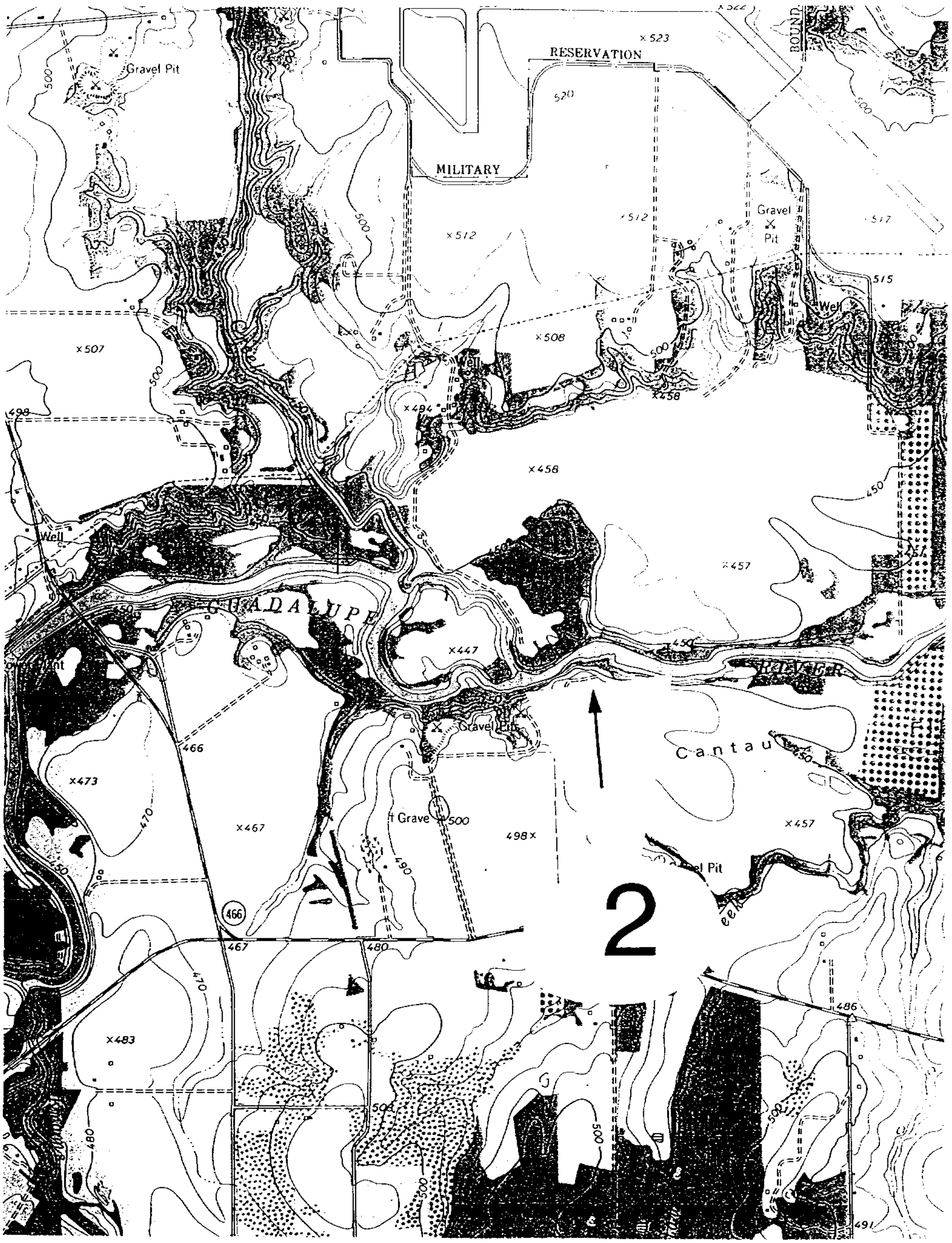


Figure 3. Site 2.

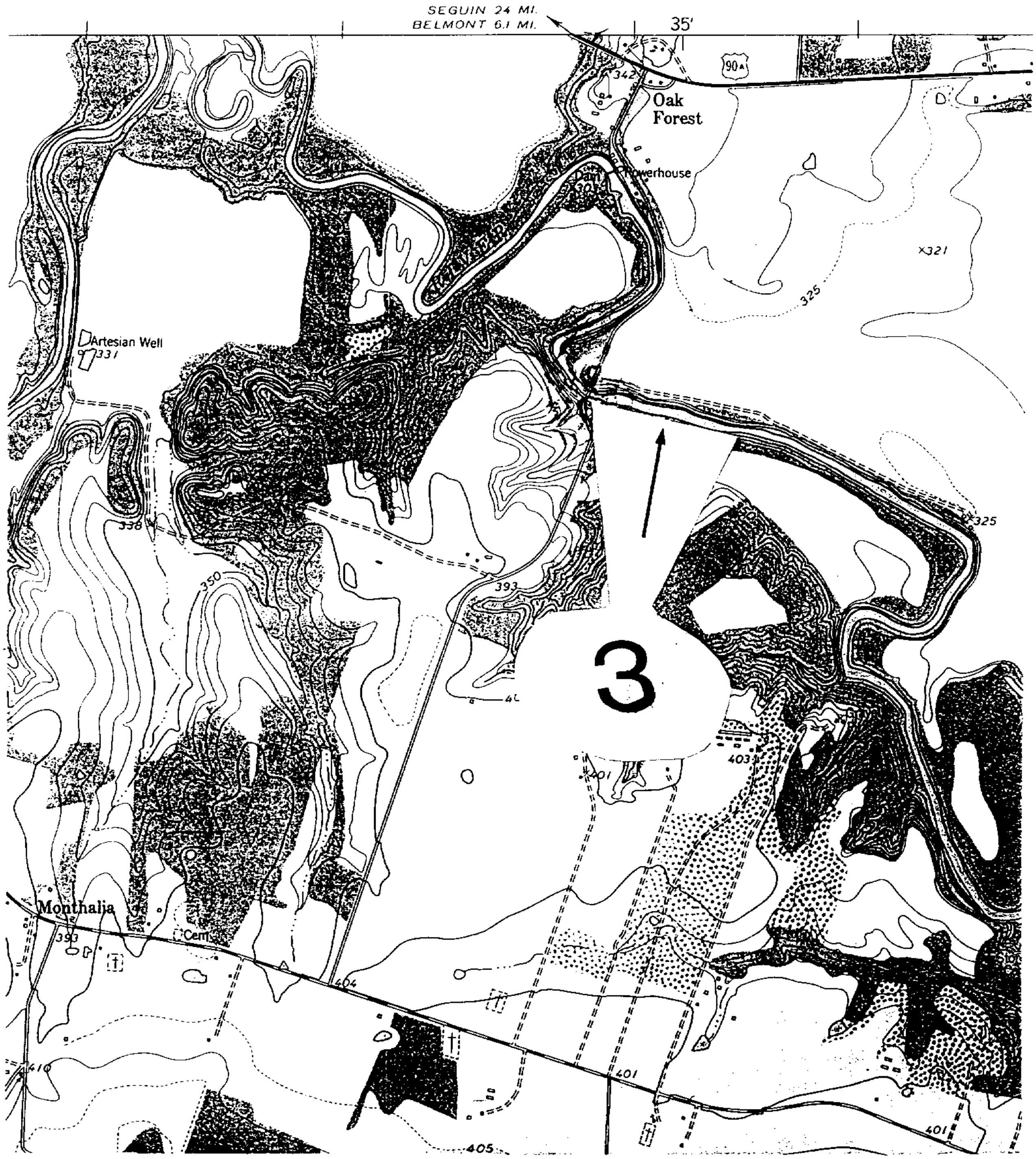


Figure 4. Site 3.

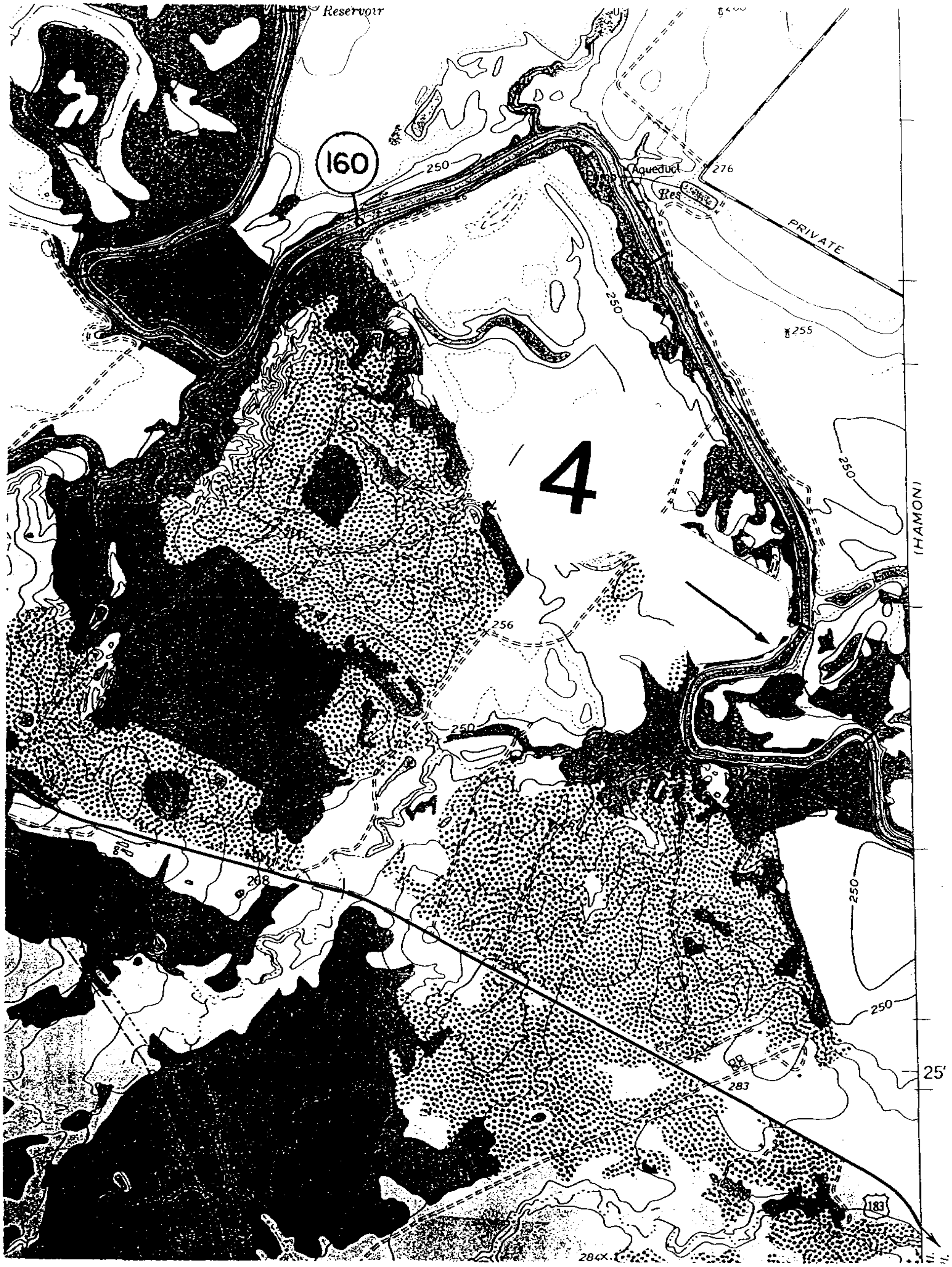


Figure 5. Site 4.

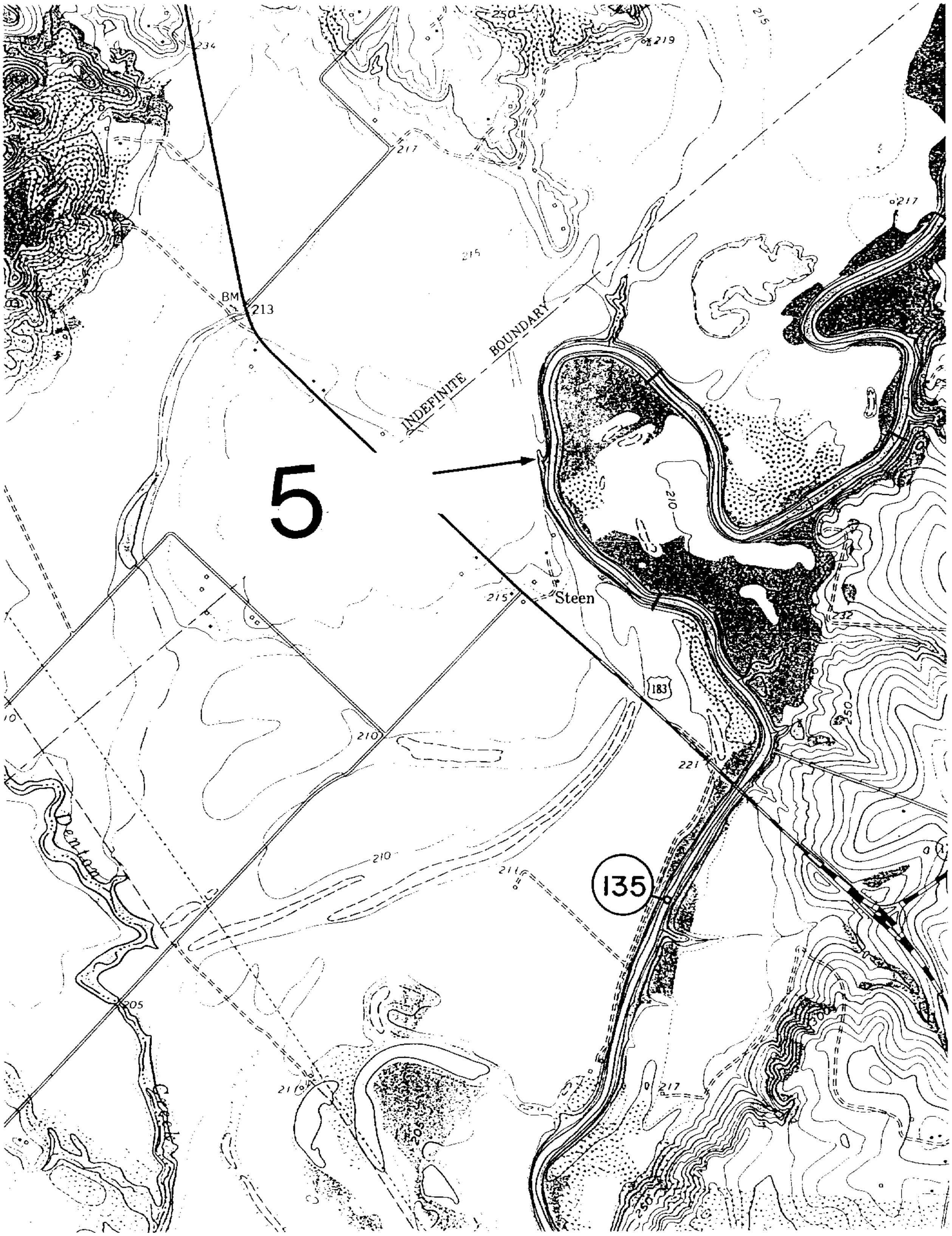


Figure 6. Site 5.

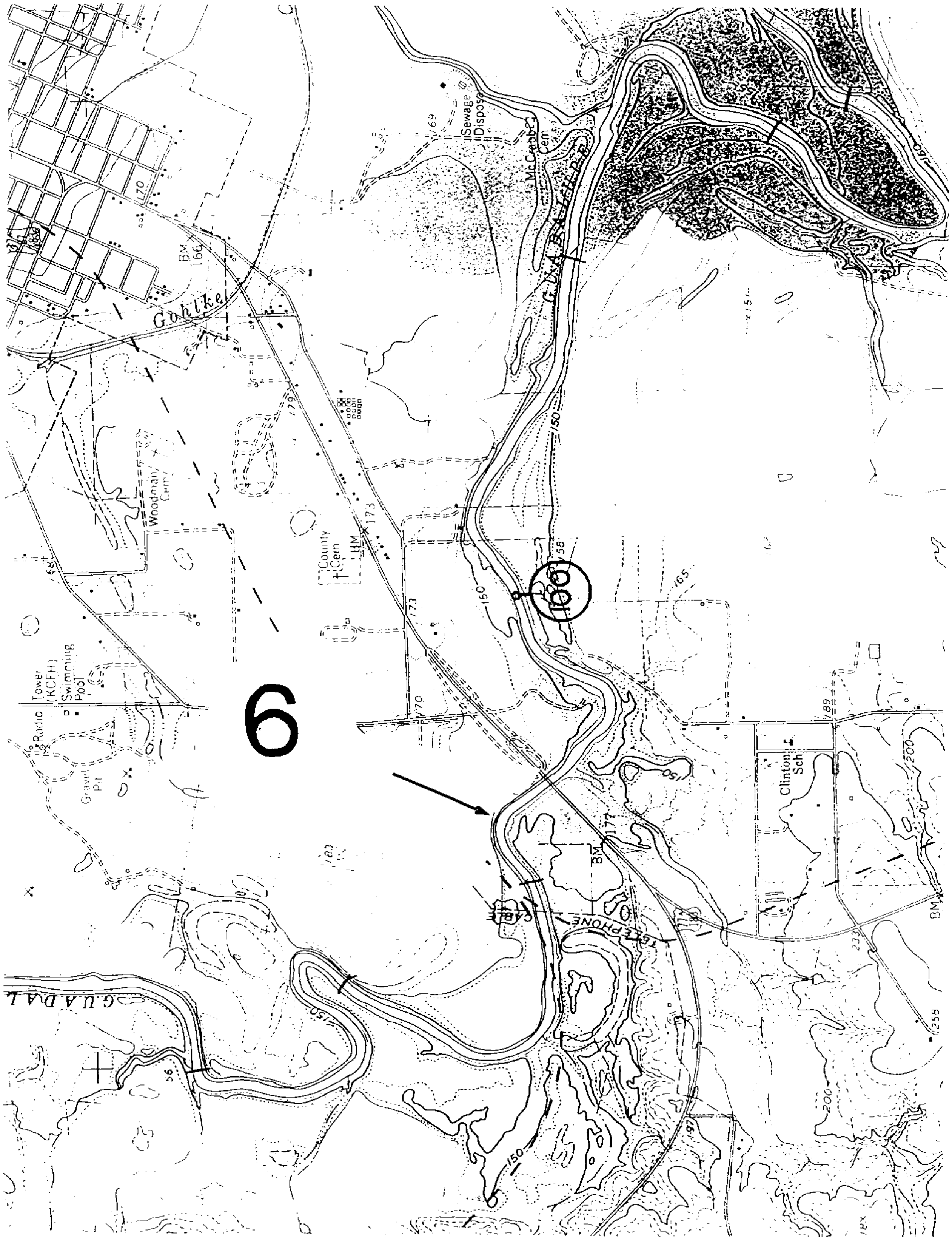


Figure 7. Site 6.

4.0 DATA COLLECTION

4.1 Bathymetric

This work is to be done by the TWDB.

4.2 Hydrological

Additional work is to be done primarily by the TWDB staff. The stream flow Information from the USGS gage at Cuero was used to select sampling times for all sites. Stream flow for the study period is shown in Figure 8. It should be noted that this graph illustrates instantaneous daily flows and is not entirely representative of stream conditions due to scale. The gage was so far removed from the upper stations that it was not useful for determining sample times. It was noted during the study that flows at all sites varied considerably during each day. It was discovered, by talking with Guadalupe Blanco River Authority staff, that these daily wide fluctuations in flow were the result of filling reservoirs of the hydroelectric dams upstream and then releasing flows at levels that allowed for more efficient generation of electricity. It is likely that these daily fluctuations have far more effect on the stream communities than any other factor. The reason is that during low flows considerable amounts of the habitat are dewatered.

4.3 Habitat assessment

US Environmental Protection Agency (EPA), Texas Natural Resource Conservation Commission (TNRCC) and TPWD have been using RBA Protocols II and V all across the state for developing criteria for setting stream classifications (Bayer et al, 1992). TWDB staff have developed their own system, known as MAT, for describing instream flow needs (Mathews and Bao 1991). Other techniques have been used for similar purposes, especially prominent is the Instream Flow Incremental Methodology (IFIM) that has been use extensively below dams (Stalnaker, Lamb, Henriksen, Bovee and Bartholow, 1995). This study utilizes the combination of RBA protocols and MAT.

4.31 Diversion Site Descriptions and flows sampled

The two proposed diversion sites are shown in Figure 9. The flows sampled for each of the study sites is given in Table 1. The individual study sites are described in Figures 10-15.

4.32 Habitat Mapping and Photodocumentation

Limited data was collected by the biologists. Figures 2-7 show the study sites. The photos of the different habitats at each site are found in the Appendices.

4.33 Microhydraulic Effect of Habitat

This work is to be completed by TWDB staff.

4.34 Instream Habitat Classification

Habitat is basically a locality, site or particular type of environment on a microscale that is occupied by an organism or population of organisms.

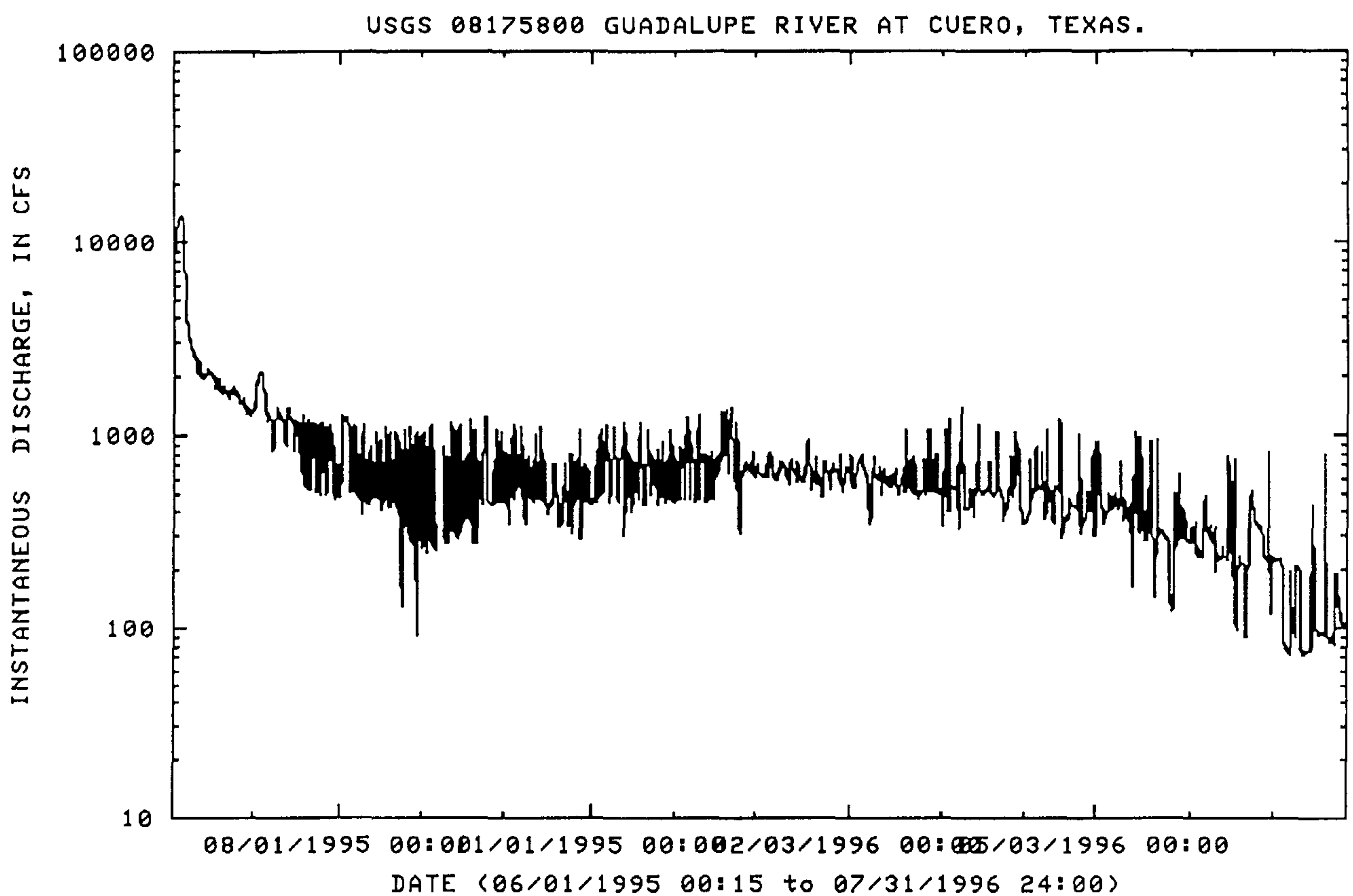


Figure 8. Instantaneous daily flows at USGS Cuero gage during the study period.

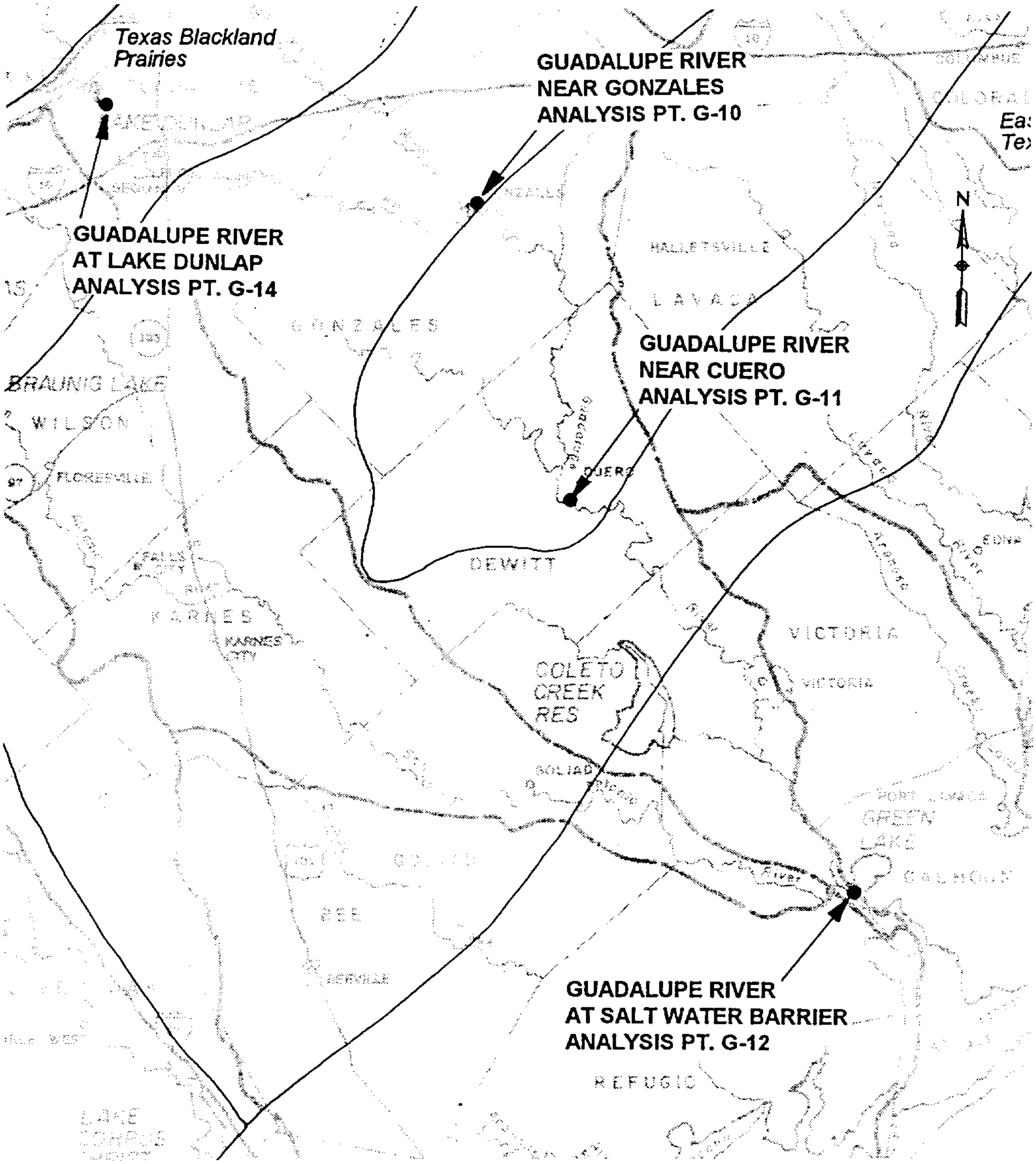
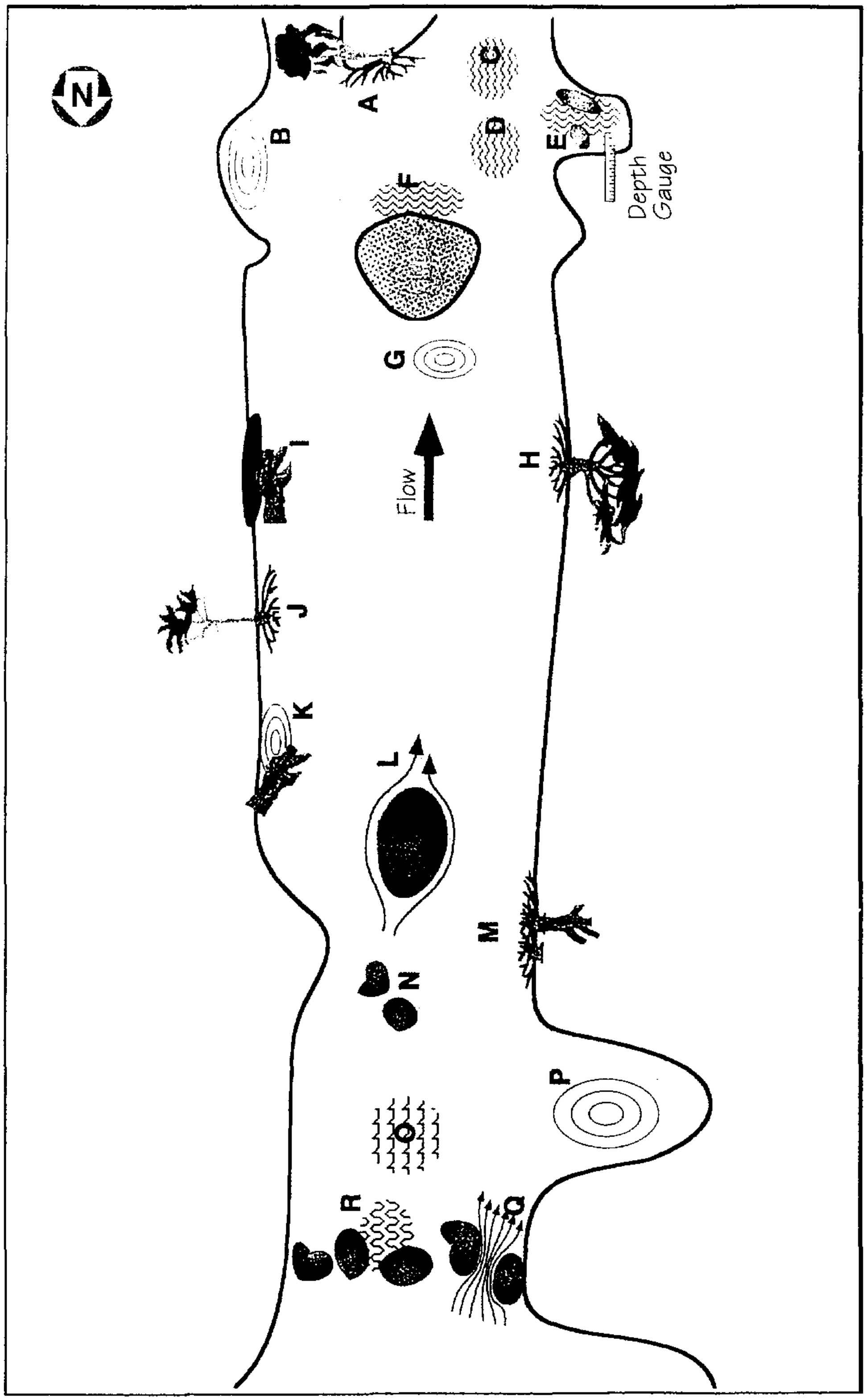


Figure 9. Locations of G-10 and G-14 proposed diversion sites.

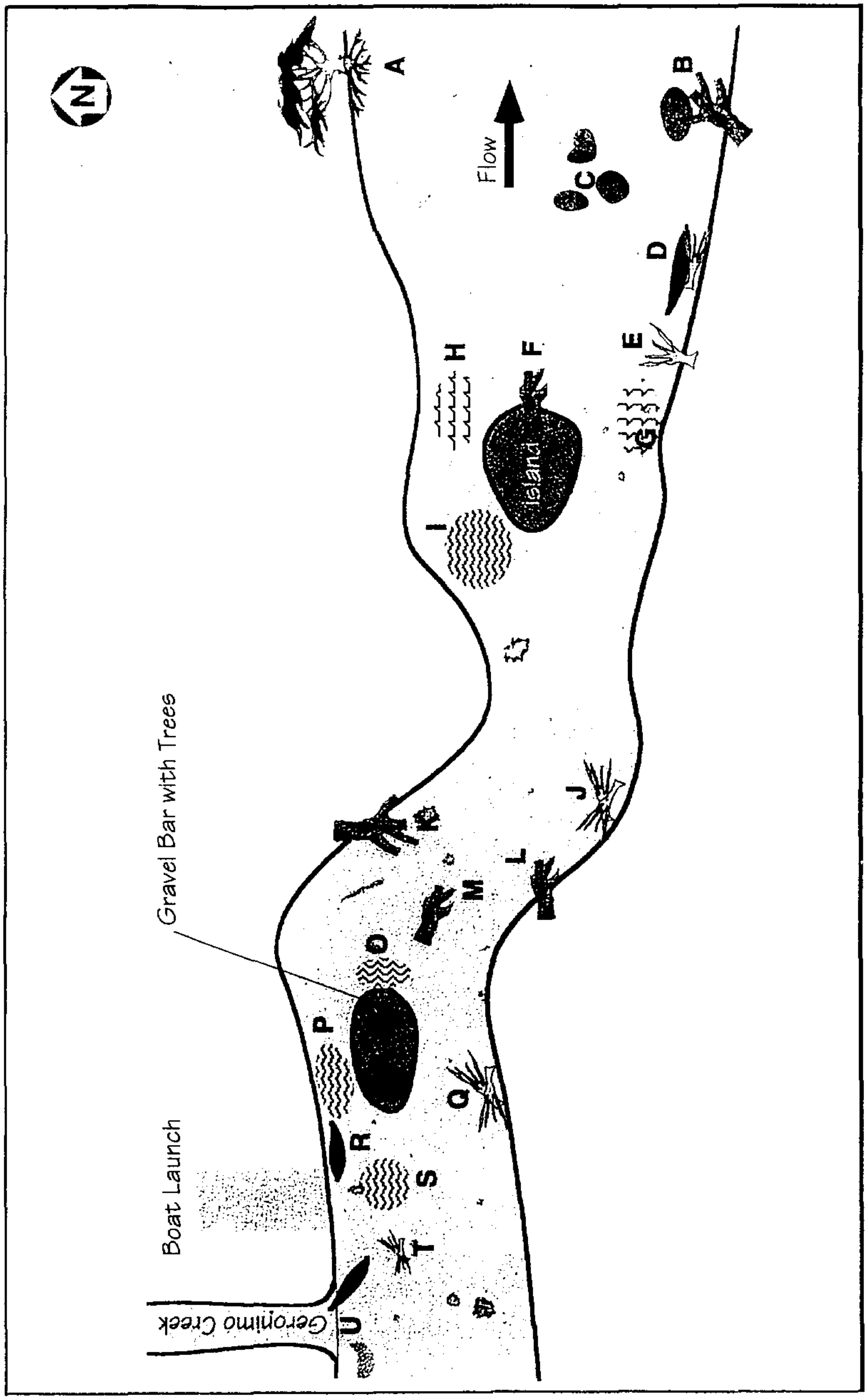
Table 1. Flows at USGS Cuero gage during sample times.

Collection Periods	Season	Q (cfs in 2nd hr) at Cuero	Flow Characteristic
Site 1			
DATE			
8/28/95	Hot	248	<Low
12/20/95	Cold	924-791	Med
2/7/96	Cold	672	Med
5/7/96	Hot	429	Low
6/14/96	Hot	279	<Low
7/2/96	Hot	231	<Low
Site 2			
DATE			
8/30/95	Hot	332	Low
12/29/95	Cold	819	Med
4/3/96	Cold	753	Med
5/13/96	Hot	372	Low
6/10/96	Hot	463	Low
7/5/96	Hot	231	<Low
Site 3			
DATE			
10/5/95	Hot	744	Med
1/3/96	Cold	781	Med
4/6/96	Cold	356	<Low
5/13/96	Hot	386	Low
6/13/96	Hot	282	<Low
7/4/96	Hot	119	<Low
Site 4			
DATE			
9/4/95	Hot	267	<Low
1/4/95	Cold	712	Med
4/3/95	Cold	786	Med
5/8/96	Hot	482	Low
6/11/96	Hot	325	<Low
7/5/96	Hot	229	<Low
Site 5			
DATE			
10/3/95	Hot	924	High
1/2/96	Cold	672	Med
4/2/96	Cold	1025	High
5/10/96	Hot	444	Low
6/12/96	Hot	342	<Low
7/3/96	Hot	229	<Low
Site 6			
DATE			
9/28/95	Hot	460	Low
1/4/96	Cold	730	Med
4/2/96	Cold	776-981	Med
5/8/96	Hot	490	Low
6/12/96	Hot	297	<Low
7/3/96	Hot	229	<Low



Sketch Map of Site 1

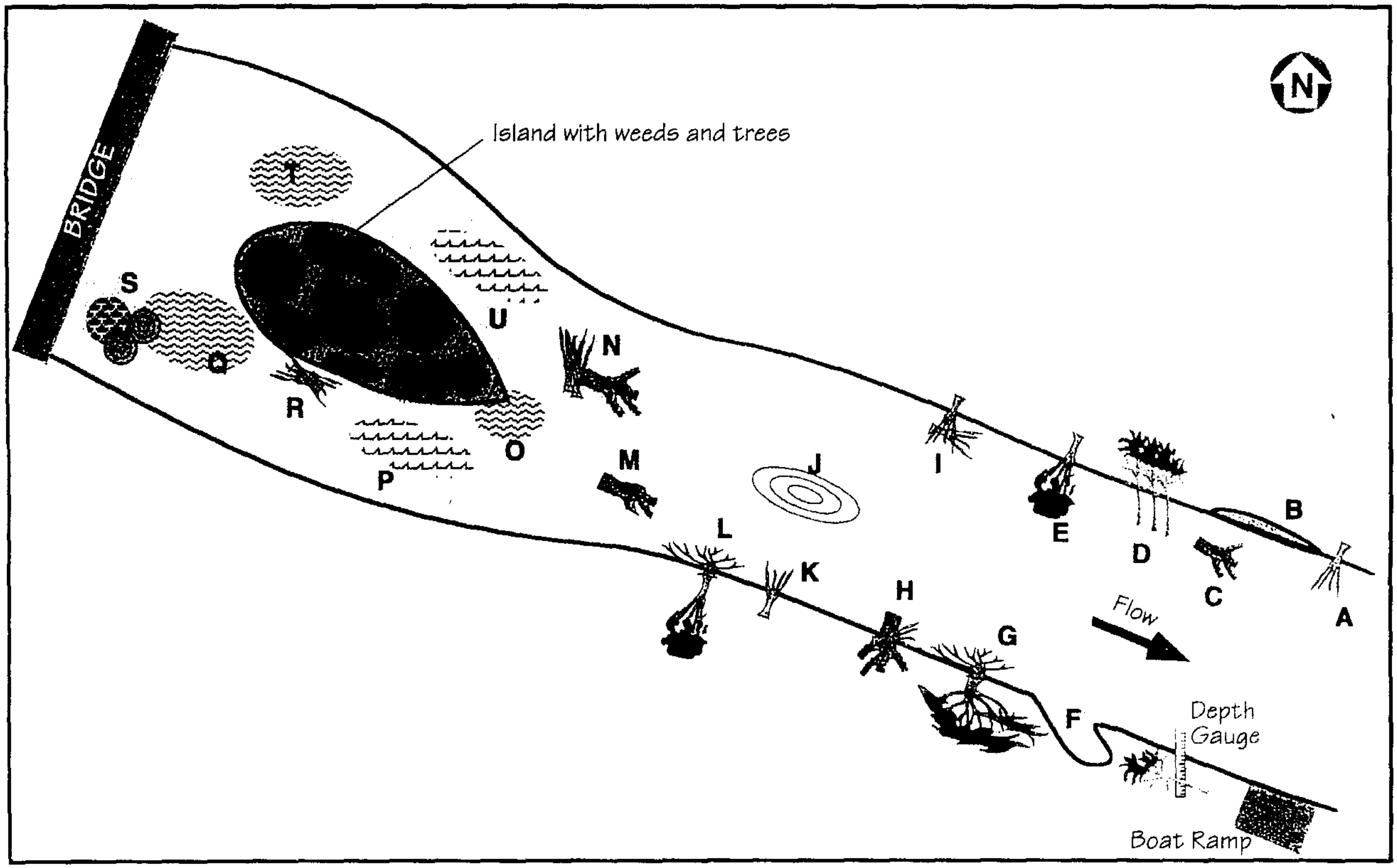
Figure 10.



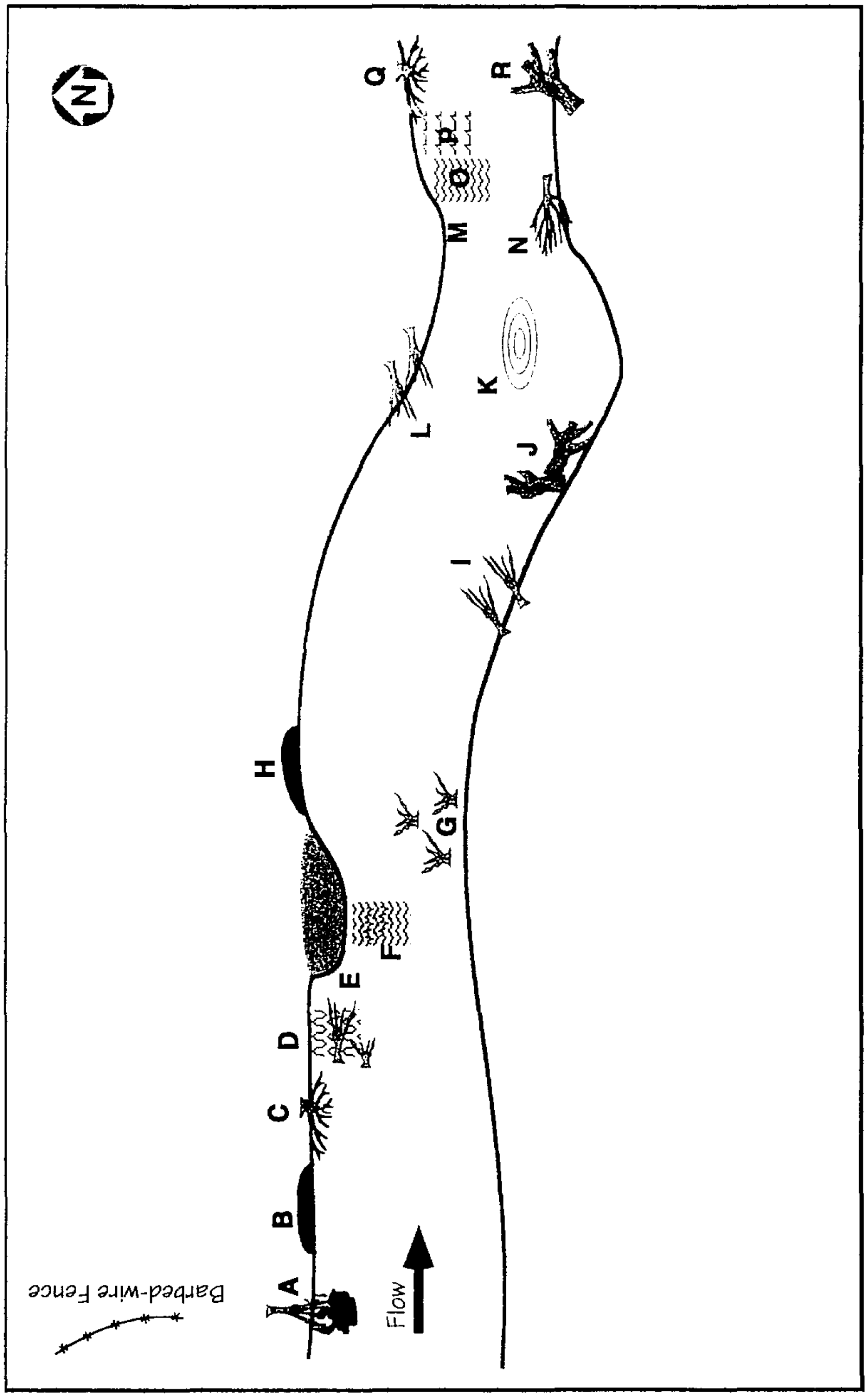
Sketch Map of Site 2

Figure 11.

Figure 12.



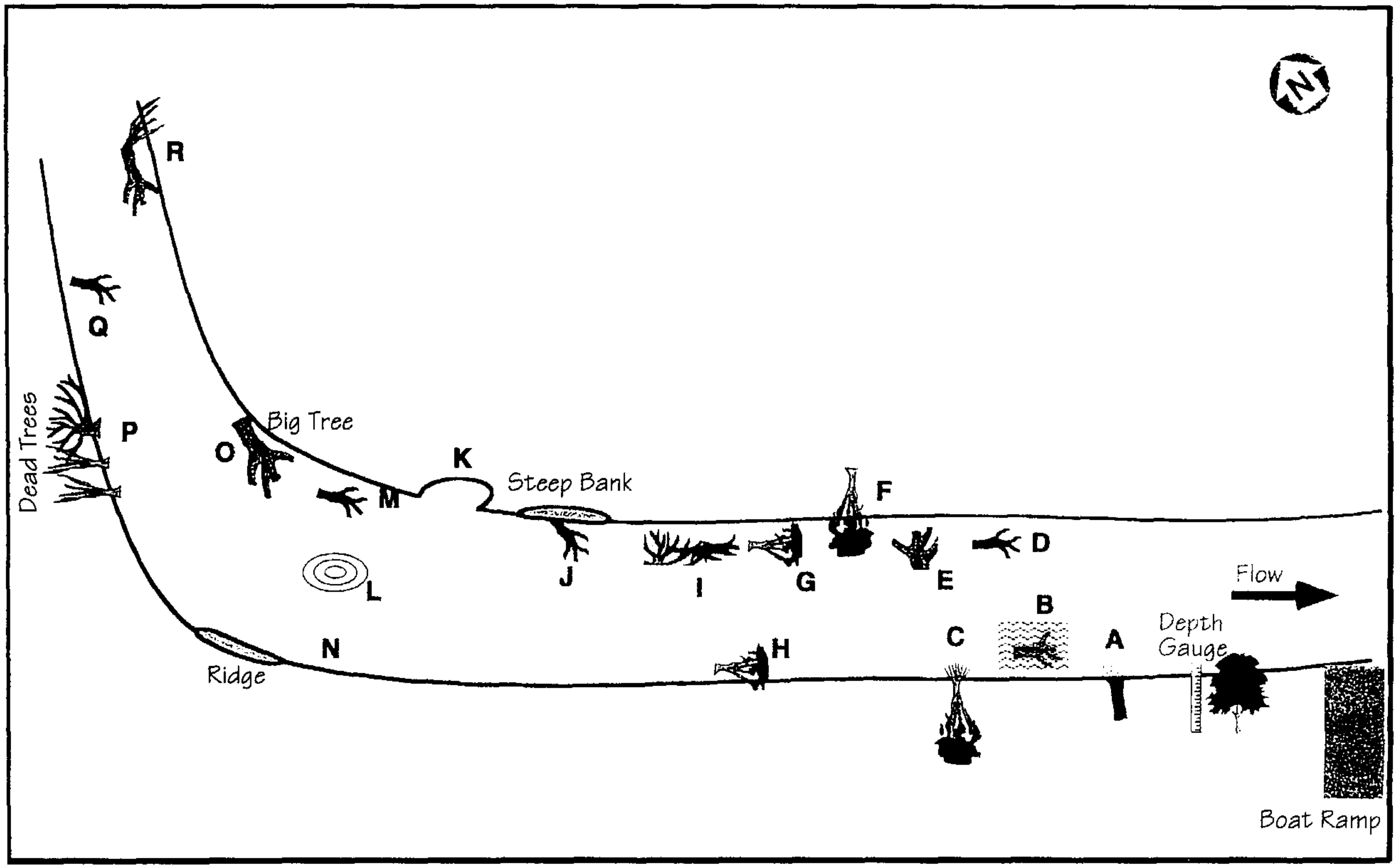
Sketch Map of Site 3



Sketch Map of Site 4

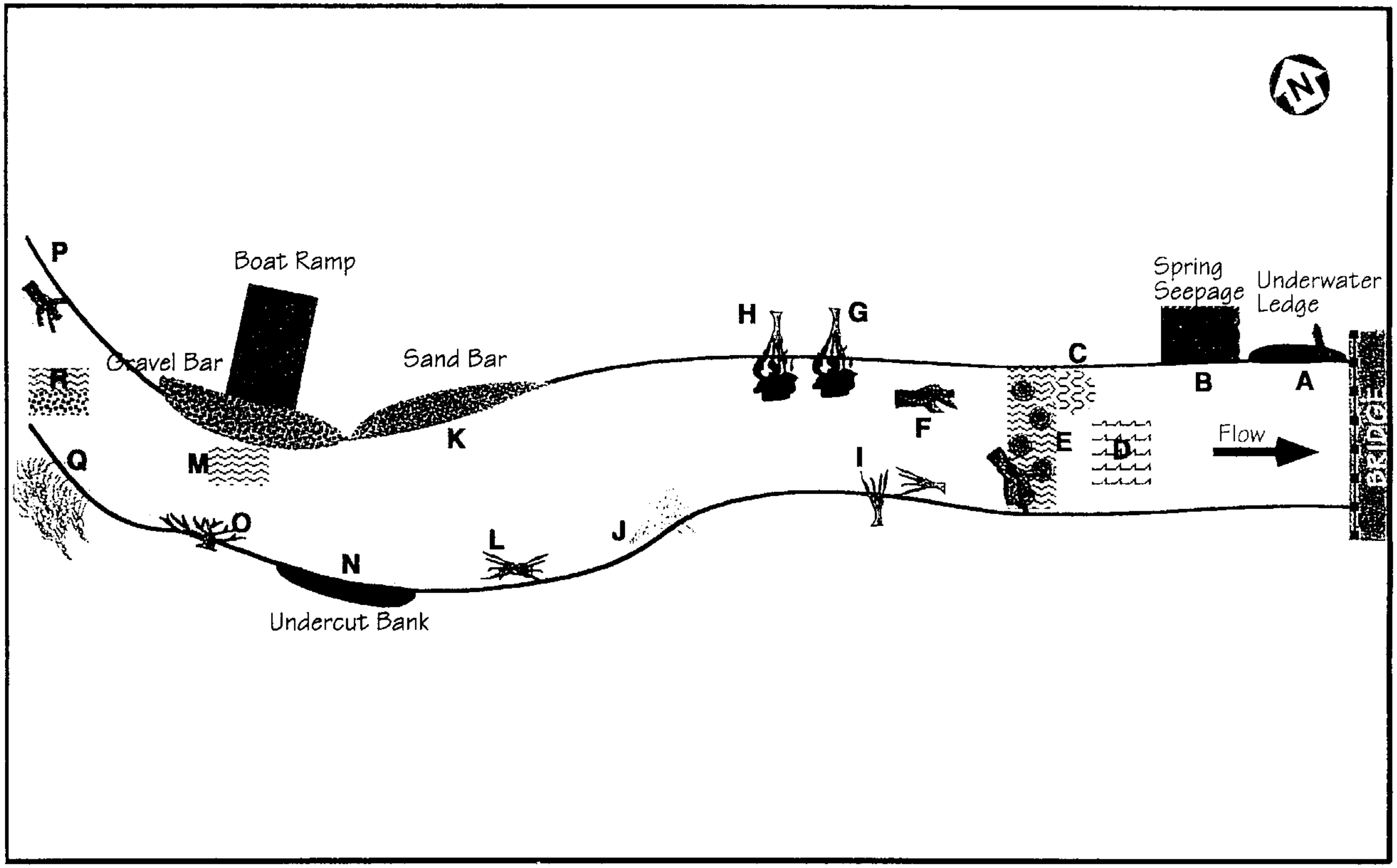
Figure 13.

Figure 14.



Sketch Map of Site 5

Figure 15.



Sketch Map of Site 6

4.4 Biological Assessment

Water development projects such as the ones proposed alter the natural flow of a stream. It is important to know what the impact of the altered flows will be on the biological community. This information is important since it may be necessary to mitigate the effects of the altered flows by various management options.

4.41 Biological Indices

The indices used in this study have been developed by EPA and modified by TPWD for the purpose of categorizing stream segments. Additionally the MAT methodology developed by TWDB has been considered by gathering data in such a way that it will be useful for this technique.

4.42 Biological Sampling Techniques

The recommended techniques given in EPA - Rapid Bioassessment Protocol (RBP)'s II and V [also known as the Index of Biological Integrity (IBI)] were used to collect organisms. In addition, effort was made to collect fish in the different types of habitats found at each of the study sites. The information resulting from this sampling is found in the following locations: RBP II - (Table 2); RBP V - (Table 3) and bubble diagrams of fish located in the different habitats at each collecting site at each sampling date (Appendices 2 - 36). Lists of all fish collected during the study are given in Table 4. Lists of all invertebrates collected during the study are given in Table 5.

4.5 Chemical - Physical - Microbiological Assessment

Stream quality was also assessed utilizing grab samples taken at the same time the macroinvertebrate and fish sampling was done. Efforts were made to obtain the following parameters in the field: temperature, pH, dissolved oxygen, specific conductance. Samples were also obtained for analysis of BOD_5, TOC, nitrate, sulfate, ortho- and total phosphate, turbidity and TSS. In addition samples were taken for fecal coliform and fecal streptococcus. All analyses were done in accordance with EPA standards for testing. The results of the analyses are given in Table 6.

4.6 Biological Assessment of Habitat Utilization and Availability Conditions

The TWDB staff will complete this portion of the study utilizing MAT methods.

5.0 RECOMMENDATIONS AND CONCLUSIONS

A better method for determining when to sample for the different flow rates needs to be developed. To try and utilize gages far removed from sampling sites is not reasonable, particularly when there are reservoirs in between the gage and the site to be sampled. Since the flow in the Guadalupe through the study area is so variable and using one afternoon's flow to predict a sampling time for the next day is not reliable, some reasonable method needs to be arrived at that will yield the information sought by the TWDB.

Table 2. Rapid Bioassessment Protocol II Metrics, Biological Condition Scores and Impairment Assessment

Site 1

DATE	#individual	#Taxa	FBI	SCR/FILT	EPT/CHIR	%CDF	EPT index	CU	Percentage: #individual	#TAXA	FBI	SCR/FILT	EPT/CHIR	EPT index	Condition Scores: #TAXA	FBI	SCR/FILT	EPT/CHIR	%CDF	EPT index	CU	Bio %	Impairment
28-Aug-95	133	15	4.09	0.17	0.95	23.00	7.0	0.27	124%	136%	82%	29%	99%	175%	6	3	3	6	6	6	6	85.7%	Non-impaired
20-Dec-95	126	15	5.34	0.23	0.87	31.00	5.0	0.87	138%	71%	89%	29%	92%	63%	3	6	3	6	3	0	3	61.5%	Moderately impaired
7-Feb-96	136	14	4.76	0.13	1.00	28.00	5.0	0.64	16%	40%	113%	44%	159%	50%	0	6	3	6	6	0	3	57.1%	Moderately impaired
7-May-96	103	10	6.11	0.24	1.00	30.00	3.0	0.90	13%	29%	86%	81%	159%	30%	0	6	6	6	3	0	3	61.5%	Moderately impaired
14-Jun-96	124	11	4.69	0.16	1.00	42.00	4.0	0.38	16%	31%	114%	54%	159%	40%	0	6	6	6	3	0	6	69.2%	Moderately impaired
2-Jul-96	130	13	4.68	0.06	0.98	50.00	5.0	0.38	17%	37%	115%	20%	156%	50%	0	6	0	6	3	0	6	53.8%	Moderately impaired
MINIMUM	103	10	4.09	0.06	0.87	23.00	3.0	0.27	13%	29%	82%	20%	92%	30%	0	3	0	6	3	0	3	53.8%	Moderately impaired
MAXIMUM	136	15	6.11	0.24	1.00	50.00	7.0	0.90	138%	136%	115%	81%	159%	175%	6	6	6	6	6	6	6	85.7%	Non-impaired
AVERAGE	125.3	13.0	4.95	0.17	0.97	34.00	4.8	0.54	54%	57%	100%	43%	137%	68%	2	6	4	6	4	1	5	64.8%	Moderately impaired

Site 2

DATE	#individual	#Taxa	FBI	SCR/FILT	EPT/CHIR	%CDF	EPT index	CU	#individual	#TAXA	FBI	SCR/FILT	EPT/CHIR	EPT index	#TAXA	FBI	SCR/FILT	EPT/CHIR	%CDF	EPT index	CU	Bio %	Impairment
30-Aug-95	8	5	4.88	0.50	1.00	38.00	1.0	1.60	1%	14%	110%	168%	159%	10%	0	6	6	6	3	0	3	61.5%	Moderately impaired
29-Dec-95	204	16	3.85	0.18	0.94	37.00	7.0	0.81	224%	76%	124%	23%	99%	88%	3	6	0	6	3	3	3	61.5%	Moderately impaired
3-Apr-96	179	14	4.20	0.24	0.90	52.00	7.0	0.43	23%	40%	128%	81%	143%	70%	0	6	6	6	0	0	6	66.7%	Moderately impaired
13-May-96	127	12	3.87	0.54	1.00	28.00	5.0	0.58	16%	34%	139%	182%	159%	50%	0	6	6	6	6	0	3	64.3%	Moderately impaired
10-Jun-96	84	13	5.18	0.50	1.00	30.00	4.0	0.23	11%	37%	104%	168%	159%	40%	0	6	6	6	3	0	6	69.2%	Moderately impaired
5-Jul-96	98	14	4.14	0.51	1.00	35.00	4.0	0.29	13%	40%	130%	172%	159%	40%	0	6	6	6	3	0	6	69.2%	Moderately impaired
MINIMUM	8	5	3.85	0.18	0.90	28.00	1.0	0.23	1%	14%	104%	23%	99%	10%	0	6	0	6	0	0	3	61.5%	Moderately impaired
MAXIMUM	204	16	5.18	0.54	1.00	52.00	7.0	1.60	224%	76%	139%	182%	159%	88%	3	6	6	6	6	3	6	69.2%	Moderately impaired
AVERAGE	116.7	12.3	4.35	0.41	0.97	36.67	4.7	0.66	48%	40%	122%	132%	146%	50%	1	6	5	6	3	1	5	65.4%	Moderately impaired

Site 3

DATE	#individual	#Taxa	FBI	SCR/FILT	EPT/CHIR	%CDF	EPT index	CU	#individual	#TAXA	FBI	SCR/FILT	EPT/CHIR	EPT index	#TAXA	FBI	SCR/FILT	EPT/CHIR	%CDF	EPT index	CU	Bio %	Impairment
5-Oct-95	26	6	6.04	1.00	0.00	65.00	0.0	1.67	21%	38%	66%	276%	0%	0%	0	3	6	0	0	0	3	33.3%	Moderately impaired
3-Jan-96	84	14	4.25	1.00	0.98	54.00	7.0	0.71	92%	67%	112%	128%	103%	88%	3	6	6	6	0	3	3	75.0%	Non-impaired
6-Apr-96	56	7	6.64	0.62	0.25	39.00	1.0	1.57	62%	44%	72%	155%	37%	20%	3	3	6	3	3	0	3	53.8%	Moderately impaired
13-May-96	54	8	7.59	0.79	1.00	33.00	2.0	0.88	37%	62%	71%	90%	316%	50%	3	3	6	6	3	0	3	61.5%	Moderately impaired
13-Jun-96	83	9	7.11	0.88	0.00	30.00	0.0	0.22	63%	60%	62%	88%	0%	0%	3	3	6	0	3	0	6	53.8%	Moderately impaired
4-Jul-96	103	10	4.70	0.94	0.91	41.00	2.0	0.30	91%	48%	88%	94%	103%	29%	3	6	6	6	3	0	6	76.9%	Non-impaired
MINIMUM	26	6	4.25	0.62	0.00	30.00	0.0	0.22	21%	38%	62%	68%	0%	0%	0	3	6	0	0	0	3	33.3%	Moderately impaired
MAXIMUM	103	14	7.59	1.00	1.00	65.00	7.0	1.67	92%	67%	112%	276%	316%	88%	3	6	6	6	3	3	6	76.9%	Non-impaired
AVERAGE	67.7	9.0	6.06	0.84	0.52	43.67	2.0	0.89	61%	53%	79%	135%	93%	31%	3	4	6	4	2	1	4	59.1%	Moderately impaired

Site 4 (Used as reference site also)

DATE	#individual	#Taxa	FBI	SCR/FILT	EPT/CHIR	%CDF	EPT index	CU	#individual	#TAXA	FBI	SCR/FILT	EPT/CHIR	EPT index	#TAXA	FBI	SCR/FILT	EPT/CHIR	%CDF	EPT index	CU	Bio %	Impairment
4-Sep-95	107	11	3.36	0.58	0.96	30.00	4.0	na	86%	69%	118%	160%	0%	67%	3	6	6	0	3	0	0	46.2%	Moderately impaired
4-Jan-95	91	21	4.78	0.78	0.95	42.00	8.0	na	100%	100%	100%	100%	100%	100%	6	6	6	6	3	6	0	84.6%	Non-impaired
3-Apr-95	131	15	5.00	0.76	0.65	23.00	6.0	na	144%	94%	96%	190%	95%	120%	6	6	6	6	6	6	0	85.7%	Non-impaired
8-May-96	77	14	5.58	0.72	0.89	25.00	5.0	na	53%	108%	96%	82%	282%	125%	6	6	6	6	6	6	0	85.7%	Non-impaired
11-Jun-96	52	8	4.12	0.93	0.88	44.00	1.0	na	40%	53%	108%	93%	160%	17%	3	6	6	6	3	0	0	61.5%	Moderately impaired
5-Jul-96	103	10	3.65	0.87	0.93	36.00	3.0	na	91%	48%	114%	87%	105%	43%	3	6	6	6	3	0	0	61.5%	Moderately impaired
MINIMUM	52	8	3.36	0.58	0.65	23.00	1.0		40%	48%	96%	82%	0%	17%	3	6	6	0	3	0	0	46.2%	Moderately impaired
MAXIMUM	131	21	5.58	0.93	0.96	44.00	8.0		144%	108%	118%	190%	282%	125%	6	6	6	6	6	6	0	85.7%	Non-impaired
AVERAGE	93.5	13.2	4.41	0.77	0.88	33.33	4.5		86%	79%	105%	119%	124%	79%	4.5	6.0	6.0	5.0	4.0	3.0	0.0	70.9%	Moderately impaired

Site 5

DATE	#individual	#Taxa	FBI	SCR/FILT	EPT/CHIR	%CDF	EPT index	CU	#individual	#TAXA	FBI	SCR/FILT	EPT/CHIR	EPT index	#TAXA	FBI	SCR/FILT	EPT/CHIR	%CDF	EPT index	CU	Bio %	Impairment
3-Oct-95		*																					
2-Jan-96	87	17	3.06	0.61	0.90	45.00	9.0	0.41	96%	81%	156%	78%	95%	113%	6	6	6	6	3	6	6	100.0%	Non-impaired
2-Apr-96	132	16	4.06	0.73	0.82	16.00	7.0	0.06	17%	57%	96%	372%	98%	70%	3	6	6	6	6	0	6	78.6%	Non-impaired
10-May-96	106	13	5.11	0.91	0.97	36.00	5.0	0.15	13%	46%	76%	464%	116%	50%	3	3	6	6	3	0	6	69.2%	Moderately impaired
12-Jun-96	82	11	5.18	0.62	1.00	20.00	3.0	0.09	10%	39%	75%	316%	119%	30%	0	3	6	6	6	0	6	64.3%	Moderately impaired
3-Jul-96	88	14	5.56	0.78	0.92	16.00	4.0	0.21	11%	50%	70%	398%	110%	40%	3	3	6	6	6	0	6	71.4%	Moderately impaired
MINIMUM	82	11	3.06	0.61	0.82	16.00	3.0	0.06	0.10	0.39	0.70	0.78	0.95	0.30	0	3	6	6	3	0	6	64.3%	Moderately impaired
MAXIMUM	132	17	5.56	0.91	1.00	45.00	9.0	0.41	0.96	0.81	1.56	4.64	1.19	1.13	6	6	6	6	6	6	6	100.0%	Non-impaired
AVERAGE	99.0	14.2	4.59	0.73	0.92	26.60	5.6	0.18	0.29	0.55	0.95	3.26	1.07	0.61	3	4	6	6	5	1	6	76.7%	Non-impaired

*No sample taken due to lack of riffle.

Site 6

DATE	#individual	#Taxa	FBI	SCR/FILT	EPT/CHIR	%CDF	EPT index	CU	#individual	#TAXA	FBI	SCR/FILT	EPT/CHIR	EPT index	#TAXA	FBI	SCR/FILT	EPT/CHIR	%CDF	EPT index	CU	Bio %	Impairment
28-Sep-95	18	5	6.33	1.00	0.29	56.00	1.0	1.60	2%	18%	61%	510%	35%	10%	0	3	6	3	0	0	3	41.7%	Moderately impaired
4-Jan-96	84	12	5.80	0.97	0.66	27.00	4.0	1.10	92%	57%	62%	124%	69%	50%	3	3	6	3	6	0	3	57.1%	Moderately impaired
2-Apr-96	109	13	4.80	0.93	0.69	25.00	6.0	0.30	14%	46%	81%	474%	82%	60%	3	3	6	6	6	0	6	71.4%	Moderately impaired
8-May-96	90	13	4.20	0.80	0.92	28.00	6.0	0.40	11%	46%	93%	408%	110%	60%	3	6	6	6	6	0	6	78.6%	Non-impaired
12-Jun-96	81	10	3.90	0.29	1.00	44.00	4.0	0.30	10%	36%	100%	148%	119%	40%	0	6	6	6	3	0	6	69.2%	Moderately impaired
3-Jul-96	107	9	3.60	0.42	1.00	29.00	4.0	0.30	14%	32%	108%	214%	119%	40%	0	6	6	6	6	0	6	71.4%	Moderately impaired
MINIMUM	18	5	3.60	0.29	0.29	25.00	1.0	0.30	2%	18%	61%	124%	35%	10%	0	3	6	3	0	0	3	41.7%	Moderately impaired
MAXIMUM	109	13	6.33	1.00	1.00	56.00	6.0	1.60	92%	57%	108%	510%	119%	60%	3	6	6	6	6	0	6	78.6%	Non-impaired
AVERAGE	81.5	10.3	4.77	0.74	0.76	34.83	4.2	0.67	24%	39%	87%	313%	89%	43%	2	5	6	5	5	0	5	64.9%	Moderately impaired

# Taxa = Number of families represented in the sample
FBI = Modified Family Biotic Index
SCR/FILT = Ratio of scrapers to filtering collectors
EPT/CHIR = Ratio of EPT individuals to chironomids
% CDF = Percent contribution of dominant family
EPT Index = Number of families collected from Ephemeroptera, Plecoptera, and Trichoptera
CU = Community Loss Index
Bio % = Percent comparison to reference score

Table 3. Rapid Bioassessment Protocol V Metrics, Biological Condition Scores and Impairment Assessment

Site 1

Sample Date:	28-Aug-95		20-Dec-95		7-Feb-96		7-May-96		14-Jun-96		2-Jul-96			
Metrics Used:	Raw Score	Metric Score	Raw Score	Metric Score	Raw Score	Metric Score	Raw Score	Metric Score	Raw Score	Metric Score	Raw Score	Metric Score	Ave. Raw Score	Ave. Metric Score
Total # of Species	18	5	16	5	12	5	16	5	10	5	11	5	9.8	5
# of cyprinid sp.	3	3	4	5	3	3	3	3	2	3	2	3	2.8	5
# of benthic invertivores	1	3	1	3	0	1	1	3	1	3	0	1	0.7	1
# of Sunfish Species	7	5	5	5	4	5	5	5	5	5	5	5	5.2	5
% Tolerant	27%	3	23%	5	24%	5	41%	3	51%	1	78%	1	0.4	1
% Omnivores	1%	5	1%	5	0%	5	3%	5	0%	5	2%	5	0.0	5
% Insectivores	83%	5	82%	5	79%	5	81%	5	85%	5	90%	5	0.8	5
% piscivores	2%	1	1%	1	1%	1	1%	1	5%	3	5%	3	0.0	3
Total # of Indiv. per sein	25	1	3	1	10	1	4.75	1	3.5	1	605	5	108.3	5
% Hybrids	0%	5	0%	5	0%	5	0%	5	0%	5	0%	5	0.0	5
% non-native species	22%	1	43%	1	40%	1	36%	1	36%	1	46%	1	0.4	1
% Diseased/Anomalies	0%	5	0%	5	0%	5	0%	5	0%	5	0%	5	0.0	5
IBI Score		42		46		42		42		42		44		46
Score Interpretation		NI		NI		NI		NI		NI		NI		NI

IBI = Index of Biotic Integrity NI = non impaired, SI = slightly impaired, MI = moderately impaired

Site 2

Sample Date:	30-Aug-95		29-Dec-95		3-Apr-96		13-May-96		10-Jun-96		5-Jul-96			
Metrics Used:	Raw Score	Metric Score	Raw Score	Metric Score	Raw Score	Metric Score	Raw Score	Metric Score	Raw Score	Metric Score	Raw Score	Metric Score	Ave. Raw Score	Ave. Metric Score
Total # of Species	12	5	14	5	12	5	12	5	20	5	21	5	10.5	5
# of cyprinid sp.	3	3	4	5	3	3	2	3	3	3	5	5	3.3	5
# of benthic invertivores	0	1	1	3	2	5	1	3	1	3	1	3	1.0	1
# of Sunfish Species	6	5	4	5	4	5	4	5	7	5	6	5	5.2	5
% Tolerant	40%	3	62%	1	33%	3	68%	1	33%	3	71%	1	0.5	1
% Omnivores	3%	5	5%	5	26%	1	30%	1	10%	3	12%	3	0.1	5
% Insectivores	78%	5	91%	5	58%	3	64%	3	86%	5	86%	5	0.8	5
% piscivores	9%	5	4%	3	16%	5	6%	3	3%	1	2%	1	0.1	5
Total # of Indiv. per sein	5	1	21	1	3	1	6.33	1	48	3	118	5	33.6	5
% Hybrids	0%	5	0%	5	0%	5	0%	5	0%	5	0%	5	0.0	5
% non-native species	12%	1	7%	1	16%	1	15%	1	6%	1	11%	1	0.1	1
% Diseased/Anomalies	0%	5	0%	5	0%	5	0%	5	0%	5	0%	5	0.0	5
IBI Score		44		44		42		36		42		44		48
Score Interpretation		NI		NI		NI		SI		NI		NI		NI

IBI = Index of Biotic Integrity

Site 3

Sample Date:	5-Oct-95		3-Jan-95		6-Apr-96		13-May-96		13-Jun-96		4-Jul-96			
Metrics Used:	Raw Score	Metric Score	Raw Score	Metric Score	Raw Score	Metric Score	Raw Score	Metric Score	Raw Score	Metric Score	Raw Score	Metric Score	Ave. Raw Score	Ave. Metric Score
Total # of Species	22	5	12	5	9	5	14	5	11	5	13	5	9.6	5
# of cyprinid sp.	4	5	5	5	3	3	3	3	3	3	3	3	3.5	5
# of benthic invertivores	1	3	0	1	0	1	1	3	1	3	1	3	0.7	1
# of Sunfish Species	11	5	4	5	4	5	6	5	5	5	5	5	5.8	5
% Tolerant	54%	1	69%	1	86%	1	68%	1	88%	1	81%	1	0.7	1
% Omnivores	12%	3	4%	5	2%	5	14%	3	8%	5	15%	3	0.1	5
% Insectivores	71%	5	91%	5	97%	5	80%	5	91%	5	81%	5	0.9	5
% piscivores	7%	3	3%	1	1%	1	5%	3	2%	1	4%	1	0.0	3
Total # of Indiv. per sein	8.75	1	17.25	1	0	1	7	1	25	1	26	1	14.0	5
% Hybrids	0%	5	0%	5	0%	5	0%	5	0%	5	0%	5	0.0	5
% non-native species	11%	1	10%	1	1%	5	7%	1	8%	1	12%	1	0.1	1
% Diseased/Anomalies	0%	5	0%	5	0%	5	0%	5	0%	5	0%	5	0.0	5
IBI Score		42		40		42		40		40		38		46
Score Interpretation		NI		NI		NI		NI		NI		SI		NI

IBI = Index of Biotic Integrity

Table 3 continued.

Site 4

Sample Date:	4-Sep-95		4-Jan-96		3-Apr-96		8-May-96		11-Jun-96		5-Jul-96			
Metrics Used:	Raw Score	Metric Score	Raw Score	Metric Score	Raw Score	Metric Score	Raw Score	Metric Score	Raw Score	Metric Score	Raw Score	Metric Score	Ave. Raw Score	Ave. Metric Score
Total # of Species	16	5	11	5	16	5	8	3	10	5	14	5	8.9	4.6
# of cyprinid sp.	4	5	2	3	3	3	1	1	2	3	3	3	2.5	5
# of benthic invertivores	0	1	0	1	1	3	0	1	1	3	0	1	0.3	1
# of Sunfish Species	6	5	3	3	7	5	2	3	2	3	4	5	4.0	5
% Tolerant	68%	1	12%	5	61%	1	86%	1	89%	1	69%	1	0.6	1
% Omnivores	15%	3	6%	5	6%	5	4%	5	5%	5	5%	5	0.1	5
% Insectivores	76%	5	69%	5	86%	5	88%	5	93%	5	93%	5	0.8	5
% piscivores	10%	5	25%	5	9%	5	8%	3	2%	1	3%	1	0.1	5
Total # of Indiv. per sein	9	1	0	1	12.75	1	23.25	1	34.5	1	26.75	1	17.7	5
% Hybrids	0%	5	0%	5	0%	5	0%	5	0%	5	0%	5	0.0	5
% non-native species	16%	1	54%	1	19%	1	7%	1	1%	5	4%	1	0.2	1
% Diseased/Anomalies	0%	5	0%	5	0%	5	0%	5	0%	5	0%	5	0.0	5
IBI Score		42		44		44		34		42		38		47.6
Score Interpretation		NI		NI		NI		SI		NI		SI		NI

IBI = Index of Biotic Integrity

Site 5

Sample Date:	3-Oct-95		2-Jan-96		2-Apr-96		10-May-96		12-Jun-96		3-Jul-96			
Metrics Used:	Raw Score	Metric Score	Raw Score	Metric Score	Raw Score	Metric Score	Raw Score	Metric Score	Raw Score	Metric Score	Raw Score	Metric Score	Ave. Raw Score	Ave. Metric Score
Total # of Species	13	5	13	5	13	5	11	5	16	5	14	5	9.5	5
# of cyprinid sp.	3	3	3	3	4	5	2	3	3	3	3	3	3.0	5
# of benthic invertivores	0	1	2	5	0	1	1	3	1	3	1	3	0.8	1
# of Sunfish Species	6	5	6	5	5	5	5	5	6	5	7	5	5.8	5
% Tolerant	74%	1	51%	1	79%	1	41%	3	54%	1	58%	1	0.6	1
% Omnivores	19%	1	1%	5	2%	5	5%	5	4%	5	5%	5	0.1	5
% Insectivores	68%	5	83%	5	96%	5	64%	3	80%	5	81%	5	0.8	5
% piscivores	14%	5	16%	5	2%	1	30%	5	15%	5	10%	5	0.1	5
Total # of Indiv. per sein	8	1	0.5	1	35.5	1	3.5	1	9	1	0	1	9.4	5
% Hybrids	0%	5	0%	5	0%	5	0%	5	0%	5	0%	5	0.0	5
% non-native species	7%	1	16%	1	8%	1	32%	1	11%	1	9%	1	0.1	1
% Diseased/Anomalies	0%	5	0%	5	0%	5	0%	5	0%	5	0%	5	0.0	5
IBI Score		38		46		40		44		44		44		48
Score Interpretation		SI		NI		NI		NI		NI		NI		NI

IBI = Index of Biotic Integrity

Site 6

Sample Date:	28-Sep-95		4-Jan-96		2-Apr-96		8-May-96		12-Jun-96		3-Jul-96			
Metrics Used:	Raw Score	Metric Score	Raw Score	Metric Score	Raw Score	Metric Score	Raw Score	Metric Score	Raw Score	Metric Score	Raw Score	Metric Score	Ave. Raw Score	Ave. Metric Score
Total # of Species	15	5	11	5	7	3	10	5	16	5	11	5	8.5	4.6
# of cyprinid sp.	3	3	2	3	3	3	3	3	4	5	2	3	2.8	5
# of benthic invertivores	2	5	0	1	0	1	1	3	1	3	0	1	0.7	1
# of Sunfish Species	5	5	6	5	2	3	3	3	6	5	5	5	4.5	5
% Tolerant	61%	1	65%	1	81%	1	80%	1	82%	1	69%	1	0.7	1
% Omnivores	5%	5	5%	5	3%	5	7%	5	2%	5	5%	5	0.0	5
% Insectivores	87%	5	88%	5	97%	5	89%	5	94%	5	91%	5	0.9	5
% piscivores	8%	5	5%	3	0%	1	3%	1	3%	1	4%	3	0.0	3
Total # of Indiv. per sein	5.75	1	20	1	64.75	3	13.75	1	49.75	3	31.25	1	30.9	5
% Hybrids	0%	5	0%	5	0%	5	0%	5	0%	5	0%	5	0.0	5
% non-native species	10%	1	8%	1	1%	5	4%	1	1%	5	3%	1	0.0	1
% Diseased/Anomalies	0%	5	0%	5	0%	5	0%	5	0%	5	0%	5	0.0	5
IBI Score		46		40		40		38		48		40		45.6
Score Interpretation		NI		NI		NI		SI		NI		NI		NI

IBI = Index of Biotic Integrity

Table 4. Fish collected at all locations.

		SITES					
		1	2	3	4	5	6
Scientific Name	Common Name						
Anguilla rostrata	American eel				x		
Astyanax mexicanus	Mexican tetra	x	x	x		x	x
Campostoma anomalum	central stoneroller	x	x		x		
Cichlasoma cyanoguttatum	Rio Grande cichlid	x	x	x	x		
Cyprinella lutrensis	red shiner	x	x	x	x	x	x
Cyprinella venusta	blacktail shiner	x		x	x	x	x
Dorosoma cepedianum	gizzard shad	x	x	x	x	x	x
Erimyzon oblongus	creek chubsucker					x	
Etheostoma lepidum	greenthroat darter					x	
Etheostoma spectabile	orangethroat darter	x				x	
Fundulus notatus	blackstripe topminnow	x				x	x
Gambusia affinis	western mosquitofish	x	x	x	x	x	x
Hybopsis aestivalis	speckled chub		x	x		x	x
Ictalurus natalis	yellow bullhead	x		x			
Ictalurus punctatus	channel catfish	x	x	x	x	x	x
Ictiobus bubalus	smallmouth buffalo		x		x	x	x
Lepisosteus oculatus	spotted gar		x	x	x	x	x
Lepisosteus osseus	longnose gar		x			x	x
Lepomis auritus	redbreast sunfish	x	x	x			x
Lepomis cyanellus	green sunfish	x	x	x	x	x	x
Lepomis gulosus	warmouth	x	x	x	x	x	x
Lepomis macrochirus	bluegill	x	x	x	x	x	x
Lepomis megalotis	longear sunfish	x	x	x	x	x	x
Lepomis microlophus	redear sunfish		x	x	x	x	x
Lepomis punctatus	spotted sunfish	x	x	x	x		x
Menidia beryllina	inland silverside	x	x				x
Micropterus dolomieu	smallmouth bass		x				
Micropterus punctulatus	spotted bass		x	x	x	x	x
Micropterus salmoides	largemouth bass	x	x	x	x	x	x
Micropterus treculi	Guadalupe bass	x		x			
Minytrema melanops	spotted sucker						x
Moxostoma congestum	gray redhorse		x	x	x	x	x
Mugil cephalus	striped mullet						x
Notropis amabilis	Texas shiner		x				
Notropis volucellus	mimic shiner		x	x	x	x	x
Notropis stramineus	sand shiner	x					
Percina macrolepida	bigscale logperch	x	x				
Pimephales vigilax	bullhead minnow	x	x	x	x	x	x
Poecilia latipinna	sailfin molly	x	x		x		
Pomoxis annularis	white crappie			x		x	
Pomoxis nigromaculatus	black crappie			x		x	
Pylodictis olivaris	flathead catfish	x	x	x	x	x	x

Table 5. Invertebrates collected at all locations.

Order	Family	SITES 1	2	3	4	5	6
Oligochaeta	Lumbriculidae						
	Tubificidae	X	X	X	X	X	X
Tricladida	Planariidae	X	X	X			
Gastropoda	Physidae	X		X	X	X	X
	Limnaeidae			X	X	X	
	Planorbidae	X					
Pelecypoda	Sphaeriidae	X			X		
	Louisiana fatmucket				X		
	Corbiculidae	X	X	X	X	X	X
Decapoda	Cambaridae	X	X		X		
Amphipoda	Hyallelidae	X					
Ephemeroptera	Baetidae	X	X	X	X	X	X
	Caenidae	X		X	X		X
	Ephemeridae						
	Heptageniidae	X	X	X	X	X	X
	Leptophlebiidae	X	X	X	X	X	X
	Oligoneuriidae	X			X	X	X
	Tricorythidae	X	X	X	X	X	X
Plecoptera	Perlidae		X	X	X	X	X
Trichoptera	Hydropsychidae	X	X		X	X	X
	Glossomatidae		X	X	X		
	Leptoceridae	X	X		X	X	X
	Philopotamidae	X			X		
	Helicopsychidae		X	X	X	X	X
Anisoptera	Gomphidae	X	X	X	X	X	X
	Libellulidae	X			X	X	X
Zygoptera	Coenagrionidae	X	X		X	X	
Hemiptera	Corixidae			X	X		
	Mesoveliidae			X			
	Naucoridae		X	X	X	X	X
Coleoptera	Elmidae	X	X	X	X	X	X
	Psephenidae	X	X				
	Dryopidae				X		
Megaloptera	Corydalidae	X	X		X	X	X
Lepidoptera	Pyralidae	X	X	X	X	X	X
Diptera	Ceratopogonidae		X	X			
	Simuliidae	X					X
	Tabanidae		X	X			
	Tipulidae			X			
	Col Chironomidae	X	X	X	X	X	X

Table 6. Physical, Chemical and Bacteriological data.

Site One

DATE	TIME	FECAL COLIFORM	FECAL STREP	FC/FS RATIO	BOD mg/L	TOC mg/L	pH	TEMP C	CONDUCTIVITY umhos/cm	DO mg/L	NITRATE mg/L	NITRITE mg/l	SULFATE mg/L	O-PHOS mg/L	T-PHOS mg/L	TURBIDITY NTU	TSS mg/L
26-Aug-95	1315	14	52	0.27	<2.0	1.9	7.5	29.0	401	8.2	0.5	<0.1	29.4	0.01	0.03	2.1	7
20-Dec-95	1200	4	16	0.25	<2.0	1.82	7.8	15.7	489	10.9	1.2		29.9	0.03	0.02	2.37	9.76
7-Feb-96	1200	8	24	0.33	<2.0	51	7.2	14.5	564	11.1	1		28.4	0.038	0.06		<10.0
7-May-96	1130	30	14	2.14	<2.0	7	7.3	24.0	424	7.08	0.8	<0.1	29	0.03	0.06	7.3	<10
14-Jun-96	830	322	tntc		<2	2.8	7.8	28.0	486	10.11	0.5		29.3	0.01	0.06	11.3	24.8
2-Jul-96	900	56	8	7.00	<2	2.7	7.7	29.4	505	7.62	<0.1	<0.1	37.4	0.04	0.05	6.8	<10
MINIMUM		4	8	0.250	<2.0	1.82	7.2	14.5	401	7.08	0.5	<0.10	28.4	<0.01	<0.01	2.1	7
MAXIMUM		322	52	7.00	0	51	7.8	29.4	564	11.1	1.2	0	37.4	0.04	0.06	11.3	24.8
AVERAGE		72	23	2.00	-	11.20	7.6	23.4	478	9.17	0.80	-	30.37	-	-	5.97	13.85

CG = colonies have grown together, and cannot be counted

Site Two

DATE	TIME	FECAL COLIFORM	FECAL STREP	FC/FS RATIO	BOD mg/L	TOC mg/L	pH	TEMP C	CONDUCTIVITY umhos/cm	DO mg/L	NITRATE mg/L	NITRITE mg/l	SULFATE mg/L	O-PHOS mg/L	T-PHOS mg/L	TURBIDITY NTU	TSS mg/L
30-Aug-95	1445	142	70	2.00	<2.0	2.49	7.7	29.0	616	7.5	<0.10	<0.10	29.6	0.07	0.02	1.8	10
29-Dec-95	1315	0	26	0.00	<2.0	2.45	7.8	12.3	603	7.5	3		41.6	0.13	0.12	1.73	2.18
3-Apr-96	1215	4	72	0.03	4.41	55	8.3	19.9	522	13.7	1.1		34.4	0.05	0.11	3.7	<10
13-May-96	1440	16	66	0.24	2	3.4	na	27.8	475	9.51	2.1		37.8	0.08	0.1	5.2	<10
10-Jun-96	1030	10	92	0.11	2	4.2	7.1	27.9	543	9.91	2.1		38.6	0.14	0.16	2	<10
5-Jul-96	900		100	0.00	<2	4	8.1	27.7	509	4.39	1.1	<0.1	33.8	0.06	0.32	2.3	<10
MINIMUM		0	26	0.000	<2.0	2.45	7.1	12.3	475	4.39	1.1	<0.10	29.6	<0.01	<0.01	1.73	2.18
MAXIMUM		142	100	2.00	4.41	55	8.3	29.0	616	13.7	3	0	41.6	0.14	0.32	5.2	10
AVERAGE		34	71	0.40	-	11.92	7.8	24.1	528	8.75	1.99	-	35.97	-	-	2.79	6.09

Site Three

DATE	TIME	FECAL COLIFORM	FECAL STREP	FC/FS RATIO	BOD mg/L	TOC mg/L	pH	TEMP C	CONDUCTIVITY umhos/cm	DO mg/L	NITRATE mg/L	NITRITE mg/l	SULFATE mg/L	O-PHOS mg/L	T-PHOS mg/L	TURBIDITY NTU	TSS mg/L
5-Oct-95	1200	60	34	1.47	<2.0	2.1	7.8	24.3	502	7.8	1.1	<0.1	30.8	0.18	0.06	16	29
3-Jan-96	1200	18	32	0.56	2.71	2.04	8	10.9	373	10.25	1.7		33.2	0.02	0.03	1.53	7.88
6-Apr-96	1000	18	16	1.13	4	6	7.5	16.6	524	10.35	0.8	<0.1	44.4	0.03	0.06	16.3	30
13-May-96	1120	102	260	0.39	<2	5.2	na	26.3	455	6.8	1.1		31.4	0.08	0.08	43.7	77
13-Jun-96	900	372	382	0.97	<2	3	8.1	29.8	485	7.68	0.2		33.4	0.04	0.07	12.8	24
4-Jul-96	800	120	98	1.22	<2	5.4	7.5	29.7	492	6.16	0.22	<0.1	35.8	0.07	0.09	18.2	21.2
MINIMUM		18	16	0.392	<2.0	2.04	7.5	10.9	373	6.16	0.2	<0.10	30.8	<0.01	<0.01	1.53	7.88
MAXIMUM		372	382	1.47	-	6	8.1	29.8	524	10.35	1.70	-	44.4	-	0.09	43.7	77
AVERAGE		113	137	0.96	-	3.96	7.8	22.9	472	8.17	0.85	-	34.83	-	-	18.09	31.51

Site Four

DATE	TIME	FECAL COLIFORM	FECAL STREP	FC/FS RATIO	BOD mg/L	TOC mg/L	pH	TEMP C	CONDUCTIVITY umhos/cm	DO mg/L	NITRATE mg/L	NITRITE mg/l	SULFATE mg/L	O-PHOS mg/L	T-PHOS mg/L	TURBIDITY NTU	TSS mg/L
4-Sep-95	1130	42	38	1.11	<2.0	2.7	6.7	30.0	462	5.9	0.2	<0.1	33.4	0.02	0.02	7.9	13
4-Jan-95	1115	8	8	1.00	2.91	2.44	8.4	11.3	525	10.1	1.6		32.4	0.03	0.02	1.53	6.11
3-Apr-96	935	30	12	2.50	2.56	54	8.2	26.0	1930	8.36	0.6		34.6	0.03	0.08	9.2	<10
8-May-96	1000	38	106	0.36	<2	8.1	8	24.5	458	6.66	0.9	<0.1	33.6	0.06	0.09	17.4	28
11-Jun-96	1015	42	188	0.22	<2	3.5	7.5	28.7	512	8.73	0.2		36.1	0.05	<0.05	11	14
5-Jul-96	1230	136	42	3.24	<2	4.2	8.4	31.1	502	6.91	0.2	<0.1	34.6	0.06	0.09	12.8	16.5
MINIMUM		8	8	0.223	<2.0	2.44	6.7	11.3	458	5.90	0.20	<0.10	32.4	<	<0.01	1.53	6.11
MAXIMUM		136	188	3.24	2.91	54	8.4	31.1	1930	10.1	1.6	-	36.1	-	0.09	17.4	28
AVERAGE		49	66	1.40	-	12.49	7.9	25.3	732	7.78	0.62	-	34.12	-	-	9.97	15.52

Site Five

DATE	TIME	FECAL COLIFORM	FECAL STREP	FC/FS RATIO	BOD mg/L	TOC mg/L	pH	TEMP. C	CONDUCTIVITY umhos/cm	DO mg/L	NITRATE mg/L	NITRITE mg/l	SULFATE mg/L	O-PHOS mg/L	T-PHOS mg/L	TURBIDITY NTU	TSS mg/L
3-Oct-95	1130	138	160	0.86	<2.0	6.7	7.4	26.9	604	8.3	0.91	<0.1	28.1	0.19	0.08	28	31
2-Jan-96	1130	18	20	0.90	2.71	2.39	7.8	12.0	507	9.74	ran outofsample	no sample	no sample	0.04	no sample	no sample	29.5
2-Apr-96	1240	144	24	6.00	3.48	51	8.4	18.0	558	8.93	0.4		23	0.03	0.09	4.9	24
10-May-96	1315	12	736	0.02	<2	4.5	7.5	25.6	451	7.23	0.8	<0.1	33.8	0.06	0.09	26.5	47
12-Jun-96	930	14	308	0.05	<2	3.6	7.4	28.4	528	8.13	0.2		35.4	0.04	0.05	12.9	23
3-Jul-96	1300	138	18	7.67	<2	5.6	na	32.1	497	6.78	0.13	<0.1	36	0.07	0.09	16.7	20.5
MINIMUM		12	18	0.016	<2.0	2.39	7.4	12.0	451	6.78	0.13	<0.10	23	<0.01	0.05	4.9	20.5
MAXIMUM		144	736	8	2.93	51	8.4	32.1	558	9.74	0.91	0	36	0.19	0.09	28	47
AVERAGE		77	211	2.58	-	12.38	7.7	23.8	508	8.19	0.49	-	31.26	-	0.08	17.80	29.17

CG = colonies have grown together, and cannot be counted

Site Six

DATE	TIME	FECAL COLIFORM	FECAL STREP	FC/FS RATIO	BOD mg/L	TOC mg/L	pH	TEMP. C	CONDUCTIVITY umhos/cm	DO mg/L	NITRATE mg/L	NITRITE mg/l	SULFATE mg/L	O-PHOS mg/L	T-PHOS mg/L	TURBIDITY NTU	TSS mg/L
28-Sep-95	1200	34	76	0.45	<2.0	2.34	7.4	26.7	430	8.2	0.1	<0.1		0.09	0.05	25	25
4-Jan-96	800	8	20	0.40	2.01	1.87	8.4	12.0	518	10.31	1.6		33.4	0.04	0.04	1.43	3.8
2-Apr-96	946	44	34	1.29	2.61	56	7.8	18.6	555	8.5	0.5		46.8	0.03	0.08	11.3	15
8-May-96	1246	16	222	0.07	<2	4.2	7.7	25.5	461	6.94	0.7	<0.1	38	0.06	0.07	8.6	18
12-Jun-96	1320	0	148	0.00	<2	3.6	7.6	29.9	535	9.82	0.2		35.4	0.04	0.06	10.6	14
3-Jul-96	1030	30	54	0.56	<2	4	8.4	30.0	496	8.16	<0.1	<0.1	36.2	0.07	0.09	20.4	25.7
MINIMUM		0	20	0.000	<2.0	1.87	7.4	12.0	430	6.94	0.10	<0.10	33.4	0.03	0.04	1.43	3.8
MAXIMUM		44	222	1.29	2.61	56	8.4	30.0	555	10.31	1.6	0	46.8	0.09	0.09	25	25.7
AVERAGE		22	92	0.46	-	12.00	7.9	23.8	499	8.66	0.62	-	37.96	0.05	0.07	12.89	16.92

CG = colonies have grown together, and cannot be counted

It is often not possible to put together a sampling trip on such short notice, especially when using graduate students that have classes during the week days.

The biological and chemical-physical information developed during this study is more than adequate to evaluate the present environmental conditions of the study areas. To try to further develop detailed flow information for each study site will require much greater costs, because to do it right should involve the flows being taken at the sites at the times of sampling. I recommend that a beginning and ending flow be measured and that the flows available on regular sampling dates be used instead of trying to get into to narrow flow categories. Practicality has to be an important part of any field study and I feel that under the circumstances found in this river area, a modification of the usual methods must be employed. Based on the information gained from the invertebrate studies in RBA Protocol II, the sites are either non-impaired or moderately impaired (Table 2). The information gained from RBA Protocol V shows that the sites are generally non-impaired (Table 3).

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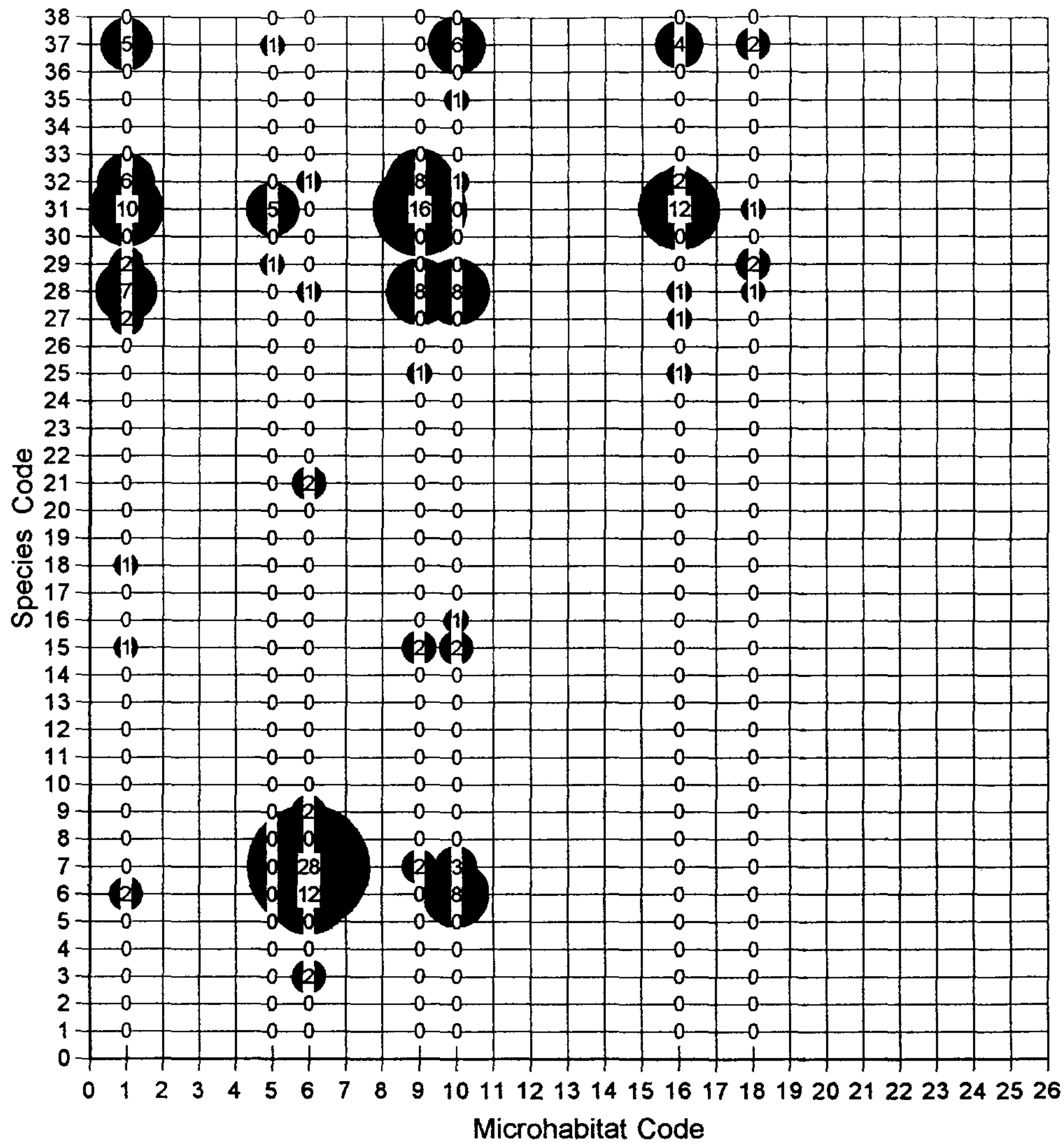
APPENDICES

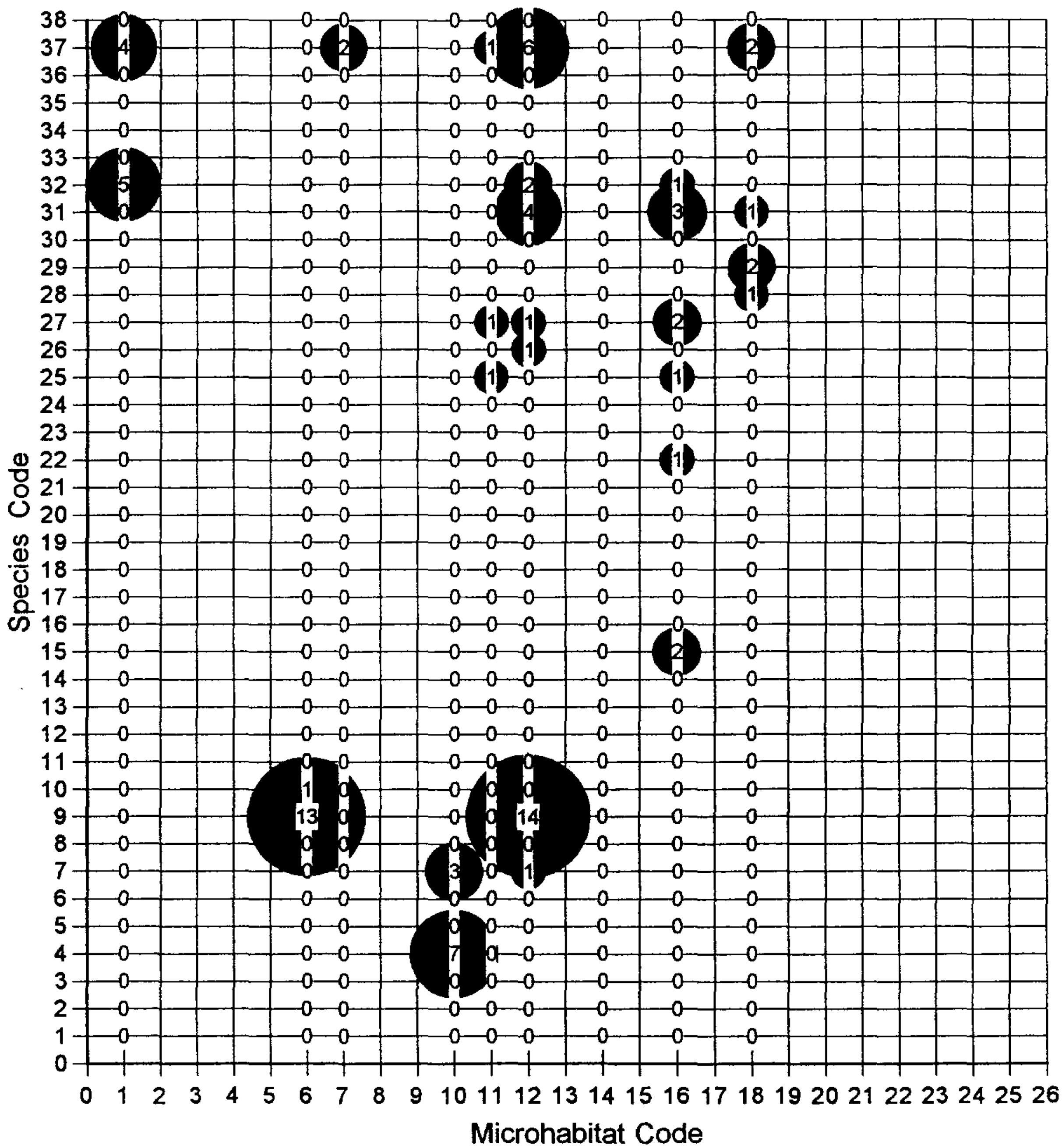
GUADALUPE RIVER BASIN		USES				CRITERIA						
SEGMENT NUMBER	SEGMENT NAME	RECREATION	AQUATIC LIFE	DOMESTIC WATER SUPPLY	OTHER	CHLORIDE (mg/L) Annual average not to exceed	SULFATE (mg/L) Annual average not to exceed	TOTAL DISSOLVED SOLIDS (mg/L) Annual average not to exceed	DISSOLVED OXYGEN (mg/L)	pH RANGE	FECAL COLIFORM (#/100 mL) Thirty-day geometric mean not to exceed	TEMPERATURE (°F) Not to exceed
1801	Guadalupe River Tidal	CR	E						5.0	6.5-9.0	200	95
1803	Guadalupe River Below San Marcos River	CR	H	PS		100	50	400	5.0	6.5-9.0	200	93
1804	Guadalupe River Below Comal River	CR	H	PS		80	50	400	5.0	6.5-9.0	200	90
1805	Canyon Lake	CR	E	PS/AP		40	40	400	6.0	6.5-9.0	200	90
1806	Guadalupe River Above Canyon Lake	CR	E	PS		40	40	400	6.0	6.5-9.0	200	90
1807	Coleto Creek	CR	H	PS		250	100	500	5.0	6.5-9.0	200	93
1808	Lower San Marcos River	CR	H	PS		60	50	400	5.0	6.5-9.0	200	90
1809	Lower Blanco River	CR	H	PS		40	50	400	5.0	6.5-9.0	200	92
1810	Plum Creek	CR	H			350	150	1,120	5.0	6.5-9.0	200	90
1811	Comal River	CR	H	PS		25	30	400	5.0	6.5-9.0	200	90
1812	Guadalupe River Below Canyon Dam	CR	E	PS/AP		40	40	400	6.0	6.5-9.0	200	90
1813	Upper Blanco River	CR	E	PS/AP		30	35	400	6.0	6.5-9.0	200	92
1814	Upper San Marcos River	CR	E			25	25	380	6.0	6.5-9.0	200	80
1815	Cypress Creek	CR	E	PS		20	20	350	6.0	6.5-9.0	200	86
1816	Johnson Creek	CR	E	PS		20	20	350	6.0	6.5-9.0	200	86
1817	North Fork Guadalupe River	CR	E	PS		20	20	350	6.0	6.5-9.0	200	86
1818	South Fork Guadalupe River	CR	E	PS		20	20	350	6.0	6.5-9.0	200	86

Code	Scientific Name	Common Name	Habitat
1	Anguilla rostrata	American eel	Pool
2	Lepisosteus oculatus	Spotted gar	Chute
3	Dorosoma cepedianum	Gizzard shad	Rapid
4	Astyanax mexicanus	Mexican tetra	Root wad
5	Hybopsis aestivalis	Speckled chub	Edgewater
6	Notropis venustus	Blacktail shiner	Run
7	Notropis lutrensis	Red shiner	Undercut Bank
8	Notropis stramineus	Sand shiner	Bank snag
9	Notropis volucellus	Mimic shiner	Backwater
10	Pimephales vigilax	Bullhead minnow	Riffle
11	Campostoma ornatum	Central stoneroller	Debris dam
12	Ictiobus bubalus	Smallmouth buffalo	Snag complex
13	Moxostoma congestum	Gray redhorse	Channel snag
14	Minytrema melanops	Spotted sucker	Eddy pool
15	Ictalurus punctatus	Channel catfish	Glide
16	Pylodictis olivaris	Flathead catfish	P-RW
17	Ictalurus natalis	Yellow bullhead	P-BS
18	Zygonectes notatus	Blackstripe topminnow	P-UB
19	Gambusia affinis	Western mosquitofish	P-SC
20	Poecilia latipinna	Sailfin molly	P-CS
21	Menidia beryllina	Inland silversides	P-DD
22	Micropterus punctatus	Spotted bass	RI-DD
23	Erimyzon oblongus	Creek chubsucker	RU-BS
24	Micropterus treculi	Guadalupe bass	RU-CS
25	Micropterus salmoides	Largemouth bass	BW-CS
26	Lepomis gulosus	Warmouth	SP-BS
27	Lepomis cyanellus	Green sunfish	
28	Lepomis auritus	Redbreast sunfish	
29	Lepomis punctatus	Spotted sunfish	
30	Lepomis microlophus	Redear sunfish	
31	Lepomis macrochirus	Bluegill sunfish	
32	Lepomis megalotis	Longear sunfish	
33	Pomoxis annularis	White crappie	
34	Pomoxis nigromaculatus	Black crappie	
35	Percina macrolepida	Bigscale logperch	
36	Etheostoma spectabile	Orangethroat darter	
37	Cichlasoma cyanoguttatum	Rio Grande cichlid	
38	Mugil curema	Striped mullet	

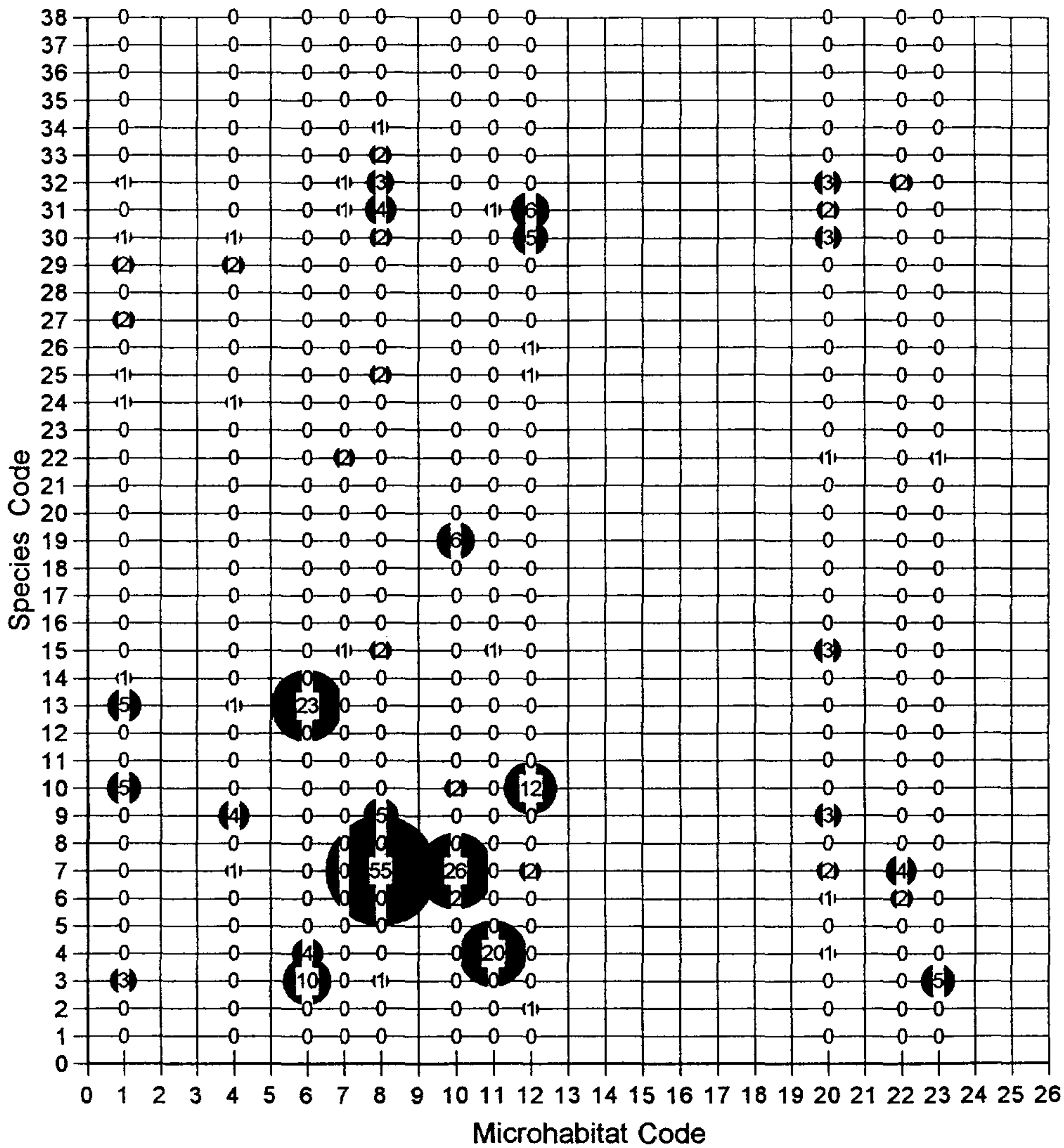
Appendix 2. Legend.



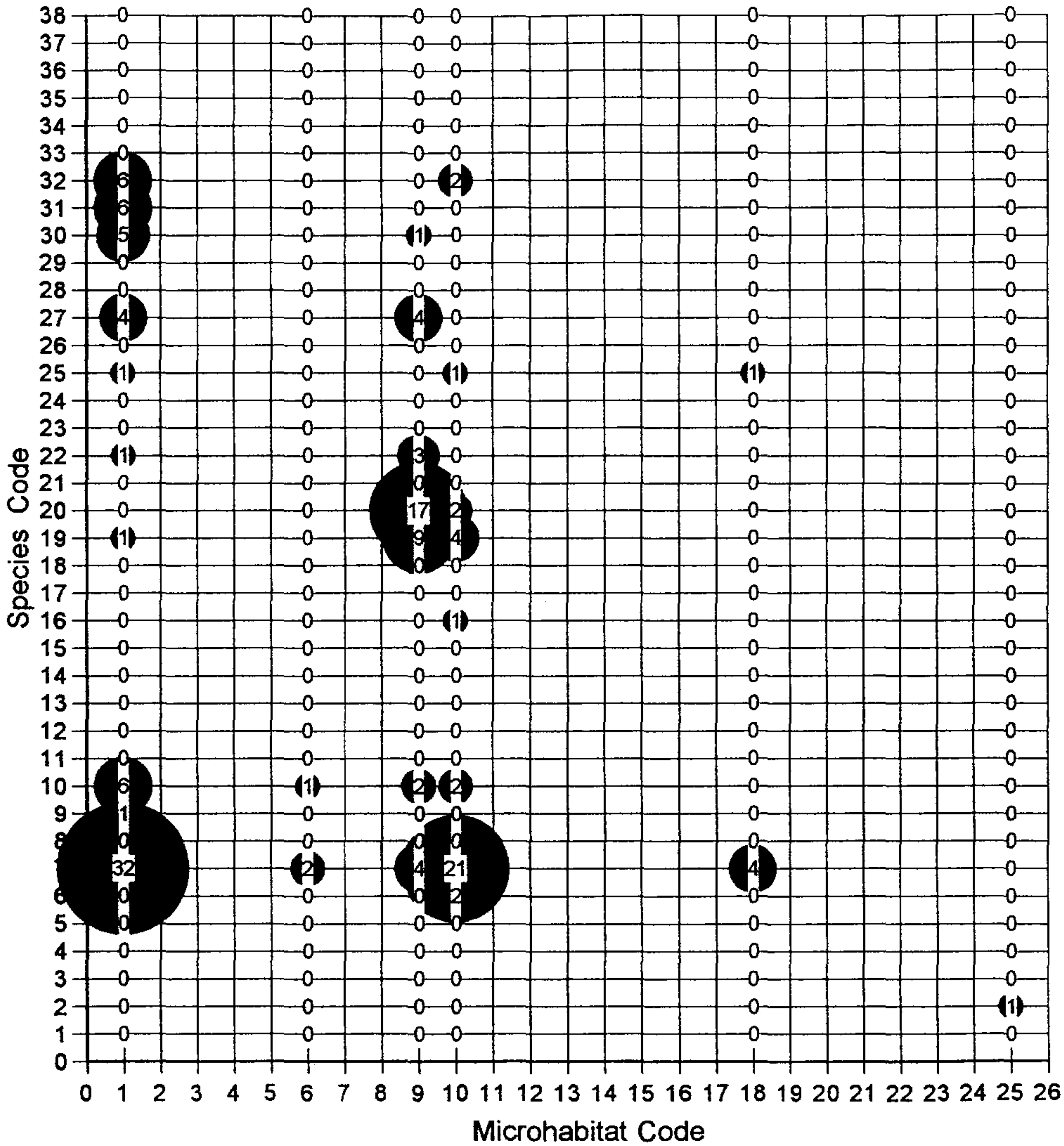
Appendix 2. Site 1 Sample 1, 8-28-95.



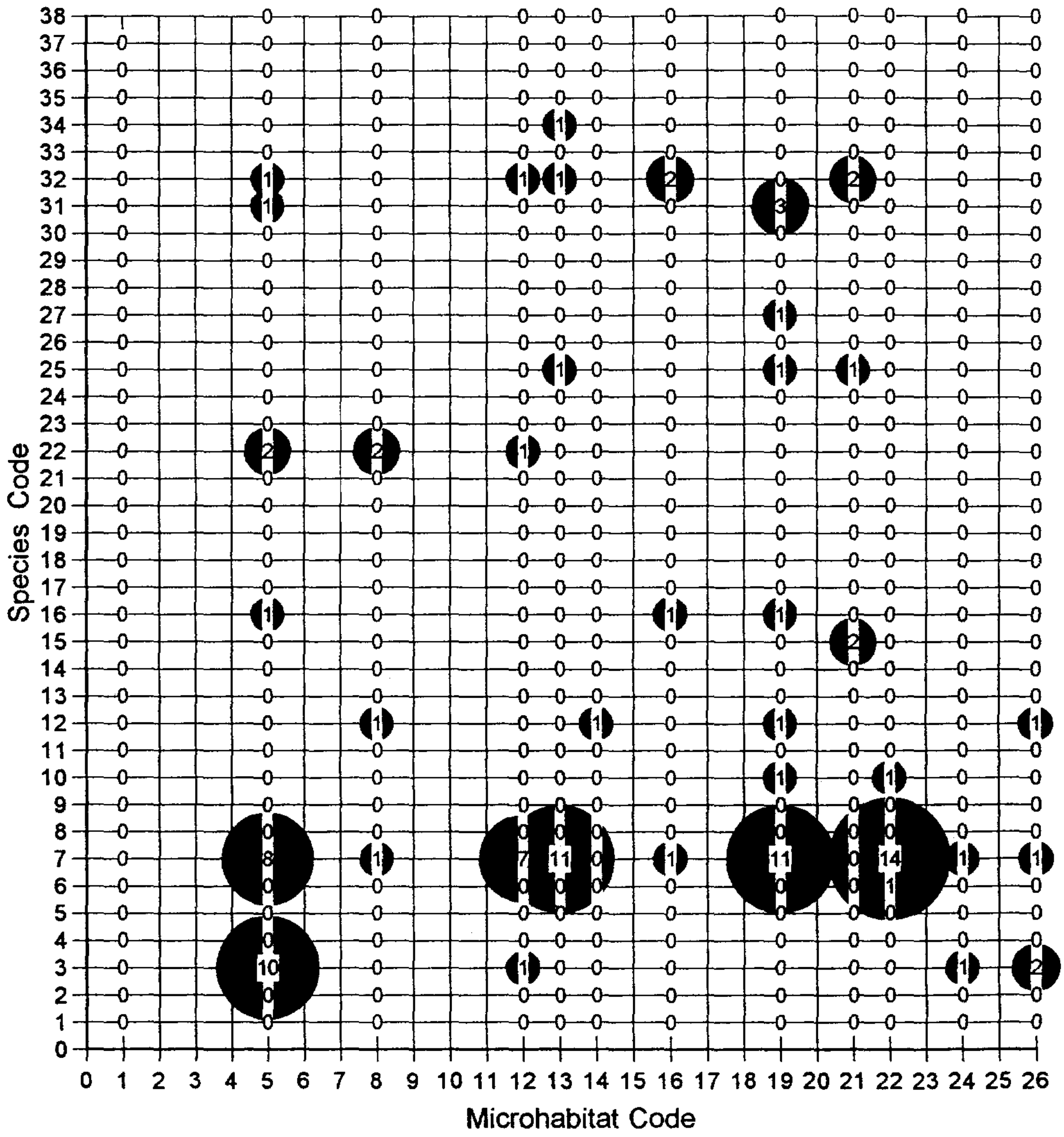
Appendix 2. Site 2 Sample 1, 8-30-95.



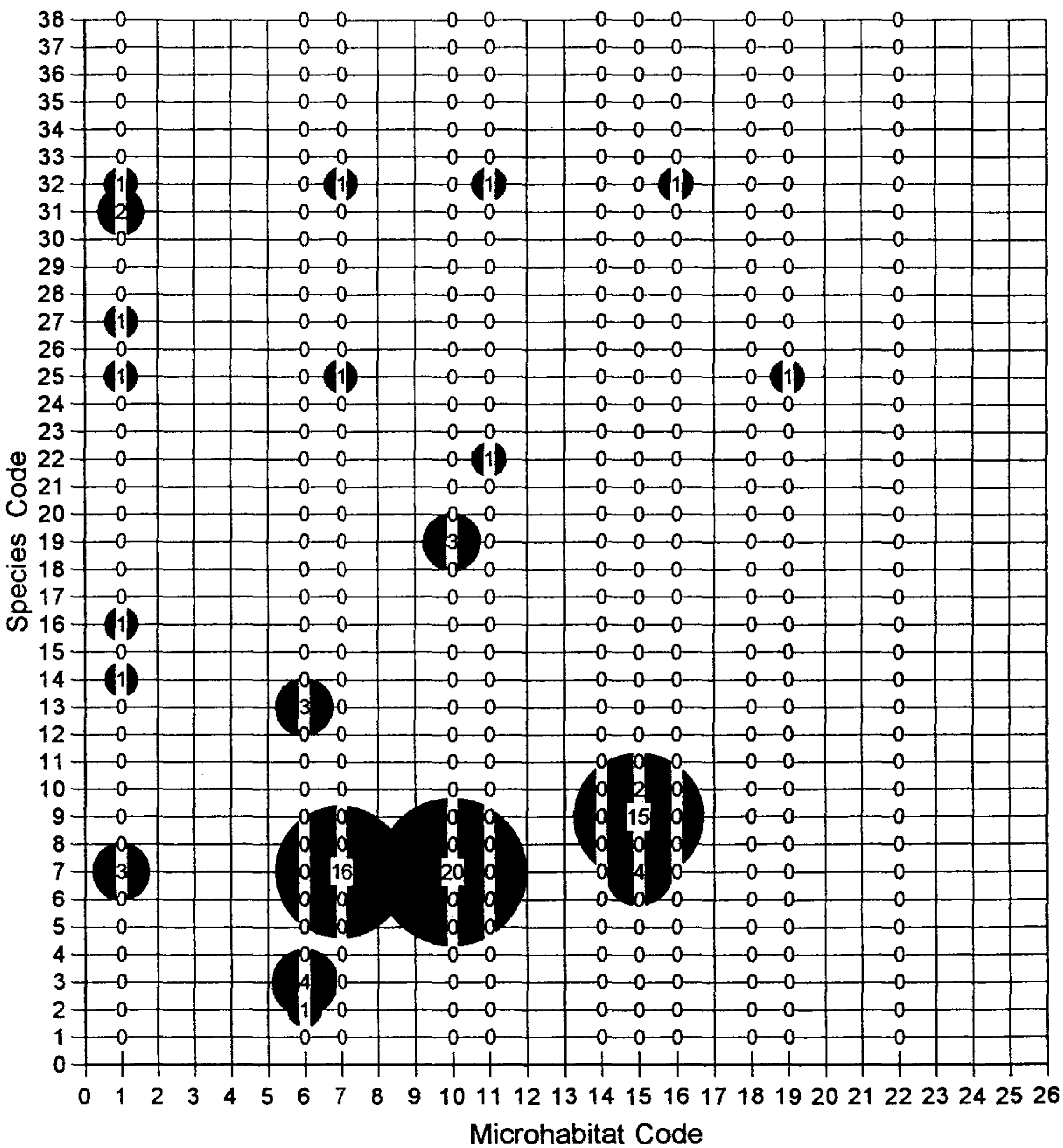
Appendix 2. Site 3 Sample 1, 10-05-95.



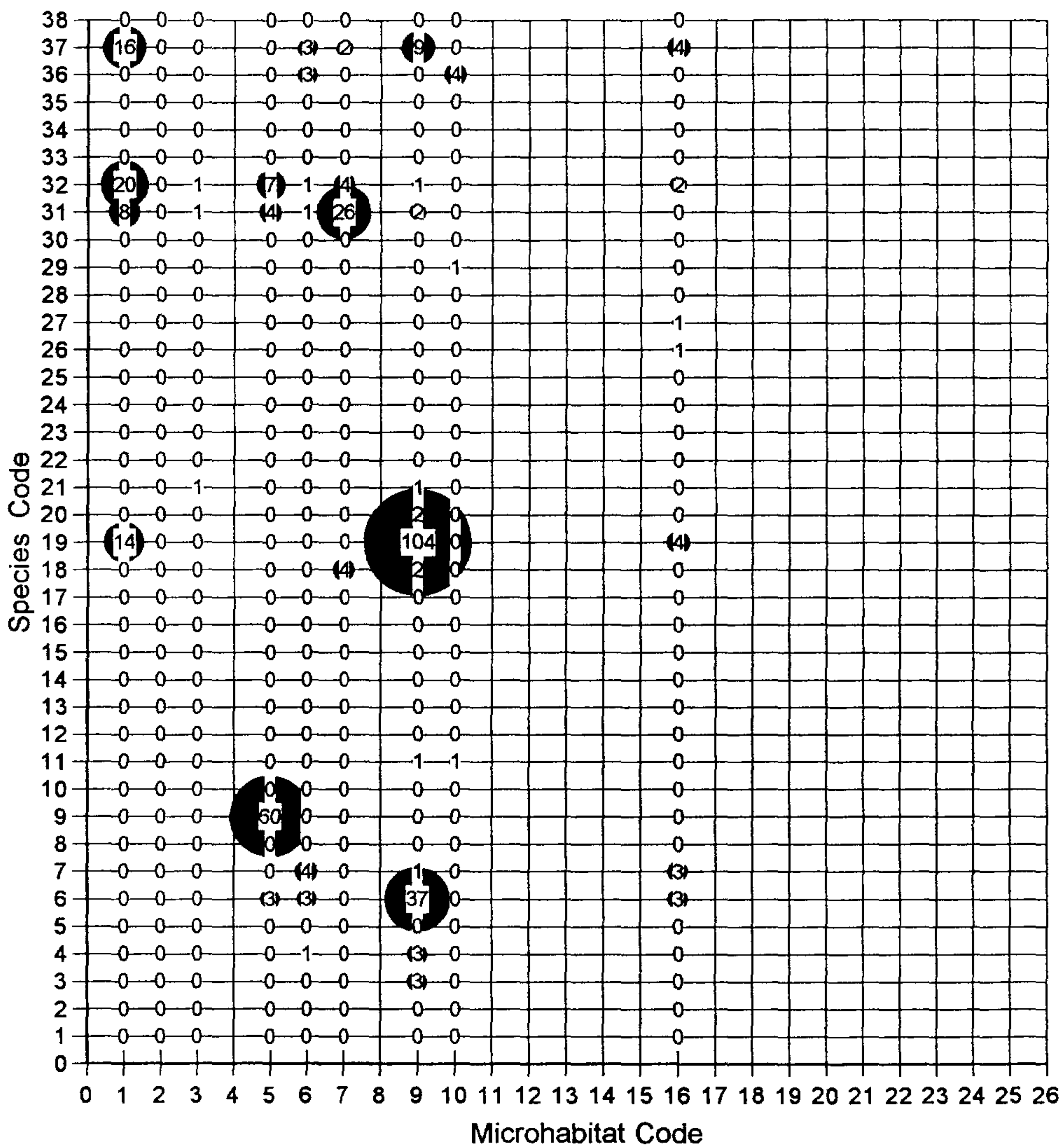
Appendix 2. Site 4 Sample 1, 10-03-95.



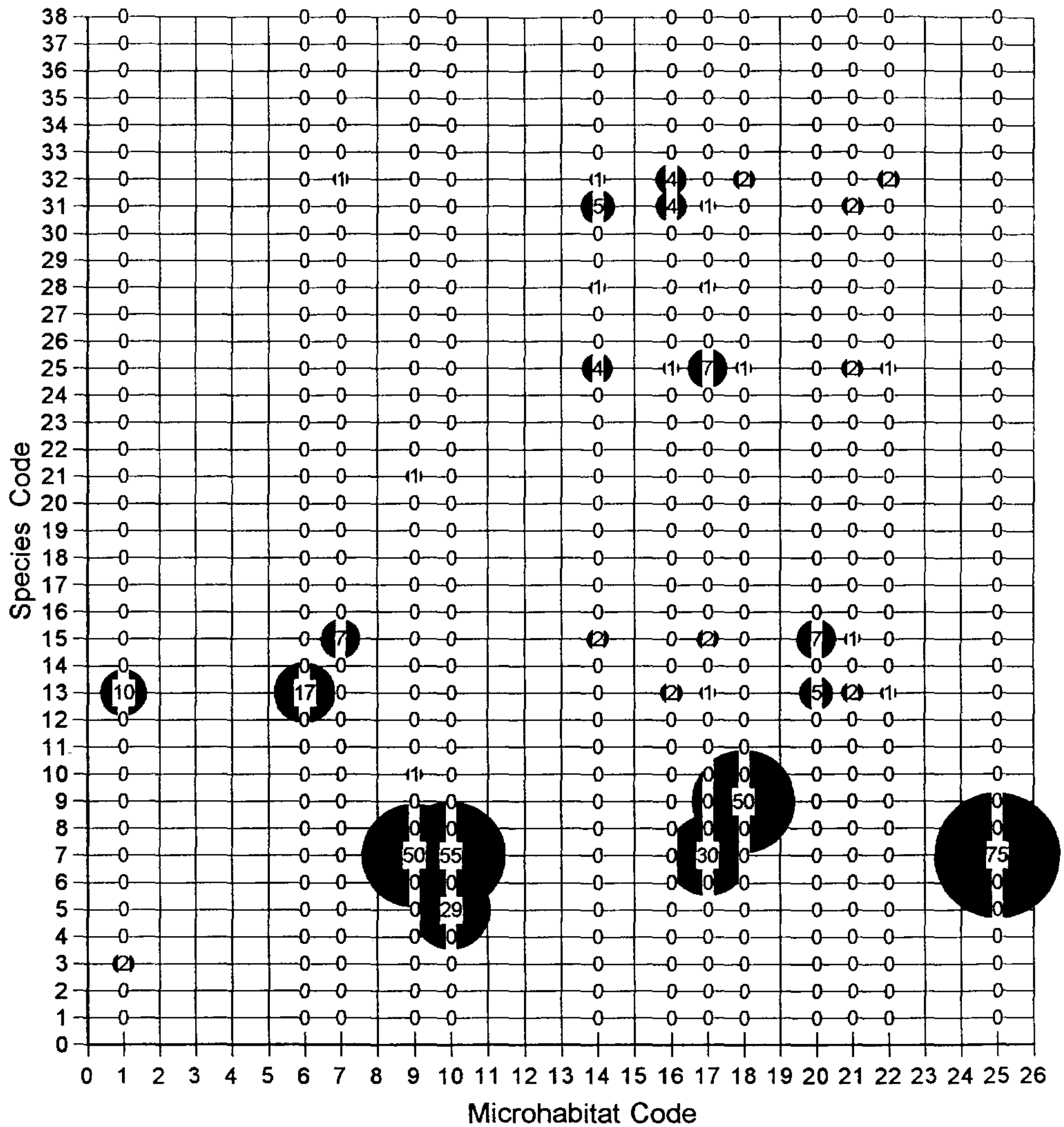
Appendix 2. Site 5 Sample 1, 10-03-95.



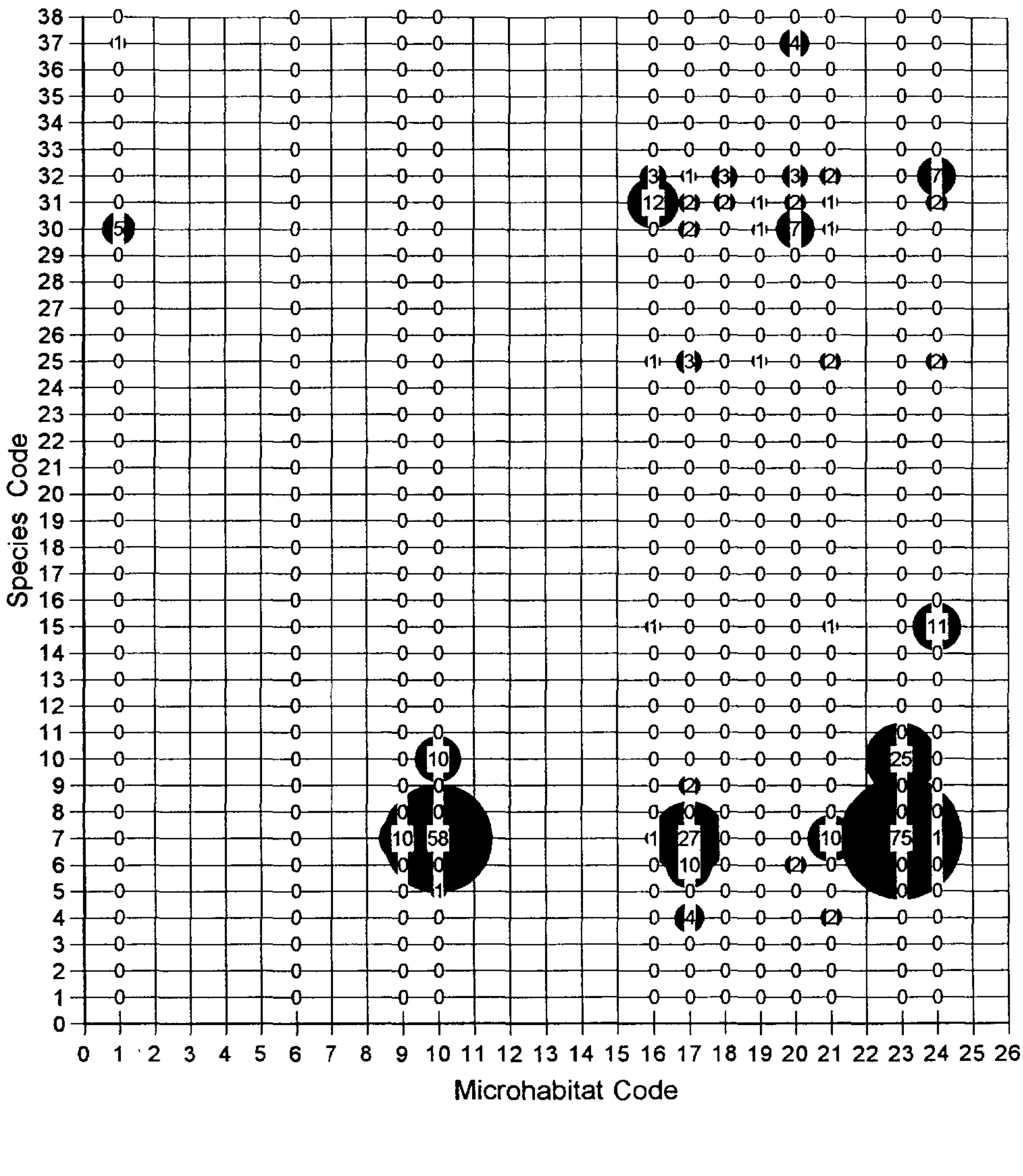
Appendix 2. Site 6 Sample 1, 09-28-95.



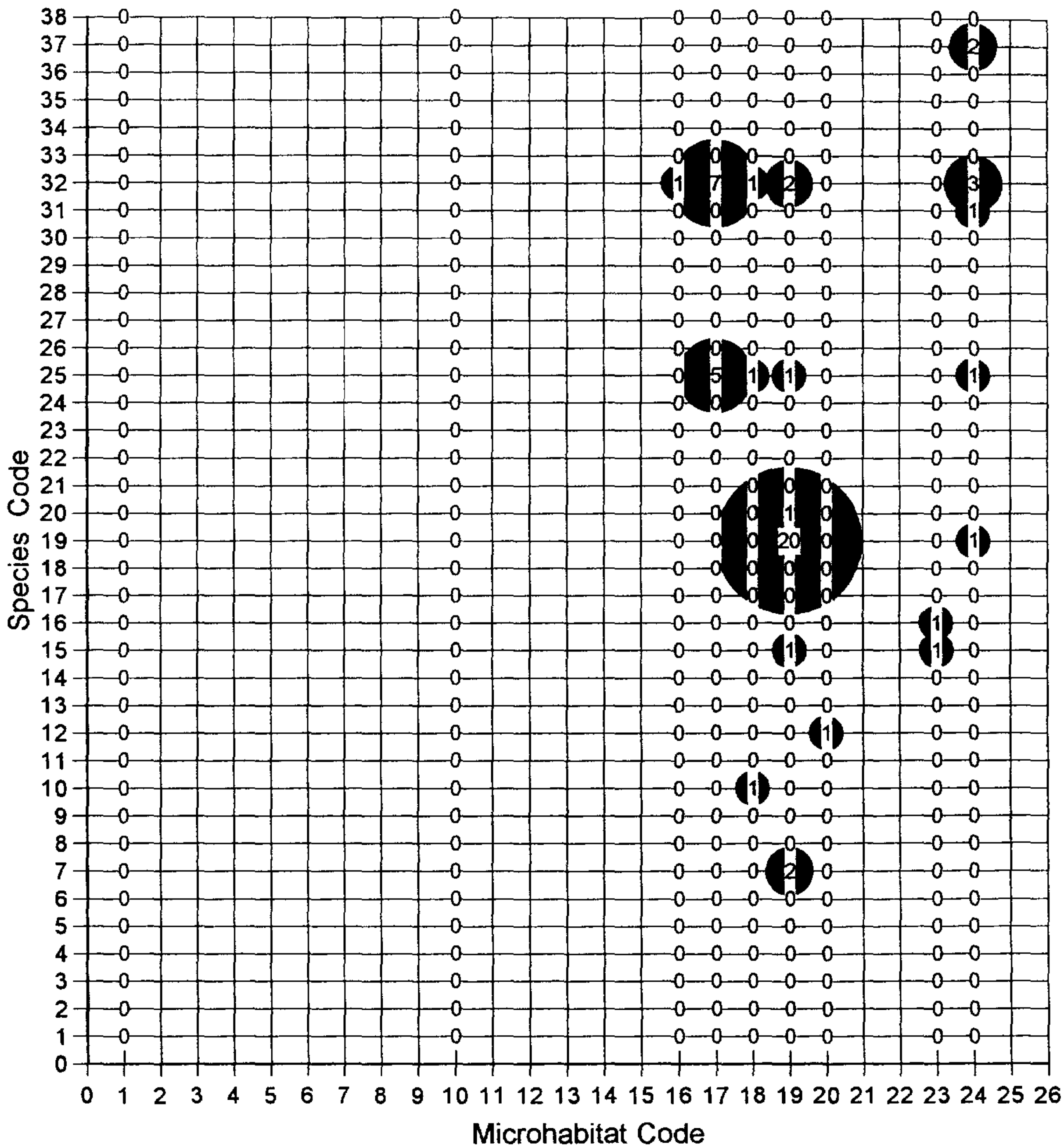
Appendix 2. Site 1 Sample 2, 12-20-95.



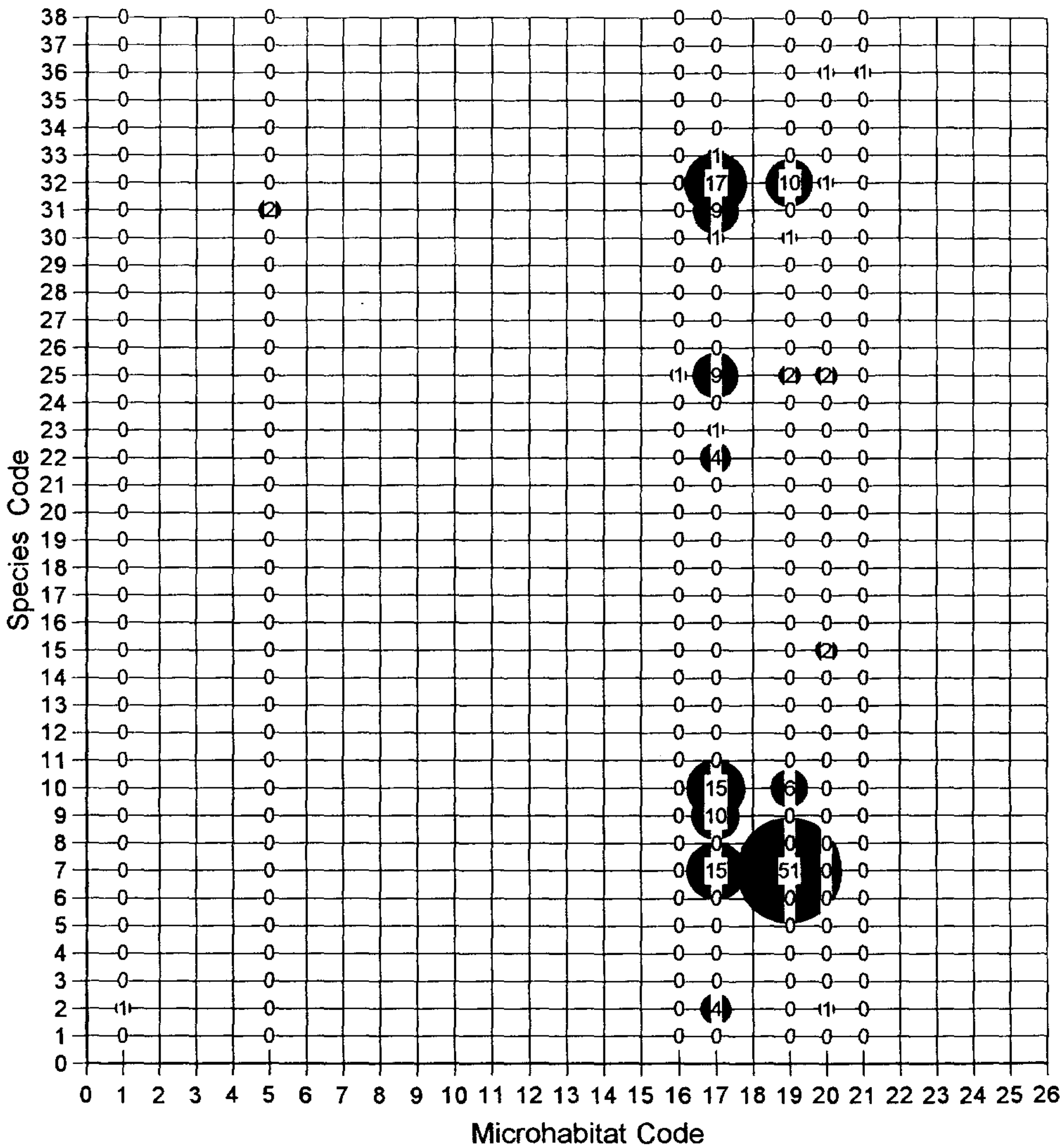
Appendix 2. Site 2 Sample 2, 12-28-95.



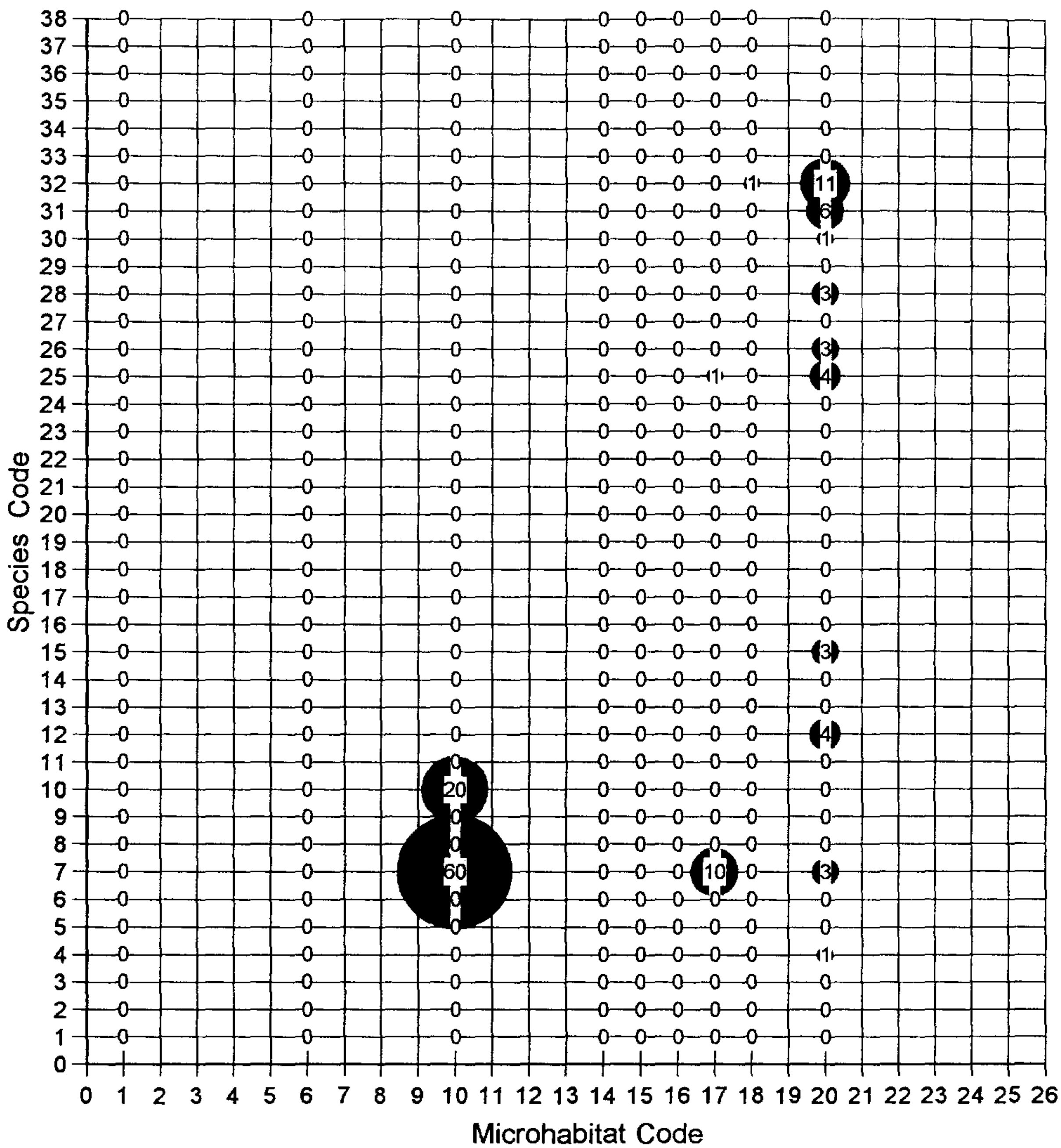
Appendix 2. Site 3 Sample 2, 01-03-96.



Appendix 2. Site 4 Sample 2, 01-04-96.



Appendix 2. Site 5 Sample 2, 01-02-96.



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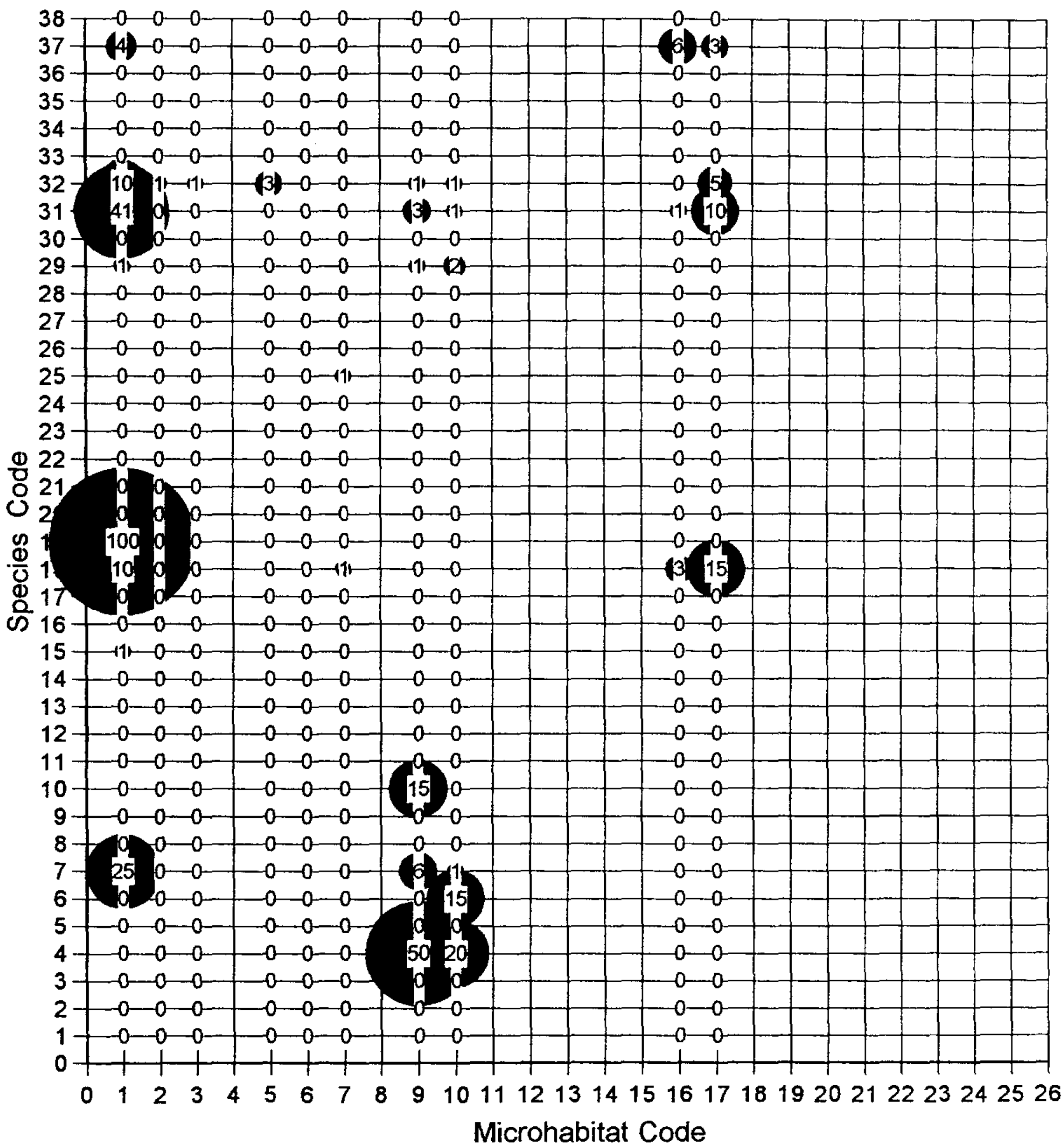
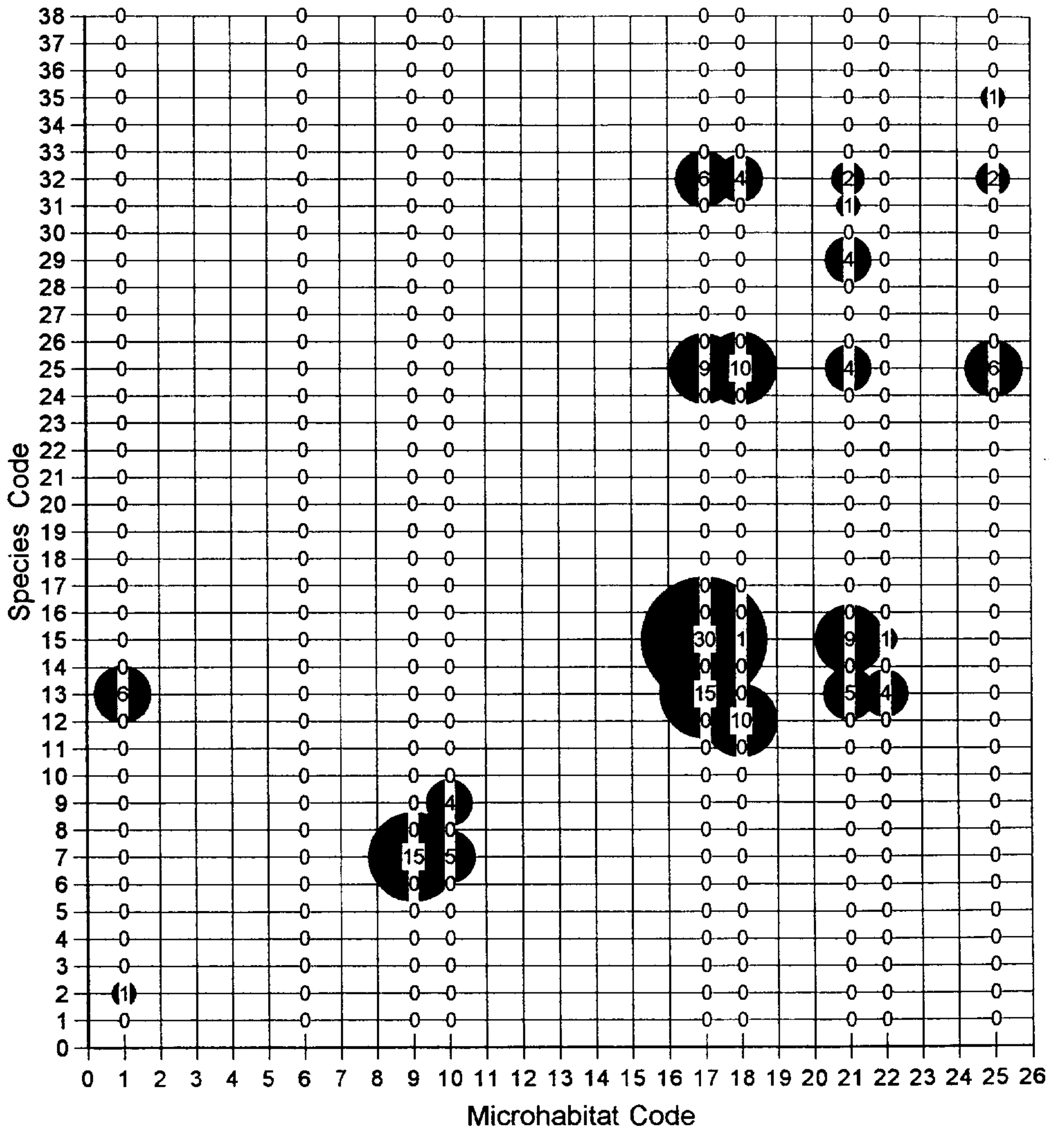
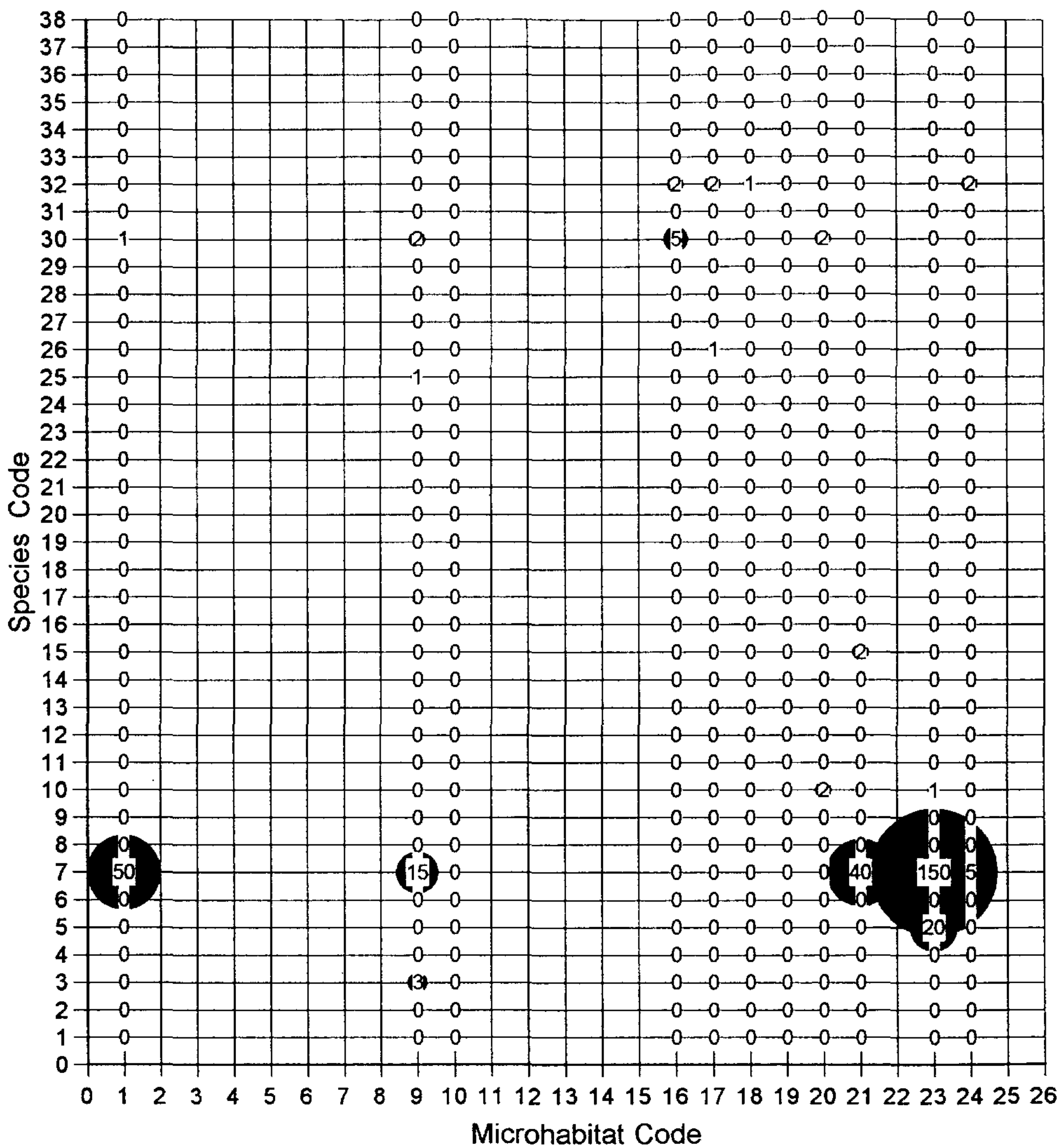


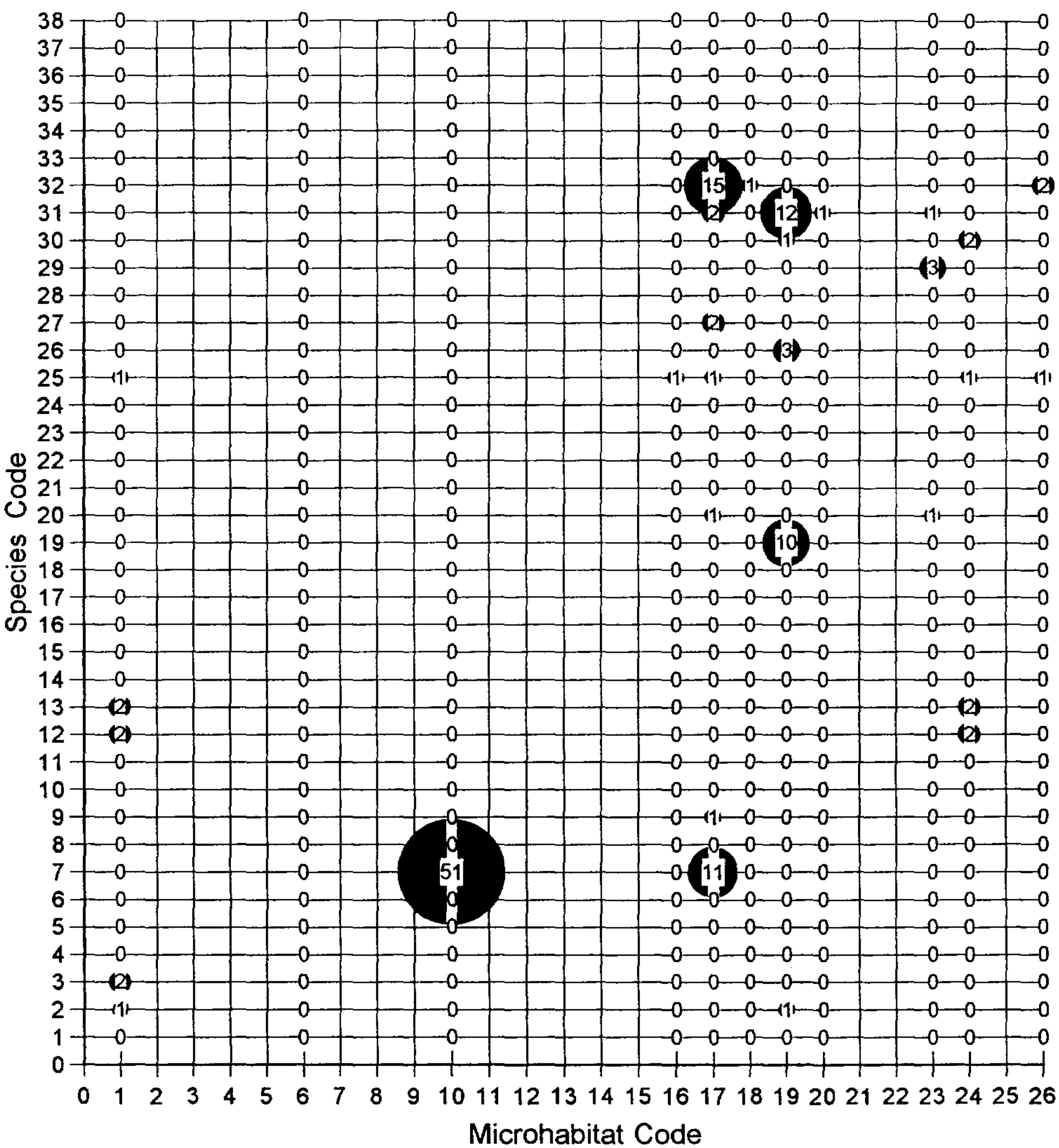
Appendix 2. Site 1 Sample 3, 02-07-96.



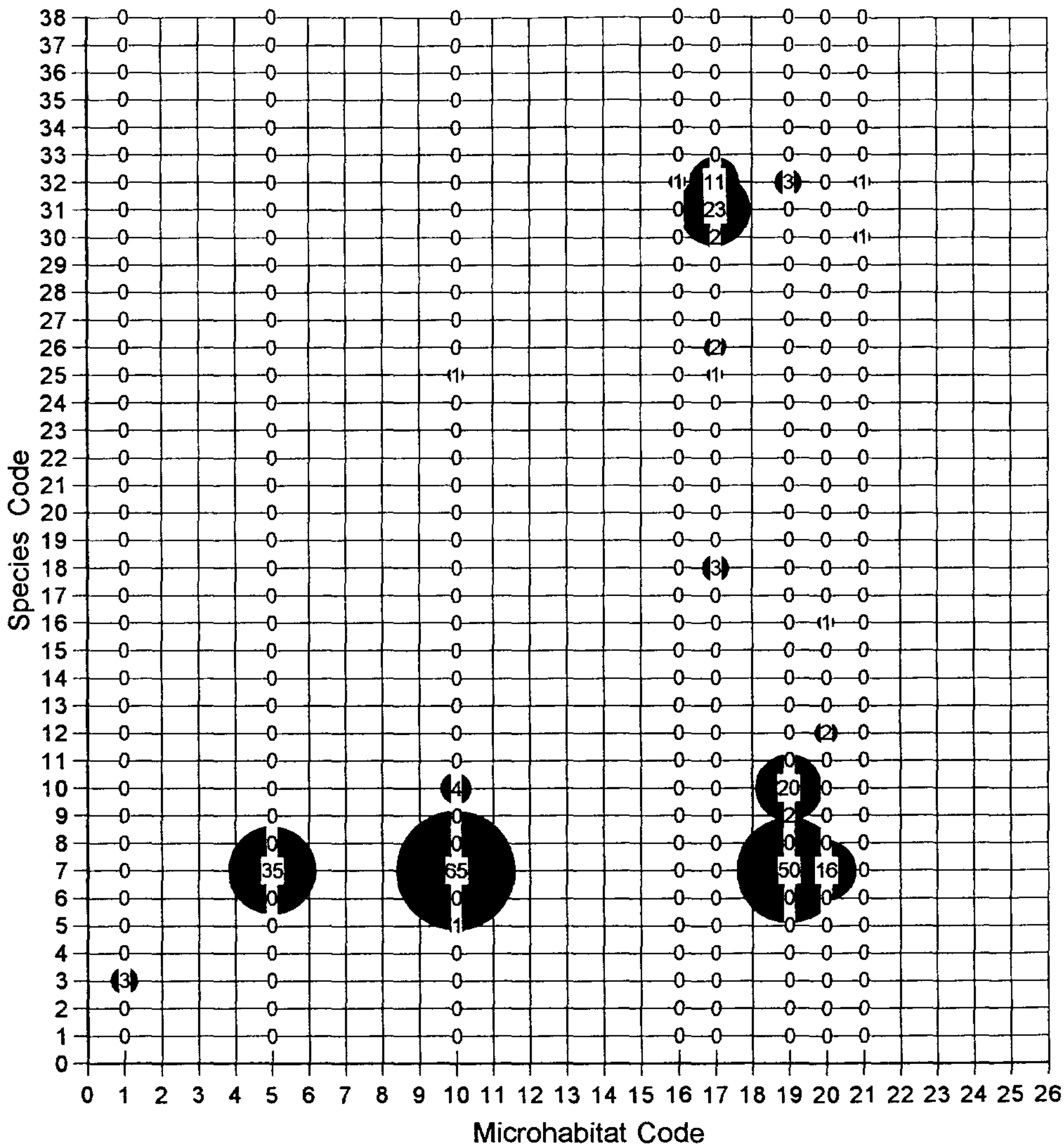
Appendix 2. Site 2 Sample 3, 04-03-96.



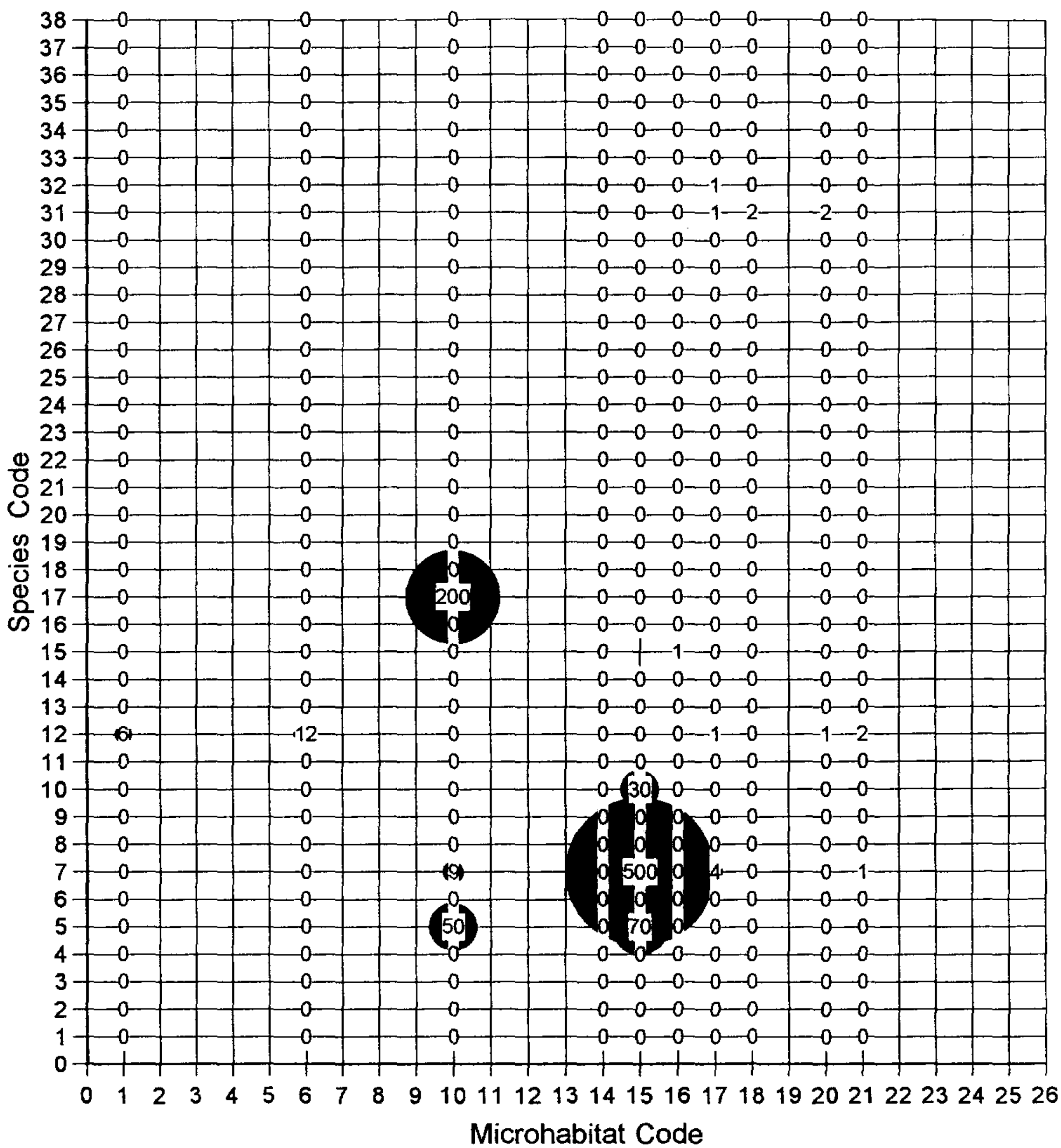
Appendix 2. Site 3 Sample 3, 04-06-96.



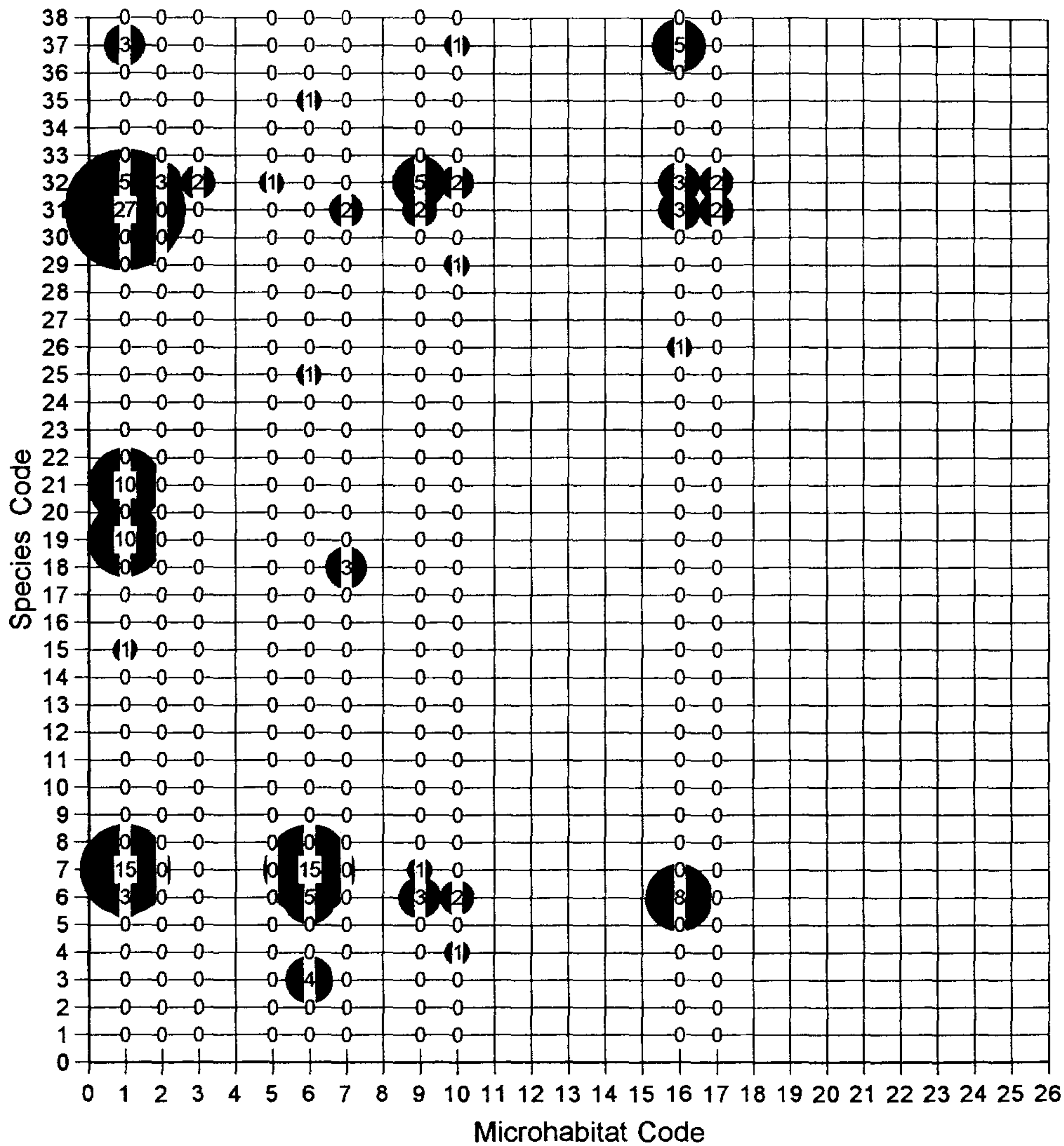
Appendix 2. Site 4 Sample 3, 04-03-96.



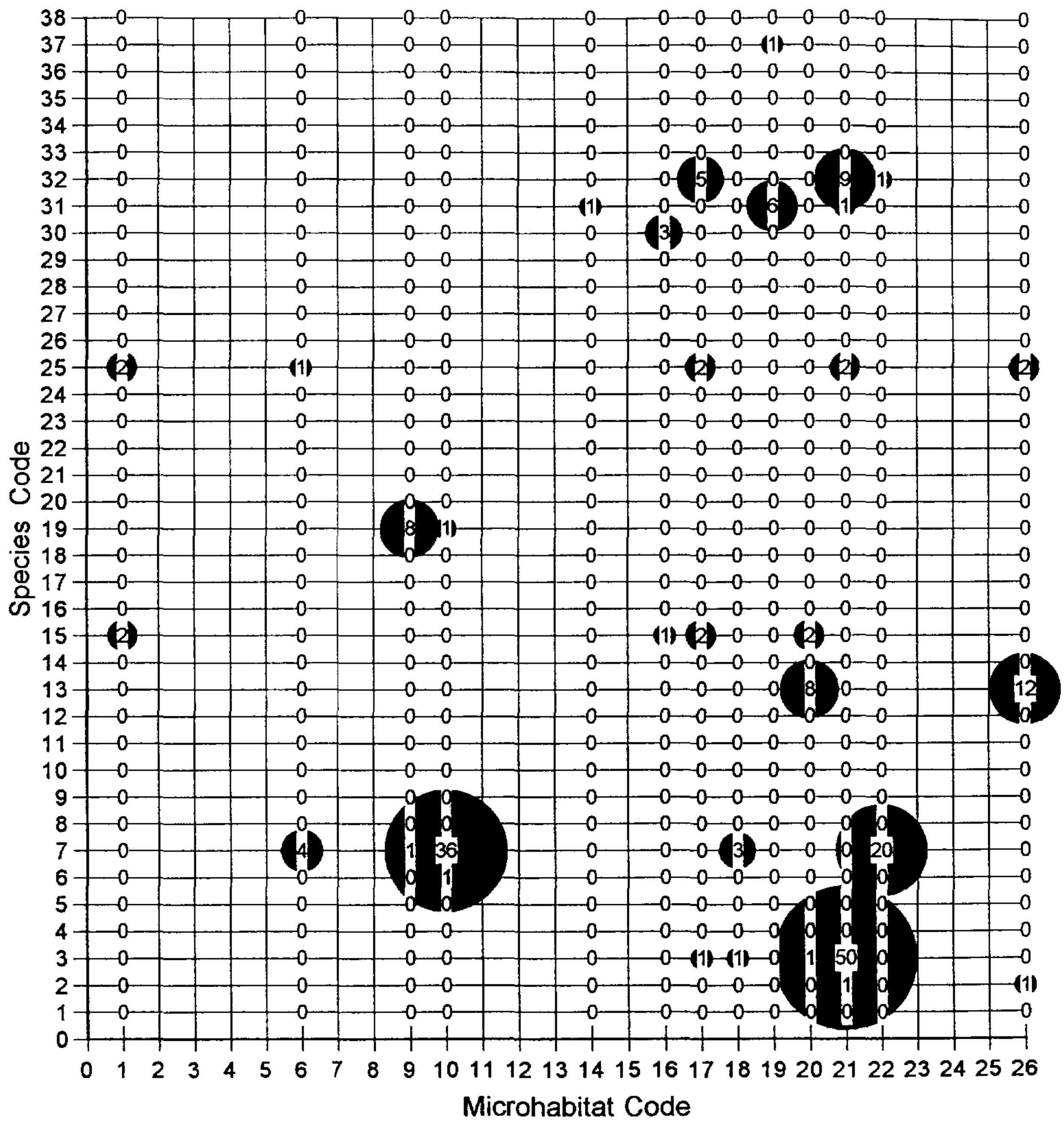
Appendix 2. Site 5 Sample 3, 04-02-96.



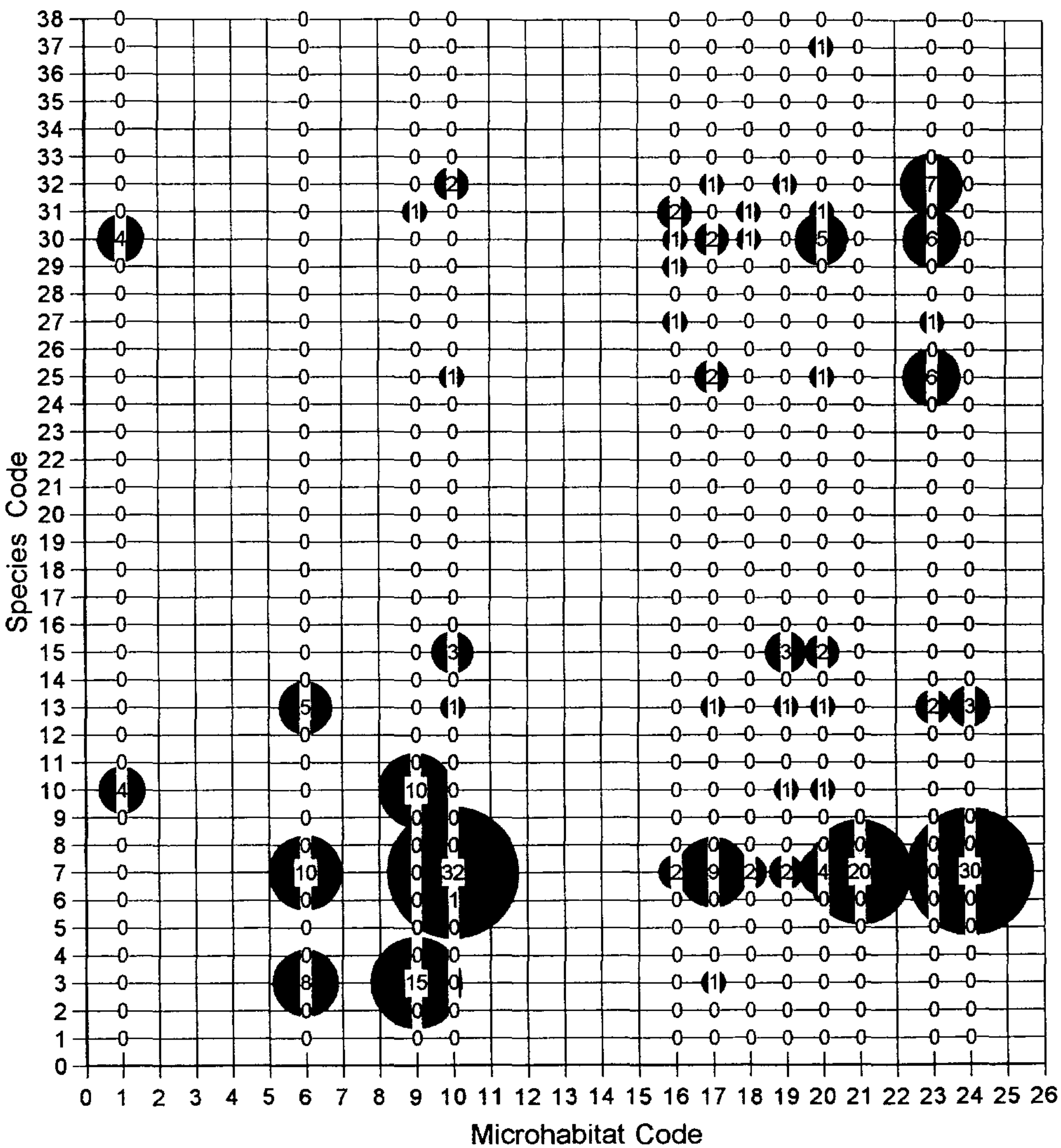
Appendix 2. Site 6 Sample 3, 04-02-96.



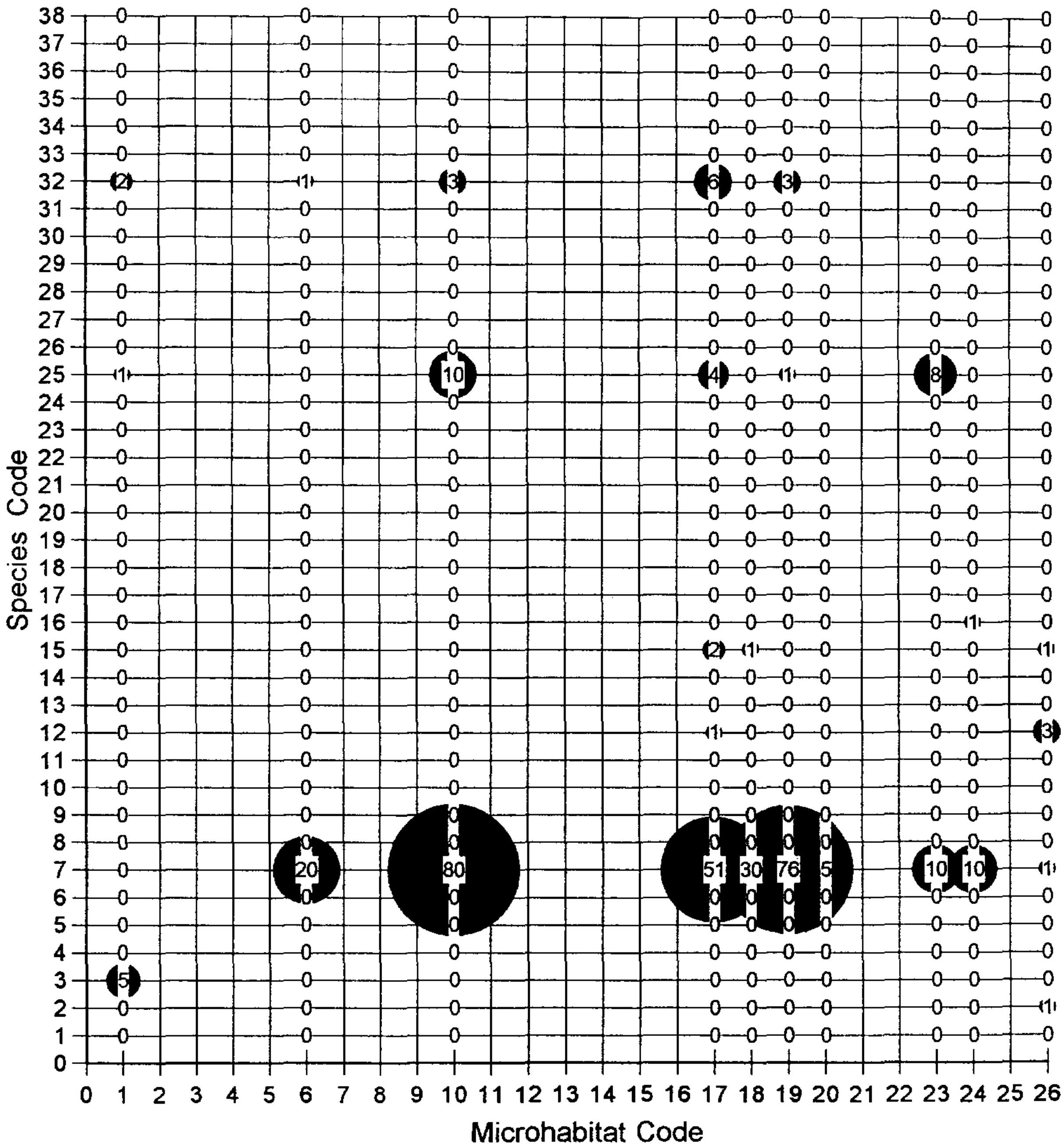
Appendix 2. Site 1 Sample 4, 05-07-96.



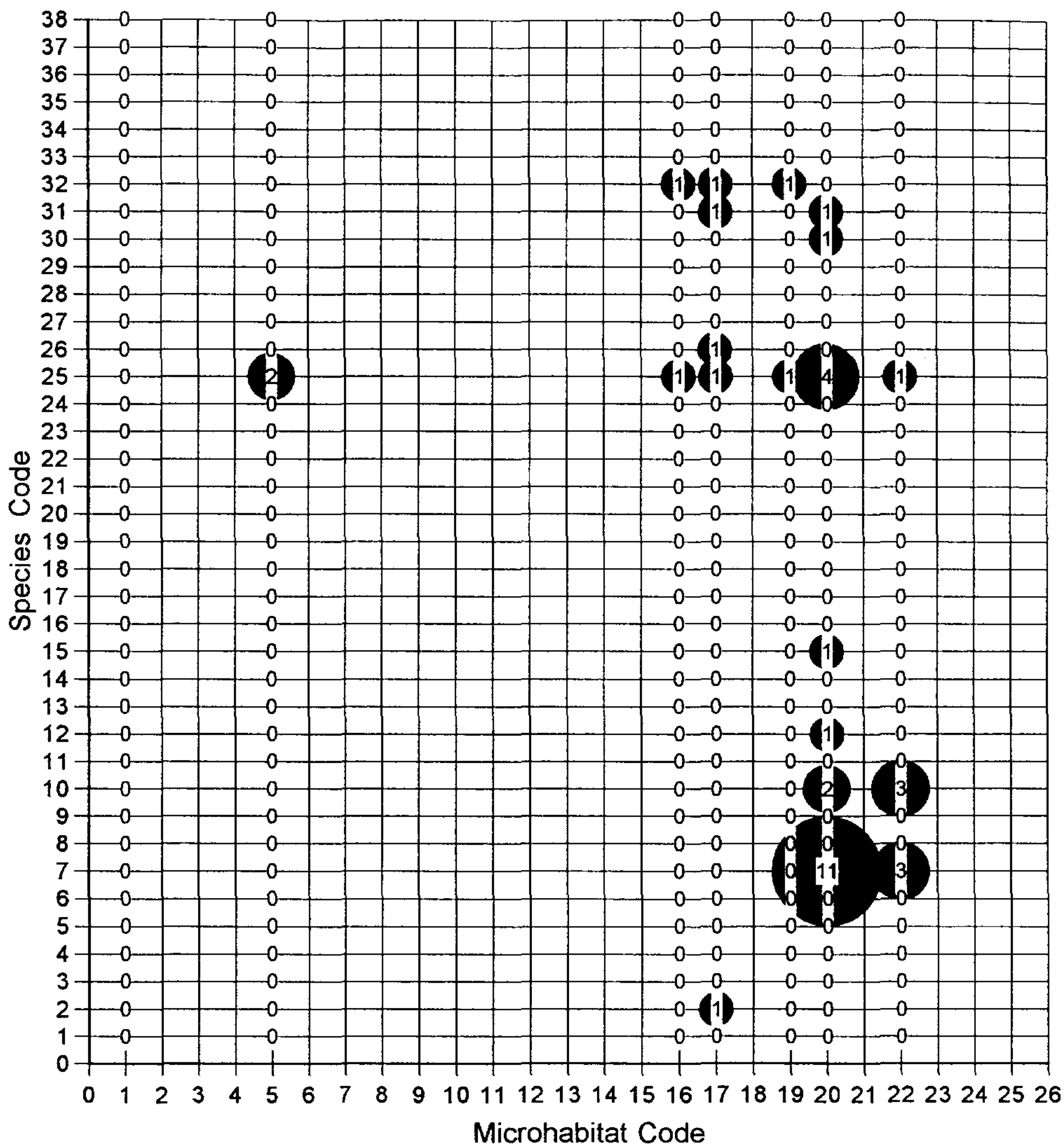
Appendix 2. Site 2 Sample 4, 05-01-96.



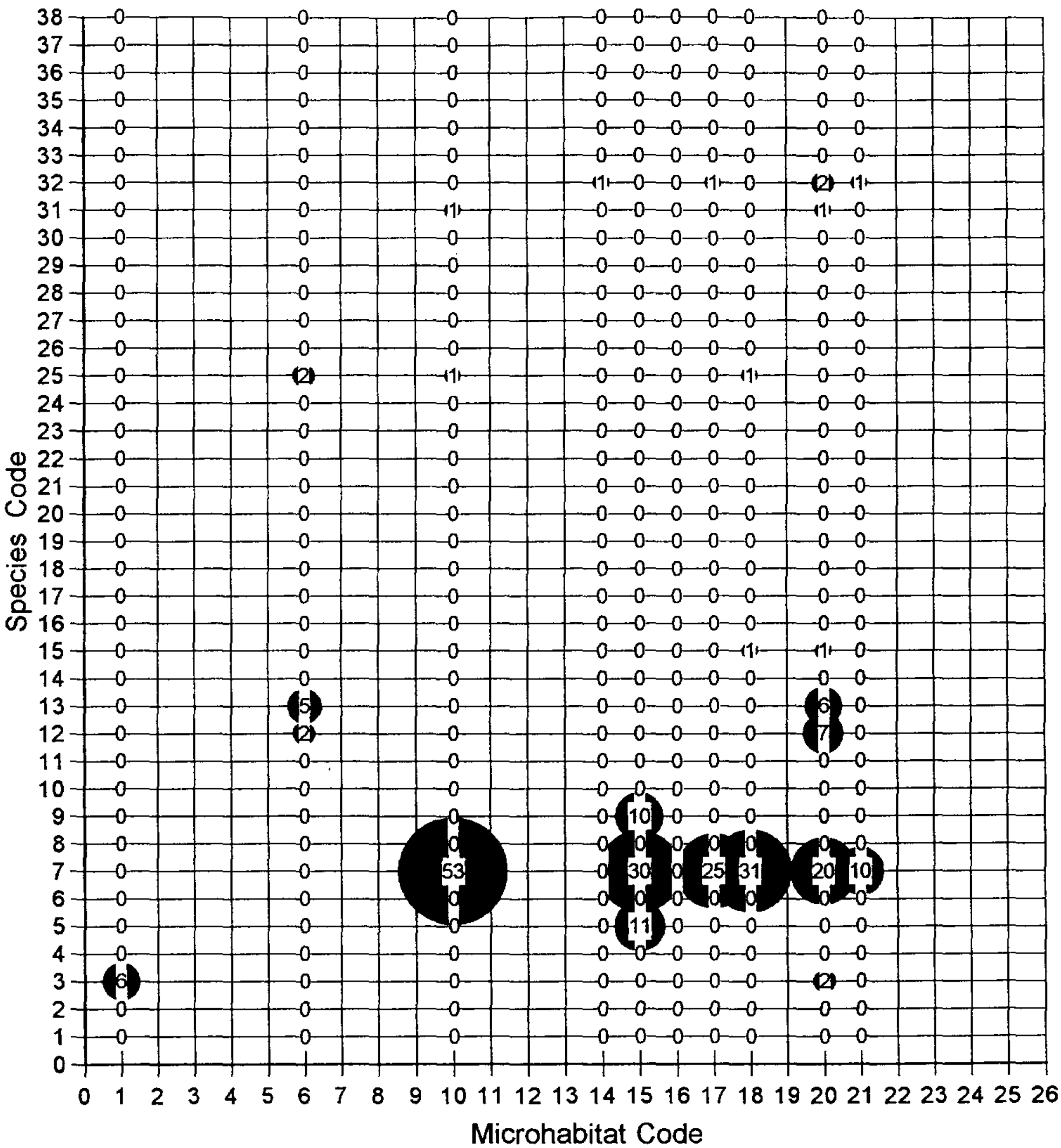
Appendix 2. Site 3 Sample 4, 05-13-96.



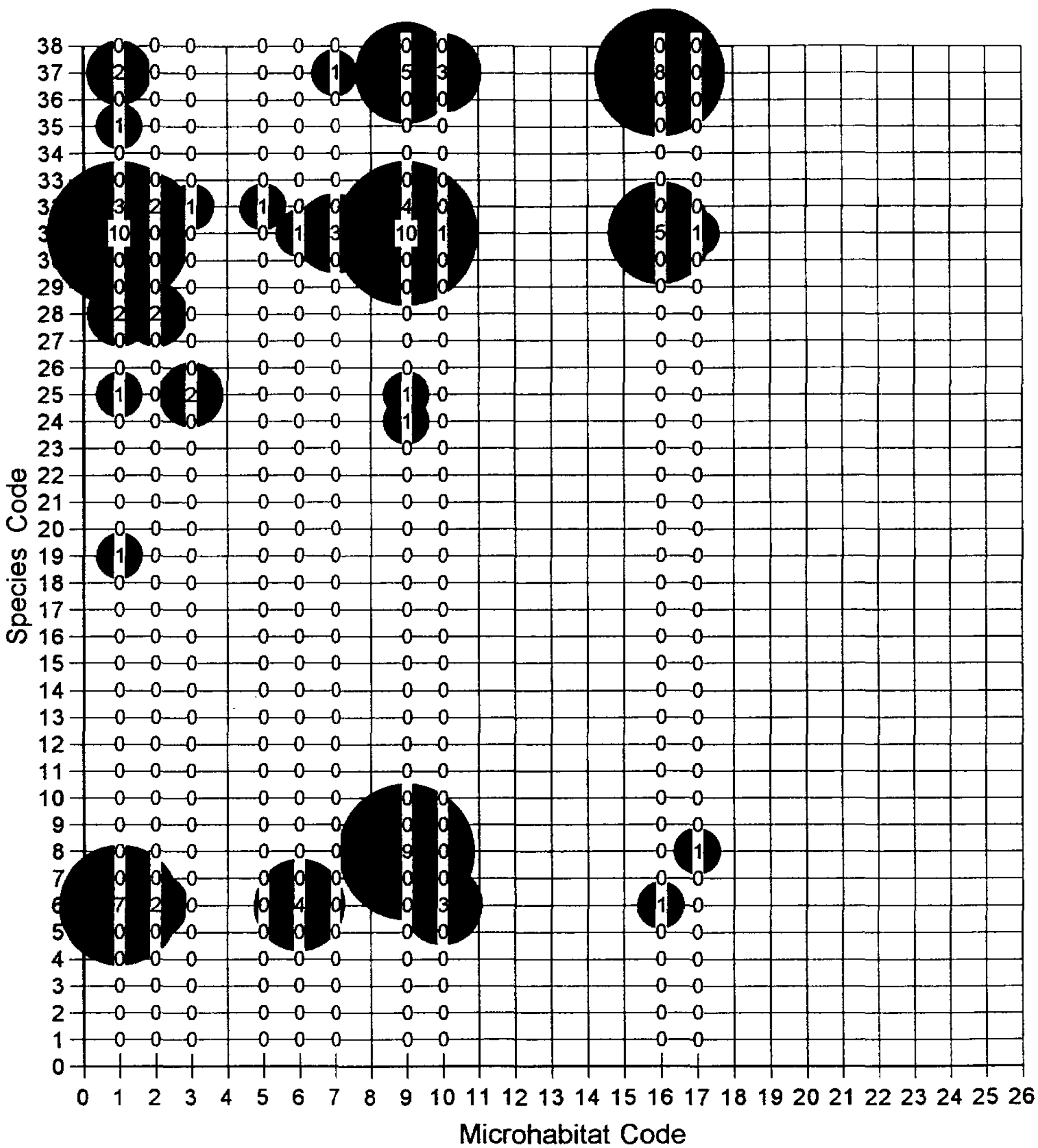
Appendix 2. Site 4 Sample 4, 05-08-96.



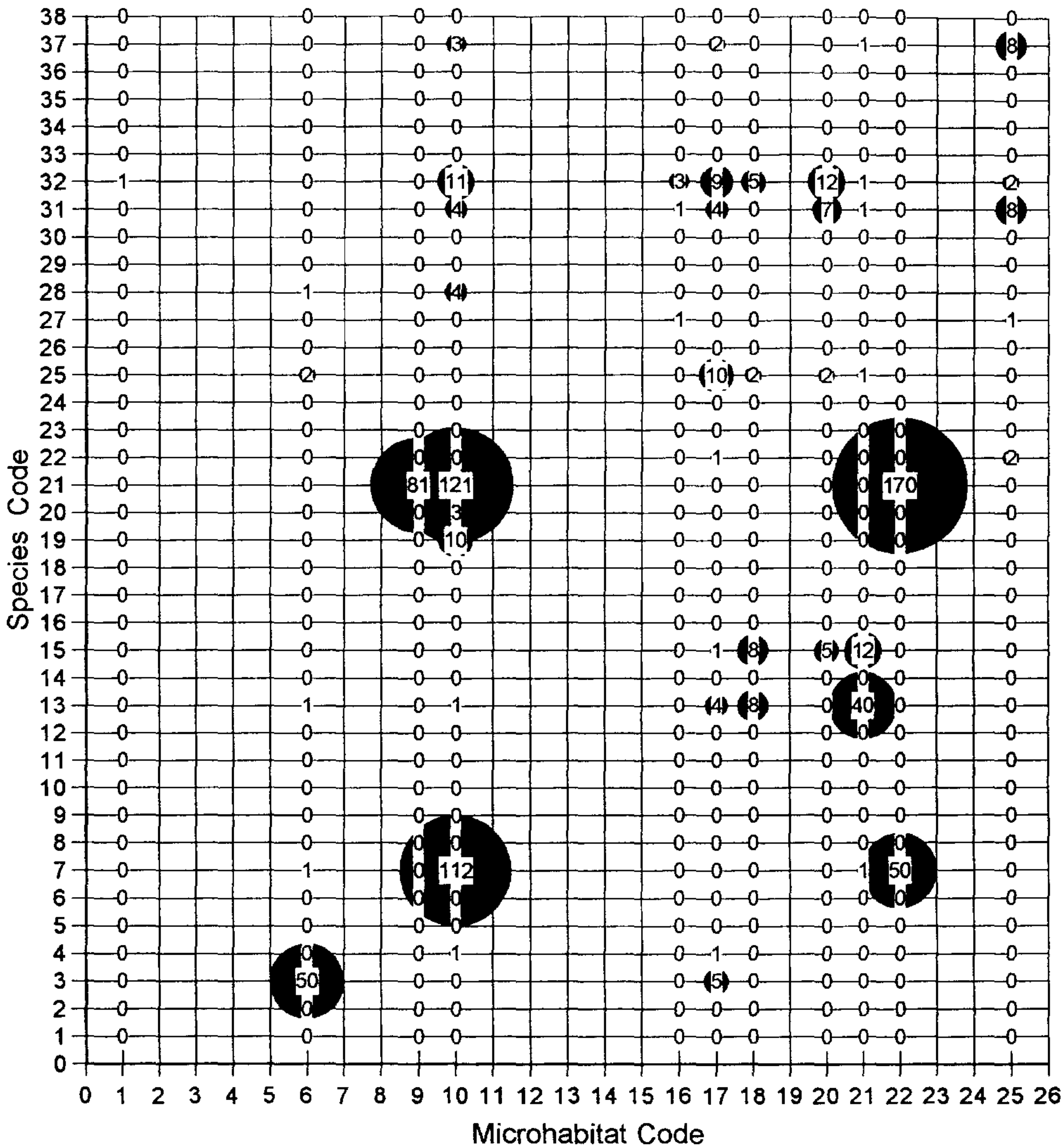
Appendix 2. Site 5 Sample 4, 05-10-96.



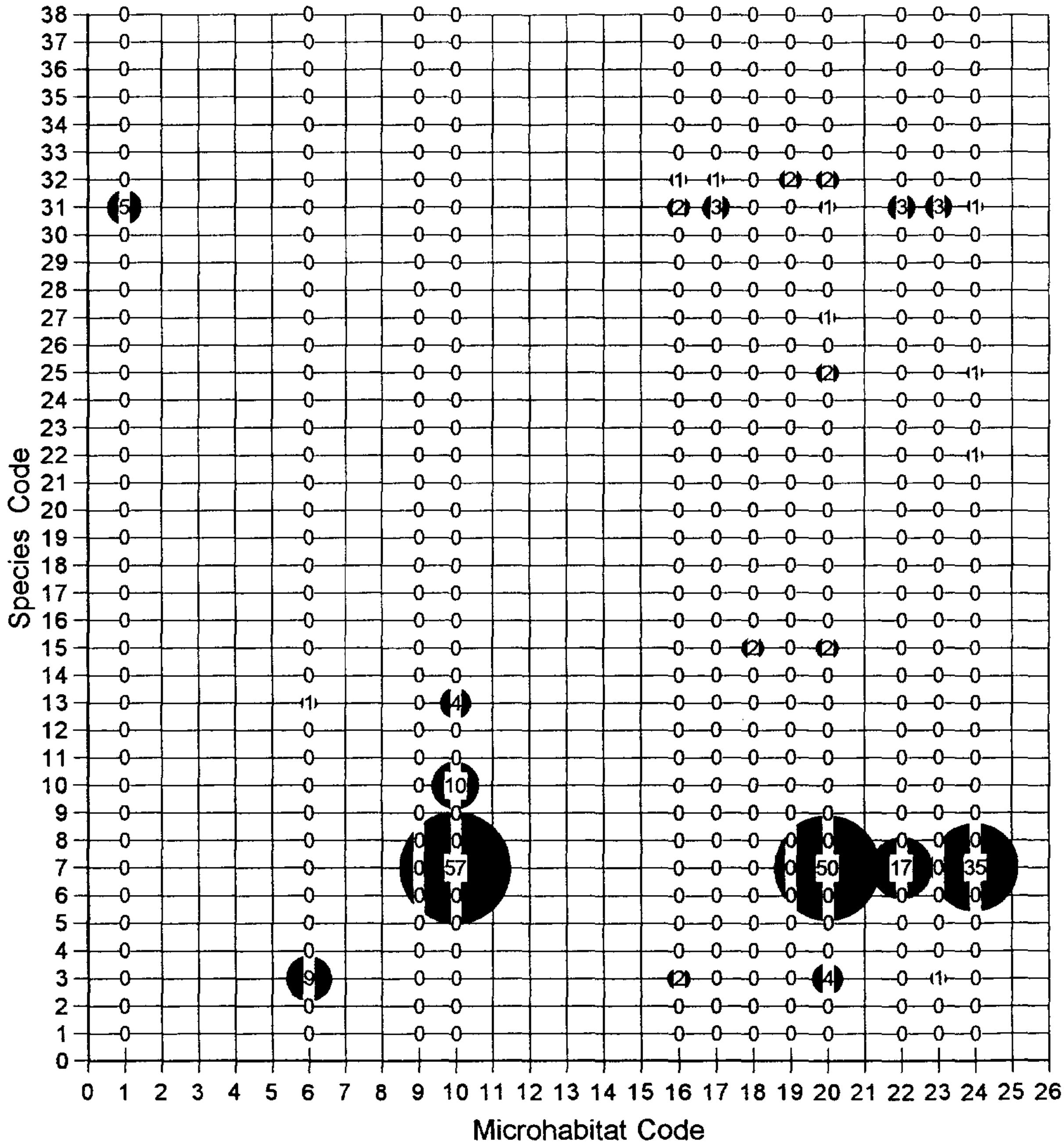
Appendix 2. Site 6 Sample 4, 05-08-96.



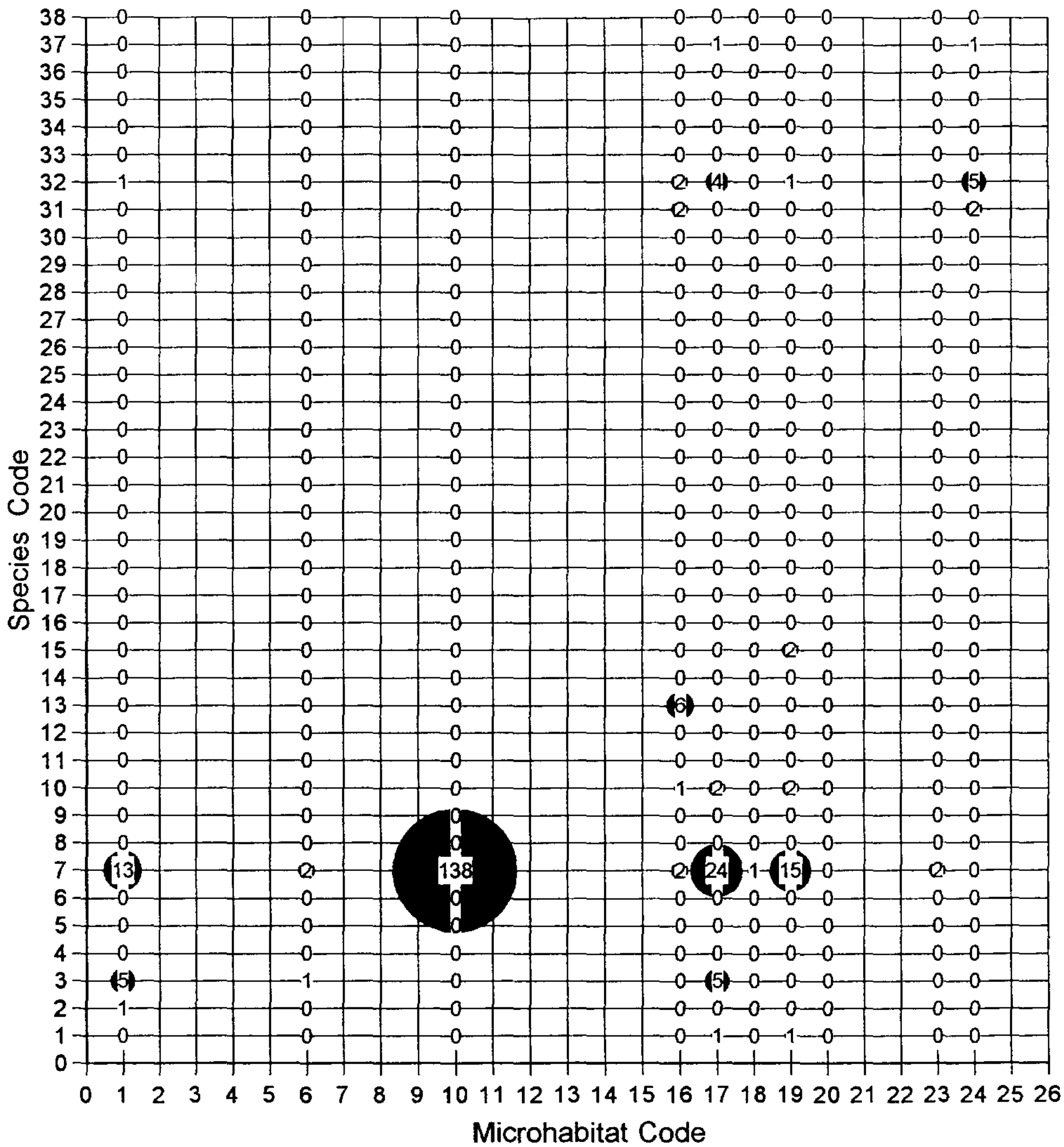
Appendix 2. Site 1 Sample 5, 06-14-96.



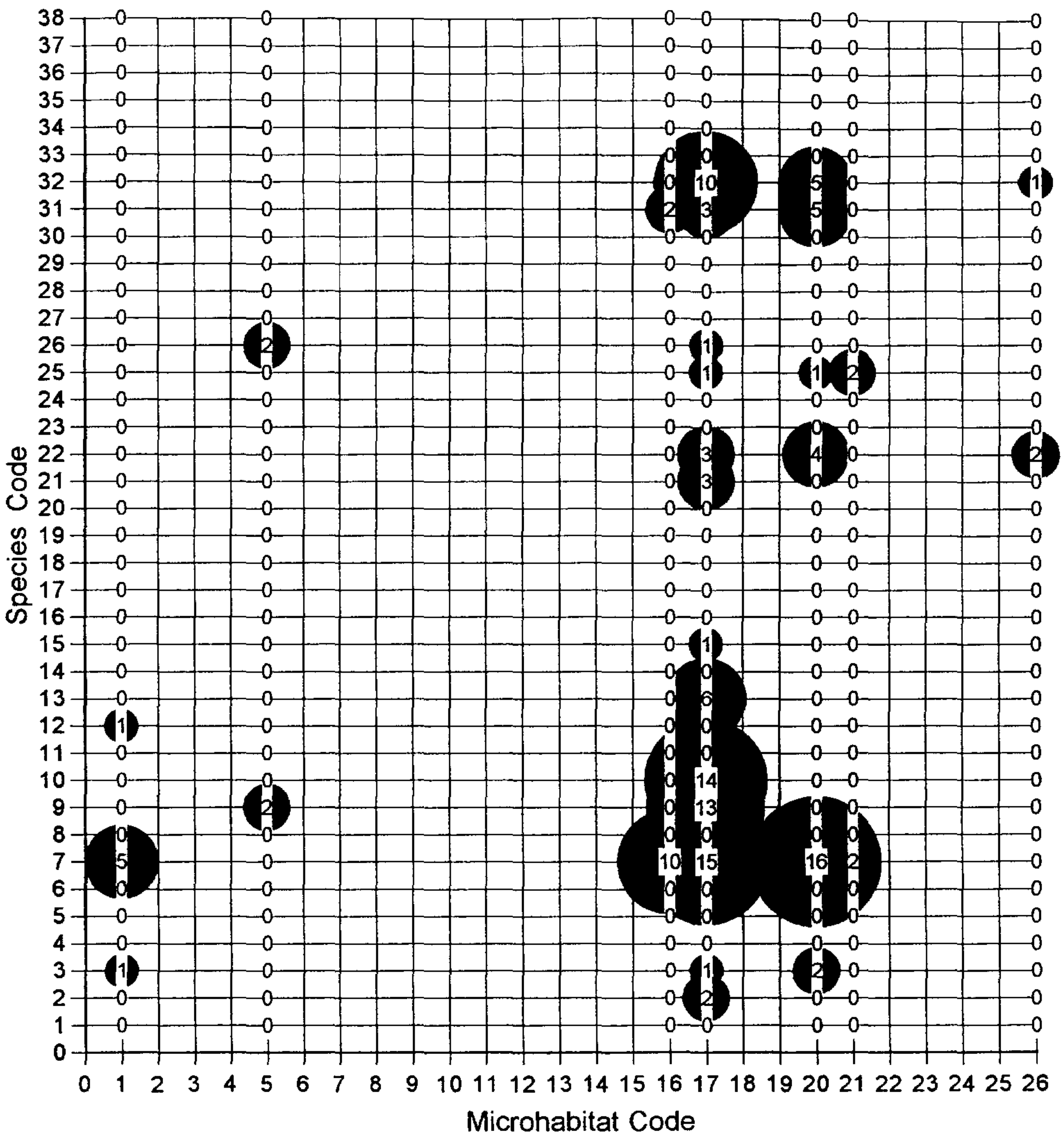
Appendix 2. Site 2 Sample 5, 06-10-96.



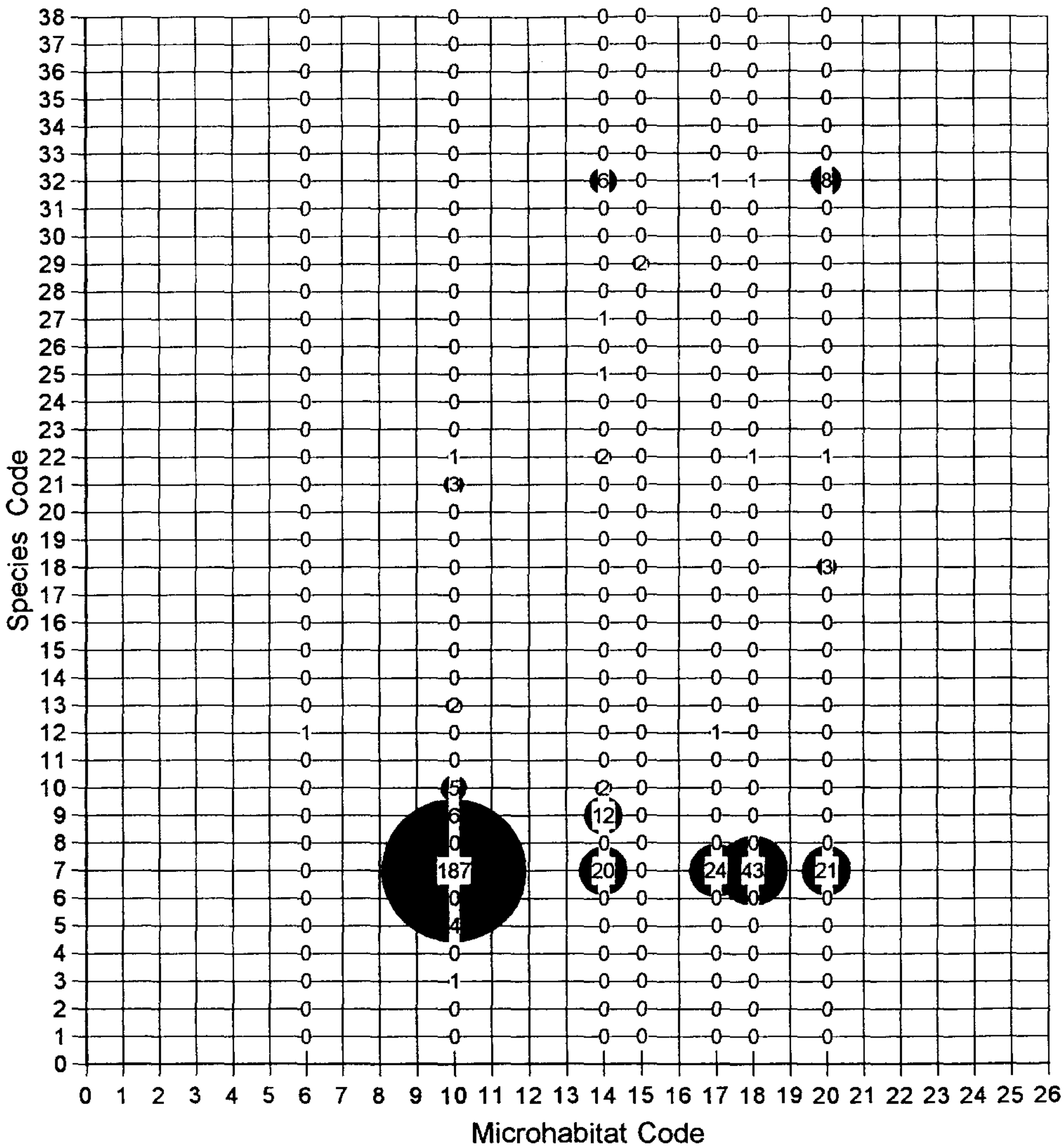
Appendix 2. Site 3 Sample 5, 06-13-96.



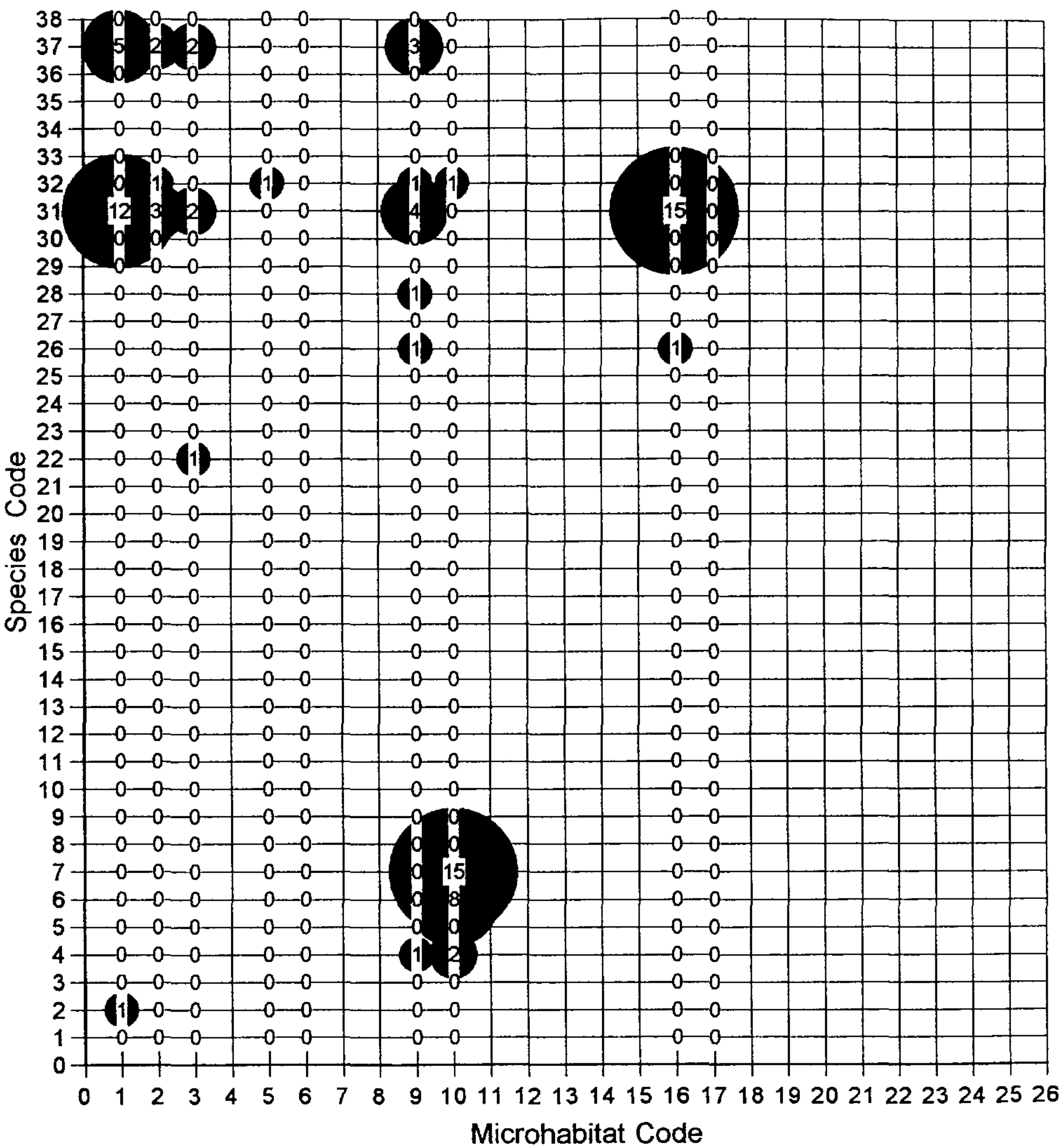
Appendix 2. Site 4 Sample 5, 06-11-96.



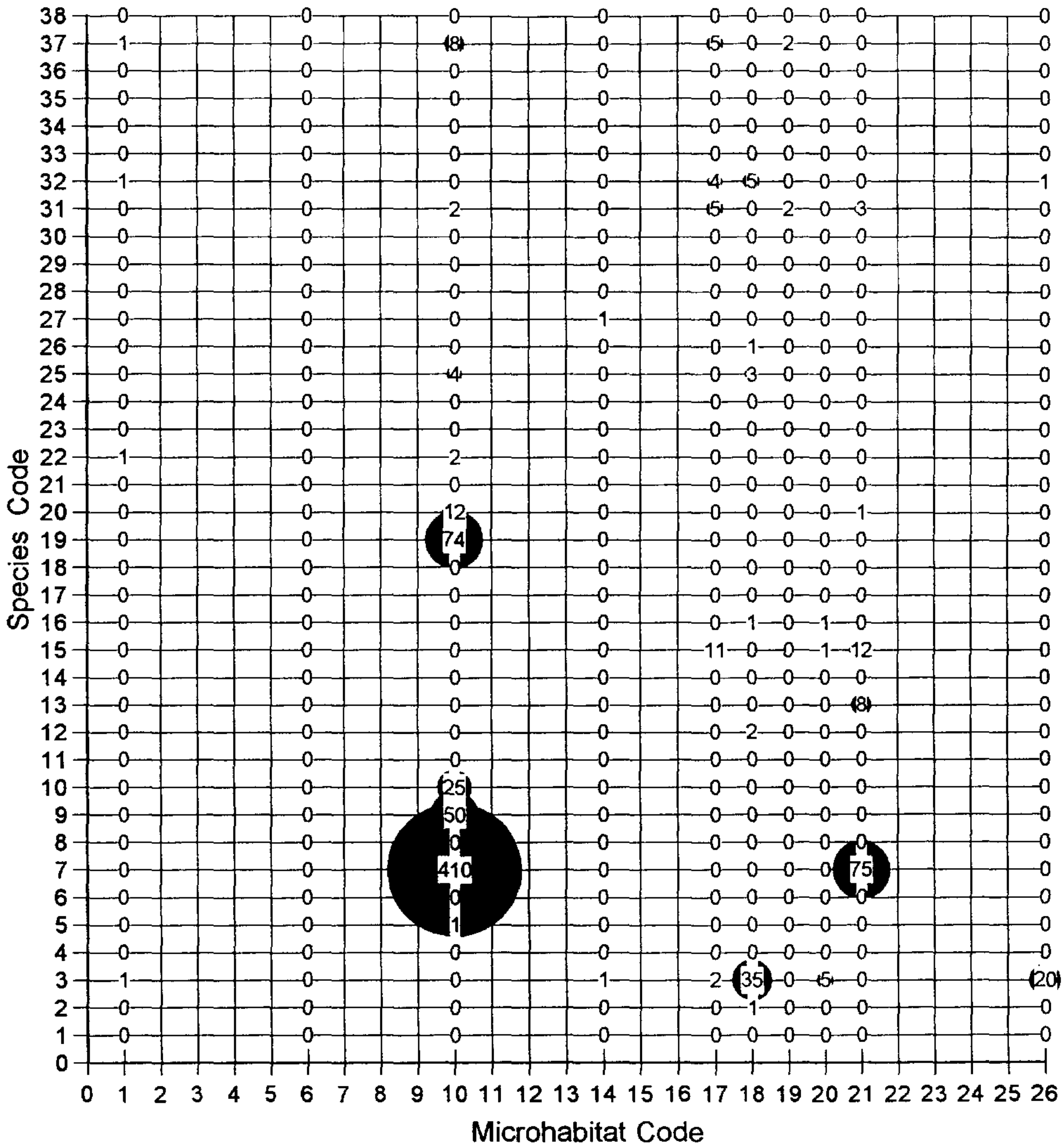
Appendix 2. Site 5 Sample 5, 06-12-96.



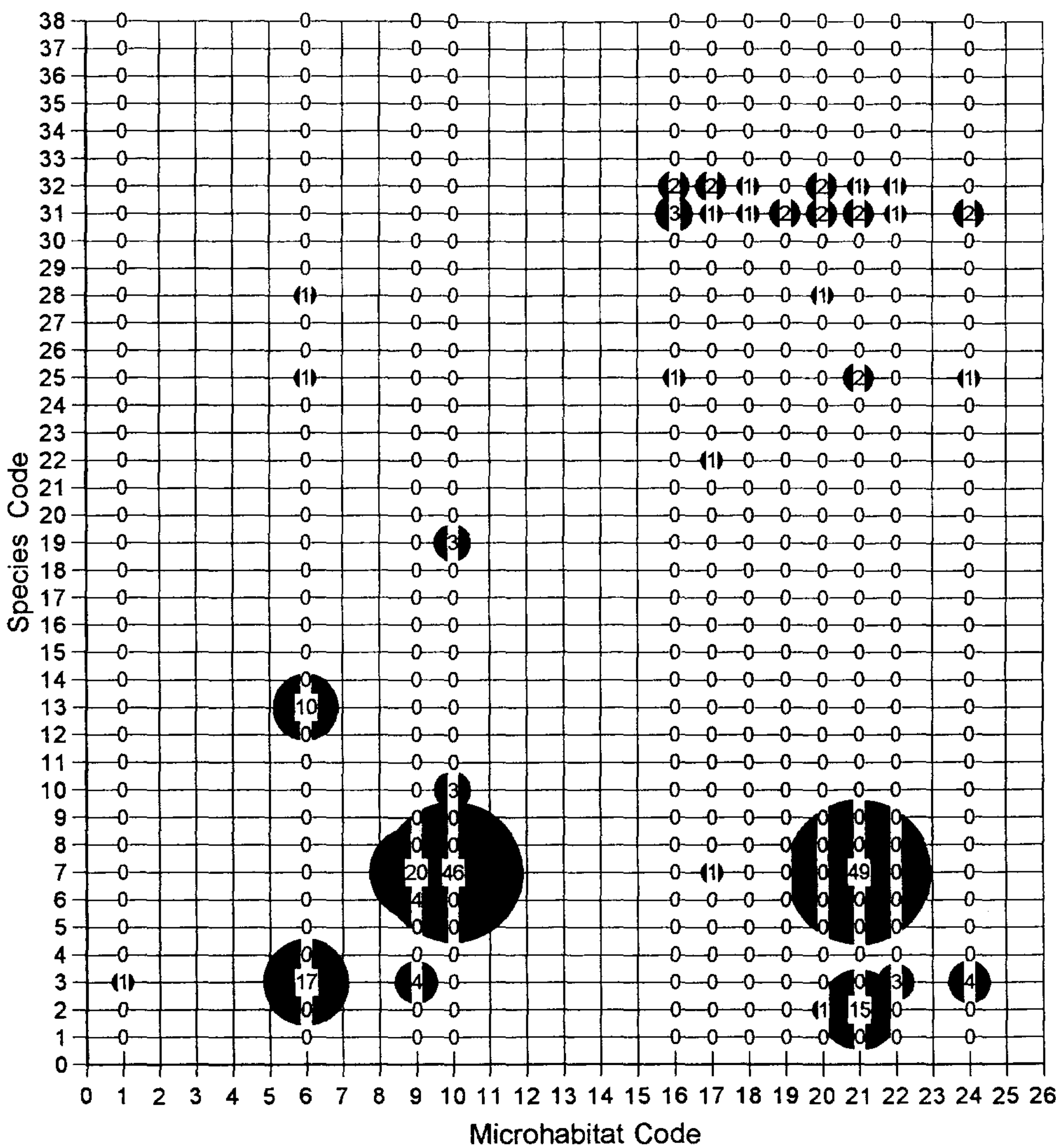
Appendix 2. Site 6 Sample 5, 06-12-96.



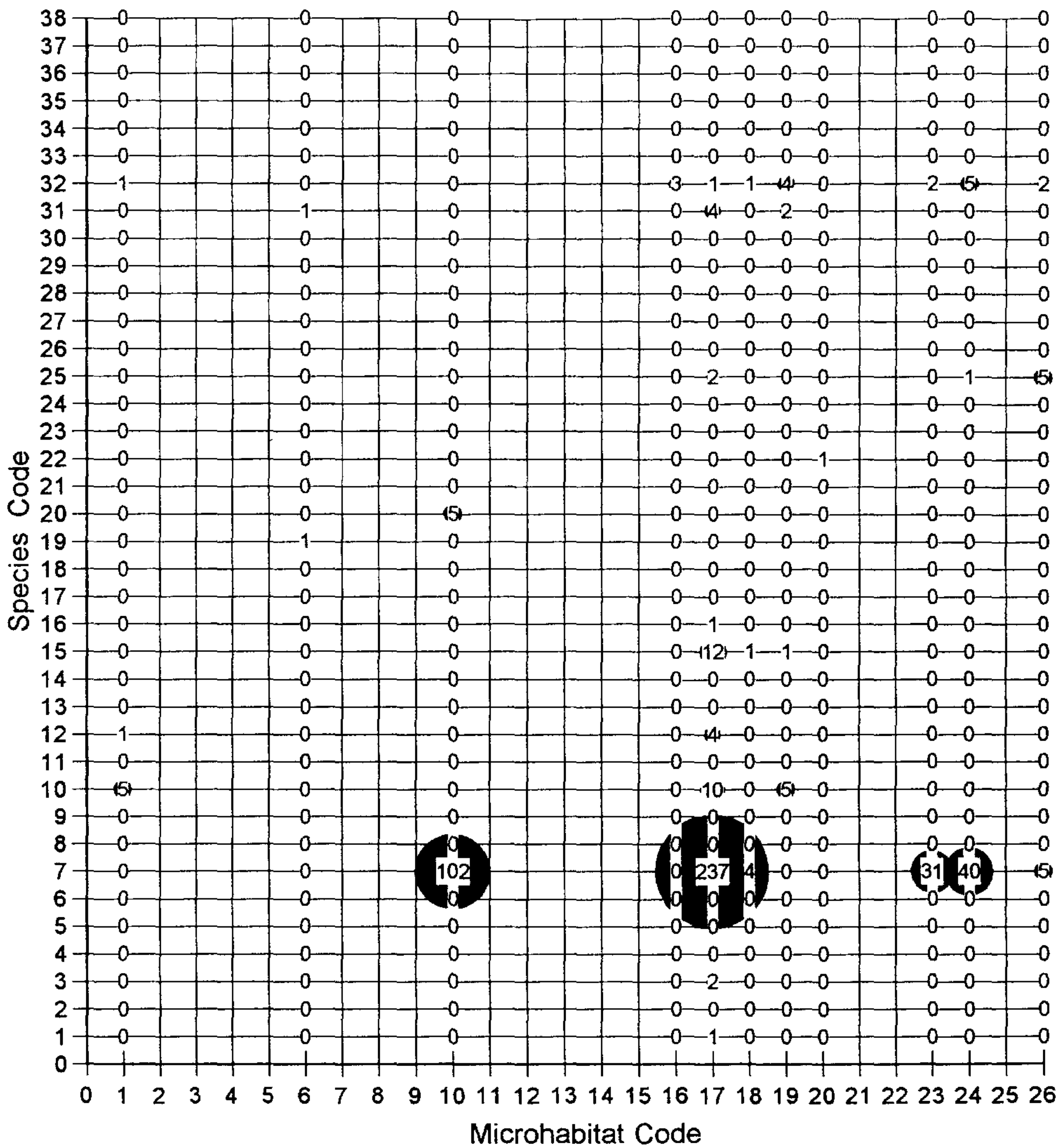
Appendix 2. Site 1 Sample 6, 07-02-96.



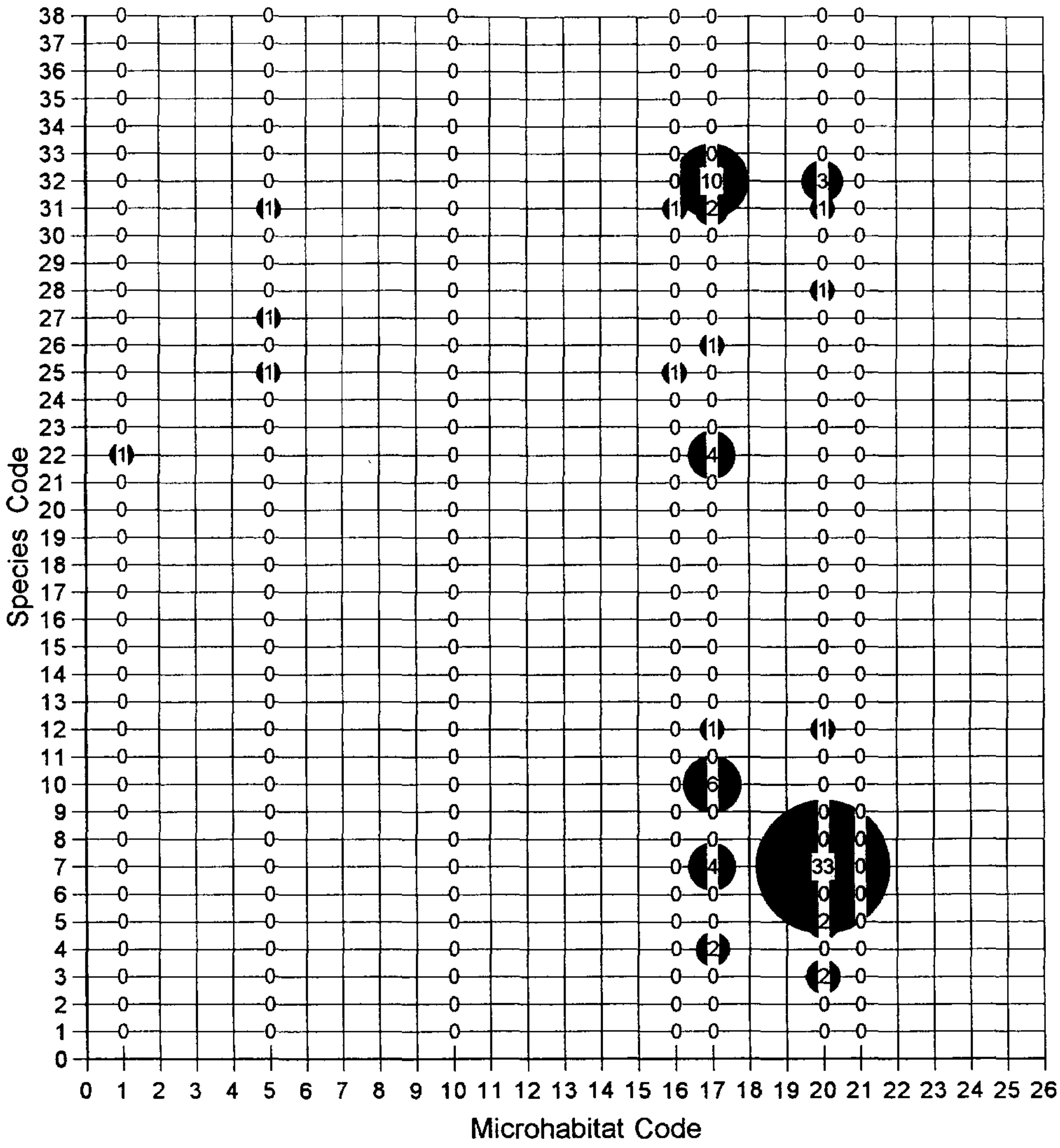
Appendix 2. Site 2 Sample 6, 07-05-96.



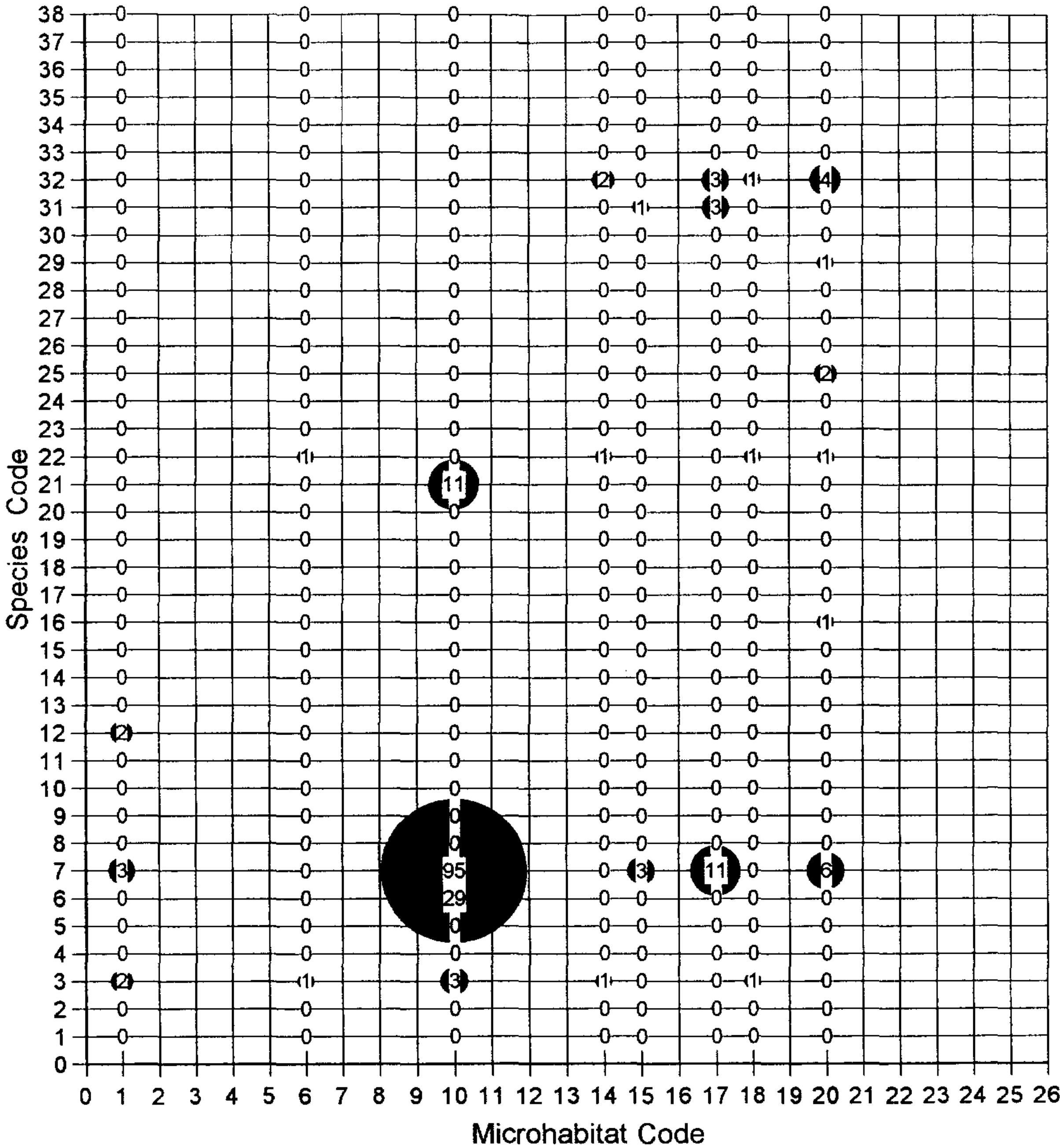
Appendix 2. Site 3 Sample 6, 07-04-96.



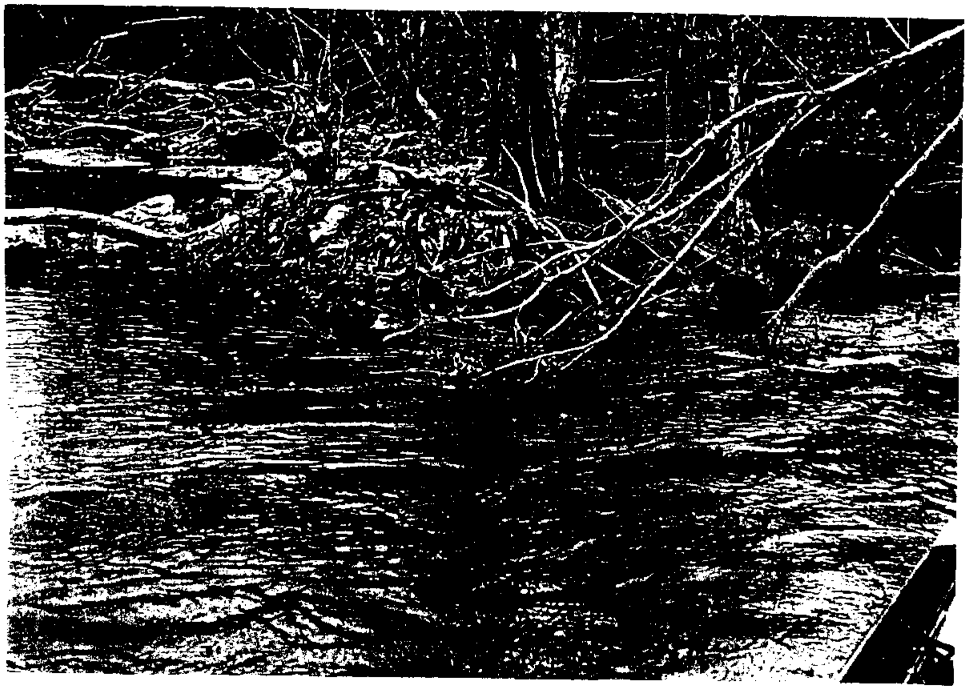
Appendix 2. Site 4 Sample 6, 07-05-96.



Appendix 2. Site 5 Sample 6, 07-03-96.



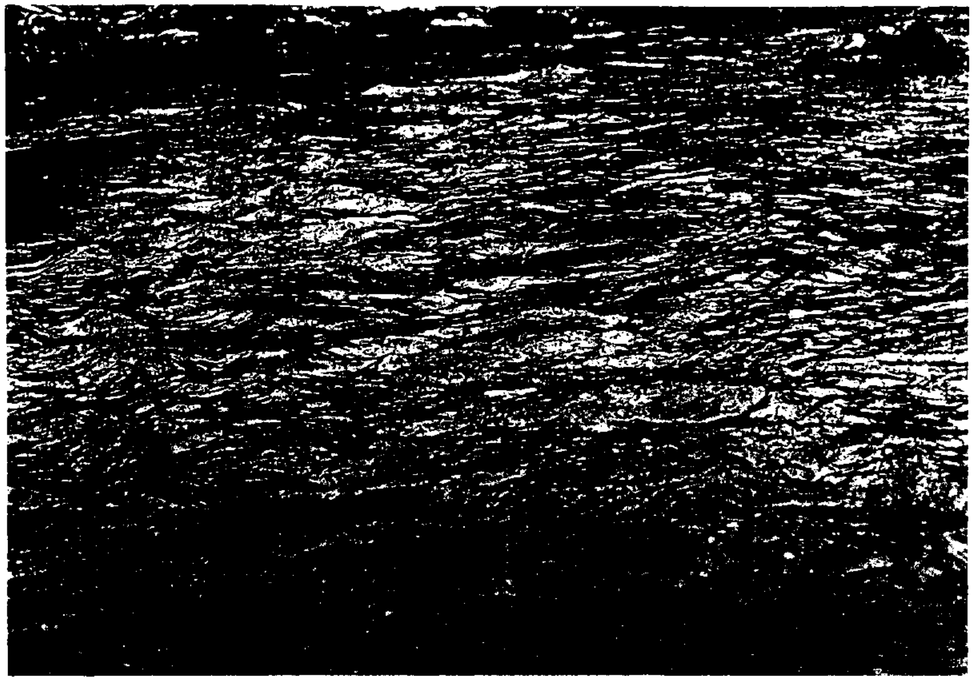
Appendix 2. Site 6 Sample 6, 07-03-96.



Site 1-A

Site 1-B

Appendix 3. Microhabitats at Sample Sites.



Site 1-C

Site 1-D

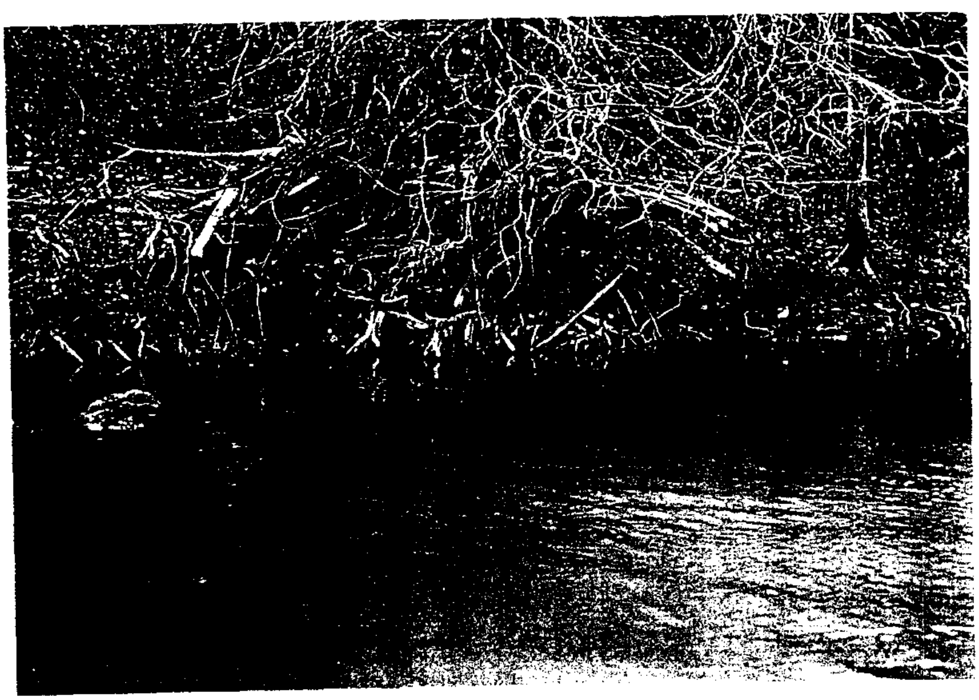
Appendix 3. Microhabitats at Sample Sites.

Site 1-E

Site 1-F

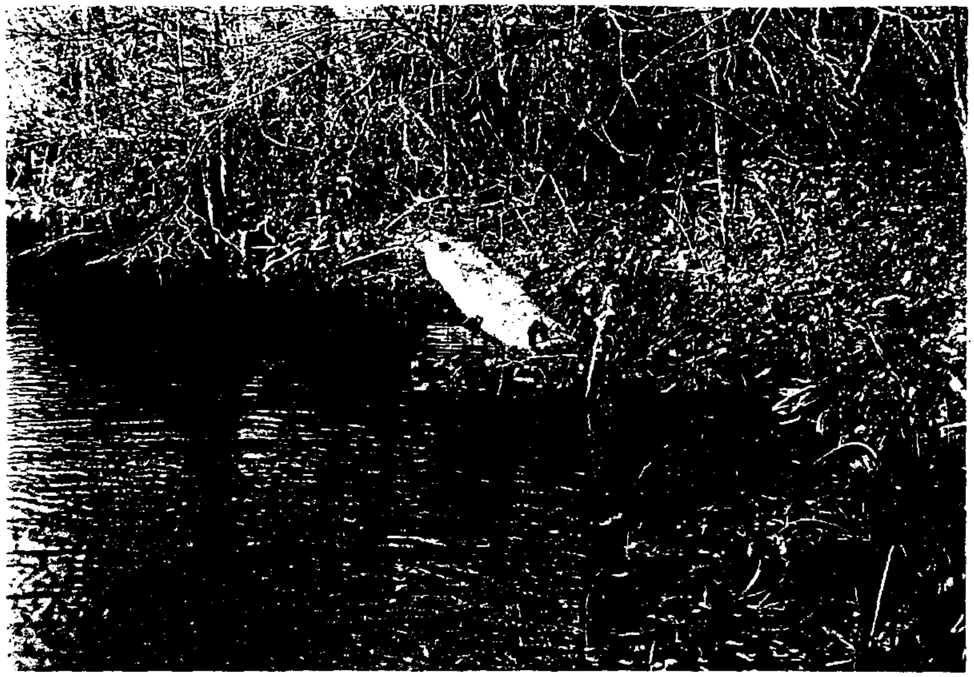
Appendix 3. Microhabitats at Sample Sites.

Site 1-G



Site 1-H

Appendix 3. Microhabitats at Sample Sites.



Site 1-I

Site 1-J

Appendix 3. Microhabitats at Sample Sites.

Site 1-K

Site 1-L

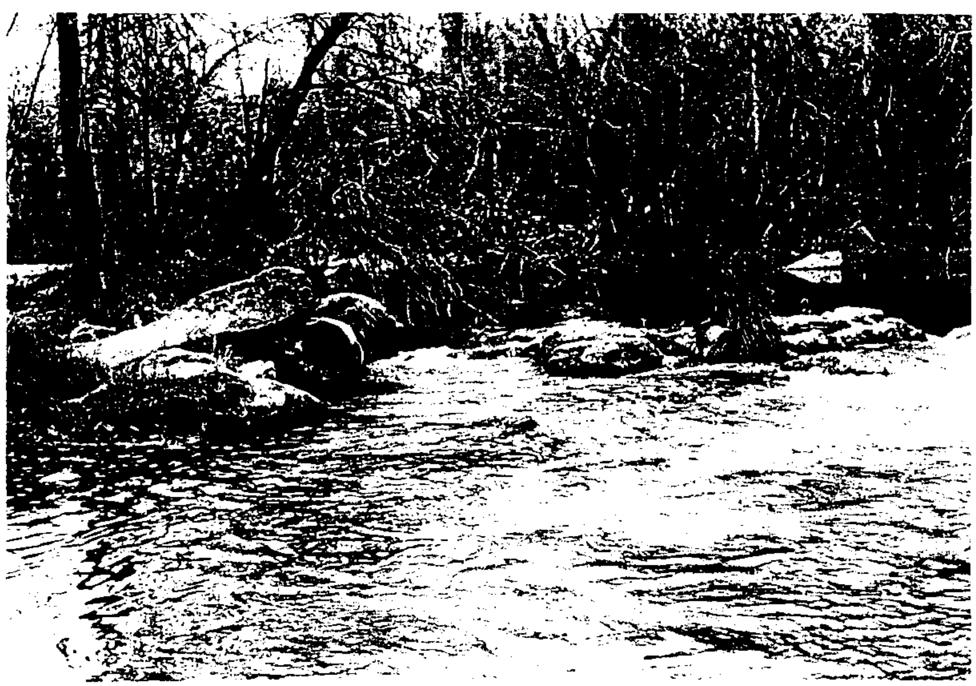
Appendix 3. Microhabitats at Sample Sites.

Site 1-M

Site 1-N

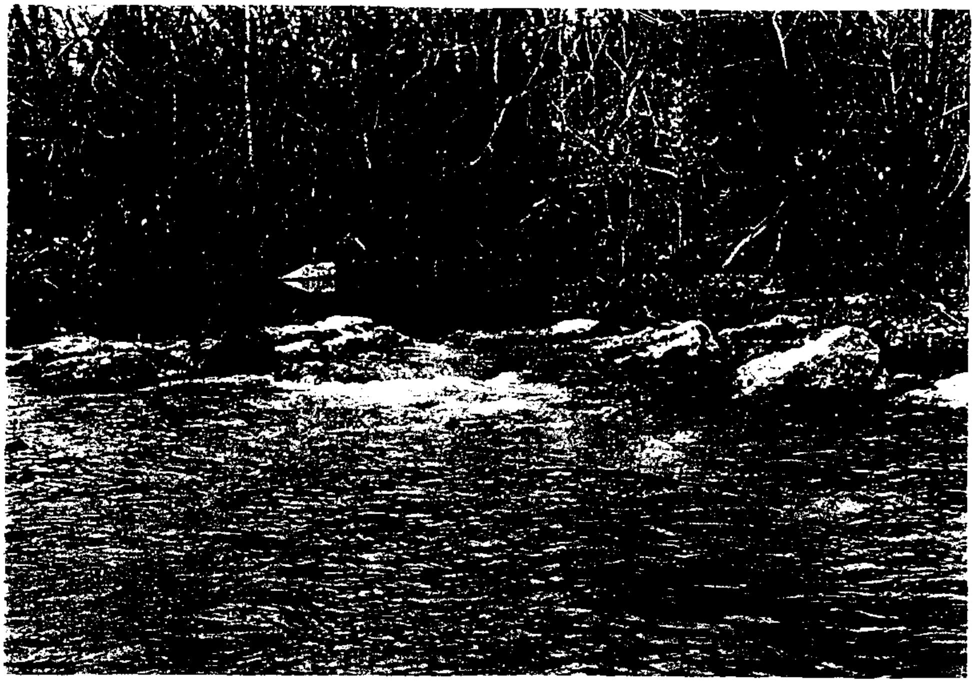
Appendix 3. Microhabitats at Sample Sites.

Site 1-O



Site 1-P

Appendix 3. Microhabitats at Sample Sites.



Site 1-Q & R

Appendix 3. Microhabitats at Sample Sites.

Site 2-A

Site 2-B

Appendix 3. Microhabitats at Sample Sites.

Site 2-C

Site 2-D

Appendix 3. Microhabitats at Sample Sites.

Site 2-E

Site 2-F

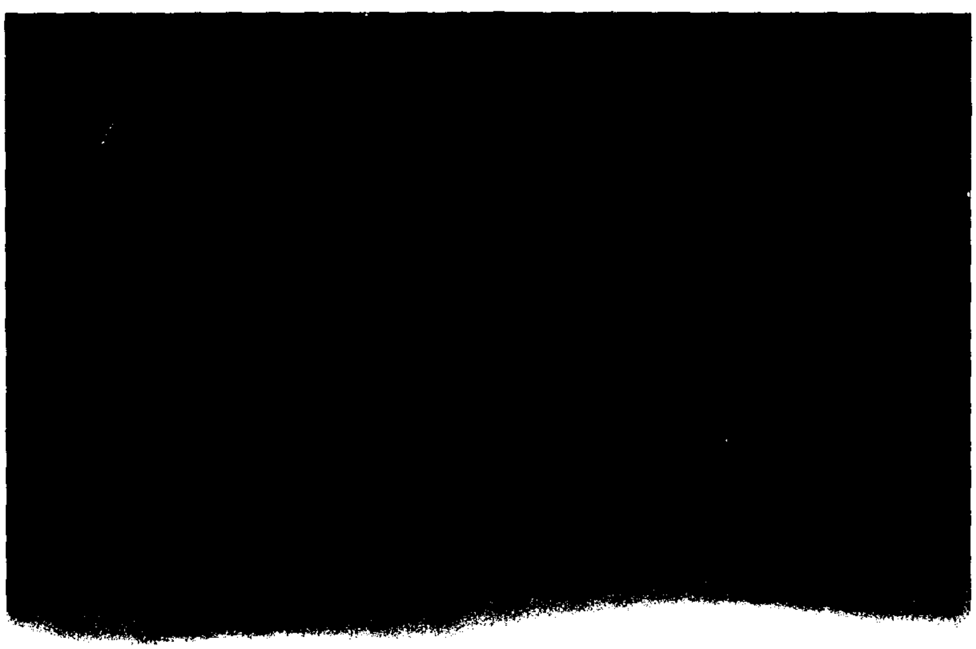
Appendix 3. Microhabitats at Sample Sites.

Site 2-G

Site 2-H & I

Appendix 3. Microhabitats at Sample Sites.

Site 3-A



Site 3-B

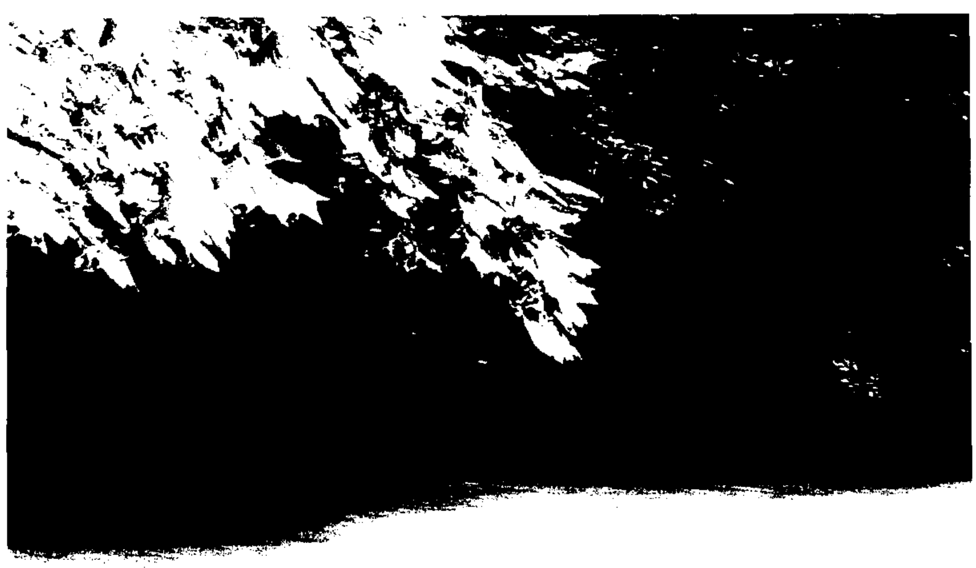
Appendix 3. Microhabitats at Sample Sites.

Site 3-C

Site 3-D

Appendix 3. Microhabitats at Sample Sites.

Site 3-E



Site 3-F

Appendix 3. Microhabitats at Sample Sites.

Site 3-G

Site 3-H

Appendix 3. Microhabitats at Sample Sites.

Site 3-I

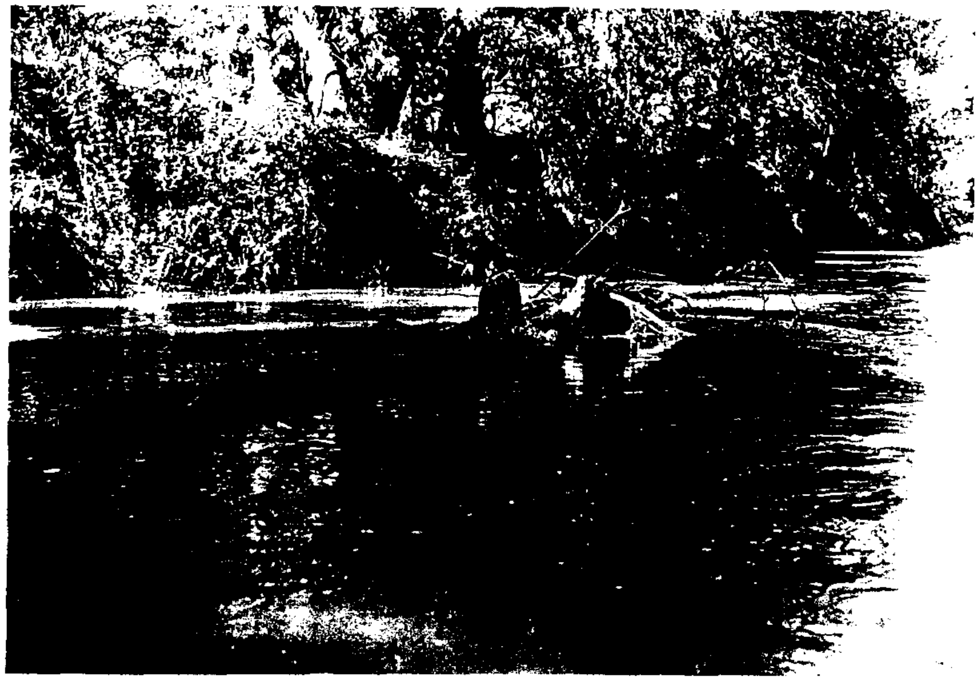
Site 3-J

Appendix 3. Microhabitats at Sample Sites.

Site 3-K

Site 3-L

Appendix 3. Microhabitats at Sample Sites.



Site 3-M

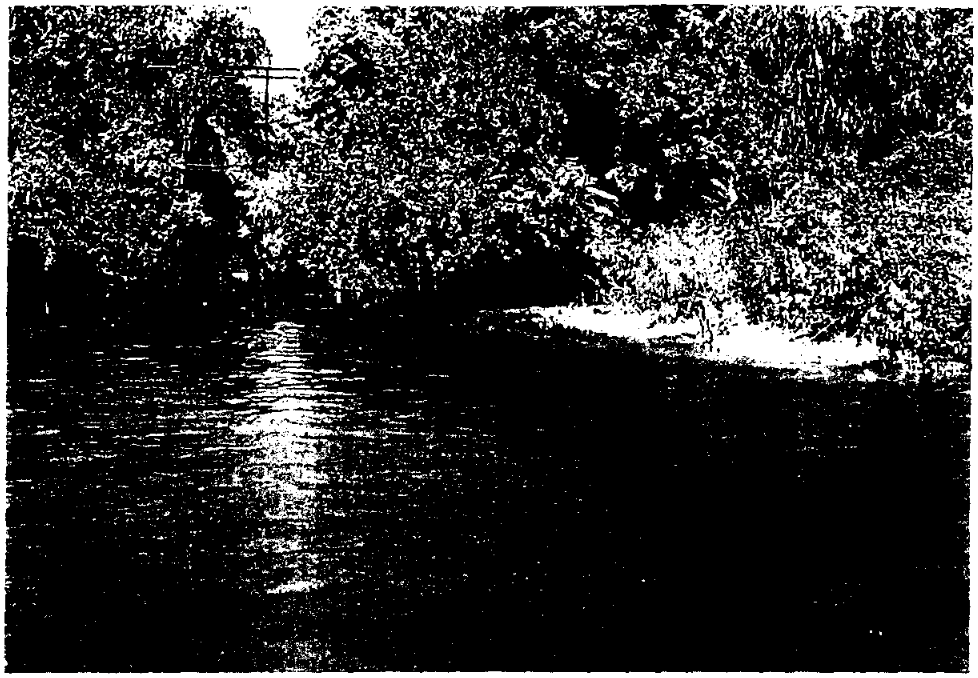
Site 3-N

Appendix 3. Microhabitats at Sample Sites.

Site 3-O

Site 3-P

Appendix 3. Microhabitats at Sample Sites.



Site 3-Q

Site 3-R

Appendix 3. Microhabitats at Sample Sites.

Site 3-S

Site 3-T

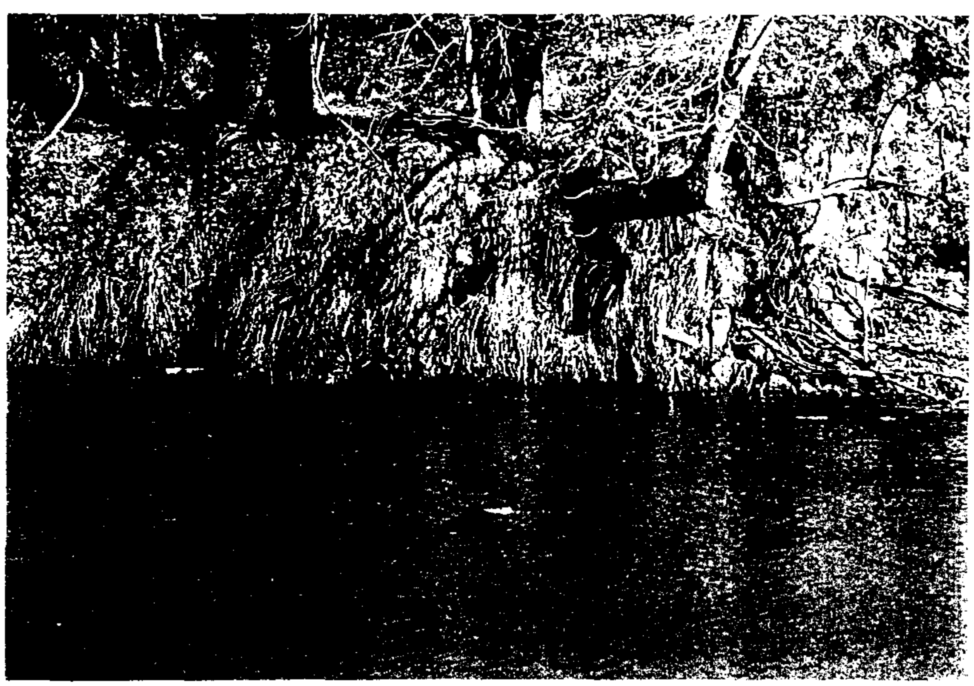
Appendix 3. Microhabitats at Sample Sites.

Site 4-D

Site 4-E,F,&G

Appendix 3. Microhabitats at Sample Sites.

Site 4-G (close-up)



Site 4-H

Appendix 3. Microhabitats at Sample Sites.

Site 4-I

Site 4-J

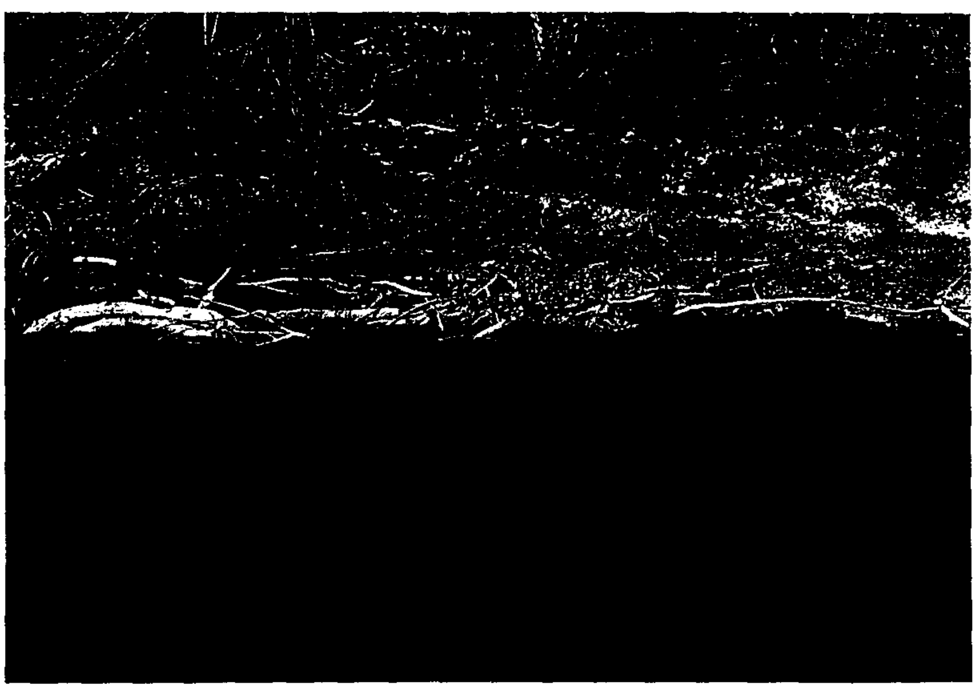
Appendix 3. Microhabitats at Sample Sites.

Site 4-K

Site 4-L

Appendix 3. Microhabitats at Sample Sites.

Site 4-M



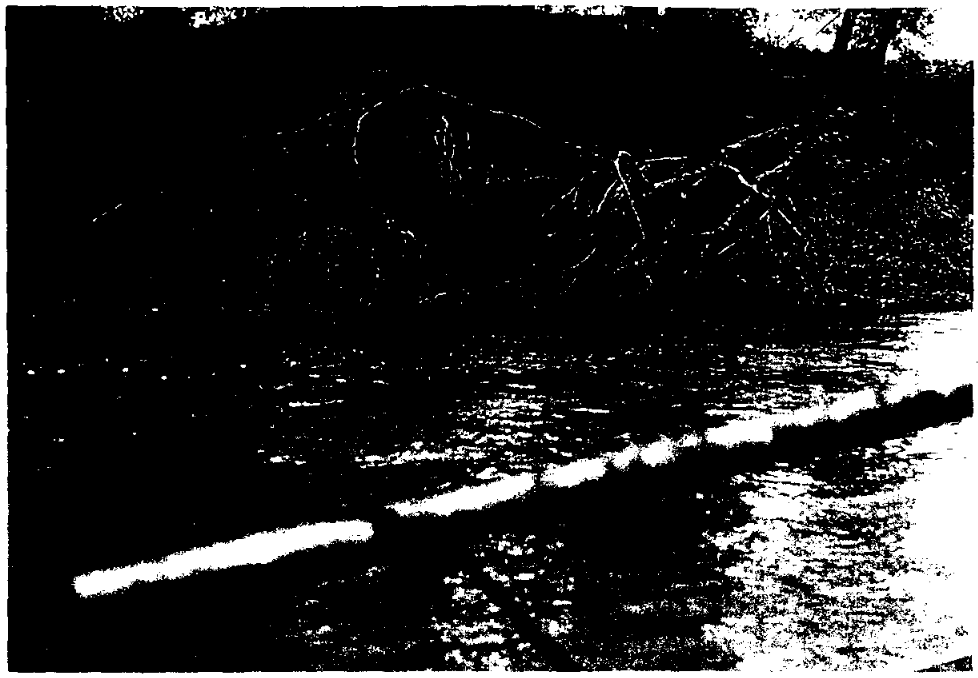
Site 4-N

Appendix 3. Microhabitats at Sample Sites.

Site 4-O

Site 4-P

Appendix 3. Microhabitats at Sample Sites.



Site 5-A

Site 5-B

Appendix 3. Microhabitats at Sample Sites.

Site 5-C

Site 5-D

Appendix 3. Microhabitats at Sample Sites.

Site 5-E

Site 5-F

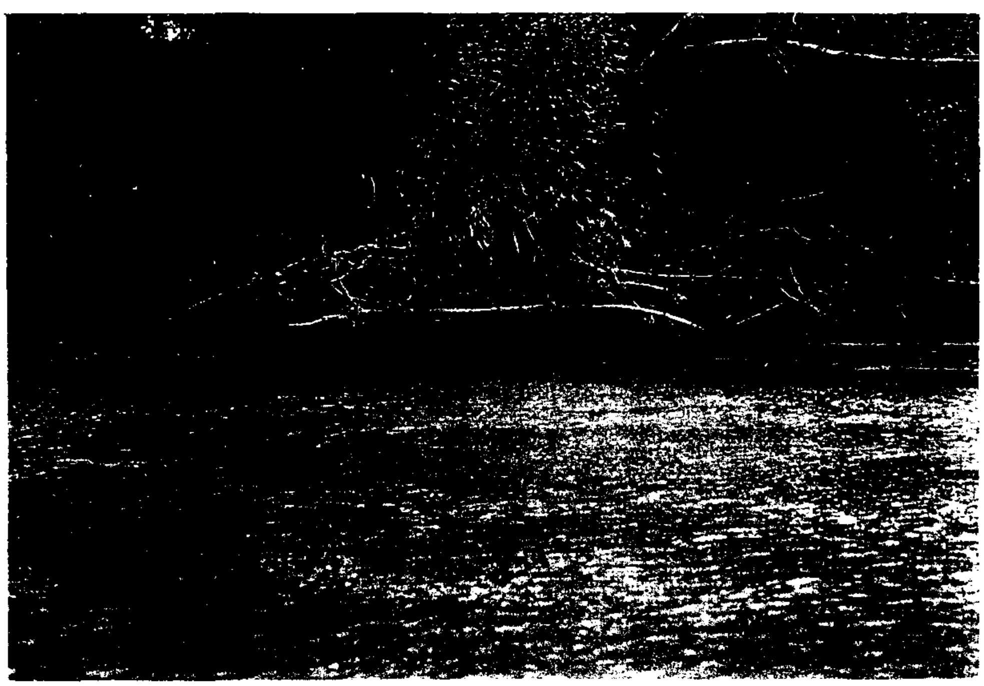
Appendix 3. Microhabitats at Sample Sites.


Site 5-G

Site 5-H

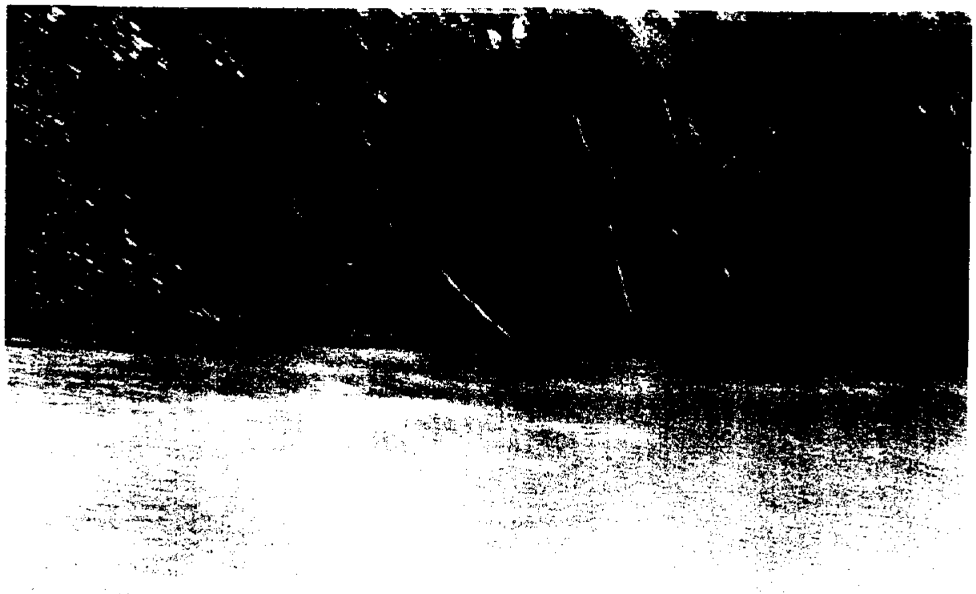
Appendix 3. Microhabitats at Sample Sites.

Site 5-I

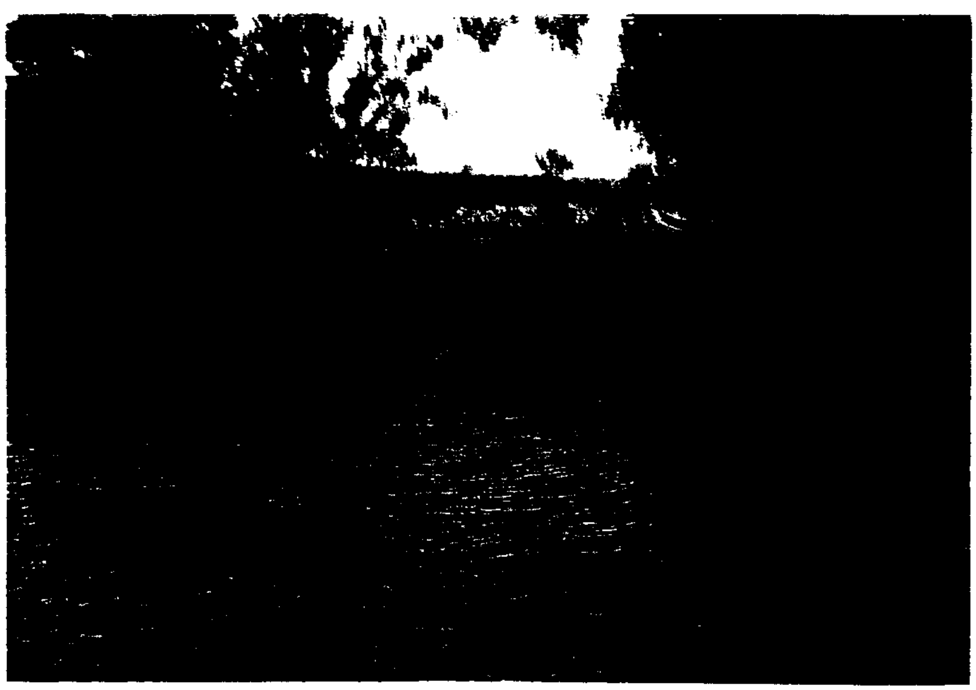


Site 5-J

Appendix 3. Microhabitats at Sample Sites.



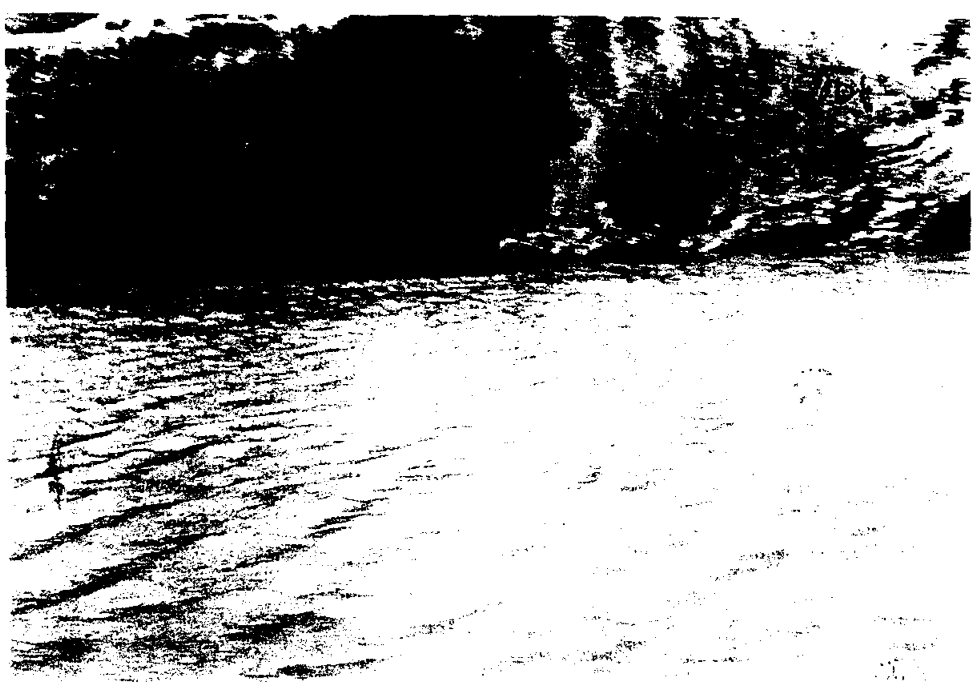
Site 5-K



Site 5-L

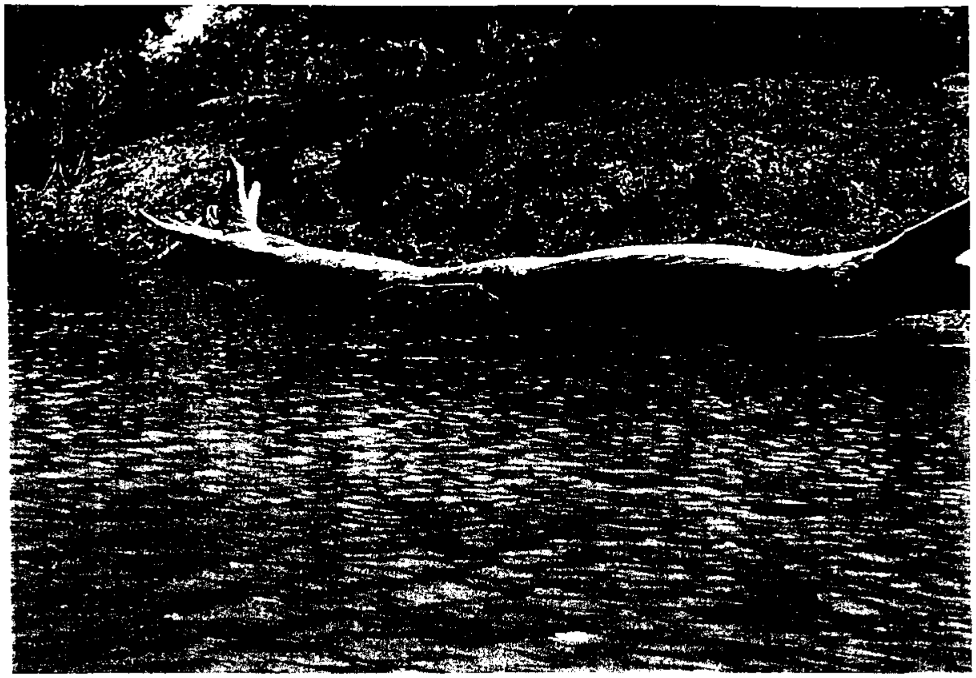
Appendix 3. Microhabitats at Sample Sites.

Site 5-M



Site 5-N

Appendix 3. Microhabitats at Sample Sites.

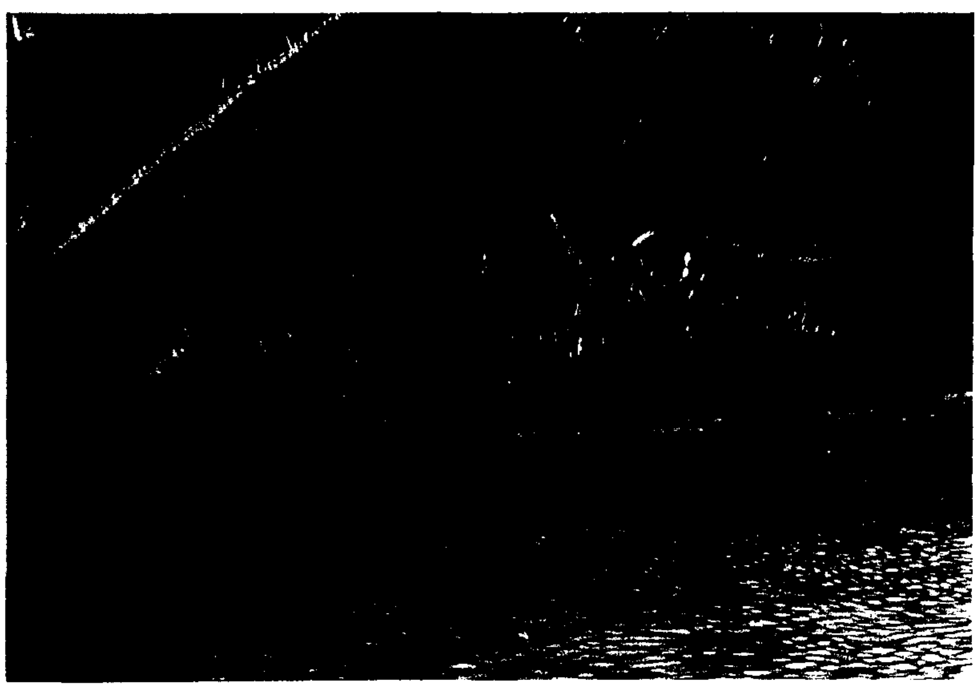


Site 5-O

Site 5-P

Appendix 3. Microhabitats at Sample Sites.

Site 5-Q



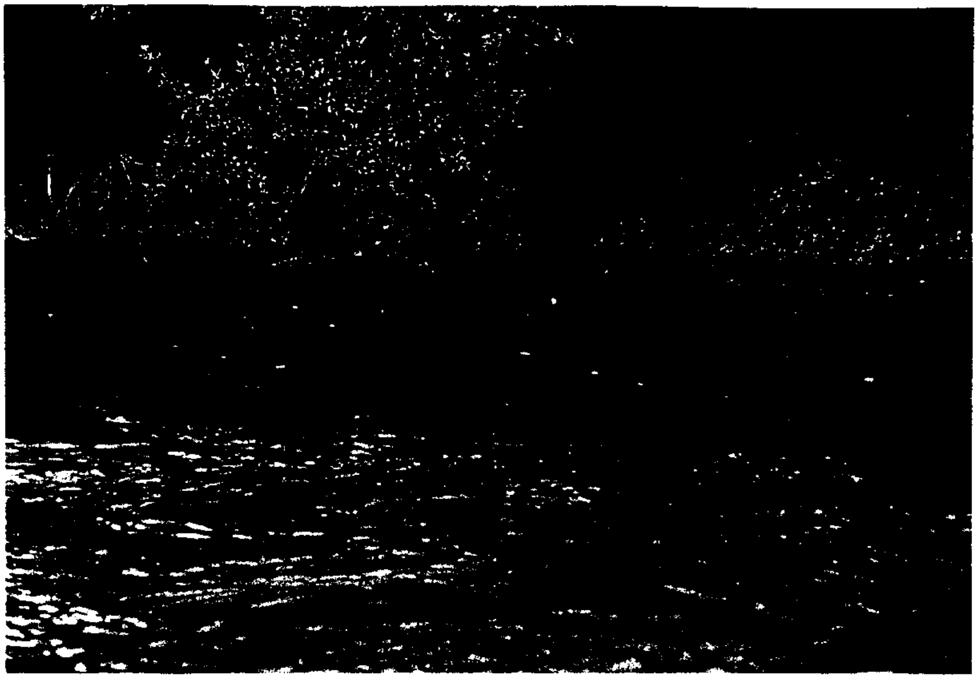
Site 5-R

Appendix 3. Microhabitats at Sample Sites.

Site 6-A

Site 6-B

Appendix 3. Microhabitats at Sample Sites.

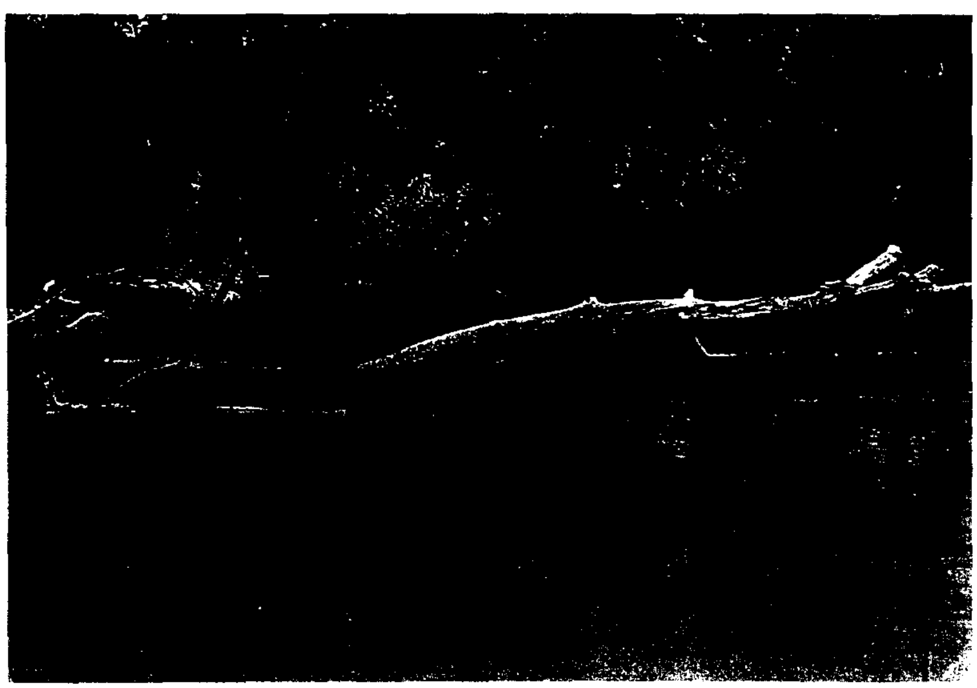


Site 6-C

Site 6-D

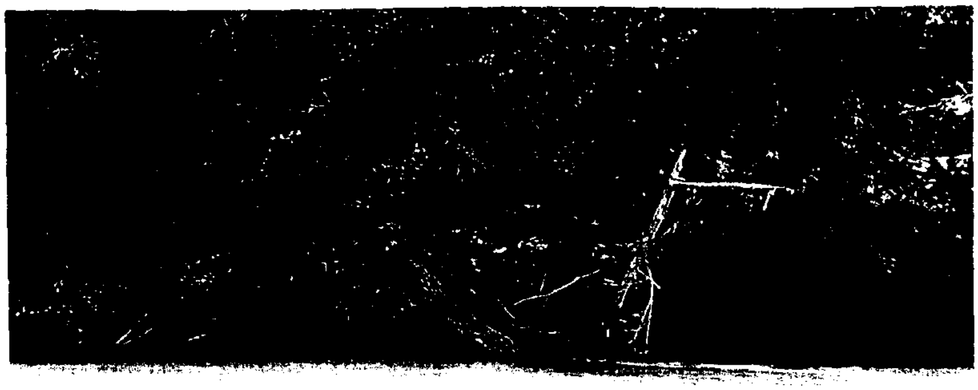
Appendix 3. Microhabitats at Sample Sites.

Site 6-E

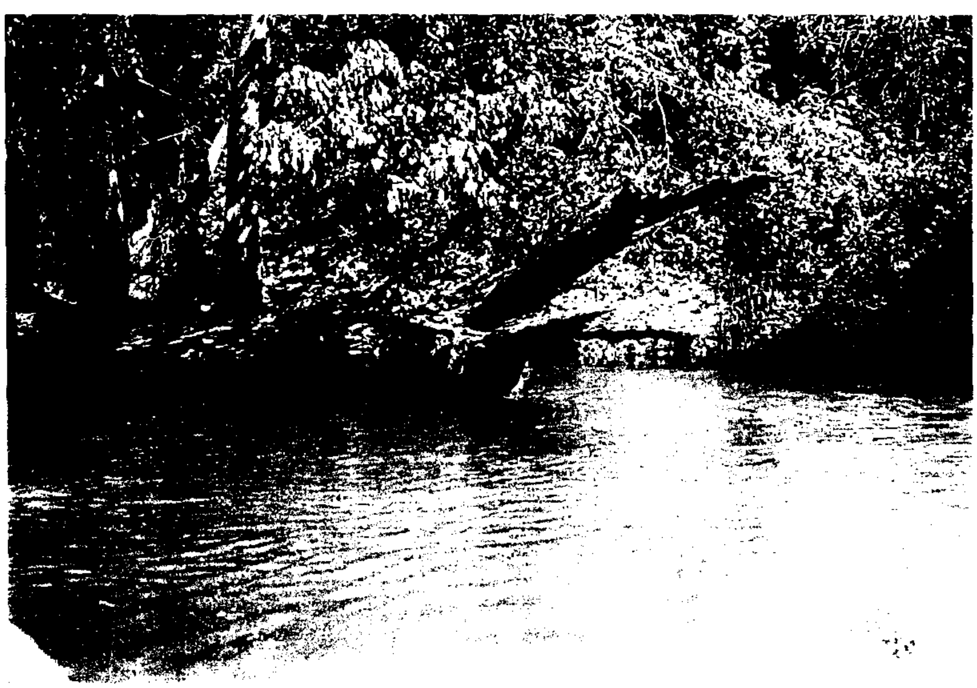


Site 6-F

Appendix 3. Microhabitats at Sample Sites.



Site 6-G



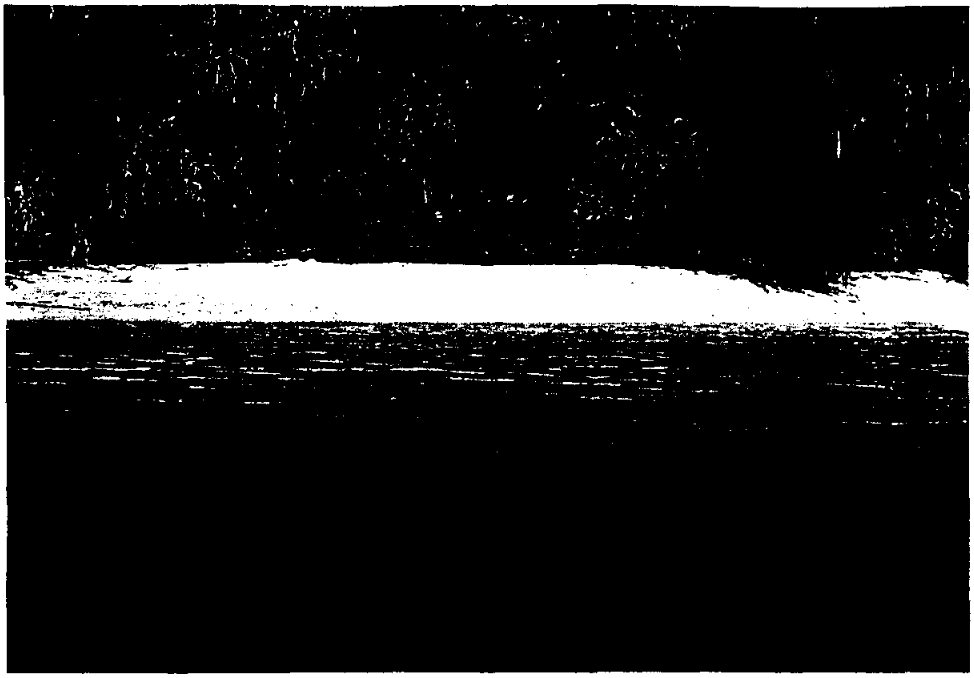
Site 6-H

Appendix 3. Microhabitats at Sample Sites.

Site 6-I

Site 6-J

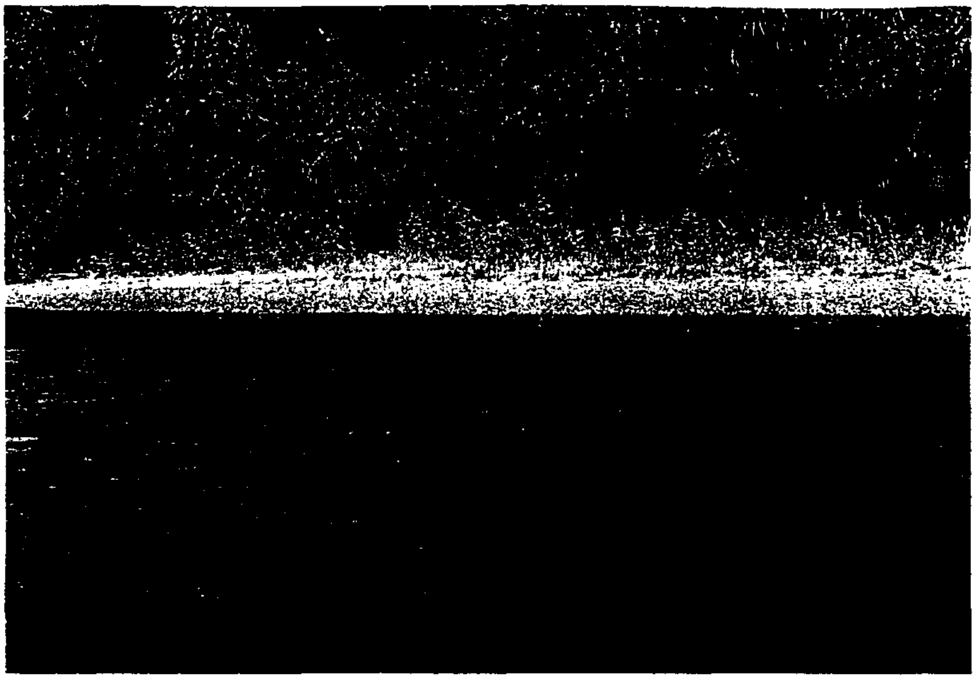
Appendix 3. Microhabitats at Sample Sites.



Site 6-K

Site 6-L

Appendix 3. Microhabitats at Sample Sites.



Site 6-M

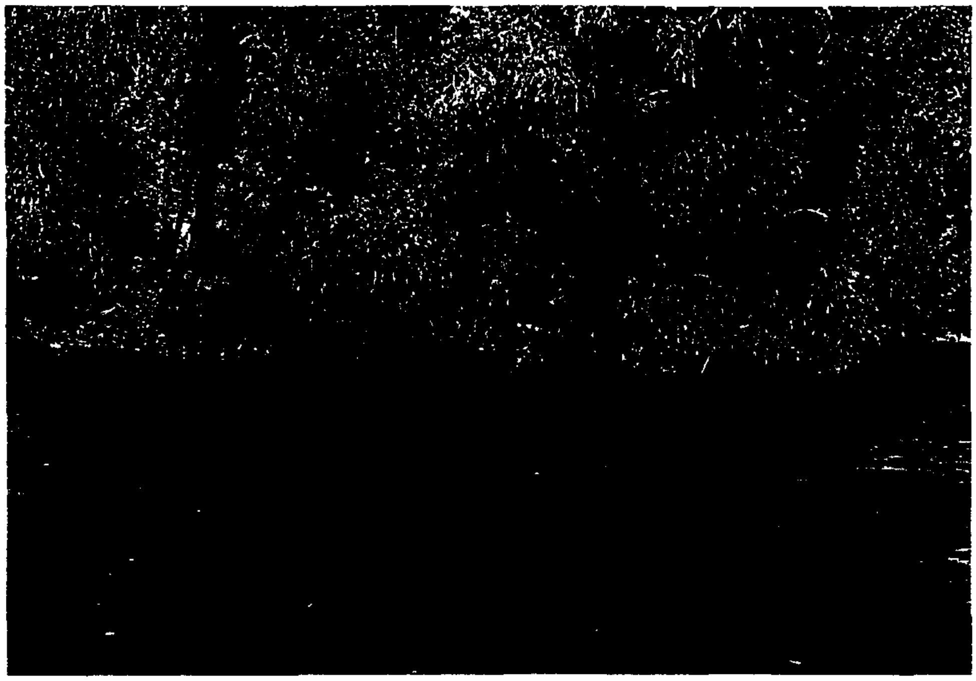
Site 6-N

Appendix 3. Microhabitats at Sample Sites.

Site 6-O

Site 6-P

Appendix 3. Microhabitats at Sample Sites.



Site 6-Q

Site 6-R

Appendix 3. Microhabitats at Sample Sites.