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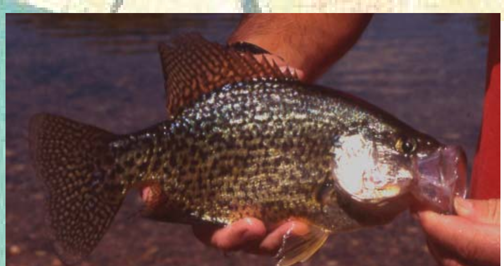
Fish and Aquatic Invertebrate Communities in Waterways, and Contaminants in Fish, at the Barataria Preserve of Jean Lafitte National Historical Park and Preserve, Louisiana, 1999-2000

SCIENTIFIC
INVESTIGATIONS REPORT
2004-5065



U.S. Department of the Interior
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Front cover photographs

Upper left: Black crappie (*Pomoxis nigromaculatus*)
(Photograph provided by James C. Petersen, U.S. Geological Survey)

Center: Pipeline Canal near Segnette Waterway, Jean Lafitte National Historical Park and Preserve, Louisiana
(Photograph provided by Christopher M. Swarzenski, U.S. Geological Survey)

Lower right: Damselfly (order Odonata)
(Photograph provided by Dennis K. Demcheck, U.S. Geological Survey)

Fish and Aquatic Invertebrate Communities in Waterways, and Contaminants in Fish, at the Barataria Preserve of Jean Lafitte National Historical Park and Preserve, Louisiana, 1999–2000

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Contents

Figures

Tables

Conversion Factors and Datum

Multiply	By	To obtain
Length		
inch (in.)	2.54	centimeter (cm)
inch (in.)	25.4	millimeter (mm)
inch (in.)	25,400	micrometer (µm)
foot (ft)	0.3048	meter (m)
mile (mi)	1.609	kilometer (km)
Area		
acre	4,047	square meter (m^2)
acre	0.004047	square kilometer (km^2)
square foot (ft^2)	929.0	square centimeter (cm^2)
square foot (ft^2)	0.09290	square meter (m^2)
Volume		
ounce, fluid (fl. oz)	0.02957	liter (L)
pint (pt)	0.4732	liter (L)
quart (qt)	0.9464	liter (L)
gallon (gal)	3.785	liter (L)
cubic inch (in^3)	0.01639	liter (L)
Mass		
ounce (oz)	28.35	gram (g)
pound (lb)	0.4536	kilogram (kg)

Temperature in degrees Celsius (°C) may be converted to degrees Fahrenheit (°F) as follows:

°F = (1.8 x °C) + 32

Vertical coordinate information is referenced to the North American Vertical Datum of 1988 (NAVD 88).

Horizontal coordinate information is referenced to the North American Datum of 1927 (NAD 27).

Abbreviated water-quality and chemical concentration units:

Specific conductance is given in microsiemens per centimeter at 25 degrees Celsius (µS/cm at 25°C).

Concentrations of chemical constituents in water are given in micrograms per gram (µg/g) and micrograms per kilogram (µg/kg).

Fish and Aquatic Invertebrate Communities in Waterways, and Contaminants in Fish, at the Barataria Preserve of Jean Lafitte National Historical Park and Preserve, Louisiana, 1999-2000

By Christopher M. Swarzenski[1], Scott V. Mize[1], Bruce A. Thompson[2], and Gary W. Peterson[3]

Abstract

Fish and aquatic invertebrate communities in waterways of the Barataria Preserve of Jean Lafitte National Historical Park and Preserve, Louisiana, were surveyed from 1999 to 2000. An inventory of fish in the Barataria Preserve was established, and concentrations of selected organochlorine pesticides, polychlorinated biphenyls, and trace elements; iron; and manganese in fish tissue for selected species were determined. The fish and aquatic invertebrate sampling completed for this study indicated that abundant and diverse communities are present in the Barataria Preserve.

Thirty-two species of fish were identified in the Barataria Preserve during this survey. The total number of species identified in a single sampling ranged from 20 to 26. Most of the fish sampled are designated as intermediate in their tolerance to poor water quality. Three species of fish designated as tolerant (common carp, *Cyprinus carpio*; golden shiner, *Notemigonus crysoleucas*; and yellow bullhead, *Ameiurus natalis*), and one as intolerant (lake chubsucker, *Erymizon sucetta*), were identified.

In November 1999, the average total weight of all fish collected by boat-mounted electroshocker from a single site was about 35,000 grams; in May and July 1999, the average total weight was between 9,000 and 10,000 grams. The contribution of spotted gar (*Lepisosteus oculatus*) to the total weight of the fish averaged between 38 and 41 percent among the three sample periods. Members of the sunfish family (Centrarchidae) contributed between 18 and 28 percent of the total weight. For each sampling period, 60 to 83 percent of the total weight from the sunfish family was contributed by bluegill (*Lepomis macrochirus*) and largemouth bass (*Micropterus salmoides*).

Aquatic invertebrates were sampled at three sites. Most aquatic invertebrates identified were freshwater species, but some were brackish-water and marine species. About 234,000 organisms were identified and enumerated from the richest-targeted habitat (RTH, floating rafts of aquatic plants). Individuals from 84 genera belonging to 51 families were identified. Diptera (true flies) was the most diverse group. Malacostraca (crustaceans), especially Amphipoda (scuds and sideswimmers), were the most abundant (36 percent). Total abundance and taxa richness of aquatic invertebrates were comparable during the March and July sampling in 1999, but were lower in samples collected from the same habitat at all three sites in April 2000. About 106 individuals were identified and enumerated from the depositional-targeted habitat (DTH, bottom material). Individuals from 7 genera belonging to 9 families were identified. Diptera was the most diverse group, and Annelida, especially tubificid worms, were the most abundant organisms identified (52 percent). Total abundance and composition of aquatic invertebrate communities differed between RTH and DTH at all three sites in April 2000.

Organic compounds in whole fish, and trace elements, iron, and manganese in fillets, were analyzed in bowfin (*Amia calva*), bluegill (*Lepomis macrochirus*), largemouth bass (*Micropterus salmoides*), and common carp (*Cyprinus carpio*). Organic compounds were not detected. Mercury was detected in fillets of all four species. Highest concentrations of mercury were detected in fillets from bowfin and largemouth bass. Mercury concentrations increased with increasing weight in the three predatory fish species (bowfin, bluegill, and largemouth bass), but were much lower, relative to weight, in the omnivore, common carp. Chromium concentrations were detected in tissue of the two larger fish, bowfin and common carp. Cadmium and lead were not detected in any samples.

Mercury concentrations for larger predatory fish caught in Preserve waterways may be a concern if the fish are frequently consumed by humans. The process of mercury accumulation appears to be natural, and not related to a local source problem. Mercury concentrations in comparable fish tissue at some other sites in coastal Louisiana were higher per unit wet weight of fish.

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[3]Coastal Ecology Institute, Louisiana State University.

Introduction

The Barataria Preserve of Jean Lafitte National Historical Park and Preserve is a healthy 20,600-acre wetland ecosystem about 10 mi southwest of New Orleans, Louisiana (fig. 1). Proximity to a large metropolitan area and easy access to water make the Preserve a popular center for fishing; however, the abundant aquatic resources of the Preserve have not been systematically surveyed and tabulated. To effectively manage these resources, information is needed about fish and aquatic invertebrate communities, as well as concentrations of selected contaminants in fish tissue.

Many natural and anthropogenic factors influence water quality in the Barataria Preserve and may affect aquatic resources. In other studies, the U.S. Geological Survey (USGS) analyzed physical properties and selected major ions, trace elements, nutrients, and organic compounds of surface water and bottom material within the Barataria Preserve (Garrison, 1982; Swarzenski, 2004). These studies demonstrated that water with differing quality was entering the study area from several sources, including Lake Salvador, Segnette Waterway, and Bayou Villars. Stormwater runoff from suburban areas also was entering the Preserve. Bottom sediments contained some organic pollutants and some trace elements. DDT concentrations appeared to decrease over time, but polychlorinated biphenyl (PCB) concentrations remained constant or increased. Concentrations of organic compounds and trace elements in surface water and bottom material (Swarzenski, 2004) were below levels at which the Canadian Council of Ministers of the Environment (1999) determined impairment of aquatic resources could occur.

Large-scale projects are being developed to restore the coastal wetlands (Barataria-Terrebonne National Estuary Program, 1994). One strategy is the diversion of freshwater from the Mississippi River across the levees into the wetlands to mimic the natural springtime overbank flooding that occurred before the levees were constructed. The Davis Pond diversion, located about 5 mi northwest of the Preserve, was scheduled to begin operation in 2001, and would result in a seasonal influx of nutrient- and sediment-rich water. As the Davis Pond diversion introduces Mississippi River water into the Park and Preserve, the fish and aquatic invertebrate communities in the Preserve may change in response to the change in water quality.

During 1999-2000, the USGS, in cooperation with the National Park Service, conducted a survey of fish and other aquatic communities in waterways of the Barataria Preserve to provide data essential to the effective management of these resources. Major objectives included (1) compiling an inventory of fish in the Preserve; (2) describing aquatic invertebrate and algal communities; (3) collecting data on concentrations of selected organochlorine pesticides, PCB's, and trace elements; iron; and manganese in fish tissue; and (4) compiling a list of submerged aquatic vegetation (SAV) observed in the waterways.

Purpose and Scope

This report describes fish and aquatic invertebrate community composition in waterways of the Barataria Preserve of Jean Lafitte National Historical Park and Preserve, based on samples collected during 1999-2000. Concentrations of selected contaminants in tissue and whole organism samples of four fish species commonly caught in waters of the Barataria Preserve and consumed by humans are presented. A list of SAV species observed during the survey also is presented, in appendix 1. Samples to determine algal populations in surface water of the Preserve were collected, but these data are not included in this report because of inconsistencies in sample processing and preservation between sampling periods. This report provides data on conditions in Preserve waterways prior to the freshwater diversion from the Mississippi River taking effect.

Description of Study Area

The Barataria Preserve includes swamp forests and large expanses of freshwater peat marsh, with interconnected canals and other waterways. The terrain is relatively flat; water flow is sluggish and bidirectional. The water in the canals and bayous is low in suspended sediment and high in dissolved organic compounds (Garrison, 1982). The bottom material consists of soft clays and silts with a high proportion of organic matter (Garrison, 1982; Skrobialowski, 2001). The Preserve (fig. 1) is located in Barataria Basin, a low-lying interdistributary basin flanked by the Mississippi River to the east and a former distributary of the Mississippi River, Bayou Lafourche, to the west. The west side of the Barataria Preserve adjoins Lake Salvador.

There is a continuum from fresh to saltwater in Barataria Basin. Salinity of surface water in the basin varies and is determined by the mixture of marine water from the Gulf of Mexico and freshwater runoff from precipitation and local drainage. Direct inflow from the Mississippi River is limited and occurs through a diversion structure that crosses the flood control levees. Canals, lakes, and bayous connect the Gulf of Mexico to the most inland parts of the basin. There is no structural impediment to flow of water and material. An excellent description of Barataria Basin is given by Conner and Day (1987). They discuss the physical environment and climatic forcing factors, and provide profiles of all estuarine habitats and communities in this subtropical estuary.

Approach and Methods

Fish and aquatic invertebrates residing in the major waterways of the Preserve were sampled. Fish samples were collected along canal banks. Their habitat consisted of overhanging wax-myrtle (*Myrica cerifera*) shrubs sometimes reaching into the water, SAV, and occasional tree stumps or logs. The SAV at three sites were identified (app. 1). The SAV provides shelter for species such as golden topminnow (*Fundulus crysotus*), western mosquitofish (*Gambusia affinis*),

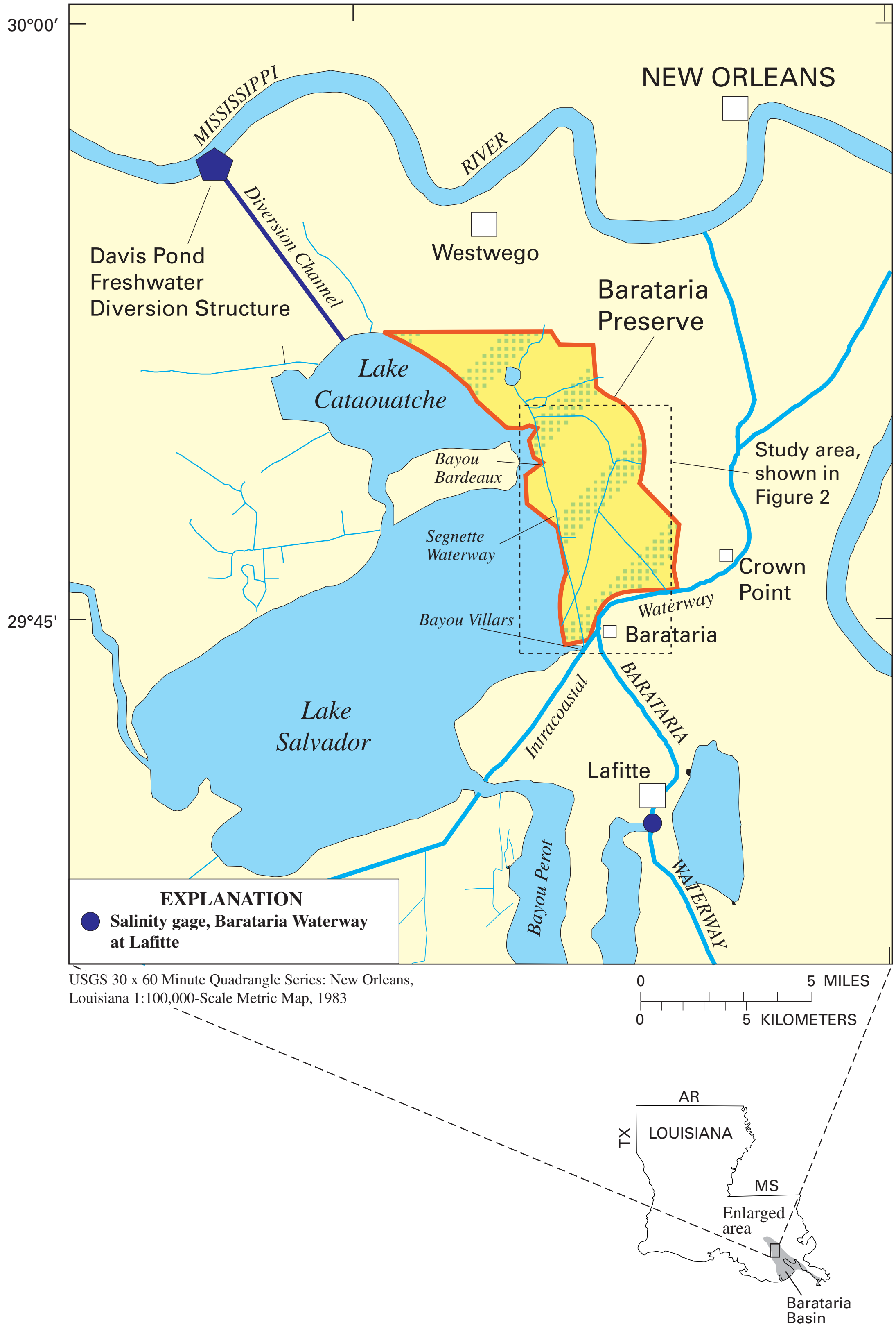

Figure 1. Location of the Barataria Preserve, Jean Lafitte National Historical Park and Preserve in Barataria Basin, Louisiana.

and banded pygmy sunfish (*Elassoma zonatum*), as well as the early life-history stages of many of the larger species such as spotted gar (*Lepisosteus oculatus*) and largemouth bass (*Micropterus salmoides*) (Ross, 2001). Aquatic invertebrates were sampled from rafts of floating vegetation or the soft bottom sediments.

Fish and aquatic invertebrates were sampled and SAV noted at Tarpaper Canal near Keyhole 6 (site 1, fig. 2), Pipeline Canal west of Crown Point (site 2), and North Twin Canal (site 3), following techniques established by the National Water-Quality Assessment (NAWQA) Program (Meador and others, 1993; Cuffney and others, 1993). Sites 2 and 3 were on or near sites for which contaminant data on bottom material was known (Swarzenski, 2004). At sites 4 and 6, only fish were sampled. Fish were sampled in mid-May, late July, and early November 1999 to determine seasonal variations and community structure. Aquatic invertebrates were sampled in mid-March and late July 1999, and again in mid-April 2000, also to assess seasonality in communities. In contrast to fish, aquatic invertebrates were sampled in April 2000 rather than in November 1999. Fall sampling, originally planned for late September, was delayed until early November. It was decided that fish collections would not be affected by the delay, but that invertebrate communities could be depauperate that late in the year, and not representative. Hence, invertebrate sampling was postponed until the following spring.

At sites 1-3, fish were surveyed on both banks of a reach of canal (transects A and B) with a boat-mounted electroshocker. Site 1 reach was 800 m in length, site 2 reach was 700 m, and site 3 reach was 500 m. The same transects were sampled each time at each site. During fish collection, the boat was maneuvered slowly along the bank. The hull served as the cathode. A pole-mounted anode ring covered with small-mesh netting was manually swept through and under the diverse microhabitats. This net and two additional nets were used to capture the fish, which were put into buckets filled with canal water. After both sides of a reach were electrofished, the fish were identified, weighed, length measured, physical deformities noted, and then released back into the canal. These data were used to tabulate fish species and individual numbers.

To determine if smaller fish species and early life-history stages were efficiently sampled by electrofishing, two additional sites (sites 4 and 6) were sampled during each trip using a seine 10 ft in length, with 3/16-in. mesh. For each trip, three to four seine hauls were made along a short length of canal in shallow-marsh (site 4) or swamp-forest (site 6) habitat. Site 4 also was sampled in mid-May at two randomly selected points with a 1-m^2 drop-net sampler. Fish species collected using these techniques were compared with those collected by electrofishing to evaluate sampling efficiency.

Aquatic invertebrate communities were sampled from richest-targeted habitat (RTH) and depositional-targeted habitat (DTH) (Cuffney and others, 1993) at sites 1-3. The RTH selected was the floating rafts of aquatic plants, primarily water-hyacinth (*Eichhornia crassipes*), along the banks of the waterways. In coastal Louisiana freshwater areas, floating rafts of vegetation are considered preferred habitat not only for invertebrates in the water column but also for some invertebrates more typically found in bottom sediment (Sklar, 1985). Within each reach, the underside of five rafts was scooped using a 0.25-m^2, fine-mesh (425-μm), wire-rim net, and the scooped material was composited in a 19-L bucket. Invertebrates were carefully picked out of the vegetation, preserved in a 10-percent formalin solution, and shipped to the USGS National Water Quality Laboratory (NWQL) in Denver, Colorado, for enumeration and taxonomic identification. Rare and large organisms were preserved separately. DTH, sampled only in April 2000, was fine-grained material from the waterway soft bottom sediments. At each of the three sites, five samples were collected with a petite Ponar sampler with a surface area of 0.24 m^2 (a combined surface area of 1.2 m^2), and composited for analysis. Invertebrates in bottom material retained by a 425-μm sieve were removed, preserved in a 10-percent formalin solution, and shipped to the NWQL.

In consultation with the Natural Resource Manager of Jean Lafitte National Historical Park and Preserve, bowfin (*Amia calva*), bluegill (*Lepomis macrochirus*), largemouth bass (*Micropterus salmoides*), and common carp (*Cyprinus carpio*) were selected for contaminant analyses. Two species were collected and submitted for analyses in July, and two additional species were collected and submitted for analyses during the November trip. The largest individuals of the targeted species that were collected at sites 1-3 were analyzed for selected chemicals. This number varied depending on the catch from electrofishing. Whole fish were homogenized, composited, and analyzed for organochlorine pesticides and PCB's. Skin-off fish fillets were composited and analyzed for trace elements, iron, and manganese. Samples were chilled and sent to the NWQL for analysis. Analytical methods for tissue are published in Hoffman (1996) and Leiker and others (1995).

Acknowledgments

The authors thank Sandee Dingmann and David Muth of the National Park Service for their assistance with all aspects of the survey. Patricia J. D'Arconte, Lane B. Simmons, and Roland W. Tollett of the USGS assisted with field collections.

Fish and Aquatic Invertebrate Communities

Water quality greatly influences the composition and relative abundances of aquatic communities including fish and invertebrates. Aquatic communities can be useful indicators of water quality (Karr, 1981; Barbour and others, 1995). Chemical and physical surveys of water quality may not always detect problematic water quality, because they are subject to continuously fluctuating conditions. Frequent sampling may be needed to detect poor water-quality. In contrast, fish and aquatic invertebrates have life cycles that span months to years and integrate

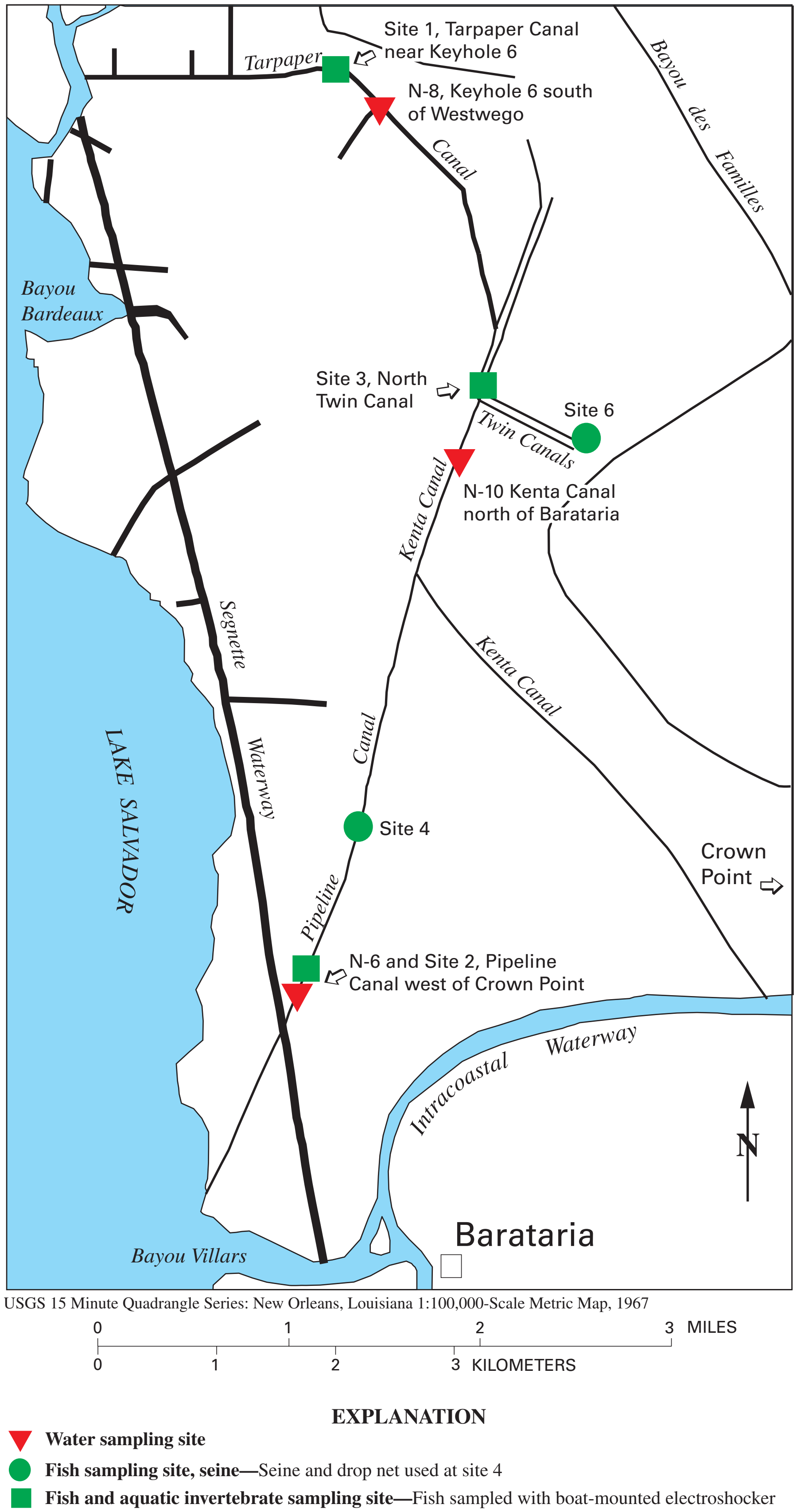

Figure 2. Sample sites in the Barataria Preserve, Jean Lafitte National Historical Park and Preserve, Louisiana.

water-quality conditions over long periods. In an area where habitat quality is good and remains stable, the presence and relative abundances of taxa can be used to evaluate water quality and determine whether an optimal community composition (high biotic integrity) is present along a given reach of waterway. Of the two aquatic communities, fish live longer, often surviving several years; invertebrates generally have lifespans of less than a year.

For aquatic communities to be useful as indicators of biotic integrity and water quality, the optimal community composition in a given physiographic area should be well documented. Ideally, a pristine or minimally affected area in an environmental setting similar to the proposed study area must first be identified (Karr and Chu, 1997). This pristine area is sampled at a reference site for several successive years so that seasonal and inter-annual variations of individuals and species can be documented. Taxa and relative abundances at the study site(s) then are compared to those from the reference site. In the absence of data from reference sites, routine monitoring over several years can help determine the stability of the communities. For the study described in this report, fish and aquatic invertebrates were sampled in a manner that would permit these data being included in long-term assessments of water quality and biotic integrity in the Preserve.

Fish

In the Barataria Preserve, there were small variations in the number and taxa of fish sampled during the three trips. The fish sampling completed for this study indicated that abundant and diverse communities are present in the Barataria Preserve. With the exception of the common carp, all fish collected are native to Barataria Basin. Fish were most abundant in November 1999. Specific conductance, possibly an important influence on aquatic community composition, increased in Preserve waterways from 1,000-3,000 µS/cm to 4,000-6,000 µS/cm during the study (fig. 3).

During this survey, 16 families, comprising 32 species of fish, were identified in the Barataria Preserve. They are listed, along with ecological affinity and relative pollution tolerance where that information was available, in table 1. Fish in the Barataria Preserve during the study were similar to those found in freshwater swamps and low-salinity marshes of coastal Louisiana (Conner and Day, 1987). Of the 32 species identified, 22 had freshwater affinities. All life-history stages of many of the species were present. The total number of species found during a single sampling event ranged from 20 to 26. Seining added from 1 to 2 species to the total during each sampling event. The total was lowest in July 1999, when only two of the three sites were sampled. Two to four species were unique to each of the three sampling periods.

Catfish (Family Ictaluridae) were not found in the July 1999 sampling. Bowfin (*Amia calva*) were abundant in the November sampling, were observed but not caught in the May sampling, and were not observed or caught during the July sampling. Seven members of the sunfish family (Centrarchidae) were identified in the Barataria Preserve during this study. Sixteen species belonging to the sunfish family are found in freshwater systems in Louisiana.

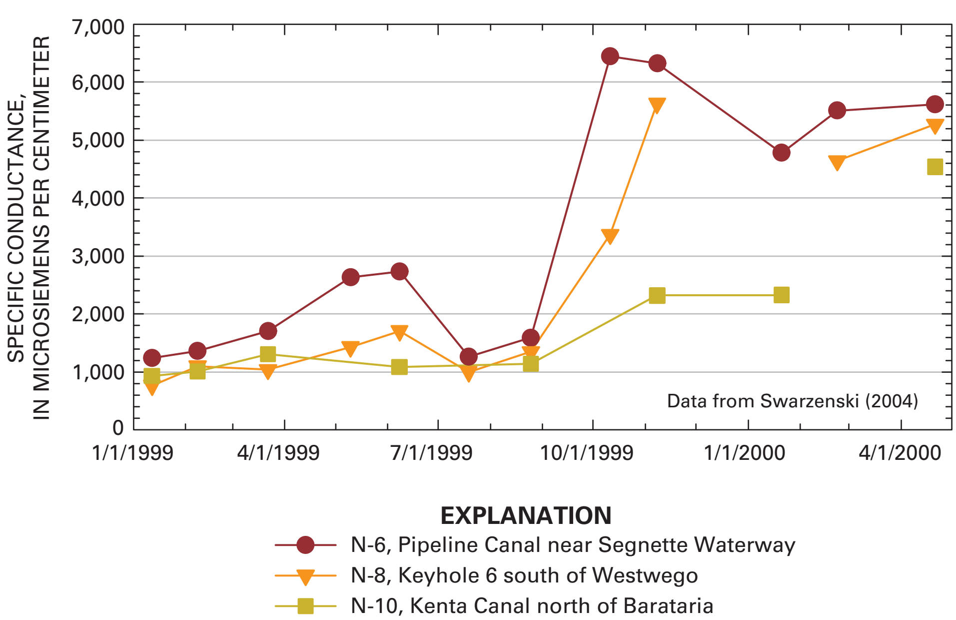

Figure 3. Specific conductance at selected sites in waterways of the Barataria Preserve, Jean Lafitte National Historical Park and Preserve in Barataria Basin, Louisiana, January 1999–April 2000.

Table 1. Ecological affinity, trophic guild, and relative pollution tolerance of fish species identified at the Barataria Preserve, Jean Lafitte National Historical Park and Preserve in May, July, and November 1999.

[Y, fish identified during sampling period; N, fish not identified during sampling period; **Ys**, fish captured only by seine; --, not known]

Fish species by family[1] Scientific name (common name) FAMILY Genus species	Ecological affinity[1]	Trophic guild[2]	Relative pollution tolerance[3]	Sampling date (1999)		
				May 17–19	July 26–28	November 1–3
LEPISOSTEIDAE (gars)						
Lepisosteus oculatus (spotted gar)	Freshwater	Piscivore	Intermediate	Y	Y	Y
AMIIDAE (bowfins)						
Amia calva (bowfin)	Freshwater	Piscivore	Intermediate	Y	N	Y
ANGUILLIDAE (freshwater eels)						
Anguilla rostrata (American eel)	Catadromous	Piscivore	Intermediate	Y	N	N
CLUPEIDAE (herrings)						
Brevoortia patronus (gulf menhaden)	Estuarine/marine	--	--	N	Y	Y
Dorosoma cepedianum (gizzard shad)	Freshwater	Omnivore	Intermediate	Y	Y	Y
Dorosoma petenense (threadfin shad)	Freshwater	Omnivore	Intermediate	N	N	Y
ENGRAULIDAE (anchovies)						
Anchoa mitchilli (bay anchovy)	Estuarine/marine	--	--	Y	Y	Y
CYPRINIDAE (carps and minnows)						
Cyprinus carpio (common carp)	Freshwater	Omnivore	Tolerant	Y	Y	Y
Notemigonus crysoleucas (golden shiner)	Freshwater	Omnivore	Tolerant	Y	Y	Y
CATOSTOMIDAE (suckers)						
Erymizon sucetta (lake chubsucker)	Freshwater	Insectivore	Intolerant	Y	N	Y
ICTALURIDAE (bullhead catfish)						
Ameiurus natalis (yellow bullhead)	Freshwater	Insectivore	Tolerant	N	N	Y
Ictalurus furcatus (blue catfish)	Freshwater	Piscivore	Intermediate	Y	N	N
Ictalurus punctatus (channel catfish)	Freshwater	Piscivore	Intermediate	Y	N	Y
BELONIDAE (needlefish)						
Strongyluria marina (Atlantic needlefish)	Estuarine/marine	Insectivore/Piscivore		Y	N	N
CYPRINODONTIDAE (toothcarps)						
Cyprinodon variegatus (sheepshead minnow)	Estuarine	Omnivore	Intermediate	**Ys**	N	N
FUNDULIDAE (killifish and topminnows)						
Fundulus chrysotus (golden topminnow)	Freshwater	--	--	Y	Y	Y
Fundulus grandis (Gulf killifish)	Estuarine	Piscivore	--	N	N	**Ys**
Fundulus pulvereus (bayou topminnow)	Estuarine	--	--	N	**Ys**	N
Lucania parva (rainwater killifish)	Estuarine	--	--	Y	Y	Y
POECILIIDAE (livebearers)						
Gambusia affinis (western mosquitofish)	Freshwater	Insectivore	Intermediate	Y	Y	Y
Heterandria formosa (least killifish)	Freshwater	--	--	Y	Y	N
Poecilia latipinna (sailfin molly)	Freshwater	--	--	**Ys**	Y	Y
ATHERINIDAE (silversides)						
Menidia beryllina (inland silverside)	Estuarine	--	--	N	Y	N

Table 1. Ecological affinity, trophic guild, and relative pollution tolerance of fish species identified at the Barataria Preserve, Jean Lafitte National Historical Park and Preserve in May, July, and November 1999.—Continued

[Y, fish identified during sampling period; N, fish not identified during sampling period; **Ys**, fish captured only by seine; --, not known]

Fish species by family[1] Scientific name (common name) FAMILY Genus species	Ecological affinity[1]	Trophic guild[2]	Relative pollution tolerance[3]	Sampling date (1999) May 17–19	July 26–28	November 1–3
ELASSOMIDAE (pigmy sunfish)						
Elassoma zonatum (banded pygmy sunfish)	Freshwater	Insectivore	Intermediate	Y	N	Y
CENTRARCHIDAE (sunfish)						
Chaenobryttus (Lepomis) gulosus (warmouth)	Freshwater	Piscivore	Intermediate	Y	Y	Y
Lepomis macrochirus (bluegill)	Freshwater	Insectivore	Intermediate	Y	Y	Y
Lepomis microlophus (redear sunfish)	Freshwater	Insectivore	Intermediate	Y	Y	Y
Lepomis punctatus (redspotted sunfish)	Freshwater	--	--	Y	Y	Y
Lepomis symmetricus (bantam sunfish)	Freshwater	Insectivore	Intermediate	Y	Y	Y
Micropterus salmoides (largemouth bass)	Freshwater	Piscivore	Intermediate	Y	Y	Y
Pomoxis nigromaculatus (black crappie)	Freshwater	Piscivore	Intermediate	Y	N	Y
MUGILIDAE (MULLETS)						
Mugil cephalus (striped mullet)	Estuarine/marine	--	--	Y	Y	Y
TOTAL				26	20	25
Exclusive to sampling period				4	2	3

[1]Fish species by family taxonomic nomenclature (scientific names and common names) follow Robins and others, 1991.

[2]Trophic guild based on Appendix C of Barbour and others, 1999.

[3]Relative pollution tolerance based on Appendix C of Barbour and others, 1999.

Most of the fish collected in the Barataria Preserve for this study are classified as intermediate in their tolerance to poor water quality (table 1). Only three species identified during this study are designated as tolerant: the common carp (*Cyprinus carpio*), golden shiner (*Notemigonus crysoleucas*) and yellow bullhead (*Ameiurus natalis*). Small numbers of lake chubsucker (*Erymizon sucetta*) were collected in the May and November samples. This species is classified as intolerant of poor water quality (Barbour and others, 1999).

The total number of species found during each sampling trip was similar, but the number of individuals and the total weight of fish sampled was much higher in November 1999 (table 2). In May and July, the total weight of electroshocked fish from a single site averaged between 9,000 and 10,000 g; in November, the average weight of all fish from a single site was about 35,000 g. The number of individuals for most species and families increased by 3 to 5 times in November. Catfish were an exception, with both the number of individuals and the average weight per individual decreasing in November compared to May collections. The higher specific conductance at this time could be a factor (fig. 3). The contribution of spotted gar (*Lepisosteus oculatus*) to the total weight of the electroshocked fish averaged 38 to 41 percent among the three sample periods. Members of the sunfish family contributed between 18 and 28 percent to the total fish weight. Bowfin (*Amia calva*) and common carp (*Cyprinus carpio*) contributed almost 25 percent of weight in November; their relative contribution to total weight was less in the two earlier sampling periods. The average weight per individual for most species sampled was lowest in July.

All seven members of the sunfish family (Centrarchidae) found in the Barataria Preserve during this study were collected during each sampling period, with the exception of black crappie (*Pomoxis nigromaculatus*), which was not collected in July (table 3). Bluegill (*Lepomis macrochirus*) and largemouth bass (*Micropterus salmoides*) contributed 60 to 83 percent of the total Centrarchidae weight during each sampling period (table 3). In November, redear sunfish (*Lepomis microlophus*) contributed 29 percent of the total weight (table 3).

Table 2. Number, weight, length, and weight contribution of dominant fish sampled at the Barataria Preserve, Jean Lafitte National Historical Park and Preserve, Louisiana, in May, July, and November 1999.

[NA, not applicable]

Dominant fish	May 15–17[1]				July 26–28[2]				November 1–3[1]			
	Number of individuals	Average weight per individual (grams)	Average length per individual[3] (millimeters)	Contribution to total sample weight (percent)	Number of individuals	Average weight per individual (grams)	Average length per individual (millimeters)	Contribution to total sample weight (percent)	Number of individuals	Average weight per individual (grams)	Average length per individual (millimeters)	Contribution to total sample weight (percent)
CLUPEIDAE (herrings) Gizzard shad, *Dorosoma cepedianum*	5	180	194	3	2	54	90	1	21	137	204	3
CYPRINIDAE (carps and minnows) Common carp, *Cyprinus carpio*	1	1,106	331	4	1	2,041	410	11	5	3,665	498	17
LEPISOSTEIDAE (gars) Spotted gar, *Lepisosteus oculatus*	20	570	377	39	20	349	402	38	92	473	394	41
ICTALURIDAE (bullhead catfish) (3 species total)	12	631	270	26	0	NA	NA	NA	4	321	238	1
CENTRARCHIDAE (sunfish) (7 species total)	189	28	79	18	231	23	70	28	790	31	92	23
AMIIDAE (bowfins) Bowfin, *Amia calva*	0	NA	NA	NA	0	NA	NA	NA	6	1,015	366	6
MUGILIDAE (mullets) Striped mullet, *Mugil cephalus*	11	234	207	9	23	173	181	22	28	294	225	8
	May 15–17				July 26–28				November 1–3			
Total weight, in grams, of above categories	28,871				18,307				104,588			
Total weight, in grams, of all fish collected	29,550				18,343				104,809			
Average weight of fish collected, in grams per meter of shoreline sampled	7.2				6.1				26.2			

[1]Three sites sampled.

[2]Two sites sampled.

[3]Standard length used (from tip of snout to base of tail).

Table 3. Number, weight, and weight contribution of sunfish (Family Centrarchidae) sampled at the Barataria Preserve, Jean Lafitte National Historical Park and Preserve, Louisiana, in May, July, and November 1999.

[<, less than indicated value]

Sunfish species	[1]May 15–17			[2]July 26–28			[1]November 1–3		
	Number of individuals	Average weight per individual (grams)	Contribution to total sample weight (percent)	Number of individuals	Average weight per individual (grams)	Contribution to total sample weight (percent)	Number of individuals	Average weight per individual (grams)	Contribution to total sample weight (percent)
Warmouth, *Chaenobryttus gulosus*	7	110	14	3	20	1	27	39	4
Bluegill, *Lepomis macrochirus*	77	22	33	45	34	29	270	29	32
Redear sunfish, *Lepomis microlophus*	28	31	16	35	21	14	354	20	29
Redspotted sunfish, *Lepomis punctatus*	8	17	3	27	2	1	64	12	3
Bantam sunfish, *Lepomis symmetricus*	4	3	<1	20	2	1	8	1	<1
Largemouth bass, *Micropterus salmoides*	63	27	32	101	28	54	56	121	28
Black crappie, *Pomoxis nigromaculatus*	2	48	2	0	0	0	11	79	4
	May 15–17			July 26–28			November 1–3		
Total weight (grams)	5,318			5,198			24,285		

[1]Three sites sampled.

[2]Two sites sampled.

Seasonal sampling of three sites (sites 1-3) using a boat-mounted electroshocker appeared to provide a good representation of fish community composition in Preserve waterways. At least three sample-collection sites probably are necessary to describe fish communities. Species generally were added with each additional transect sampled (fig. 4). Fish were most abundant, and the full complement of species for a particular trip was reached more quickly, in November; but May sampling yielded the highest number of species, and the highest number of species uniquely collected during a single sampling event. Using only a boat-mounted electroshocker may suffice to describe fish communities in Preserve waterways over time. The boat-mounted electroshocker (sites 1-3) captured 29 of the 32 species of fish found during this study. Seining at two additional sites (4 and 6) only added 3 species: sheepshead minnow (*Cyprinodon variegatus*), Gulf killifish (*Fundulus grandis*), and bayou topminnow (*Fundulus pulvereus*). The drop-net sampler (site 4) did not add to the species list. A boat-mounted electroshocker can sample larger areas more efficiently than the other two techniques.

Aquatic Invertebrates

The fish and aquatic invertebrate sampling completed for this study indicated that abundant and diverse communities are present in the Barataria Preserve. Most aquatic invertebrates identified in the Barataria Preserve were freshwater species, but some brackish-water and marine species also were collected. In April 2000, total abundance (number of organisms per square meter) and taxa richness (total number of taxa) declined, and changes in community composition occurred in the RTH at all three sites, compared to March and July 1999. Abundance and composition of aquatic invertebrate communities differed between RTH and DTH habitats at all three sites.

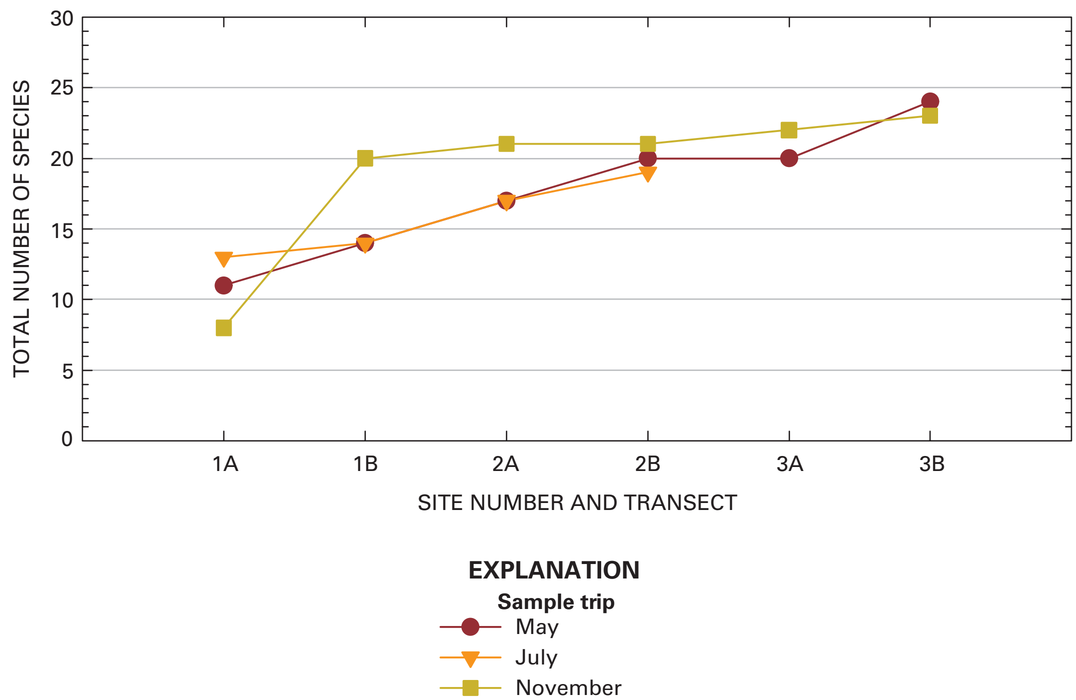

Figure 4. Number of new species of fish added per additional length of waterway sampled using a boat-mounted electroshocker, 1999.

Richest-Targeted Habitat

About 234,000 organisms were identified and enumerated from the RTH during the study. Abundances for organisms by taxa are listed in appendix 2, along with total abundances for each sampling period. Individuals from 84 genera belonging to 51 families were identified. Thirty-five individuals were identified to species. Taxa identified to Order, and their respective abundances for the three sampling periods, are listed in table 4. Sites having the highest taxa richness did not necessarily have the highest total abundance. Diptera (true flies) was the most diverse group (38 taxa), followed by Coleoptera (beetles; 23 taxa), and Gastropoda (snails, limpets; 17 taxa). Malacostraca (crustaceans), especially Amphipoda, were the most abundant (36 percent) followed by other noninsects (sponges, hydras, moss animals, flatworms, roundworms, leeches, and eight-legged arthropods; 19 percent) and Diptera (14 percent), especially the family Chironomidae (midges) (app. 2).

The largest seasonal variation in composition in RTH samples from spring (March 1999) to summer (July 1999) occurred at sites 1 and 2 (fig. 5). Malacostraca, which dominated in the spring samples at all sites (41 to 75 percent of the community), decreased in relative abundance to 7 to 31 percent in the summer samples; Amphipoda decreased from 71 to 7 percent at site 1 and from 45 to 15 percent at site 2 (table 4; app. 2). In contrast, other noninsects, nematodes in particular, increased in relative abundance from 0 to 38 percent at site 1 and from 0 to 20 percent at site 2 from spring to summer. Ephemeroptera (mayflies) and Trichoptera (caddisflies) also increased in relative abundance from 0 to 5 percent at site 1 and from 0 to 18 percent at site 2 from spring to summer. The smallest seasonal variation in relative abundance between sampling periods was at site 3, at the marsh-swamp interface.

Ephemeroptera, Plechoptera (stoneflies), and Trichoptera, referred to collectively as EPT, generally are intolerant to pollution or perturbation, and are expected to decrease with water-quality degradation (Barbour and others, 1999). The percentage of EPT in a sample, therefore, can be related to water-quality conditions. Typically, aquatic invertebrates are subjected to the most stress in the summer, when water temperatures are high and dissolved-oxygen concentrations are low (Hynes, 1970). However, in the Barataria Preserve, mayflies and caddisflies in RTH samples were proportionally more abundant in July than during the other two sampling periods. Stoneflies prefer cool running waters (Hynes, 1970) and usually are not present in the waterways of southern Louisiana. No stoneflies were present in any of the invertebrate samples collected from the Barataria Preserve. Mayflies, especially *Caenis*, which is generally considered a more tolerant mayfly, composed the largest percentage of EPT at all sites in July.

Table 4. Taxa, abundances, and percentages of aquatic invertebrates in richest-targeted habitat in the Barataria Preserve, Jean Lafitte National Historical Park and Preserve, Louisiana, 1999–2000.

[Abundances of aquatic invertebrates are rounded to the nearest whole number and reported as organisms per square meter. --, species not collected]

Taxa	Tarpaper Canal near Keyhole 6 (site 1)						Pipeline Canal west of Crown Point (site 2)						North Twin Canal (site 3)					
PHYLUM	3/16/99		7/27/99		4/21/00		3/16/99		7/27/99		4/21/00		3/16/99		7/27/99		4/21/00	
CLASS ORDER	Abundance	Percent	Abundance	Percent	Abundance	Percent	Abundance	Percent	Abundance	Percent	Abundance	Percent	Abundance	Percent	Abundance	Percent	Abundance	Percent
PORIFERA (sponges)	--	--	--	--	--	--	--	--	67	0.22	--	--	--	--	59	0.29	--	--
CNIDARIA (coelenterates)	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
HYDROZOA (hydras)	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
HYDROIDA	--	--	--	--	--	--	--	--	--	--	--	--	--	--	59	.29	--	--
BRYOZOA (moss animals)	--	--	--	--	--	--	50	0.26	--	--	--	--	108	0.26	59	.29	--	--
PLATYHELMINTHES (flatworms)	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
TURBELLARIA (free-living flatworms)	212	0.86	392	0.67	--	--	101	.53	874	2.81	--	--	748	1.80	176	.87	67	0.28
NEMERTEA (proboscis worms)	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
ENOPLA	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
HOPLONEMERTEA	--	--	--	--	--	--	50	.26	--	--	--	--	--	--	--	--	--	--
NEMATODA (roundworms)	--	--	22,540	38.55	20	0.27	--	--	6,250	20.10	--	--	1,818	4.38	1,588	7.85	--	--
MOLLUSCA (clams, snails, and limpets)	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
BIVALVIA (bivalve molluscs)	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
VENEROIDA	--	--	--	--	--	--	--	--	--	--	--	--	3	.01	59	.29	--	--
GASTROPODA (snails, limpets)	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
BASOMMATOPHORA	1,348	5.45	5,106	8.73	40	.55	403	2.12	3,231	10.39	161	2.13	8,570	20.65	1,717	8.48	136	.57
MESOGASTROPODA	215	.87	395	.68	--	--	--	--	201	.65	--	--	--	--	648	3.20	--	--
ANNELIDA (segmented worms)	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
HIRUDINEA (leeches)	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
ARHYNCHOBDELLAE	--	--	--	--	--	--	1	.01	--	--	--	--	--	--	--	--	1	.00
RHYNCHOBDELLAE	72	0.29	1	.00	20	.27	4	.02	--	--	--	--	6	.01	1	.00	268	1.13
OLIGOCHAETA (aquatic worms)	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
TUBIFICIDA	847	3.43	12,936	22.12	--	--	1,866	9.80	2,957	9.51	--	--	2,139	5.15	941	4.65	2,419	10.19
ARTHROPODA (arthropods)	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
ARACHNIDA (eight-legged arthropods)	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
ACARI (water mites)	988	4.00	2,744	4.69	60	.82	252	1.32	1,277	4.11	--	--	1,603	3.86	1,294	6.39	67	.28
MALACOSTRACA (crustaceans)	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
AMPHIPODA (scuds, sideswimmers)	17,441	70.53	3,921	6.71	5,907	80.60	8,527	44.80	4,638	14.92	5,230	69.33	15,086	36.35	6,358	31.41	11,022	46.41
DECAPODA (crayfishes, shrimps)	4	.02	5	.01	5	.07	10	.05	72	.23	71	.94	7	.02	4	.02	2	.01
ISOPODA (aquatic sow bugs)	917	3.71	--	--	81	1.11	1,413	7.42	2	.01	0	.00	1,925	4.64	1	.00	1,612	6.79
MYSIDA (opossum shrimps)	80	.32	--	--	202	2.76	--	--	--	--	484	6.42	--	--	--	--	--	--
INSECTA (insects)	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
COLEOPTERA (beetles)	154	0.62	6	.01	--	--	262	1.38	154	.50	25	.33	881	2.12	257	1.27	2	0.01
COLLEMBOLA (springtails)	635	2.57	--	--	--	--	101	.53	67	.22	23	.30	855	2.06	235	1.16	--	--
DIPTERA (true flies)	1,277	5.16	5,693	9.74	482	6.58	5,154	27.08	5,511	17.73	483	6.40	5,675	13.67	2,827	13.97	5,173	21.78
EPHEMEROPTERA (mayflies)	9	.04	2,951	5.05	40	.55	59	.31	5,108	16.43	46	.61	1,503	3.62	2,592	12.81	942	3.97
HEMIPTERA (true bugs)	443	1.79	599	1.02	128	1.75	110	.58	70	.23	192	2.55	121	.29	184	.91	480	2.02
LEPIDOPTERA (aquatic caterpillars)	5	.02	196	.34	60	.82	50	.26	67	.22	69	.91	217	.52	--	--	134	.56
ODONATA (damsel/dragonflies)	79	.32	793	1.36	244	3.33	621	3.26	207	.67	760	10.07	236	.57	1,122	5.54	1,423	5.99
TRICHOPTERA (caddisflies)	1	.00	197	.34	40	.55	--	--	337	1.08	--	--	--	--	60	.30	--	--
TOTAL ABUNDANCE	24,727	100.00	58,475	100.00	7,329	100.00	19,034	100.00	31,090	100.00	7,544	100.00	41,501	100.00	20,241	100.00	23,748	100.00

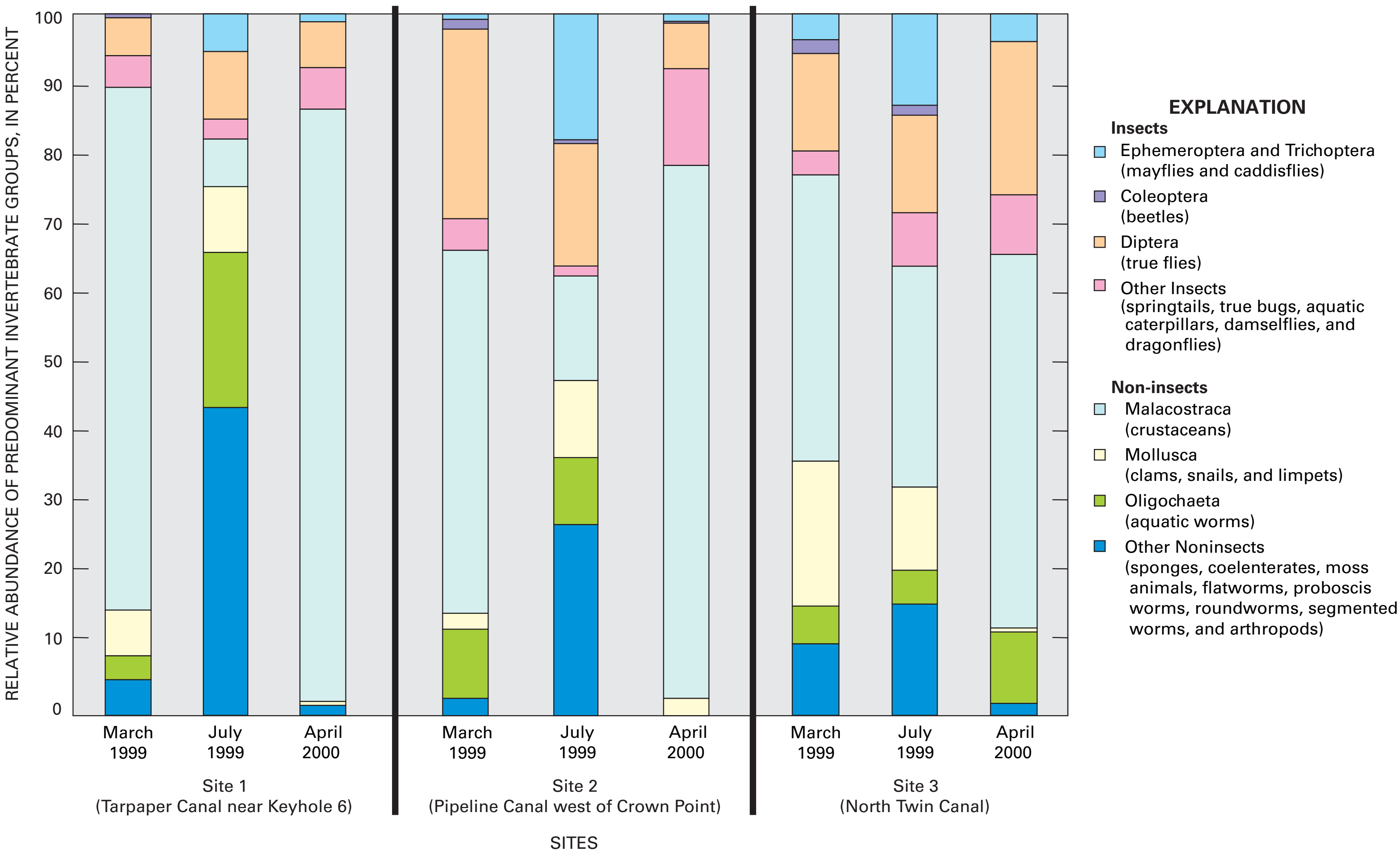

Figure 5. Relative abundances of predominant groups of aquatic invertebrates for richest-targeted habitat in the Barataria Preserve, Jean Lafitte National Historical Park and Preserve, Louisiana, 1999–2000.

Compared to the samples collected in spring 1999, total abundance and taxa richness of RTH decreased at all sites between RTH samples collected in the spring 2000 (fig. 6). At sites 1 and 2, total abundance was greatest in July 1999; at site 3, however, total abundance was greatest in March 1999. Total abundance in spring samples decreased by 43 to 70 percent and taxa richness decreased by 36 to 54 percent from 1999 to 2000 (fig. 6). Taxa richness of aquatic invertebrates in RTH samples was comparable in March and July 1999, but was lower in samples from all three sites in April 2000. Total abundance and taxa richness in April 2000 were highest at site 3. A nearby water-quality data-collection site (N-10, fig. 2) near site 3 exhibited the smallest increase in specific conductance of all sites in waterways during the study (fig. 3). The largest decrease in total abundance occurred at site 1, and the largest decrease in taxa richness occurred at site 2.

Composition measures such as relative abundance (fig. 5) and the percentages of the five dominant taxa (fig. 7) illustrate the differences between 1999 and 2000 spring samples. Mollusca (clams, snails, and limpets), especially Gastropoda, as well as other noninsects, decreased in relative abundance at all sites except site 2, where relative abundance of Mollusca remained the same. The relative abundance of Malacostraca, particularly Amphipoda, increased at all sites from 36 to 71 percent of the community in 1999 to 46 to 81 percent in 2000, with the largest increase occurring at site 2. Perturbation may increase the dominance of a few taxa (Barbour and others, 1999). The percentages of the five dominant taxa (fig. 7) increased at all sites from 54 to 79 percent of the community in 1999 to 69 to 86 percent in 2000, with the largest increase occurring at site 2.

The decrease in total abundance and taxa richness, and the changes in community composition between March 1999 and April 2000, are likely due to drought conditions in southern Louisiana (Swenson and others, 2003), and the corresponding increase in salinity as measured by the specific conductance values that occurred between July 1999 and April 2000 in Preserve waterways (Swarzenski, 2004). During that time, salinity was much higher than is usual for this part of Barataria Basin (Swarzenski, 1992). Elevated salinity in Preserve waterways broke up large rafts of floating water-hyacinth (*Eichhornia crassipes*) that had clogged canals near the data-

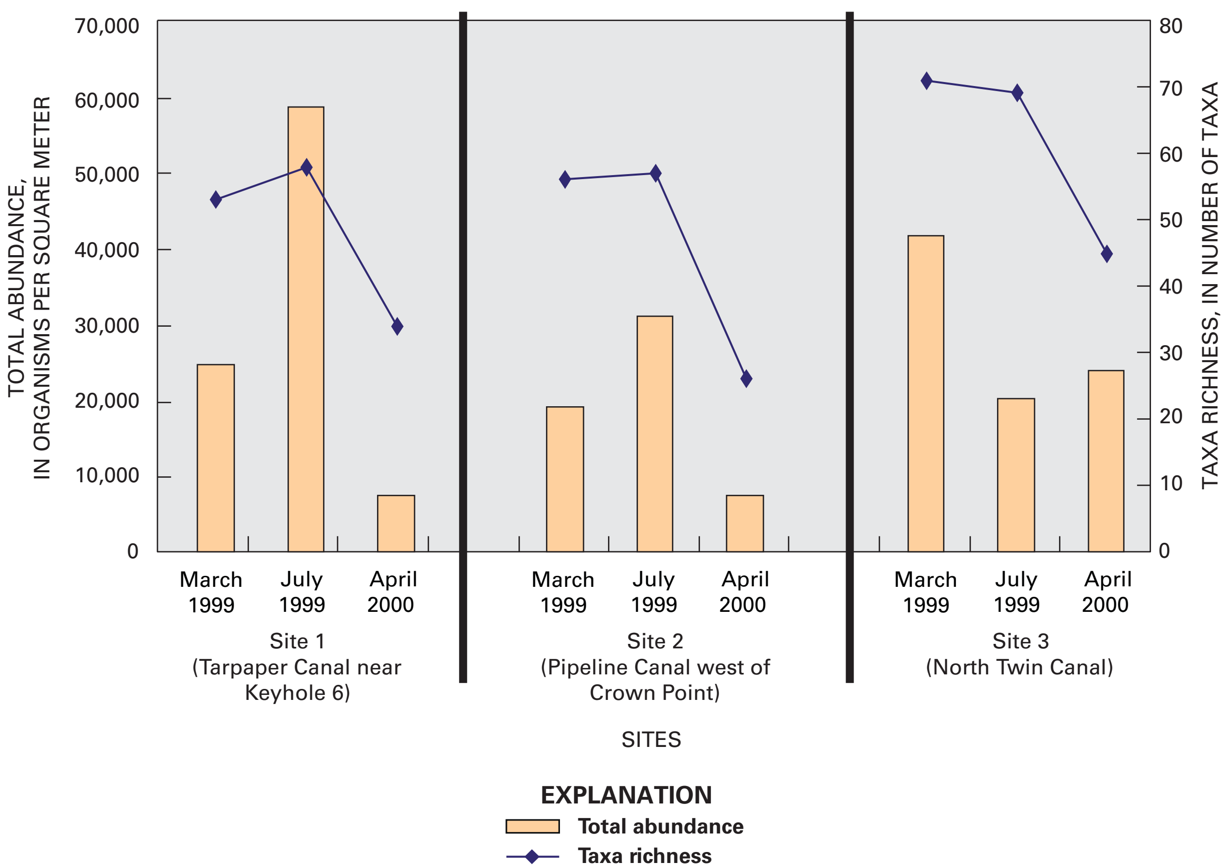

Figure 6. Total abundance and taxa richness of aquatic invertebrates for richest-targeted habitat in the Barataria Preserve, Jean Lafitte National Historical Park and Preserve, Louisiana, 1999–2000.

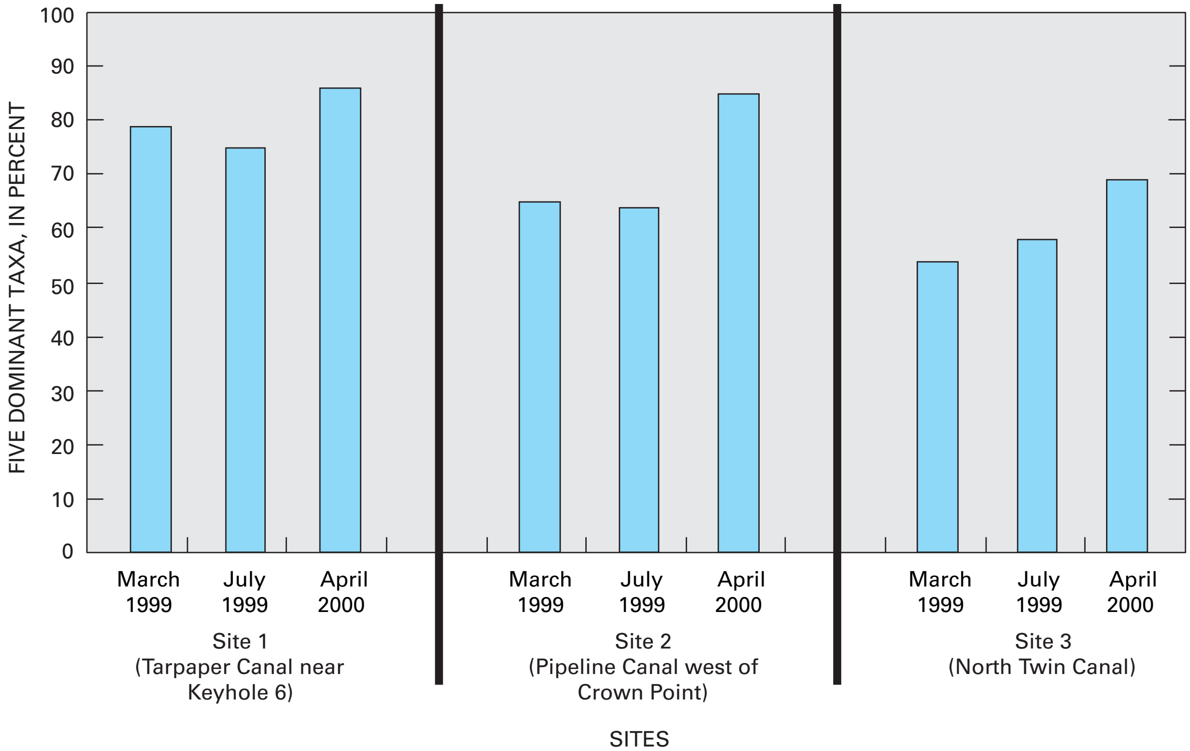

Figure 7. Percentages of five dominant taxa of aquatic invertebrates for richest-targeted habitat in the Barataria Preserve, Jean Lafitte National Historical Park and Preserve, Louisiana, 1999–2000.

collection sites for 2 or more years, reducing the RTH in the Preserve. Sikora and Sklar (1987, p. 62) noted that seasonal changes in floating aquatic raft extent affected the abundance of aquatic invertebrates. Aquatic invertebrate communities in floating aquatic rafts in the Preserve may be influenced by the higher salinity and overall loss in habitat that occur during regional droughts.

Depositional-Targeted Habitat

Aquatic invertebrates in bottom material at the three sites were sampled only in April 2000. About 106 organisms were identified and enumerated from all the DTH samples. Individuals from 7 genera belonging to 9 families were identified (app. 3). Four individuals were identified to species. Diptera (true flies) was the most diverse group (5 taxa), followed by Malacostraca (crustaceans; 4 taxa) and Annelida (worms; 3 taxa). Together, these three groups comprised more than 94 percent of the individual aquatic invertebrates collected in DTH samples. Annelida (52 percent), especially tubificid worms, were the most abundant, followed by Diptera (26 percent), especially the family Chironomidae (midges), and Malacostraca (16 percent). The aquatic invertebrate communities represented in DTH samples from this survey were similar in composition to the communities found in bottom material during the earlier survey by Garrison (1982).

The total abundance and taxa richness of aquatic invertebrate communities differed between the RTH and DTH samples collected from all three sites in April 2000 (fig. 8). The RTH had substantially more individuals (38,621 aquatic invertebrates), and higher taxa richness (26 to 45 taxa) than the DTH (106 aquatic invertebrates, 3 to 7 taxa), even though roughly the same total area (about 1.2 m^2) was sampled. These findings were similar to those of an earlier study of a swamp forest in Barataria Basin (Sikora and Sklar, 1987; Sklar, 1985), in which floating plant rafts contained the most abundant and diverse invertebrate communities. One possible explanation for the lower total abundance and taxa richness in DTH environments may be the low dissolved-oxygen concentrations and lack of diverse habitat and food resources in bottom sediments, compared to floating plant rafts.

Compositional differences in RTH and DTH samples collected in April 2000 from site 3 distinguish this site from the other sites in the Preserve. Noninsects, primarily crustaceans (amphipods such as scuds and sideswimmers) and annelid worms, dominated all RTH and DTH samples from sites 1 and 2 and the RTH sample from site 3. At site 3, insects (mostly midges) dominated the DTH sample (fig. 9). Crustaceans,

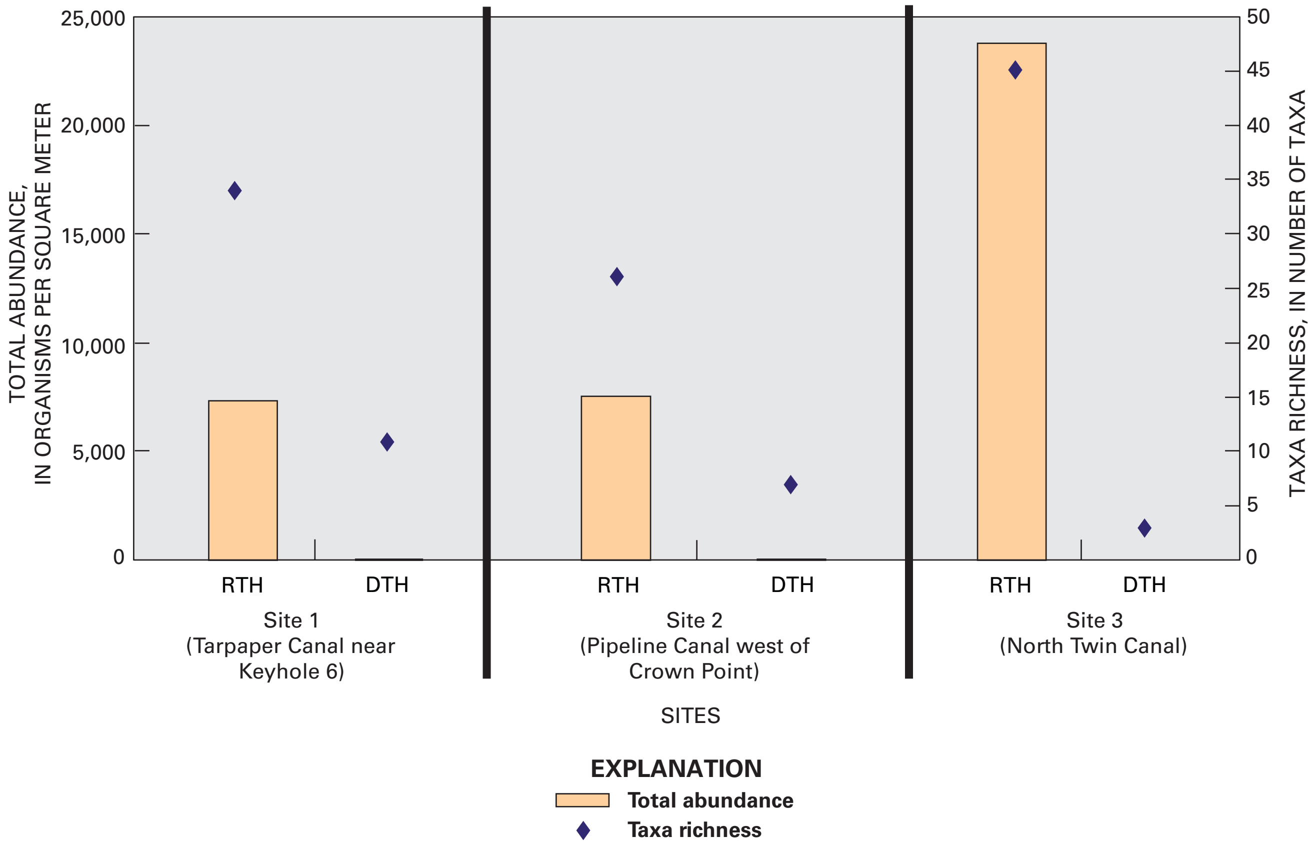

Figure 8. Total abundance and taxa richness of aquatic invertebrates for richest-targeted habitat (RTH) and depositional-targeted habitat (DTH) in the Barataria Preserve, Jean Lafitte National Historical Park and Preserve, Louisiana, April 2000.

primarily mysids (opossum shrimps) and annelids in the class Polychaeta (marine worms), which are almost exclusively marine species (Pennak, 1954), were present in April 2000 samples from sites 1 and 2. Mysids were present in RTH and DTH samples from site 1, and only in RTH samples from site 2 (table 5). Polychaetes were present only in DTH samples at sites 1 and 2. The presence of mysids and polychaetes in April samples was consistent with the increase in specific conductance (fig. 3) at these sites.

Contaminants in Fish

Three predators, bowfin (*Amia calva*), bluegill (*Lepomis macrochirus*), and largemouth bass (*Micropterus salmoides*), and the omnivore common carp (*Cyprinus carpio*) were selected for analyses because of their feeding habits (trophic level) and frequency of human consumption. Their biology and feeding habitats are described in detail by Ross (2001). Bowfin feed in the water column, consuming a diet mostly of fish and also large crustaceans such as crayfish. Bluegill typically feed in the water column, primarily on zooplankton, but also on terrestrial and aquatic insects. Largemouth bass also feed in the water column, consuming aquatic insects and fish (bluegill, and gizzard and threadfin shads). Common carp are bottom feeders, sifting through soft mud and detritus for food.

Whole fish analyses did not detect any organic compounds (table 6). In a concurrent study, organic compounds were not found in water samples from Preserve waterways, with the exception of the herbicide 2,4-D, which was detected at one of three sites during one of three sampling events. 2,4-D is occasionally sprayed onto floating aquatic vegetations in parts of the Preserve to keep waterways clear for boats (Swarzenski, 2004).

Trace elements, iron, and manganese analyzed in fish fillets are listed in table 7. Mercury (as total Hg) was detected in all four species, with greatest concentrations detected in largemouth bass and bowfin. Mercury concentrations increased with increasing wet weight of the three predatory fish species, but were much lower, relative to weight, in the common carp (fig. 10). Arsenic was not detected in bluegill and common carp tissue, but was detected in largemouth bass and bowfin. Chromium concentrations were detected in tissue of the two largest fish, common carp and bowfin, suggesting

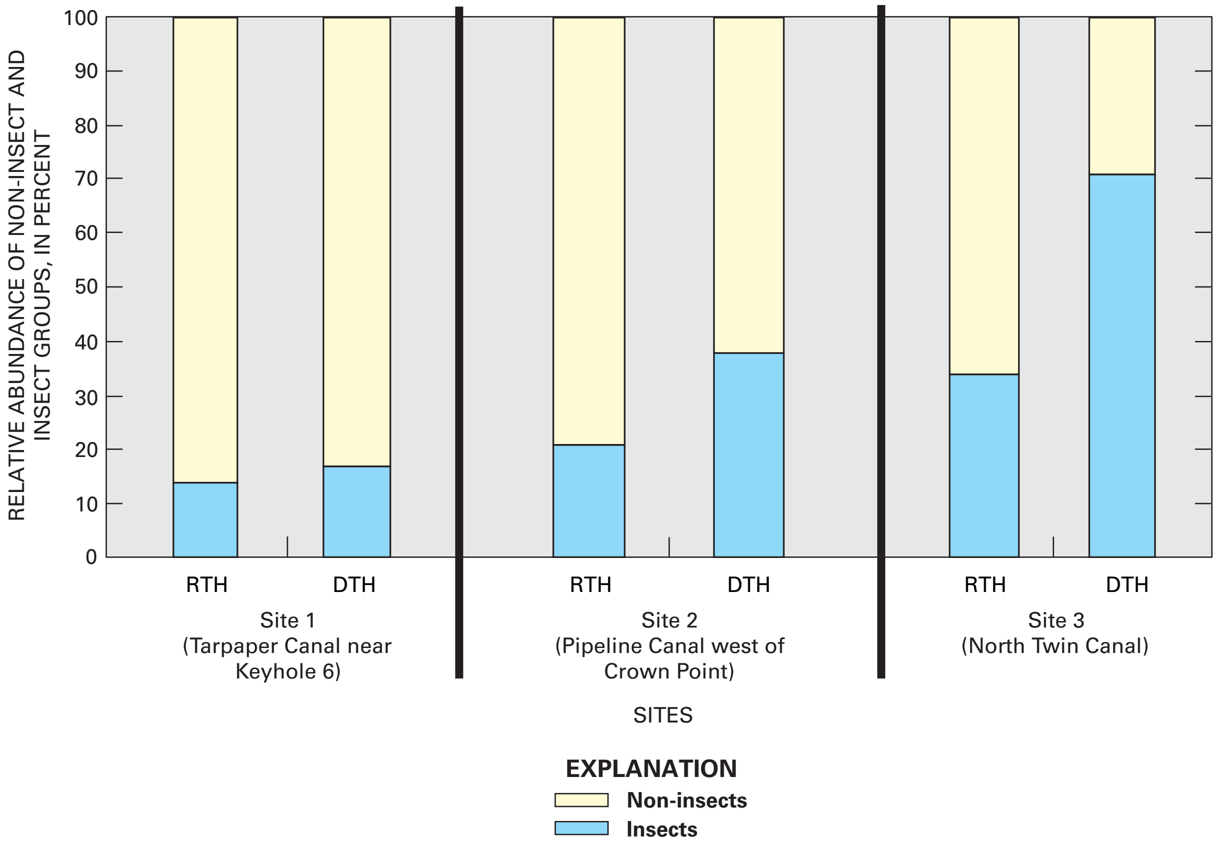

Figure 9. Relative abundance of noninsect and insect groups of aquatic invertebrates for richest-targeted habitat (RTH) and depositional-targeted habitat (DTH) areas for three sites in the Barataria Preserve, Jean Lafitte National Historical Park and Preserve, Louisiana, April 2000.

that weight (a surrogate for age), plays a role in accumulation of this trace element. Cadmium and lead were below detection in all tissue samples. The smallest fish, bluegill, had the highest concentrations of manganese, selenium, and strontium.

Sampling for contaminants was exploratory and was limited to a few fish per analysis. In a more rigorous sampling scheme, typically fillets from at least eight individuals of similar size and caught at a single location would be composited to establish age-related concentrations of contaminants. Fish would be electroshocked for the sole purpose of obtaining sufficient individuals of a single age class. Although mercury concentrations are expected to increase as fish increase in weight, the linear trend indicated in figure 10 seems to be somewhat idealized. The relation between age and tissue contaminant concentration is better quantified using larger, more robust sampling populations.

In most adult fish, 90-100 percent of the total mercury present is in the form of methylmercury. This is the biologically active and toxic form of mercury. An advisory of fish consumption by humans at indicated levels of methylmercury is given in table 8. The consistent linear increase in mercury concentration with increasing fish weight at the Barataria Preserve (fig. 10) suggests concentrations for larger fish caught in Preserve waterways may be a concern, if the fish are frequently consumed by humans. At mercury concentrations detected in fish tissue during this study (table 7), monthly consumption limits for the typical consumer (table 8) are as follows: common carp or bluegill, more than 3,500 g (128 oz, about 15 meals); largemouth bass, more than 1,800 g (64 oz, a little less than 8 meals); or bowfin, 600 g (more than 21 oz, about 2.6 meals).

For women of childbearing age, consumption of fish with tissue methylmercury concentrations of 0.1 to 0.15 µg/g wet tissue weight (0.5 to 0.75 µg/g dry tissue weight, assuming 80 percent moisture content for fish) should be limited to less than 10 g of wet weight fillet per day. This amount is equivalent to about 1/4 of a cup of fish or one fish sandwich per week (U.S. Environmental Protection Agency, 2001, p. 4). Mercury concentrations below levels that pose a risk to adults can harm children. Children 7 years or younger are especially sensitive to mercury because their nervous systems are still forming (Louisiana Department of Health and Hospitals, 1998b).

Table 5. Taxa, abundances, and percentages of aquatic invertebrates in richest-targeted habitat and depositional-targeted habitat in the Barataria Preserve, Jean Lafitte National Historical Park and Preserve, Louisiana, April 2000.

[Abundances of aquatic invertebrates are rounded to the nearest whole number and reported as organisms per square meter. RTH, richest-targeted habitat; DTH, depositional-targeted habitat; --, species not collected; * Suborder]

Taxa	Tarpaper Canal near Keyhole 6 (site 1)				Pipeline Canal west of Crown Point (site 2)				North Twin Canal (site 3)			
PHYLUM	RTH		DTH		RTH		DTH		RTH		DTH	
CLASS / ORDER	Abundance	Percent	Abundance	Percent	Abundance	Percent	Abundance	Percent	Abundance	Percent	Abundance	Percent
PLATYHELMINTHES (flatworms)	--	--	--	--	--	--	--	--	--	--	--	--
TURBELLARIA (free-living flatworms)	--	--	--	--	--	--	--	--	67	0.28	--	--
NEMATODA (roundworms)	20	0.27	--	--	--	--	--	--	--	--	--	--
MOLLUSCA (clams, snails, and limpets)	--	--	--	--	--	--	--	--	--	--	--	--
GASTROPODA (snails, limpets)	--	--	--	--	--	--	--	--	--	--	--	--
BASOMMATOPHORA	40	0.55	--	--	161	2.13	--	--	136	0.57	--	--
PROSOBRANCHIA*	--	--	--	--	--	--	2	5.13	--	--	--	--
ANNELIDA (segmented worms)	--	--	--	--	--	--	--	--	--	--	--	--
HIRUDINEA (leeches)	--	--	--	--	--	--	--	--	--	--	--	--
ARHYNCHOBDELLAE	--	--	--	--	--	--	--	--	1	0.00	--	--
RHYNCHOBDELLAE	20	0.27	--	--	--	--	--	--	268	1.13	--	--
OLIGOCHAETA (aquatic worms)	--	--	--	--	--	--	--	--	--	--	--	--
TUBIFICIDA	--	--	34	56.67	--	--	10	25.64	2,419	10.19	2	28.57
POLYCHAETA (marine worms)	--	--	--	--	--	--	--	--	--	--	--	--
TEREBELLIDA	--	--	4	6.67	--	--	5	12.82	--	--	--	--
ARTHROPODA (arthropods)	--	--	--	--	--	--	--	--	--	--	--	--
ARACHNIDA (eight-legged arthropods)	--	--	--	--	--	--	--	--	--	--	--	--
ACARI (water mites)	60	0.82	2	3.33	--	--	--	--	67	0.28	--	--
MALACOSTRACA (crustaceans)	--	--	--	--	--	--	--	--	--	--	--	--
AMPHIPODA (scuds, sideswimmers)	5,907	80.60	8	13.33	5,230	69.33	7	17.95	11,022	46.41	--	--
DECAPODA (crayfishes, shrimps)	5	0.07	--	--	71	0.94	--	--	2	0.01	--	--
ISOPODA (aquatic sow bugs)	81	1.11	--	--	0	0.00	--	--	1,612	6.79	--	--
MYSIDA (opossum shrimps)	202	2.76	2	3.33	484	6.42	--	--	--	--	--	--
INSECTA (insects)	--	--	--	--	--	--	--	--	--	--	--	--
COLEOPTERA (beetles)	--	--	--	--	25	0.33	--	--	2	0.01	--	--
COLLEMBOLA (springtails)	--	--	--	--	23	0.30	--	--	--	--	--	--
DIPTERA (true flies)	482	6.58	8	13.33	483	6.40	15	38.46	5,173	21.78	5	71.43
EPHEMEROPTERA (mayflies)	40	0.55	--	--	46	0.61	--	--	942	3.97	--	--
HEMIPTERA (true bugs)	128	1.75	--	--	192	2.55	--	--	480	2.02	--	--
LEPIDOPTERA (aquatic caterpillars)	60	0.82	--	--	69	0.91	--	--	134	0.56	--	--
ODONATA (damsel/dragonflies)	244	3.33	2	3.33	760	10.07	--	--	1,423	5.99	--	--
TRICHOPTERA (caddisflies)	40	0.55	--	--	--	--	--	--	--	--	--	--
TOTAL ABUNDANCE	7,329	100.00	60	100.00	7,544	100.00	39	100.00	23,748	100.00	7	100.00

Table 6. Concentrations of selected organochlorine pesticides, and polychlorinated biphenyls in whole tissue of fish from selected waterways in the Barataria Preserve, Jean Lafitte National Historical Park and Preserve, Louisiana, July and November 1999.

[Values for constituents, except lipids, are measured in wet weight, recoverable, in micrograms per kilogram. <, less than indicated value]

Species:	**Bluegill (*Lepomis macrochirus*)**	**Largemouth bass (*Micropterus salmoides)***	**Bowfin (*Amia calva*)**	**Common carp (*Cyprinus carpio*)**
Sample date:	**July 28**		**November 1**	
Number of individual fish composited:	**4**	**3**	**2**	**2**
Average fresh weight (grams):	**60**	**279**	**1,389**	**3,815**
Constituents	**Concentrations**			
Percent lipids, in whole fish	0.7	0.9	2.5	6.6
Aldrin	<5	<5	<5	<5
Alpha-BHC	<5	<5	<5	<5
Benzene, hexa-chloro-	<5	<5	<5	<5
Beta-BHC	<5	<5	<5	<5
Cis-chlordane	<5	<5	<5	<5
Cis-nonachlor	<5	<5	<5	<5
DCPA	<5	<5	<5	<5
Delta-BHC	<5	<5	<5	<5
Dieldrin	<5	<5	<5	<5
Endrin	<5	<5	<5	<5
Heptachlor epoxide	<5	<5	<5	<5
Heptachlor	<5	<5	<5	<5
Lindane	<5	<5	<5	<5
Methoxychlor, O, P′ -	<5	<9	<5	<5
Methoxychlor, P, P′ -	<5	<5	<5	<5
Mirex	<5	<5	<5	<5
O, P′ -DDD	<5	<5	<5	<5
O, P′ -DDE	<5	<5	<5	<5
O, P′ -DDT	<5	<5	<5	<5
Oxychlordane	<5	<5	<5	<5
P, P′ -DDD	<5	<5	<5	<5
P, P′ -DDE	<5	<5	<5	<5
P, P′ -DDT	<5	<5	<5	<5
Pentachloroanisole	<5	<5	<5	<5
Toxaphene	<200	<200	<200	<200
Trans-chlordane	<5	<5	<5	<5
Trans-nonachlor	<5	<5	<5	<5
Polychlorinated biphenyls	<50	<50	<50	<50

Table 7. Concentrations of selected trace elements, iron, and manganese in muscle (fillet) tissue of fish from selected waterways in the Barataria Preserve, Jean Lafitte National Historical Park and Preserve, Louisiana, July and November 1999.

[Values for constituents, except water, are measured in dry weight, recoverable, in micrograms per gram. <, less than indicated value]

Species:	**Bluegill (*Lepomis macrochirus*)**	**Largemouth bass (*Micropterus salmoides*)**	**Bowfin (*Amia calva*)**	**Common carp (*Cyprinus carpio*)**
Sample date:	**July 28**		**November 1**	
Number of individual fish composited:	**4**	**2**	**2**	**1**
Average fresh weight (grams):	**81**	**380**	**1,602**	**5,557**
Constituents	**Concentrations[1]**			
Percent water in tissue	82	80	79	79
Aluminum	<1.0	<1.0	<1.0	<1.0
Antimony	<.3	<.2	<.2	<.2
Arsenic	<.3	.6	1.4	<.2
Barium	.8	<.1	.3	.9
Beryllium	<.3	<.2	<.2	<.2
Boron	.9	.9	1.2	.7
Cadmium	<.3	<.2	<.2	<.2
Chromium	<.5	<.5	.6	.5
Cobalt	<.3	<.2	<.2	<.2
Copper	.9	.8	1	2.8
Iron	5	7	12	73
Lead	<.3	<.2	<.2	<.2
Manganese	2.4	.5	1.1	1.5
Mercury[1]	.2	.4	1.5	.2
Molybdenum	<.3	<.2	<.2	<.2
Nickel	<.3	<.2	<.2	<.2
Selenium	3.8	1.9	.8	.8
Silver	<.3	<.2	<.2	<.2
Strontium	6.9	1	2.3	4.7
Vanadium	<.3	<.2	<.2	<.2
Zinc	24	17	14	25

[1]To convert to wet weight concentration, divide dry weight concentration by 5. Mercury concentrations must be converted to wet weight concentrations for direct comparison with fish consumption limits listed in table 8.

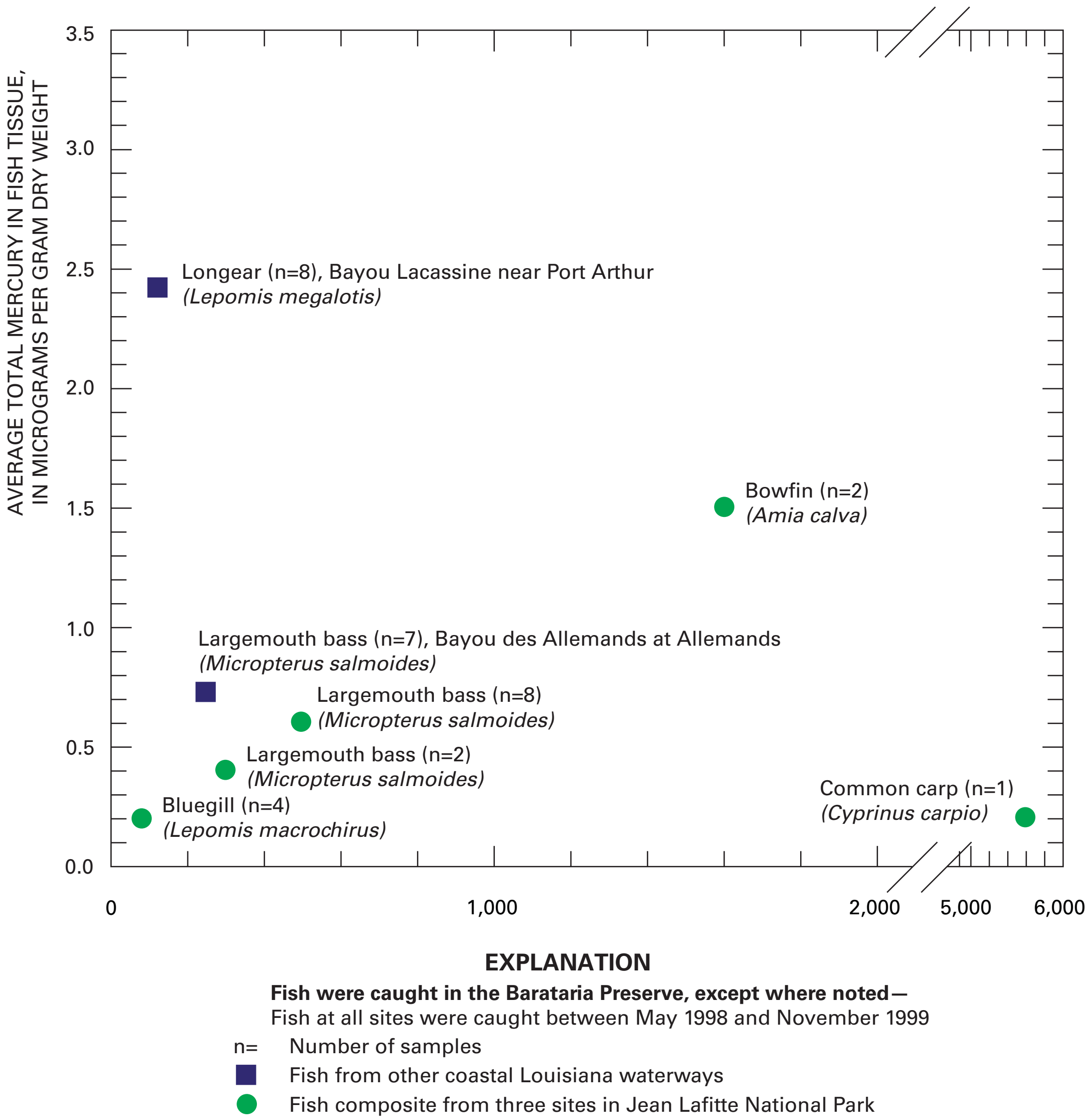

Figure 10. Relation between total mercury concentrations in composited fish fillet tissue and average wet weight of fish in selected surface-water sites in southern Louisiana.

Table 8. Monthly fish consumption limits for methylmercury.

[Source: U.S. Environmental Protection Agency, 2001, p. 5. >, greater than]

Risk-based consumption limit for humans	Noncancer health endpoints
Fish meals[1] per month	Fish tissue concentration, micrograms per gram wet weight[2]
16	>0.03 to 0.06
12	>0.06 to 0.08
8	>0.08 to 0.12
4	>0.12 to 0.24
3	>0.24 to 0.32
2	>0.32 to 0.48
1	>0.48 to 0.97
0.5	>0.97 to 1.9
None	>1.9

[1]A fish meal is assumed to be about 227 grams wet weight; consumer weight is 70 kilograms; reference dose for methylmercury is 10^{-4} milligrams per kilogram per day.

[2]To convert to dry weight concentration, multiply wet weight concentration by 5; a moisture content of 80 percent was assumed for fish.

In many waters in Louisiana, mercury concentrations are sufficiently high in fish fillets to be of concern (Louisiana Department of Environmental Quality, no date; Louisiana Department of Health and Hospitals, 1998a). There are 35 consumptive advisories (including a statewide coastal advisory) listed for Louisiana by the Louisiana Department of Health and Hospitals (1998a). Mercury concentrations in comparable fish tissue at some other sites in coastal Louisiana were higher per unit wet weight of fish compared to concentrations in fish tissue sampled at the Barataria Preserve (fig. 10), indicating that mercury is not an issue specific to the Barataria Preserve, with a unique local source. Mercury concentrations in bottom material of Barataria Preserve waterways were between 0.01 and 0.03 µg/g sediment dry weight in a recent survey (Swarzenski, 2004). These concentrations are below levels that would raise toxicity concerns for aquatic life (Canadian Council of Ministers of the Environment, 1999).

The sources and processes by which mercury becomes available to, and accumulates in, aquatic organisms in areas where direct inputs of mercury appear to be low, such as the Preserve waterways, is not well understood. There is no apparent local source to Preserve waterways that can be mitigated or removed. Wetland environments in general appear to play a key role because of anaerobic conditions in soils. Highly organic soils, for example the Everglades marshes or the peat marshes that make up much of the Preserve, also may be important in making mercury bioavailable. Studies of mercury cycling in wetlands (Krabbenhoft and others, 1999; Gilmour and others, 1992) suggest that, under certain conditions, wetlands may make atmospheric mercury deposited in wetlands more readily available for biological uptake. This is because the reduction of sulfate to sulfide, which occurs in the anaerobic wetland soils containing sulfate, may facilitate methylation of mercury. Further study on this issue in the Preserve is warranted, especially in light of the Davis Pond diversion. The diversion may change the way sulfates enter Barataria Preserve wetlands, which could enhance mercury methylation rates.

Summary and Conclusions

Fish and aquatic invertebrate communities in waterways of the Barataria Preserve of the Jean Lafitte National Historical Park and Preserve, Louisiana, were surveyed from 1999 to 2000. An inventory of fish in the Barataria Preserve was established, and concentrations of selected organochlorine pesticides, polychlorinated biphenyls, and trace elements; iron; and manganese for selected fish species were determined. The fish and aquatic invertebrate sampling completed for this study indicated that abundant and diverse communities are present in the Barataria Preserve.

Fish were surveyed at three sites in Preserve waterways in May, July, and November 1999. Sixteen families, comprising 32 species of fish, were identified in the Barataria Preserve during this survey. Of the 32 species, 22 had freshwater affinities. All life-history stages of many of the species were present.

The total number of fish species found in a single sampling ranged from 20 to 26. The total was lowest in July, when only two of the three sites were sampled. Between 2 and 4 species were unique to each of the three sampling periods. A boat-mounted electroshocker was sufficient to collect most species; seining added from 1 to 2 species to the total during each sampling event. A drop-net sampler did not add to the species list.

In November, the average weight of all fish recovered from a single site was about 35,000 grams; in May and July the average weight of all fish from a single site was between 9,000 and 10,000 grams. The number of individuals for most species or categories also increased, by about 3 to 5 times, in November. The contribution of spotted gar (*Lepisosteus oculatus*) to the total weight of the electroshocked fish averaged between 38 and 41 percent among the three sample periods. Bowfin (*Amia calva*) and common Carp (*Cyprinus carpio*) contributed almost 25 percent of fish weight in November; their relative contribution to total weight was less in the two earlier sampling periods. Members of the sunfish family (Centrarchidae) contributed between 18 and 28 percent of the total fish weight; for each sampling period, bluegill (*Lepomis macrochirus*) and largemouth bass (*Micropterus salmoides*) contributed 60 to 83 percent of the total Centrarchidae weight. The average weight per individual for most species or categories was lowest in July.

Most of the fish collected in the Barataria Preserve during this study are classified as intermediate in their tolerance to poor water quality. Three species designated as tolerant of poor water quality, the common carp (*Cyprinus carpio*), golden shiner (*Notemigonus crysoleucas*), and yellow bullhead (*Ameiurus natalis*), and one intolerant species, lake chubsucker (*Erymizon sucetta*), were identified during the study.

Aquatic invertebrates were sampled from three sites in March and July 1999 and April 2000. Most aquatic invertebrates identified in the Barataria Preserve were freshwater species, but some were brackish-water and marine species. About 234,000 organisms were identified and enumerated from the richest-targeted habitat (RTH, floating rafts of aquatic plants) during the study. Individuals from 84 genera belonging to 51 families were identified. Thirty-five individuals were identified to species. Diptera (true flies) was the most diverse group (38 taxa), and Malacostraca (crustaceans), especially Amphipoda, were the most abundant (36 percent).

Total abundance and taxa richness of aquatic invertebrates in RTH samples were comparable during the March and July sampling in 1999, but were lower in samples collected from the same habitat at all three sites in April 2000. From 1999 to 2000, total abundance in spring samples decreased by 43 to 70 percent and taxa richness decreased by 36 to 54 percent. The largest decrease in total abundance occurred at site 1 (Tarpaper Canal near Keyhole 6); the largest decrease in taxa richness occurred at site 2 (Pipeline Canal west of Crown Point). Composition measures such as relative abundance and proportion of the five most dominant taxa illustrate the differences between 1999 and 2000 spring samples. Mollusca (clams, snails, and limpets), especially Gastropoda, as well as other noninsects, decreased in relative abundance at all sites except site 2 (Pipeline Canal west of Crown Point), where relative abundance of Mollusca remained the same. The relative abundance of Malacostraca, particularly Amphipoda, increased at all sites from 36 to 71 percent of the community in 1999 to 46 to 81 percent of the community in 2000, with the largest increase occurring at site 2. The percentages of the five most dominant taxa increased at all sites from 54 to 79 percent of the community in 1999 to 69 to 86 percent in 2000, with the largest increase occurring at site 2.

The decrease in total abundance and taxa richness and the changes in community composition between March 1999 and April 2000 are likely due to drought conditions in southern Louisiana and the corresponding increase in salinity in waterways of the Barataria Preserve. Elevated salinity in Preserve waterways broke up large rafts of floating water hyacinth, reducing the RTH. Salinity levels in surface water were atypically high by April 2000 at all three sites.

Aquatic invertebrates in bottom material at the three sites were sampled only in April 2000. About 106 individuals were identified and enumerated from all depositional-targeted habitat (DTH, bottom material) samples. Individuals from 7 genera belonging to 9 families were identified. Four individuals were identified to species. Diptera was the most diverse group (5 taxa), and Annelida, especially tubificid worms, were the most abundant (52 percent).

Total abundance and composition of aquatic invertebrate communities differed between RTH and DTH at all three sites in April 2000. The RTH environment had substantially more individuals (38,621 aquatic invertebrates) than the DTH environment (106 aquatic invertebrates), even though roughly the same total area (about 1.2 square miles) was sampled. Compositional differences in RTH and DTH samples collected from site 3 distinguish this site from the other sites in the Preserve. Noninsects dominated all RTH and DTH samples from sites 1 and 2, and the RTH sample from site 3. Insects (mostly midges) dominated the DTH sample from site 3. The presence of mysids (opossum shrimps) and polychaetes (marine worms), which are almost exclusively marine species, were present only in samples from sites 1 and 2. This was consistent with the increase in specific conductance at these sites. Sampling of aquatic invertebrate communities may have potential for evaluating water-quality conditions and trends in the Barataria Preserve.

Three predators, bowfin (*Amia calva*), bluegill (*Lepomis macrochirus*), and largemouth bass (*Micropterus salmoides*), and the omnivore common carp (*Cyprinus carpio*) were selected for contaminant analyses. Organic compounds were not detected in any whole fish analyses. Mercury was detected in fillets of all four species sampled. The greatest concentrations of mercury were detected in bowfin and largemouth bass. Mercury concentrations increased with increasing wet weight in the three predatory fish species, but were much lower, relative to weight, in the omnivore. Arsenic was detected in bowfin and largemouth bass. Chromium concentrations were detected in tissue of the two larger fish, bowfin and common carp, suggesting that weight plays a role in accumulation of this trace element. Cadmium and lead concentrations were below detection in all tissue samples.

The consistent linear increase in mercury concentration with increasing fish weight at the Barataria Preserve suggests that mercury concentrations for larger predatory fish caught in Preserve waterways may be a concern if the fish are frequently consumed by humans. The process of mercury accumulation appears to be natural, and not related specifically with Preserve waterways or a local source problem. Mercury concentrations in comparable fish tissue at some other sites in coastal Louisiana were higher per unit wet weight of fish, supporting the conclusion that mercury is not an issue specific to the Barataria Preserve. Other studies of mercury cycling in wetlands suggest that wetlands under certain conditions may make atmospheric mercury deposited in wetlands more readily available for biological uptake. The reduction of sulfate to sulfide which occurs in anaerobic wetland soils, provided there is a source of sulfate, may facilitate methylation of mercury. The Davis Pond diversion, about 4 miles northwest of the Preserve, may change the way sulfates enter Barataria Preserve wetlands, which could enhance mercury methylation rates. As the diversion introduces Mississippi River water into the Park and Preserve, the fish and aquatic invertebrate communities in the Preserve may change in response to the change in water quality.

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Appendixes

Appendix 1. Submerged aquatic vegetation observed along transects of waterways sampled for fish in the Barataria Preserve, Jean Lafitte National Historical Park and Preserve, Louisiana, 1999–2000.

Species	Common name	Characteristic
Azolla caroliniana	Mosquito-fern	Free-floating
Ceratophilum demersum	Coontail	Free-floating
Eichhornia crassipes	Water hyacinth	Free-floating
Utricularia macrorhiza	Common bladderwort	Free-floating
Cabomba caroliniana	Fanwort	Rooted, floating
Nymphaea odorata	Water lily	Rooted, floating
Hydrilla verticillata	Hydrilla	Rooted, submerged
Myriophyllum spicatum	Eurasian water-milfoil	Rooted, submerged
Vallisneria americana.	Tapegrass, wild celery	Rooted, submerged
Potamogeton epihydrus	Ribbon-leaf pondweed	Rooted, submerged, and floating-leaved
Heteranthera reniformis	Kidney-leaf mud plantain	Free-floating and submerged

Appendix 2. Taxa and abundances of aquatic invertebrates in richest-targeted habitat at selected sites in the Barataria Preserve, Jean Lafitte National Historical Park and Preserve, Louisiana, 1999–2000.

[Abundances of aquatic invertebrates are rounded to the nearest whole number and reported as organisms per square meter. --, species not collected; *, Suborder; **, Subfamily; ***, Tribe]

Taxonomic Heirarchy[1] PHYLUM CLASS ORDER Family *Genus species*	Tarpaper Canal near Keyhole 6 (site 1)			Pipeline Canal west of Crown Point (site 2)			North Twin Canal (site 3)		
	3/16/99	7/27/99	4/21/00	3/16/99	7/27/99	4/21/00	3/16/99	7/27/99	4/21/00
PORIFERA (sponges)	--	--	--	--	67	--	--	59	--
CNIDARIA (coelenterates)	--	--	--	--	--	--	--	--	--
HYDROZOA (hydras)	--	--	--	--	--	--	--	--	--
HYDROIDA	--	--	--	--	--	--	--	--	--
Hydridae	--	--	--	--	--	--	--	--	--
Hydra sp.	--	--	--	--	--	--	--	59	--
BRYOZOA (moss animals)	--	--	--	50	--	--	108	59	--
PLATYHELMINTHES (flatworms)	--	--	--	--	--	--	--	--	--
TURBELLARIA (free-living flatworms)	212	392	--	101	874	--	748	176	67
NEMERTEA (proboscis worms)	--	--	--	--	--	--	--	--	--
ENOPLA	--	--	--	--	--	--	--	--	--
HOPLONEMERTEA	--	--	--	--	--	--	--	--	--
Tetrastemmatidae	--	--	--	--	--	--	--	--	--
Prostoma sp.	--	--	--	50	--	--	--	--	--
NEMATODA (roundworms)	--	22,540	20	--	6,250	--	1,818	1,588	--
MOLLUSCA (clams, snails, and limpets)	--	--	--	--	--	--	--	--	--
BIVALVIA (bivalve molluscs)	--	--	--	--	--	--	--	--	--
VENEROIDA	--	--	--	--	--	--	--	--	--
Sphaeriidae (fingernail clams)	--	--	--	--	--	--	--	--	--
Sphaeriinae**	--	--	--	--	--	--	--	59	--
Musculium sp.	--	--	--	--	--	--	3	--	--
GASTROPODA (snails, limpets)	--	--	--	--	--	--	--	--	--
BASOMMATOPHORA	--	--	--	--	269	--	427	59	--
Ancylidae (limpets)	141	2,548	--	--	538	--	1,711	118	--
Ferrissia sp.	--	392	--	--	--	--	--	--	--
Hebetancylus excentricus	--	1	--	50	134	--	429	235	--
Laevapex fuscus	--	2	--	--	--	--	6	3	--
Laevapex sp.	1	--	--	--	202	--	1	294	67
Lymnaeidae (pond snails)	71	--	--	50	--	--	321	--	--
Fossaria/Stagnicola sp.	--	--	--	--	--	--	108	--	--
Pseudosuccinea columella	1	--	--	--	--	--	--	--	1
Physidae (pouch snails)	--	--	--	--	--	--	--	--	--
Physella sp.	1,060	1,372	40	303	1,277	161	3,746	588	67
Planorbidae (orb snails)	71	588	--	--	605	--	321	294	--
Biomphalaria havanensis	2	201	--	--	4	--	2	6	--
Micromenetus dilatatus	1	2	--	--	134	--	1,497	59	--
Micromenetus sp.	--	--	--	--	--	--	--	--	--
Planorbella sp.	--	--	--	--	68	--	1	61	1
MESOGASTROPODA	--	--	--	--	--	--	--	--	--
Hydrobiidae	212	392	--	--	134	--	--	647	--
Amnicola sp.	3	3	--	--	--	--	--	--	--
Pyrgophorus sp.	--	--	--	--	67	--	--	1	--
ANNELIDA (segmented worms)	--	--	--	--	--	--	--	--	--
HIRUDINEA (leeches)	--	--	--	--	--	--	--	--	--
ARHYNCHOBDELLAE	--	--	--	--	--	--	--	--	--
Erpobdellidae	--	--	--	1	--	--	--	--	1

Appendix 2. Taxa and abundances of aquatic invertebrates in richest-targeted habitat at selected sites in the Barataria Preserve, Jean Lafitte National Historical Park and Preserve, Louisiana, 1999–2000.—Continued

[Abundances of aquatic invertebrates are rounded to the nearest whole number and reported as organisms per square meter. --, species not collected; *, Suborder; **, Subfamily; ***, Tribe]

Taxonomic Heirarchy[1] PHYLUM / CLASS / ORDER / Family / *Genus species*	Tarpaper Canal near Keyhole 6 (site 1)			Pipeline Canal west of Crown Point (site 2)			North Twin Canal (site 3)		
	3/16/99	7/27/99	4/21/00	3/16/99	7/27/99	4/21/00	3/16/99	7/27/99	4/21/00
RHYNCHOBDELLAE	--	--	--	--	--	--	--	--	--
Glossiphoniidae	71	--	20	--	--	--	--	--	134
Helobdella stagnalis	--	--	--	--	--	--	--	1	134
Helobdella triserialis	--	1	--	--	--	--	6	--	--
Piscicolidae	--	--	--	--	--	--	--	--	--
Myzobdella lugubris	1	--	--	4	--	--	--	--	--
OLIGOCHAETA (aquatic worms)	--	--	--	--	--	--	--	--	--
TUBIFICIDA	--	--	--	--	--	--	--	--	--
Naididae	776	12,740	--	1,866	2,957	--	2,139	941	2,419
Tubificidae	71	196	--	--	--	--	--	--	--
ARTHROPODA (arthropods)	--	--	--	--	--	--	--	--	--
ARACHNIDA (eight-legged arthropods)	--	--	--	--	--	--	--	--	--
ACARI (water mites)	988	2,744	60	252	1,277	--	1,603	1,294	67
MALACOSTRACA (crustaceans)	--	--	--	--	--	--	--	--	--
AMPHIPODA (scuds, sideswimmers)	8,542	588	423	2,778	336	207	8,665	647	672
Corophiidae	--	--	--	--	--	--	--	--	--
Corophium sp.	73	196	--	--	--	--	--	--	--
Crangonyctidae	--	--	--	--	--	--	--	--	--
Crangonyx sp.	--	--	--	--	--	--	427	--	605
Synurella sp.	--	--	20	--	--	--	--	--	--
Gammaridae	--	--	--	--	--	--	--	--	--
Gammarus sp.	1,411	--	1,634	907	--	3,664	--	--	2,823
Hyalellidae	--	--	--	--	--	--	--	--	--
Hyalella azteca	7,415	3,137	3,830	4,842	4,302	1,359	5,994	5,711	6,922
DECAPODA (crayfishes, shrimps)	--	--	--	--	--	--	--	--	--
Cambaridae	1	--	3	--	1	--	--	--	2
Cambarellus shufeldtii	--	--	--	--	68	--	--	1	--
Palaemonidae (prawns and river shrimps)	--	--	--	--	--	--	--	--	--
Palaemonetes kadiakensis	1	--	--	4	--	--	6	2	--
Palaemonetes paludosus	2	4	2	6	3	2	1	1	--
Palaemonetes sp.	--	1	--	--	--	69	--	--	--
ISOPODA (aquatic sow bugs)	353	--	--	--	--	--	--	--	--
Asellidae	--	--	--	706	--	--	535	--	134
Caecidotea sp.	564	--	81	707	2	--	1,390	1	1,478
MYSIDA (opossum shrimps)	--	--	--	--	--	--	--	--	--
Mysidae	--	--	--	--	--	--	--	--	--
Taphromysis louisianae	80	--	202	--	--	484	--	--	--
INSECTA (insects)	--	--	--	--	--	--	--	--	--
COLEOPTERA (beetles)	--	--	--	--	--	--	--	--	--
Curculionidae (weevils)	76	1	--	--	74	--	323	61	--
Dytiscidae (predaceous diving beetles)	--	--	--	--	--	--	--	--	--
Colymbetinae**	--	--	--	--	--	--	--	--	--
Agabini***	--	--	--	--	--	--	--	--	--
Ilybius sp.	--	--	--	--	--	--	--	1	--

Appendix 2. Taxa and abundances of aquatic invertebrates in richest-targeted habitat at selected sites in the Barataria Preserve, Jean Lafitte National Historical Park and Preserve, Louisiana, 1999–2000.—Continued

[Abundances of aquatic invertebrates are rounded to the nearest whole number and reported as organisms per square meter. --, species not collected; *, Suborder; **, Subfamily; ***, Tribe]

Taxonomic Heirarchy[1] PHYLUM CLASS ORDER Family *Genus species*	Tarpaper Canal near Keyhole 6 (site 1)			Pipeline Canal west of Crown Point (site 2)			North Twin Canal (site 3)		
	3/16/99	7/27/99	4/21/00	3/16/99	7/27/99	4/21/00	3/16/99	7/27/99	4/21/00
Matini***	--	--	--	--	--	--	--	--	--
Matus sp.	--	1	--	--	--	--	108	--	--
Cybistrinae**	--	--	--	--	--	--	--	--	--
Cybister fimbriolatus	--	--	--	--	--	--	1	--	--
Cybister sp.	--	2	--	2	4	2	2	--	1
Hydroporinae**	--	--	--	--	--	--	--	--	--
Bidessini***	71	--	--	--	--	--	--	--	--
Hydrovatini***	--	--	--	--	--	--	--	--	--
Hydrovatus sp.	--	--	--	1	69	--	3	1	--
Methilinae**	--	--	--	--	--	--	--	--	--
Celinini***	--	--	--	--	--	--	--	--	--
Celina sp.	--	--	--	--	--	--	--	1	--
Haliplidae (crawling water beetles)	--	--	--	--	--	--	--	--	--
Haliplus sp.	--	--	--	--	--	--	--	1	--
Peltodytes sexmaculatus	--	--	--	1	--	--	--	13	--
Hydraenidae (minute moss beetles)	--	--	--	--	--	--	--	--	--
Hydraena sp.	--	--	--	--	--	23	108	--	--
Hydrophilidae (water scavenger beetles)	--	--	--	--	--	--	108	--	--
Derallus altus	--	--	--	--	--	--	3	--	--
Enochrus sp.	--	--	--	3	--	--	2	--	1
Helobata larvalis	--	--	--	--	--	--	2	--	--
Paracymus sp.	--	--	--	--	--	--	3	--	--
Noteridae (burrowing water beetles)	--	--	--	--	--	--	--	176	--
Hydrocanthus sp.	3	2	--	2	2	--	3	3	--
Notomicrus sp.	--	--	--	50	--	--	--	--	--
Suphisellus bicolor	--	--	--	--	5	--	--	--	--
Scirtidae (marsh beetles)	4	--	--	153	--	--	215	--	--
Staphylinidae (rove beetles)	--	--	--	50	--	--	--	--	--
COLLEMBOLA (springtails)	635	--	--	101	67	23	855	235	--
DIPTERA (true flies)	--	--	--	--	--	--	--	--	--
Brachycera*	71	--	--	--	--	--	109	--	--
Ephydridae (shore and brine flies)	--	1	--	--	--	--	--	--	67
Sciomyzidae (marsh flies)	--	--	--	--	--	--	2	--	--
Stratiomyidae (soldier flies)	--	--	--	--	--	--	--	--	67
Stratiomyinae**	--	--	--	--	--	--	--	--	--
Hedriodiscus/Odontomyia sp.	2	2	--	1	--	--	--	2	--
Nematocera*	--	--	--	--	--	--	--	--	--
Ceratopogonidae (biting midges, no-see-ums)	71	197	40	51	--	--	--	--	--
Ceratopogoninae**	--	--	--	--	--	--	--	--	--
Bezzia/Palpomyia sp.	--	393	--	50	134	--	321	588	--
Dasyheleinae**	--	--	--	--	--	--	--	--	--
Dasyhelea sp.	--	393	--	--	--	--	108	353	--
Chironomidae (midges)	2	3	--	13	2	--	--	--	--
Chironominae**	--	--	--	302	134	--	--	--	--

Appendix 2. Taxa and abundances of aquatic invertebrates in richest-targeted habitat at selected sites in the Barataria Preserve, Jean Lafitte National Historical Park and Preserve, Louisiana, 1999–2000.—Continued

[Abundances of aquatic invertebrates are rounded to the nearest whole number and reported as organisms per square meter. --, species not collected; *, Suborder; **, Subfamily; ***, Tribe]

Taxonomic Heirarchy[1] PHYLUM CLASS ORDER Family *Genus species*	Tarpaper Canal near Keyhole 6 (site 1)			Pipeline Canal west of Crown Point (site 2)			North Twin Canal (site 3)		
	3/16/99	7/27/99	4/21/00	3/16/99	7/27/99	4/21/00	3/16/99	7/27/99	4/21/00
Chironomini***	71	--	--	--	--	--	641	118	67
Chironomus sp.	--	--	--	--	--	--	--	--	134
Cryptochironomus sp.	71	--	--	--	--	--	--	--	--
Dicrotendipes sp.	--	--	--	50	--	--	--	59	--
Endochironomus sp.	212	196	242	1,462	202	92	535	--	2,688
Glyptotendipes sp.	--	--	40	--	--	--	--	--	336
Goeldichironomus sp.	--	--	40	50	67	--	214	--	874
Parachironomus sp.	282	--	20	1,411	874	161	641	412	336
Polypedilum sp.	--	392	--	50	941	--	214	59	--
Zavreliella sp.	--	196	--	--	403	--	--	176	--
Tanytarsini***	--	--	--	--	--	--	--	59	--
Micropsectra/Tanytarsus sp.	71	196	--	151	--	--	--	59	--
Tanytarsini genus "A"	--	--	--	--	67	--	108	118	67
Tanytarsus sp.	--	784	--	--	67	--	1,711	59	--
Orthocladiinae**	--	--	--	--	--	--	--	--	--
Cricotopus trifascia group	--	--	--	--	--	92	--	--	--
Cricotopus sp.	--	392	--	1,260	67	--	--	--	67
Limnophyes sp.	71	--	--	--	--	--	108	--	--
Nanocladius sp.	141	--	--	202	--	--	--	--	--
Rheocricotopus sp.	--	--	--	50	--	--	--	--	--
Tanypodinae**	--	196	20	--	67	--	--	--	--
Pentaneurini***	--	--	40	--	--	--	--	--	--
Ablabesmyia sp.	212	--	--	--	605	--	427	353	67
Labrundinia sp.	--	1,176	40	--	1,478	138	214	176	336
Larsia sp.	--	1,176	--	--	336	--	--	118	--
Monopelopia sp.	--	--	--	--	67	--	--	118	--
Culicidae (mosquitos)	--	--	--	51	--	--	--	--	--
Culex sp.	--	--	--	--	--	--	--	--	67
Psychodidae (moth flies)	--	--	--	--	--	--	322	--	--
EPHEMEROPTERA (mayflies)	--	--	--	--	--	--	--	--	--
Baetidae	--	--	20	--	67	46	--	--	--
Callibaetis sp.	3	203	20	55	135	--	114	239	67
Caenidae	--	--	--	--	--	--	--	--	--
Caenis diminuta	6	4	--	2	--	--	--	177	--
Caenis sp.	--	2,744	--	2	4,906	--	1,389	2,176	875
HEMIPTERA (true bugs)	--	--	--	--	--	--	--	--	--
Belostomatidae (giant water bugs)	--	--	2	--	--	25	--	--	72
Belostoma lutarium	--	1	--	--	3	--	--	2	--
Belostoma sp.	--	--	--	--	--	--	1	--	--
Corixidae (water boatmen)	423	196	81	101	67	115	108	118	202
Trichocorixa sp.	18	8	--	4	--	23	6	1	--
Gerridae (water striders)	--	--	--	--	--	--	--	--	--
Neogerris hesione	--	--	--	--	--	1	--	--	--
Naucoridae (creeping water bugs)	--	--	20	--	--	--	--	--	--
Pelocoris femoratus	2	1	--	1	--	--	4	2	4
Pelocoris sp.	--	--	20	--	--	--	--	2	--

Appendix 2. Taxa and abundances of aquatic invertebrates in richest-targeted habitat at selected sites in the Barataria Preserve, Jean Lafitte National Historical Park and Preserve, Louisiana, 1999–2000.—Continued

[Abundances of aquatic invertebrates are rounded to the nearest whole number and reported as organisms per square meter. --, species not collected; *, Suborder; **, Subfamily; ***, Tribe]

Taxonomic Heirarchy[1] PHYLUM / CLASS / ORDER / Family / *Genus species*	Tarpaper Canal near Keyhole 6 (site 1)			Pipeline Canal west of Crown Point (site 2)			North Twin Canal (site 3)		
	3/16/99	7/27/99	4/21/00	3/16/99	7/27/99	4/21/00	3/16/99	7/27/99	4/21/00
Nepidae (water scorpions)	--	--	--	--	--	--	--	--	--
Ranatra australis	--	--	--	--	--	--	1	--	--
Ranatra nigra	--	--	--	4	--	--	--	--	--
Ranatra sp.	--	--	5	--	--	5	--	59	--
Pleidae (pigmy back swimmers)	--	1	--	--	--	23	--	--	--
Veliidae (broad-shouldered water striders)	--	196	--	--	--	--	--	--	202
Microvelia pulchella	--	196	--	--	--	--	--	--	--
Platyvelia brachialis	--	--	--	--	--	--	1	--	--
LEPIDOPTERA (aquatic caterpillars)	--	196	60	50	67	69	--	--	134
Pyralidae	5	--	--	--	--	--	217	--	--
ODONATA (damsel/dragonflies)	--	--	40	--	--	23	--	118	134
Aeshnidae (darners)	--	--	--	--	--	--	--	--	--
Anax junius	--	--	--	--	--	--	2	--	--
Coenagrionidae	--	588	162	605	202	719	214	823	1,215
Coenagrion/Enallagma sp.	--	--	21	--	--	--	--	--	4
Enallagma signatum	--	--	--	1	2	--	--	--	--
Enallagma sp.	--	3	--	5	--	8	--	118	--
Ischnura posita	--	--	--	--	--	--	6	--	--
Ischnura ramburii	--	--	--	1	--	--	--	--	--
Ischnura sp.	73	1	20	6	1	10	4	--	67
Telebasis byersi	--	--	--	--	--	--	1	--	--
Libellulidae	--	196	--	--	--	--	--	59	--
Erythemis simplicicollis	5	5	--	1	2	--	2	2	1
Erythemis sp.	--	--	--	2	--	--	--	2	--
Pachydiplax longipennis	1	--	1	--	--	--	7	--	2
TRICHOPTERA (caddisflies)	--	--	--	--	--	--	--	--	--
Hydroptilidae (microcaddis)	--	--	--	--	--	--	--	--	--
Hydroptila sp.	--	--	--	--	202	--	--	--	--
Orthotrichia sp.	--	196	--	--	67	--	--	--	--
Leptoceridae	--	--	--	--	--	--	--	--	--
Oecetis cinerascens	1	--	--	--	--	--	--	1	--
Oecetis sp.	--	1	40	--	68	--	--	59	--
TOTAL ABUNDANCE	24,727	58,475	7,329	19,034	31,090	7,544	41,501	20,241	23,748

[1]Aquatic invertebrate community data and taxonomy used in this report are presented in alphabetical order and are taxonomically representative (spelling and taxonomic heirarchy) of data provided by the U.S. Geological Survey National Water Quality Laboratory, Lakewood, Colorado.

Appendix 3. Taxa and abundances of aquatic invertebrates in depositional-targeted habitat at selected sites in the Barataria Preserve, Jean Lafitte National Historical Park and Preserve, Louisiana, 2000.

[Abundances of aquatic invertebrates are rounded to the nearest whole number and reported as organisms per square meter. --, species not collected; *, Suborder; **, Subfamily; ***, Tribe]

Taxonomic Heirarchy[1] PHYLUM CLASS ORDER Family Genus species	Tarpaper Canal near Keyhole 6 (site 1) 4/21/00	Pipeline Canal west of Crown Point (site 2) 4/21/00	North Twin Canal (site 3) 4/21/00
MOLLUSCA (clams, oysters, squids, octopods, snails, and limpets)	--	--	--
GASTROPODA (snails, limpets)	--	--	--
PROSOBRANCHIA*	--	2	--
ANNELIDA (segmented worms)	--	--	--
OLIGOCHAETA (aquatic worms)	--	--	--
TUBIFICIDA	--	--	--
Naididae	6	--	--
Tubificidae	28	10	2
POLYCHAETA (marine worms)	--	--	--
TEREBELLIDA	--	--	--
Ampharetidae	--	--	--
Hobsonia florida	4	5	--
ARTHROPODA (arthropods)	--	--	--
ARACHNIDA (eight-legged arthropods)	--	--	--
ACARI (water mites)	2	--	--
MALACOSTRACA (crustaceans)	--	--	--
AMPHIPODA (scuds, sideswimmers)	--	7	--
Crangonyctidae	4	--	--
Hyalellidae	--	--	--
Hyalella azteca	4	--	--
MYSIDA (opossum shrimps)	--	--	--
Mysidae	--	--	--
Taphromysis louisianae	2	--	--
INSECTA (insects)	--	--	--
DIPTERA (true flies)	--	--	--
Ceratopogonidae (biting midges, no-see-ums)	--	--	--
Ceratopogoninae**	--	--	--
Sphaeromias sp.	--	--	3
Chironomidae (midges)	--	--	--
Chironominae**	--	--	--
Chironomini***	--	2	--
Chironomus sp.	4	10	2
Tanytarsini***	--	--	--
Tanytarsus limneticus	2	3	--
Tanypodinae**	--	--	--
Coelotanypodini***	--	--	--
Clinotanypus sp.	2	--	--
ODONATA (damsel/dragonflies)	--	--	--
Coenagrionidae	2	--	--
TOTAL ABUNDANCE	60	39	7

[1]Aquatic invertebrate community data and taxonomy used in this report are presented in alphabetical order and are taxonomically representative (spelling and taxonomic heirarchy) of data provided by the U.S. Geological Survey National Water Quality Laboratory, Lakewood, Colorado.

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