Microhabitat Utilization and Fish Survey of the San Antonio River

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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 to the region and relieving demand on the Edwards Aquifer. One alternative is a proposed reservoir to be located on the San Antonio River near Goliad, Texas for water storage and diversion. The purpose of this study was to survey fish microhabitat utilization at study sites on the San Antonio River that will be utilized in the Texas Water Development Board's (TWDB) Macrohabitat Assessment Technique (MAT) for instream flow requirements. This study also used the Index of Biotic Integrity (IBI) proposed by Karr et al. (1986) to assess the water quality at the study sites and continued the listing of fish species from this drainage. The species of fish present in different habitats were determined. Physicochemical data was collected at each site during each sampling period.

2.0 INTRODUCTION

2.1 Study Area

The San Antonio River headwaters are located in the city of San Antonio, north of Brackenridge Park (Gonzales 1988). They originate from pumped wells drilled into the Edwards Aquifer. The topography at the sample sites consists of low rolling hills. The riparian zone of the sample sites consisted of hardwood trees, vines, shrubs, and various weeds and grasses. Banks along the San Antonio River were generally high with steep sides.

The four sample sites are located in Goliad county. Much of the land surrounding the sites was used for agriculture (ranching) purposes.

Site 1 was located immediately upstream from the Hwy. 183 bridge in Goliad State Park, south of the city of Goliad. The USGS gage (08188500) used to monitor flows was located at this bridge. Site 2 was located 8 river km downstream of Site 1. Site 4 was located 4 river km downstream from Site 1. Access to Sites 2 and 4 was through the Baker Ranch located off Hwy. 59, southwest of the city of Goliad. Site 5 was located immediately upstream from the Duke bridge on Hwy. 2506, south of the town of Fannin.

This study used fish species as biological indicators of water quality. The biological methods indicate that the stream at all sites had poor to fair water quality. Extensive laboratory chemical analyses were done on previous studies (Whiteside, et al. 1993 and Whiteside, et al. 1994). Temperature, dissolved oxygen, pH, and specific conductivity were recorded at each sample date.

2.3 Protected Species

No endangered or protected species were found at these three sites. No effort was made to collect species other than fish.

2.4 Climate

All four San Antonio River sites are located in South Central Texas. The rainfall has varied greatly during 1996 and 1997 to the extent that this region experienced a drought and flood period within a 12 month period. The study area is humid sub-tropical 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 flows into the area and is often stopped by warmer air off the Gulf. This usually results in mild winters. 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

The river substrate consists of soft mud, sand, and silt along the edges and sand and small gravel in the middle of the channel. Pools and runs are the common morphological habitat types of the river. Riffles are rare except for small ones found along sharp, rocky bends. The water color ranges from a murky brown to a translucent green. Fallen trees, exposed roots, other woody debris, pools, and runs made up most of the microhabitats. Aquatic macrophytes are typically non-existent, however, algae grows on some of the submerged rocks and trees (Findeisen 1997).

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. TWDB staff required sites that had representative habitat and hydrologic conditions which would allow them to obtain information useful to their MAT protocol. TWDB staff participated in the selection of sites. Once sites were chosen, sampling began. Photos were made of the sites and of the microhabitats.

3.2 Soil Associations

The study area is located in the Coastal Plains area of the state. Soils near the river are dark gray to reddish brown calcareous clay loams and clays were prevalent (Arbingast, et al. 1976).

3.3 Hydrologic and Geomorphic Criteria

The intent of the study was to combine the reports of the San Antonio River fish sampling during winter and summer seasons at three different flow ranges: low (150-225 cfs), medium (225-300 cfs), and high (300-400 cfs).

3.4 Field Reconnaissance

As indicated under 3.1, both Edwards Aquifer Research and Data Center (EARDC) and TWDB staff were utilized to help locate suitable sites. Participating in this phase were Dr. Glenn Longley, Director of EARDC at Southwest Texas State University (SWTSU), and two SWTSU graduate students, John Burch and Keith Cox. Ray Mathews, fisheries biologist/ecologist (Contract Manager), James Tallent, civil engineer; and Randy Burns, hydrogeologist participated from TWDB. The ecologists offered ideas of suitable microhabitats while the geomorphologists assisted in the determination of stream segments with several flow characteristics.

4.0 DATA COLLECTION

4.1 Bathymetric

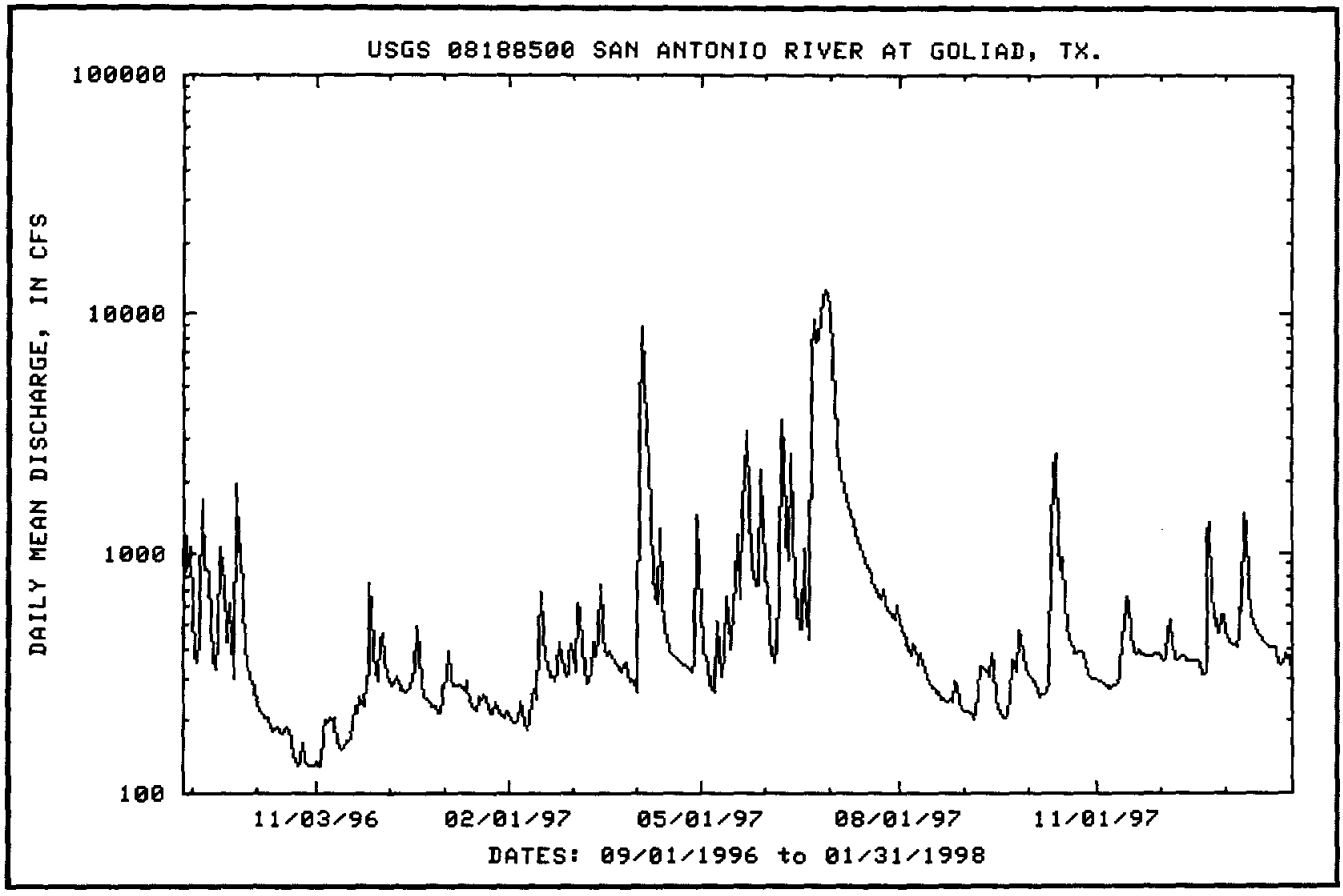
This work is to be done by the TWDB.

4.2 Hydrologic

Additional work is to be done primarily by the TWDB staff. Information from the USGS gage 08188500 at Goliad, was used to determine when stream flow was within appropriate range for sampling to be performed. The daily mean flows for San Antonio River during 1996-1998 can be seen in Figure 1.

4.3 Habitat assessment

US Environmental Protection Agency (EPA), Texas Natural Resource Conservation Commission (TNRCC) and Texas Parks and Wildlife (TPWD) have been using IBI protocols in the state to develop criteria for 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). This study utilizes the combination of IBI protocols and MAT.



Data is provisional and subject to revision.
Source: USGS

Daily mean flows at USGS gage 08188500 at Goliad, during study period.

Figure 1.

4.31 Habitat Mapping and Photodocumentation

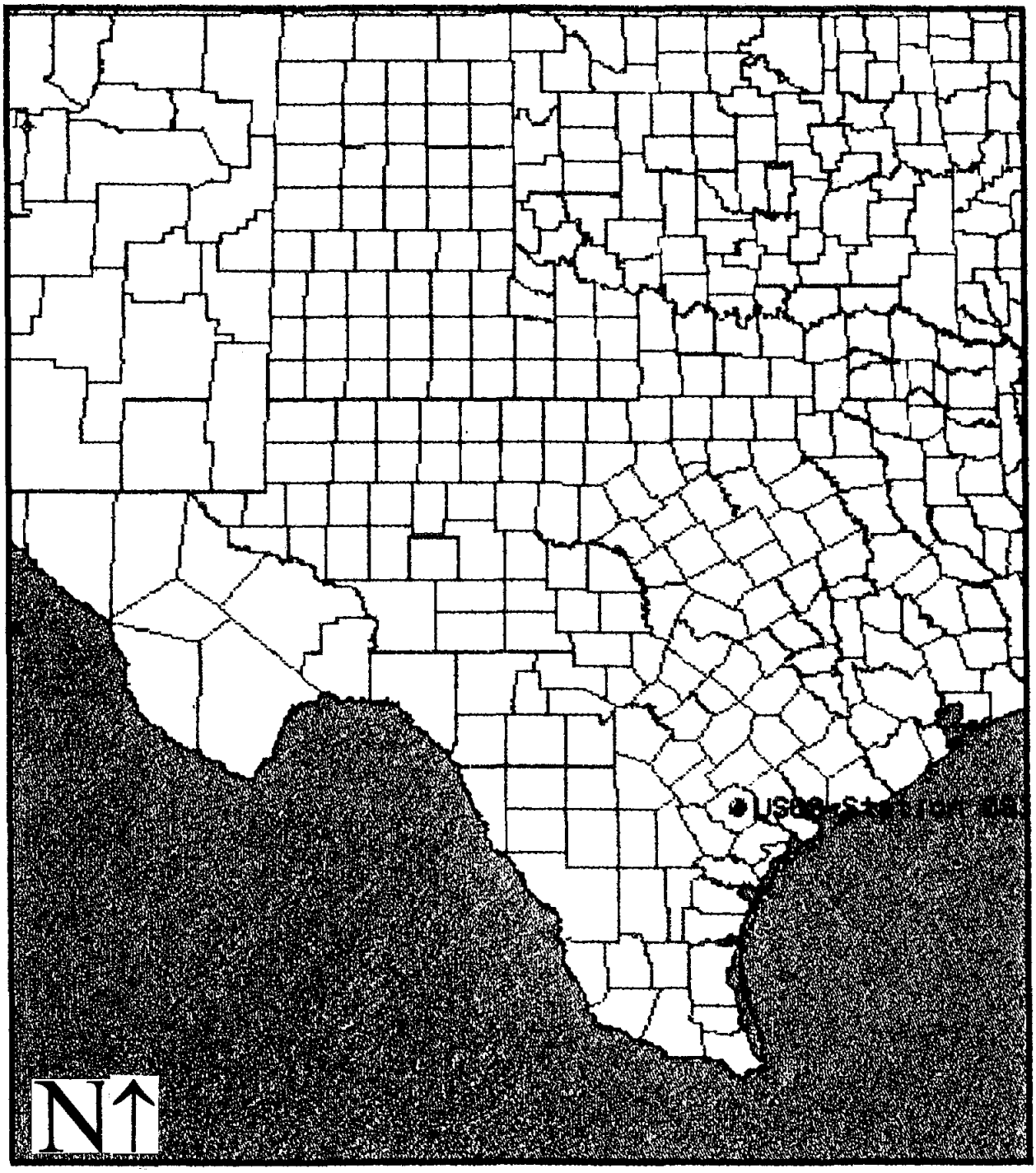
Figures 2 and 3 show generalized maps of the study location. Figures 4, 5, 6 show the study sites on USGS quadrant maps. Figures 7, 8, 9, and 10 are sketch maps showing microhabitat locations within the study site. Numbers on the maps correspond with the microhabitat code found in Appendix 1. Representative photographs of the sample sites and microhabitats within those sites are found in Appendix 3.

4.32 Microhydraulic Effect of Habitat

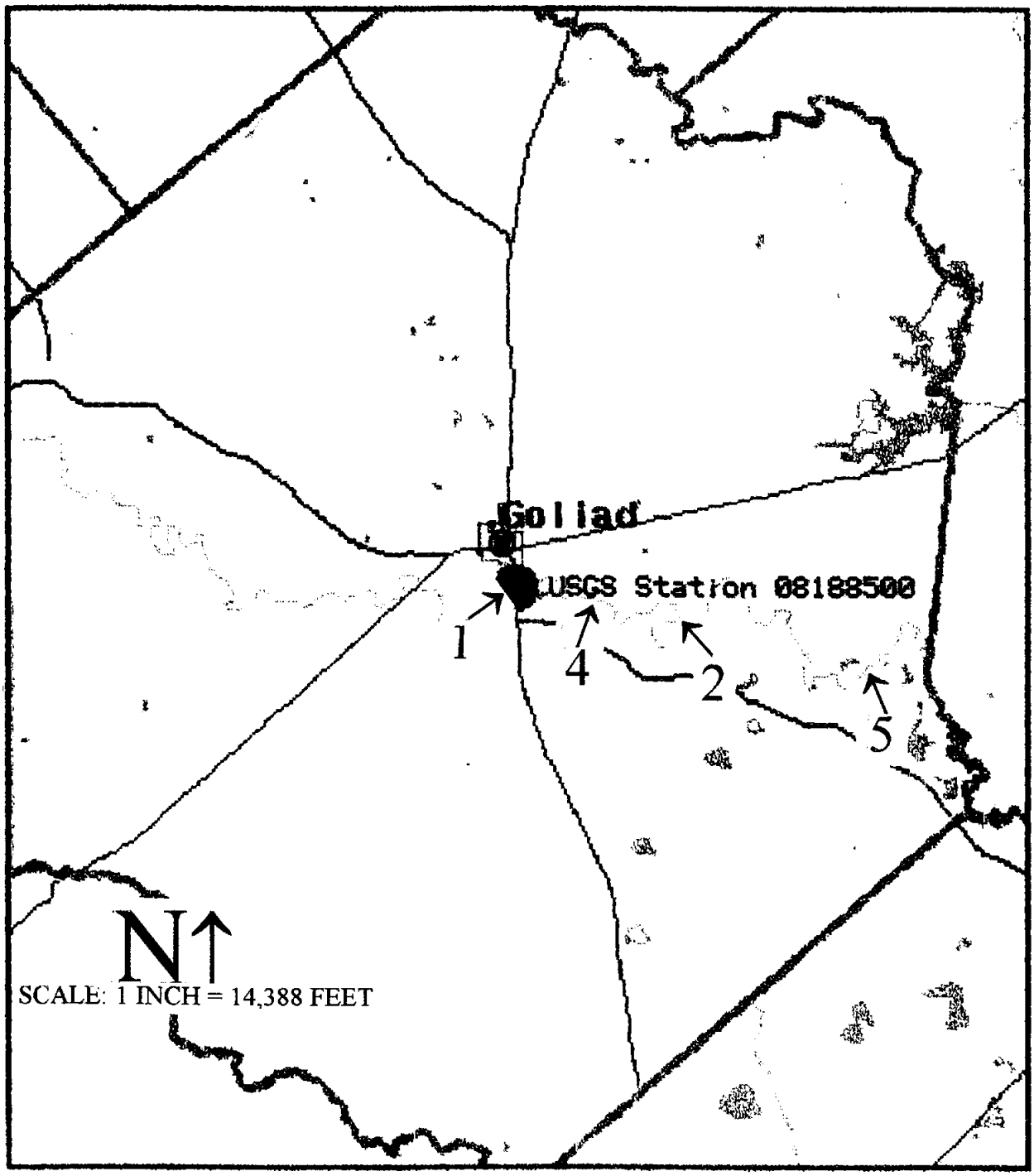
This work is to be completed by TWDB staff.

4.33 Instream Habitat Classification

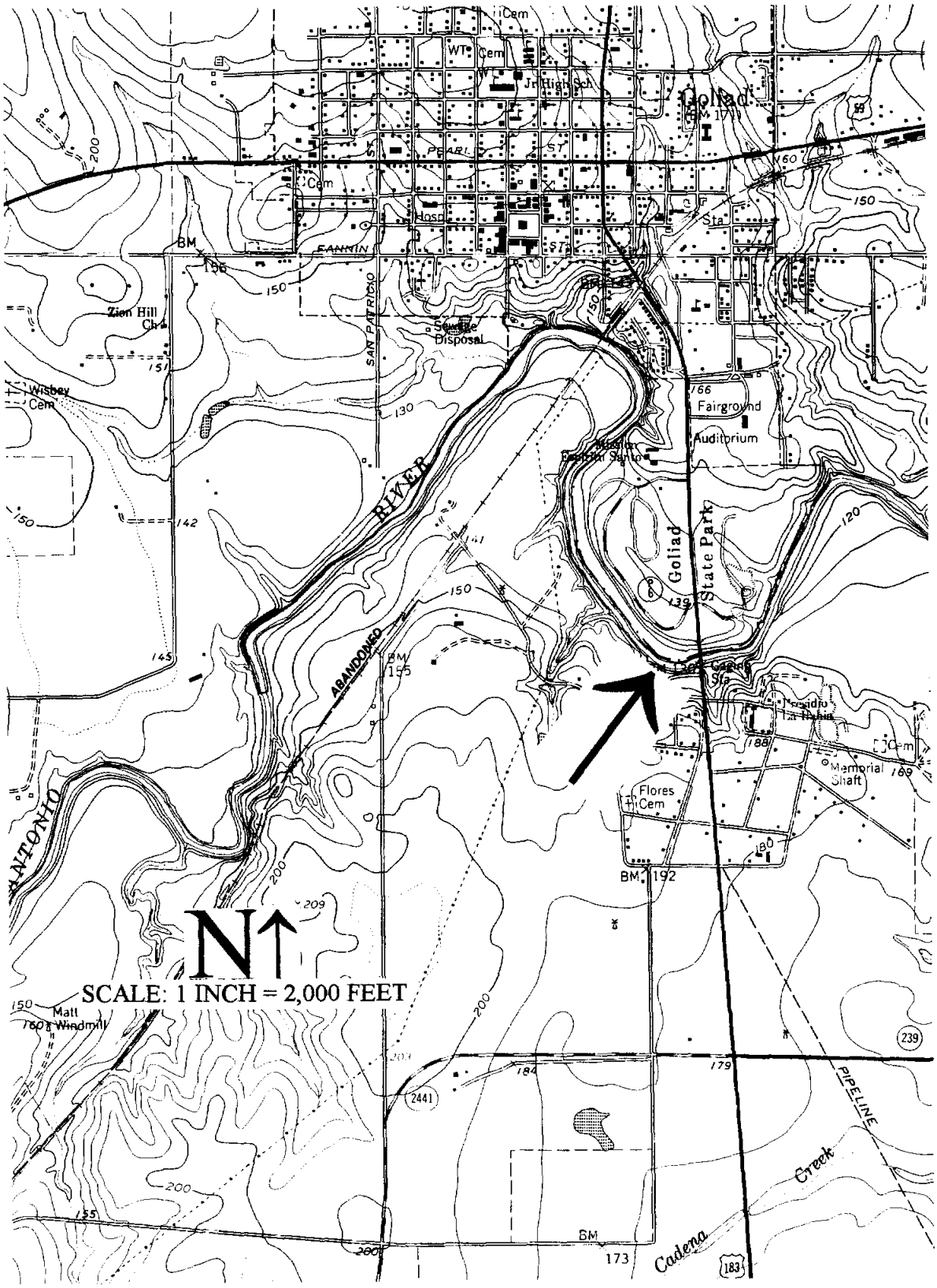
Habitat is basically a locality, site or particular type of environment on a microscale that is occupied by an organism or population of organisms.



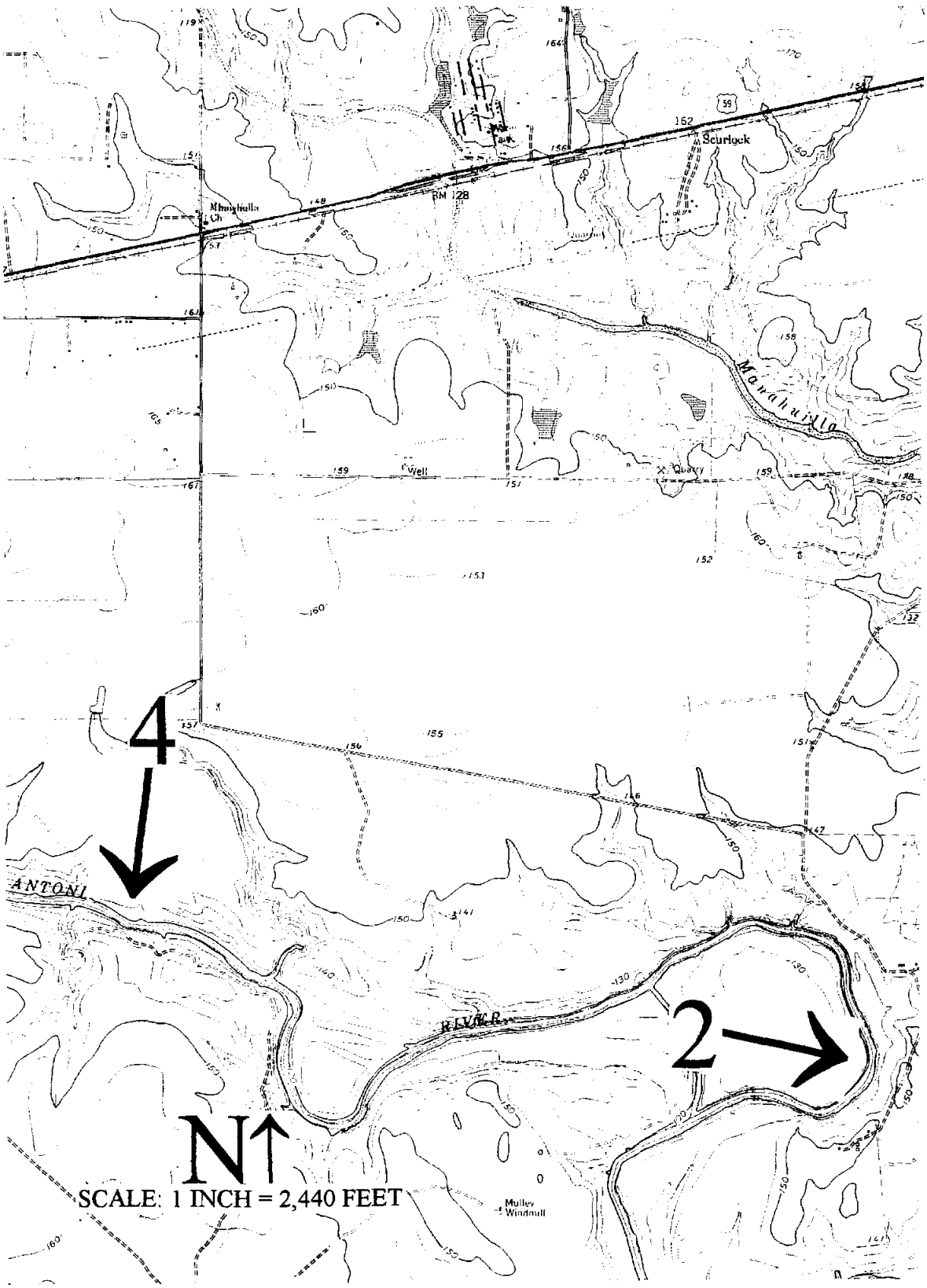
General study area. *Source: USGS.*
Figure 2.



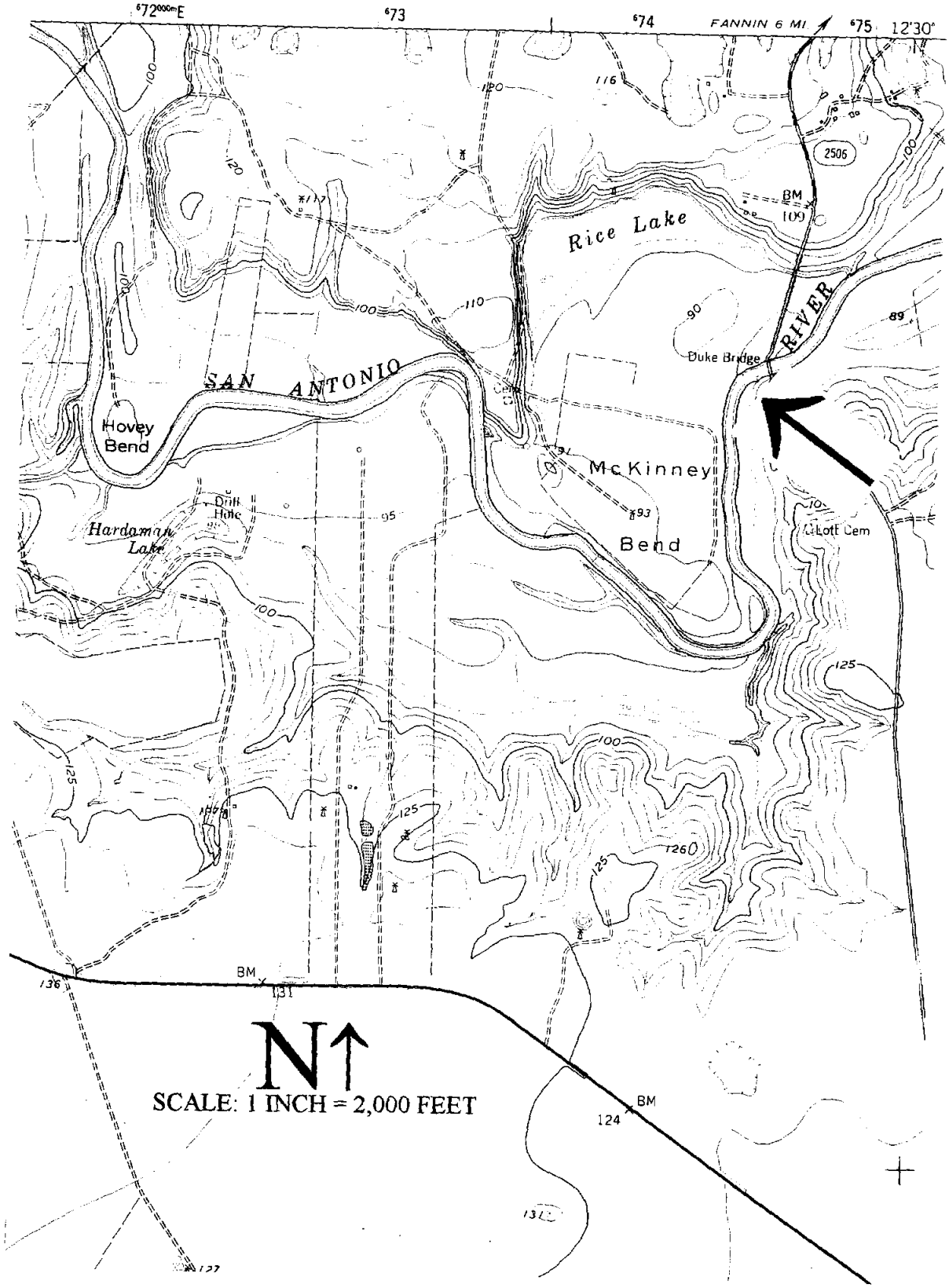
General study area (Sites 1, 2, 4, and 5). *Source: USGS.*
Figure 3.



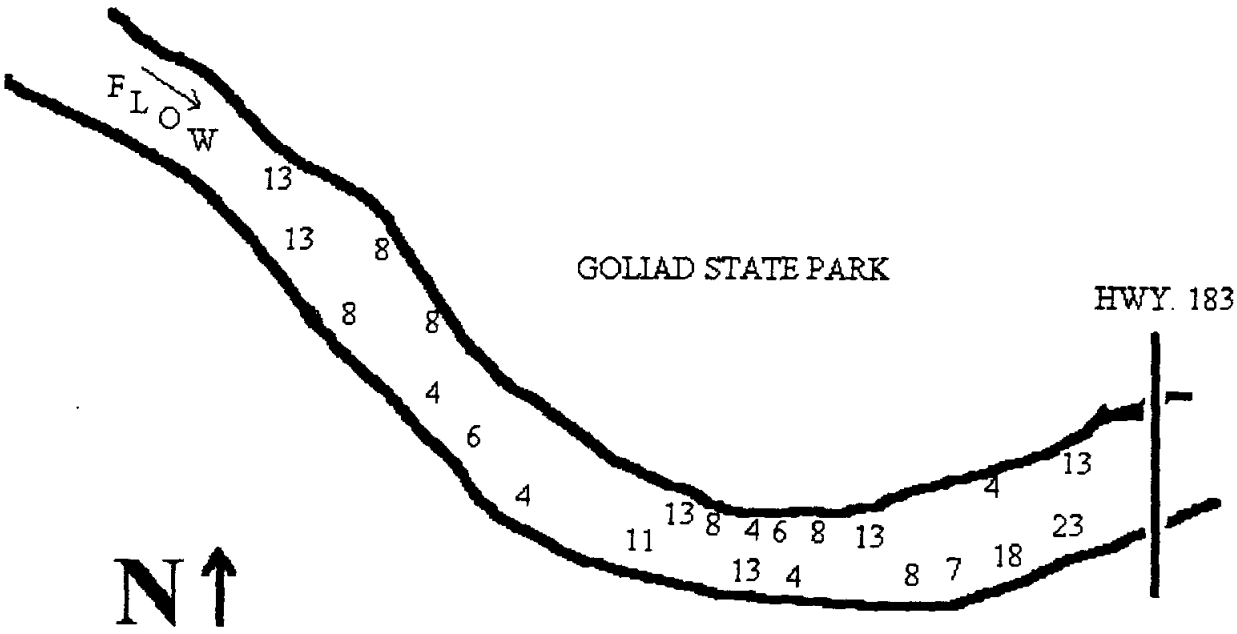
Specific study area (Site 1). *Source USGS.*
Figure 4.



Specific study area (Sites 2 and 4). *Source: USGS.*
Figure 5.



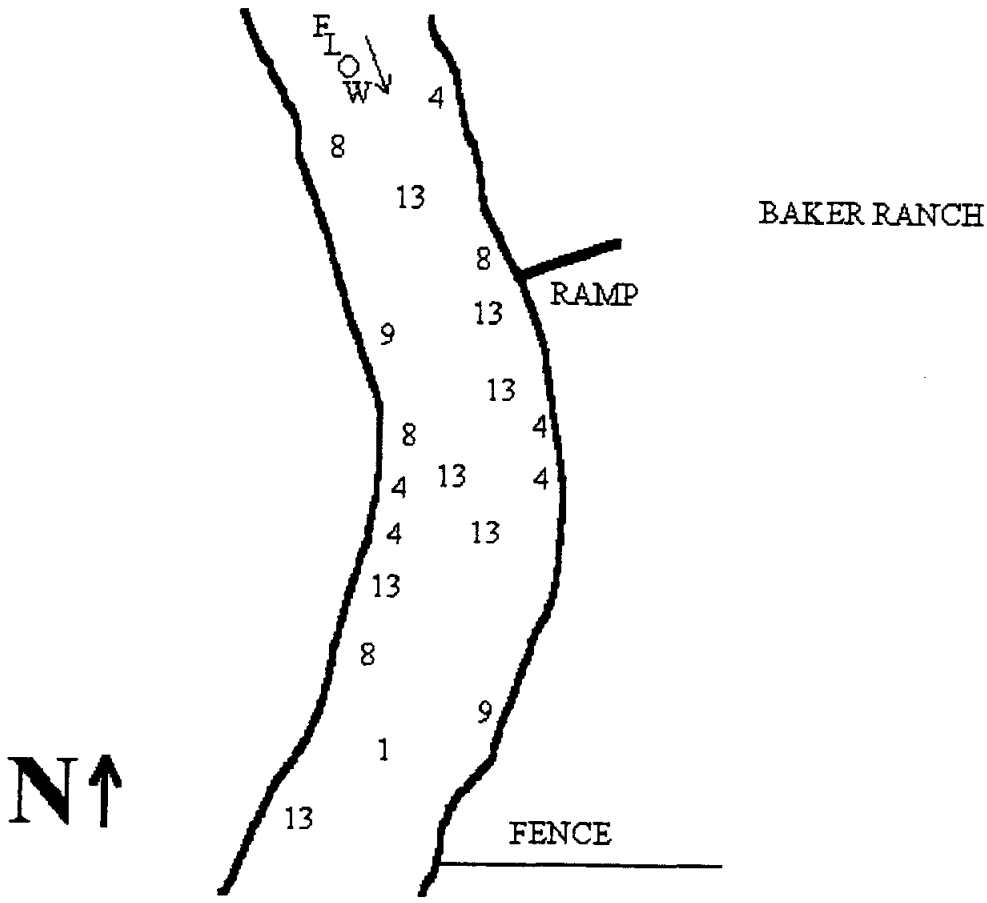
Specific study area (Site 5). *Source: USGS.*
Figure 6.



Numbers correspond with microhabitat code numbers.
(Site is 2,566 feet in length)

Sketch map of Site 1.

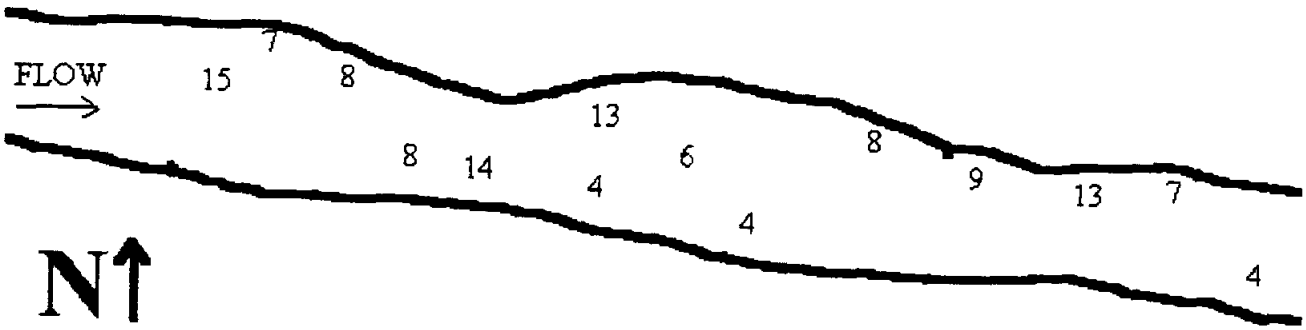
Figure 7.



Numbers correspond with microhabitat code numbers.
(Site is 1,821 feet in length)

Sketch map of Site 2.

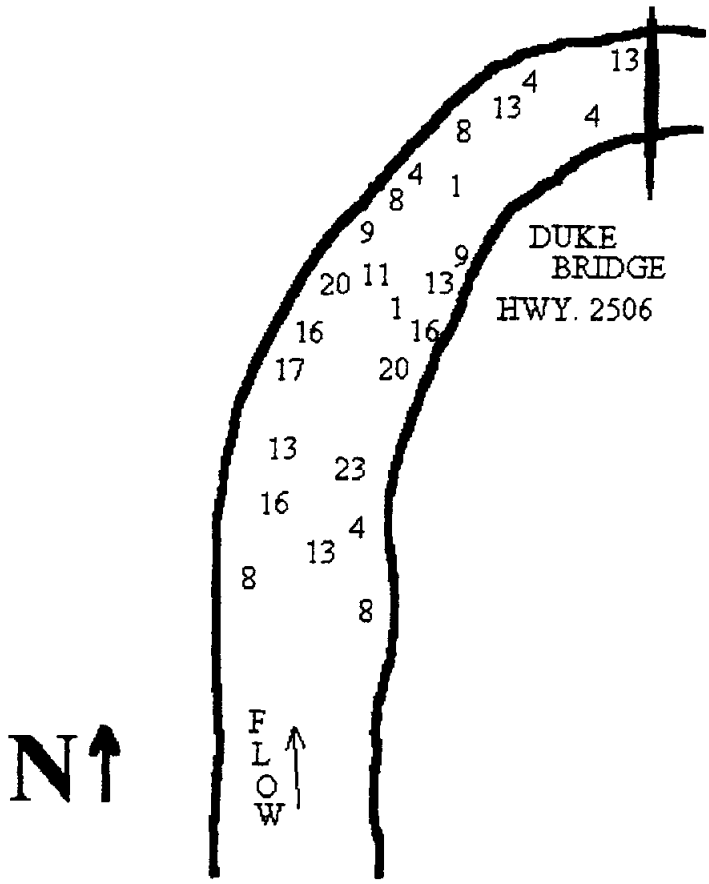
Figure 8.



Numbers correspond with microhabitat code numbers.
(Site is 1,817 feet in length)

Sketch map of Site 4.

Figure 9.



Numbers correspond with microhabitat code numbers.
(Site is 2,063 feet in length)

Sketch map of Site 5.

Figure 10.

4.4 Biological Assessment

Water development projects such as the ones proposed alter the natural flow of the 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 effect of the altered flows by various management options.

4.41 Biological Indices

The indices used in this study have been developed by the EPA and modified for the purpose of categorizing stream segments. The water quality assessment technique chosen was the IBI found in Table 1. Reference streams were Arenosa Creek, Metate Creek, Placedo Creek, San Miguel Creek and West Caranchua Creek as used in previous studies of these sites (Whiteside, et al. 1993 and Whiteside, et al. 1994). A list of the fishes used in the IBI calculations can be found in Table 2. Additionally, the MAT methodology developed by TWDB was considered and the data was collected in such a way as to be useful for this type of technique.

4.42 Biological Sampling Techniques

The information gathered from sampling can be seen in bubble graphs which indicate the fish collected from different habitats (Appendices 1, 2, and 3). The Appendices include bubble graphs that represent individual sample dates and combined sampling dates from a previous study.

4.5 Physicochemical

The following parameters were analyzed in the field: temperature, pH, dissolved oxygen, specific conductance and flows at each microhabitat. The results, for sampling done during this study are in Table 3. Flows for the individual microhabitats at each site are found in Tables 4 and 5.

4.6 Biological Assessment of Habitat Utilization and Availability Conditions

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

Table 1.
Index of Biotic Integrity (IBI) for fish collected 1996 and 1997.

Sample Date: Winter at med flows	Site 1 3-Jan-97		Site 2 1-Nov-97		Site 4 1-Nov-97		Site 5 1-Nov-97	
Metrics Used:	**Raw Score**	**Metric Score**	**Raw Score**	**Metric Score**	**Raw Score**	**Metric Score**	**Raw Score**	**Metric Score**
Total # of Species	7	3	4	1	2	1	5	3
# of Darter/Catfish Species	2	3	0	1	0	1	1	3
# of Sunfish Species	1	1	1	1	0	1	1	1
# of Minnow Species	2	3	1	3	1	3	2	3
# of Intolerant Species	0	1	0	1	0	1	0	1
% Green Sunfish	0%	5	0%	5	0%	5	0%	5
% Omnivores	12%	5	30%	3	75%	1	7%	5
% Insectivores	46%	5	60%	5	25%	3	93%	5
% Top Carnivores	23%	5	10%	5	0%	1	0%	1
Total # of Individuals	26	1	10	1	4	1	28	1
% Hybrids	0%	5	0%	5	0%	5	0%	5
% Diseased/Anomalies	0%	5	0%	5	0%	5	0%	5
IBI Score		**42**		**36**		**28**		**38**
Score Interpretation		**Fair**		**Fair**		**Poor**		**Fair**

IBI = Index of Biotic Integrity

Sample Date: Summer at high flows	Site 1 9-Sep-97		Site 2 9-Sep-97		Site 4 10-Sep-97		Site 5 22-Oct-97	
Metrics Used:	**Raw Score**	**Metric Score**	**Raw Score**	**Metric Score**	**Raw Score**	**Metric Score**	**Raw Score**	**Metric Score**
Total # of Species	6	3	8	3	8	3	9	3
# of Darter/Catfish Species	2	3	2	3	2	3	2	3
# of Sunfish Species	1	1	3	3	3	3	4	3
# of Minnow Species	1	3	1	3	1	3	1	3
# of Intolerant Species	0	1	0	1	0	1	0	1
% Green Sunfish	3%	5	13%	3	13%	3	6%	3
% Omnivores	10%	5	13%	5	13%	5	11%	5
% Insectivores	31%	3	33%	3	33%	3	69%	5
% Top Carnivores	59%	5	53%	5	53%	5	19%	5
Total # of Individuals	29	1	15	1	15	1	36	1
% Hybrids	0%	5	0%	5	0%	5	0%	5
% Diseased/Anomalies	0%	5	0%	5	0%	5	0%	5
IBI Score		**40**		**40**		**40**		**42**
Score Interpretation		**Fair**		**Fair**		**Fair**		**Fair**

IBI = Index of Biotic Integrity

Table 2.
List of freshwater fishes collected from the San Antonio River system.

Family	Species	Common Name
Lepisosteidae	*Lepisosteus oculatus*	Spotted gar
Anguillidae	*Anguilla rostrata*	American eel
Clupeidae	*Dorosoma cepedianum*	Gizzard shad
Cyprinidae	*Campostoma anomalum*	Central stoneroller
	Cyprinella lutrensis	Red shiner
	C. venusta	Blacktail shiner
	Macrhybopsis aestivalis	Speckled chub
	Notropis stramineus	Sand shiner
	N. volucellus	Mimic shiner
	Pimephales vigilax	Bullhead minnow
Catostomidae	*Ictiobus bubalus*	Smallmouth buffalo
	Moxostoma congestum	Gray redhorse
Characidae	*Astyanax mexicanus*	Mexican tetra
Ictaluridae	*Ameiurus melas*	Black bullhead
	A. natalis	Yellow bullhead
	Ictalurus punctatus	Channel catfish
	Pylodictis olivaris	Flathead catfish
Poeciliidae	*Gambusia affinis*	Western mosquitofish
	Poecilia latipinna	Sailfin molly
Centrarchidae	*Lepomis auritus*	Redbreast sunfish
	L. cyanellus	Green sunfish
	L. gulosus	Warmouth
	L. macrochirus	Bluegill sunfish
	L. megtalotis	Longear sunfish
	L. microlophus	Redear sunfish
	L. punctatus	Spotted sunfish
	Micropterus salmoides	Largemouth bass
Percidae	*Etheostoma cholorosomum*	Bluntnose darter
	E. spectabile	Orangethroat darter
Cichlidae	*Cichlasoma cyanoguttatum*	Rio Grande cichlid

Table 3.
Physicochemical data for 1996 and 1997, San Antonio River.

Site Number	Date	pH	S. Cond (µmhos/cm)	DO (mg/l)	Temperature (C)
1	1-3-97	8.4	726	8.2	19.9
	9-10-97	8.1	957	7.0	28.7
2	9-9-97	7.4	1023	6.5	28.4
	11-1-97	8.0	792	8.1	23.0
4	9-10-97	8.4	825	7.0	29.2
	11-1-97	8.6	842	8.1	22.7
5	10-22-97	7.8	660	7.8	21.5
	11-1-97	7.9	825	7.5	22.3

Table 4.
Flow data for microhabitats on San Antonio River for sites 1, 2, 4 and 5 during summer 1997.

Microhabitat	Site 1	9-10-97	Site 2	9-9-97	Site 4	9-10-97	Site 5	10-22-97
Code	Depth	Flow	Depth	Flow	Depth	Flow	Depth	Flow
1	3.7	0.8	NA	NA	3.0	0.2	NA	NA
2	4.0	0.7	NA	NA	3.0	0.5	NA	NA
3	3.5	0.4	NA	NA	4.0	0.1	NA	NA
4	2.5	0.4	NA	NA	2.5	0.3	NA	NA
5	3.0	0.7	NA	NA	2.0	0.2	NA	NA
6	2.5	0.2	NA	NA	1.5	0.1	NA	NA
7	2.5	0.5	NA	NA	1.0	0.4	NA	NA
8	3.0	0.6	NA	NA	2.0	0.2	NA	NA
9	2.5	0.2	NA	NA	3.0	0.2	NA	NA
10	1.7	0.6	NA	NA	3.5	0.3	NA	NA
11	2.7	0.6	NA	NA	3.0	0.0	NA	NA
12	2.5	0.6	NA	NA	D	D	NA	NA
13	2.5	0.9	NA	NA	3.5	0.5	NA	NA
14	3.0	0.8	NA	NA			NA	NA
15	3.5	1.0	NA	NA			NA	NA
16	1.5	0.3	NA	NA			NA	NA
17	3.5	0.5	NA	NA			NA	NA
18	3.0	0.0	NA	NA			NA	NA
19	3.5	0.6	NA	NA			NA	NA
20	3.0	0.3	NA	NA			NA	NA
21	1.5	0.7	NA	NA			NA	NA
22	1.0	0.3	NA	NA			NA	NA
23	4.0	0.2	NA	NA			NA	NA
24	2.5	0.6	NA	NA			NA	NA
25			NA	NA			NA	NA

Depth is in feet and flow is feet/sec. The character W reflects a washed out microhabitat. The character D reflects to deep to measure.

Table 5.
Flow data for microhabitats on San Antonio River for sites 1,2, 4 and 5 during winter 1997.

Microhabitat	Site 1	1-3-97	Site 2	11-1-97	Site 4	11-1-97	Site 5	11-1-97
Code	Depth	Flow	Depth	Flow	Depth	Flow	Depth	Flow
1	NA	NA	4	0.8	4.0	2.0	3.0	0.1
2	NA	NA	3	0.5	4.0	0.0	3.2	0.3
3	NA	NA	3.5	0.1	4.0	0.0	4.0	0.2
4	NA	NA	1.5	0.0	3.0	0.9	W	W
5	NA	NA	2.8	0.0	2.0	0.6	4.5	0.2
6	NA	NA	3.5	0.2	3.0	1.7	5.0	0.3
7	NA	NA	3.0	0.5	2.0	1.8	1.7	0.2
8	NA	NA	2.6	0.3	2.7	1.3	3.5	0.8
9	NA	NA	3.2	0.6	2.0	0.8	4.5	1.3
10	NA	NA	1.5	0.1	3.5	1.3	1.5	0.3
11	NA	NA	1.0	0.4	2.0	0.0	4.5	1.1
12	NA	NA	4.0	0.8	W	W	2.0	0.7
13	NA	NA	2.6	0.6	3.5	1.0	3.0	2.2
14	NA	NA	3.2	0.6	2.5	1.8	4.5	0.3
15	NA	NA			3.0	0.7	1.7	0.9
16	NA	NA			2.0	0.6	5.0	0.8
17	NA	NA					6.0	0.0
18	NA	NA					2.2	1.1
19	NA	NA					3.0	2.0
20	NA	NA					2.0	0.5
21	NA	NA						
22	NA	NA						
23	NA	NA						
24	NA	NA						
25	NA	NA						

Depth is in feet and flow is feet/sec. The character W reflects a washed out microhabitat. The character D reflects to deep to measure.

5.0 RECOMMENDATIONS AND CONCLUSIONS

The data that was collected in this study will be incorporated with hydrologic and bathymetric data obtained by TWDB personnel and used in their MAT model. The MAT study reach model involves analysis of biological data from microhabitats at different flows, especially the distribution of fish within those microhabitats at different flows, during summer and winter.

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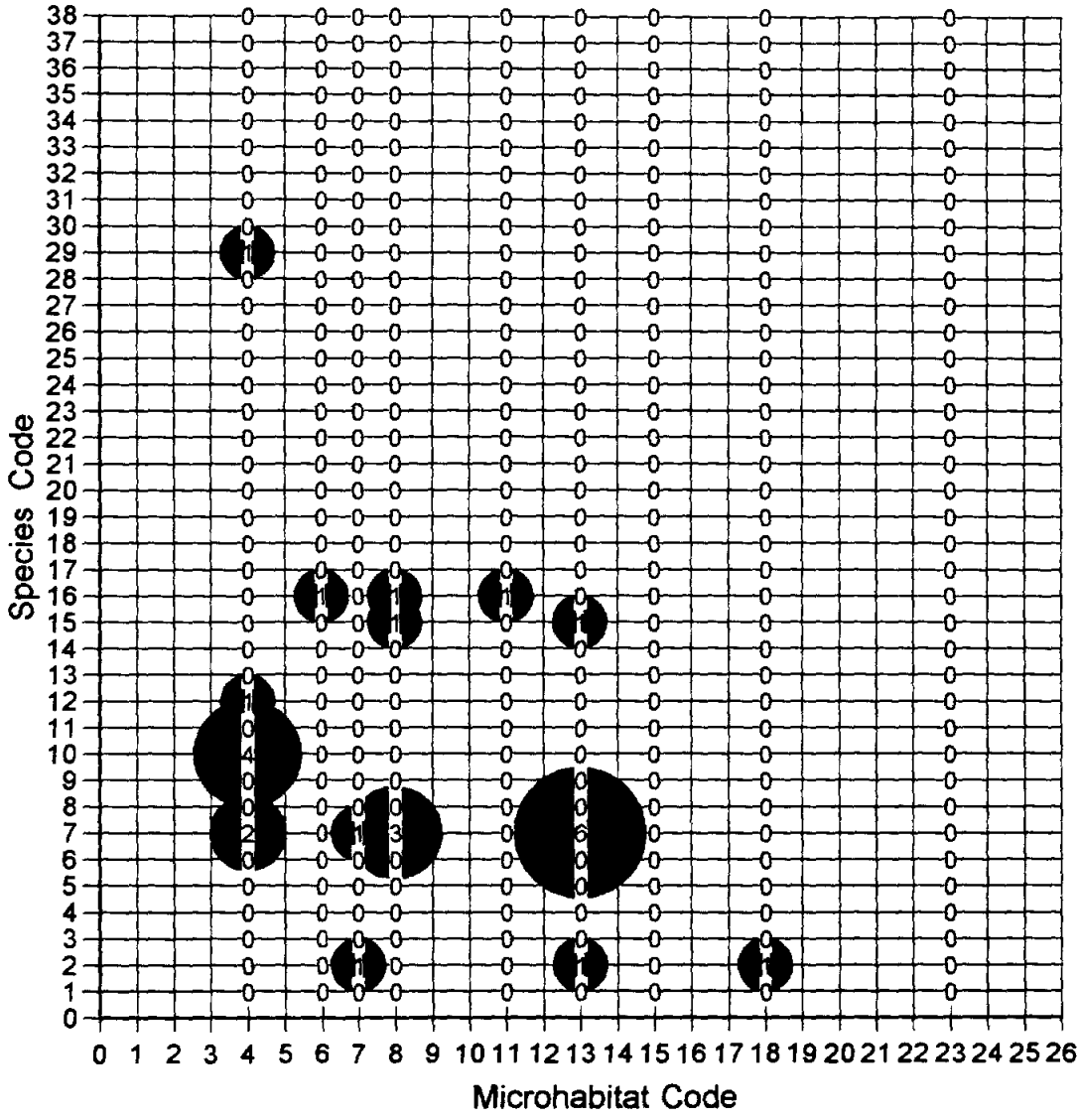
APPENDICES

Appendix 1.
Fish species code for bubble graphs.

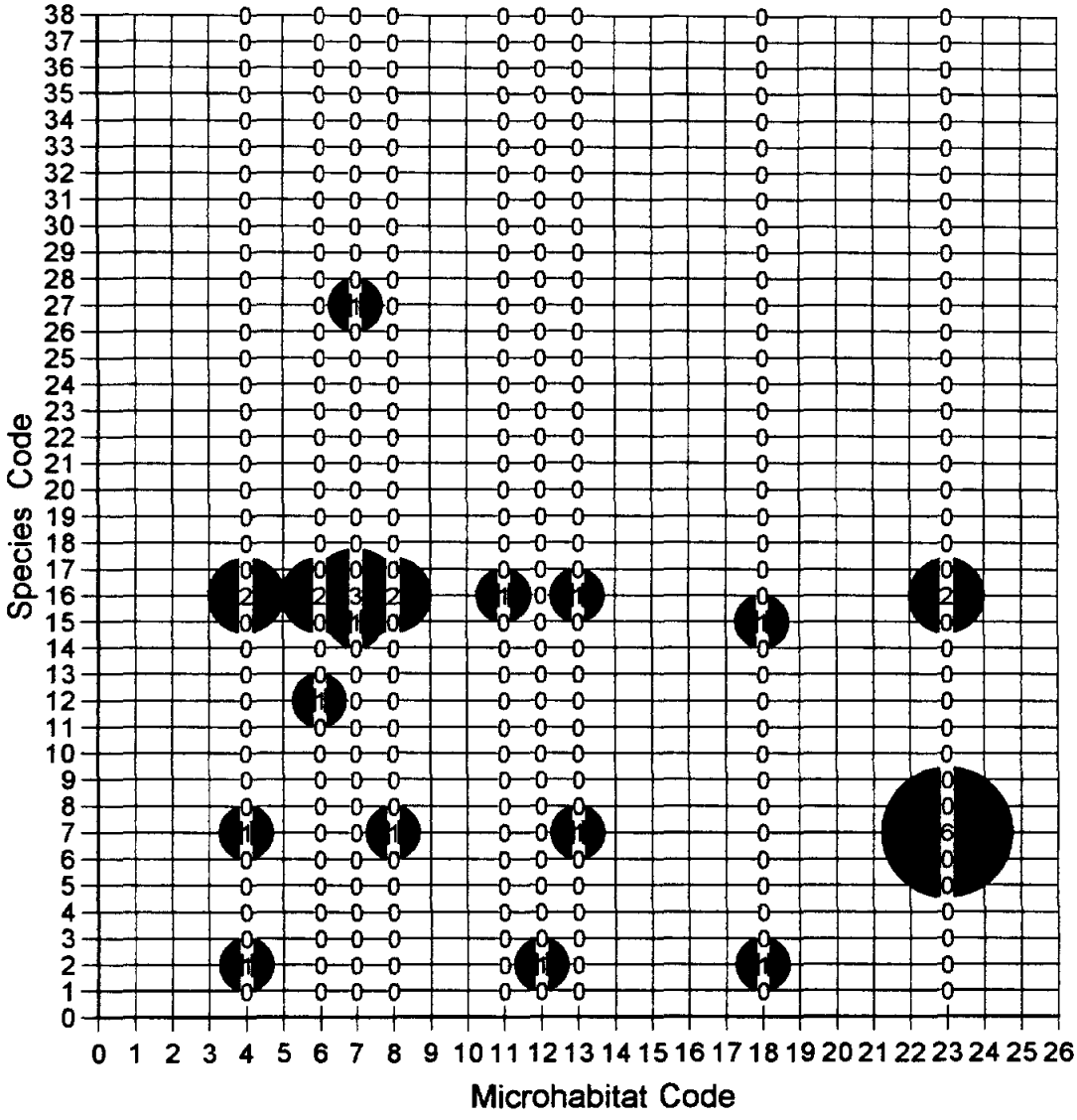
Code	Scientific Name	Common Name
1	*Anguilla rostrata*	American eel
2	*Lepisosteus sp.*	Spotted/Longnose gar
3	*Dorosoma cepedianum*	Gizzard shad
4	*Astyanax mexicanus*	Mexican tetra
5	*Hybopsis aestivalis*	Speckled chub
6	*Cyprinella venusta*	Blacktail shiner
7	*Cyprinella lutrensis*	Red shiner
8	*Notropis stramineus*	Sand shiner
9	*Notropis volucellus*	Mimic shiner
10	*Pimephales vigilax*	Bullhead minnow
11	*Campostoma anomalum*	Central stoneroller
12	*Ictiobus bubalus/Cyprinus carpio*	Smallmouth buffalo/Common carp
13	*Moxostoma congestum*	Gray redhorse
14	*Minytrema melanops*	Spotted sucker
15	*Ictalurus sp.*	Channel/Blue catfish
16	*Pylodictis olivaris*	Flathead catfish
17	*Ameirus natalis*	Yellow bullhead
18	*Fundulus notatus*	Blackstripe topminnow
19	*Gambusia affinis*	Western mosquitofish
20	*Poecilia latipinna*	Sailfin molly
21	*Menidia beryllina*	Inland silverside
22	*Micropterus punctulatus*	Spotted bass
23	*Erimyzin oblongus*	Creek chubsucker
24	*Micropterus treculi*	Guadalupe bass
25	*Micropterus salmoides*	Largemouth bass
26	*Lepomis gulosus*	Warmouth
27	*Lepomis cyanellus*	Green sunfish
28	*Lepomis auritus*	Redbreast sunfish
29	*Lepomis punctatus*	Spotted sunfish
30	*Lepomis microlophus*	Redear sunfish
31	*Lepomis macrochirus*	Bluegill
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 cephalus*	Striped mullet

Appendix 1.
Microhabitat code for bubble graphs.

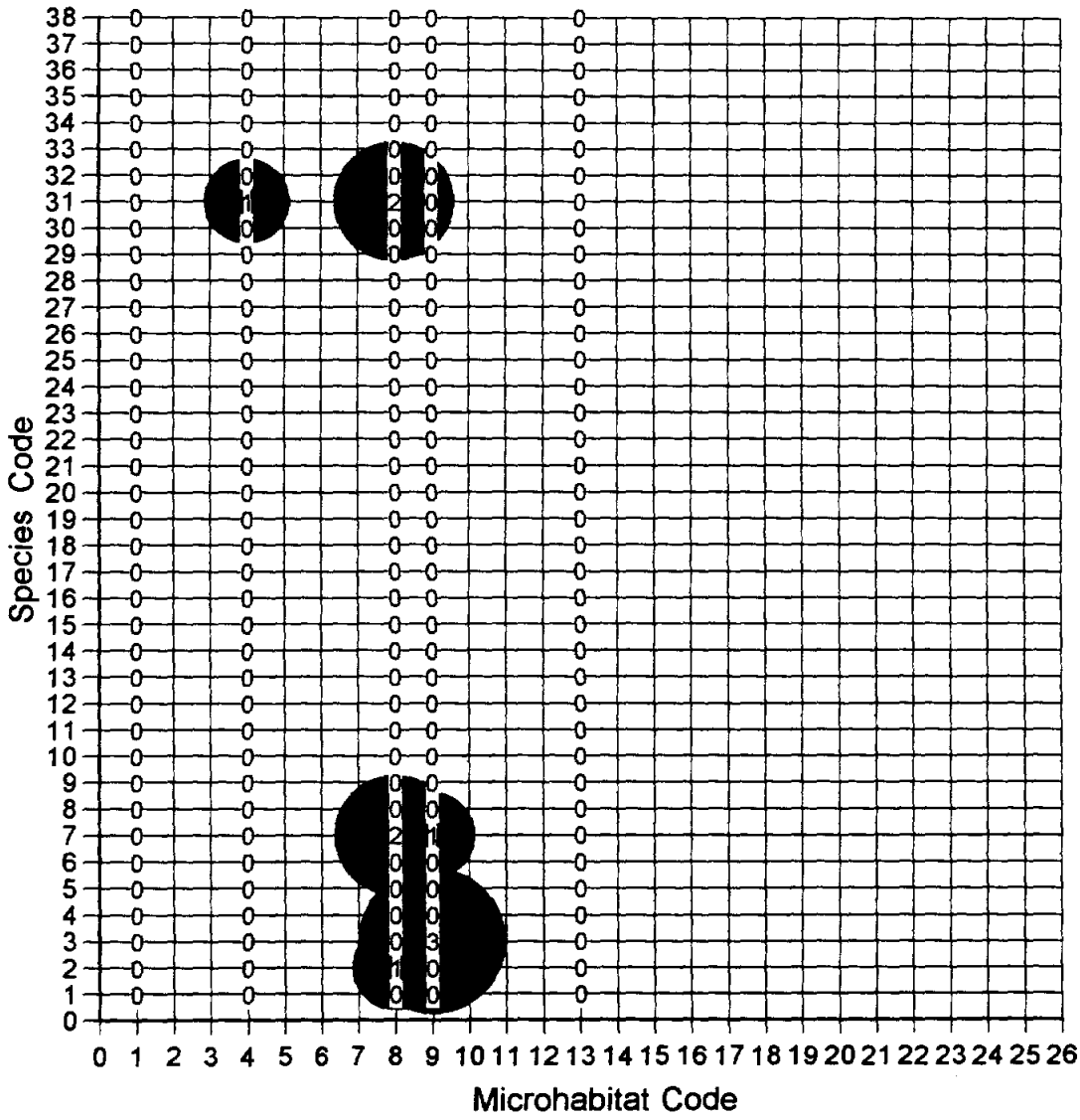
Individual Graphs	
Code	**Microhabitat**
1	Pool
2	Chute
3	Rapid
4	Pool - Root Wad
5	Edgewater
6	Run
7	Pool - Undercut Bank
8	Riffle - Bank Snag
9	Backwater
10	Riffle
11	Riffle - Debris dam
12	Riffle - Snag complex
13	Riffle - Channel snag
14	Eddy pool
15	Glide
16	Run - -Root Wad
17	Pool - Bank Snag
18	Pool - Undercut Bank
19	Pool - Snag Complex
20	Pool - Channel Snag
21	Pool - Debris Dam
22	Run - Debris Dam
23	Run - Bank Snag
24	Run - Channel Snag
25	Backwater - Channel Snag



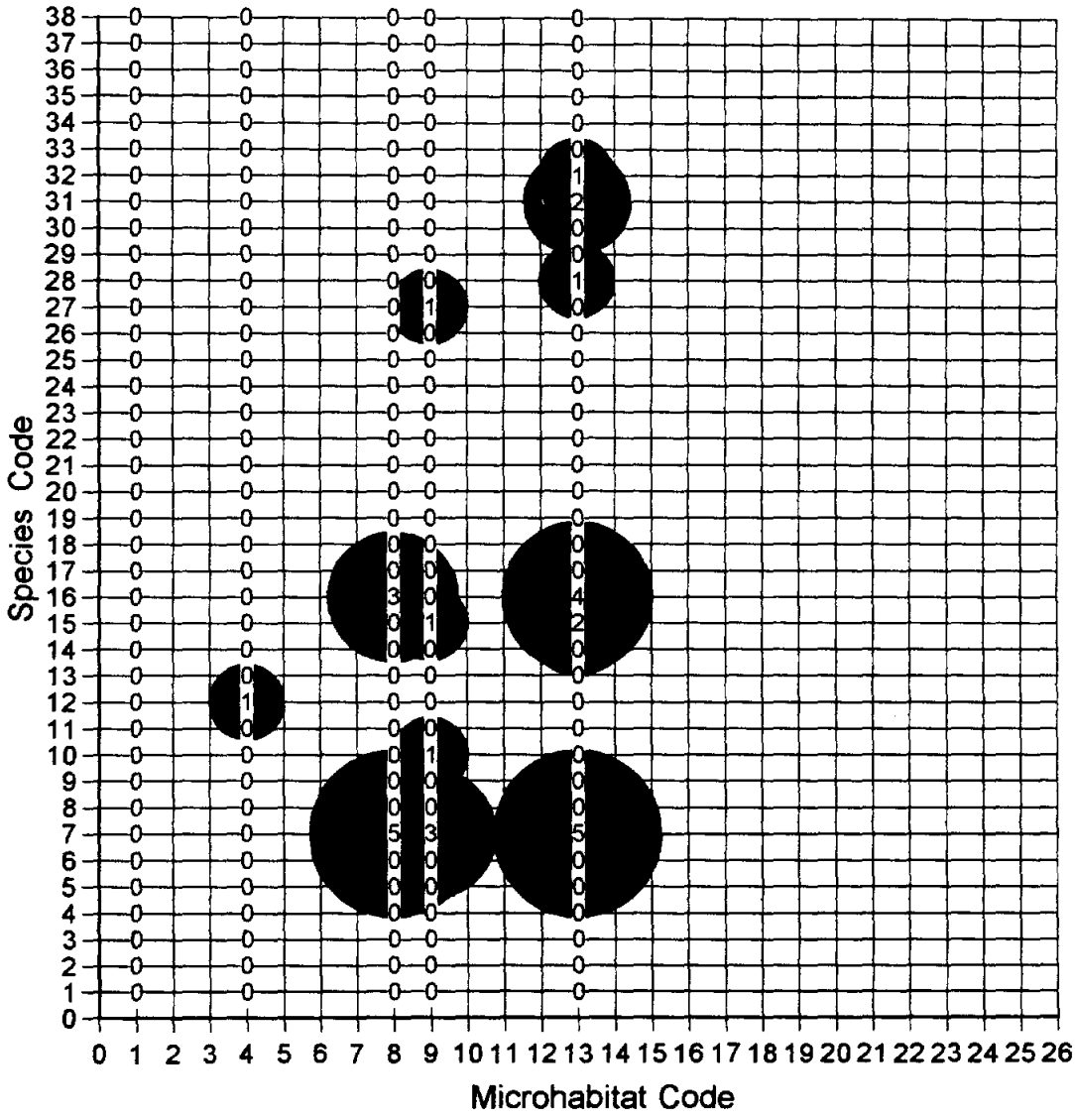
Appendix 2. Site 1 at winter medium flow, Jan. 3, 1997.



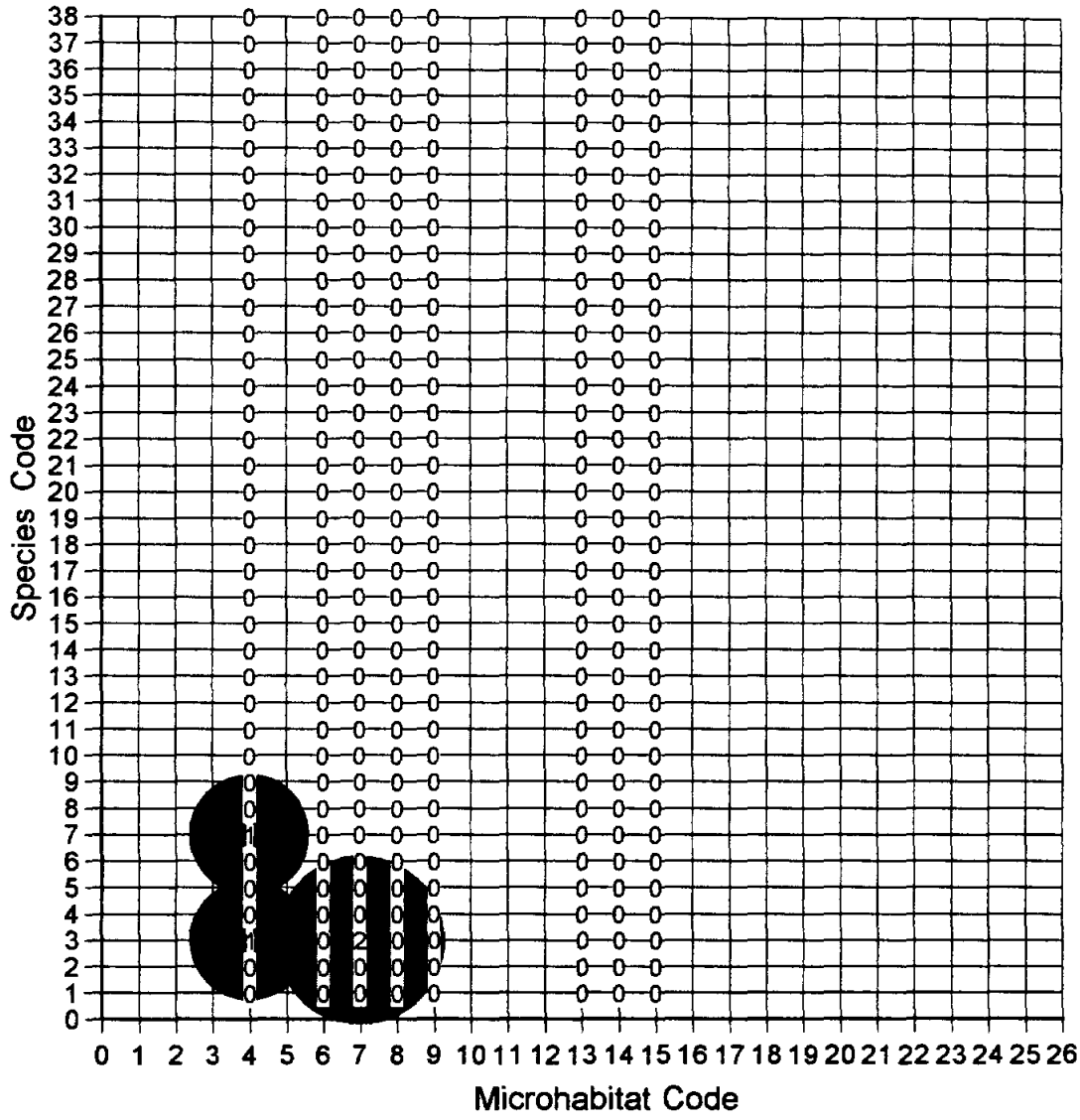
Appendix 2. Site 1 at summer high flow, Sept. 10, 1997.



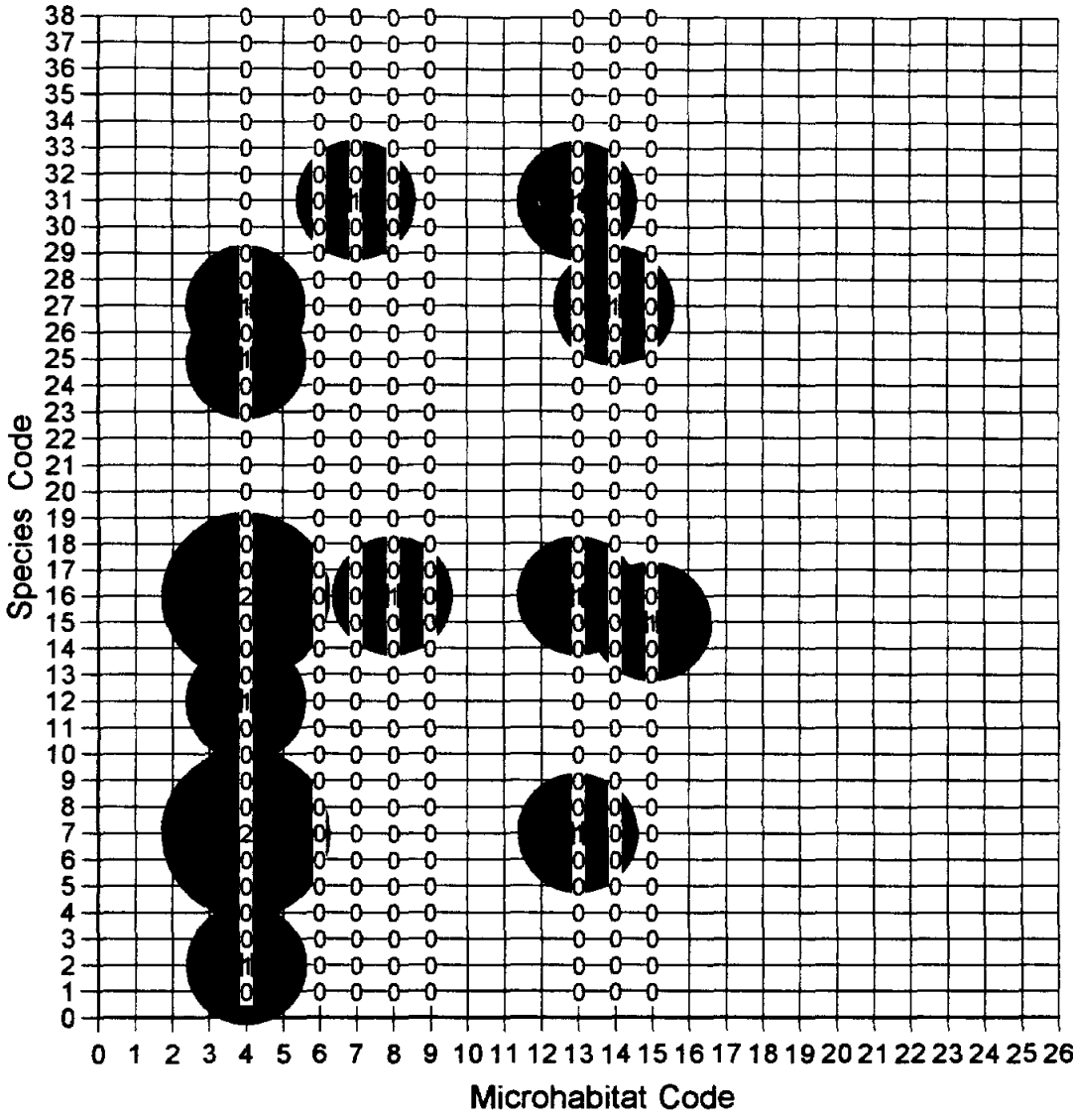
Appendix 2. Site 2 at winter medium flow, Nov. 1, 1997.



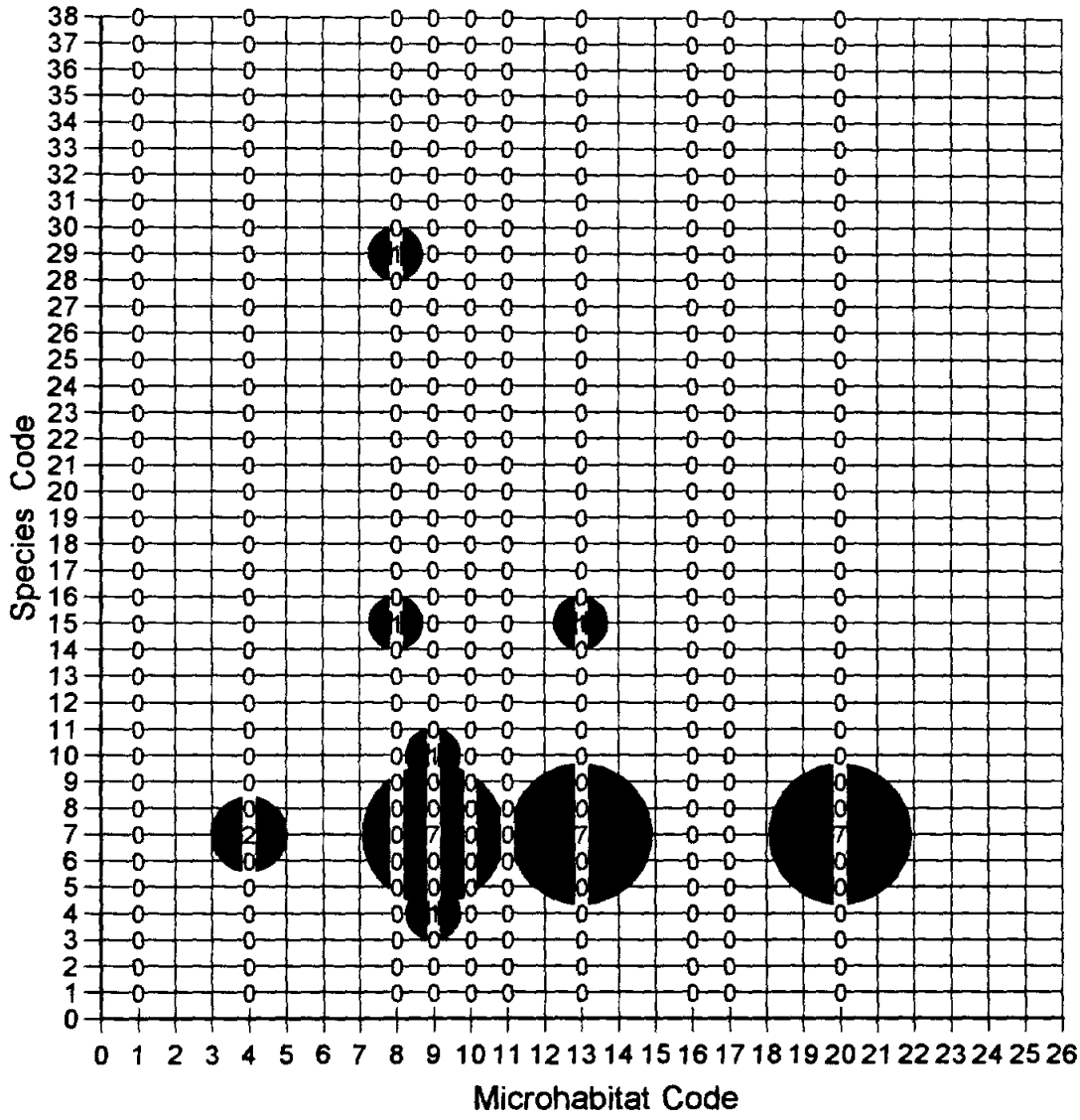
Appendix 2. Site 2 at summer high flow, Sept. 9, 1997.



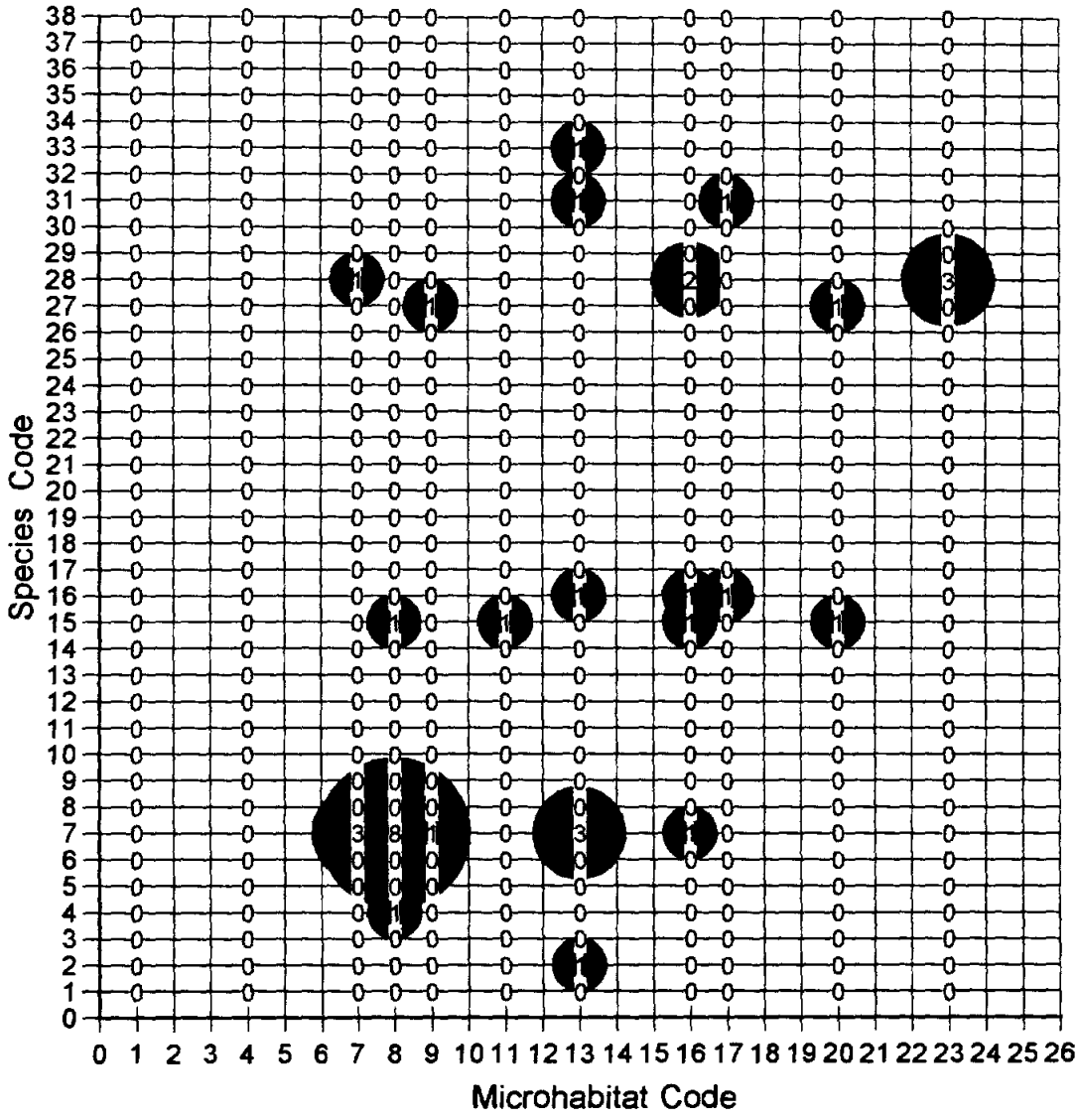
Appendix 2. Site 4 at winter medium flow, Nov. 1, 1997.



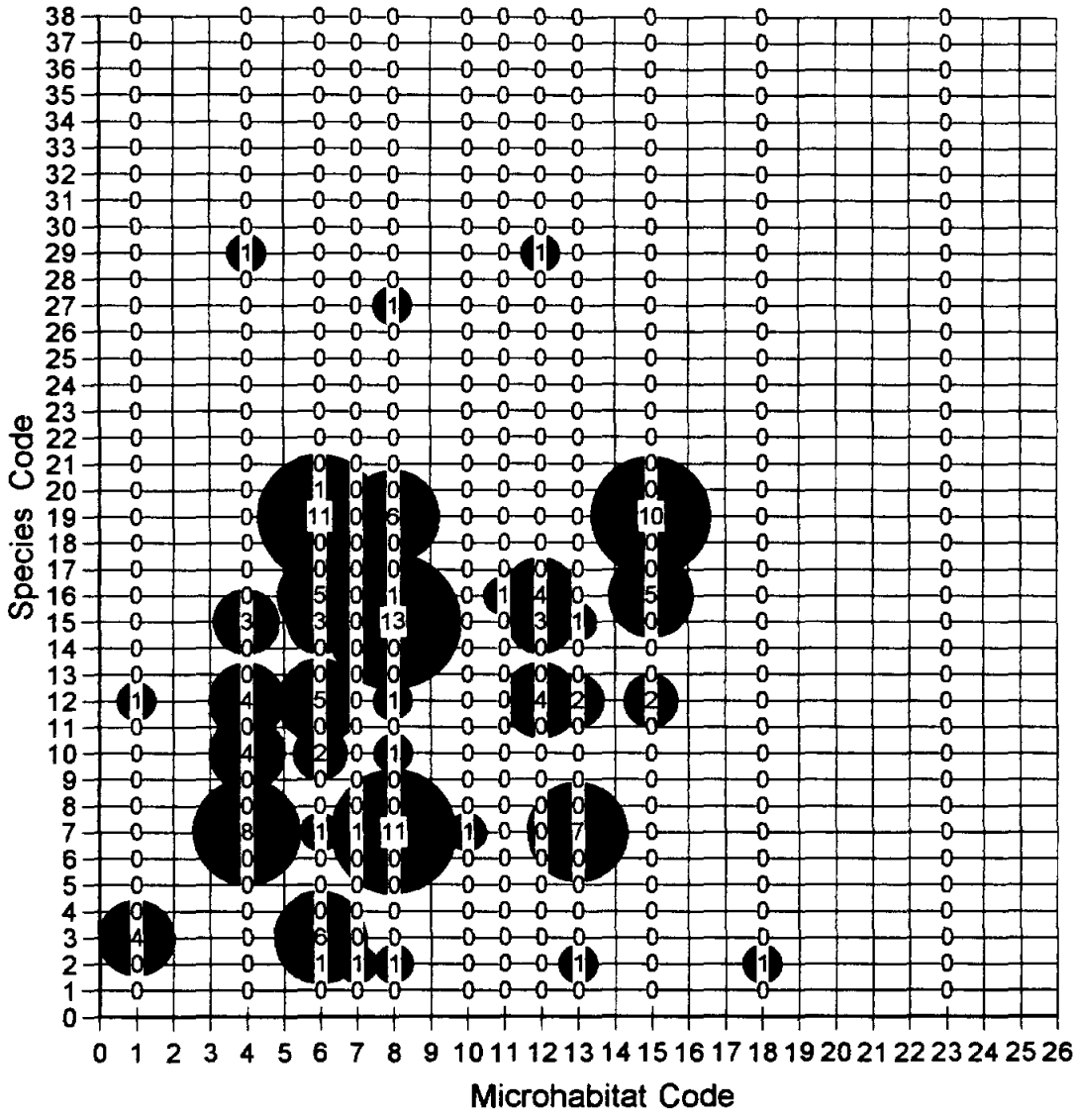
Appendix 2. Site 4 at summer high flow, Sept. 10, 1997.



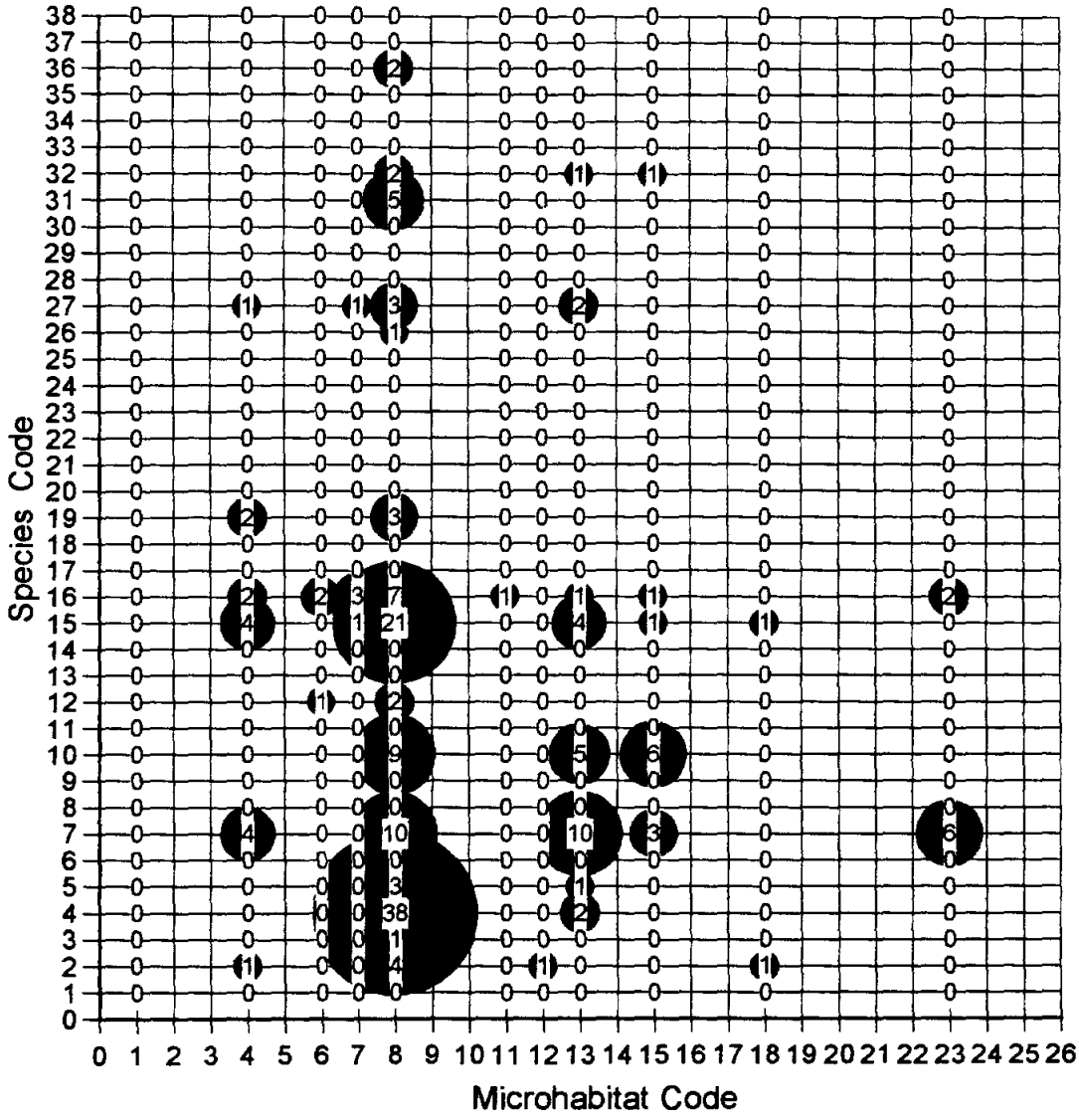
Appendix 2. Site 5 at winter medium flow, Nov. 1, 1997.



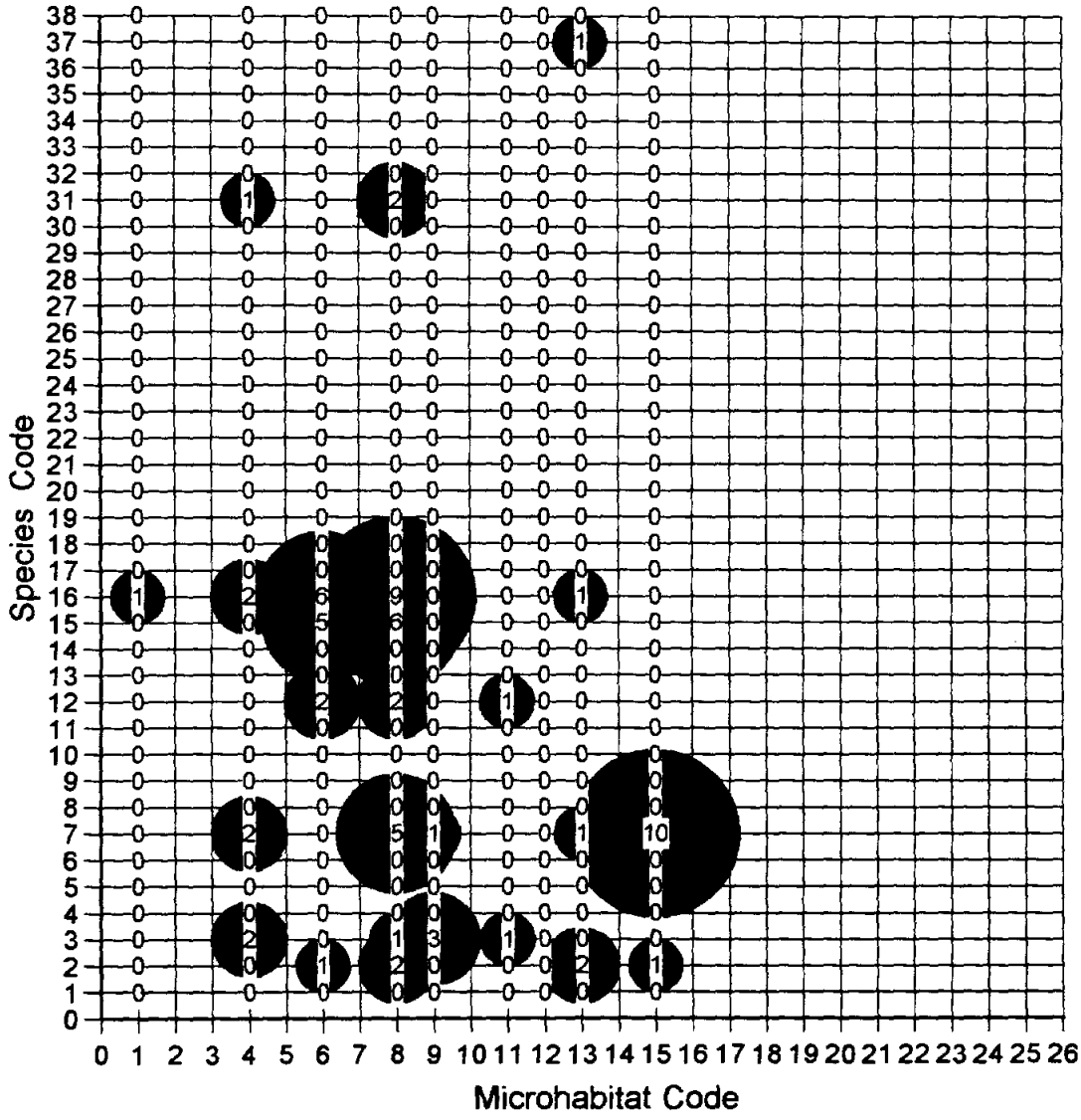
Appendix 2. Site 5 at summer high flow, Oct. 22, 1997.



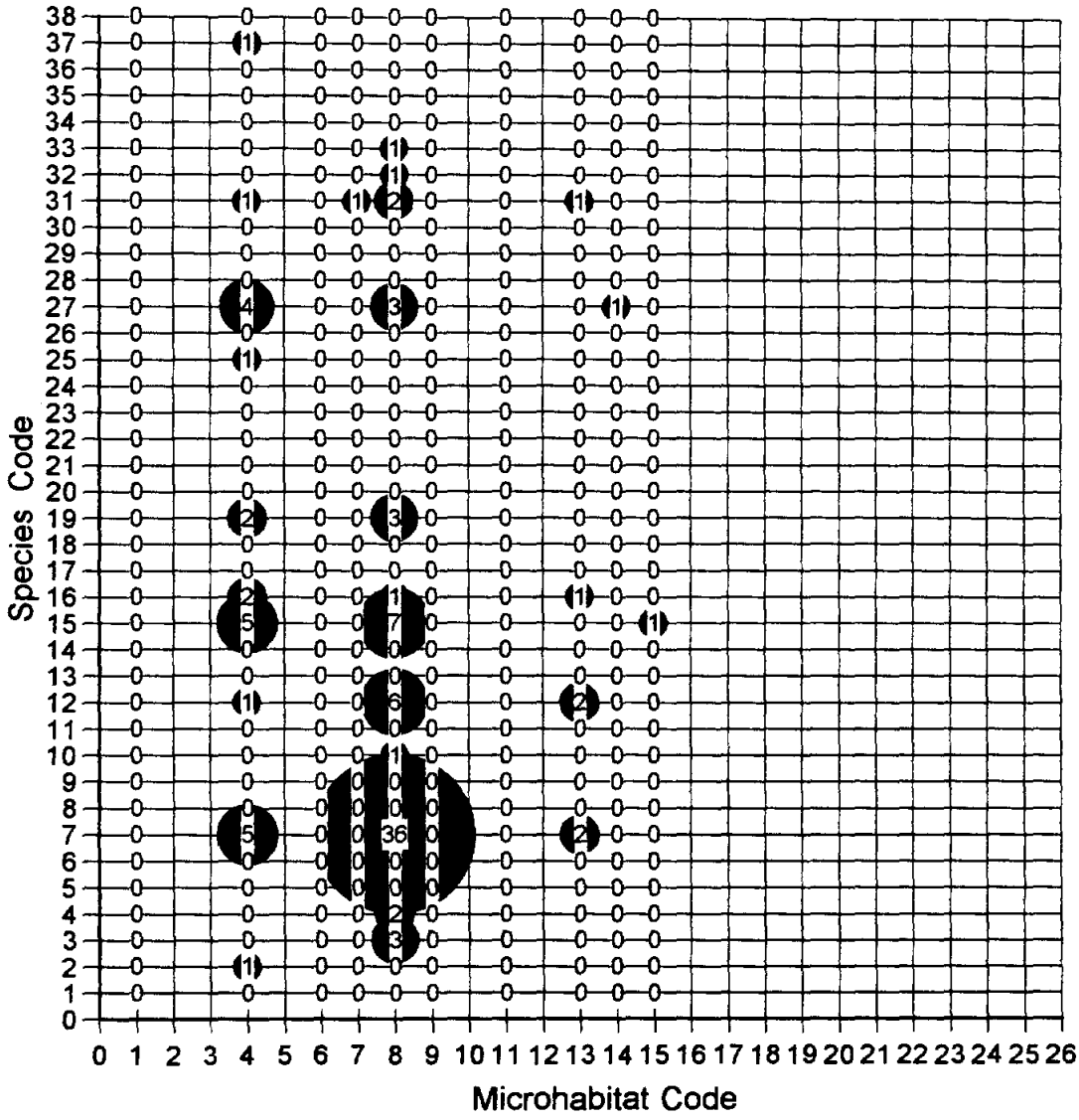
Appendix 2. Site 1 at medium flows, July 15, 1994 and Jan. 3, 1997.



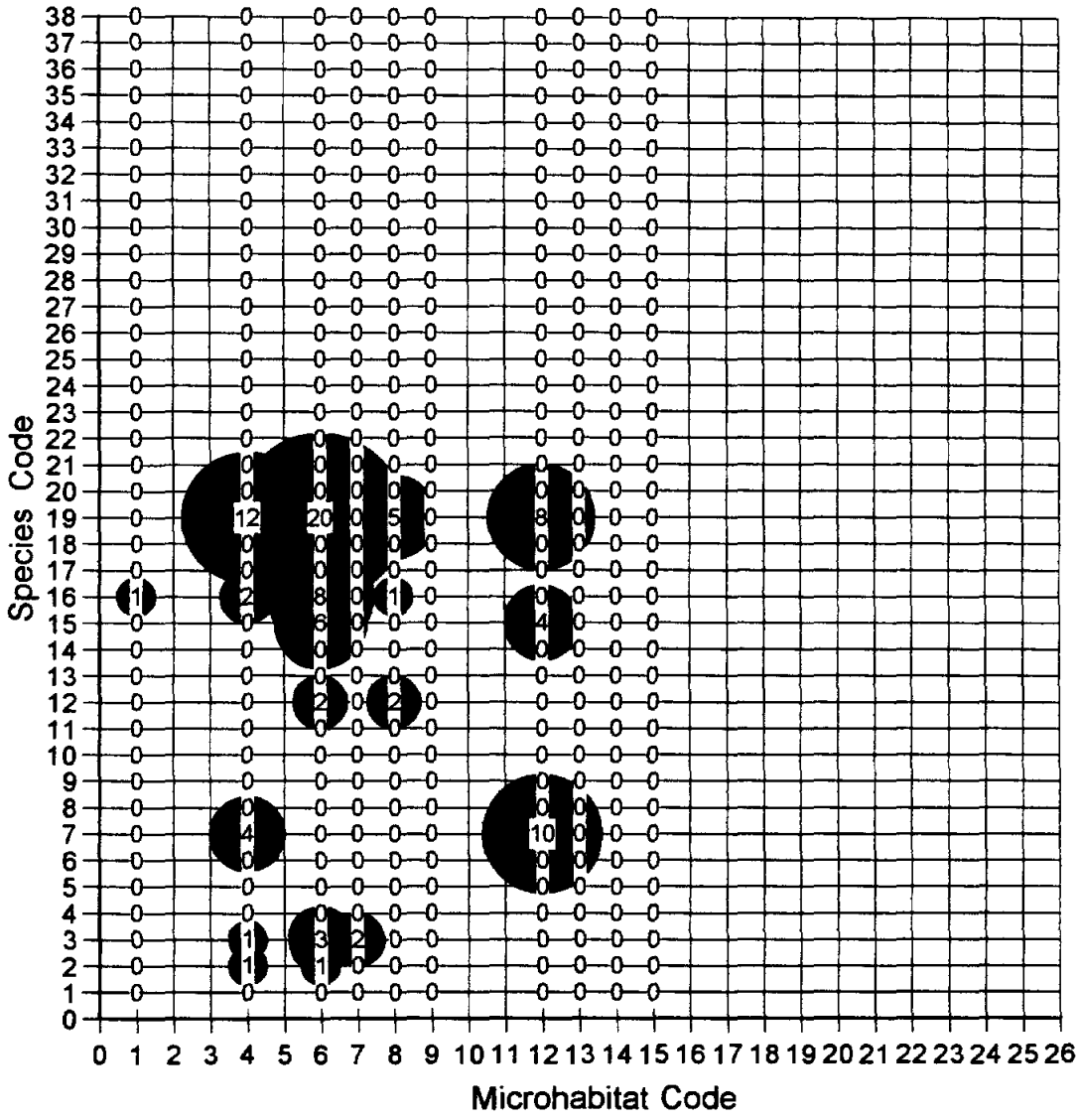
Appendix 2. Site 1 at high flows, Dec. 15, 1993 and Sept. 10, 1997.



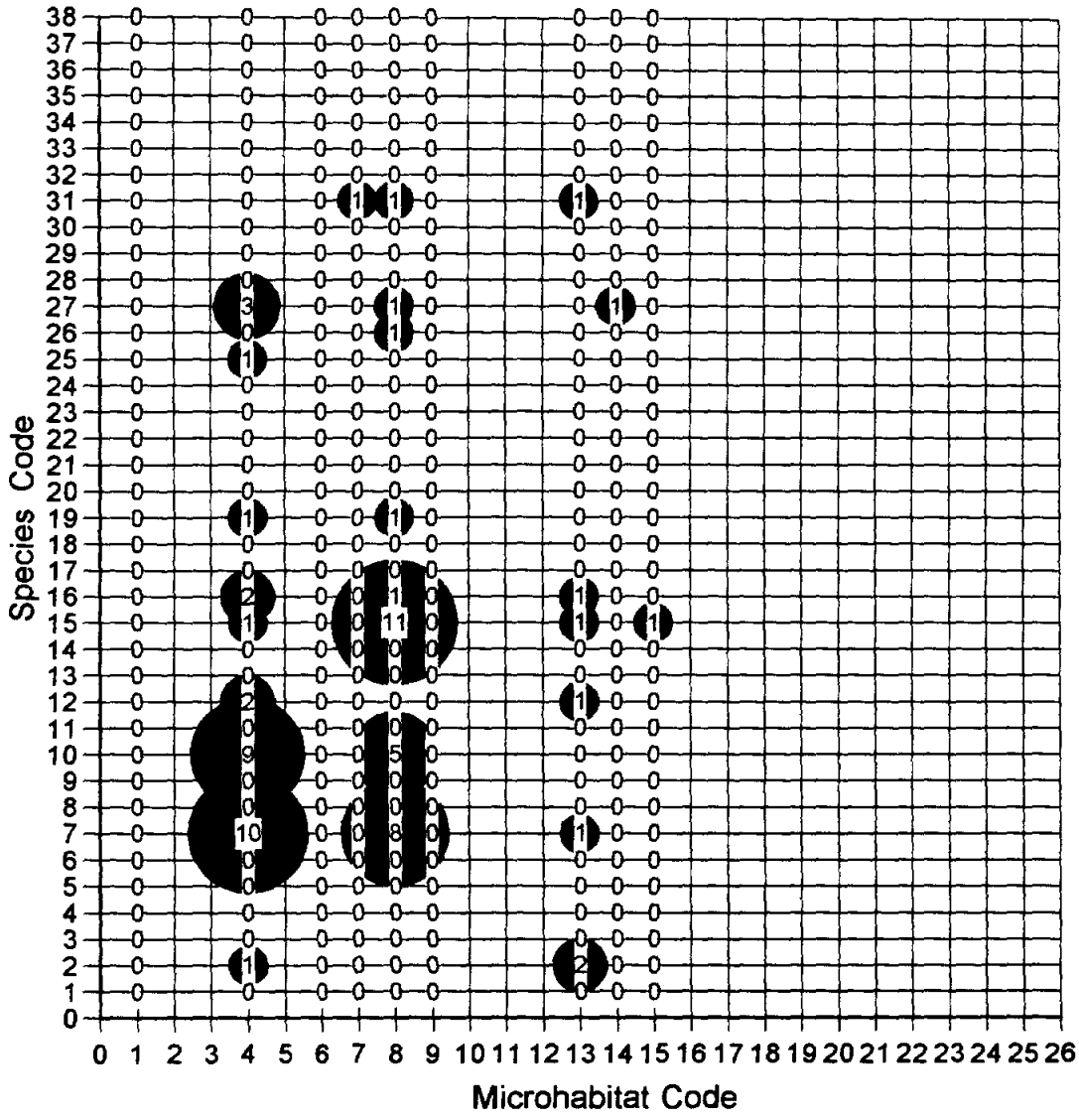
Appendix 2. Site 2 medium flows, July 14, 1994 and Nov. 1, 1997.



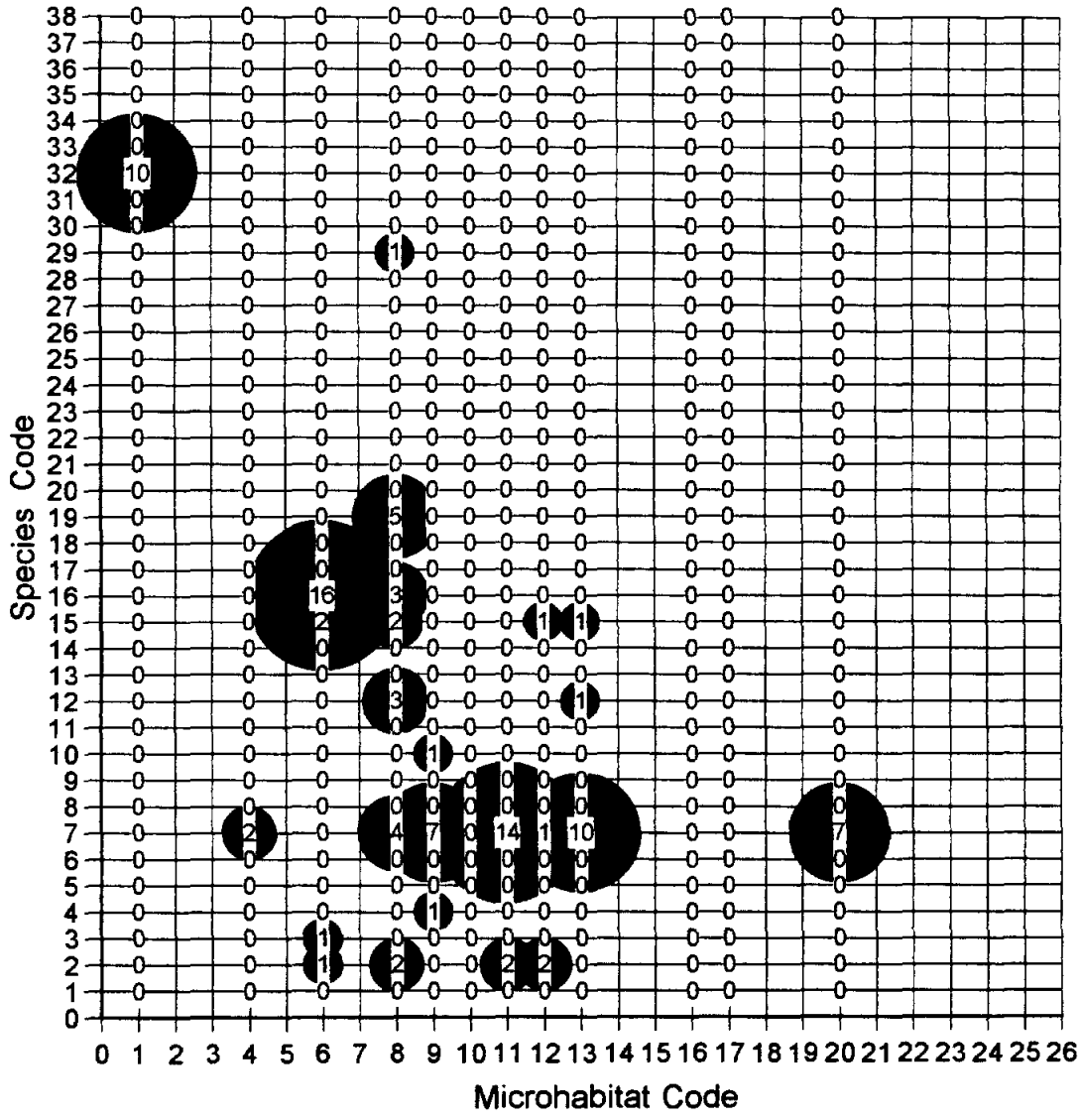
Appendix 2. Site 2 at high flows, Jan. 7, 1994 and Sept. 9, 1997.



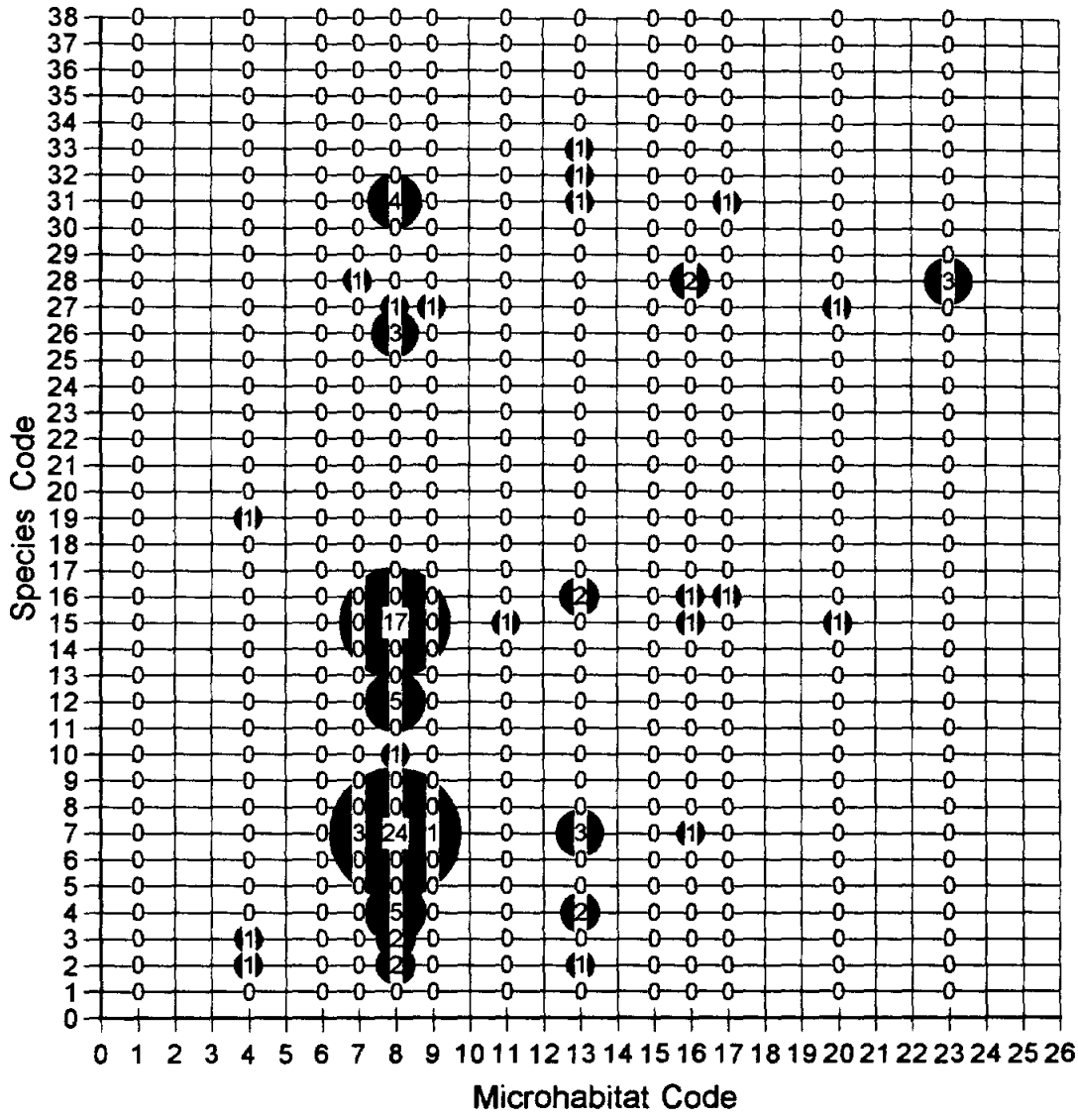
Appendix 2. Site 4 medium flows, July 14, 1994 and Nov. 1, 1997.



Appendix 2. Site 4 at high flows, Jan. 10, 1994 and Sept. 10, 1997.



Appendix 2. Site 5 at medium flows, July 13, 1994 and Nov. 1, 1997.



Appendix 2. Site 5 at high flows, Jan. 10, 1994 and Oct. 22, 1997.

Site 1 - Upstream View

Site 1 - Downstream View

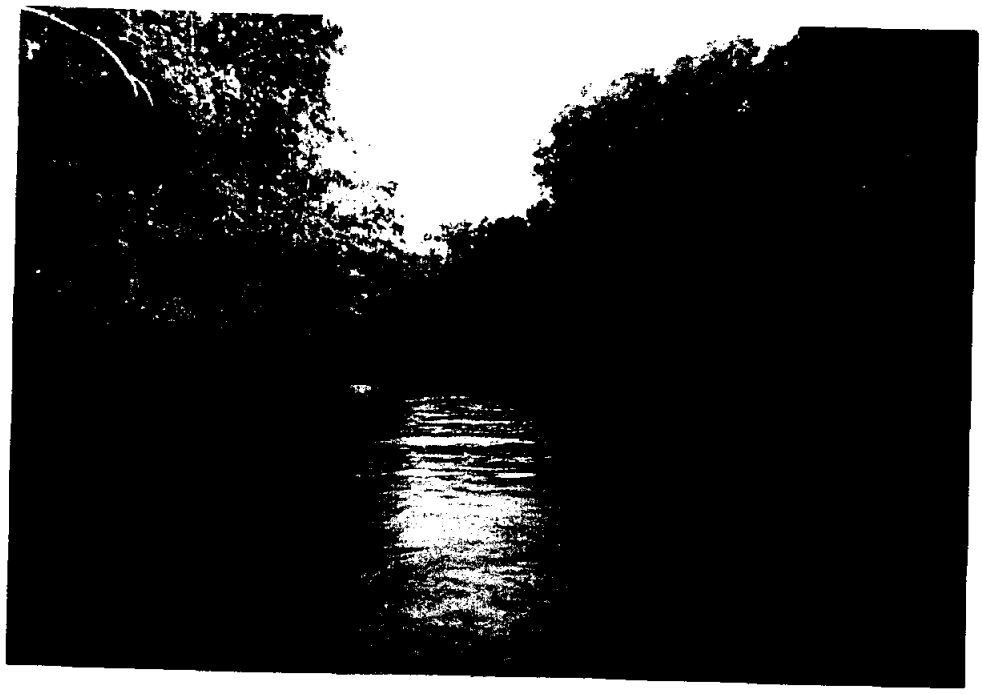
Appendix 3. Representative photographs of sample sites.

Site 2 - Upstream View

Site 2 - Downstream View

Appendix 3. Representative photographs of sample sites.

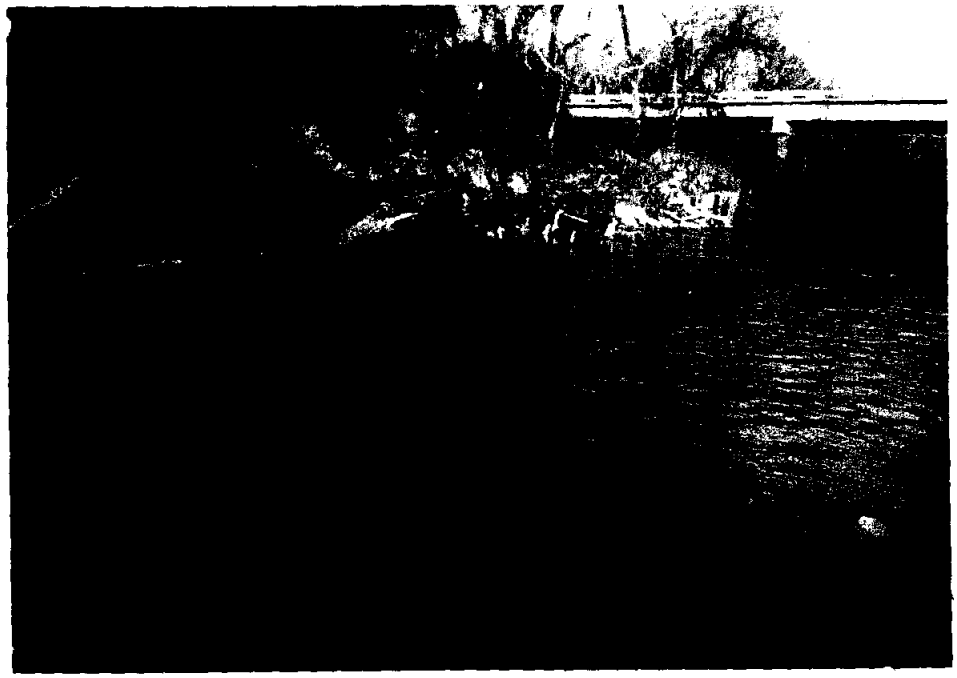
Site 4 - Upstream View



Site 4 - Downstream View

Appendix 3. Representative photographs of sample sites.

Site 5 - Upstream View



Site 5 - Downstream View

Appendix 3. Representative photographs of sample sites.

Root Wad

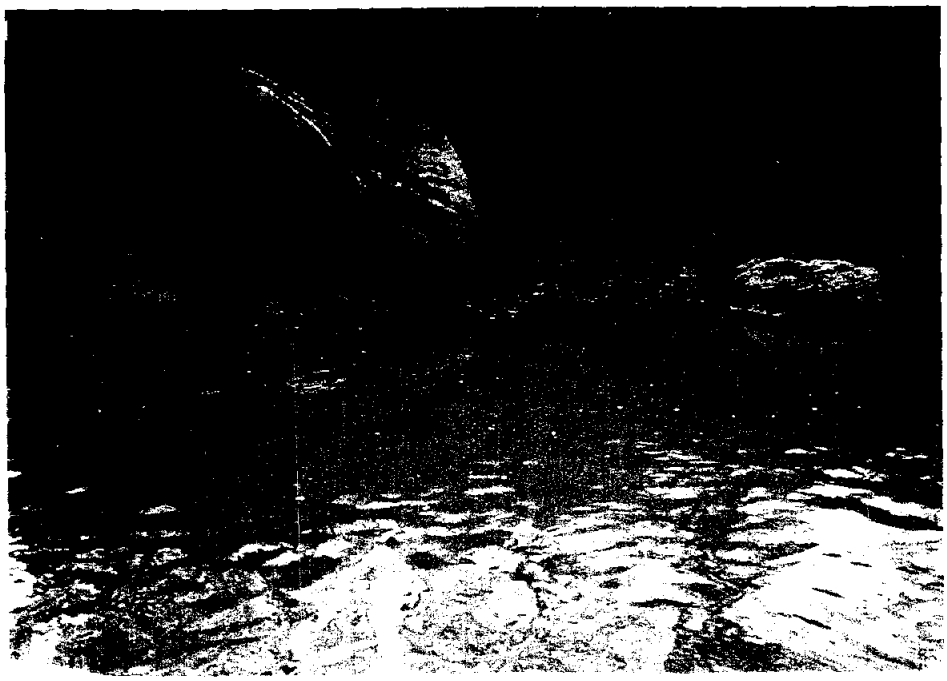
Run

Appendix 4. Representative microhabitat photographs.

Undercut Bank

Bank Snag

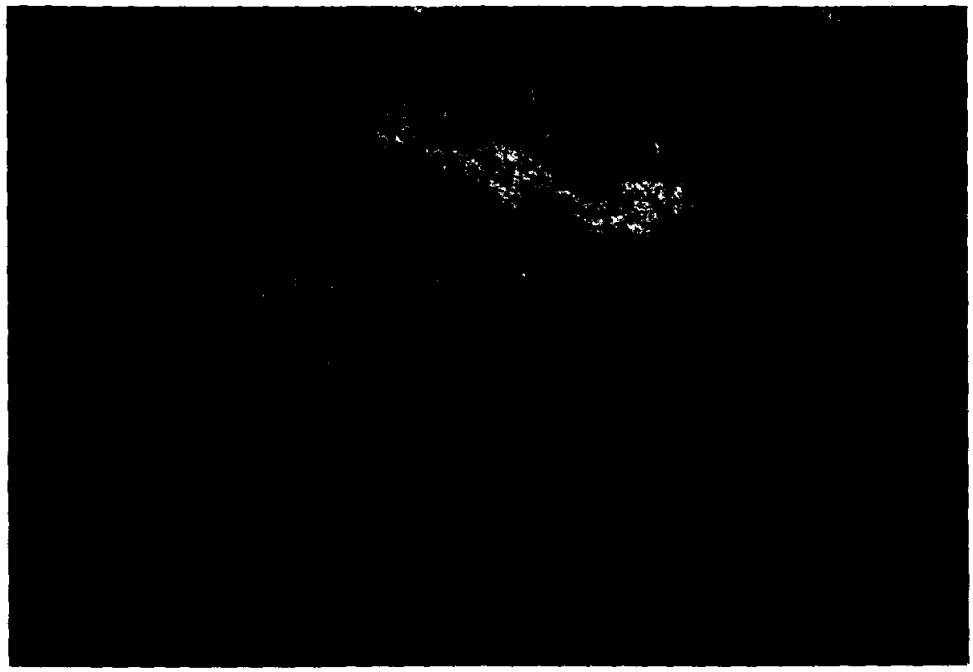
Appendix 4. Representative microhabitat photographs.



Backwater

Snag Complex

Appendix 4. Representative microhabitat photographs.



Channel Snag

Eddy Pool

Appendix 4. Representative microhabitat photographs.

Pool-Root Wad

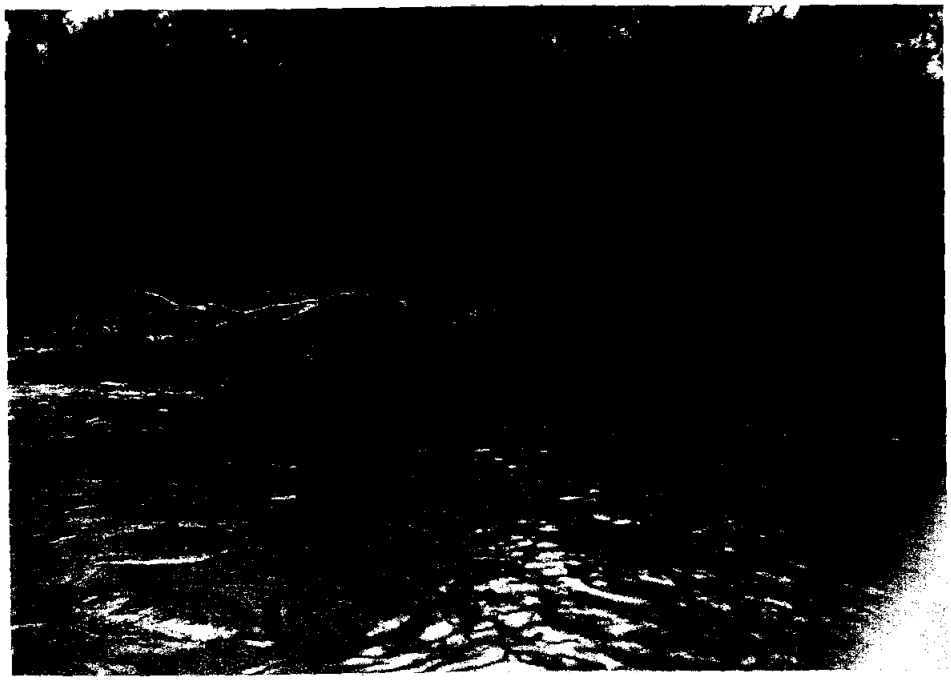
Pool-Bank Snag

Appendix 4. Representative microhabitat photographs.

Pool-Undercut Bank

Pool-Channel Snag

Appendix 4. Representative microhabitat photographs.



Run-Bank Snag

Appendix 4. Representative microhabitat photographs.