

Sabine River

INTRODUCTION

The Sabine River in the southwestern United States flows southeast and south for 380 mi from Hunt County in eastern Texas to Sabine Lake and through Sabine Pass into the Gulf of Mexico. It has a drainage basin of 9,756 mi², which lies in Texas and in the Louisiana Coastal Plain. Discharge of the river varies from 372 to 61,200 ft³/s. The Texas–Louisiana boundary follows the river, Sabine Lake, and Sabine Pass (Figure 1.1).

The entire Sabine basin lies within the Western Gulf Coastal Plain Section of the Coastal Plain Physiographic Province (Fenneman, 1938). According to the biotic provinces developed by Blair (1950), the upper third of the Sabine lies within the Texan Province, while the remainder lies within the more humid Austroriparian Province. Rolling plains characterize the upper fourth of the basin, but the topography becomes progressively flatter downstream (Hughes and Leifeste, 1965). Within the lower Sabine, the topography grades from low hills in the upper half (i.e., near Ruliff, Texas) to flat and often swampy topography in the lower half (i.e., in Orange County, Texas) (Seidensticker, 1980).

The Sabine River basin lies within three major land resource areas: the Black Land Prairies, East Texas Timberlands, and the Coastal Prairie. The Black Land Prairies land resource area encompasses approximately 960 mi² within the basin and comprises the entire area upstream of Iron Bridge Dam and the extreme upper portion of Lake Fork Creek Subwatershed. The East Texas Timberlands area comprises about

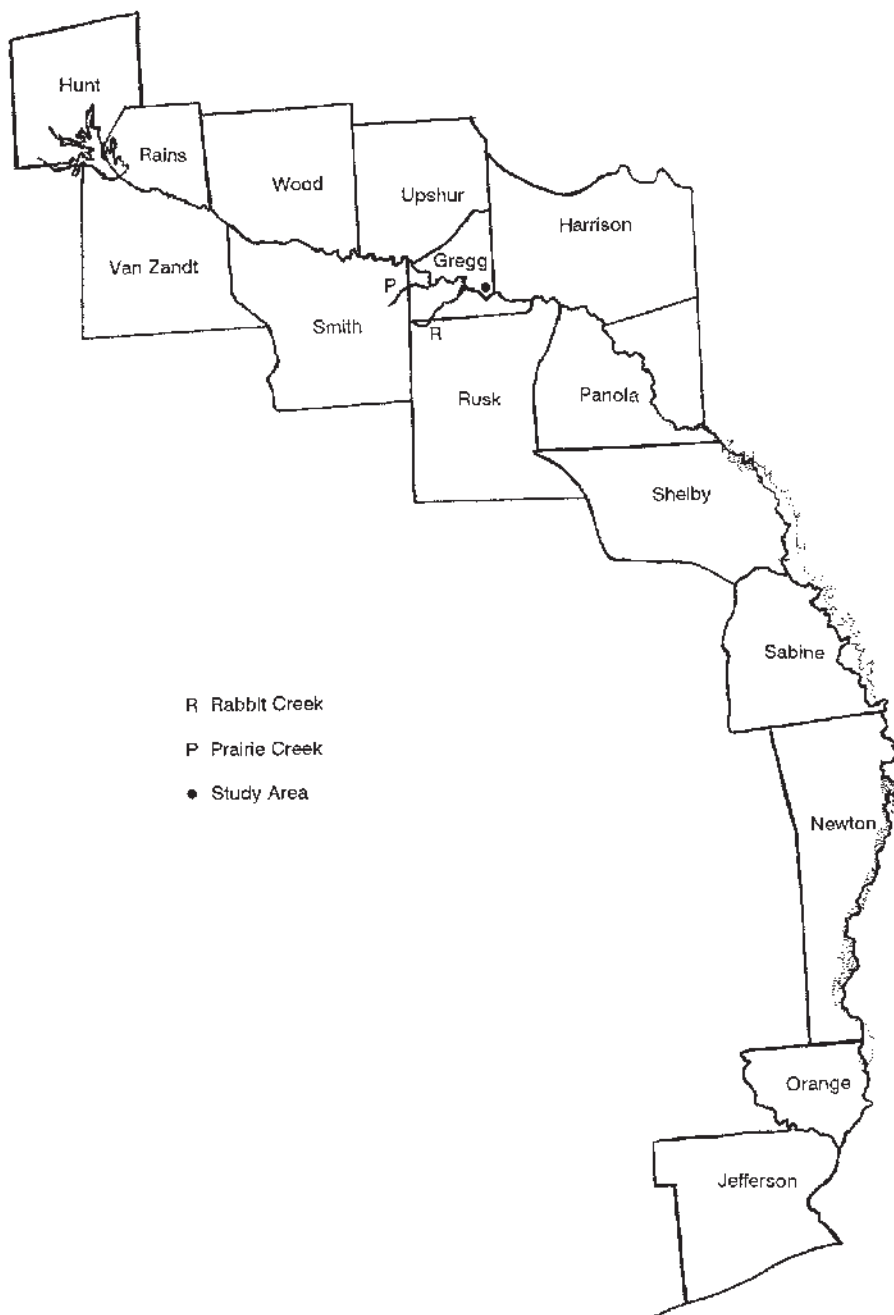


FIGURE 1.1. Map of the Sabine River.

88% of the basin. The Coastal Prairie land resource area comprises approximately the lower 10 mi of the Sabine River basin.

PHYSICAL CHARACTERISTICS

Geology

Geologically, the Sabine basin is underlain with sedimentary deposits that range from Upper Cretaceous to Recent in age. The oldest deposits are found in the northwestern part of the basin. Tertiary deposits of sandstones, shales, and unconsolidated sediments are prevalent in most of the basin, while Pleistocene deposits of clay, silt, sand, and gravel characterize much of the lower basin. Recent alluvium underlies and borders most of the middle and lower river (Hughes and Leifeste, 1965).

Watershed

With the exception of Black Land Prairies (predominantly *Andropogon* spp. and *Stipa leucotrichia*) in the northwest, the presettlement watershed of the Sabine River was covered with pine and hardwood forests. A longleaf pine (*Pinus palustris*) covered most of the lower Sabine watershed, but repeated clearing has largely replaced this assemblage with a Southern Mixed Forest characterized by sweetgum (*Liquidambar styraciflua*), post oak (*Quercus stellata*), blackjack oak (*Q. marilandica*), and yellow pine (*P. echinata*) in the uplands. Bottomland forests are characterized by *L. styraciflua*, magnolia (*Magnolia grandiflora*), tupelo gum (*Nyssa sylvatica*), and water oak (*Q. nigra*). Cypress–tupelo (*Taxodium–Nyssa*) swamps are extensive in the flatter, downstream reaches and along some of the tributaries, but these forests grade into coastal grassy wetlands within the estuary [Academy of Natural Sciences of Philadelphia (ANSP), 1954; Blair, 1950; Hubbs, 1957; Sala et al., 1979; Seidensticker, 1980]. Agricultural activity was formerly extensive within the lower basin, but yellow pine and hardwood forestry dominate current land use. Industrial activity is considerable within the estuary (ANSP, 1970; Sala et al., 1979).

The climate within the Sabine basin ranges from subhumid in the northwest to humid or subtropical in the lower Sabine. Precipitation, which occurs almost exclusively as rain, averages 142 cm yr⁻¹. The 30-year mean at Bon Wier indicates that precipitation occurs throughout the year, with minima occurring in September and October. Nonetheless, precipitation can be highly variable, particularly in the upper basin, where drought conditions have resulted in occasional intermittency in the main stem (Hughes and Leifeste, 1965).

River Structure

The drainage area of the upper part of the Sabine River is about 4846 mi². The lower basin or state line portion has a contributing area of some 4910 mi², of which 2550 mi² lies within Texas and 2360 mi² lies in Louisiana. The total watershed is approximately 9756 mi², of which 76% lies within the boundaries of Texas.

The lower Sabine River is typical of many low-gradient, meandering Coastal Plain rivers. The river flows through a wide, well-developed floodplain with numerous

sloughs, overflow channels, and wetlands (Hughes and Leifeste, 1965). The channel is relatively wide. Sala et al. (1979) reported that the river at West Bluff (river km 31) and Ruliff (km 60) was between 75 and 110 ft (23 to 34 m) wide during normal flow. Farther upstream at Bon Wier (km 150), they reported that the river was 30 to 50 ft (9 to 15 m) wide during low flow, but expanded to 100 yards (92 m) during high flow. Depths at Ruliff and West Bluff ranged from 10 to 20 ft (3 to 6 m). Seidensticker (1980) reported that widths increased substantially (e.g., $\frac{1}{4}$ mile; 155 m) as the river neared the estuary and that depths varied considerably (1 to 75 ft; 0.3 to 22.9 m). Sand is the predominant substrate, but mud and hard clay can be found in some shallow areas. Snags, woody debris, and undercut banks are moderately common (ANSP, 1954; Sala et al., 1979; Seidensticker, 1980).

Variability in flow characterized the preimpoundment lower Sabine River. Annual mean discharge near Ruliff ranged from 1760 to 17,210 ft³/s (49.8 to 487.3 m³ s⁻¹) between 1925 and 1962. Instantaneous discharge has been even more variable, ranging from 270 to 121,000 ft³/s (7.6 to 3426.4 m³ s⁻¹) (Hughes and Leifeste, 1965). Since 1966, flow in the lower Sabine has been regulated by Toledo Bend Dam. Nonetheless, flows are still highly variable. For instance, annual mean discharge at Ruliff during water year 1969 (348.9 m³ s⁻¹) was almost triple what it was during water year 1970 (117.0 m³ s⁻¹) [U.S. Geological Survey (USGS), 1975a].

Discharge in the lower Sabine River is significantly influenced by discharge from both the upper basin (via Toledo Bend Reservoir) and local tributaries (via Bayou Anacoco and Big Cow Creek). Discharge maxima in reservoir releases (i.e., near Burkeville) generally correspond to discharge maxima, more than 160 km downstream near Ruliff. On the other hand, tributary inputs within the lower basin tend to moderate peak discharge by increasing discharge minima. During water year 1969, for example, there was relatively little difference between the maximum instantaneous discharge recorded near Ruliff and the one recorded near Burkeville. On the other hand, the minimum discharge near Ruliff was more than an order of magnitude greater than it was just below the reservoir (USGS, 1975a). In addition to its influence on seasonal patterns in discharge, hydroelectric generation at Toledo Bend Dam results in severe daily fluctuations in discharge and river stage. Variations in river stage ranging from 4 to 10 ft (1.2 to 3.0 m) have been recorded in the upper half of the lower Sabine (Seidensticker, 1980).

The lower Sabine River is relatively turbid, largely because of high silt loads incurred in the upper and middle basins. Turbidities at Bon Wier, Ruliff, and West Bluff ranged from 3 to 20 NTU, 10 to 110 NTU, and 7 to 99 NTU, respectively, for six collection dates during 1976 to 1977. Concurrent Secchi disk readings ranged from 15 to 48, 9 to 25, and 13 to 28 in., respectively (Sala et al., 1979). The ranges for JTU turbidities for four collection dates during 1979 ranged from 13 to 32, 15 to 34, and 8 to 46 JTU, respectively (Seidensticker, 1980).

The lower Sabine is a warm-water stream with temperatures commonly ranging from 5 to 32°C (ANSP, 1954, 1970; Sala et al., 1979; Seidensticker, 1980). For example, temperatures at Ruliff ranged from 6.0 to 32.0°C during water year 1970. Temperatures were usually greater than 25.0°C from late May through mid-October. Temperatures less than 10°C were recorded only during January (USGS, 1975b).

CHEMICAL CHARACTERISTICS

Upper Sabine

The study area was just above the boundary between Gregg and Harrison counties on the Sabine River. It was a short distance below the junction of Prairie Creek and Rabbit Creek (Figure 1.1). The hardness ranged between 52 and 52.3 mg L⁻¹ at the time it was sampled, which was in October 1995 (Table 1.1). Dissolved oxygen was below saturation, which is probably caused by runoff from agricultural activities and from oil well activities in the watershed, which is also indicated by the relatively high chloride concentrations, which are higher than they would be for a natural stream. The nitrates and phosphates were also higher than one would find in a pristine stream, and these concentrations indicate the agricultural activities that take place in the watershed. The dissolved oxygen is similar in concentration to that found in the lower Sabine. However, there were occasions when supersaturation occurred in the lower Sabine, probably due to excessive algal activity.

TABLE 1.1. *Mean, Minimum, Maximum Values, and Standard Deviations for Water Quality Parameters in Samples Collected October 9–11, 1995, from the Upper Sabine River*

Parameter	Mean	Min.	Max.	Std. Dev.
Temperature (°C)	20.73	20.20	21.00	0.46
pH	7.17	7.10	7.30	0.11
Dissolved oxygen (mg L ⁻¹)	7.70	7.50	8.00	0.26
Conductivity (μS cm ⁻¹)	261	245	273	14
TSS (mg L ⁻¹)	26.00	25.80	26.20	0.20
BOD ₅ (mg L ⁻¹)	1.85	1.55	2.10	0.28
Total hardness (mg L ⁻¹)	52.31	52.00	52.90	0.51
Calcium hardness (mg L ⁻¹)	34.93	32.70	36.70	2.04
Alkalinity (mg L ⁻¹)	36.90	33.30	41.80	4.40
Sulfate (mg L ⁻¹)	29.65	28.87	31.11	1.27
Chloride (mg L ⁻¹)	49.17	45.00	55.00	5.20
DOC-C (mg L ⁻¹)	5.74	5.66	5.86	0.10
NH ₃ + NH ₄ -N (mg L ⁻¹)	0.065	0.012	0.154	0.078
NO ₂ -N (mg L ⁻¹)	0.012	0.008	0.020	0.007
NO ₃ + NO ₂ -N (mg L ⁻¹)	1.31	1.05	1.53	0.24
TKN-N (mg L ⁻¹)	0.830	0.761	0.907	0.073
Orthophosphate-P (mg L ⁻¹)	0.093	0.072	0.109	0.019
Total phosphate-P (mg L ⁻¹)	0.191	0.170	0.221	0.027

Source: ANSP (1996).

Lower Sabine

Water in the lower Sabine River is soft, moderately acidic to moderately alkaline, slightly saline, and stained with organic acids (Table 1.2). This water chemistry is the result of interactions of mineral-rich waters originating from upstream reaches and mineral-poor waters entering from local tributaries. Under very high tides, salt water from the estuary may invade the area.

TABLE 1.2. *Selected Chemical Characteristics of Three Stations in the lower Sabine River, Louisiana and Texas, 1972-1977^a*

	Bon Wier	Ruliff	West Bluff
Inorganic constituents			
Chloride (mg L ⁻¹)			
Mean	26	21	19
Range	20–40	10–31	6–33
Sulfate (mg L ⁻¹)			
Mean	20	16	19
Range	13–38	9–24	8–34
Specific conductance (μS cm ⁻¹)			
Mean	205	180	165
Range	165–250	145–220	90–335
Alkalinity			
Total alkalinity (mg L ⁻¹)			
Mean	28	25	25
Range	22–42	11–43	8–61
pH			
Mean	7.0	7.0	7.0
Range	6.9–7.3	6.7–7.4	6.7–7.6
Nutrients			
NO ₃ -N (mg L ⁻¹)			
Mean	0.11	0.15	0.08
Range	<0.01–0.21	<0.10–0.37	<0.10–0.26
NH ₃ -N (mg L ⁻¹)			
Mean	0.12	0.10	0.08
Range	0.02–0.42	0.04–0.21	0.01–0.34
PO ₄ -P (mg L ⁻¹)			
Mean	0.03	0.03	0.03
Range	<0.01–0.06	0.02–0.04	0.02–0.04
Dissolved oxygen			
Concentration (mg L ⁻¹)			
Mean	8.3	8.0	7.5
Range	6.4–12.4	6.4–12.0	5.9–11.6
Percent saturation			
Mean	89	85	82
Range	78–101	80–95	64–97
Color (Pt-Co units)			
Mean	36	40	53
Range	15–90	26–50	23–120

Source: After Sala et al. (1979).

^aData from Bon Wier and Ruliff are from July 1976 through Oct. 1977. Data from West Bluff are from Feb. 1972 through Oct. 1977.

Waters draining the northwestern headwaters are hard to medium-hard. Water hardness is reduced as the river passes through the middle basin, but chloride concentrations remain high as a result of both natural inputs and brine pollution from oil fields. Natural levels of chloride concentrations for tributaries upstream from Toledo Bend Reservoir usually range between 20 and 100 ppm. A major exception occurs in Grand Saline Creek, Van Zant County, where water draining a salt flat contained chloride concentrations as high as 39,200 ppm. Otherwise, levels in excess of 100 ppm were usually the result of oil field brine pollution. Chloride concentrations in excess of 20 ppm persist throughout the lower Sabine as a result of these upstream inputs (Hughes and Leifeste, 1965).

Macronutrient concentrations in the lower Sabine are moderate but probably not limiting to primary production. Presumably, these moderate levels result from the prevalence of heavily forested watersheds combined with relatively few municipal inputs. The differences between nitrate-nitrogen concentrations near Bon Wier and Ruliff evident in Table 1.2 suggest a longitudinal increase in this form of inorganic nitrogen. Significantly, both sources (Sala et al., 1979, and the Academy's survey site) reported that a large part of the organic nitrogen was reduced (i.e., ammonia-nitrogen and/or nitrite-nitrogen rather than nitrate-nitrogen) (Table 1.3).

TABLE 1.3. *Water Chemistry for the Lower Sabine River near Orange, Texas*

	Aug. 1952	Apr. 1953	Aug. 1962	Summer 1969
Inorganic constituents				
Total hardness (ppm)	75	46	77	46
Calcium (ppm)	12	11	13	10
Magnesium (ppm)	11	4	11	4
Sulfate (ppm)	6	25	32	17
Chloride (ppm)	156	46	180	26
Specific conductance ($\mu\text{S cm}^{-1}$)	966	197	1440	189
Alkalinity				
Bicarbonate alkalinity (ppm)	38	30	27	32
pH	7.3	6.9	7.2	6.9
Nutrients				
$\text{NO}_3\text{-N}$ (ppm)	0.04	0.09	—	—
$\text{NO}_2\text{-N}$ (ppm)	0.02	0.003	0.002	0.008
$\text{NH}_3\text{-N}$ (ppm)	0.22	0.11	0.056	0.413
$\text{PO}_4\text{-P}$ (ppm)	0.002	0.005	0.042	0.036
SiO_2 (ppm)	12	12	15	9
Dissolved oxygen				
Concentration (ppm)	6.5	6.8	5.9	5.1
Percent saturation ^a	83	76	76	65
Temperature ($^{\circ}\text{C}$)	31.1	21.5	32.2	30.3

Source: Data for 1952 and 1953 after ANSP (1954); data for 1962 after ANSP (1963); data for 1969 after ANSP (1970). Data for all of these sources are from station 1.

^aPercent saturation determined from dissolved oxygen concentration and stream temperature. Percentages for 1952, 1962, and 1969 are percent saturations if the stream temperatures were 29.0°C. Actual percent saturations would be somewhat higher.

The lower Sabine River is relatively well oxygenated. Dissolved oxygen concentrations at Bon Wier, Ruliff, and West Bluff ranged between 5.5 and 12.4 mg L⁻¹, while percent saturation ranged between 62 and 104% (Sala et al., 1979; Seidensticker, 1980; USGS, 1975b). Dissolved oxygen concentrations and percent saturations at the Academy's survey site near Orange also suggested relatively oxygenated conditions. Saltwater intrusion at this site during August 1953 and August 1962 resulted in stratification and reduced benthic dissolved oxygen concentrations to less than 1 ppm (ANSP, 1954, 1963.)

Pollution in the lower Sabine River is minimal, with point sources being limited primarily to two paper mills. One of the apparent impacts from these mills is the increase in river color during low flow. Another water quality problem encountered in the lower Sabine concerns elevated concentrations of mercury, the origin of which has not been determined (Sala et al., 1979; Seidensticker, 1980). In contrast to the freshwater portion of the lower Sabine, the estuary receives considerable municipal and industrial pollution (ANSP, 1954, 1963, 1970).

ECOSYSTEM DYNAMICS

Detritus and Dissolved Organic Carbon

Upper Sabine. No measurements have been made of the detrital and dissolved organic carbon concentrations in the upper Sabine. They are probably low, as the river has a moderately high gradient, the stream is very shallow and floods would probably wash out any accumulation of organic debris.

Lower Sabine. Information concerning detrital and dissolved organic carbon (DOC) dynamics in the lower Sabine River is limited. Observations at the Academy's site near Orange indicated that concentrations of suspended detritus were relatively high and that there was some detrital accumulation along the shores (ANSP, 1954). Six sets of total organic carbon (TOC) concentrations were measured between July 1976 and October 1977 by Sala et al. (1979). TOC concentrations were relatively high, ranging from 9 to 18 mg L⁻¹ at Bon Wier, 6 to 18 mg L⁻¹ at Ruliff, and 7 to 19 mg L⁻¹ at West Bluff. No consistent relationship between TOC and either season or discharge was evident.

The organic matter dynamics of the lower Sabine may have many characteristics in common with the Ogeechee River, a subtropical Coastal Plain river located in Georgia. Organic matter dynamics in the Ogeechee are characterized by high allochthonous inputs of DOC, leaf litter, and allochthonous bacteria during floodplain inundation. In contrast, autochthonous production is largely limited to low-flow periods during summer, when the river is shallower and less darkly stained by DOC (Benke and Meyer, 1988). Both the Ogeechee and the lower Sabine have well-developed and densely forested floodplains, subtropical climates, and seasonal floodplain inundation. However, floodplain inundation in the lower Sabine is probably not as predictable nor as extensive as it is in the Ogeechee. In addition, the lower Sabine has higher silt loads and its flow is largely regulated.

While seasonal pulses of organic matter were not evident from the TOC concentrations reported by Sala et al. (1979), more extensive monitoring of the river's color indicates that DOC inputs are associated with floodplain inundation. During water

year 1970, for instance, color in the lower Sabine at Bon Wier ranged from 5 to 220 Pt-Co units, with values typically exceeding 100 Pt-Co units during winter and usually less than 50 Pt-Co units from April through September. Similar seasonal patterns occurred near Ruliff, where color ranged from 15 to 220 Pt-Co units (USGS, 1975b).

Primary Production

Upper Sabine. No measurements were made of the amount of primary production in the upper Sabine. However, since there is a well-developed algal flora in this reach of the river, it is very probable that primary production is relatively high.

Lower Sabine. Chlorophyll *a* concentrations at Bon Wier, Ruliff, and West Bluff averaged 0.003, 0.004, and 0.004 mg L⁻¹, respectively, from July 1976 through October 1977. Concentration maxima were most often recorded during summer, but were also recorded in winter and spring. Algal blooms are apparently infrequent (Sala et al., 1979).

Information on algal distribution and taxonomic composition in the lower Sabine River is largely restricted to investigations at the Academy's survey site near Orange. Algae were found on a variety of habitats at up to a depth of 1 m during a low-water, high salinity survey conducted in August 1952. The flora was characterized by *Spirogyra*, as well as by a variety of blue-greens and diatoms. In contrast, high turbidity during a high water survey conducted the following April (1953) largely limited algae to snags and shallow bank habitats. Blue-greens and diatoms were both moderately common (ANSP, 1954). Saline and moderately turbid conditions also occurred during an August 1962 survey. Algal growth was moderately heavy, although most algae were limited to shallow or snag habitats. The 1962 flora was similar to that recorded during August 1952 (ANSP, 1963).

Low salinity and high turbidity characterized conditions during the summer 1969 survey. Algal growth was extensive but was again largely restricted to either woody or shallow habitats. Blue-greens were abundant and diatoms were common, but green and red algae were scarce. *Microcoleus vaginatus*, *Oscillatoria princeps*, *O. retzii*, *Schizothrix calcicola*, and *S. tenerrima* were the more abundant blue-green algae. Diatoms were especially diverse, with 111 species being recorded during this survey. Of these, *Nitzschia filiformis* and *N. frustulum* var. *perminuta* were the most frequent (ANSP, 1970).

Characteristics of the Macroinvertebrate Fauna

Upper Sabine. The macroinvertebrate fauna was diverse in the upper Sabine, as all the major groups that one would expect to find in fresh water were present. The area was particularly rich in unionid molluscs. Nine taxa belonging to the family Unionidae were present. Also present was the fingernail clam, *Sphaerium striatinum*. The occurrence of *Corbicula fluminea* was discouraging, as this unionid is known to develop large colonies rather rapidly and displace native clams, which now seem diverse and fairly abundant in the river. Several species of decapods were found in the river. A total of three taxa were identified. The insect fauna was diverse in this area. A total of 35 taxa were collected, which is somewhat less than the number collected (42) in 1987 and 41 in 1982. The main differences seem to be fewer

Heteroptera and Diptera. Mayflies and stoneflies, which are indicators of normal water conditions, were similar in the various studies. The fish fauna was very diverse in this area; a total of 35 taxons were collected. The species were diversified and represented various feeding groups. It is quite evident from examining the structure of the communities of various groups of organisms in the river in this area that the stream has a normal diversity and appears to be in a healthy condition.

Lower Sabine. Macroinvertebrate assemblages at the Academy's survey site near Orange were characterized by relatively few freshwater taxons, presumably because of periodically high salinities. *Stenonema* was the most abundant insect during the April 1953 survey, but it was not collected during other surveys. Two amphipods, *Gammarus mucronatus* and *Hyalella azteca*, were abundant among cypress roots during the summer 1969 survey, and a bryozoan (*Plumatella repens*) was abundant on wood. On the other hand, these assemblages included several abundant estuarine taxa. *Rangia cuneata* was the dominant clam during the 1953 survey. Blue crab (*Callinectes sapidus*), white shrimp (*Penaeus setiferus*), fiddler crab (*Uca rapax*), and grass shrimp (*Palaemonetes pugio*) were abundant. A wood-boring clam (*Congeria leucophaeata*), a barnacle (*Balanus*), and a wood-boring isopod (*Sphaeroma destructor*) were abundant on wood (ANSP, 1954, 1970).

Fish Fauna

Upper Sabine. The fish fauna in the upper Sabine was not only diverse but well established. For example, there was an average of 608 bullhead minnows (*Pimephales vigilax*) in 100 m². There was also an average of 238 red shiners (*Cyprinella lutrensis*) per 100 m². These were the most common fish in this area. The fish collections were separated according to zones, that is, gradual slopes versus steep slopes. A general statement that one could make concerning the number of fish collected of different types at different slopes in the river is that some fish, such as *Cyprinella lutrensis*, were most numerous in zone 1 in the gradual slope, whereas in the moderate slope there were only 58.15 individuals collected in 6.2 m of net (0.32-cm mesh). However, for *Lythurus fumeus* there were 55.64 fish collected in moderate slopes and only 2.01 collected in gradual slopes. Thus it is evident that the slope affects individual species, not the entire fauna. The average density of fish (i.e., number per 25 m² in backpack samplers) from different riffle types and raceways indicates that raceways have the greatest number of fish collected and that the mixed cobble and cobble gravel were quite similar in numbers of fish collected.

Lower Sabine. The lower Sabine River supports a significant sport fishery for blue catfish (*Ictalurus furcatus*), channel catfish (*I. punctatus*), flathead catfish (*Pylodictis olivaris*), largemouth bass (*Micropterus salmoides*), and crappie (*Pomoxis* spp.). In addition, estuarine species such as seatrout (*Cynoscion* spp.) and southern flounder (*Paralichthys lethostigma*) enter the fishery in downstream reaches (Seidensticker, 1980).

A series of gill net collections near Bon Wier, Ruliff, and West Bluff yielded a mean catch per unit effort (CPUE) of 12.52 fish per 200 ft. of net and a mean mass per unit effort (MPUE) of 5.80 kg per net. An estuarine/marine species, sand seatrout (*Cynoscion arenarius*), was the most numerous species (24.8% of CPUE), but it accounted for only 1% of the MPUE. Spotted gar (*Lepisosteus oculatus*), longnose gar (*L. osseus*), alligator gar (*L. spathula*), bowfin (*Amia calva*), ladyfish (*Elops saurus*), gizzard shad (*Dorosoma cepedianum*), threadfin shad (*D. petenense*), river carp-

TABLE 1.4. Catch per Unit Effort (CPUE; number per 200 ft of net) and Mass per Unit Effort (MPUE; kg per 200 ft of net) for Gill Net Collections in the Lower Sabine River, Texas and Louisiana, June–September 1979

	CPUE	MPUE
Lepisosteidae		
<i>Lepisosteus oculatus</i>	1.65	1.55
<i>L. osseus</i>	0.35	0.58
<i>L. spathula</i>	0.02	0.67
Amiidae		
<i>Amia calva</i>	0.13	0.34
Elopidae		
<i>Elops saurus</i>	0.65	0.11
Clupeidae		
<i>Brevoortia gunteri</i>	0.02	<0.01
<i>Dorosoma cepedianum</i>	1.02	0.29
<i>D. petenense</i>	.85	0.01
Catostomidae		
<i>Carpionodes carpio</i>	0.57	0.28
<i>Ictiobus bubalus</i>	0.28	0.30
Other Catostomidae	0.17	0.06
Cyprinidae		
<i>Cyprinus carpio</i>	0.09	0.30
<i>Notropis venustus</i>	0.013	<0.01
Ictaluridae		
<i>Ictalurus furcatus</i>	0.11	0.13
<i>I. punctatus</i>	0.46	0.34
<i>Pilodictis olivaris</i>	0.02	0.03
Centrarchidae		
<i>Lepomis</i> spp.	0.52	0.02
<i>Micropterus punctulatus</i>	0.13	0.02
<i>M. salmoides</i>	0.22	0.10
<i>Pomoxis annularis</i>	0.70	0.10
<i>P. nigromaculatus</i>	0.19	0.04
Mugilidae		
<i>Mugil cephalus</i>	0.30	0.11
Sciaenidae		
<i>Aplodinotus grunniens</i>	0.09	0.16
<i>Cynoscion arenarius</i>	3.11	0.06
<i>Micropogonias undulatus</i>	0.28	0.01
Other		
Total	0.47	0.16
Total CPUE and MPUE	12.52	5.80

Source: Modified from Seidensticker (1980).

sucker (*Carpionodes carpio*), smallmouth buffalo (*Ictiobus bubalus*), carp (*Cyprinus carpio*) and *Ictalurus punctatus* were abundant in terms of numbers and/or biomass (Seidensticker, 1980) (Table 1.4).

Boat electrofishing collections in the lower Sabine yielded a mean CPUE of 23.89 fish per 15 min of electrofishing and a mean MPUE of 6.34 kg per 15 min. Another primarily estuarine/marine fish, striped mullet (*Mugil cephalus*), accounted for 28.7% of the mean CPUE and 28.2% of the MPUE. *Lepisosteus oculatus*, *Amia calva*, finescale menhaden (*Brevoortia gunteri*), *Dorosoma cepedianum*, *Cyprinus carpio*, bluegill (*Lepomis macrochirus*), redear sunfish (*Lepomis microlophus*), *Micropterus salmoides*, and black crappie (*Pomoxis nigromaculatus*) were common to abundant (Table 1.5). Seining conditions in the main stem were generally unfavorable, but relatively high catches of blacktail shiner (*Notropis venustus*) in both the gill nets and with electrofishing suggest that this species is among the most numerous of the small species. *N. venustus*, ironcolored shiner (*N. chalybaeus*), ribbon shiner (*N. fumeus*), and redfin shiner (*N. umbratilis*) were numerous in seine collections from several lower Sabine tributaries (Seidensticker, 1980). Of these, only *N. venustus* and *N. umbratilis* are characteristic of main-stem rivers. Distribution and habitat preference data suggest that four other cyprinids, central silvery minnow (*Hypognathus nuchalis*), pallid shiner (*Notropis amnis*), emerald shiner (*N. atherinoides*), and ghost shiner (*N. buechanani*), may also be numerous in the main stem (Lee et al., 1980). Three of these, *H. nuchalis*, *N. amnis*, and *N. atherinoides*, were collected in the main stem either at the Academy's survey site or at downstream estuarine sites (ANSP, 1954).

Rotenone collections in a small bayou adjoining the Academy's survey site near Orange yielded 31 fish taxons during the April 1953 survey. *Mugil cephalus* was the most abundant of these, while red shiner (*Notropis lutrensis*) was common (ANSP, 1954).

COMMUNITIES OF AQUATIC LIFE

These studies of riverine systems support the theory of Eugene P. and Howard T. Odum that in each stable community there are four functional stages of nutrient and energy transfer; (1) detritus producers and primary producers; (2) detritivores and herbivores; (3) omnivores; and (4) carnivores.

Functional Relationships

Upper Sabine. The diversity of species in the upper Sabine station indicates that at each stage of nutrient and energy transfer there were many species, representing several different phylogenetic groups. This structure ensures the transfer of nutrients through the food web because if conditions change, eliminating one group, individuals of other species are present to secure the passage of energy and nutrients through the food web. The species diversity characteristic of natural small streams of this type was excellent.

Lower Sabine. Trophic dynamics in the lower Sabine probably depend primarily on allochthonous inputs from inundated floodplains and secondarily on autochthonous primary production and inputs from Toledo Bend Reservoir. Qualitative

TABLE 1.5. Catch per Unit Effort (CPUE; number per 15 min) and Mass per Unit Effort (MPUE; kg per 15 min) for Boat Electrofishing in the lower Sabine River, Texas and Louisiana, August–October 1979

	CPUE	MPUE
Lepisosteidae		
<i>Lepisosteus oculatus</i>	1.68	0.60
<i>L. osseus</i>	0.04	0.03
Amiidae		
<i>Amia calva</i>	0.71	1.12
Clupeidae		
<i>Brevoortia gunteri</i>	0.82	0.01
<i>Dorosoma cepedianum</i>	2.61	0.15
Catostomidae		
<i>Minytrema melanops</i>	0.18	0.10
<i>Moxostoma poecilurum</i>	0.25	0.07
Other Catostomidae	0.19	0.07
Cyprinidae		
<i>Cyprinus carpio</i>	0.29	1.71
<i>Notropis venustus</i>	0.21	<0.01
Ictaluridae		
Total Ictaluridae	0.22	0.08
Centrarchidae		
<i>Lepomis gulosus</i>	0.46	0.02
<i>L. macrochirus</i>	3.36	0.05
<i>L. megalotis</i>	0.71	0.05
<i>L. microlophus</i>	1.57	0.05
<i>Micropterus punctulatus</i>	0.46	0.10
<i>M. salmoides</i>	1.93	1.11
<i>Pomoxis nigromaculatus</i>	0.50	0.07
Other Centrarchidae	0.54	0.04
Mugilidae		
<i>Mugil cephalus</i>	6.82	1.79
Percithyidae		
<i>Morone mississippiensis</i>	0.21	0.03
Other		
Total	0.16	0.06
Total CPUE and MPUE	23.89	6.34

Source: Modified from Seidensticker (1980).

macroinvertebrate collections suggest an abundance of benthic detritivores, including oligochaetes, *Hexagenia*, and chironomids. They also suggest an abundance of filter-feeding bivalves, including Sphaeriidae and *Corbicula fluminea*. Both of these groups probably feed heavily on fine detritus and free-living bacteria.

Fish collections in the lower Sabine were dominated by benthic feeding omnivores (e.g., *Carpionodes carpio*, *Ictiobus bubalus*, and *Cyprinus carpio*), generalist omnivores (e.g., *Mugil cephalus*), planktivores (e.g., *Dorosoma* spp., *Brevoortia gunteri*, and immature centrarchids), and medium-sized to large predators (e.g., *Lepisosteus* spp., *Amia calva*, and *Micropterus salmoides*).

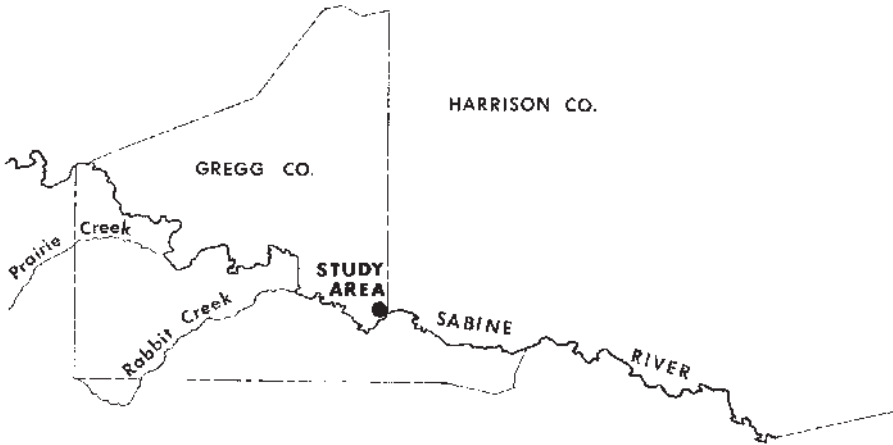


FIGURE 1.2. Map of the study site on the Sabine River.

Structure of Aquatic Ecosystems

The Sabine River has been studied over many years by the Academy of Natural Sciences. Therefore, ecosystems in the upper area as well as near its mouth are described.

Upper Sabine. The Sabine River in the study area (Figure 1.2) is a moderate-sized headwater with a typical riffle-pool sequence. The bed of the river consists of rocks and gravel in the riffles and a great deal of sand and mud in the lentic areas.

Vegetative Habitats. The banks are sandy and there are patches of various aquatic plants found along the edges of the stream and edges of the pools. The main plants found in these vegetative habitats were *Amaranthus tamariscina*, *Ludwigia decurrens*, *Polygonum persicaria*, *Lindernia dubia*, *Mollugo verticillata*, and *Eclipta alba*. All of these plants grow partially emerged and partially submerged. They typically occur in lentic habitats or along the margins of the stream (Table 1.6).

The blue-green alga, *Anabaena oscillariodes*, was found associated with these plants, as were the desmids *Closterium acerosum* and an unidentified species of *Spirogyra*. Several diatoms were found either growing attached to the plants or among the debris: *Cyclotella comta*, *Melosira ambigua* found attached to some of the leaves of the plants, and *Skeletonema potamos* in and among the debris. Other algae found attached to the debris and in some cases to the leaves of the plants were *Synedra rumpens* var. *familiaris*, *S. ulna*, and *S. ulna* var. *contracta*. In and among the debris was *Eunotia exigua*. Attached to the leaves and stems of the plants were *Achnanthes exigua* and *Cocconeis fluviatilis*. Other diatoms found attached to the stems of the plants or the debris were *Amphora ovalis*, *Cymbella minuta*, and *Gomphonema clevei*. *G. intricatum* was also in this habitat, as were *Capartogramma crucicula* and *Diploneis puella*. In and among the debris were found *Navicula arvensis*, *N. canalis*, *N. capitata*, and *N. cohnii*. Attached to the stems of some of the plants was *N. confervacea*. Other naviculoid species found in these habitats were *N. integra*,

(text continues on page 24)

TABLE 1.6. Species List: Upper Sabine River

Taxon ^a	Substrate ^b				
	V	Lentic		Lotic	
		M	S	G	R
SUPERKINGDOM PROKARYOTAE					
KINGDOM MONERA					
Division Cyanophycota					
Class Cyanophyceae					
Order Chroococcales					
Family Chroococcaceae					
* <i>Agmenellum quadruplicatum</i>		X			
Order Nostocales					
Family Nostocaceae					
* <i>Anabaena oscillariodes</i>	X	X			
Family Oscillatoriaceae					
* <i>Microcoleus vaginatus</i>					X
* <i>Schizothrix arenaria</i>		X			
* <i>S. calcicola</i>		X			X
* <i>S. friesii</i>		X			
SUPERKINGDOM EUKARYOTAE					
KINGDOM PLANTAE					
SUBKINGDOM THALLOBIONTA					
Division Chlorophycota					
Class Chlorophyceae					
Order Chlorococcales					
Family Oocystaceae					
<i>Micractinium</i> sp.					
Family Scenedesmaceae					
* <i>Scenedesus ecornis</i>		X			
* <i>S. quadricauda</i>		X			
Order Cladophorales					
Family Cladophoraceae					
* <i>Cladophora glomerata</i>				X	X
Order Zygnematales					
Family Desmidiaceae					
* <i>Closterium acerosum</i>	X	X			
* <i>C. venus</i>		X			
Family Zygnemataceae					
* <i>Spirogyra</i> sp.	X	X			
Division Chromophycota					
Class Bacillariophyceae					
Order Eupodiscales					
Family Coscinodiscaceae					
* <i>Cyclotella aliquidantula</i>		X			
* <i>C. atomus</i>		X			
* <i>C. comta</i>	X	X			
* <i>C. meneghiniana</i>		X		X	X
* <i>C. pseudostelligera</i>		X			
<i>C. stelligera</i>					
* <i>Melosira ambigua</i>	X			X	X

(continued)

TABLE 1.6. (Continued)

Taxon ^a	Substrate ^b				
	V	Lentic		Lotic	
		M	S	G	R
Family Coscinodiscaceae (cont.)					
* <i>M. distans</i> v. <i>alpigena</i>		X		X	
* <i>M. varians</i>				X	X
* <i>Skeletonema potamos</i>	X				
* <i>Stephanodiscus astraeta</i> v. <i>minutula</i>			X		
* <i>S. hantzschii</i>			X		
* <i>S. invisitatus</i>			X		
* <i>S. minutus</i>			X	X	
<i>Thalassiosira fluviatilis</i>					
<i>T. visurgis</i>					
Order Biddulphiales					
Family Biddulphiaceae					
* <i>Biddulphia laevis</i>		X			
Order Fragilariales					
Family Fragilariaceae					
* <i>Synedra rumpens</i> v. <i>familiaris</i>	X			X	
* <i>S. ulna</i>	X	X			
* <i>S. ulna</i> v. <i>contracta</i>	X				
Order Eunotiales					
Family Eunotiaceae					
* <i>Eunotia exigua</i>	X	X		X	
* <i>E. major</i>		X			
* <i>E. monodon</i>		X			
Order Achnanthes					
Family Achnantheaceae					
* <i>Achnanthes exigua</i>	X	X		X	
* <i>A. minutissima</i>		X		X	
* <i>Cocconeis fluviatilis</i>	X				X
Order Naviculales					
Family Cymbellaceae					
* <i>Amphora ovalis</i>	X			X	
* <i>A. submontana</i>		X		X	
* <i>Cymbella minuta</i>	X	X			X
* <i>C. minuta</i> v. <i>silesiaca</i>		X			
* <i>C. naviculiformis</i>		X			
Family Gomphonemaceae					
* <i>Gomphonema clevei</i>	X	X		X	
* <i>G. grunowii</i>		X		X	
* <i>G. intricatum</i>	X			X	
* <i>G. parvulum</i>		X			
Family Naviculaceae					
* <i>Anomoeneis folis</i>		X	X		
* <i>Caloneis bacillum</i>		X	X		
* <i>Capartogramma crucicula</i>	X				
* <i>Diploneis puella</i>	X				
* <i>Frustulia rhomboides</i> v. <i>crassinervia</i>		X	X		
* <i>F. weinholdii</i>		X	X		
* <i>Gyrosigma nodiferum</i>		X	X		

TABLE 1.6. (Continued)

Taxon ^a	Substrate ^b				
	V	Lentic		Lotic	
		M	S	G	R
Family Naviculaceae (cont.)					
* <i>G. obscurum</i>		X	X		
* <i>G. spencerii</i>		X	X		
* <i>Navicula arvensis</i>	X	X	X		
* <i>N. atomus</i>		X	X		
* <i>N. biconica</i>		X	X		
* <i>N. canalis</i>	X	X	X		
* <i>N. capitata</i>	X	X	X		
* <i>N. cohnii</i>	X				
* <i>N. confervacea</i>	X				
* <i>N. contenta</i> v. <i>biceps</i>		X	X	X	
* <i>N. cryptocephala</i>		X	X		
* <i>N. grimmei</i>		X	X		
* <i>N. integra</i>	X	X			
* <i>N. minima</i>	X	X	X		
* <i>N. mutica</i>		X	X		
* <i>N. ochridana</i>		X	X		
* <i>N. omissa</i>		X	X		
* <i>N. paratunkae</i>	X	X	X		
* <i>N. paucivistata</i>		X	X		
* <i>N. pelliculosa</i>	X			X	
* <i>N. placentula</i>		X	X		
* <i>N. pupula</i>		X	X	X	
<i>N. pupula</i> v. <i>mutata</i>		X	X	X	
* <i>N. pupula</i> v. <i>rectangularis</i>	X			X	
* <i>N. rhynchocephala</i> v. <i>germainii</i>	X				
* <i>N. salinicola</i>	X				
* <i>N. symmetrica</i>	X				
* <i>N. tenera</i>		X	X		
* <i>N. texana</i>	X				
<i>N. tripunctata</i> v. <i>schizonemoides</i>				X	
* <i>Neidium affine</i> v. <i>longiceps</i>		X	X		
* <i>Pinnularia biceps</i>	X			X	
* <i>P. intermedia</i>	X		X		
* <i>P. major</i>	X		X		
* <i>P. obscura</i>			X		
* <i>P. subcapitata</i>			X		
Order Bacillariales					
Family Nitzschiaceae					
* <i>Bacillaria paradoxa</i>	X	X	X	X	
* <i>Denticulata elegans</i>	X				
* <i>Nitzschia accomodata</i>				X	
* <i>N. acicularis</i>	X				
* <i>N. amphibia</i>	X	X			
* <i>N. apiculata</i>				X	
* <i>N. bacata</i>				X	

(continued)

TABLE 1.6. (Continued)

Taxon ^a	Substrate ^b				
	V	Lentic		Lotic	
		M	S	G	R
Family Nitzschiaceae (cont.)					
* <i>N. biacrola</i>	X				
* <i>N. circumscuta</i>	X				
* <i>N. clausii</i>	X	X	X		
* <i>N. confinis</i>		X	X		
* <i>N. constricta</i> v. <i>subconstricta</i>				X	
* <i>N. filiformis</i>		X	X		
* <i>N. frequens</i>		X	X		
* <i>N. frustulum</i>	X				
* <i>N. frustulum</i> v. <i>perminuta</i>	X	X	X		
* <i>N. frustulum</i> v. <i>subsalina</i>		X			
* <i>N. gracilis</i>				X	
* <i>N. granulata</i>		X			
* <i>N. hungarica</i>		X			
* <i>N. intermedia</i>		X			
* <i>N. kuetzingiana</i>				X	
* <i>N. mediastalsis</i>	X				
* <i>N. obtusa</i> v. <i>scalpelliformis</i>	X				
* <i>N. obtusa</i>	X				
* <i>N. palea</i>		X			
<i>N. reversa</i>		X	X		
<i>N. sigma</i>		X	X		
<i>N. sigmoidea</i>		X	X		
* <i>N. subtilis</i>		X	X		
* <i>N. tarda</i>		X		X	
<i>N. tryblionella</i> v. <i>debilis</i>		X			
<i>N. tryblionella</i> v. <i>levidensis</i>		X			
<i>N. tryblionella</i> v. <i>victoriae</i>		X			
* <i>N. umbilicata</i>	X				
<i>N. vasta</i>		X			
Order Surirellales					
Family Surirellaceae					
<i>Surirella augusta</i>		X	X		
<i>S. brightwellii</i>		X	X		
* <i>S. salina</i>	X	X	X		
<i>S. stalagma</i>		X	X		
<i>S. suecica</i>		X	X		
<i>S. tenera</i> v. <i>nervosa</i>		X	X		
Division Rhodophycota					
Class Rhodophyceae					
Order Acrochaetinales					
Family Audouinellaceae					
* <i>Audouinella violacea</i>					X
SUBKINGDOM EMBRYOBIONTA					
Division Magnoliophyta					
Class Dicotyledoneae					
Order Caryophyllales					

TABLE 1.6. (Continued)

Taxon ^a	Substrate ^b				
	V	Lentic		Lotic	
		M	S	G	R
Family Aizoaceae					
* <i>Mollugo verticillata</i>	X	X	X		
Family Amaranthaceae					
* <i>Amaranthus tamariscina</i>	X	X	X		
Order Myrtales					
Family Onagraceae					
* <i>Ludwigia decurrens</i>	X				
Order Polygonales					
Family Polygonaceae					
* <i>Polygonum persicaria</i>	X				
Order Scrophulariales					
Family Scrophulariaceae					
* <i>Lindernia dubia</i>	X				
Order Asterales					
Family Compositae					
* <i>Eclipta alba</i>	X	X			
Class Monocotyledoneae					
Order Arales					
Family Lemnaceae					
* <i>Lemna</i> sp.		X	X		
Order Cyperales					
Family Cyperaceae					
* <i>Fimbristylis vahlii</i>	X	X			
KINGDOM ANIMALIA					
SUBKINGDOM PROTOZOA					
Class Mastigophora					
Order Euglenoidida					
Family Euglenidae					
* <i>Euglena</i> sp.	X	X	X	X	
*o <i>Trachelomonas hispida</i>		X	X		
SUBKINGDOM PARAZOA					
Phylum Porifera					
Class Demospongiae					
Order Haplosclerida					
Family Spongillidae					
unident. sp.	X				
SUBKINGDOM EUMETAZOA					
Phylum Mollusca					
Class Gastropoda					
Order Basommatophora					
Family Ancyliidae					
*do <i>Ferrisia rivularis</i>	X	X			
Class Bivalvia					
Order Unionoida					

(continued)

TABLE 1.6. (Continued)

Taxon ^a	Substrate ^b				
	V	Lentic		Lotic	
		M	S	G	R
Family Unionidae					
*dh <i>Amblema plicata</i>		X	X	X	
*dh <i>Arcidens confragosus</i>		X	X		
* <i>Fusconaia lananensis</i>				X	
* <i>Lampsilis satura</i>				X	
* <i>L. teres</i>				X	
*oh <i>Megaloniaias nervosa</i>		X	X		
<i>Plectomerus dombeyanus</i>					
*oh <i>Quadrula pustulosa</i> v. <i>mortoni</i>				X	
*oh <i>Q. quadrula</i>			X	X	
*oh <i>Strophitus undulatus</i>				X	
*oh <i>Tritogonia verrucosa</i>		X	X	X	
*oh <i>Truncilla donaciformis</i>			X	X	
*oh <i>T. truncata</i>			X	X	
*oh <i>Utterbackia imbecillis</i>		X	X		
Order Veneroida					
Family Corbiculidae					
*do <i>Corbicula fluminea</i>			X	X	
Family Sphaeriidae					
*do <i>Sphaerium striatinum</i>		X	X		
Phylum Annelida					
Class Oligochaeta					
Order Tubificida					
Family Tubificidae					
*do <i>Branchiura sowerbyi</i>		X			
Phylum Arthropoda					
Class Crustacea					
Subclass Malacostraca					
Order Decapoda					
Family Cambridae					
*o <i>Orconectes palmeri</i> v. <i>longimanus</i>		X			X
* <i>Procambarus dupratzi</i>		X			X
Family Palaemonidae					
*ho <i>Palaemonetes kadiakensis</i>	X			X	
Class Insecta					
Order Odonata					
Suborder Zygoptera					
Family Coenagrionidae					
*c <i>Argia</i> sp.		X	X		X
Suborder Anisoptera					
Family Aeshnidae					
*c <i>Nasiaeschna pentacantha</i>		X	X		X
Family Corduliidae					
*c <i>Neurocordulia molesta</i>					X
Family Macromiidae					
*c <i>Macromia</i> sp.		X	X		X

TABLE 1.6. (Continued)

Taxon ^a	Substrate ^b				
	V	Lentic		Lotic	
		M	S	G	R
Order Ephemeroptera					
Suborder Schistonota					
Family Baetidae					
*do <i>Baetis</i> sp.	X				X
Family Ephemeridae					
*o <i>Hexagenia</i> sp.		X	X		
Family Heptageniidae					
*o <i>Stenacron interpunctatum</i>					X
*o <i>S. exiguum</i>					X
Family Oligoneuriidae					
*o <i>Isonychia sicca</i>	X				X
Family Tricorythidae					
*o <i>Tricorythodes</i> sp.	X	X	X		
Order Plecoptera					
Family Perlidae					
* <i>Neoperla</i> prob. <i>clymene</i>				X	
Order Hemiptera					
Family Belostomatidae					
*c <i>Belostoma lutarium</i>	X	X	X		
Family Nepidae					
*c <i>Ranatra</i> sp.	X	X	X		
Family Veliidae					
* <i>Rhagovelia</i> sp.	X			X	X
Order Megaloptera					
Family Corydalidae					
*c <i>Corydalus cornutus</i>	X	X	X		
Order Coleoptera					
Suborder Adephaga					
Family Dytiscidae					
*c <i>Deronectes</i> spp.		X			
Family Gyrinidae					
*c <i>Dineutes</i> spp.	X	X			
*c <i>Gyrinus</i> sp.	X				
Family Noteridae					
<i>Hydrocanthus</i> spp.	X				
Suborder Polyphaga					
Family Elmidae					
*o <i>Stenelmis</i> spp.		X	X		
Order Trichoptera					
Family Hydropsychidae					
*o <i>Cheumatopsyche</i> spp.				X	X
*o <i>Hydropsyche simulans</i>				X	X
*o <i>H. orris</i>				X	X
*o <i>Macrostenum carolina</i>				X	X
*o <i>Potomyia flava</i>				X	X

(continued)

TABLE 1.6. (Continued)

Taxon ^a	Substrate ^b				
	V	Lentic		Lotic	
		M	S	G	R
Family Hydroptilidae					
*h <i>Hydroptila</i> spp.	X				
Family Leptoceridae					
*o <i>Nectopsyche candida</i>	X				
Family Polycentropodidae					
*o <i>Cyrnellus</i> spp.	X				
Order Diptera					
Suborder Nematocera					
Family Chironomidae					
*o <i>Ablabesmyia rhamphe</i>	X	X		X	
*o <i>Ablabesmyia</i> sp.	X	X		X	
*h <i>Glyptotendipes</i> sp.	X	X			
*o <i>Polypedilum</i> spp.	X				
*o <i>Rheotanytarsus</i> sp.				X	
*o <i>Thienemannimyia</i> sp.	X	X		X	
Family Simuliidae					
* <i>Simulium</i> spp.				X	
Phylum Bryozoa					
Class Ectoprocta					
Order Phylactolaemata					
Family Plumatellidae					
*o <i>Plumatella emarginata</i>					X
*o <i>P. repens</i>					X
Phylum Chordata					
Subphylum Vertebrata					
Class Osteichthyes					
Order Lepisosteiformes					
Family Lepisosteidae					
*c <i>Lepisosteus oculatus</i>	X	X	X		
*c <i>L. osseus</i>	X	X	X	X	
Order Clupeiformes					
Family Clupeidae					
*o <i>Dorosoma cepedianum</i>	X	X	X	X	X
Order Cypriniformes					
Family Catostomidae					
*o <i>Carpiodes carpio</i>			X	X	X
*c <i>Cyprinella lutrensis</i>			X		X
*c <i>C. venusta</i>			X		
*c <i>Lythurus fumeus</i>			X	X	
*c <i>Macrhybopsis aestivalis</i>		X	X	X	X
Family Cyprinidae					
*o <i>Hybognathus nuchalis</i>	X	X	X		
* <i>Notropis amnis</i>		X	X		
*c <i>N. atrocaudalis</i>	X	X	X		

TABLE 1.6. (Continued)

Taxon ^a	Substrate ^b				
	V	Lentic		Lotic	
		M	S	G	R
Family Cyprinidae (cont.)					
*c <i>N. buchanani</i>			X		X
* <i>N. sabiniae</i>			X		
*o <i>Pimephales vigilax</i>		X	X		
Order Siluriformes					
Family Ictaluridae					
*c <i>Ictalurus furcatus</i>		X	X	X	X
*o <i>I. punctatus</i>		X	X	X	X
*c <i>Noturus nocturnus</i>			X	X	X
*c <i>Pygocentrus nattereri</i>		X	X		
Order Cyprinodontiformes					
Family Cyprinodontidae					
*o <i>Fundulus notatus</i>				X	X
Family Poeciliidae					
*o <i>Gambusia affinis</i>	X	X	X		
Order Atheriniformes					
Family Atherinidae					
*c <i>Labidesthes sicculus</i>		X	X	X	
Order Perciformes					
Family Centrarchidae					
*c <i>Lepomis humilis</i>	X	X	X		
*o <i>L. macrochirus</i>	X	X	X		
*c <i>L. megalotis</i>	X	X	X	X	X
*o <i>Micropterus punctulatus</i>		X	X	X	
*c <i>Pomoxis annularis</i>	X	X	X		
Family Percidae					
*c <i>Ammocrypta vivax</i>			X		X
*c <i>Etheostoma asprigene</i>		X	X		X
*c <i>E. chlorosomum</i>		X	X		
*c <i>E. gracile</i>		X	X		
*c <i>E. histrio</i>	X			X	X
*c <i>Percina caprodes</i>	X	X	X		
*c <i>P. sciera</i>	X	X	X		
*c <i>P. shumardi</i>			X	X	X
Family Sciaenidae					
*c <i>Aplodinotus grunniens</i>		X	X		

Source: Adapted from monitoring zone 1 from Academy of Natural Sciences Report 9–96, 1995 Sabine River Studies for the Texas Eastman Company.

*Species found in the habitat described in the section “Structure of Aquatic Ecosystems.”

^a c, Carnivore; dh, detritivore-herbivore; do, detritivore-omnivore (devours organisms and all types of detritus); ho, herbivore-omnivore; o, omnivore.

^b V, vegetation; M, mud; S, sand; G, gravel; R, rock.

N. minima, *N. paratunkae*, *N. pelliculosa*, and *N. pupula* var. *rectangularis*. *N. rhynchocephala* var. *germainii* was in among the plant debris, as were *N. salinicola*, *N. symmetrica*, and *N. texana*. Several species of *Pinnularia* were found associated with the plants. They were *Pinnularia biceps*, *P. intermedia*, and *P. major*. Growing in and among the plants in quiet water were *Bacillaria paradoxa*, *Denticula elegans*, and *Nitzschia amphibia*. Several species of *Nitzschia* were found in and among the vegetation (Table 1.6). These Nitzschias may on occasion grow attached to the plants, but typically are among the debris and roots of the plants. They are *Nitzschia acicularis*, *N. biacrula*, *N. circumscuta*, *N. clausii*, *N. frustulum*, *N. frustulum* var. *perminuta*, *N. mediastalis*, *N. obtusa*, *N. obtusa* var. *scalpelliformis*, and *N. umblicata* (Table 1.6). On the debris was also found *Surirella salina*.

One of the monocotyledons present was *Fimbristylis vahlii*. These plants and their debris form excellent habitats for several species of animals. Among these were the protozoan, *Euglena* sp., an autotroph. Attached to the plants were an unidentified species of the Spongillidae and the detritivore-omnivore, *Ferrissia rivularis*. In and among the plants was the decapod, *Palaemonetes kadiakensis*, a herbivore-omnivore.

A few mayflies were found in this habitat. They were an unidentified species of *Baetis*, which is a herbivore-detritivore, perhaps an omnivore; *Isonychia sicca*, an omnivore; and an unidentified species of *Tricorythodes*, also an omnivore. A few Hemiptera were found: the carnivorous *Belostoma lutarium*, *Ranatra* sp., and *Rhagovelia* sp. Also present was the carnivorous *Corydalus cornutus*. A few beetles were found in this habitat: *Dineutes*, perhaps more than one species, and *Gyrinus* sp. Both of these are probably carnivores. A few caddisflies were found in this habitat. They were unidentified species of the genus *Hydroptila*, which are herbivores; and *Nectopsyche candida*, an omnivore. Several species belong to the genus *Cyrnellus*, which are omnivores. Several chironomids were in and among the debris of the vegetation. They were the omnivorous *Ablabesmyia* sp.; *A. rhamphe*, also an omnivore; *Glyptotendipes* sp., a herbivore; *Polypedilum*, an omnivore; and *Thienemannimyia* sp., omnivore. All of these were found in the detritus of the plants.

Several fish were found in and among the plants. They were the carnivorous *Lepisosteus oculatus* and *L. osseus*. Other fish that might be found in and among the vegetation were the omnivorous *Dorosoma cepedianum*; *Hybognathus nuchalis*, an omnivore; and *Notropis atrocaudalis*, a carnivore. The omnivorous *Gambusia affinis* was also found grazing in and among the plants. Other fish found associated with the plants were the carnivorous *Lepomis humilis*; the omnivorous *L. macrochirus*; *L. megalotis*, a carnivore; and the carnivore *Pomoxis annularis*. Three species of percids were also found. They were the carnivorous *Etheostoma histrio*, *Percina caprodes*, *P. sciera*, and *P. shumardi*.

Lentic Habitats. The lentic habitats were mainly the pools that had mud and sand as their substrate. Sand was more prevalent than mud in many cases. In the lentic habitats were *Amaranthus tamariscina*, *Mollugo verticillata*, *Ludwigia decurrens*, *Polygonum persicaria*, *Lindernia dubia*, and the composite *Eclipta alba*. Also floating on the surface of the water in the pool was an unidentified species of *Lemna*. In the edges of the pools or in the margins of the stream was *Fimbristylis vahlii*.

Several algae were found in these areas where the current was very slow or not present, and they were often attached to the mud and debris. They occurred not only in pools but also along the margins of the stream.

Several blue-green algae were quite common in this habitat. They were *Agmenellum quadruplicatum*, *Anabaena oscillarioides*, *Schizothrix arenaria*, *S. calcicola*, and *S. friesii*. The colonial green algae, *Scenedesmus ecornis* and *S. quadricauda*, were in this habitat. A few desmids were found in the pools: *Closterium acerosum*, *C. venus*, and *Spirogyra* sp.

These pools and shallow-water areas along the margins of the stream were favorite habitats for several species of diatoms: *Cyclotella aliquidula*, *C. atomus*, *C. comta*, *C. meneghiniana*, and *C. pseudostelligera*. Attached to debris and sometimes to plants living in this area were *Melosira distans* var. *alpigena*. Associated with the sandy mud were *Stephanodiscus astraea* var. *minutula*, *S. hantzschii*, *S. invisitatus*, and *S. minutus*. Living on the sandy mud was *Biddulphia laevis*. Attached to debris and plants living in these lentic areas was *Synedra ulna*. On the surface of the detritus in these lentic habitats were also *Eunotia exigua*, *E. major*, and *E. monodon*. Attached to the debris and stems of plants growing in these lentic habitats were *Achnanthes exigua*, *A. minutissima*, and *A. submontana*. Other diatoms in and among the debris were *Cymbella minuta*, *C. minuta* var. *silesiaca*, *C. naviculiformis*, and *Gomphonema clevei*. Other Gomphonemas in these habitats were *G. grunowii* and *G. parvulum*, which were attached to the debris in and among the substrate. Many species belonging to the order Naviculales and family Naviculaceae were found in these lentic habitats. On the surface of the sandy mud were *Anomooneis folis* and *Caloneis bacillum*. Also present on the surface of the substrate, muddy sand, were *Frustulia rhomboides* var. *crassinervia* and *F. weinholdii*. On the surface of the sandy mud were *Gyrosigma nodiferum*, *G. obscurum*, and *G. spencerii*. The genus *Navicula* was represented by 19 taxons in these lentic habitats (Table 1.6). Usually, they were either on the surface of the substrate or attached to the debris or plants living in these habitats. A single taxon belonging to the genus *Neidium* was found on the sandy mud. The genus *Pinnularia* was represented by four taxons living on the fine sand containing very little mud. The family Nitzschiaceae was well represented in this habitat. Moving over the substrate was *Bacillaria paradoxa*. In and among the debris were *Nitzschia amphibia*, *N. clausii*, *N. confinis*, *N. filiformis*, *N. frequens*, *N. frustulum* var. *perminuta*, and *N. frustulum* var. *subsalina*. Other Nitzschias associated with the debris were *N. hungarica*, *N. intermedia*, and *N. granulata*. On muddy substrates that were organically enriched were *N. palea*, *N. subtilis*, and *N. tarda*. The diatom *Surirella salina* was found in substrates consisting of mud, sand, and debris.

As stated earlier, a few plants were found in these lentic habitats: *Mollugo verticillata*, *Amaranthus tamariscina*, *Eclipta alba*, *Lemna* sp., and *Fimbristylis vahlii*. Several protozoans were found in these lentic habitats usually associated with the debris or plants. They were *Euglena* sp., an autotroph, and *Trachelomonas hispida*, also an autotroph. Attached to the debris was a detritivore-omnivore, *Ferrissia rivularis*. In the sand containing small amounts of mud were several unionids: *Amblema plicata*, *Arcidens confragosus*, *Megaloniais nervosa*, *Quadrula quadrula*,

Tritogonia verrucosa, *Truncilla donaciformis*, *T. truncata*, and *Utterbackia imbecillis*. All of these species are detritivore-herbivores. Also present was *Corbicula fluminea*, which is a filter feeder and therefore a detritivore-omnivore, as is *Sphaerium striatinum*.

Crawling over the debris was the tubificid worm, *Branchiura sowerbyi*, a detritivore-omnivore. Two crayfish, *Procambarus dupratzi* and *Orconectes palmeri* var. *longimanus*, were found in these lentic habitats in among the plants and debris.

Insects were also fairly common in these lentic habitats. There were a few odonates, the carnivorous *Argia* sp.; the carnivorous *Nasiaeschna pentacantha*, and the carnivorous *Macromia* sp. A few mayflies were present: the omnivorous *Hexagenia* sp. and *Tricorythodes* sp., also an omnivore. A few bugs were present: the carnivorous *Belostoma lutarium* and *Ranatra* sp. Present in and among the detritus was *Corydalus cornutus*, a carnivore, which belongs to the order Megaloptera. A very few beetles were found in this habitat. They were *Deronectes* sp., a carnivore and often associated with the plants and their debris. Another species found in this habitat was *Dineutes*, a surface diver that is carnivorous. Elmid beetles were also found in these lentic habitats. They were species belonging to the genus *Stenelmis*, which are omnivores. Several chironomids were in and among the mud and debris. They were *Ablabesmyia* sp. and *A. rhamphe*, both omnivores, and an undetermined species of the genus *Glyptotendipes*, which is a herbivore. Another chironomid belongs to the genus *Thienemannimyia*, which is an omnivore.

Several fish were found in the pools. They were the carnivores *Lepisosteus oculatus* and *L. osseus*. Also present was the omnivorous *Dorosoma cepedianum*. Also in the pools were the carnivores *Cyprinella lutrensis*, *C. venusta*, *Lythurus fumeus*, and *Macrhybopsis aestivalis* and the omnivore *Carpionotus carpio*. Various cyprinids were also found in the pools or grazing on the algae and debris along the margins of the stream where lentic conditions existed. They were *Hybognathus nuchalis* and the carnivores *Notropis amnis*, *N. atrocaudalis*, *N. buechanani*, and *N. sabiniae*. Another species in the pools was *Pimephales vigilax*, an omnivore. Several catfish were found in these lentic habitats. They were *Ictalurus furcatus*, a carnivore; *I. punctatus*, an omnivore; *Noturus nocturnus*, a carnivore; and *Pylodictus olivaris*, a carnivore. A few cyprinids were found in these lentic habitats. They were *Gambusia affinis*, an omnivore, and *Labidesthes sicculus*, a carnivore. Belonging to the order Perciformes were *Lepomis humilis*, a carnivore; *L. macrochirus*, an omnivore; *L. megalotis*, a carnivore; *Micropterus punctulatus*, an omnivore; and *Pomoxis annularis*, a carnivore. Other fish were the Percidae, *Ammocrypta vivax*, a carnivore; *Etheostoma asprigene*, a carnivore; *E. chlorosomum*, a carnivore; *E. gracile*, a carnivore; *Percina caprodes*, a carnivore; *P. sciera*, a carnivore; *P. shumardi*, a carnivore; and *Aplodinotus grunniens*, a carnivore.

Lotic Habitats. The substrate of the lotic environment is mainly rocks, pebbles, and gravel. The current varies greatly depending on how the rocks are placed. Downstream from the riffle is the slack water. The bed of the slack water is mainly gravel and sand. Growing attached to the rocks were *Microcoleus vaginatus* and *Schizothrix calcicola*. Also attached to the rocks was the green alga, *Cladophora glomerata*.

Several diatoms were found among the algal mats and also in the gravel and sand between the rocks where the current was somewhat reduced. These diatoms were *Cyclotella meneghiniana*, *Melosira ambigua*, and *M. varians*. Other diatoms found attached to the gravel in the slack waters were *Synedra rumpens* var. *familiaris*, *Eunotia exigua*, *Achnanthes exigua*, and *A. minutissima*. Attached to the rocks in the riffle were specimens of *Cocconeis fluviatilis* and *Cymbella minuta*. Among the gravel is *Amphora submontana*. Also attached to the gravel in the riffles, but in areas where the current was moderate, were specimens of *Gomphonema clevei*, *G. grunowii*, and *G. intricatum*. In the slack waters attached to the pebbles was *Navicula contenta* var. *biceps*. *Navicula pelliculosa* was also in this habitat in areas where the current was less strong. In the slack water were *N. pupula*, *N. pupula* var. *mutata*, and *N. pupula* var. *rectangularis*. In very much reduced current, in between the gravel grains, were *Navicula tripunctata* var. *schizonemoides* and *Pinnularia biceps*. Several diatoms belonging to the family Nitzschiaceae were found in and among the gravel in the slack water. They were *Bacillaria paradoxa*, *Nitzschia apiculata*, *N. accomodata*, *N. bacata*, and *N. constricta* var. *subconstricta*. Also present were *N. gracilis*, *N. keutzingiana*, and *N. tarda*. Attached to the rocks where the current was moderately fast was the red alga, *Audouinella violacea*.

In and among the sand and gravel in the slack water were several protozoans. The autotroph, *Euglena* sp., was present. In and among the gravel in the slack water were several mussels: *Amblema plicata*, *Fusconaia lananensis*, *Lampsilis satura*, and *L. teres*. Other unionids found in these lotic habitats were *Quadrula pustulosa* var. *mortoni*, *Q. quadrula*, *Strophitus undulatus*, *Tritogonia verrucosa*, *Truncilla donaciformis*, and *T. truncata*. All of these are omnivore-herbivores; that is, they eat bacteria, protozoans, and various unicellular algae or colonial algae, which they engulf by filtration. The other unionid sometimes forming beds of single species was the detritivore-omnivore, *Corbicula fluminea*. A few crayfish were found in and among the rocks. They were *Procambarus dupratzi* and *Orconectes palmeri* var. *longimanus*.

Several insects were found on the rocks, often on the undersides of rocks or in areas where the current was somewhat reduced. They were the odonate, *Argia* sp., a carnivore, and the carnivores *Nasiaeschna pentacantha*, *Neocordulia molesta*, and *Macromia* sp. Also present was *Baetis* sp., detritivore-omnivore; *Stenacron interpunctatum*, an omnivore; and *S. exiguum*, also an omnivore, as is *Isonychia sicca*. A few stoneflies were found in this habitat. In the gravel, particularly associated with algae living in the gravel, was *Neoperla* prob. *clymene*. The coleopterans *Deronectes* spp. (carnivores) were found here. In gravel and rocks was *Rhagovelia* sp. Several Hydropsychidae were attached to the rocks. They were *Cheumatopsyche* sp., *Hydropsyche simulans*, *H. orris*, *Macrostemum carolina*, and *Potamyia flava*, all omnivores. A few chironomids were found in and among the gravel. They were an unidentified species of *Ablabesmyia*, an omnivore; *A. rhamphe*, an omnivore; *Rheotanytarsus* sp., an omnivore; and *Thienemannimyia* sp., an omnivore. Blackflies (*Simulium* spp.) were also found here.

Attached to the rocks were the bryozoans *Plumatella emarginata* and *P. repens*. These are filter feeders and probably omnivores. The riffles and slack waters were

favorite habitats for several species of fish. They were a carnivore, *Lepisosteus osseus*; *Dorosoma cepedianum*, an omnivore; *Cyprinella lutrensis*, a carnivore; *Lythurus fumeus*, a carnivore; *Macrhybopsis aestivalis*, a carnivore, and *Carpiodes carpio*, an omnivore. Also present were *Notropis buchanani*, a carnivore; *Ictalurus furcatus*, a carnivore; *I. punctatus*, an omnivore; and *Noturus nocturnus*, a carnivore; and *Fundulus notatus*, an omnivore. Particularly in the slack waters were *Labidesthes sicculus*, a carnivore; *Lepomis megalotis*, a carnivore; and *Micropterus punctulatus*, an omnivore. Three other species, *Ammocrypta vivax*, *Etheostoma histrio*, and *Percina shumardi*, all carnivores, were found among the rocks.

Lower Sabine. In the summers of 1952 and 1970, studies of the lower Sabine resulted in the following association of aquatic organisms.

Vegetative Habitats. In the vegetative habitats that existed along the edges of the stream, there were beds of various species of *Scirpus* and *Typha*, which were rooted in the shallow water, and *Phragmites*, which was in the very shallow water. Living partially submerged and partially emerged were various species of *Polygonum* and *Sagittaria*. Associated with this vegetation were *Microcoleus tenerrimus*, a blue-green alga and *Nostoc* sp., *Phormidium retzii* and *Phormidium subuliforme*. Also present were the green algae, *Rhizoclonium hieroglyphicum* and *Rhizoclonium* sp. In among the debris were *Chaetophora elegans*, the desmid *Closterium moniliferum*, and unidentified species of *Spirogyra* (Table 1.7).

Also in and among the debris of the vegetation and living attached to the stems of some of the emergent plants were *Melosira distans* var. *alpigena*, and in the debris were the diatoms *Hydrosera triquetra* and *Terpsinoe musica*. Also found were *Synedra goulardi* and *S. ulna*. *Synedra* sp. and *Eunotia praerupta* var. *bidens* were attached to some of the plant debris. Attached to some of the plant stems in the water was an unidentified species of the genus *Achnanthes*. Also present in this habitat was an unidentified species of the genus *Cocconeis*. *Caloneis bacillum* and *Gomphonema parvulum* were attached to the plant debris found in shallow waters, as was *Diploneis ovalis*. In and among the debris were three taxons belonging to the genus *Frustulia* and *Gyrosigma scalproides*. Also in this habitat were *Navicula confervacea* and *N. crucicula*. Other *Naviculas* associated with the vegetation were *Navicula mobiliensis* and *N. mutica*. Among the plant debris were found *Pinnularia acrosphaeria*, *Stauroneis crucicula*, *Nitzschia amphibia*, *N. clausii*, and *N. filiformis*. Other species of *Nitzschias* found in this habitat were *N. keutzingiana*, *N. obtusa*, and *N. sigma*. Also among the plant detritus was *N. tryblionella* var. *victoriae*. Also present in this habitat were *Surirella striatula* and *S. tenera* var. *nervosa*.

Two species of the order Peridinales, *Glenodinium cinctum* and *G. oculatum*, were also moving around among the plant detritus. It was surprising to find the red alga, *Compsopogon coeruleus*, in this habitat.

Plant debris and the base of plant stems were a favorite habitat for several species of protozoans. They were the flagellates *Anthophysis steinii*, *A. vegetans*, *Monas sociabilis*, and an unidentified species of *Monas*. Other flagellates found in this habitat were *Cryptomonas erosa*, *C. marssonii*, and *Cyathomonas truncata*. *Cyathomonas* and *Cryptomonas* are primary producers. Other primary producers in this habitat

(text continues on page 54)

TABLE 1.7. Species List: Lower Sabine River

Taxon ^a	Substrate ^b					Site ^c	Source ^d
	V	Lentic		Lotic			
		M	S	G	R		
SUPERKINGDOM							
PROKARYOTAE							
KINGDOM MONERA							
Division Cyanophycota							
Class Cyanophyceae							
Order Nostocales							
Family Nostocaceae							
* <i>Anabaena tortulosa</i>		X		X		O	a
<i>Cylindrospermum lichenforme</i>		X	X			O	b
<i>Nostoc</i> sp.	X	X				O	b
Family Oscillatoriaceae							
<i>Lyngbya aeruginea acerulea</i>		X		X		O	a
<i>L. lagerheimii</i>		X		X		O	a
* <i>L. lutea</i>		X		X		O	a
* <i>L. sordida</i>		X	X			O	a
<i>Oscillatoria princeps</i>		X		X	X	O	b
<i>O. retzii</i>		X	X	X	X	O	b
* <i>Microcoleus tenerrimus</i>	X		X	X	X	O	a
<i>M. vaginatus</i>		X		X	X	O	b
* <i>Phormidium retzii</i>	X	X		X	X	O	a
* <i>P. subuliforme</i>	X	X				O	a
<i>P. valderianum</i>				X	X	O	a
<i>Schizothrix calcicola</i>			X	X		O	b
<i>S. mexicana</i>				X	X	O	b
<i>S. tenerrima</i>				X	X	O	b
SUPERKINGDOM							
EUKARYOTAE							
KINGDOM PLANTAE							
Subkingdom Thallobionta							
Division Chlorophycota							
Class Chlorophyceae							
Order Ulothrichales							
Family Ulothrichaceae							
* <i>Ulothrix implexa</i>			X	X		O	a
Order Chaetophorales							
Family Chaetophoraceae							
* <i>Chaetophora elegans</i>	X					O	a
Order Oedogoniales							
Family Oedogoniaceae							
* <i>Oedogonium</i> spp.				X	X	O	a,b
Order Siphonocladales							
Family Cladophoraceae							
<i>Pithophora oedogonia</i>		X				O	b
* <i>Rhizoclonium hieroglyphicum</i>	X			X		O	a,b
* <i>Rhizoclonium</i> sp.	X					O	a
Order Zygnematales							

(continued)

TABLE 1.7. (Continued)

Taxon ^a	Substrate ^b					Site ^c	Source ^d
	V	Lentic		Lotic			
		M	S	G	R		
Family Desmidiaceae							
* <i>Closterium moniliferum</i>	X	X				O	a
Family Zygnemataceae							
* <i>Spirogyra</i> spp.	X			X	X	O	a,b
Division Chromophycota							
Class Bacillariophyceae							
Order Eupodiscales							
Family Coscinodiscaceae							
<i>Cyclotella aliquidula</i>				X		O	b
<i>C. atomus</i>	X			X		O	b
<i>C. florida</i>	X	X	X	X		O	b
<i>C. meneghiniana</i>	X	X	X	X	X	O	a,b
<i>C. pseudostelligera</i>	X			X	X	O	b
* <i>Melosira distans</i> v. <i>alpigena</i>	X		X	X		O	b
<i>M. granulata</i> v. <i>angustissima</i>	X	X	X	X	X	O	b
<i>M. italica</i> v. <i>valida</i>	X	X		X	X	O	b
<i>M. varians</i>	X	X	X	X	X	O	a,b
Order Biddulphiales							
Family Biddulphiaceae							
* <i>Hydrosera triquetra</i>	X					O	b
* <i>Terpsinoe musica</i>	X			X		O	a,b
Order Fragilariiales							
Family Fragilariaceae							
<i>Asterionella formosa</i>				X	X	O	b
<i>Dimerogramma lanceolatum</i>						O	b
<i>Fragilaria construens</i> v. <i>subsalina</i>				X	X	O	b
<i>F. pinnata</i>	X	X	X			O	b
<i>F. virescens</i> v. <i>clavata</i>						O	b
<i>Opephora marina</i>	X	X	X			O	b
<i>O. martyii</i>			X	X	X	O	b
<i>Synedra affinis</i>	X					O	b
<i>S. affinis</i> v. <i>obtusata</i>	X	X				O	b
* <i>S. gouldardi</i>	X			X		O	a
<i>S. pulchella</i>				X		O	b
<i>S. rumpens</i>	X			X		O	b
<i>S. tenera</i>				X		O	b
* <i>S. ulna</i>	X	X	X	X		O	a,b
<i>S. ulna</i> v. <i>danica</i>	X			X		O	a
<i>S. ulna</i> v. <i>oxyrhynchus</i>	X			X		O	b
<i>S. vaucheriae</i>						O	a,b
* <i>Synedra</i> sp.	X		X			O	a
Order Eunotiales							
Family Eunotiaceae							
* <i>Eunotia formica</i>				X		O	a
<i>E. lunaris</i>				X		O	a,b

TABLE 1.7. (Continued)

Taxon ^a	Substrate ^b					Site ^c	Source ^d
	V	Lentic		Lotic			
		M	S	G	R		
Family Eunotiaceae (<i>cont.</i>)							
<i>E. monodon</i> v. <i>major</i>	X			X		O	b
<i>E. pectinalis</i> v. <i>minor</i>	X			X		O	b
* <i>E. praerupta</i> v. <i>bidens</i>	X			X		O	b
<i>E. tenella</i>				X	X	O	b
Order Achnanthales							
Family Achnanthaceae							
<i>Achnanthes biporoma</i>	X			X	X	O	b
<i>A. exigua</i> v. <i>heterovalvata</i>	X		X	X		O	b
<i>A. hauckiana</i>				X	X	O	b
<i>A. hauckiana</i> v. <i>rostrata</i>				X		O	b
<i>A. lanceolata</i>	X	X		X		O	a,b
<i>A. longiceps</i>						O	b
<i>A. minutissima</i>	X			X	X	O	a,b
* <i>A. temperei</i>		X				O	a
<i>A. tenera</i>						O	b
* <i>Achnanthes</i> sp.	X			X		O	a
<i>Cocconeis fluviatilis</i>					X	O	b
<i>C. placentula</i>	X			X	X	O	b
<i>C. placentula</i> v. <i>lineata</i>	X			X	X	O	b
* <i>Cocconeis</i> sp.	X			X	X	O	a
Order Naviculales							
Family Cymbellaceae							
<i>Amphora cymbelloides</i>	X			X	X	O	a
<i>A. ovalis</i>	X			X		O	b
* <i>Amphora</i> sp.				X		O	b
* <i>Cymbella tumida</i>				X		O	b
<i>C. ventricosa</i>		X	X	X		O	a,b
Family Gomphonemaceae							
<i>Gomphonema brasiliense</i>	X	X	X	X		O	b
<i>G. gracile</i>						O	b
* <i>G. gracile</i> v. <i>naviculoides</i>		X	X			O	a
<i>G. intricatum</i> v. <i>pumila</i>			X	X		O	b
<i>G. longiceps</i> v. <i>subclavata</i>						O	b
* <i>G. parvulum</i>	X	X	X	X		O	a,b
<i>G. sphaerophorum</i>						O	b
<i>Gomphonema</i> sp.						O	a
Family Naviculaceae							
<i>Amphipleura pellucida</i>			X	X		O	a
<i>Anonmeoneis exilis</i>		X				O	a
* <i>Caloneis bacillum</i>	X			X		O	a,b
<i>Diploneis oblongella</i>	X	X				O	b
* <i>D. ovalis</i>	X					O	b
<i>D. pseudovalis</i>	X					O	b
<i>D. puella</i>						O	a,b
<i>D. smithii</i>						O	b

(continued)

Taxon ^a	Substrate ^b					Site ^c	Source ^d
	V	Lentic		Lotic			
		M	S	G	R		
Family Naviculaceae (<i>cont.</i>)							
* <i>Frustulia rhomboides</i>	X	X		X		O	a,b
* <i>F. rhomboides</i> v. <i>crassinervia</i>	X	X		X		O	a,b
<i>F. vulgaris</i>						O	b
* <i>F. weinholdii</i>	X	X				O	a
<i>Gyrosigma acuminatum</i>						O	b
<i>G. attentuatum</i>						O	b
* <i>G. scalproides</i>	X	X		X		O	a
<i>G. spencerii</i> v. <i>nodifera</i>					X	O	a
<i>Navicula capitata</i> v. <i>hungarica</i>					X	O	b
<i>N. cincta</i> v. <i>leptocephala</i>						O	a
* <i>N. confervacea</i>	X	X	X	X		O	a
<i>N. contenta</i> f. <i>biceps</i>						O	b
* <i>N. crucicula</i>	X	X				O	a
<i>N. cryptocephala</i>					X	O	b
<i>N. deserta</i>						O	b
<i>N. expansa</i>						O	a
<i>N. germainii</i>		X				O	b
<i>N. graciloides</i>		X	X			O	b
<i>N. ingenua</i>						O	b
<i>N. integra</i>						O	b
<i>N. minima</i>	X			X		O	b
* <i>N. mobiliensis</i>	X	X				O	a
* <i>N. mutica</i>	X		X	X		O	a
<i>N. mutica</i> v. <i>cohnii</i>				X		O	b
<i>N. paratunkae</i>		X	X	X		O	b
<i>N. pupula</i>	X			X		O	b
<i>N. pupula</i> v. <i>capitata</i>	X			X		O	b
<i>N. pupula</i> v. <i>minutula</i>	X			X		O	b
<i>N. radiosa</i>	X		X	X		O	a
<i>N. rectangularis</i>						O	b
* <i>N. schroeteri</i>			X	X		O	a
<i>N. schroeteri</i> v. <i>excambica</i>				X		O	b
<i>N. secreta</i> v. <i>apiculata</i>				X		O	b
<i>N. seminulum</i>				X		O	b
* <i>N. subatomoides</i>		X	X			O	a
<i>N. symmetrica</i>	X			X		O	a,b
<i>N. tenera</i>				X		O	b
<i>N. tripunctata</i> v. <i>schizonemoides</i>				X		O	b
* <i>Navicula</i> spp.		X	X			O	a
* <i>Pinnularia acrosphaeria</i>	X	X				O	a
<i>P. braunii</i> v. <i>amphicephala</i>		X	X			O	b
<i>P. interrupta</i>	X					O	b
* <i>Stauroneis crucicula</i>	X	X	X			O	a
Order Epithemiales							

TABLE 1.7. (Continued)

Taxon ^a	Substrate ^b					Site ^c	Source ^d
	V	Lentic		Lotic			
		M	S	G	R		
Family Epithemiaceae							
* <i>Rhopalodia gibba</i>				X		O	a
* <i>R. gibberula</i>				X		O	b
Order Bacillariales							
Family Nitzschiaceae							
<i>Bacillaria paradoxa</i>				X	X	O	a,b
<i>Gomphonitzschia agma</i>						O	b
* <i>Nitzschia amphibia</i>	X					O	a
<i>N. bacata</i>	X	X	X			O	b
* <i>N. brevissima</i>				X		O	a,b
* <i>N. clausii</i>	X		X	X		O	a,b
* <i>N. fasciculata</i>				X		O	a,b
* <i>N. filiformis</i>	X	X	X	X		O	a,b
* <i>N. fonticola</i>				X		O	a
<i>N. frustulum</i>	X		X	X		O	b
<i>N. frustulum</i> v. <i>indica</i>				X		O	b
<i>N. frustulum</i> v. <i>perminuta</i>				X	X	O	b
<i>N. ignorata</i>						O	b
* <i>N. kutzingiana</i>	X	X		X		O	a,b
* <i>N. lorenziana</i> v. <i>subtilis</i>				X		O	a,b
<i>N. microcephala</i>						O	b
* <i>N. obtusa</i>	X			X		O	b
<i>N. palea</i>	X	X	X	X	X	O	a,b
* <i>N. sigma</i>	X	X				O	b
<i>N. tarda</i>		X	X			O	b
<i>N. tropica</i>		X	X			O	b
<i>N. tryblionella</i> v. <i>debilis</i>				X		O	b
* <i>N. tryblionella</i> v. <i>levidensis</i>				X		O	b
* <i>N. tryblionella</i> v. <i>victoriae</i>	X	X		X		O	a
<i>Nitzschia</i> spp.						O	a
Order Surirellales							
Family Surirellaceae							
<i>Surirella brightwellii</i>		X	X			O	a
<i>S. minuta</i>		X	X			O	a
<i>S. ovata</i>						O	b
<i>S. ovata</i> v. <i>salina</i>						O	a
* <i>S. striatula</i>	X	X				O	a
* <i>S. tenera</i> v. <i>nervosa</i>	X					O	a
unident. sp.						O	b
Class Dinophyceae							
Order Gymnodiniales							
Family Gymnodiniaceae							
<i>Gymnodinium palustre</i>	X					O	b
<i>Gymnodinium</i> sp.	X					O	b
<i>Gyrodinium hyalinum</i>						O	b
Order Peridinales							

(continued)

TABLE 1.7. (Continued)

Taxon ^a	Substrate ^b					Site ^c	Source ^d
	V	Lentic		Lotic			
		M	S	G	R		
Family Cystodiniidae							
* <i>Glenodinium cinctum</i>	X					O	a
* <i>G. oculatum</i>	X					O	a
Division Rhodophycota							
Class Rhodophyceae							
Order Compsopogonales							
Family Compsopogonaceae							
* <i>Compsopogon coeruleus</i>	X				X	O	a,b
Order Acrochaetinales							
Family Audouinellaceae							
<i>Audouinella violacea</i>					X	O	a
Order Nemalionales							
Family Batrachospermaceae							
<i>Batrachospermum</i> sp.					X	O	b
SUBKINGDOM EMBRYOBIONTA							
Division Magnoliophyta							
Class Dicotyledoneae							
Order Nymphaeales							
Family Cambombaceae							
<i>Cambomba caroliniana</i>	X					O	t
Family Ceratophyllaceae							
* <i>Ceratophyllum demersum</i>		X				O	t
Order Polygonales							
Family Polygonaceae							
* <i>Polygonum</i> spp.	X	X				O	t
Order Apiales							
Family Apiaceae							
(= <i>Umbelliferaceae</i>)							
* <i>Hydrocotyl</i> sp.		X				O	t
Class Monocotyledoneae							
Order Alismales							
Family Alismaceae							
* <i>Sagittaria</i> spp.	X	X				O	t
Order Hydrocharitales							
Family Hydrocharitaceae							
* <i>Vallisneria americana</i>		X	X			O	t
Order Najadales							
Family Potamogetonaceae							
* <i>Potamogeton</i> sp.		X	X			O	t
Order Arales							
Family Lemnaceae							
<i>Lema</i> spp.						O	t
Order Cyperales							
Family Cyperaceae							
* <i>Scirpus</i> spp.	X					O	t
unident. spp.						O	a,t

TABLE 1.7. (Continued)

Taxon ^a	Substrate ^b					Site ^c	Source ^d
	V	Lentic		Lotic			
		M	S	G	R		
Family Poaceae							
* <i>Phragmites</i> sp.	X					O	a
Order Typhales							
Family Typhaceae							
* <i>Typha</i> spp.	X					O	t
Order Iliales							
Family Pontederiaceae							
<i>Eichhornia crassipes</i>						O	a,t
KINGDOM ANIMALIA							
SUBKINGDOM PROTOZOA							
Class Mastigophora							
Order Chrysomonadida							
Family Ochromonadidae							
* <i>Anthophysis steinii</i>	X					O	a
* <i>A. vegetans</i>	X					O	a,b
<i>Monas elongata</i>	X					O	b
<i>M. guttula</i>	X					O	b
* <i>M. sociabilis</i>	X					O	b
* <i>Monas</i> sp.	X					O	a
Order Cryptomonadida							
Family Cryptomonadidae							
<i>Chilomonas paramecium</i>		X	X			O	a,b
*O <i>Cryptomonas erosa</i>	X					O	a,b
*O <i>C. marssonii</i>	X	X				O	a
*O <i>Cyathomonas truncata</i>	X	X				O	a
Order Phytomonadida							
Family Carteriidae							
*O <i>Carteria cordiformis</i>	X	X				O	a
<i>C. globosa</i>	X	X				O	b
Order Volvocales							
Family Chlamydomonadaceae							
<i>Chlamydomonas globosa</i>	X					O	b
<i>C. inversa</i>	X					O	a
<i>C. monadina</i>	X					O	b
<i>C. variabilis</i>	X					O	a
*O <i>Chlamydomonas</i> sp.	X					O	a
<i>Diplostauron</i> sp.	X					O	a
*O <i>Scourfieldia complanata</i>	X					O	a
Family Volvocaceae							
<i>Eudorina elegans</i>	X					O	b
*O <i>E. illinoensis</i>	X					O	a
*O <i>Gonium pectorale</i>	X					O	b
*O <i>Pandorina morum</i>	X					O	a,b
<i>Platydorina caudata</i>						O	b
<i>Pleodorina illinoensis</i>						O	b
<i>Spondylomorum</i> sp.						O	b
Order Euglenoidida							

(continued)

TABLE 1.7. (Continued)

Taxon ^a	Substrate ^b					Site ^c	Source ^d
	V	Lentic		Lotic			
		M	S	G	R		
Family Anisonemidae							
*o <i>Anisonema acinus</i>	X					O	a
<i>A. emarginatum</i>	X					O	b
*o <i>Anisonema</i> sp.	X					O	a
*o <i>Entosiphon ovatum</i>	X					O	a
<i>Heteronema acus</i>	X	X				O	b
<i>Notosolenus apocamptus</i>	X	X				O	b
*o <i>N. lens</i>	X	X				O	a
*o <i>Peranema deflexum</i>	X	X				O	a
*o <i>P. trichophorum</i>	X	X				O	a,b
Family Astasiidae							
<i>Petalomonas quadrilineata</i>	X					O	a
<i>Urceolus cyclostomus</i>	X	X				O	a
Family Euglenidae							
*o <i>Ascoglena</i> sp.	X					O	a
<i>Euglena agilis</i>	X					O	a
*o <i>E. anabaena</i>	X					O	a
<i>E. caudata</i>	X					O	a
*o <i>E. fusca</i>	X					O	a
*o <i>E. haematodes</i>	X					O	a
*o <i>E. intermedia</i>	X					O	a
<i>E. oxyuris</i>	X					O	b
<i>E. pisciformis</i>	X					O	a
<i>E. terricola</i>	X					O	b
* <i>E. viridis</i>	X					O	a
*o <i>Lepocinclis texta</i>		X				O	a
<i>Phacus accuminata</i>		X				O	b
<i>P. alata</i>		X				O	a
<i>P. anacoelus</i>		X				O	a
*o <i>P. curvicauda</i>		X				O	a
<i>P. longicauda</i>		X				O	b
*o <i>P. orbicularis</i>		X				O	a
<i>P. pleuronectes</i>		X				O	b
<i>P. torta</i>		X				O	b
<i>Phacus</i> sp.		X				O	a
<i>Trachelomonas hispida</i>	X	X				O	a,b
<i>T. horrida</i>	X	X				O	a
<i>T. mirabilis</i>	X	X				O	b
*o <i>T. schauinslandii</i>	X	X				O	a
*o <i>T. verrucosa</i>	X	X				O	a,b
*o <i>T. volgensis</i>	X	X				O	a
*o <i>T. volvocina</i>	X	X				O	a
Order Protomonadida							
Family Bodonidae							
d <i>Bodo allexeieffii</i>	X	X				O	a
d <i>B. caudatus</i>	X	X				O	b
d <i>B. obovatus</i>	X	X				O	a

TABLE 1.7. (Continued)

Taxon ^a	Substrate ^b					Site ^c	Source ^d
	V	Lentic		Lotic			
		M	S	G	R		
Family Bodonidae (<i>cont.</i>)							
d <i>B. variabilis</i>	X	X				O	b
Class Sarcodina							
Order Amoebida							
Family Amoebidae							
<i>Amoeba gorgonia</i>	X	X				O	b
<i>A. guttula</i>	X	X				O	b
<i>A. radiosa</i>	X	X				O	b
<i>A. spumosa</i>	X	X				O	a
<i>A. striata</i>	X	X				O	a
<i>Vahlkampfia limax</i>	X	X	X			O	a,b
Order Testacida							
Family Arcellidae							
*do <i>Arcella gibbosa</i>	X	X				O	a
<i>A. vulgaris</i>	X					O	b
*do <i>Arcella</i> sp.	X	X				O	a
Family Diffugiidae							
*do <i>Diffugia arcula</i>	X	X				O	a
* <i>D. globosa</i>	X	X				O	b
<i>D. oblonga</i>	X	X				O	a
* <i>Diffugia</i> sp.	X	X				O	a
Order Heliozoida							
Family Acanthocystidae							
<i>Acanthocystis</i> sp.	X					O	b
Family Actinophryidae							
<i>Actinophrys sol</i>		X				O	b
<i>Actinosphaerium eichhorni</i>		X				O	b
Family Lithocollidae							
<i>Lithocolla globosa</i>		X				O	b
Class Ciliata							
Order Gymnostomatida							
Family Amphileptidae							
do <i>Amphileptus claparedie</i>	X					O	b
do <i>Lionotus fasciola</i>		X				O	b
do <i>L. trichocystus</i>		X				O	b
*o <i>Lionotus</i> sp.		X				O	a
do <i>Loxophyllum meleagris</i>						O	b
Family Chlamydodontidae							
d <i>Chilodonella cucullulus</i>	X	X	X			O	b
d <i>C. fluviatilis</i>	X	X	X			O	b
d <i>C. uncinata</i>	X	X	X			O	b
Family Holophryidae							
<i>Holophrya</i> sp.						O	b
<i>Lacrymaria olor</i>						O	b
<i>Placus ovum</i>						O	a
<i>Platyophrya</i> sp.						O	a

(continued)

TABLE 1.7. (Continued)

Taxon ^a	Substrate ^b					Site ^c	Source ^d
	V	Lentic		Lotic			
		M	S	G	R		
Family Tracheliidae							
d <i>Trachelius ovum</i>		X				O	b
Order Trichostomatida							
Family Colpodidae							
<i>Colpoda</i> sp.						O	a
Order Hymenostomatida							
Family Frontoniidae							
*o <i>Cinetochilum margaritaceum</i>		X				O	a,b
*o <i>Cyrtolophosis musicola</i>		X					
<i>Frontonia elliptica</i>		X				O	a
*o <i>F. leucas</i>		X				O	b
Family Parameciidae							
<i>Paramecium aurelia</i>					X	O	a,b
*o <i>P. multimicronucleatum</i>					X	O	a
Family Pleuronematidae							
*o <i>Cyclidium glaucoma</i>		X				O	a
*o <i>C. hepatrichum</i>		X				O	a
<i>C. litomesum</i>		X				O	b
Order Heterotrichida							
Family Stentoridae							
<i>Stentor igenus</i>					X	O	b
Order Oligotrichida							
Family Halteriidae							
*o <i>Halteria grandinella</i>	X			X	X	O	b
Family Strobilidiidae							
*o <i>Strobilidium concicum</i>	X				X	O	a
Order Tintinnida							
Family Tintinnidae							
o <i>Tintinnidium semiciliatum</i>	X					O	a
Order Hypotrichida							
Family Aspidiscidae							
*o <i>Aspidisca costata</i>		X				O	a,b
*o <i>A. lynceus</i>		X				O	a
Family Euplotidae							
*o <i>Euplotes affinis</i>		X				O	a
*o <i>E. carinatus</i>		X				O	a
*o <i>E. novemcarinatus</i>		X				O	a
*o <i>Euplotes</i> sp.		X				O	a
Family Oxytrichidae							
*o <i>Keronopsis spectabilis</i>		X				O	a
<i>Oxytricha setigera</i>					X	O	b
<i>Stichotricha secunda</i>					X	O	b
<i>Stylonychia mytilus</i>					X	O	b
<i>S. pustulata</i>					X	O	b
*d <i>Uroleptus limnetis</i>	X				X	O	a
<i>Urosoma caudata</i>					X	O	b
Order Odontostomatida							

TABLE 1.7. (Continued)

Taxon ^a		Substrate ^b					Site ^c	Source ^d
		V	Lentic		Lotic			
			M	S	G	R		
	Family Epalxellidae							
	Order Peritrichida							
	Family Epistylidae							
	<i>Campanella umbellaria</i>						O	b
	Family Vaginicolidae							
do	<i>Cothurnia annulata</i>						O	b
do	<i>C. imberis</i>						O	b
do	<i>C. ovata</i>						O	b
do	<i>Cothurnia</i> sp.						O	b
do	<i>Vaginicola annulata</i>						O	b
	Family Vorticellidae							
do	<i>Vorticella convallaria</i>	X			X		O	b
do	<i>V. elongata</i>	X			X		O	b
do	<i>V. microstoma</i>	X			X		O	b
do	<i>V. similis</i>	X			X		O	b
*do	<i>V. vestita</i>	X			X		O	a
	Class Suctoria							
	Order Suctoria							
	Family Dendrosomatidae							
do	<i>Trichophrya</i> sp.						O	b
	Family Podophryidae							
do	<i>Metacineta mystacina</i>					X	O	b
	SUBKINGDOM PARAZOA							
	Phylum Porifera							
	Class Demospongiae							
	Order Haplosclerida							
	Family Spongillidae							
o	<i>Spongilla fragilis</i> ?	X	X		X		O	b
*o	<i>Spongilla</i> cf. <i>lacustris</i>	X	X		X		O	a
do	<i>Trochospongilla horrida</i>	X	X		X		O	a
	SUBKINGDOM EUMETAZOA							
	Phylum Cnideria							
	Class Hydrozoa							
	Order Hydroida							
	Family Hydridae							
do	<i>Hydra</i> sp.	X			X		O	s
	Phylum Platyhelminthes							
	Class Turbellaria							
	Order Tricladida							
	Family Planariidae							
do	<i>Cura foremanii</i>						N	s
do	<i>Dugesia</i> sp.	X	X		X		O	s
	Phylum Nemertea							
	unident. sp.						O	a
	Class Enopla							
	Order Hoplonemertea							

(continued)

TABLE 1.7. (Continued)

Taxon ^a	Substrate ^b					Site ^c	Source ^d
	V	Lentic		Lotic			
		M	S	G	R		
Family Tetrastemmatidae							
*do <i>Prostoma rubrum</i>	X					N,O	s
Phylum Rotifera							
Class Digonota							
Order Bdelloidea							
Family Philodinidae							
<i>Dissotrocha aculeata</i>	X					O	a
Class Monogononta							
Order Ploima							
Family Brachionidae							
*o <i>Brachionus angularis</i>	X					O	a
*o <i>B. havanaensis</i>	X					O	a
*o <i>B. plicatilis</i>	X					O	a
<i>B. quadridentatus</i>	X					O	a
<i>Kellicottia bostoniensis</i>	X					O	a
*o <i>Keratella cochlearis</i>	X					O	a
<i>K. gracilentia</i>	X					O	a
*o <i>Platyaais patulus</i>	X					O	a
Family Lecaniidae							
*o <i>Lecane luna</i>	X					O	a
Family Notommatidae							
<i>Reticula nyssa</i>	X					O	a
Family Synchaetidae							
*o <i>Polyarthra remata</i>	X					O	a
<i>P. vulgaris</i>	X					O	a
Order Floscialariaceae							
Family Filiniidae							
*o <i>Filinia terminalis</i>	X					O	a
*o <i>Pedalia jenkiniae</i>	X					O	a
Phylum Nemata							
unident. spp.						O	s
Phylum Mollusca							
Class Gastropoda							
Order Mesogastropoda							
Family Hydrobiidae							
o <i>Amnicola limosa</i>	X			X	X	N,O	s
o <i>Amnicola</i> sp.	X			X	X	O	s
unident. spp.						O	b
Family Viviparidae							
o <i>Viviparus (Cochliopa)</i> sp.	X					O	s
Order Basommatophora							
Family Ancyliidae							
o <i>Ferrissia</i> sp.					X	O	a,s
o <i>Hebetancyclus excentricus</i>	X		X	X	X	O	b
o <i>Laevapex diaphanus</i>	X			X	X	N,O	s
unident. sp.						O	s

TABLE 1.7. (Continued)

Taxon ^a	Substrate ^b					Site ^c	Source ^d
	V	Lentic		Lotic			
		M	S	G	R		
Family Physidae							
o <i>Physa forsheyi</i>	X	X		X		O	b
o <i>P. virgata</i>	X	X		X		O	s
o <i>Physa</i> sp.	X	X		X		N,O	s
Family Planorbidae							
o <i>Helosoma trivolvis</i>	X	X				O	b
o <i>Menetus dilatatus</i>	X	X		X		N,O	s
o <i>M.?</i> <i>sampsoni</i>	X	X		X		O	b
Order Prosobranchiata							
Family Amnicolidae							
*o <i>Littoridina</i> sp.	X	X		X		O	a
Class Bivalvia							
Order Unionoida							
Family Unionidae							
o <i>Tritogonia</i> sp.		X				O	s
Order Veneroida							
Family Corbiculidae							
*o <i>Corbicula manilensis</i> (= <i>fluminea</i> ?)	X	X	X			N,O	s
Family Dreissensiidae							
o <i>Cogeria leucophaeata</i>				X		O	b
*o <i>Mytilopsis leucophaeatus</i> (= <i>Cogeria leucophaeata</i> ?)				X		O	a
Family Mactridae							
*o <i>Rangia cuneata</i>	X					O	a,b,s
<i>Rangia</i> sp.	X					O	a
Family Sphaeriidae							
*o <i>Eupera cubensis</i>	X			X		O	s
o <i>Musculum partumeium</i>		X	X			N,O	s
o <i>Pisidium</i> sp.		X	X			O	s
Phylum Annelida							
Class Polychaeta							
Order Phyllodocida							
Family Nereidae							
do <i>Laeonereis culveri</i>						O	a
<i>Namalycastis</i> sp.						O	b
Class Hirudinoidia							
Order Rhynchobdellida							
Family Glossiphoniidae							
c <i>Batrachobdella phalera</i>		X				O	s
c <i>B. picta</i>		X				N	s
c <i>Helobdella elongata</i>	X					O	s
c <i>Placobdella hollensis</i>	X					N	s
c <i>P. monitifera</i>	X					O	s
c <i>P. multilineata</i>	X					O	s
c <i>Placobdella</i> sp.	X			X		O	s

(continued)

TABLE 1.7. (Continued)

Taxon ^a	Substrate ^b					Site ^c	Source ^d
	V	Lentic		Lotic			
		M	S	G	R		
Family Piscicolidae							
unident. sp.							
Order Arhynchobdellida							
Family Erpobdellidae							
do <i>Dina? anoculata</i>						O	b
Class Oligochaeta							
Order Haplotaxida							
Family Enchytraeidae							
unident. sp.						N	s
Family Lumbricidae							
do <i>Eclipidrilus</i> sp.						N,O	s
do <i>Eisenella tetraedra</i>						O	b
do <i>Lumbriculus variegatus</i>	X					O	s
do <i>Rhynchelmis</i> sp.						O	s
Family Megascolecidae							
unident. sp.						O	b
Family Naididae							
do <i>Chaetogaster diastrophus</i>	X	X		X		O	s
do <i>Dero furcata</i>	X	X				N	s
(= <i>Aulophorus furcatus</i>)							
do <i>D. nivea</i>	X					O	s
do <i>D. obtusa</i>	X					O	s
*do <i>Dero</i> sp.	X					N,O	s
do <i>Dero</i> (<i>Aulophorus</i>) sp.	X					O	a
do <i>Haemonais waldvogeli</i>			X			O	s
do <i>Nais communis</i>	X					N,O	s
do <i>N. eliguis</i>	X	X				O	s
do <i>N. variabilis</i>	X					O	s
do <i>Ophidonais serpentina</i>						N	s
do <i>Paranais littoralis</i>						O	s
do <i>Pristina aequiseta</i>	X					N,O	s
do <i>P. breviseta</i>						N,O	s
do <i>P. idrensis</i>	X					O	s
do <i>P. longidentata</i>						O	s
do <i>P. longiseta</i>						O	s
do <i>P. longiseta leidy</i>						O	s
do <i>P. longisoma</i>						N	s
<i>P. osborni</i>						N,O	s
do <i>P. plumaseta</i>	X					N,O	s
do <i>P. sima</i>						O	s
do <i>P. undentata</i>						O	s
do <i>Pristina</i> sp.						O	s
do <i>Slavina appendiculata</i>						N,O	s
do <i>Stylaria fossularis</i>			X			O	s
<i>S. littoralis</i>			X			O	s
*do <i>Stylaria</i> sp.			X			N	s
Order Branchiobdellida							

TABLE 1.7. (Continued)

Taxon ^a	Substrate ^b					Site ^c	Source ^d
	V	Lentic		Lotic			
		M	S	G	R		
Family Branchiobdellidae							
unident. sp.							
Family Tubificidae							
do <i>Aulodrilus pigueti</i>						N,O	s
do <i>A. pluriseta</i>	X	X				O	s
do <i>Aulodrilus</i> sp.						O	s
do <i>Branchiura sowerbyi</i>	X	X				N,O	s
do <i>Limnodrilus hoffmeisteri</i>	X	X				O	s
do <i>Limnodrilus</i> sp.	X	X				N,O	s
do <i>Peloscolex</i>	X	X	X			N,O	s
(= <i>Quistadrilus</i>)							
<i>multisetosus</i>							
do <i>Potamothrix vehodovskyi</i>						O	s
do <i>Rhyacodrilus coccineus</i>						N,O	s
do <i>Tubifex</i> sp.	X	X				N,O	s
unident. spp.						O	s
Phylum Arthropoda							
Class Arachnida							
Order Acariformes							
Family Athienamannidae							
unident. sp.						O	b
Family Pionidae							
c <i>Forelia</i> sp.	X		X	X		O	b
Family Tyrrelliidae							
unident. sp.						O	b
Family Unionicolidae							
<i>Unionicola</i> sp.	X					O	s
unident. sp.						O	s
Class Crustacea							
Subclass Cephalocarida							
(= Branchiopoda)							
Order Cladocera							
Family Chydoridae							
<i>Eurycercus lamellatus</i>	X		X	X		O	s
Family Daphnidae							
<i>Daphnia</i> sp.	X		X	X		O	s
<i>Simocephalus</i> sp.	X		X	X		O	s
Family Sididae							
<i>Latona setifera</i>	X		X	X		O	s
<i>Sida crystallina</i>	X		X	X		O	s
Subclass Copepoda							
Order Cyclopoida							
unident. spp.						O	s
Family Cyclopodae							
o <i>Cyclops</i> sp.						O	s
o <i>Macrocylops</i> sp.						O	s
Subclass Cirripedia							

(continued)

TABLE 1.7. (Continued)

Taxon ^a	Substrate ^b					Site ^c	Source ^d
	V	Lentic		Lotic			
		M	S	G	R		
Order Thoracica							
Family Balanidae							
*o <i>Balanus amphitrite niveus</i>				X		O	a
o <i>Balanus</i> sp.				X		O	a
Subclass Malacostraca							
Order Mysidacea							
Family Mysidae							
o <i>Taphromysis louisianae</i>	X			X	X	N,O	b,s
Order Isopoda							
Family Asellidae							
<i>Asellus intermedius</i>	X			X		O	s
<i>Lirceus louisianae</i>	X	X		X		O	s
Family Parasellidae							
*do <i>Munna</i> sp.	X					O	a
Family Sphaeromidae							
o <i>Sphaeroma destructor</i>					X	O	b
Order Amphipoda							
Family Corophidae							
*o <i>Corophium lacustre</i>		X		X	X	O	b
<i>Corophium</i> cf. <i>lacustris</i>		X				O	a
Family Crangomycetidae							
o <i>Crangonyx</i> sp.				X	X	N,O	s
Family Gammaridae							
*o <i>Gammarus fasciatus</i>	X	X		X		O	a,s
o <i>G. mucronatus</i>	X			X		O	b
o <i>G. tigrinus</i>	X	X		X		O	b
o <i>Gammarus</i> spp.	X	X		X		N,O	s
Family Talitridae							
o <i>Hyalella azteca</i>	X	X	X	X	X	N,O	b,s
Order Decapoda							
Family Cambaridae							
o <i>Cambarellus schufeldti</i>	X	X	X		X	O	b
o <i>Cambarellus</i> sp.	X	X	X		X	O	a
Family Ocypodidae							
o <i>Uca pugnax</i>		X					
* <i>U. rapax</i>		X				O	b
Family Palaemonidae							
o <i>Macrobrachium ohione</i>	X	X	X			N,O	s,a
o <i>Palaemonetes kadiakensis</i>	X					O	b,s
*o <i>P. paludosus</i>	X		X	X	X	O	b
*o <i>P. pugio</i>	X		X	X	X	O	a
*o <i>P. vulgaris</i>	X		X	X	X	O	s
Family Penaeidae							
*o <i>Panaeus setiferous</i>	X	X		X	X	O	b

TABLE 1.7. (Continued)

Taxon ^a	Substrate ^b					Site ^c	Source ^d
	V	Lentic		Lotic			
		M	S	G	R		
Family Portunidae							
<i>Callinectes sapidus</i>		X				O	b
*c <i>C. sapidus acutidens</i>		X				O	a
Family Xanthidae							
*c <i>Rithropanopeus harrissi</i>	X	X		X	X	O	b
Class Insecta							
Order Collembola							
Family Isotomidae							
<i>Isotomurus palustris</i>	X	X	X			N	s
Order Odonata							
Suborder Zygoptera							
Family Calopterygidae							
c <i>Hetaerina</i> sp.				X	X	O	b,s
Family Coenagrionidae							
*c <i>Argia</i> sp.	X	X	X	X	X	N,O	s
* <i>Chromagrion</i> sp.	X	X	X	X	X	N	s
*c <i>Enallagma</i> nr. <i>signatum</i>	X	X	X			O	a
*c <i>Enallagma</i> sp.	X	X	X			O	b
c <i>Ischnura</i> nr. <i>posita</i>	X					O	a
c. <i>I.</i> nr. <i>verticalis</i>	X					O	a
Family Protoneuridae							
c <i>Neoneura</i> sp.					X	O	s
Suborder Anisoptera							
Family Aeshnidae							
*c <i>Nasiaeschna</i> sp.		X	X	X		N	s
Family Corduliidae							
c <i>Epicordulia</i> nr. <i>princeps</i>	X	X	X			O	b
c <i>Epicordulia</i> sp.	X	X	X			O	s
c <i>Somatochlora</i> sp.		X	X			N,O	s
Family Gomphidae							
c <i>Dromogomphus</i> sp.	X	X		X		N,O	s
c <i>Gomphus submedianus</i>	X	X				N	s
c <i>Gomphus</i> sp.	X	X				N,O	s
c <i>Octogomphus</i> sp.	X	X				O	s
c <i>Ophiogomphus</i> sp.	X			X	X	N	s
c <i>Progomphus</i> sp.	X			X	X	N,O	s
unident. sp						O	b
Family Libellulidae							
c <i>Libellula</i> sp.	X	X				N	s
c <i>Macrothemis</i> sp.	X	X				N	s
c unident. sp. nr. <i>erythemis</i>		X				O	b
c unident. sp. nr. <i>pachydiplax</i>		X				O	b
Family Macromiidae							
c <i>Didymops</i> sp.		X				N,O	s
c <i>Macromia</i> sp.		X				N,O	s
Order Ephemeroptera							

(continued)

TABLE 1.7. (Continued)

Taxon ^a	Substrate ^b					Site ^c	Source ^d
	V	Lentic		Lotic			
		M	S	G	R		
Suborder Schistonota							
Family Baetidae							
o <i>Baetis</i> sp.	X	X	X	X	X	N,O	b,s
o <i>Centroptilum</i> sp.	X	X	X	X	X	N,O	s
Family Ephemeridae							
o <i>Hexagenia bilineata</i>		X	X			O	s
o <i>H. limbata</i>		X	X			N,O	s
o <i>Hexagenia</i> sp.		X	X			N,O	a,s
Family Heptageniidae							
<i>Cinygma (Heptagenia)</i> sp.				X	X	O	s
o <i>Heptagenia diabasis</i>				X	X	N	s
o <i>Stenonema exiguum</i>				X	X	N	s
<i>S. (= Stenacron)</i> <i>floridense</i>				X	X	O	s
o <i>S. integrum</i>				X	X	N,O	s
o <i>Stenonema</i> spp.				X	X	O	a
Family Siphonuridae							
o <i>Isonychia</i> sp.				X	X	N,O	a,s
Suborder Pannota							
Family Baetiscidae							
o unident. sp.	X					O	s
Family Caenidae							
o <i>Brachycercus</i> sp.		X	X			N,O	s
o <i>Caenis</i> sp.		X	X			N,O	s,b
Family Ephemerellidae							
o <i>Ephemerella temporalis</i>	X			X	X	N	s
Family Tricorythidae							
o <i>Tricorythodes</i> sp.	X	X	X			N,O	s
Order Plecoptera							
Family Perlidae							
<i>Acroneuria</i> sp.				X	X	N	s
c <i>Neoperla clymene</i>				X	X	N	s
c <i>Perlesta placida</i>	X	X	X	X	X	N,O	s
Order Hemiptera							
Family Belostomatidae							
c <i>Belostoma</i> nr. <i>lutarium</i>	X	X	X			O	b
c <i>Belostoma</i> sp.	X	X	X			O	b,s
Family Corixidae							
o <i>Sigara</i> sp.		X	X			N	s
Family Gerridae							
*c <i>Rheumatobates hungerfordi</i>	X			X	X		
c <i>Trepobates</i> sp.		X		X	X	N,O	a,s
Family Naucoridae							
c <i>Ambrysus?</i> sp.	X	X	X			O	b
c <i>Pelocoris femoratus</i>	X					O	b

TABLE 1.7. (Continued)

Taxon ^a	Substrate ^b					Site ^c	Source ^d
	V	Lentic		Lotic			
		M	S	G	R		
Family Nepidae							
c <i>Ranatra nigra</i>	X	X	X			O	b
Family Notonectidae							
c <i>Notonecta</i> sp.	X	X	X			O	a
Order Megaloptera							
Family Corydalidae							
c <i>Corydalus cornutus</i>		X	X	X	X	N,O	s
Family Sialidae							
c <i>Sialis americana</i>	X	X	X	X	X	O	s
c <i>S. velata</i>	X	X	X	X	X	O	s
c <i>Sialis</i> sp.	X	X	X	X	X	N,O	s
Order Coleoptera							
Suborder Adephaga							
Family Dytiscidae							
<i>Coelambus</i> spp.	X					O	a
co <i>Hydroporus</i> sp.	X	X	X			N	s
<i>Hydrovatus</i> sp.	X	X	X			O	s
<i>Laccophilus</i> sp.	X	X	X			O	b
unident. sp. nr. <i>laccophilus</i>	X	X	X			O	b
Family Gyrinidae							
c <i>Gyretes</i> sp.	X					N	s
u <i>Dineutus assimilis</i>	X					O	a
<i>D.</i> nr. <i>discolor</i>	X					O	b
u <i>Dineutus</i> sp.	X					N	s
o <i>Gyrinus analis</i>	X					O	a
o <i>G.</i> nr. <i>analis</i>	X					O	b
o <i>G. lugens</i>	X					O	a
Family Noteridae							
o <i>Colpius</i> sp.	X	X	X			N	s
o <i>Pronoterus</i> sp.	X					N	s
unident. sp. nr. <i>suphisellus</i>	X	X	X			O	b
Suborder Polyphaga							
Family Brentidae							
unident. sp.						N	s
Family Curculionidae							
<i>Conotrachelus nenuphar</i>	X	X	X			O	s
Family Elmidae							
o <i>Dubiraphia</i> sp.		X	X	X	X	N,O	s
o <i>Narpus</i> sp.				X	X	N,O	s
o <i>Stenelmis</i> nr. <i>quadrimaculata</i>		X	X	X	X	O	b
o <i>Stenelmis</i> sp.		X	X	X	X	N,O	s
unident. sp.						O	s
Family Helodidae							
unident. sp.						N	s

(continued)

TABLE 1.7. (Continued)

Taxon ^a	Substrate ^b					Site ^c	Source ^d
	V	Lentic		Lotic			
		M	S	G	R		
Family Hydrophilidae							
<i>Cercyon</i> sp.	X	X	X			N	s
h <i>Helophorus</i> sp.				X	X	N	s
Order Trichoptera							
Family Hydropsychidae							
o <i>Cheumatopsyche</i> sp.				X	X	N,O	s
o <i>Hydropsyche betteni</i>				X	X	N	s
o <i>H. cuanis</i>				X	X	N	s
o <i>H. frisoni</i>				X	X	N,O	s
o <i>Hydropsyche</i> sp.				X	X	N,O	s
unident. spp.						N	s
Family Hydroptilidae							
<i>Agraylea</i> sp.	X					N	s
o <i>Mayatrichia</i> sp.	X	X	X	X	X	N,O	s
<i>Ochrotrichia</i> sp.	X	X	X	X	X	O	s
<i>Oxyethira</i> sp.	X			X	X	O	s
Family Leptoceridae							
h <i>Oecetis cinerascens</i>	X	X	X	X	X	O	s
h <i>Oecetis</i> spp.	X	X	X	X	X	O	s
Family Polycentropodidae							
c <i>Cernotina</i> sp.	X	X	X			O	s
o <i>Neureclipsis</i> spp.				X	X	N	s
<i>Nyctiophylax moestus</i>	X			X	X	O	s
<i>Phylocentropus</i> sp.		X	X			N,O	s
o <i>Polycentropus centralis</i>		X	X			O	s
o <i>P. remotus</i>				X	X	O	s
o <i>Polycentropus</i> sp.				X	X	N,O	s
Family Psychomidae							
unident. sp.							
Order Lepidoptera							
h unident. sp.						O	s
Family Cossidae							
<i>Prionoxystus</i> sp.	X					N	s
Order Diptera							
Suborder Nematocera							
Family Ceratopogonidae							
co <i>Palpomyia tibialis</i>	X	X	X			O	s
co <i>Palpomyia</i> sp.	X	X	X			O	s
c <i>Probezzia</i> sp.	X	X	X	X		N,O	s
c <i>Stilobezzia</i> sp.	X	X	X	X		O	s
Family Chaoboridae							
*c <i>Chaoborus punctipennis</i>	X					N	s
c <i>Chaoborus</i> sp.	X					N	s
Family Chironomidae							
o <i>Ablabesmyia</i> sp.	X	X		X		N,O	s
<i>Anatopynia brunnea</i>						O	s

TABLE 1.7. (Continued)

Taxon ^a	Substrate ^b					Site ^c	Source ^d
	V	Lentic		Lotic			
		M	S	G	R		
Family Chironomidae (<i>cont.</i>)							
do <i>Brillia par</i>	X	X		X		O	s
<i>Chironomus</i> sp.	X	X				N,O	s
<i>Cladotanytarsus</i> sp.	X	X				N,O	s
c <i>Clinotanypus</i> sp.	X	X	X			O	s
c <i>Coleotanypus concinnus</i>	X	X	X			O	s
c <i>C. scapularis</i>	X	X	X			O	s
c <i>Coleotanypus</i> spp.	X	X	X			N,O	s
<i>Constempellina</i> sp.				X		O	s
<i>Corynoneura</i> sp.	X	X	X			N	s
hd <i>Cricotopus bicinctus</i>	X	X	X	X		O	s
hd <i>Cricotopus</i> spp.	X	X	X	X		N,O	s
c <i>Cryptochironomus fluvius</i>	X	X				O	s
c <i>C. parafluvius</i>	X	X				O	s
c <i>C. ponderosus</i>	X	X				O	s
*o <i>Cryptochironomus</i> nr. <i>digitatus</i>	X	X				O	a
*o <i>Cryptochironomus</i> nr. <i>psittacinus</i>	X	X	X			O	a
<i>Cryptocladopelma</i> sp.		X		X		O	s
<i>Cryptotendipes</i> sp.		X		X		N,O	s
<i>Demicryptochironomus</i> sp.						N	s
o <i>Dicrotendipes modestus</i>	X	X				N,O	s
o <i>D. nemodestus</i>	X	X				O	s
o <i>Dicrotendipes</i> sp.	X	X				N,O	s
<i>Einfeldia</i> sp.	X	X				N	s
<i>Endochironomus</i> sp.	X					N	s
co <i>Epoicocladius flavens</i>	X	X	X	X		O	s
co <i>Epoicocladius</i> sp.	X	X	X	X		N,O	s
o <i>Eukiefferiella</i> sp.	X	X	X	X		N,O	s
*ho <i>Glyptotendipes senelis</i>	X	X	X			N	s
*ho <i>Glyptotendipes</i> sp.	X	X	X			N,O	s
o <i>Harnischia curtilamellata</i>	X					O	s
<i>Keifferulus</i> sp.						N	s
<i>Lauterborniella</i> sp.	X	X	X			N	s
<i>Micropsectra</i> sp.	X	X				O	s
<i>Microtendipes</i> sp.	X	X				O	s
<i>Nanocladius distinctus</i>	X	X		X		O	s
<i>Nilothauma</i> sp.		X	X			N	s
<i>Pagastiella ostansa</i>	X	X	X			O	s
<i>Pagastiella</i> sp.	X	X	X			O	s
co <i>Parachironomus</i> spp.	X	X	X			N,O	s
o <i>Paralauterborniella</i> sp.	X					N,O	s
<i>Paratanytarsus</i> sp.	X	X	X	X		O	s
<i>Paratendipes</i> sp.	X	X	X			N,O	s
co <i>Pentaneura flavifrons</i>	X	X	X	X		O	s
co <i>Pentaneura</i> sp.	X	X	X	X		O	s

(continued)

TABLE 1.7. (Continued)

Taxon ^a	Substrate ^b					Site ^c	Source ^d
	V	Lentic		Lotic			
		M	S	G	R		
Family Chironomidae (<i>cont.</i>)							
<i>Phaenopsectra</i> sp.	X	X	X			O	s
o <i>Polypedilum fallax</i>	X					O	a
o <i>P. haltare</i>	X					O	s
o <i>P. illinoense</i>	X					N,O	s
o <i>P. prob. illinosense</i>	X					O	a
o <i>P. ophioides</i>	X					O	s
h <i>Polypedilum</i> sp.	X					N,O	s
o <i>Potthastia longimanus</i>				X		O	s
o <i>Potthastia</i> sp.				X		N	s
<i>Procladius</i> spp.	X	X				N,O	s
<i>Psectrocladius</i> spp.	X	X				O	s
o <i>Rheotanytarsus</i> spp.				X		N,O	s
<i>Stempellinella</i> sp.	X	X	X	X		O	s
o <i>Stenochironomus</i> sp.	X					N,O	s
<i>Stictochironomus flavicingula</i>		X	X			O	s
<i>Stictochironomus</i> sp.		X	X			N,O	s
<i>Tanytus</i> sp.	X	X	X			N,O	s
*o <i>Tanytarsus</i> (= <i>Endochironomus</i> ?) nr. <i>nigricans</i>	X			X	X	O	a
*o <i>Tanytarsus</i> spp.	X			X	X	N,O	s
<i>Thienemanniella</i> sp.	X	X	X	X	X	O	s
o <i>Thienemannimyia</i> gr.	X	X	X	X	X	O	s
<i>Tribelos</i> sp.	X	X				N,O	s
<i>Trichocladius</i> sp.			X			O	s
<i>Xenochironomus</i> sp.			X			O	s
unident. <i>Chironominae</i>	X	X		X	X	N,O	s
unident. <i>Diamesinae</i>	X	X		X	X	N	s
unident. <i>Orthocladinae</i>	X	X		X	X	N,O	s
unident. <i>Pentaneurini</i>	X	X		X	X	O	s
unident. spp.						O	b
Family Culicidae							
<i>Aedes</i> sp.		X	X			O	s
Family Simuliidae							
<i>Ectemnia incenusta</i>				X	X	N	s
<i>Ectemnia</i> sp.				X	X	N	s
<i>Metacnephia</i> sp.				X	X	N	s
<i>Prosimilium ursinum</i>				X	X	N,O	s
<i>Simulium canadense</i>				X	X	N	s
unident. spp.						O	s
Family Tipulidae							
<i>Tipula</i> sp.		X	X	X		N	s
unident. sp.							
Suborder Brachycera							
Family Dolichopodidae							
<i>Hydrophorus</i> sp.	X	X	X			N	s

TABLE 1.7. (Continued)

Taxon ^a	Substrate ^b					Site ^c	Source ^d
	V	Lentic		Lotic			
		M	S	G	R		
Family Empididae							
<i>Hemerodromia</i> sp.		X	X	X	X	N	s
Family Stratiomyidae							
<i>Stratiomyia</i> sp.	X	X	X	X	X	O	s
Family Syrphidae							
<i>Tubifera</i> sp.	X	X	X	X		O	b
Phylum Bryozoa							
Class Ectoprocta							
Order Gymnolaemata							
Family Crisiidae							
unident. spp.	X					O	a
Family Nolellidae							
* <i>Nolella</i> sp.	X						
Order Phylactolaemata							
Family Lophopodidae							
<i>Pectinatella magnifica</i>	X					O	b
Family Plumatellidae							
*o <i>Plumatella repens</i>	X					O	a,b
Class Entoprocta							
Family Urnatellidae							
*o <i>Urnatella gracilis</i>	X					O	a
Phylum Chordata							
Subphylum Vertebrata							
Class Cephalaspidomorphi							
Order Petromyzontiformes							
Family Petromyzontidae							
<i>Ichthyomyzon castaneus</i>		X	X	X	X	S	t
Class Osteichthyes							
Order Acipenseriformes							
Family Polydontidae							
<i>Polydon spathula</i>	X	X	X	X	X	S	z
Order Lepisosteiformes							
Family Lepisosteidae							
<i>Lepisosteus oculatus</i>	X	X	X			E,S	t
c <i>L. osseus</i>	X	X	X	X		S	t
*c <i>L. productus</i> (= <i>oculatus</i> ?)	X					O	a
<i>L. spathula</i>						E,S	t
Order Amiiformes							
Family Amiidae							
<i>Amia calva</i>	X	X				O,S	a,t
Order Elopiformes							
Family Elopidae							
<i>Elops saurus</i>	X	X	X			S	t
Order Anguilliformes							

(continued)

TABLE 1.7. (Continued)

Taxon ^a	Substrate ^b					Site ^c	Source ^d
	V	Lentic		Lotic			
		M	S	G	R		
Family Anguillidae							
c <i>Anguilla rostrata</i>	X	X	X	X	X	O,S	a,t
Family Enchelidae							
<i>Myrophis punctatus</i>						O	a
Order Clupeiformes							
Family Clupeidae							
<i>Brevoortia gunteri</i>						S	t
o <i>Dorosoma cepedianum</i>	X	X	X	X	X	O,S	a,t
o <i>D. petenense</i>			X	X	X	O,S	a,b,t
Family Engraulididae							
<i>Anchoa mitchilli</i>		X	X			O,S	b,z
*o <i>A. mitchilli diaphana</i>		X	X			O	a
Order Cypriniformes							
Family Catostomidae							
o <i>Carpionotus carpio</i>	X	X				S	t
<i>Cycleptus elongatus</i>			X	X	X	S	t
<i>Ictiobus bubalus</i>			X	X		E,S	a,t
<i>I. cyprinellus</i>	X	X	X			S	z
<i>Minytrema melanops</i>	X	X				S	t
<i>Moxostoma poecilurum</i>		X	X	X		S	t
Family Cyprinidae							
<i>Cyprinus carpio</i>		X	X	X		O,S	b,t
o <i>Hybognathus nuchalis</i>		X	X			E	
*o <i>Notropis amnis</i>	X	X				E	a
<i>N. atherinoides</i>			X			O	a
<i>N. emiliae</i>	X	X				O	a
<i>N. lutrensis</i>			X	X		O	a
*o <i>N. roseus</i>	X		X			O	a
<i>N. venustus</i>		X	X			O,S	b,t
*o <i>Opsopoeodus emiliae</i>	X					O	a
*o <i>Pimephales vigilax perspicuous</i>	X	X				E	a
Order Siluriformes							
Family Ariidae							
<i>Arius felis</i>		X	X			S	t
<i>Barge marinus</i>						S	t
Family Ictaluridae							
<i>Ictalurus furcatus</i>			X	X	X	O,E,S	a,b,t
<i>I. natalis</i>	X	X	X	X		O,S	a,t
*o <i>I. punctatus</i>			X	X		O,S	a,b,t
<i>Noturus gyrinus</i>	X	X	X			O	a
<i>Pilodictis olivaris</i>		X	X			O,S	a,t
Order Percopsiformes							
Family Aphredoderidae							
<i>Aphredoderus sayanus</i>	X	X				O,S	a,t
Order Cyprinodontiformes							

TABLE 1.7. (Continued)

Taxon ^a	Substrate ^b					Site ^c	Source ^d
	V	Lentic		Lotic			
		M	S	G	R		
Family Belonidae							
<i>Strongylura marina</i>			X			O,S	b,t
Family Cyprinodontidae							
<i>Fundulus chrysotus</i>	X	X				E	b
<i>F. grandis</i>	X	X	X			O	b
<i>F. olivaceus</i>	X		X			O	a
<i>Lucania parva</i>	X	X				O	b
Family Poeciliidae							
*o <i>Gambusia affinis</i>	X	X				E	a
<i>Poecilia latipinna</i>	X	X				E	a
Order Atheriniformes							
Family Atherinidae							
<i>Menidia beryllina</i>			X			O	b
Order Syngnathiformes							
Family Syngnathidae							
<i>Syngnathus scovelli</i>	X	X				O	b
Order Perciformes							
Family Carangidae							
<i>Caranx hippos</i>	X		X			O	b
Family Centrarchidae							
* <i>Chaenobryttus coronarius</i>	X	X	X			O	a
*c <i>Elassoma zonatum</i>	X	X				O	a
<i>Lepomis auritus</i>			X			S	z
<i>L. cyanellus</i>	X	X	X			E	c
<i>L. gulosus</i>	X	X				S	t
<i>L. humilis</i>	X	X	X			S	t
*o <i>L. macrochirus</i>	X	X	X			O,S	a,b,t
*c <i>L. megalotis</i>	X	X	X	X	X	O,S	b,t
*c <i>L. microlophus</i>	X	X				O,S	b,t
<i>L. punctatus</i>	X	X				O	b
*o <i>L. punctatus miniatus</i>	X	X				O	a
<i>Lepomis</i> sp.	X	X	X	X	X	O	b
*o <i>Micropterus punctulatus</i>		X	X	X	X	O,S	b,t
<i>M. salmoides</i>	X	X	X	X		O,S	a,b,t
<i>Pomoxis annularis</i>	X	X				O,S	a,b,t
<i>P. nigromaculatus</i>	X		X			O,S	a,t
Family Gobiidae							
<i>Gobionella shufeldti</i>	X	X	X			O	b
<i>Gobiosoma bosci</i>						O	a
<i>Microgobius gulosus</i>	X	X				O	b
Family Mugilidae							
<i>Mugil cephalus</i>	X	X	X			O,S	a,b,t
Family Percidae							
c <i>Etheostoma asprigene</i>	X	X				O	a
c <i>Percina caprodes</i>			X	X	X	S	z

(continued)

TABLE 1.7. (Continued)

Taxon ^a	Substrate ^b					Site ^c	Source ^d
	V	Lentic		Lotic			
		M	S	G	R		
Family Percithyidae							
c <i>Morone chrysops</i>			X	X	X	S	z
<i>M. mississippiensis</i>			X	X	X	O,S	b,t
<i>M. saxatilis</i>			X	X	X	S	t
<i>M. chrysops</i> × <i>M. saxatilis</i>						S	z
<i>M. mississippiensis</i> × <i>M. saxatilis</i>						S	z
Family Sciaenidae							
c <i>Aplodinotus grunniens</i>		X	X			O,S	a,t
<i>Cynoscion arenarius</i>		X	X			S	t
<i>Micropogonais undulatus</i>		X	X			S	t
Family Sparidae							
<i>Archosargus probatocephalus</i>	X	X	X		X	S	t
Order Pleuronectiformes							
Family Bothidae							
<i>Paralichthys lethostigma</i>		X				O,S	b,t
Family Soleidae							
<i>Trinectes maculatus</i>		X	X			O	b
*o <i>T. maculatus fasciatus</i>	X	X	X			O	a

*Species found in the habitat described in the section "Structure of Aquatic Ecosystems."

^a c, Carnivore; co, carnivore-omnivore; d, detritivore; do, detritivore-omnivore (devours organisms and all types of detritus); h, herbivore; hd, herbivore-detritivore; ho, herbivore-omnivore; o, omnivore.

^b V, vegetation; M, mud; S, sand; G, gravel; R, rock.

^c N, Lower Sabine River along Newton County, Texas; O, lower Sabine River along Orange County; S, lower Sabine River (unspecified); E, freshwater fishes recorded in brackish waters of the Sabine estuary.

^d a, ANSP (1954) (spring 1953 only except for freshwater species recorded at estuarine sites); b, ANSP (1970) (summer); s, Sala, unpublished data; t, Seidensticker (1980); z, Seidensticker, personal communication.

were *Carteria cordiformis*. A few other flagellates were present that were primary producers. They were an unidentified species of *Chlamydomonas* and *Scourfieldia complanata*. Colonial algae that are primary producers in this habitat were *Eudorina illinoensis*, *Gonium pectorale*, and *Pandorina morum*. Several euglenoids were found in and among the vegetation: *Anisonema acinus*, *Anisonema* sp., *Entosiphon ovatum*, *Notosolenus lens*, *Peranema deflexum*, and *P. trichophorum*, all primary producers. Other euglenas in this habitat were *Ascoglena* sp., *Euglena anabaena*, *E. fusca*, *E. haematodes*, *E. intermedia*, *E. viridis*, *Trachelomonas schauinslandii*, *T. verrucosa*, *T. volgensis*, and *T. volvocina*, all primary producers. Crawling over the

debris in these vegetative habitats were the detritivore-omnivores *Arcella gibbosa* and *Arcella* sp. Also present were *Diffugia arcula*, *D. globosa*, and an unidentified species of *Diffugia*. Also present among the debris were the omnivores *Halteria grandinella* and *Strobilidium concicum*. Attached to the stems of some of the plants were colonies of *Uroleptus limnetis* as well as *Vorticella vestita*. *Uroleptus* is a bacterial detritivore, whereas the *Vorticella* is probably omnivorous.

Also omnivorous and attached to the stems of the plants were a sponge, *Spongilla* prob. *lacustris* and the detritivore-omnivore *Prostoma rubrum*. Rotifers found in this habitat were the omnivorous *Brachionus angularis*, *B. havanaensis*, *B. plicatilis*, *Keratella cochlearis*, and *Platyais patulus*, and the omnivore *Lecane luna*. Other omnivores found in this habitat were *Polyarthra remata* and *Filinia terminalis* and *Pedalia jenkiniae*. Also found in this habitat was a gastropod, *Littoridina* sp.

Bivalves were found in this habitat associated with the debris of vegetation. They were *Rangia cuneata*, probably an omnivore; *Corbicula manilensis*, an omnivore; and *Eupera cubensis*. A few oligochaete worms, such as two unidentified species of the genus *Dero*, detritivore-omnivores, were also found here, as was a member of the family Naididae *Stylaria* sp., a detritivore-omnivore; an isopod, an unidentified species of the genus *Munna*; and the amphipod, *Gammarus fasciatus*, which tends to be omnivorous. A decapod, *Palaemonetes pugio*, was in and among the vegetative debris, as was *Penaeus setiferous*, both of which are omnivores, and *Rithropanopeus harrissi*, a carnivore.

Several insect larvae, the carnivores *Enallagma* near *signatum* and an unidentified species of the same genus, were in these vegetative habitats. The gerrid *Rheumatobates hungerfordi*, a carnivore, was crawling over the detritus. Also found in this habitat were the dipteran *Chaoborus punctipennis* and the chironomids *Cryptochironomus* near *digitatus* and *Cryptochironomus* near *psittacinus*, both omnivores. The omnivore-herbivores *Glyptotendipes senelis* and an unidentified species of the same genus were found in and among the debris, as were the chironomids *Tanytarsus* near *nigricans* and unidentified species of the same genus, all probably omnivores.

Attached to the stems of the aquatic plants were two ectoprocts, *Nolella* sp. and unidentified species belonging to the family Crisiidae. Also present were the bryozoan *Plumatella repens*, an omnivore, and *Urnatella gracilis*, which is probably omnivorous. Several fish were found in and among the roots of the emergent vegetation and swimming over the debris. They were the carnivore *Lepisosteus productus*; the cyprinid *Notropis amnis*, perhaps an omnivore with herbivorous preferences; *N. roseus*, an omnivore; *Opsopoeodus emiliae*, an omnivore; and *Pimephales vigilax* var. *perspicuous*. Other fish that were present in this habitat were *Gambusia affinis*, an omnivore; *Chaenobryttus coronarius*; the carnivorous *Elassoma zonatum*; *Lepomis macrochirus*, an omnivore; *L. megalotis*, a carnivore; *L. microlophus*, a carnivore; *L. punctatus miniatus*, an omnivore; and *Trinectes maculatus fasciatus*, an omnivore.

Thus we see in the vegetative habitat, species representing the various stages of nutrient and energy transfer. At each stage of nutrient and energy transfer—that is,

primary producers, detritivores, detritivore-omnivores, herbivore-omnivores, omnivores, and carnivores—there are many species representing many different major groups of organisms.

Lentic Habitats. Lentic habitats occur in pools, along the sides of the river channel away from the main force of the flow, in and among rooted aquatics, and sometimes behind obstructions such as logs that inhibit the flow of the river. In these lentic habitats were several dicotyledons: *Ceratophyllum demersum*, several unidentified species of the genus *Polygonum*, and *Hydrocotyl* sp. Also present were various monocotyledons. These were usually partially submergent and partially emergent plants, such as unidentified species of *Sagittaria*. Floating on the water with partially submerged stems were *Vallisneria americana* and an unidentified species of the genus *Potamogeton*.

The blue-green algae *Anabaena tortulosa*, *Lyngbya sordida*, *L. lutea*, *Phormidium retzii*, and *P. subuliforme* were present attached to the stems of the rooted aquatics. Also present was the desmid *Closterium moniliferum*. Several diatoms were present in this habitat: *Melosira distans* var. *alpigena*, *Synedra ulna*, and an unidentified species of the genus *Synedra*. Also present in these lentic habitats were *Achnanthes temperei*, specimens of which were attached to the detritus in the bottom of pools. Also present were *Gomphonema gracile* var. *naviculoides* and *G. parvulum*. *Frustulia rhomboides* and *Frustulia rhomboides* var. *crassinervia* were in and among the detritus in these lentic areas, as were *F. weinholdii* and *Gyrosigma scalproides*. *Navicula confervacea* was common along the edges of the river in these lentic habitats. *N. crucicula*, *N. mobiliensis*, *N. mutica*, *N. schroeteri*, *N. subatomoides*, and some unidentified species of the genus *Navicula* were present on the surface of the mud in these lentic habitats. In shallow pools were *Pinnularia acrosphaeria* and *Stauroneis crucicula*. Other diatoms found in these lentic habitats were several species of the genus *Nitzschia*: *N. clausii*, *N. filiformis*, *N. keutzingiana*, *N. sigma*, and *N. tryblionella* var. *victoriae*. *Surirella striatula* was found in the same habitats as the various species of *Nitzschia*. In the mud were *Ceratophyllum demersum* and *Polygonum* spp.

Various protozoans were present in these lentic habitats: the primary producers *Cryptomonas marssonii* and *Cyathomonas truncata*. Other protozoans present were *Carteria cordiformis*, a primary producer; the euglena, *Notosolenus lens*, a primary producer, and *Peranema deflexum* and *P. trichophorum*, also primary producers. Other protozoans found in this habitat were *Lepocinclis texta*, a primary producer, as well as *Phacus curvicauda* and *P. orbicularis*. In pool-like areas were the primary producers *Trachelomonas schauinslandii*, *T. verrucosa*, *T. volgensis*, and *T. volvocina*. Various amoeba associated with the muddy sand habitat were *Arcella gibbosa*, *Arcella* sp., *Diffflugia arcula*, *D. globosa*, and *Diffflugia* sp. These are detritivore-omnivores.

Several ciliates were in and among the detritus in these lentic habitats. They were an unidentified species of the genus *Lionotus*, *Cinetochilum margaritaceum*, *Cyrtolophosis mucicola*, and *Frontonia leucas*. These are bacterial and diatom feeders. Other protozoans that live largely on bacteria that were found in and among the de-

tritus in these lentic habitats were *Cyclidium glaucoma* and *C. heptatrichum*. The hypotrichs *Aspidisca costata* and *A. lynceus* were found among the detritus in pools and along the margins of the river. These habitats were also favorable for four taxons belonging to the genus *Euplotes*, which are omnivores (Table 1.7). Also present in this habitat was *Keronopsis spectabilis*, which is probably an omnivore. Found here was the sponge, *Spongilla c.f. lacustra*.

A mollusc found in this habitat was *Littoridina* sp., which belongs to the family Amnicolidae. An oligochaeta, *Stylaria* sp., which is probably a detritivore-omnivore, was in and among the detritus. The amphipod *Corophium lacustre* was collected in and among the detritus, as was *Gammarus fasciatus*, which is an omnivore. The crab, *Uca pugnax*, which is an omnivore, was found in pools. Here were also *Palaemonetes pugio*, *P. paludosus*, and *P. vulgaris*, omnivores, and *Penaeus setiferous*, an omnivore. *Callinectes sapidus acutidens*, a carnivore, was also found here, as was *Rithropanopeus harrissi*.

On the surface of debris, particularly on the stems of plants that are living in these lentic habitats, were several odonates: *Enallagma* near *signatum*, a carnivore, and *Nasiaeschna* sp., a carnivore. The chironomids *Cryptochironomus* near *digitatus* and *C.* near *psittacinus* were found here. Both of these species are probably omnivorous, feeding on bits of algae, detritus, bacteria, and protozoans in these lentic habitats. Also present were two taxons belonging to the genus *Glyptotendipes*, omnivores with a tendency toward being herbivorous. They were found in the sandy mud.

A few fish were collected in these lentic habitats. They were omnivorous *Anchoa mitchilli diaphana* and *Notropis amnis*. Also present were the omnivorous *Notropis roseus* and *Pimephales vigilax perspicuous*. They were present in the pools, which were often near the edges of the river. In one of the deeper pools was the catfish, *Ictalurus punctatus*, an omnivore. In and among the vegetation in these lentic habitats were the omnivorous *Gambusia affinis* and the centrarchid *Chaenobryttus coronarius*. Other fish in these lentic habitats were the carnivorous *Elassoma zonatum*; the omnivorous *Lepomis macrochirus*; the carnivorous *L. megalotis*; the carnivorous *L. microlophus*; the omnivorous *L. punctatus miniatus*; and *Micropterus punctulatus*. Also present was *Trinectes maculatus fasciatus*, an omnivore.

As can be seen from the species present, this lower station of the Sabine River is not a typical freshwater large river habitat because of the saline influence of the nearby estuary.

Lotic Habitats. Lotic habitats existed around snags and debris caught in the bed of the river. These were excellent habitats for a fairly large variety of aquatic life. On the surface of snags was the blue-green alga, *Anabaena tortulosa*. Also present were *Lyngbya lutea* and the blue-green algae *Microcoleus tenerrimus* and *Phormidium retzii*. Attached to debris in these lotic habitats were *Ulothrix implexa* and filaments of *Oedogonium* spp. and *Rhizoclonium hieroglyphicum*. Here and there in areas where the current was weaker were filaments of *Spirogyra* spp.

These lotic habitats were very favorable for several species of diatoms. Attached to debris where the current was not very strong was *Melosira distans* var. *alpigena*. Also present in areas where the current was not very strong was *Terpsinoe musica*.

Synedra gouldardi and *S. ulna* were found in these lotic habitats where the current was moderate in swiftness. Here one also found *Eunotia formica* among the gravel in lotic habitats with moderately fast current. Also here was *Eunotia praerupta* var. *bidens*. Attached to the surface of debris were *Achnanthes* sp., *Cocconeis* sp., *Amphora* sp., and *Cymbella tumida*. A few Gomphonemas were found in this habitat. They belonged to the species *Gomphonema parvulum*. On the surface of the muddy sand in these lotic habitats was *Caloneis bacillum*. Also present in areas where the current was moderate to slow were *Frustulia rhomboides*, *F. rhomboides* var. *crassinervia*, and *Gyrosigma scalproides*. A few species of *Navicula* were found in the sandy substrates. They were *Navicula confervacea*, *N. mutica*, and *N. schroeteri*. *Rhopalodia gibberula* was found attached to the debris in these lotic habitats. In the surface of the sandy mud were *Nitzschia brevissima*, *N. clausii*, *N. fasciculata*, *N. filiformis*, and *N. fonticola*. Other species found on the surface of the sandy mud were *N. keutzingiana*, *N. lorenziana* var. *subtilis*, *N. obtusa*, *N. tryblionella* var. *levidensis*, and *N. tryblionella* var. *victoriae*.

Attached to debris in moderately swift water was the red alga, *Compsopogon coeruleus*. In relatively protected areas associated with the gravel in these lotic habitats were *Paramecium multimicronucleatum*, an omnivore, and *Halteria grandinella*, an omnivore. Also found in this habitat was *Strobilidium concicum*. *Uroleptus limnetis* was also in this habitat. Several vorticellids of the species *Vorticella vestita* were present. Attached to debris was the sponge, *Spongilla* prob. *lacustris*. Crawling over the debris was a mollusc, *Littoridina* sp., an omnivore. Also present was *Mytilopsis leucophaeatus*. This unionid is a filter feeder. Attached to the debris was the barnacle, *Balanus amphitrite niveus*, a filter feeder and an omnivore. An omnivorous amphipod, *Corophium lacustre*, was also found in these lotic habitats in the gravel. Here also was the gammarid, *Gammarus fasciatus*, an omnivore. *Palaemonetes pugio*, an omnivore, was also in these lotic habitats, as was *Rithropanopeus harrissi*, a carnivore.

The anisopteran *Nasiaeschna* sp., which is mainly a detritivore, possibly an omnivore, was found here in the lotic habitats. A gerrid, *Rheumatobates hungerfordi*, was present. A few chironomids were in and among the sandy mud: *Tanytarsus* nr. *nigricans*, an omnivore, and unidentified species of *Tanytarsus*, probably also omnivorous.

A few fish were found in these lotic habitats. They were the carnivorous *Lepomis megalotis* and *Micropterus punctulatus*, an omnivore with carnivorous tendencies. Also present was *Ictalurus punctatus*, an omnivore.

SUMMARY

The Sabine River is in the southwestern United States and flows southeast and south for 180 mi from Hunt County in eastern Texas, to Sabine Lake, through Sabine Pass, into the Gulf of Mexico. The structures of the aquatic ecosystems in a freshwater reach near the source of the river and in a freshwater site influenced by salt water in the upper part of the estuary are described. Each of these communities supports a large number of species, which function in varying ways to secure the breakdown of

waste and the transfer of nutrients and energy through the food web. In both the upper Sabine and lower Sabine areas, the base of the food web is, on the one hand, algae and protozoans that are photosynthetic and, on the other hand, protozoans and other organisms that feed upon detritus and bacteria. These ecosystems include species that are primarily herbivores and detritivores, omnivores, and carnivores. At each stage of nutrient and energy transfer there are many species representing different phylogenetic groups. The four stages of nutrient and energy transfer function in and among the vegetation, in pools, and in lotic areas where current is present, such as around snags and debris in the lower Sabine River and in association with rocks and gravel and snags in the upper reaches of the river. In each area we find many different habitats occupied by many species functioning in the transfer of nutrients and energy through the ecosystem or food web. In the upper station all the species are characteristic of fresh water of low or moderately high conductivity, whereas in the lower study area, freshwater species as well as those that can tolerate slightly brackish-water conditions are present.

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