Waterway System. These stations ranged from the mouth of the North Shore Channel to the confluence of the CSSC and the Cal-Sag Channel, then extended eastward to the Calumet River. This report contains information on the numbers and weights of fish collected and the quality of the streams.

As part of this same study, MWRDGC conducted surveys of benthic macroinvertebrates during 1989-1991 at sampling stations throughout this same stretch. Sampling was conducted with a Ponar Grab. The results of these surveys are described in MWRDGC (1990) and Polls, et al. (1991; 1992).

Commonwealth Edison has three power generating stations along the lower reaches of the study corridor. To determine a relationship between thermal discharges from power stations and aquatic plant and animal communities, the utility company initiated ecological studies of the lower waterway system. Data from several of the reports generated from these studies have been reviewed and are cited. These include the results of fisheries investigations (EA Engineering, Science & Technology, 1992, 1994, 1995; Lawler, Matusky & Skelly Engineers, 1993); aquatic macrophytes (Environmental Science and Engineering, 1994a); and benthic invertebrates (Environmental Science and Engineering, 1994b, 1995).

STUDY RESULTS

Reach 1: West Fork of the North Branch of the Chicago River

Wetlands Characterization

NWI identified 127 wetlands, totaling 291.5 acres, within the study corridor in Reach 1. Although a variety of wetland types occurred in the study area, numerically the most abundant wetland types were POWGx (52 wetlands), PEMC/PEMCd (32 wetlands), and PFO1C (18 wetlands). These wetlands ranged from 0.1 to 26.27 acres and averaged 2.3 acres. The largest wetland type in Reach 1 was L1OWGx (2 wetlands), which covered 43.2 acres.

Currently, 178 wetlands, totaling 355.5 acres, exist within Reach 1, representing nearly 22 percent more wetlands than were mapped by NWI in 1981 (Table 15). Five wetlands originally mapped by NWI are larger by approximately 1.1 acres, and one wetland is approximately 2 acres smaller due to filling. Only one NWI wetland (PFO1C, 0.7 acres) no longer exists. This loss represents less than a 1-percent decrease in the number of originally mapped wetlands. A total of 52 unmapped wetlands, totaling 64.7 acres and averaging 1.2 acres per wetland, were identified. Numerically, the most abundant, previously unmapped wetlands are POWGx (26 wetlands) and PEMC (12 wetlands).

In total area, the most extensive wetland types are POWGx/POWG (143.6 acres; 40 percent of the total wetland acreage), PEMC (62.2 acres; 18 percent), L1OWGx (43.2 acres; 15 percent), and PFO1C (50.2 acres; 17 percent).

Four wetlands were field-checked. One is no longer present, and the others are classified as PEMC, PFO1C, and PFO/SS1A wetland types. Herbaceous plant species typical of these wetland types include blue flag iris, reed canary grass, common reed, blue vervain, dark green bulrush, and wool grass. Commonly occurring trees and shrubs include red ash, white oak, swamp white oak, bur oak, common buckthorn, and American elm.

Fishes and Benthic Invertebrates

During August and September 1993, a total of 183 fish, representing 14 species at 4 stations in Reach 1, were collected (Figure 4). The collection of an Iowa Darter, a State-threatened species at Station 1, was the most significant species found.

For all sampling stations in Reach 1, green sunfish, fathead minnows, and bluegills were the most abundant species collected, representing 33 percent, 22 percent, and 10 percent of the combined collections, respectively. The largest collection (170 individuals; 93 percent of the total) was made at Station 2. No fish were collected at Station 4; 8 were collected at Station 1, and 5 fish were collected at Station 3 (Table 8).

In 1976, the Metropolitan Water Reclamation District of Greater Chicago (MWRDGC) conducted fish sampling in Reach 1 at Dundee Road (Station 51, Figure 4) (Brigham et al., 1978). A total of 69 fish, comprised of 5 species and one hybrid shiner, were collected (Table 9). Green sunfish, fathead minnows, and pumpkinseed represented 96 percent of the total collected. Green sunfish was the most abundant species, representing 43 percent of the total number of fish collected (Brigham et al., 1978).

In 1980 and 1981, MWRDGC collected fish at two sites in Reach 1 (Figure 4) (Schmeelk, 1984, 1985). All fish were collected with electrofishing gear. Combined collections made at Deerfield Road (Station 280) consisted of fathead minnows and green sunfish. These two species, plus goldfish, carp, bluegills, large mouth bass, golden shiners, and carp x goldfish hybrids, were collected at Dundee Road (Station 51) over the two-year sampling period. Green sunfish, the most abundant species collected at both stations, represented 50 percent of the combined sample in 1980 and 61 percent of the combined sample in 1981 (Tables 10 and 11). Hite and Bertrand (1989) classified this reach as a Class D stream (limited aquatic resource), based on IBI or MBI scores.

During August and September 1993, 14 major groups of macroinvertebrates, comprised of 111 individual organisms, were collected from the four stations in Reach 1. The most abundant groups were Mollusca (23 percent), Hemiptera (21 percent), Coleoptera (14 percent), Isopoda (12 percent), Zygoptera (12 percent), Neuroptera (5 percent), and Trichoptera (4 percent). Based on the number of organisms and taxa collected, an MBI value was calculated for each station in Reach 1. Index values ranged from 5.6 to 6.1, which indicated a community of moderately pollution-tolerant species (Table 12).

A freshwater sponge (Porifera) collected at Station 4 could not be identified. Some sponge species are tolerant of highly

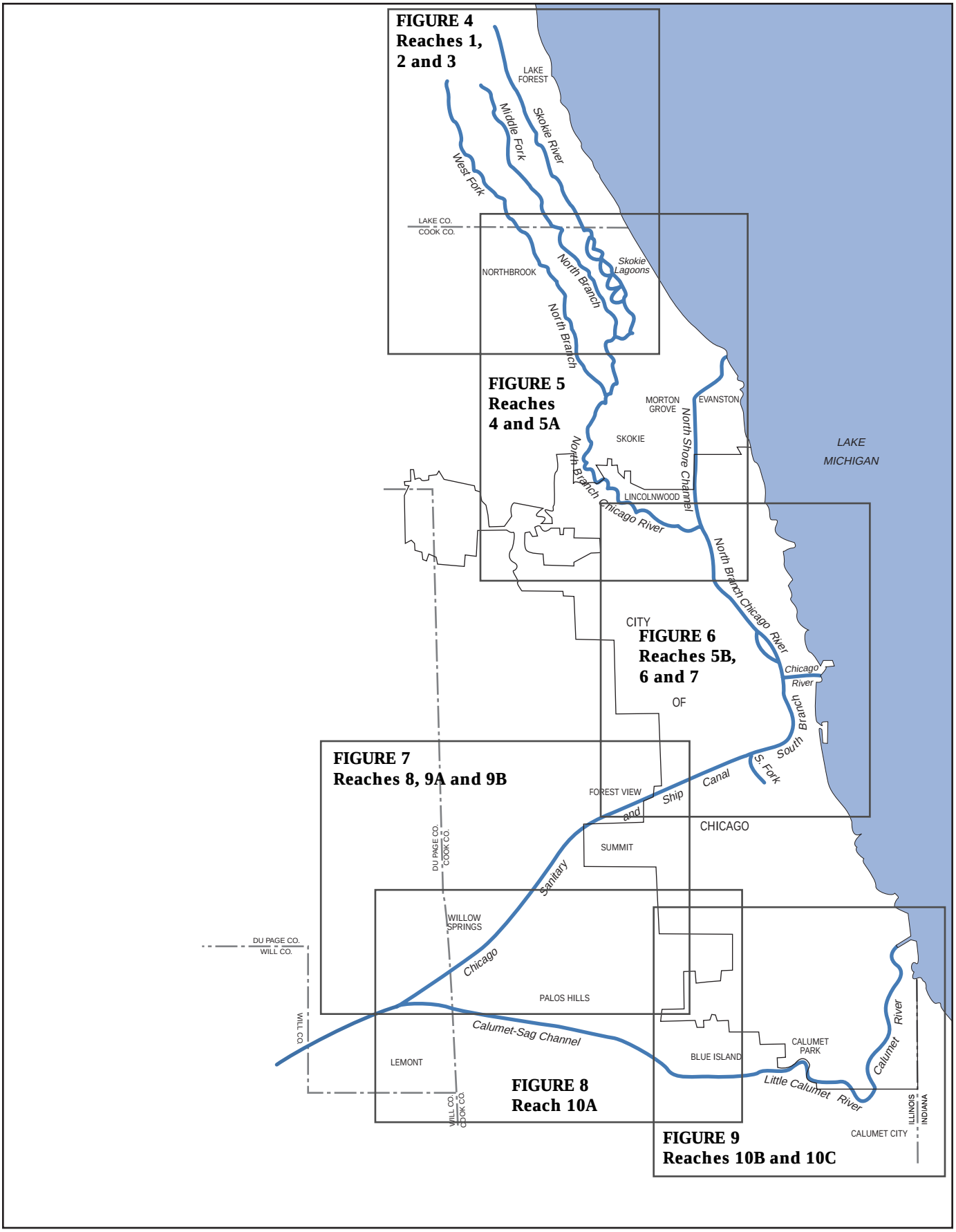

FIGURE 3
Map of Study Reaches with Location of Survey Sampling Site and Wetland Area Maps

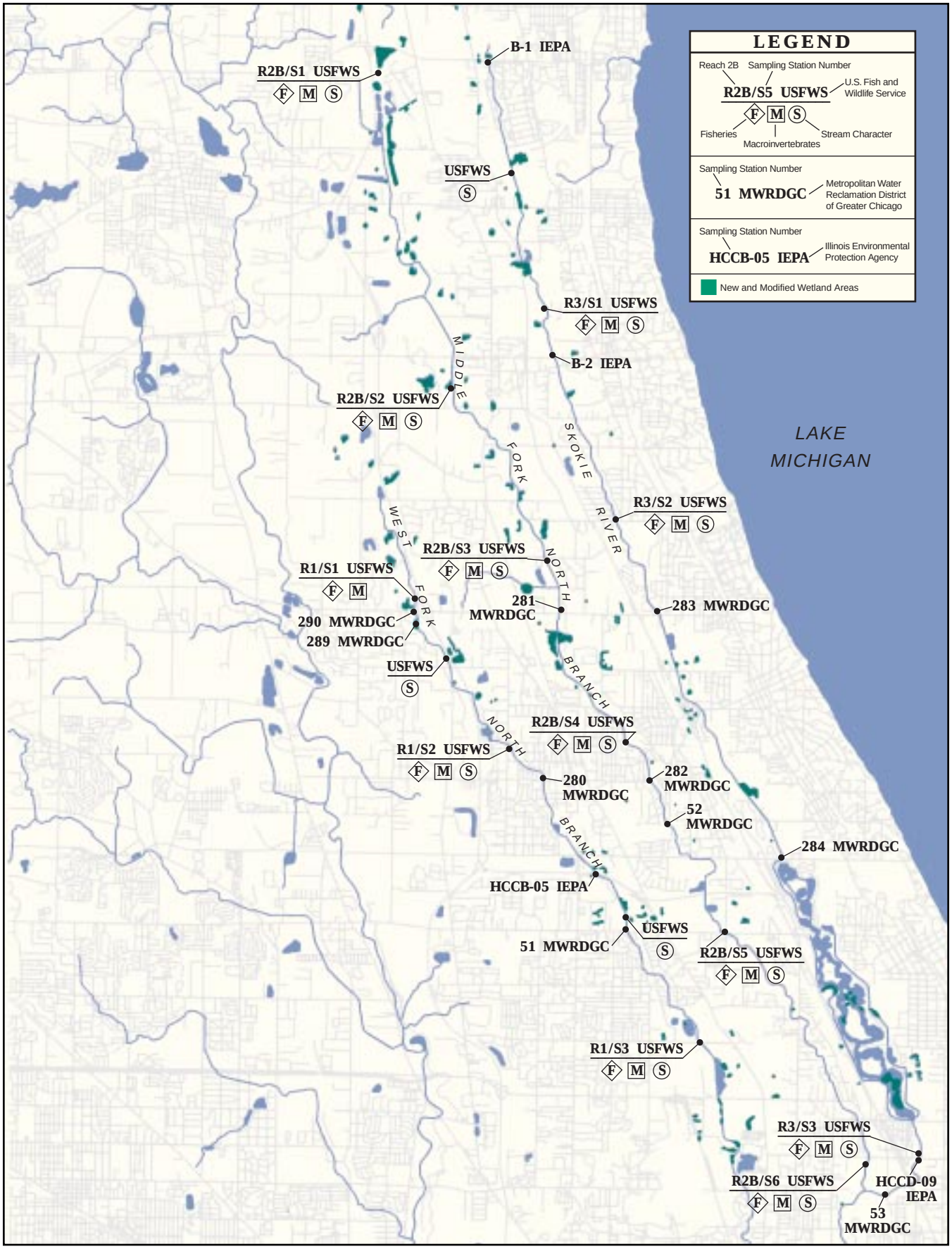

FIGURE 4
Survey Sampling Sites and Wetland Areas, Reaches 1, 2 and 3

eutrophic conditions, living in water with high coliform and siltation levels and low oxygen levels, but there are many species that cannot tolerate heavily polluted waters.

In 1983, IEPA staff sampled macroinvertebrates in the West Fork of the Chicago River at a site located near Dundee Road (Station 05) as part of a study of the DesPlaines River Basin (Figure 4). Eight taxa were recorded. Aquatic sowbugs (Isopoda) of the genus Caecidotea, snails of the genus Physa, and fingernail clams of the family Sphaeriidae were the dominant organisms. These represented 63 percent of the total macroinvertebrates collected (IEPA, 1988) (Table 13). The calculated MBI value for this collection was 6.6, which indicated a community of moderately tolerant species.

Waterway Characterization

Reach 1 (West Fork of the North Branch of the Chicago River) has been channelized and highly modified over the years. The headwaters of Reach 1 is a very narrow, shallow ditch with brush-lined banks. The banks are composed chiefly of clay with some rock mixed with silt. The bank heights vary from 4 feet to 10 feet and average 8 feet. The slope of the banks averages 35 degrees with no artificial stabilization evident. Water depths average 18 inches in August 1993. The substrate is composed primarily of silt at all six stations. Both silt and gravel substrates were recorded farther downstream at Station 4 (Figure 5).

The in-stream cover for fish and aquatic invertebrates in Reach 1 is quite diverse and includes submerged tree roots, logs, and aquatic vegetation. Concrete pieces were observed at one station (Table 3). Throughout much of the reach, the tree canopy cover over the channel varies from 20 percent (sparse) to 70 percent (dense) and averages 40 percent (moderate) (Figures 4 and 5). Conditions at Station 4 represent the lowest extreme of canopy cover. A golf course is situated on both sides of the stream and turf extends to the streambank. Elsewhere silver maple, box elder, American elm, and white mulberry are the dominant trees and shrubs that form the canopy along the channel banks. Typical herbaceous plants include reed canary grass, giant ragweed, purple loosestrife, and tall goldenrod (Table 14).

Natural Areas and Other Natural Land Features

There is relatively little natural area or dedicated open space along the Lake County portion of the West Fork North Branch Chicago River. The sole LCFPD holding is a 79-acre parcel known as the Bannockburn site, located at I-94 and Duffy Lane. This is the site of Reservoir 27, a regional flood control project constructed by the Army Corps of Engineers in 1990. There is no developed access to the site.

Somme Woods, a 375-acre site, lies within the Cook County portion of Reach 1. This site extends eastward to the Middle Fork North Branch Chicago River (Reach 2B). Additional FPDCC holdings, contiguous with Somme Woods, extend southward along the Middle Fork, and are discussed in the Reach 2B section of this document.

The 70-acre Somme Prairie Nature Preserve is located within Somme Woods. Major plant communities found in this area are marsh, wet prairie, mesic prairie, and oak savanna. The prairie communities of pre-settlement quality support conservative native prairie plant species, such as leadplant, cream false indigo, prairie brome, prairie gentian, hoary puccoon, and prairie phlox.

Approximately 454 acres of dedicated natural open space, representing approximately 5 percent of the total land area within the corridor segment, exists within Reach 1 (Table 6).

Recent records exist for four State-listed threatened or endangered plant species in the vicinity of the Chicago River in Reach 1 (Table 7). Most species are found on protected forest preserve land. There are no recent records identifying federally listed species in this reach.

Reach 2A: Middle Fork of the North Branch of the Chicago River (Skokie River to West Fork)

Wetlands Characterization

In 1981, NWI identified and mapped 17 wetlands, totaling 66.2 acres, within Reach 2A. Although a variety of wetland types occurred in the study area, numerically the most abundant wetland types shown on the NWI were PFO1A (11 wetlands) and POWGx (5 wetlands). These wetlands ranged between 0.2 and 26.3 acres and averaged 3.9 acres. The most extensive wetland type in Reach 2A was PFO1A, which covered 63.6 acres. One wetland (PEMA) in Reach 2A was a linear wetland, totaling 0.15 linear miles.

Seven previously unmapped wetlands, totaling 10.5 acres and averaging 1.5 acres per wetland, were identified. Numerically, the most abundant, previously unmapped wetland types are PFO1A, PFO1C, and PFO1C/PEMC (6 wetlands). With the addition of the 17 wetlands that NWI mapped, there are currently 24 wetlands, totaling 76.7 acres, that occur within the study corridor in Reach 2A. This represents a total wetland acreage that is 16 percent larger than mapped by NWI (Table 15). In total, the most extensive wetland types are PFO1A (66.4 acres; 87 percent acreage) and POWGx (3.2 acres; 4 percent acreage).

Three wetlands, representing PEMC, PFO1C/PEMC, and PFO1A wetland types, were field-checked. Some of the characteristic species of herbaceous plants recorded at these sites include sweetflag, fowl mannagrass, narrow-leaved cattail, broadleaf arrowhead, hop sedge, and water parsnip. Common trees and shrubs in the area are shagbark hickory, red ash, and American elm.

Fishes and Benthic Invertebrates

In 1980, MWRDGC collected fish on two separate dates at a sampling station at Glenview Road (Station 285, Figure 5) (Schmeelk et al., 1984). All fish were collected using electrofishing gear. Green sunfish, carp, and fathead minnows were the only species collected at this station. Green sunfish was the most abundant species, representing 73 percent of the total collection (Table 10).

Sampling on two separate dates in 1981 by MWRDGC at the Glenview Road station yielded largemouth bass, black crappies, and pumpkinseeds, as well as the species collected in 1980. Green sunfish was again the most abundant species recorded at this station, representing 96 percent of the sample (Table 11) (Schmeelk et al., 1985). Hite and Bertrand (1989) classified this reach as a Class D stream (limited aquatic resource), based on IBI and MBI values.

During August 1993, only 6 fish were collected, representing six species collected at two stations in Reach 2A (Figure 5; Table 8). All were common species adaptable to a wide range of environmental conditions.

Six major groups of macroinvertebrates, comprised of 62 individual organisms, were collected in Reach 2A (Table 12). The five most abundant groups were Trichoptera (42 percent), Crustacea (34 percent), Megaloptera (10 percent), Hemiptera (8 percent), and Zygoptera (5 percent). The caddisfly *(Hydropsyche sp.)* was the most abundant organism. This genus is commonly associated with freshwater habitats that have an adequate oxygen supply and running water. The calculated MBI values for Stations 1 and 2 are 4.9 and 5.1, respectively, which are indicative of moderately tolerant species.

In 1984, IEPA staff sampled macroinvertebrates in the Middle Fork of the Chicago River at a site near Golf Road (Station 04, Figure 5) (IEPA, 1988). Eight taxa were recorded. Isopoda, Trichoptera, Ephemeroptera, and Mollusca were the most abundant taxa collected (Table 13). The calculated MBI value for the collection was 6.6, which is within the moderately tolerant range. Represented in the collection were genera of mayflies (Ephemeroptera), which are somewhat less pollution-tolerant than other species.

Waterway Characterization

The stream channel at the Glenview Road station in Reach 2A was characterized. At the time of the assessment (March 1994), the stream was at high flow with water depths ranging from 3.5 feet to 4 feet. The bank slope was 2 degrees on the left and 45 degrees on the right. The bank was composed mainly of clay and sand, and was not artificially stabilized. The substrate was composed of silt and sand.

In Reach 2A, the in-stream cover is comprised of undercut banks, submerged tree roots and aquatic vegetation (Table 3). Total canopy cover over the channel is 60 percent (dense) (Figure 5). Some of the dominant trees and shrubs comprising the canopy cover are cottonwood, swamp white oak, American elm, and green ash. Some of the herbaceous plants are bur sedge, hop sedge, yellow swamp buttercup, blue flag iris, Virginia wild rye, and moneywort (Table 14).

Natural Areas and Other Natural Land Features

FPDCC lands form a continuous corridor along the entire 3-mile length of Reach 2A. Forest Preserve District holdings total 650 acres and include Blue Star Memorial Woods, Glenview Woods, Camp Glenview, and Harms Woods. This represents approximately 34 percent of the total area within the Reach 2A corridor (Table 6). There are no INAI sites, dedicated Illinois Nature Preserves, or records of threatened or endangered species in Reach 2A.

Reach 2B: Middle Fork of the North Branch of the Chicago River (headwaters to Skokie River)

Wetlands Characterization

NWI identified and mapped 170 wetlands, totaling 555.2 acres, within the study corridor in Reach 2B. Although a variety of wetland types occurred in the study area, the most abundant wetland types were POWHx (59 wetlands), PEMC (32 wetlands), PFO1C (13 wetlands) and PEMF (12 wetlands). The wetlands ranged in size from 0.1 to 47.2 acres and averaged 3.5 acres. The most extensive wetland type in Reach 2B was POWHx, which covered 142.5 acres. Nine of the wetlands in Reach 2B were linear, totaling 0.35 linear miles.

Of the 170 wetlands originally mapped by NWI, nine totaling 9.6 acres no longer exist, leaving 161 wetlands (545.6 acres). This represents less than a 1-percent decrease in the number of originally mapped NWI wetlands. Sixty-six previously unmapped wetlands, totaling 122.5 acres and averaging 1.9 acres per wetland, were identified.

The most abundant previously unmapped wetlands identified were POWGx (34 wetlands) and PFO1C (11 wetlands). With the addition of the 66 wetlands, there are currently 227 wetlands, totaling 668.1 acres that occur within Reach 2B. This represents a 20-percent increase in total wetland acreage compared to the original NWI mapping (Table 15).

As previously stated, POWHx, PEMC, PFO1C, and PEMF are the most abundant wetland types in Reach 2B. In total area, the most extensive wetland types are POWGx/POWHx (188.4 acres; 28 percent of the total acreage), PFO1C (152.6 acres; 23 percent), PEMC (110.0 acres; 16 percent), and PFO1A (87.4 acres; 13 percent) (Table 15).

Thirty-seven wetlands, representing PAB4F, PEMA, PEMC, PFO1C, and PFO1A wetland types, were field-checked. Some of the characteristic species of herbaceous plants recorded at these sites were small water plantain, blue joint grass, water hemlock, blue flag iris, reed canary grass, blue vervain, dark green rush, and wool grass. Commonly occurring trees and shrubs were box elder, silver maple, white ash, white oak, swamp white oak, bur oak, common buckthorn, and American elm.

In 1991 and 1993, faunal surveys were conducted at the Middle Fork Savanna for the LCFPD (Mierzwa and Beltz, 1994). Thirteen species of amphibians and reptiles were either collected or observed (Table 17). The most abundant species was the blue-spotted salamander *(Ambystoma laterale)*, which comprised 28 percent of the total collection. Larvae of five of the most common species were collected from wetlands in the project area.

Fishes and Benthic Invertebrates

In 1976, MWRDGC collected fishes from a single sampling site (Station 52, Figure 4) in Reach 2B (Brigham et al., 1978).

The total collection included green sunfish, fathead minnows, and bluegills. Green sunfish represented 67 percent of the total collection (Table 9).

In 1980, MWRDGC electrofished Reach 2B for two days at Half Day Road and Route 22, and at Lake Cook Road (Stations 281 and 282, Figure 4) (Schmeelk, 1984). Eight fish species and one hybrid were collected. The collection at the upstream location consisted of four species. Downstream at the Lake Cook station, seven species and one hybrid were collected. Green sunfish was the most abundant species, representing 63 percent of the total collection (Table 10).

In 1981, MWRDGC again sampled fish at both stations (Schmeelk, 1985). Seven species and one hybrid were collected at the upstream Station 281, and 11 species were collected at the downstream Lake Cook Station 282. As in 1980, green sunfish was the most abundant species collected at both sites, representing 61 percent of the sample (Table 11). Hite and Bertrand (1989) classified this reach as a Class D stream (limited aquatic resource), based on IBI and MBI scores.

In May 1993, fish sampling was included as part of a faunal survey conducted at the Middle Fork Savanna for the LCFPD (Mierzwa and Beltz, 1994). This collection consisted of six species, with fathead minnows representing 91 percent of the sample (Table 16). During this study, 15 major groups of benthic invertebrates, comprised of 365 individual organisms at six stations in Reach 2B were collected. The five most abundant groups were Crustacea (53 percent), Hemiptera (14 percent), Coleoptera (8 percent), Mollusca (6 percent), and Trichoptera (4 percent). The calculated MBI values for Stations 1-6 ranged from 5.3 to 6.4 (Table 12), which reflected a community of moderately pollution-tolerant species.

During August and September 1993, a total of 171 fish, representing 15 species at 6 stations in Reach 2B, were collected (Figure 4). Green sunfish, bluegill, and white sucker represented 33 percent, 19 percent, and 16 percent, respectively. The largest collection (102 individuals; 60 percent of total) was made at Station 6. No fish were collected at Station 1 (Table 8).

Waterway Characterization

Reach 2B has been channelized and highly modified. Bank heights at six stations ranged from 2 to 9 feet and averaged 7 feet. Slopes ranged from 7 degrees to 80 degrees and averaged 40 degrees.

Similar to the other upper reaches, banks are not stabilized and their composition is predominantly clay mixed with silt, rock, or gravel. The channel substrate, similar to Reaches 1 and 2A, consists of gravel, sand, and silt. The water depths in the channel ranged from 4 inches to 3 feet during low flow conditions in August 1993.

Compared to stations on Reaches 1 and 2A, the six stations on Reach 2B have more diverse in-stream cover (Table 3). Average tree canopy cover is 85 percent (very dense). Characteristic streambank trees and shrubs include box elder, silver maple, American elm, swamp white oak, cottonwood, common buckthorn, red-osier dogwood, and pale dogwood. Herbaceous species include the exotic garlic mustard, purple-leaved willow herb, spotted-touch-me-not, purple loosestrife, and narrow-leaved cattail (Table 14).

Natural Areas and Other Natural Land Features

Four LCFPD holdings are located along the Lake County portion of the Middle Fork North Branch Chicago River. These holdings total 995 acres and are Berkeley Prairie, Middle Fork Savanna, Lake Forest Preserve, and the Atkinson Road Reservoir (Table 6).

Berkeley Prairie is an 18-acre mesic and wet-mesic prairie remnant of moderate natural quality located south of Berkeley Avenue near Deerfield. It is currently managed by the LCFPD and volunteers, using prescribed burning and seed collection as the primary management activities.

Middle Fork Savanna extends 2.7 miles from Route 176 on the north to Route 60 on the south. This 478-acre site is the most biologically significant site within Reach 2B, and perhaps within the entire region. It contains a representative community type (rich savanna, Midwest type) that is considered globally endangered. Some consider it one of the two best remaining examples of tall grass savanna in the world. A variety of baseline biotic inventories of the site have been conducted, including inventories of mammals, birds, herptiles, beetles, and vascular and non-vascular vegetation (for citations see Mierzwa and Beltz, 1994).

Lake Forest Preserve, centered north and south of Route 22 along the Middle Fork on 431 acres, consists of recently abandoned agricultural land, old field, degraded and partially drained wetlands, and small tracts of oak woodland. The portion of the preserve south of Route 22 is currently being restored to wetland, prairie, and savanna communities as part of the ChicagoRivers Demonstration Project. The area north of Route 22 has been proposed as a possible site for a regional flood control project.

Atkinson Road Reservoir, also Station 15, is a 69-acre site located north of Atkinson Road. This site has been developed by the Army Corps of Engineers as a regional flood control project. There is no public access to this site.

Perhaps the most significant undeveloped tract not in public ownership in this reach is the parcel known as the Wrigley tract, managed and owned by Abbott Laboratories. This site, located north of Route 137 and west of Route 43, includes native wet and wet-mesic prairie, sedge meadow, marsh, and oak woodland. This site has important natural area and wildlife habitat values.

Three contiguous FPDCC Preserves are situated along the Middle Fork North Branch Chicago River in Cook County. Somme Woods, discussed in Reach 1, spans the area between the West and Middle Forks. Chipilly Woods and Sunset Ridge Woods, totaling approximately 280 acres, are located south of Somme Woods.

Four INAI sites and three dedicated nature preserves are within or adjacent to Reach 2B (Tables 4 and 5). Approximately 1,300 acres of dedicated natural open space exist within the Reach 2B corridor, representing approximately 10 percent of the total area in this segment.

Recent records exist for four State-listed endangered and threatened plant species in the vicinity of the Chicago River in Reach 2B, one of which is also listed as a federally threatened species (Table 7). Most of these species are found on protected forest preserve land.

Reach 3: Skokie River

Wetlands Characterization

NWI identified and mapped 177 wetlands, totaling over 600.2 acres. Although a variety of wetland types were shown in the study area, the most abundant wetland types were POWGx (59 wetlands), PFO1A (28 wetlands), PEMC (22 wetlands), and PEMF (17 wetlands). These wetlands ranged from 0.1 to 41.8 acres, and averaged 3.4 acres. The most extensive wetland type in Reach 3 was PFO1A (28 wetlands), covering 261.3 acres.

Only one of the wetlands originally mapped by NWI (4.8 acres) no longer exists. This loss represents less than a 1-percent decline in the number of originally mapped wetlands. Twenty-six previously unmapped wetlands, totaling 50.3 acres and averaging 1.9 acres per wetland, were identified. Of these, 13 wetlands are constructed ponds (POWx). Fifteen wetlands originally mapped by NWI have been modified. With the addition of the 26 wetlands, there are currently 202 wetlands, totaling 676.4 acres, that occur within Reach 3. This total is 13 percent larger than the area mapped by NWI (Table 15).

The most extensive wetland types in the area are PFO1A (261.3 acres or 39 percent of the total wetland acreage), POWGx (72.4 acres or 11 percent of the total wetland acreage), and PSS1A (68.5 acres or 10 percent of the total wetland acreage). More than 50 percent of the new wetlands are POWGx.

Fourteen wetlands were field-checked. Most of these wetlands are either PEMC or PEMF. Characteristic herbaceous plant species recorded at these sites include big bluestem, crested oval sedge, common tussock sedge, reed canary grass, dark green rush, sawtooth sunflower, spotted touch-me-not, wild bergamot, and yellow coneflower. Commonly occurring trees and shrubs are box elder, cottonwood, sandbar willow, and black willow.

There are no known rookeries in the immediate vicinity of Reach 3. Several great egrets and black-crowned night herons, which are State-listed endangered species, were observed roosting in trees along the banks of the Chicago River. The birds observed were likely juveniles or post-breeding adults.

Fishes and Benthic Invertebrates

In 1976, MWRDGC collected fishes from Station 53 (Figure 4) in Reach 3 (Brigham et al., 1978). The most abundant species collected were green sunfish, bluegill, goldfish, and carp, which represented 69 percent of the total collection. Green sunfish, represented 37 percent of the total number of fish collected (Table 9).

In 1980, MWRDGC made fish collections both upstream and downstream of the Skokie Lagoons (Schmeelk et al., 1984) (Figure 4). All fish were collected with electrofishing gear. Upstream of the Lagoons at Halfday Road (Station 283), six species and one hybrid were collected. Green sunfish was the only species captured at Lake Cook Road (Station 284). Downstream of the lagoons, near W. Frontage Road (Station 53), five species were collected. Green sunfish was the most abundant species, representing 49 percent of the total number of fish collected (Table 10).

Additional fish collections were made by MWRDGC in 1981. All the species collected at Halfday Road (Station 283) in 1980 were again collected in 1981, with the addition of golden shiner and black crappie (Schmeelk et al., 1985). At Lake Cook Road, three species were collected. Downstream of the Lagoons, seven species and one hybrid comprised the sample. Green sunfish was the most abundant species, representing 50 percent of the total number of fish collected (Table 11). Hite and Bertrand (1989) have classified various sections of this reach as a Class C (moderate aquatic resource) or Class D (limited aquatic resource) stream, based on IBI and MBI scores.

During August and September 1993, a total of 88 fish, representing 9 species at 3 stations in Reach 3, were collected (Figure 4). Young of the year black bullheads, carp, and bluegills comprised 63 percent, 15 percent, and 7 percent of the total collections, respectively, and represented approximately 85 percent of the total. The largest collection of fishes (63 individuals, 72 percent of the total) was made at Station 3 (Table 8).

During the MWRDGC study, nine major groups of macroinvertebrates, comprised of 103 individual organisms from three stations in Reach 3, were collected. The five most abundant groups of macroinvertebrates were Crustacea (37 percent), Hirudinea (17 percent), Mollusca (16 percent), Hemiptera (14 percent), and Coleoptera (5 percent). All of the taxa collected were moderately pollution-tolerant, which was reflected in the 6.2 to 6.5 MBI scores (Table 12).

Benthic invertebrate sampling was conducted at stations in the Skokie Lagoons in 1976 by the Illinois State Water Survey (Butts and Evans 1978). Aquatic worms (Oligachaeta) and midges (Chironomidae) were the dominant organisms (Table 18). Both taxa are tolerant of pollution, and their dominance indicated fair to poor water quality and degraded sediment conditions within the lagoons (Butts and Evans, 1978).

In 1978, Matsunaga and Murphy (1979) conducted macroinvertebrate sampling throughout most of the Skokie River system. Macroinvertebrates were collected from 12 stations along the 23-mile-long study area, with 5 stations upstream and 1 station downstream of the Skokie Lagoons. For the five upstream stations, an average of eight macroinvertebrate

species per station was recorded. Aquatic worms (Oligachaeta), midges (Chironomidae), damselflies (Coenagrionidae), water boatmen (Corixidae), and fingernail clams (Sphaeriidae) were the dominant organisms upstream of the lagoons. Within the lagoons, aquatic worms (Oligachaeta) and midges (Chironomidae) were dominant. Downstream of the lagoons at Winnetka Road, midges and scuds (Hyalellidae) comprised 58 percent of the organisms collected (Table 19). In general, highly pollution-tolerant species tended to dominate in the soft sediments of the lagoons, whereas upstream and downstream stations also included moderately tolerant species.

In 1981, NIPC conducted a benthic macroinvertebrate survey of the Skokie Lagoons. Sampling stations were established at Clavey Road Bridge, Lagoon 7, Lagoon 4, Lagoon 1, and Willow Road. Midges *(Polypedilum sp.)* and aquatic worms *(Limnodrilus cervix, L. hoffmeisteri, Peloscolex multisetosus longidentus)* were the most common organisms collected at the sampling stations. Fingernail clams (Sphaeriidae) were found only at Clavey Road. Greatest species diversity occurred downstream of the lagoons at the Willow Road station (Kirschner, 1983) (Table 20).

In November 1983, IEPA staff sampled macroinvertebrates in the Skokie River at Willow Road (Station 09, Figure 4) as part of a study of the DesPlaines River Basin (IEPA, 1988). Three taxa were recorded. Moderately pollution-tolerant aquatic sowbugs (Isopoda) and scuds (Amphipoda) were the dominant organisms, as reflected in the 5.9 MBI score (Table 13).

The Illinois Natural History Survey (INHS) maintains voucher specimens of fish, mussels, and crustaceans collected from the Skokie River System. A July 21, 1981, fish collection consisted of black bullhead, warmouth, green sunfish, orangespotted sunfish, and largemouth bass. INHS also holds voucher specimens of two species of crayfish *(Procambarus acutus* and *Orconectes virilis)*. INHS collections also contain mussels (*Anadonta grandis* and *Toxolasma parvus)* collected from the Skokie Marsh in 1908 by Frank Collins Baker.

Waterway Characterization

The appearance and condition of the upper and lower portions of the Skokie River are characteristic of a highly modified, artificial system. Most of the upper segments of Reach 3 are linear, with few natural meanders or oxbows. The northern part of Reach 3 resembles an agricultural drainage ditch and is lined with dense brush. Throughout this reach, the instream cover for fish and other aquatic life consists of undercut banks, submerged tree roots, submerged logs, and aquatic vegetation (Table 3).

The channel substrate material does not vary appreciably in segments north of the Skokie Lagoons. This material consists primarily of silt, with occasional sand and gravel in areas of swifter current. Downstream of the lagoons, the channel substrate consists of thick silt deposits. Most of the silt deposits in the lagoons have been removed as part of a lake rehabilitation project conducted under USEPA's Clean Lakes Program.

Channel banks are generally very steep with some evidence of erosion. Bank slopes range from 5 to 45 degrees. The most severe slopes are located in the southern segments near the Chicago Botanic Gardens and immediately south of the Skokie Lagoons from Willow Road to Happ Road. The channel banks are primarily composed of hard compacted clay. The channel segments passing through Lake Forest, however, have banks composed of a mix of clay and sand. The banks of the channel at the Old Elm Road sampling station are a mix of clay, sand, and gravel (Table 3). Construction rubble is strewn on the banks and is used to a limited degree as a bank stabilizer.

Long stretches of streambank that were nearly denuded within 10 feet of the edge of the stream were observed. A thick canopy of deciduous trees is located within 30 feet of the channel, but seasonal high water levels, compact bank soil, and dense shading contribute to a lack of herbaceous growth beneath the trees. Ground cover, when present, is typically a mix of the exotic garlic mustard, riverbank grape, and poison ivy (Table 3). The Laurel Avenue fish sampling station is one of the areas where major canopy gaps persist, allowing growth of more dense vegetation.

Cottonwood, box elder, ash, and common buckthorn dominate the tree canopy. The streambanks are wooded along approximately 75 percent of the total stream length. Upstream of the lagoons, the tree canopy ranges from 75 to 90 percent, creating very shaded conditions during peak sun hours.

Natural Areas and Other Natural Land Features

Two LCFPD preserves are located within the Reach 3 corridor in Lake County. The 559-acre Greenbelt Preserve is located at the extreme headwaters of Reach 3 near Park City. The 84-acre Lake Bluff Preserve is located near Route 41, west of Lake Forest.

FPDCC lands form a continuous corridor on both sides of the river for its entire length in the Cook County portion of this reach. Most of this land consists of the Skokie Lagoons within the William E. Erickson Preserve. Other preserves include Turnbull Woods east of the Lagoons at Lake Cook Road, and additional holdings along the Skokie River at Hibbard and Winnetka Roads in Winnetka. Total acreage of these lands is approximately 1,600 acres.

As mentioned in the Human Settlement and Watershed Development section of this document, the Skokie Lagoons occupy a portion of the former Skokie Marsh. These lagoons were excavated largely by hand in the 1930's and early 1940's. As a result of erosion from agriculture and urban development, the lagoons had become significantly silted by the 1970's. This condition was exacerbated by wastewater discharges rich in organics and nutrients, causing highly eutrophic conditions. Algal blooms, low oxygen concentrations and high turbidity caused by resuspension of sediments from carp created highly degraded ecological communities.

Two actions undertaken in the 1980's have significantly improved water quality in the lagoon. First, wastewater

discharges from the Clavey Road wastewater treatment plant were diverted around the lagoons, eliminating a source of nutrients. Secondly, a grant through the USEPA's Clean Lakes Program enabled removal of much of the accumulated sediment, resulting in a deepening of the lagoons and eliminating in-place organics and flocculent sediments. The fish community was subsequently rehabilitated by removal of rough fish and stocking of sport fish. Shoreline stabilization using biotechnical techniques has been undertaken by the FPDCC and other cooperators. Plans are under development for wetland habitat enhancement within the lagoons. All of these actions have vastly improved habitat conditions within the lagoons.

Two dedicated nature preserves and seven INAI sites are located within or adjacent to the Reach 3 corridor (Tables 4 and 5). In total, approximately 2,360 acres of dedicated natural open space are found in the Reach 3 corridor. Of this acreage, 2,243 acres are dedicated Forest Preserve District lands, which represent 22 percent of the total land area in this reach.

Although not included in the natural open space land calculations, 10 golf courses are situated along the Reach 3 corridor from Waukegan south to Glencoe. The channel bisects or borders all of these courses, many of which occupy floodplains and/or former wetlands.

Records show five State-listed endangered or threatened species in or near the study corridor in Reach 3 (Table 7). One of these species is also listed as federally threatened. Most of these species occur on protected FPDCC land.

Reach 4: North Shore Channel

Wetlands Characterization

The only wetland identified in Reach 4 is R2OWHx, which is the channel proper (Table 15). This wetland reflects the highly modified and developed character of the corridor within this reach.

Several great egrets and black-crowned night herons, a State-listed endangered species, were observed roosting in trees along the channel banks. These birds may represent post-breeding adults or juveniles, although black-crowned night herons have been known to nest occasionally along the North Shore Channel (Alan Anderson, North Shore Bird Club, pers. comm.).

Fishes and Benthic Invertebrates

MWRDGC collected fish from the North Shore Channel in the mid-1970's (Brigham, 1978). Collections were made at Sheridan Road in Wilmette, Dempster Street in Skokie and Devon Avenue in Lincolnwood (Stations 57-59, Figure 5). The greatest species diversity and overall abundance of fish were recorded at the Sheridan Road station, which is the station closet to Lake Michigan. A total of 234 individuals were collected, representing 12 species and 2 hybrids. The most abundant species were bluntnose minnow, alewife, and orangespotted sunfish (Table 21).

Species diversity progressively decreased farther away from the mouth of the river at Lake Michigan. The collection made at the Dempster Street sampling station consisted only of carp, goldfish, and fathead minnows. Carp and spottail shiners were the only two species collected at Devon Avenue (Table 21).

In 1991, MWRDGC collected fishes using electrofishing gear at four sampling stations along the North Shore Channel: Sheridan Road in Wilmette, Dempster Street in Skokie, Touhy Avenue in Lincolnwood, and Peterson Avenue in Chicago (Stations 1-4, Figure 5). A total of 6,027 fish, comprised of 25 species, was collected. The predominant species was bluntnose minnow and the most important species by weight was carp. Harvestable-size fish included black bullhead, black crappie, bluegill, carp, and white sucker (Dennison et al., 1992) (Table 22). Hite and Bertrand (1989) classified this reach as a Class D stream (limited aquatic resource), based on IBI and MBI scores.

In 1989, 1990 and 1991, the MWRDGC conducted surveys of aquatic macroinvertebrates in the Chicago Waterway System (MWRDGC, 1990; Polls et al., 1991; 1992). Six sampling stations were established on the North Shore Channel: two at Linden Street in Wilmette, two at Dempster Street in Skokie, and two at Touhy Avenue in Lincolnwood (Figure 5).

In 1989, 90 species were collected at the six sampling stations, including midges, naidid worms, tubificid worms, leeches, clams, snails, and amphipods. The most abundant species were naidid worms and tubificid worms, which represented 46.6 percent and 43.9 percent, respectively, of the combined samples. The naidid worm *(Nais elinguis)* was the dominant benthic invertebrate (Table 23).

The 1990 collection consisted of 73 species with similar species composition. Numerically, naidid and tubificid worms comprised more than 96 percent of the combined sample. The naidid worms *(Nais elinguis* and *N. simplex)* were the dominant benthic invertebrates (Table 24).

In 1991, 62 species were collected. The most diverse species were naidid worms, chironomid midges, and tubificid worms. Numerically, tubificid worms and naidid worms comprised more than 94 percent of the combined samples. The naidid worms *(Dero digitata)* and the tubificid worms *(Limnodrilus hoffmeisteri* and *L. cervix)* were the dominant macroinvertebrates (Table 25). Oligochaete worms proliferate in silty, organically rich substrates, and their dominance in all collections reflected poor sediment quality.

Waterway Characterization

The stream channel and streambanks were characterized at one station representative of Reach 4 (Table 3). The physical characteristics of Reach 4 are mostly homogenous throughout the entire length. Although the North Shore Channel is entirely artificially constructed, its banks have become naturalized over time. Banks are steep, with 35- to 65-degree slopes. Bank heights range from 15 feet to 20 feet. Both banks are composed primarily of clay with no gullies or rills and minimal erosion.

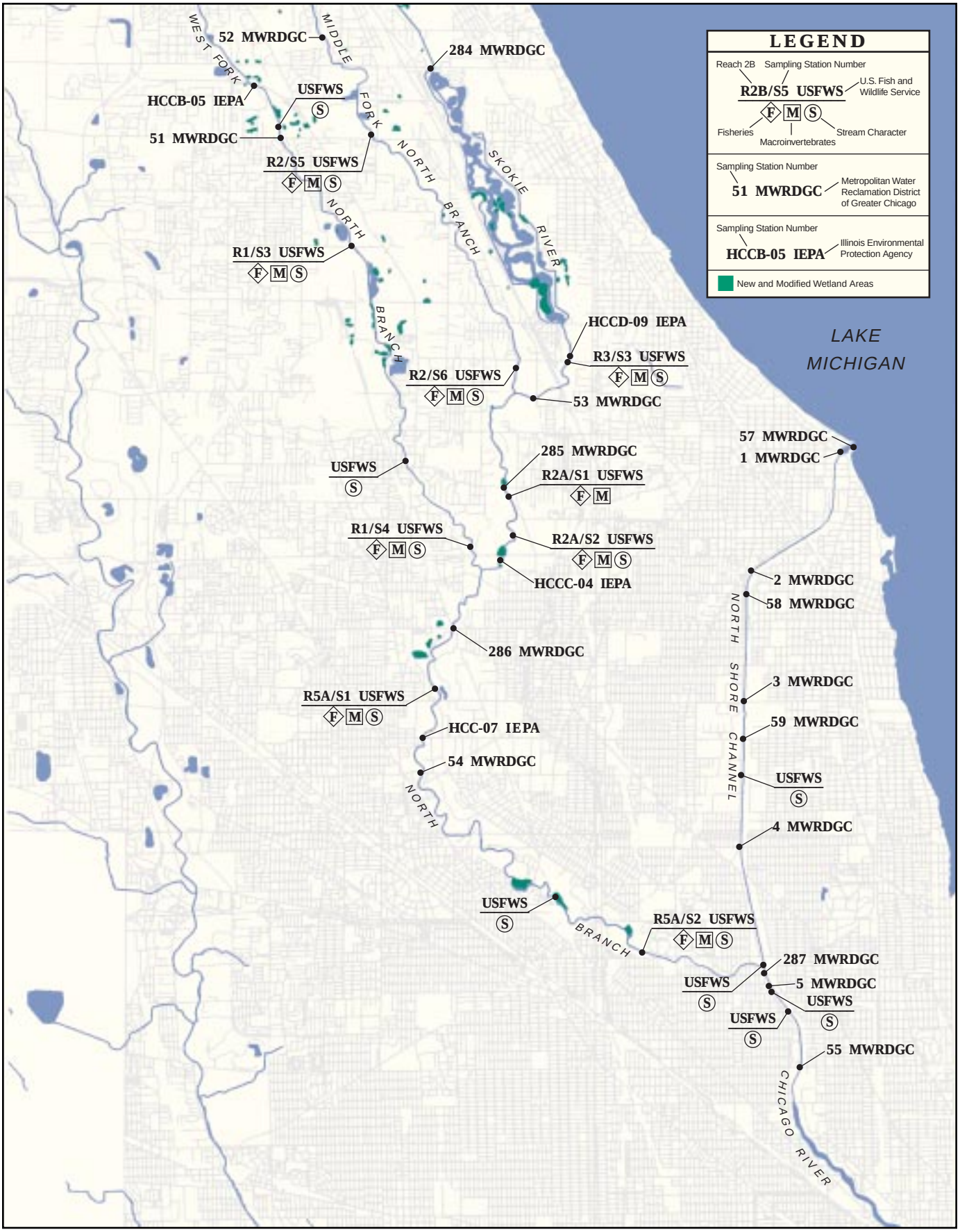

FIGURE 5
Survey Sampling Sites and Wetland Areas, Reaches 4 and 5A

Large piles of household refuse and construction debris are found on the upper portions of the banks. Most of the debris is on the east bank within the Lincolnwood and City of Chicago segments. Vegetation has overgrown several refuse piles and trees are commonly found growing through debris. Thick stands of deciduous trees, such as cottonwood, box elder, and common buckthorn, dominate the banks. Herbaceous groundcover, limited by tree shading, consists of maintained turfgrass or a mix of exotic garlic mustard, poison ivy, riverbank grape, and common buckthorn seedlings.

Undercut banks, submerged tree roots, and submerged terrestrial vegetation occur as in-stream cover. Aquatic macrophytes are frequently observed near bridge columns within the channel, and aquatic macrophyte beds are more extensive in the area above the discharge from the North Side Water Reclamation Plant (Irwin Polls, MWRDGC, pers. comm.). Aquatic flora was not sampled. The channel substrate is composed of clay overlain with silt. The canopy cover at the characterization station on Reach 4 is approximately 25 percent, and is representative of the entire reach. Most of the trees grow vertically out of the steeply inclined banks and have twisted or distorted bases.

Natural Areas and Other Natural Land Features

An open space corridor has been established along most of the 4-mile length of the North Shore Channel on land owned by the MWRDGC. Within the limits of the City of Chicago, open space is primarily parkland along the east bank. This greenway is the only open space associated with the reach, excluding city parks and ballfields. No FPDCC lands or other natural open space areas are located along this portion of the study corridor. There are no INAI sites, dedicated Illinois Nature Preserves, or recent records of State or federally listed endangered or threatened species along Reach 4.

The Ladd Arboretum is a segment of the parkland in Evanston. Recreational trails are common along and within the northern parkland areas. This 20-acre reforested area is a refuge for native songbirds. Between 1974 and 1991, naturalists from the Evanston Environmental Center recorded 132 bird species at the Ladd Arboretum, including a variety of warblers, raptors, sparrows, and thrushes.

Reach 5A: North Branch of the Chicago River (West Fork to North Shore Channel)

Wetlands Characterization

NWI identified and mapped 46 wetlands, totaling nearly 200 acres within the study corridor in Reach 5A. Although a variety of wetlands occur in the study area, numerically the most abundant wetland types are PFO1A (24 wetlands), POWG/POWH (9 wetlands), and PFO1C (6 wetlands). The wetlands range in size from 0.1 to 28 acres and average 4.3 acres. Six of the wetlands in Reach 5A are linear, and total 0.67 linear miles.

All of the wetlands originally mapped by NWI in 1981 are still present. Eight previously unmapped wetlands, totaling 111.8 acres and averaging 14.0 acres per wetland, were identified. Numerically, the most abundant previously unmapped wetlands are PEMB/C (4 wetlands) and PFO1C/A (4 wetlands). With the addition of these 8 wetlands, there are currently 54 wetlands totaling 311.4 acres within Reach 5A. This represents a total wetland area that is 56 percent larger than the area mapped by NWI (Table 15).

As previously stated, PFO1A, PFO1C, and POWG/POWH are the most abundant wetland types in Reach 5A. In total area, the most extensive wetland types are PFO1A (274.8 acres; 88 percent of the total wetland acreage), PFO1C (17.1 acres; 5.5 percent of the total wetland acreage), and POWG/POWH (2.4 acres; 0.7 percent of the total wetland acreage).

Based on a field-check, two areas are PFO1C wetland types, one of which is located in the Edgebrook Flatwoods. Flatwoods are unique forested wetland communities that form in shallow claypan depressions. These depressions collect surface runoff, and the underlying impervious clay or glacial till prevents infiltration which causes shallow seasonal ponding. Swamp white oak is the typical dominant flatwoods tree in this area.

Some of the characteristic species of herbaceous plants recorded at these sites are Virginia wild rye, fowl mannagrass, bottlebrush grass, rice cutgrass, small water plantain, Short's aster, white trout lily, blue flag iris, and water parsnip. Commonly occurring trees and shrubs are red ash, white oak, swamp white oak, common buckthorn, and spicebush.

Fishes and Benthic Macroinvertebrates

Although fish sampling was conducted at two stations in Reach 5A (Figure 5), no fish were collected at either station (Table 8). MWRDGC sampled fish populations at a single station at Touhy Avenue in Niles in the mid-1970's (Figure 5) (Brigham et al., 1978). No fish were collected despite three sampling attempts. Absence of fish was assumed to be due to degraded water conditions.

In 1980, MWRDGC made fish collections at Dempster Street in Morton Grove and at Albany Street in Chicago along the North Branch (Stations 286 and 287, Figure 5) (Schmeelk et al., 1984). Both sites are south of the Middle Fork and West Fork confluence, and north of the confluence of the North Branch and North Shore Channel. All fish were collected with electrofishing gear. These collections consisted of only carp and pumpkinseeds at Dempster Street and fathead minnows at Albany Street (Table 10).

In 1981, MWRDGC again sampled fish populations at the Dempster Street and Albany Street stations (Schmeelk, 1985). Six species were collected at Dempster Street (Station 286), with green sunfish in greatest abundance. Green sunfish was the only species collected at Albany Street (Station 287) (Table 11).

In 1990, researchers from the North American Water Quality Assessment Program (NAWQA) sampled fish populations at Hart Road in Niles. Only four species, white suckers (3), yellow bullheads (2), green sunfish (2), and largemouth bass

(1), were collected (Warren, 1991). Hite and Bertrand (1989) classified this reach as a Class D stream (limited use aquatic resource), based on IBI and MBI scores.

During the study, four major groups of benthic invertebrates, comprised of 276 organisms, were collected from Stations 1 and 2 in Reach 5A. The four most abundant groups were Crustacea (66 percent), Hirudinea (13 percent), Pelecypoda (11 percent), and Gastropoda (9 percent). The calculated MBI values in this reach were 5.3 and 6.3, which suggested a community of moderately pollution-tolerant species (Table 12).

In 1976, the Illinois State Water Survey collected benthic macroinvertebrates at nearly 100 sites in the Chicago Waterway System (Butts and Evans, 1978). One of these sites was located on the North Branch approximately 0.5 miles north of Oakton Street in Miami Woods. The collection at this site (Station 73) consisted of mayflies *(Caenis),* phantom midges *(Chaoborum* sp), unidentified chironomid midges (Chironomidae) and aquatic worms (Oligochaetae). Of the total 385 organisms collected, midges (Chironomidae) and aquatic worms (Oligochaetae) comprised 77 percent of the sample (Table 18). Both oligochaetes and chironomidae are tolerant of pollution, and their presence indicates fair to poor water quality and degraded sediment conditions at the sampled site (Butts and Evans, 1978).

In 1983, the IEPA sampled macroinvertebrates at Touhy Avenue along the North Branch (Station 07, Figure 5). A total of 94 organisms, representing 6 taxa, were collected. The most abundant taxa were flatworms (Turbellaria), aquatic sowbugs (Isopoda), and leeches (Hirudinea) (Table 13).

In 1989, IEPA again sampled for macroinvertebrates at Touhy Avenue. A total of 308 individuals, representing 22 species, were collected. The most abundant species was the isopod, *Caecidotea intermedia.* Tubificid worms and turbellarian flatworms were also abundant in the sample (Essig, 1994). The calculated MBI at this station was 6.2, indicating a community of moderately pollution-tolerant species.

NAWQA researchers collected 15 species of aquatic invertebrates at the Hart Road site in 1989 (NAWQA, 1994). The most abundant groups were isopods, leeches, and the planarian flatworms, *Cura foremanii* and *Cricipterus sp.* At the same location in 1990, the most abundant groups collected were isopods, midges, fingernail clams, and turbellarian flatworms. In addition to these species, three species of crayfish *(Procambarus acutus, Orconectes virilis,* and *O. immunis),* totaling 11 individuals, were also collected from this station (Cummings, 1990).

A review of Illinois Natural History Survey (INHS) collections identified a fish collection made at Dempster Street in 1981. This collection consisted of spotfin shiner, fathead minnow, black bullhead, green sunfish, bluegill, largemouth bass, and black crappie. Other INHS collections included the giant floater mussel collected from Dempster Street in 1992 and 1993, and the mussel *Lasmigona complanata* collected at Beckwith Road along the North Branch in 1992.

Waterway Characterization

The appearance and condition of the 10-mile-long segment of the North Branch differs from the upstream river reaches. While upstream reaches have been channelized and straightened, the channel in Reach 5A retains a sinuous, meandering pattern. Natural meanders, ox-bow lakes and backwater channels are found on FPDCC land at Miami Woods and St. Paul Woods.

The stream and channel banks at four locations (Figure 5) along the river in Reach 5A were characterized (Table 3). These are, from north to south, Oakton Street in Morton Grove (Station 1); Central Avenue (Station 2); Foster Avenue (Station 3); and near Albany Avenue (Station 4). Stations 2, 3, and 4 are located within the limits of the City of Chicago.

Bank characteristics vary throughout this reach. At Miami Woods, the west bank rises 8 to 10 feet above the river and has a slope of 35 degrees. The east bank rises only 3 feet and has a slope of less than 5 degrees. Similar bank characteristics are found at Station 2; however, the west bank is 30 to 35 feet high with a 35-degree slope, and the east bank rises 3 feet with a 5-degree slope. At Station 3, both banks rise about 4 feet above the river, but are steep, with slopes of 55 to 60 degrees. The stream banks are hand-laid limestone and brick walls approximately 400 feet south of Station 3.

Two distinct bank terraces are present at Station 4. The first set of banks closest to the river are 5 feet high and have a 35-degree slope. The second set of banks are formed by long, high-cut limestone rock and concrete walls approximately 30 feet from the edge of the river. This feature forms a box canyon channel.

Throughout the reach, channel banks are primarily composed of hard compacted clay, with silt as a minor constituent of banks at Stations 1 and 3. Engineered bank stabilization structures are not apparent along the reach. Construction rubble strewn on the banks near bridge abutments and outfalls is used for bank stabilization.

The predominant streambed material is silt. Station 1 at Oakton Street and Station 3 at Foster Avenue revealed gravel in addition to silt as a substrate component.

Dense stands of deciduous trees comprise the dominant streambank vegetation on FPDCC land, but seasonally high water levels, compacted bank soil, and dense shading have contributed to the nearly complete loss of herbaceous vegetation within these areas. Long stretches of nearly denuded banks have occurred. Dominant trees along the river include cottonwood, American elm, ash, box elder, and common buckthorn. Stands of large oaks are found at FPDCC Bunker Hill, St. Paul Woods, and Miami Woods. Groundcover is typically a mix of exotic garlic mustard, poison ivy, riverbank grape, and common buckthorn seedlings (Table 14). Dense herbaceous vegetation is present in areas where large gaps in the tree canopy exist, or where the land is being actively managed and kept open. Some examples of open areas are located near the Miami Woods Prairie, north of Oakton Street

and along a river ox-bow approximately 1/2 mile north of Devon Avenue in Chicago.

Native herbaceous vegetation becomes more prevalent and diverse beyond the 100-foot zone immediately adjacent to the river within the floodplain. Species such as prairie cord grass, yellow swamp buttercup, bur sedge, fowl mannagrass, common water plantain, blue flag iris, tall water parsnip, white vervain, and clearweed are found near Station 1 (Table 14).

The canopy along Reach 5A is variable. At Miami Woods, the dense canopy (75 percent cover) shades 80 percent of the water surface. The less dense canopy at Central Avenue provides 50 percent cover, shading 60 to 75 percent of the stream surface. Downstream at Foster Avenue near the St. Lucas Cemetery, the tree canopy is 60 percent. The channel at Station 2 is slightly wider than upstream at Oakton Street and the canopy shades only 40 percent of the water surface. Near Albany Avenue, a canopy with 50 percent total cover provides 50 percent shading of the water surface.

In-stream cover for fish and other aquatic life is very abundant in the river at all four sampling sites. Undercut banks, submerged tree roots, brush jams, submerged logs, and submerged terrestrial vegetation provide excellent escape, resting, and foraging habitat for both adult fish and fish fry, as well as attachment surfaces for aquatic macroinvertebrates (Table 3).

Natural Areas and Other Natural Land Features

FPDCC holdings total approximately 1,800 acres within Reach 5A, and include Chick Evans Golf Course, Linne Woods, Wayside Woods, Miami Woods, St. Paul Woods, Bunker Hill/Caldwell Woods, Edgebrook Woods, Billy Caldwell Golf Course, Indian Road Woods, Forest Glen, and LaBagh Woods East and West. Approximately 75 percent of the total length of the river in this reach is within forest preserve holdings. FPDCC lands comprise most of the dedicated natural open space (28 percent) within the corridor (Table 6). One dedicated nature preserve and six INAI sites are located within or adjacent to the Reach 5A corridor (Tables 4 and 5).

IDNR records show nine State-listed threatened or endangered plant species and one federally listed species along Reach 5 (Table 7).

Reach 5B: North Branch of the Chicago River (North Shore Channel to Chicago River)

Wetlands Characterization

There are no wetlands within the study corridor in Reach 5B except for the channel proper. These wetlands are designated R2OWHx and total 133.9 acres (Table 15). All other wetlands have long since been converted to urban uses.

Fishes and Benthic Invertebrates

In 1976, MWRDGC collected fishes from Reach 5B between Montrose and Wilson, a short distance downstream from its confluence with the North Shore Channel. The collection consisted of only one of each of four species (goldfish, black bullhead, bluegill, and black crappie) and seven specimens of the carp/goldfish hybrid (Table 21) (Brigham et al., 1978).

While electrofishing at this same general location in 1991 (Wilson Avenue sampling Station 5), MWRDGC collected 16 species and 3 hybrid combinations (Figure 6). At Grand Avenue (Station 6), 10 species were collected as part of this same sampling program. The combined collections at these two stations consisted of 568 individuals of 16 species (Table 26). The most abundant species was the goldfish, and carp was the dominant species by weight (Dennison et al., 1992).

In 1989, 1990, and 1991, MWRDGC conducted surveys of aquatic macroinvertebrates in the Chicago Waterway System. Four sampling stations were established on the North Branch of the Chicago River: two at Wilson Avenue and two at Grand Avenue (MWRDGC, 1990; Polls et al., 1991; 1992) (Figure 6).

The 1989 collection consisted of 34 species, including 16 species of naidid worms, 10 species of tubificid worms, and 8 species of fingernail clams. The most abundant species were the naidid worm *(Dero digitata)*, the tubificid worm *(Limnodrilus hoffmeisteri)*, the clam *(Sphaerium corneum)*, and the isopod *(Caecidotea intermedia)* (Table 27).

The 1990 collection consisted of 45 species, including 11 species of naidid worms, 10 species of tubificid worms, 10 species of midges, 8 species of fingernail clams, 3 species of leeches, and 3 species of snails. The most common benthic invertebrate in Reach 5B was the tubificid worm *(Quistadrilus multisetosus)*, the naidid worm *(N. elinguis)*, and the tubificid worm *(L. hoffmeisteri)* (Table 28).

In 1991, a total of 54 species were collected, including 11 species of tubificid worms, 14 species of naidid worms, 11 species of fingernail clams, 9 species of midges, and 3 species of leeches. Predominant benthic organisms were the tubificid worms (*L. hoffmeisteri* and *Quistadrilus multisetosus)* (Table 29). All of the dominant species in the 3 years of collections were moderately to highly tolerant of organic pollution and tended to be found in poor quality environments with silty, organically rich substrates.

Waterway Characterization

Reach 5B, which is entirely within the limits of the City of Chicago, has been modified and channelized. The stream and channel banks at three stations along this reach are characterized as stable, composed primarily of clay with silt substrates. Bank heights range from 8 to 20 feet and average 16 feet; bank slopes range from 30 degrees to 90 degrees and average 45 degrees. Sheet piling is used for additional stabilization in places. Water depths in the channel range from 8 to 13 feet (Table 3).

Compared to the other stations on the upper reaches, the three stations on Reach 5B have the smallest variety of in-stream cover. The tree canopies average 15 percent (very sparse) coverage. Deciduous trees (80 percent) and shrubs (20 percent) dominate the riparian vegetation on both banks of the river.

FIGURE 6
Survey Sampling Sites and Wetland Areas, Reaches 5B, 6 and 7

Natural Areas and Other Natural Land Features

Reach 5B includes portions of the river in the City of Chicago that have been intensively developed for residential, commercial, and industrial purposes. There are no natural areas or forest preserves located along this stretch of the river, nor are there records of known threatened or endangered species. However, several city parks comprise the only open space within this reach.

Reach 6: Chicago River

Wetlands Characterization

No wetlands exist within Reach 6 except for the channel proper, which is classified as R2OWHx.

Fishes and Benthic Invertebrates

In 1976, MWRDGC sampled fish populations with electrofishing gear at Station 60 located at the Chicago Locks (Figure 6) (Brigham et al., 1978). A total of 209 individuals, representing 14 species, were collected. Rock bass, bluntnose minnow, and alewife were the most abundant species. By contrast, a downstream sample at Station 67, located near the confluence of the North and South Branches (Reach 7), showed only 43 individuals, representing 5 species. Goldfish, alewife, and carp were the most abundant species collected (Table 21).

The higher water quality at the sampling station nearest Lake Michigan was due to the diversion of lake water into the Chicago Waterway System. This higher water quality accounted for the disparity in collection size, diversity, and percentage of intolerant species between the two collections. The influence of Lake Michigan water rapidly decreased as the water flowed downstream until only a degraded fishery remained (Brigham et al., 1978).

In 1991, MWRDGC conducted fish sampling at two stations in Reach 6: one in the Loop (Station 19) and one in the Inner Harbor (Station 18, Figure 6). The total catch at both stations was 1,196 fish, composed of 23 species and 2 hybrid combinations (Table 30). The bluntnose minnow was the most abundant species and carp was the most abundant species by weight (Dennison et al., 1992).

The differences between the two stations was reflected in the IBI values. Based on four separate collection dates, Station 18, nearest Lake Michigan, had a maximum IBI of 38 (Class C stream, moderate aquatic resource) and a minimum IBI of 26. Station 19, the more inland station, had a maximum IBI score of 30 (Class D Stream, limited aquatic resource) and a minimum IBI of 22.

In 1989, 1990, and 1991, the MWRDGC conducted surveys of aquatic macroinvertebrates at two sampling stations near the mouth of the river at Outer Drive (Figure 6) (MWRDGC, 1990; Polls, et al., 1991; 1992). Nineteen species were collected from these sites in 1989, including 7 species of tubificid worms, 5 species of midges, 4 species of naidid worms, 2 species of leeches, and one clam species. The dominant species was the tubificid worm *(Quistadrilus multisetosus)* (Table 31). The 1990 collection effort revealed 22 species, including 9 species of tubificid worms, 5 species of midges, 4 species of naidid worms, 2 species of leeches, and one clam species. The most abundant species was the tubificid worm *(Quistadrilus multisetosus)* (Table 32).

In 1991, 32 species were identified from the two sites, including 10 species of tubificid worms, 9 species of midges, 8 species of naidid worms, and 5 species of clams. The most abundant species were the tubificid worm *(Q. multisetosus)* and the naidid worm *(Vejdovskyella intermedia)* (Table 33). The dominance of these species indicated poor sediment quality.

Waterway Characterization

Reach 6 is situated entirely within downtown Chicago and extends from Wolf Point to the mouth of the Chicago River at Chicago Harbor. The total water surface of the channel is 47.7 acres. There is no natural vegetation present within this reach. The river is completely contained within sheet piling and bulkheads, behind which is high-rise commercial and residential development.

Natural Areas and Other Natural Land Features

There are no natural areas, forest preserves, or records of known Federal or State-listed threatened or endangered species located along Reach 6 of the Chicago River.

Reach 7: South Branch of the Chicago River and South Fork of the South Branch of the Chicago River

Wetlands Characterization

NWI identified and mapped two wetlands located within the study corridor in Reach 7. The channel proper is mapped as R2OWHx, totaling 101.3 acres. The only other mapped wetland is an excavated pond classified as POWHx (Table 15). The absence of natural wetlands or other water bodies within this reach is due to the long history of industrial use.

Fishes and Benthic Invertebrates

In 1976, MWRDGC sampled fish populations in this reach using electrofishing gear at Station 67, which extended from Kinzie Street on the north to Randolph Street on the south (Figure 6) (Brigham et al., 1978). The northern end of this sample station actually extended into Reach 5B, but is considered because of the potential effect of Lake Michigan water on the sample as a whole. Only 43 individuals, representing 5 species and 1 hybrid combination, were collected. Goldfish, alewife, and carp were the most abundant species collected (Table 21).

In 1989, 1990, and 1991, MWRDGC sampled at two stations (Jackson Boulevard and South Branch) in Reach 7 for benthic macroinvertebrates (Figure 6) (MWRDGC, 1990; Polls et al., 1991, 1992). In 1989, the combined collection for the reach consisted of 23 species, comprised of 9 species of tubificid worms, 4 species of naidid worms, 3 species of midges, 3 species of clams, 2 species of leeches, and 2 species of

snails (Table 35). In 1990, 21 species were collected, including 8 species of tubificid worms, 4 species of clams, 3 species of naidid worms, 2 species of midges, and 2 species of leeches (Table 36). In 1991, 23 species were collected, including 8 species of tubificid worms, 4 species of clams, 4 species of naidid worms, and 5 species of midges (Table 37). The dominant species collected in all three years were the tubificid worms *(Limnodrilus hoffmeisteri* and *Quistadrilus multisetosus)* and the fingernail clam *(Sphaerium corneum).* All of the species collected are tolerant of degraded sediment conditions except for the fingernail clam, which has broad ecological tolerances but is considered relatively intolerant of pollution.

In 1991, MWRDGC collected fish with electrofishing gear in Reach 7 at Station 20, located at the junction of the North and South Branches of the Chicago River (Figure 6). The combined collection at both Stations 20 and 67 was 548 individuals, composed of 17 species and 1 hybrid combination (Table 34). The most abundant species was the gizzard shad. Carp was the most abundant species by weight (Dennison et al., 1992). The maximum IBI of 4 sampling dates for this site was 32 (Class C stream, moderate aquatic resource), although the remaining 3 samples each had IBI scores of 22. No individual collection had fewer than 7 species.

The Commonwealth Edison thermal discharge study established three fish sampling stations within this reach (Stations 101-103). Fish were collected by electrofishing and gill netting. A total of 60 individual fish were collected during 1993, representing 12 species and 1 hybrid. Largemouth bass, green sunfish, and bluntnose minnow were the most abundant species collected (EA Engineering, Science and Technology, 1994).

As part of the Commonwealth Edison thermal discharge study, a benthic macroinvertebrate investigation was conducted in the southern reaches of the Chicago River (Stations 1 and 2). The most abundant groups collected were tubificid and naidid worms, and chironomid midges (Environmental Science & Engineering, Inc., 1994).

Waterway Characterization

Years ago, the South Branch of the Chicago River was channelized to accommodate barge and commercial boat traffic. The stream channel and channel banks are unstable and mainly devoid of vegetation due to industrialized development up to the edge of the river. Banks are composed primarily of clay and rock and the substrate is primarily silt (Table 3). Tree cover is sparse (approximately 5 percent) and consists of scattered cottonwood and box elder. The slopes at the assessment stations are approximately 25 degrees on both banks. In-stream cover visible from the surface is limited, although beds of aquatic vegetation have begun to re-establish, responding presumably to improvements in water quality.

In 1992 and 1993, an aquatic macrophyte study was conducted for the Commonwealth Edison Company. Narrow fringing communities of aquatic vegetation were found along the main channel border. Sago pondweed and water milfoil were the dominant species of submersed aquatic vegetation, followed by curlyleaf pondweed and eelgrass (Environmental Science & Engineering, Inc., 1994a).

Some of the dominant species of submersed aquatic vegetation identified through the Commonwealth Edison study included common arrowhead, narrow-leaved cattail, common reed, and river bulrush. Other species collected included reed canary grass, rice cutgrass, purple loosestrife, and common cattail.

Natural Areas and Other Natural Land Features

There are no natural areas or forest preserves located along Reach 7 of the Chicago River.

The peregrine falcon *(Falco peregrinus),* listed as both federally and State endangered, has been successfully reintroduced into the South Loop area as part of the Chicago Peregrine Release and Restoration Project. Since 1986, captive bred falcons have been released at a number of locations in northeastern Illinois (and at other midwestern locations). Falcons have occupied a territory at 125 South Wacker Drive since 1987, and have successfully fledged young at least five times since that time.

Reach 8: Chicago Sanitary and Ship Canal (Ashland Avenue to Interstate 55)

Wetlands Characterization

NWI identified and mapped 33 wetlands, totaling 480.0 acres. Of the total area, the canal proper is comprised of 330.6 acres and is designated R2OWHx. Although a variety of wetland types occur in the study area, the most abundant wetland types are POWKh (11 wetlands) and POWHx (5 wetlands). Excluding the canal, the wetlands range from 0.1 - 22.1 acres and average 5.1 acres. The largest non-riverine wetland type is POWKh, covering 113.4 acres. Three of the wetlands in Reach 8 are linear, totaling 0.59 linear miles.

Two wetlands mapped by NWI, totaled 0.6 acres, but are no longer present. This represents a loss of less than 1 percent of the originally mapped wetlands, leaving 31 wetlands (479.4 acres). Three previously unmapped wetlands, totaling 3.2 acres and averaging 1.1 acres per wetland, were identified and classified as PEMA, PEMC, and POWGx. Currently, there are 34 wetlands totaling 482.6 acres within Reach 8, representing an area less than 1 percent greater than originally mapped by NWI (Table 15). POWKh, POWHx, and POWKHx are numerically the most abundant non-riverine wetland types and also have the greatest areal coverage (128.02 acres, or 26.5 percent of the total wetland acreage).

Fishes and Benthic Invertebrates

MWRDGC sampled fish populations in 1976 using electrofishing gear at Station 48 near Cicero Avenue (Table 21) (Brigham et al., 1978). Only four species (alewife, goldfish, carp, and black crappie) and one hybrid, totaling 17 individuals, were collected.

In 1989, MWRDGC sampled benthic macroinvertebrates at 10 stations in the Chicago Sanitary and Ship Canal (CSSC), which corresponded to Reaches 8, 9A, and 9B (Fig. 14) (MWRDGC, 1990). A total of 49 species were collected from all 10 stations, including 15 species of naidid worms, 11 species of tubificid worms, 8 species of clams, 7 species of midges, 5 species of snails, and 3 species of leeches. The tubificid worms were numerically the most abundant species. Predominant benthic organisms were the tubificid worms *(Quistadrilus multisetosus* and *L. hoffmeisteri),* the fingernail clams *(S. corneum* and *Pisidium casertaneum),* and the naidid worm *(Dero digitata)* (Table 39).

In 1990, sampling at these 10 stations resulted in a total collection of 45 species, including 15 species of naidid worms, 9 species of tubificid worms, 8 species of leeches, 7 species of clams, 4 species of midges, and 2 species of snails. The tubificid worms were numerically the dominant species. Predominant benthic organisms were the tubificid worm *(L. hoffmeisteri)* and the naidid worm *(Naias elinguis)* (Table 40) (Polls et al., 1991).

In 1991, MWRDGC again sampled benthic macroinvertebrates at the 10 stations. A total of 49 species were collected, including 14 species of naidid worms, 11 species of tubificid worms, 9 species of fingernail clams, 6 species of leeches, 5 species of midges, and 4 species of snails. The tubificid worms were numerically the dominant species. Predominant benthic organisms were the naidid worm *(Naias elinguis)* and tubificid worms *(L. hoffmeisteri* and *Q. multisetosis)* (Table 41) (Polls et al., 1992).

The dominance of tubificid and naidid worms indicates a community of pollution-tolerant species. However, the abundance of fingernail clams, which are tolerant of a broad range of ecological conditions, but tend to be relatively intolerant of pollution, may suggest that conditions are improving in this portion of the waterway.

In 1991, MWRDGC collected fish at Station 7, Damen Avenue; Station 8, Cicero Avenue; and Station 9, Harlem Avenue (Figure 7). The total catch was 1,908 individuals, composed of 18 species and 1 hybrid combination (Table 38). The most abundant species was the bluntnose minnow; carp was the dominant species by weight (Dennison et al., 1992). The IBI score of four separate collection dates ranged from a high of 30 (Class D stream, limited aquatic resource) to a low of 22.

Nine fish sampling stations (Stations 104-106 and 201-206) were established in this reach as part of Commonwealth Edison's thermal discharge study. In 1993, a total of 3,417 fish were collected by electrofishing and gill netting. The most abundant species were bluntnose minnow, gizzard shad, and largemouth bass (EA Engineering, Science and Technology, 1994).

Waterway Characterization

The bank heights at the three sampling stations range from 8 to 40 feet, with steep slopes occurring at all three stations. The composition of the banks includes clay, rock, gravel, sand, silt, and sheet pilings. At two stations, the banks are stabilized with sheet piling or rock and the bottom substrate is primarily silt (Table 3). Although there is riparian vegetation along the shoreline, it does not form an appreciable canopy over the canal, nor does it contribute to any in-stream cover. Cottonwood and box elder are the dominant trees and garlic mustard is the most abundant herbaceous plant.

Aquatic macrophyte beds can be found in channel border locations in this reach. In 1992 and 1993, surveys of aquatic macrophytes were conducted for Commonwealth Edison. The "Waterway Characterization" section in Reach 7 summarizes the findings for Reach 8 (Environmental Science and Engineering, Inc., 1994a).

Natural Areas and Other Natural Land Features

The Reach 8 study corridor has largely been developed for industrial and commercial uses. The only dedicated natural open spaces within the corridor is Chicago Portage Woods and a portion of Ottawa Trail South, which are FPDCC holdings along the Des Plaines River where it joins the CSSC. The total area of these preserves within the study corridor is approximately 80 acres (Table 6). Only 2 percent of the total corridor in this reach is dedicated natural open space. There are no INAI sites or nature preserves in this reach, nor are there any records of known federally or State-listed endangered or threatened species.

Reach 9A: Chicago Sanitary and Ship Canal (Interstate 55 to Calumet-Sag Channel)

Wetlands Characterization

NWI identified and mapped 100 wetlands, totaling 1,594.4 acres. Of this total, 1,069.7 acres included the I&M Canal, the Des Plaines River, and the CSSC. These wetlands were distributed among 15 mapping polygons and designated R2OWHx. Excluding the river channel and canals, the most abundant wetland types were POWKh (32 wetlands, primarily diked lagoons), PEMC (13 wetlands), and POWHx (8 wetlands). These wetlands ranged from 0.2 to 45.9 acres and averaged 6.4 acres. Six linear water bodies, primarily small streams, were classified as R2OWHx and totaled 3.43 linear miles (Table 15).

Two of the wetlands originally mapped by NWI, totaling 10.7 acres, are no longer in existence, leaving 98 wetlands (1,583.7 acres). This loss represents a decline of less than 1 percent of NWI originally mapped wetlands. Four previously unmapped wetlands, totaling 5.6 acres and averaging 1.4 acres per wetland, were identified. One wetland was 1.52 acres larger than originally mapped. With the addition of these 4 wetlands, there are currently 102 wetlands, totaling 1,589.3 acres within Reach 9A. This represents a total wetland area slightly larger (less than 1 percent) than the wetlands originally mapped by NWI.

Those wetlands with the greatest total areal coverage are R2OWHx (1,069.7 acres; 67.1 percent of total wetland and

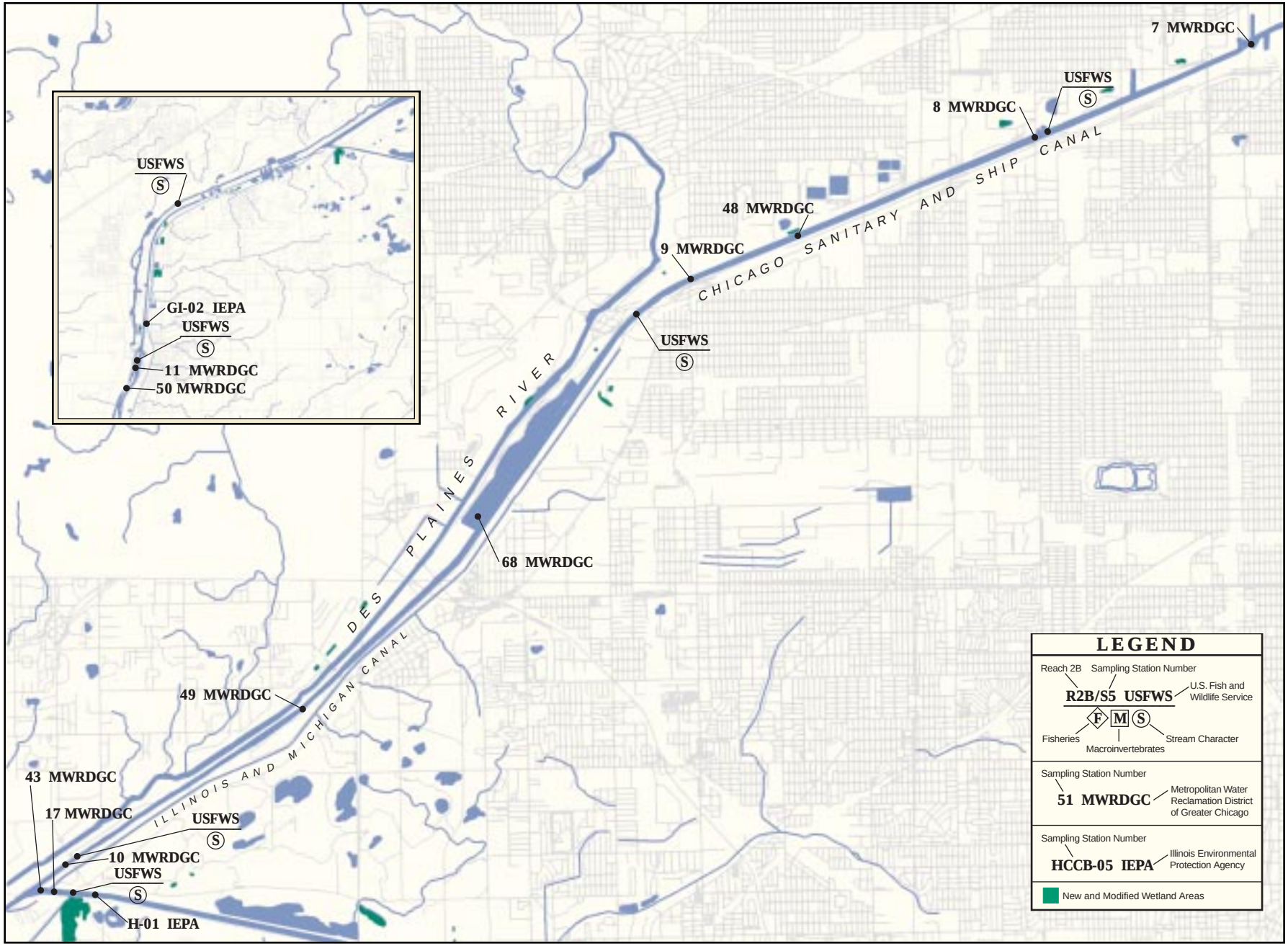

FIGURE 7
Survey Sampling Sites and Wetland Areas, Reaches 8, 9A and 9B

aquatic habitat acreage), POWKH (279.2 acres; 18 percent of the total wetland acreage) and PFO1A (117.2 acres; 7 percent of the total wetland acreage) (Table 15). The most numerically abundant, previously unmapped wetlands are three POWKx areas (75 percent of the total number of new wetlands).

Six wetlands were field-checked: two PEMC, two PEMF, one PFO1A, and one POWKh. Some of the characteristic species of herbaceous plants recorded at these sites are common tussock sedge, big bluestem, little bluestem, jack-in-the-pulpit, heath aster, reed canary grass, common reed, blue vervain, river bulrush, and prairie dock. Commonly occurring trees and shrubs include red ash, white oak, common buckthorn, and red osier dogwood.

Fishes and Benthic Invertebrates

In 1976, MWRDGC sampled fish populations near Willow Springs Road and the Argo Shell Plant in Justice (Stations 49 and 68; Figure 7) (Brigham et al., 1978). Six species were collected at Station 68, with green sunfish and goldfish representing 84 percent of the total number. Only one carp and one goldfish were collected at Station 49 (Table 21).

In 1989, 1990, and 1991, MWRDGC sampled 10 sites in the CSSC for benthic macroinvertebrates. The results were pooled for Reaches 8, 9A, and 9B, and are presented in the "Fishes and Benthic Invertebrates" section of Reach 8.

In 1991, the MWRDGC made 4 fish collections at Station 10 near Willow Springs Road (Figure 7) (Dennison et al., 1992). Nine species and two hybrids were collected, all of which were moderately to highly tolerant of polluted waters. The three most abundant species were carp, bluntnose minnow, and goldfish (Table 42). The IBI score ranged from 16 to 20 (Class E stream, restricted use aquatic resource).

INHS collections for this reach included only one specimen of goldfish collected near Willow Springs Road on May 2, 1988, and specimens of the mussel *(Dreissena polymorpha),* which were collected near Archer Avenue on October 3, 1991.

Waterway Characterization

The physical appearance and character of Reach 9A is nearly identical to that presented for Reach 8. The banks heights average 10 feet and are sheer-sided vertical walls of hand-cut limestone. The channel's original construction is rectangular in cross section. In places where the rock wall has been damaged or is severely eroded, the banks are stabilized with concrete or rock rubble. The channel substrate was not sampled due to barge traffic. The bottom material is composed of silt overlying rock (Environmental Science and Engineering, Inc., 1994a).

Both canopy and visible in-stream cover are sparse. The entire canopy is estimated at 15 percent, and trees lining both channel banks shade approximately 10 percent of the water surface. Rock ledges provide the only visible in-stream cover (Table 3). It is unlikely that any significant submerged cover exists because of the regular maintenance of the canal for commercial navigation by the Corps of Engineers.

The rock walls are barren of vegetation except for small trees growing occasionally from rock crevices near the waterline. Cottonwoods and box elder are the dominant trees in the area.

In 1992-93, a study of aquatic macrophytes was conducted in the upper Illinois Waterway for the Commonwealth Edison Company. No aquatic macrophytes were collected near the southern end of Reach 9A, and aquatic macrophyte coverage near the upper segment of the reach was sparse. Species collected in this reach included duckweed, water milfoil, pondweed, and broad-leaved arrowhead (Environmental Science & Engineering, Inc., 1994a).

Natural Areas and Other Natural Land Features

The northern half of this reach is largely developed for industrial and commercial purposes. The southern half contains the 320-acre Little Red Schoolhouse Marsh, the 11-acre Santa Fe Prairie, the 4-acre Reavis High School INAI sites, and Cranberry Slough and Paw Paw Woods Nature Preserves managed by FPDCC (Tables 4 and 5).

Distinctive woodland, marsh, and prairie remnants are found on Mount Forest, which is the area between the CSSC and the Cal-Sag Channel. Most of this land is located within county forest preserves and totals over 6,300 acres. Much of this area includes Columbia Woods, Paw Paw Woods, Henry DeTony Woods, Red Gate Woods, Pulaski Woods, Wolf Road Woods, Maple Lake, Willow Springs Woods, Buffalo Woods, Pioneer Woods, Crooked Creek Woods, White Oak Woods, Little Red Schoolhouse Marsh, Spears Woods, Hidden Pond, and Tomahawk Slough. Many of these sites are managed for ecological restoration purposes by the FPDCC and The Nature Conservancy's volunteer stewardship network.

Forest preserve lands extend well beyond the limits of the 1-mile-wide study corridor. Considering only those portions within the corridor, about 25 percent of the corridor in this reach is dedicated natural open space (Table 6).

Sixteen known State and federally listed threatened and endangered species of flora and fauna persist along Reach 9 (Table 7).

Reach 9B: Chicago Sanitary and Ship Canal (Calumet-Sag Channel to Lockport)

Wetlands Characterization

NWI mapped 168 wetlands, totaling 2,408.8 acres, of which 373.2 acres comprise the I&M Canal, Des Plaines River, and the CSSC. These wetlands were distributed among 15 mapping polygons and were designated R2OWHx and R2UBHx. The most abundant wetland types in this reach were PUBGx (33 wetlands), PFO1C (29 wetlands), and PFO1Ch (15 wetlands). These wetlands ranged in size from 0.1 to 308.8 acres, and averaged 13.6 acres. Nine of the wetlands in Reach 9B were linear wetlands, totaling 7.97 linear miles.

Five wetlands originally mapped by NWI, totaling 14.9 acres, are no longer in existence, leaving 163 wetlands (2,393.9 acres). This loss represents less than 1 percent of the originally mapped NWI wetlands. Two NWI wetlands appear to

have decreased by more than 2 acres due to a quarry expansion. Eight previously unmapped wetlands, totaling 47.1 acres and averaging 5.9 acres per wetland, were identified.

With the addition of these 8 wetlands, there are currently 171 wetlands, totaling 2,441.1 acres, within Reach 9B. This represents approximately 2 percent more wetlands than originally mapped by NWI (Table 15). Wetland types with the greatest total areal coverage are PEMF (394.5 acres; 16.2 percent), PFO1C (380.4 acres; 15.6 percent), R2OW and R2UB (373.2 acres; 15.3 percent), and PEMC (351.30 acres; 15 percent). The most abundant, previously unmapped wetlands are PEMC.

Of the eight wetlands field-checked, one wetland is no longer in existence. The remaining wetlands are PEMA, PEMF, POWGx, and PFO1C. Some of the characteristic species of herbaceous plants recorded at these sites are redtop, hop sedge, common tussock sedge, reed canary grass, common reed, heath aster, panicled aster, late goldenrod, and narrow-leafed cattail. Common trees and shrubs include red osier dogwood, swamp white oak, and pussy willow.

A wetland inventory of northeastern Illinois was conducted on 5 acres or larger (Southern et al., 1981). Factors used to rank the value of these wetlands included the percentage of open water, vegetative interspersion, water depth, quality rating, surrounding land use, and threats. The Mount Vernon Memorial Park Cemetery, located between Illinois Route 171, McCarthy Road, and Bell Road, near Lemont, was examined. Although this wetland is located just beyond the 1/2-mile study limits, the site ranked in the highest quality category. This site is a 127-acre deep cattail marsh that provides nesting habitat for a variety of uncommon marsh birds. Species recorded from the site include soras, blue-winged teal, Canada geese, wood ducks, black-crowned night herons, great egrets, and common moorhens.

In 1990, the wetlands of Goose Lake, which are part of the FPDCC Black Partridge Preserve, were surveyed for endangered and threatened birds. This survey identified 66 great blue heron nests at the site, although there were no bird sightings (Glass, 1990).

Fishes and Benthic Invertebrates

In 1976, MWRDGC sampled fish populations in this reach at Station 50 (Figure 7), located near 16th Street in Lockport (Brigham et al., 1978). Four species and one hybrid were collected (Table 21). The sample was dominated by carp and goldfish.

In 1991, MWRDGC made four collections at this same site (Dennison et al., 1992). Carp and goldfish again dominated the collection, but the total number of species collected increased to nine and one hybrid (Table 43). The IBI score of the four collections ranged from 18 to 22 (Class D stream, limited aquatic resource).

Commonwealth Edison established three fish sampling stations in this reach (Stations 301, 302, 302A) as part of their thermal discharge study. A total of 699 fish were collected, the most abundant of which were gizzard shad, emerald shiner, fathead minnow, and bluntnose minnow (EA Engineering, Science and Technology, 1994).

Commonwealth Edison also conducted a winter fisheries survey in early 1993 using a variety of sampling gear. Collections were made at five locations in the upper Illinois Waterway System. All sampling stations but one were associated with a Commonwealth Edison power plant. A 3-mile stretch of the river adjacent to the Will County Station was sampled. A total of 115 fish were collected, representing 8 species and one hybrid. Emerald shiner and carp were the most abundant species collected, comprising 71 percent of the total fish collected (Lawler, Matusky & Skelly Engineers, 1993).

The INHS collections contained a single specimen of the emerald shiner collected near 16th Street in Lockport in October 1988.

In a basinwide survey of the Des Plaines River in 1983, IEPA sampled macroinvertebrates at Station 02 (Figure 7) at Lockport. Twenty-one individuals, representing 10 species, were collected, including four species of aquatic worms (Oligochaeta) and six species of midges (Chironomidae) (Table 13) (IEPA, 1988).

Benthic macroinvertebrate populations were evaluated as part of the upper Illinois Waterway Study for Commonwealth Edison. Two sampling stations were located near the Will County power station and a third was established in Lockport. At the station upstream of the Will County station, 10 species were collected, with tubificid worms dominating the collection. Downstream of the station, isopods *(Caecidotea sp.)* comprised nearly 58 percent of the organisms collected, followed by tubificid worms. At the far southern extent of the reach in Lockport, aquatic worms were again the dominant group of organisms collected (EA Engineering, Science and Technology, 1994b).

Waterway Characterization

The physical appearance and character of Reach 9B closely resemble the character of Reach 9A and are fairly homogeneous throughout the reach. The stream channel and banks were characterized near the Stevens Street bridge in Lemont and the 16th Street bridge in Lockport. Continuous observations were made along the entire length during a boat reconnaissance.

Banks along Reach 9B are sheer-sided, vertical walls of cut limestone. The channel exhibits a rectangular cross-section as originally constructed. Banks heights are 10 to 15 feet from the water's edge to the top of the rock wall. Portions of the rock wall have been reinforced with concrete or rubble where barge damage occurred. Although the channel substrate was not sampled due to barge traffic, Environmental Science and Engineering, Inc. (1994a) reported that the bottom material is composed of silt overlying the solid rock basement (Table 3).

The tree canopy and in-stream cover are sparse at the Lemont sampling station and at Lockport. Between these widely separated sampling points, trees cover no more than 10 percent of the water. Shading ranges from 0-10 percent.

The walls forming the channel along Reach 9B are devoid of vegetation. Throughout the Lemont section, no trees exist along the banks due to industrial development. Between Lemont and Lockport, deciduous trees become more prevalent. Many undeveloped parcels of land adjoining the channel are well-vegetated with herbaceous plants, shrubs, and trees. A channelside vegetation inventory along this stretch was not completed. However, a wetland field-check near the channel showed that the dominant trees along the banks are cottonwood, willow, and box elder. Rock ledges provide the only visible in-stream cover. Regular channel maintenance by the Corps of Engineers prevents the establishment of significant submerged cover.

Surveys of aquatic macrophytes in the upper Illinois Waterway were conducted in 1992 and 1993 for the Commonwealth Edison Company. Reach 9B corresponds to the section of this study that covers the confluence of the CSSC and the Cal-Sag Channel south to Lockport. Several beds of aquatic macrophytes were found in this area. Prominent submersed aquatic beds were found at the confluence of the CSSC and Cal-Sag Channel at Material Service's embayment, the Cargill Corporation facility dock, and the spillway at the Lockport Lock and Dam. The dominant vegetation types were elodea and pondweed. Other species observed included duckweed, arrowhead, and water milfoil (Environmental Science and Engineering, Inc., 1994a).

Natural Areas and Other Natural Land Features

Most of the natural open space within this reach is owned and managed by the Forest Preserve Districts of Cook, DuPage, and Will Counties. The WCFPD owns 5 sites, totaling 819 acres, within the Reach 9B study corridor. These sites are Keepataw, 216 acres; Veterans Woods, 77 acres; Romeoville Prairie, 251 acres; Lockport Prairie, 254 acres; and Runyon Preserve, 21 acres.

Only a very short segment of Reach 9B is located within Cook County. The only FPDCC holding in this reach is the 438.2-acre Black Partridge Woods.

The FPDDC owns and manages the 2,470-acre Waterfall Glen Forest Preserve, which is contiguous to the Argonne National Laboratory Reservation and the 234-acre Wood Ridge site. These two sites comprise about 12 percent of the FPDDC's total holdings.

Approximately 25 percent of the Reach 9B corridor is dedicated to natural open space (Table 6). Four dedicated Illinois Nature Preserves are located in this reach. These are the 254-acre Lockport Prairie, the 108.4-acre Romeoville Prairie, and the 70-acre O'Hara Woods, all under WCFPD management. The 80-acre Black Partridge Woods is managed by FPDCC (Table 5).

The INAI identified six sites along this reach in addition to the nature preserves previously identified. These include an intermittent stream habitat near Lemont known as the Bowl; two Lemont Geological Areas; Long Run Seep; Lockport Prairie East; Waterfall Glen Forest Preserve; and the Material Service Prairie. A privately owned dolomite prairie, located south of the UNO-VEN refinery along New Avenue in Will County, is a significant natural area, but not a formal INAI site (Table 4).

Some of the rarest and most unique biological communities in the study corridor and in the entire northeastern Illinois region are represented by the dolomite prairies along the lower Des Plaines River where the river parallels and eventually merges with the CSSC. These prairies were developed in shallow soils over dolomite bedrock that had been exposed when waters from Glacial Lake Chicago scoured the glacial deposits and created the existing Des Plaines River Valley. Unique plant communities in this area include wet to mesic dolomite prairie, sedge meadow, and graminoid fen. The federally listed endangered Hines Emerald Dragonfly is largely restricted to these dolomitic wetland communities.

Nearly the entire valley floor of this reach originally consisted of these wet prairies and marshes. Much of the corridor has been developed by industries that were attracted by good water transportation and mining opportunities. Although development has radically altered the valley, enough of the original character of the valley can still be observed. The best remaining examples of these prairies can be found at Lockport Prairie and Romeoville Prairie Nature Preserves. (See Table 7 for a combined list of State and federally listed threatened and endangered species found in Reaches 9A and 9B.)

Reach 10A: Calumet-Sag Channel

Wetlands Characterization

NWI identified and mapped 126 wetlands in Reach 10A, totaling 922.2 acres. Although a variety of wetland types existed in the study area, the most abundant wetland types were POWHx (27 wetlands), PEMC (25 wetlands), and PEMF (19 wetlands). The single largest wetland, Saganashkee Slough, totaled 359.4 acres and was classified as L2OWH. Excluding Saganashkee Slough, the remaining wetlands ranged from 0.11 acres to 45.9 acres and averaged 5.1 acres. Four watercourses (3 R2OWHx and 1 PFO1A) totaled 2.68 linear miles (Table 15).

Thirteen of the wetlands originally mapped by NWI, totaling 14.1 acres, no longer exist, leaving 113 wetlands (908.1 acres). This loss represents a decline of less than 1 percent of the number of originally mapped wetlands. Eighteen previously unmapped wetlands, totaling 75.8 acres and averaging 4.2 acres per wetland, were identified. With the addition of these 18 wetlands, there are currently 131 wetlands totaling 983.9 acres within the study corridor in Reach 10A, or 6.7 percent more wetlands than were mapped by NWI (Table 15).

The most numerically abundant, previously unmapped wetlands are POWHx (5 wetlands), POWGx (4 wetlands), and PEMC (4 wetlands). One PEMFh wetland appears to have been excavated, which increased its area by 12 acres and

FIGURE 8
Survey Sampling Sites and Wetland Areas, Reach 10A

changed its classification to POWGx. Several other previously mapped wetlands are no longer in existence, due most likely to filling activities. Wetland types with the greatest total areal coverage are L2OWHx (359.39 acres; 36.5 percent of the total wetland acreage), PFO1A/C (160.6 acres; 16.3 percent), PEMF (115.8 acres; 11.8 percent), POWHx (89.8 acres; 9.1 percent), and PEMC (85.9 acres; 8.7 percent).

Eleven wetlands, most of which are PEMC wetland types, were field-checked. Some of the characteristic species of herbaceous plants recorded at these sites are common tussock sedge, reed canary grass, common reed, wild golden glow, prairie cord grass, and river bulrush. Commonly occurring trees and shrubs include common buckthorn, pale dogwood, and cottonwood.

Southern et al. (1981) conducted an inventory of wetlands 5 acres or larger and ranked them from A (highest quality) to C (lowest quality) based on wildlife habitat value. Factors used in this ranking included the percentage of open water, vegetative interspersion, water depth, surrounding land use, and threats. Three sites, identified as C-27, C-45 and C-46, are located in Reach 10A.

Area C-27, a "B" site, is a 10-acre shallow lake with an emergent wetland located north of McCarthy Road and west of Will-Cook Road.

Area C-45, Saganashkee Slough, is ranked as a category A site. Saganashkee Slough is a large wetland with extensive shallow open water. Willows are the dominant shoreline vegetation. Southern et al. (1981) observed several State-listed threatened or endangered birds at this site, including pied-billed grebe, double-crested cormorant, and great egret. Other species observed included blue-winged teal, great blue heron, American coot, red-winged blackbird, barn swallow and green heron.

Area C-46, a "C" site, is a 9.5-acre cattail marsh located north of McCarthy Road and west of Flavin Road on FPDCC property.

Wetlands are also evaluated as part of an annual IDNR survey of endangered and threatened bird species in northeastern Illinois. Within Reach 10A, McGinnis Slough, also known as Orland Lake, has been censused regularly for listed bird species since 1985. This site is located 2.5 miles south of the Cal-Sag Channel at U.S. Route 45 and 143rd Street in Orland Park.

Information from these surveys is available for 1985 through 1989. State-listed birds observed during these surveys include pied-billed grebe, common moorhen, great egret, yellow-headed blackbird, double-crested cormorant, black-crowned night heron, and least bittern. All but the least bittern were sighted and recorded again in 1991 (Glass, 1990, 1991; Heidorn et al., 1991).

Black-crowned night herons, a State-listed endangered species, were observed roosting in trees along the river banks in this reach. A night heron rookery is located east of this reach near Lake Calumet. These birds most likely use this area for feeding and roosting, especially during the post-breeding dispersal period.

Fishes and Benthic Invertebrates

In 1976, MWRDGC sampled fish populations at eight stations along the Cal-Sag Channel (Brigham et al., 1978). The stations were distributed along the entire length of the channel, including the confluence with the Chicago Sanitary and Ship Canal (Station 43), the confluence with the western end of Stony Creek (Stations 182, 183, and 185), the confluence with Tinlet Creek (Stations 44, 175, and 186), and the confluence with the eastern end of Stony Creek (Station 171) (Table 21; Figures 7 and 8).

Fifteen species of fishes and 2 hybrids, consisting of 363 individuals, were collected at these 8 stations. The number of species collected per station ranged from 2 to 10, with a mean of 5 species per station. The most abundant species were creek chub, goldfish, green sunfish, and carp, which constituted 70 percent of the total number of fish for all collections.

In 1983, an INHS fish collection was made by Dennison and Dorkin at Ashland Avenue. This collection consisted of gizzard shad, goldfish, carp, fathead minnow, green sunfish, and largemouth bass. An additional collection made by Dennison and Dorkin at the same site in October 1983 included gizzard shad, central mudminnow, brook stickleback, green sunfish and bluegill. These collections compare with a collection made by G. J. Tichacek and P. Vidal near Willow Springs Road in July 1967, which consisted of goldfish, carp, creek chub, white sucker, black bullhead, green sunfish, and bluegill.

In 1991, MWRDGC collected fishes from Station 16 at Cicero Avenue and from Station 17 at Route 83 on the Cal-Sag Channel (Figure 8). A total of 314 fish were caught, representing 14 species and 2 hybrids. Of the total catch, 91 percent was composed of gizzard shad, goldfish, carp, green sunfish, and bluegill (Table 44) (Polls et al., 1992). Maximum IBI scores for the 2 stations were 22 and 24 (Class D stream, limited aquatic resource).

In addition to fish sampling, MWRDGC also conducted surveys of aquatic macroinvertebrates in this reach in 1989, 1990, and 1991 (MWRDGC, 1990; Polls et al., 1991; 1992). Six sampling stations were established on the Cal-Sag Channel: two at Western Avenue in Blue Island, two at Southwest Highway in Worth, and two at Route 83 in Lemont (Figure 8).

In the 1989 survey, these 6 sampling stations yielded a total of 28 benthic species, including 9 species of tubificid worms, 5 species of midges, 4 species of leeches, 4 species of naidid worms, and 3 species of clams. The naidid and tubificid worms were the dominant taxa. The two most abundant species were the tubificid worms *(Limnodrilus hoffmeisteri* and *Quistadrilus multisetosus)* (Table 45).

In 1990, 24 benthic species were collected from all stations, including 9 species of tubificid worms, 4 species of midges, 4 species of naidid worms, and 3 species of leeches. Tubificid

worms were most abundant in 1990, comprising 91.1 percent of the invertebrates collected. The tubificid worm *(Quistadrilus multisetosus)* was the most abundant species collected in the channel (Table 46).

In 1991, 23 benthic species were collected from the 6 stations, including 10 species of tubificid worms, 3 species of leeches, 3 species of clams, and 3 species of naidid worms. As with preceding years, tubificid worms were most abundant, comprising 93.1 percent of all organisms collected. The predominant species were the tubificid worms *(Limnodrilus hoffmeisteri* and *Quistadrilus multisetosus)* (Table 47). In September 1983, IEPA staff sampled macroinvertebrates in the Cal-Sag Channel at Route 83 (Station 01, Figure 8) as part of a study of the DesPlaines River Basin. No specimens were collected during this sampling effort (Table 13) (IEPA, 1988).

Waterway Characterization

The physical features of the Cal-Sag Channel are nearly homogenous throughout its length due to its artificial construction. Characterization data were collected at three locations: 1) Kedzie Avenue, Blue Island, 2) Illinois Route 7, 86th Street, Worth, and 3) Route 83 near Lemont (Table 3). Banks of the eastern segment near the Little Calumet River in Blue Island have a 70-degree slope and are composed of large rock rubble and exposed clay. Near Illinois Route 7, walls of cut limestone reveal a slope of 50 degrees, and the banks are composed of less severely sloped rock rubble piles. At the extreme south and west end of the reach, banks are sheer-sided vertical limestone walls. The channel substrate was mainly silt in the central and southern portions of the reach (Table 3).

Canopy and in-stream cover are sparse across the entire length of the Cal-Sag Channel. Canopy cover is absent at the Lemont sampling station, and is only 5 percent in Worth, near Illinois Route 7. Between these widely separated sampling points, canopy cover is no more than 10 percent, resulting in a low degree of shading. Canopy cover is also less than 10 percent at Kedzie Avenue.

A nearly continuous narrow band of cottonwood, willow, and box elder trees occurs on each bank along the length of the reach. These trees create a screen, blocking views of residential and industrial land uses from the waterway.

Though canopy and shading are absent, in-stream cover is present. Undercut banks, aquatic vegetation, and rock ledges, which are beneficial to fish and macroinvertebrates for attachment and cover, are present. Channel maintenance for navigation likely contributes to the absence of other cover, such as fallen trees and log jams.

Natural Areas and Other Natural Land Features

Three Illinois Nature Preserves and five INAI sites are located near the Cal-Sag Channel (Tables 4 and 5). One of the largest and first areas to be granted Illinois Nature Preserve status is the 1,530-acre Cap Sauers Holdings Nature Preserve, owned and managed by FPDCC. This site contains examples of typical glacial topography, including a well-defined esker. The site is vegetated with forest and savanna communities which are under restoration by FPDCC and The Nature Conservancy's volunteer stewardship network.

Palos Fen is another dedicated nature preserve in this reach. Located at 107th Street and Kean Avenue in Palos Hills, this 70-acre parcel is owned and managed by the FPDCC. Fen communities are unique types of wetlands that develop in association with calcium-rich groundwater seepage. This site represents the only known remaining graminoid fen on the former Chicago lakeplain.

The third designated nature preserve in this reach is the 12-acre Sagawau Canyon, located near the FPDCC Camp Sagawau Preserve along 111th Street in Lemont. This preserve has a high-quality dolomite canyon, cliffs, and ravine forests. The cliff community supports some of the most unusual and uncommon plant communities in northeastern Illinois (McFall, 1991).

Five additional INAI sites, totaling 1,275.3 acres, are found in this reach. These are the 40-acre Moraine Valley Community College Nature Area; the 29-acre Chicago Ridge Prairie at Central Avenue and 105th Street; the 2.3-acre Worth Outdoor Classroom near 115th and Ridgeland Avenue; the 1,170-acre McGinnis Slough near 131st Street and 96th Avenue; and the 34-acre Oak Lawn Prairie near Central and 111th Street.

McGinnis Slough is one of the more important wildlife habitats in this reach. Because of its large size and deep marsh habitat structure, it is used by a variety of wetland birds that have become scarce due to habitat loss. Bird species known to use this site include the State-listed endangered yellow-headed blackbird and pied-billed grebe, and the State-listed threatened common moorhen.

FPDCC controls large areas of land both north and south of the Cal-Sag Channel in the western third of Reach 10A. Land south of the Cal-Sag Channel is locally referred to as Sag Valley. North of the channel is Mt. Forest, otherwise known as the Palos Division.

To calculate forest preserve acreage nearest this reach, all Sag Valley Division land and a portion of the Palos Division acreage were considered. Because FPDCC lands near the confluence of the CSSC and the Cal-Sag Channel are located within both Reach 9A and Reach 10A, only acreages for Palos Division tracts south of 107th Street extending to the channel were used. This avoided double-counting open space assigned to Reach 9A.

FPDCC land near the Cal-Sag Channel encompasses 7,190.81 acres. Included in this figure is the acreage of the aforementioned State nature preserves. Other areas in the forest preserve system include Teasons Woods, Tampier Lake, Saganashkee Slough, Camp Sagawau, and Swallow Cliff Woods. Dedicated open space comprises about 40 percent of the Reach 10A corridor (Table 6).

Nine State and federally listed endangered and threatened species are known to occur in Reach 10, including plants, birds, and one insect (Table 7).

Reach 10B: Little Calumet River

Wetlands Characterization

NWI identified and mapped 68 wetlands, totaling 812.8 acres, in Reach 10B. Of this total, 520.7 acres were comprised of the Little Calumet River and adjoining channels designated R2OWHx. Excluding the river channel, the most abundant wetland types were POWHx (16 wetlands), PFO1C (10 wetlands), and PEMC (7 wetlands). These wetlands ranged in size from 0.1 to 33.4 acres and averaged 4.6 acres.

Seven wetlands originally mapped by NWI, totaling 1.1 acres, are no longer in existence, leaving 61 wetlands (811.7 acres). This represents a loss of only 1 percent of the number of originally mapped wetlands.

Seven previously unmapped wetlands, totaling 45.8 acres and averaging 6.5 acres per wetland, were identified during the field inventory. With the addition of these seven newly discovered wetlands, there are currently 68 wetlands, totaling 857.5 acres within Reach 10B (Table 15). This represents a total area 5.5 percent greater than the area previously mapped by NWI.

Three wetlands originally mapped by NWI are larger by 70.62 acres. A POWGx wetland type increased by more than 50 acres. This is an artificially constructed wetland, built mainly for water storage. An additional 19 acres of forested wetland were also mapped in association with an existing forested wetland (PFO1C). This discrepancy is probably due to the margin of error associated with mapping forested wetlands from aerial photography.

Wetland types with the greatest areal coverage include R2OWHx (520.7 acres; 59.8 percent of total wetland and aquatic habitat area), L1OWHx (60.5 acres; 417.1 percent), PEMC/F (56.8 acres; 6.6 percent), PEMA (37.1 acres; 4.3 percent), POWHx (34.8 acres; 4.1 percent), and PFO1A (32.5 acres; 3.4 percent).

Four wetlands, including PEMC, PEMF, and POWGx wetland types, were field-checked. Some of the most abundant herbaceous plants found at these sites were reed canary grass, common reed, river bulrush, and narrow-leaved cattail. Commonly occurring trees were cottonwood and box elder.

Surveys of State-listed endangered and threatened bird species were conducted at Powderhorn Lake from 1985 to 1989. This lake and wetland complex, owned and managed by FPDCC, is larger than 50 acres. It was used in the past as a borrow site.

State-listed species observed at this site included common moorhen, pied-billed grebe, black-crowned night heron, and least bittern (Heidorn et al., 1991). Black-crowned night herons, a State-listed endangered species, were observed roosting in trees along the banks of the Little Calumet River. Rookeries near Lake Calumet exist, and both adults and young likely use the riverbanks for roosting, as well as the river for foraging.

Fishes and Benthic Invertebrates

In 1976, MWRDGC sampled fish populations along the Little Calumet River near Halsted Street (Station 40) and near the Calumet Expressway (Station 165) (Figure 9) (Brigham et al., 1978). In total, 11 species and one hybrid were collected at the two stations using electrofishing. A total of 67 individuals, representing 7 species and 1 hybrid combination, were collected near Halsted Street. Green sunfish, the most abundant species, represented 82 percent of the total number of individuals collected. The collection made at the Calumet Expressway site consisted of 114 individuals, including 7 species and 1 hybrid combination. Gizzard shad, carp, and goldfish were the most abundant species, representing 79 percent of the collection (Table 48).

In 1991, MWRDGC collected fish from the Little Calumet River on four separate occasions at the two stations sampled in 1976 (Figure 9). A total of 963 fish, representing 15 species and 2 hybrids, were collected. The most abundant species were gizzard shad, goldfish, carp, and white perch. One grass pickerel was collected at the Halsted Street site. This species is significant because it is one of the few recent collections made of a pollution-intolerant species in the Chicago and Calumet River Waterway Systems (Table 49). The two sampling stations had maximum IBI values of 28 (Class D stream, limited aquatic resource) and 32 (Class C stream, moderate aquatic resource).

In 1989, the U.S. Geological Survey (USGS) initiated the National Water Quality Assessment Program (NAWQA), a program that evaluated streams across the United States based on the quality of the fisheries, in-stream habitat, and macroinvertebrates. Three of the stations sampled by USGS are within the study corridor. One station is located on the Little Calumet River at Halsted Street. Collections made at this site in August 1990 consisted of white sucker, green sunfish, carp, grass pickerel, bluntnose minnow, goldfish, gizzard shad, fathead minnow, creek chub, and bluegill (Warren, 1991).

NAWQA staff also collected a moderate diversity of aquatic macroinvertebrates, representing the phyla Annelida, Mollusca, and Arthropoda. Although macroinvertebrate data had not yet been published at the time the resource inventory was completed, NAWQA researchers indicated that the most abundant taxa were aquatic worms (Tubificidae), fingernail clams (Sphaerium), isopods (Caecidotea sp), and midge larva (Chironomidae) (T. Cuffney, personal comm).

During May through October 1976, macroinvertebrate sampling was conducted by NIPC in the Little Calumet River as part of a sediment oxygen demand study (Butts and Evans, 1978). Two sampling points were located west of Halsted Street near the juncture of the Little Calumet River and the Cal-Sag Channel. Six taxa were represented in the collection made at Station 79, including leeches *(Myzobdella moorei)*, fingernail clams *(Sphaerium transversum)*, aquatic sow bugs *(Asellus sp.* and *A. communis)*, midge larvae (Chironomidae) and aquatic worms (Oligochaetae). The

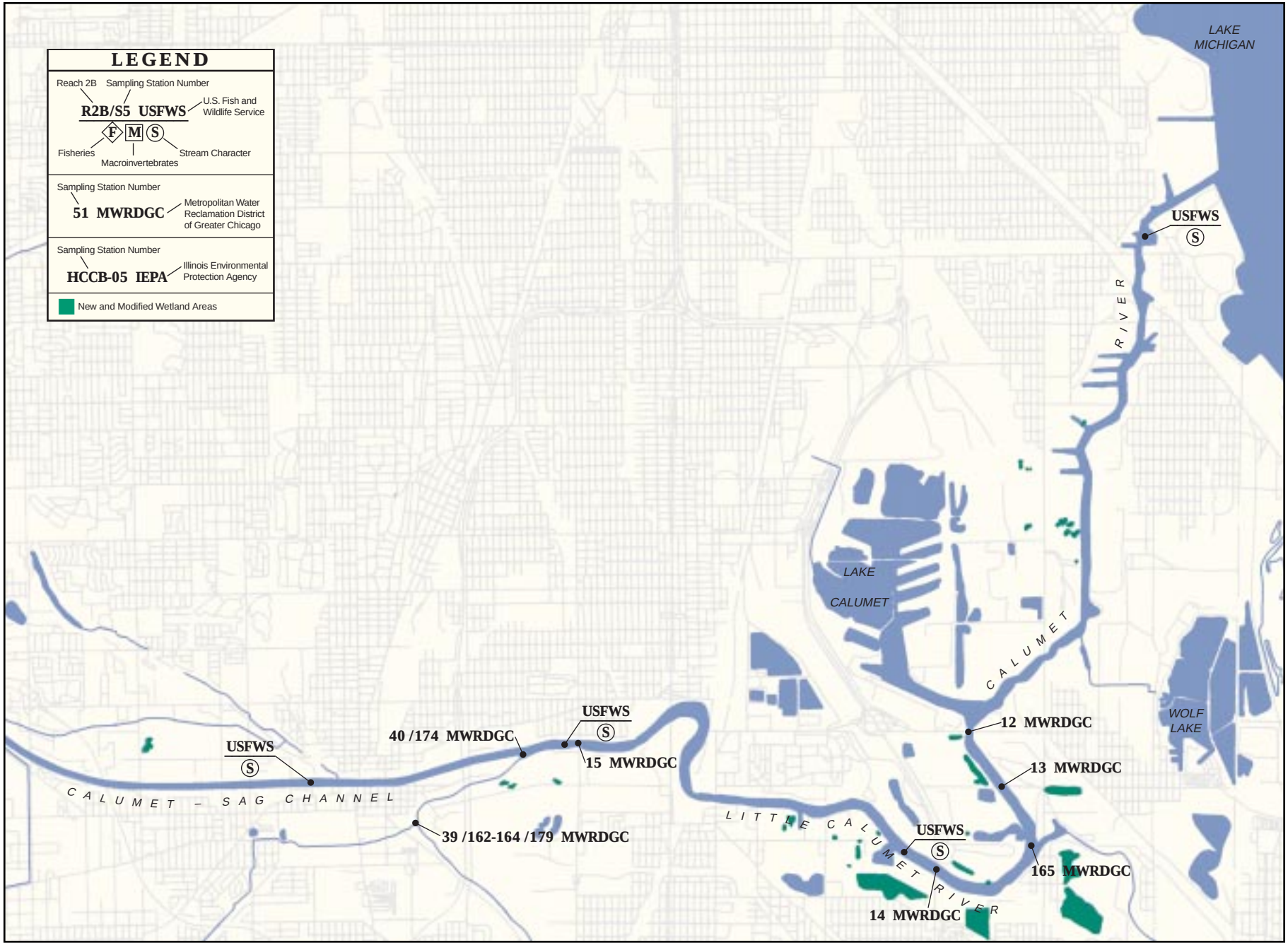

FIGURE 9
Survey Sampling Sites and Wetland Areas, Reaches 10B and 10C

collection made at Station 80 was dominated by aquatic worms (Oligochaetae) but midge larvae (Chironomidae) and the leech *(Myzobdella moorei)* were also included. Stations 74-78 were sampled along the Little Calumet River, and aquatic oligochates and chironomids dominated all collections (Table 18) (Butts and Evans, 1978).

In 1989, 1990, and 1991, MWRDGC sampled for benthic macroinvertebrates. The sampling data and results are discussed in Reach 10A.

INHS collections included specimens of banded killifish and longear sunfish collected by Forbes and Richardson in 1880. In 1967, G.J. Tichacek and P. Vidal collected green sunfish. The crustaceans, *Crangonyx pseudogracilis, Gammarus fasciatus, Orconectes virilis, O. rusticus,* and *Cambarus diogenes,* were collected in 1974. In 1975, L.M. Page collected brown bullhead, mudminnow, banded killifish, green sunfish, pumpkinseed, and largemouth bass. S.G. Dennison made a series of collections from 1988 through 1991 that included alewife, spottail shiner, goldfish, white perch, and orangespotted sunfish.

Waterway Characterization

This stretch (Reach 10B) of the Little Calumet River was dredged and channelized many years ago and is currently maintained to accommodate barges and commercial boat traffic. Stream characterization data were collected at two representative stations (Halsted Street bridge and at the Calumet Expressway). The bank heights at these stations range from 6 to 15 feet. The channel banks are stabilized primarily with sheet pilings. In areas where there are no sheet pilings, the banks are composed of clay, rock, or sand. The bank slope at one station is 30 degrees, whereas the other station has banks with 90-degree slopes. The channel substrate is primarily silt (Table 3).

Instream cover is limited to submerged aquatic vegetation, rock ledges, and submerged tree roots. Trees, shrubs, and forbs can be found along the shoreline, but the canopy is very sparse (5 to 10 percent coverage). Cottonwood and box elder are the dominant trees, and garlic mustard is the most abundant forb.

Natural Areas and Other Natural Land Features

No designated Illinois Nature Preserves are located along this reach. The INAI identified five natural areas near the corridor, including the 50-acre Dolton Avenue Prairie, the 79-acre Burnham Prairie, and the 133-acre Calumet City Prairie. None of these sites is located within the corridor (Table 4). These sites, along with several other prairie remnants located outside the corridor, are a few remnants of the vast lakeplain prairies that formerly ringed Lake Michigan in northeastern Illinois and northwestern Indiana.

Despite their small size, these sites still support significant biological diversity. Collectively, 11 remnant natural areas in the Chicago lakeplain region contain over 760 native vascular plant species. Calumet City Prairie alone has 259 native plant species. These prairies are the only potential habitat where the plant, *Thismia americana,* known only from the Lake Calumet region and currently thought to be extinct, may yet be found. The 222-acre Powderhorn Lake, which includes a marsh and a sand prairie, and Riverdale Marsh, which contains an active heron colony, are two other INAI sites.

There are several forest preserves owned and managed by the FPDCC, located within the Reach 10B corridor. These are Calumet Woods, Joe Louis Golf Course, Whistler Preserve, Beaubien Preserve, and Flatfoot Lake. These preserves comprise about 600 acres, or about 13 percent of the total area within the Reach 10B corridor (Table 6).

Refer to Reach 10A for a listing of known State and federally listed endangered and threatened species that are also found in Reach 10B (Table 7).

Reach 10C: Calumet River

Wetlands Characterization

NWI identified and mapped 69 wetlands, totaling 484.02 acres. Of this total, 210.9 acres were comprised of the Calumet River and associated channels and were designated R2OWHx. Eight additional linear mapping units, totaling 0.9 miles, were designated R2OWHx and were found within this reach. Excluding the riverine mapping units, the most numerically abundant wetland types were PEMF (15 wetlands), POWHx (9 wetlands), and POWFx (8 wetlands). The wetlands ranged from 0.1 acres to 29.4 acres and averaged 5.7 acres. The largest water body closely associated with, but technically beyond this reach, is Lake Calumet, a 3,161.8-acre lake classified as L1OWHx.

Fourteen wetlands originally mapped by NWI, totaling 17.3 acres, are no longer in existence, leaving 56 wetlands (466.7 acres). This represents a loss of 6 percent of the number of originally mapped wetlands. Four previously unmapped wetlands, totaling 4.3 acres, were identified and averaged 1.07 acres per wetland. There are currently 60 wetlands, totaling 471.0 acres, that are located within the study corridor in Reach 10C (Table 15). This represents a total wetland area only slightly larger than the area mapped by NWI. Five wetlands originally mapped by NWI appear to be larger by 1.1 acres. One wetland decreased in size by nearly 2 acres due to filling activities. Wetland types with the greatest total areal coverage include R2OWHx (210.9 acres; 44.8 percent), PEMF (148.2 acres; 31.5 percent), POWFx (32.3 acres; 6.8 percent), and POWHx (29.8 acres; 6.3 percent).

One PFO1C wetland was field-checked. Some of the characteristic species of herbaceous plants recorded at the site were reed canary grass, common reed, and narrow-leaved cattail. Commonly occurring trees included box elder, silver maple, cottonwood, and black willow.

Southern et al. (1981) conducted an inventory of northeastern Illinois wetlands 5 acres or larger and ranked them according to their wetland wildlife habitat value. Factors used in this ranking included percentage of open water, vegetative interspersion, water depth, surrounding land use, and threats.

Ten sites collectively identified as Station C-19 were inventoried in Reach 10C and were ranked Category A (highest quality). Category A includes predominantly deep cattail marshes with good interspersion of open water and emergent vegetation. Most areas provide good habitat for several State-listed endangered and threatened species that depend on semimarsh conditions. In 1981, these 10 sites encompassed 623 acres. As of 1993, 3 of the 10 sites had been filled or highly altered.

Since 1981, surveys for State-listed endangered and threatened species have been conducted at this site. Between 1985 and 1990, 4 of the 10 Station C-19 areas were surveyed. A summary of these surveys by site is provided below (Glass, 1990, 1991; Heidorn et al., 1991).

Wetland C19A is located west of Torrence Avenue and south of 120th Street. Between 1985 and 1989, this wetland was the site of a heron rookery and provided suitable habitat for adult black terns, black-crowned night herons, common moorhens, great egrets, and yellow-headed blackbirds (Heidorn et al., 1991).

Station C19B is located on the north side of 120th Street. According to Heidorn & Glass (1991), adult black terns, black-crowned night herons, common moorhens, and yellow-headed blackbirds were consistently observed between 1985 and 1989. One American bittern was recorded at C19B in 1986, and a pied-billed grebe was noted in 1985. Common moorhens were among the nine species reported for the 1990 survey (Glass, 1990). Glass (1991) reported 15 bird species at this wetland in 1991, including black-crowned night herons, yellow-headed blackbirds, common moorhens, and great egrets.

Deadstick Pond (Station C19C), located near the end of 120th Street at Lake Calumet, was also surveyed. Pied-billed grebes, black-crowned night herons, yellow-headed blackbirds,and common moorhens have each been recorded during at least one survey.

Station C19D, also known as the 130th Street Marsh, is situated south of the Chicago South Shore and South Bend Railway and west of Torrence Avenue. Common moorhens, yellow-headed blackbirds, pied-billed grebes and black-crowned night herons were observed during at least one survey.

Fishes and Benthic Invertebrates

Since 1876, the fishes of the Calumet River have been periodically surveyed (Nelson, 1876; Meek and Hildebrand, 1910; Dennison, 1978; Greenfield and Rogner, 1984), as have the fishes of Lake Calumet (Forbes and Richardson, 1920; Vidal and Wight, 1975; Polls et al., 1980; Greenfield and Rogner, 1984). Nelson (1876) cited records of nine fish species collected from the Calumet River, including lake sturgeon, longnose gar, blackchin shiner, pirate perch, green sunfish, bluegill, largemouth bass, yellow perch, and log perch.

Meek and Hildebrand (1910) also cite records of grass pickerel, northern pike, white sucker, bowfin, lake chubsucker, golden shiner, black bullhead, yellow bullhead, and bluegill.

Dennison (1978) collected 13 fish species from the river, including alewife, gizzard shad, bluntnose minnow, carp, goldfish, spottail shiner, emerald shiner, black crappie, orangespotted sunfish, green sunfish, pumpkinseed, yellow perch, and largemouth bass (Greenfield and Rogner, 1984).

Polls et al. (1980) collected the following species from Turning Basin Station 5: gizzard shad, central mudminnow, bluntnose minnow, fathead minnow, carp, goldfish, golden shiner, sand shiner, spottail shiner, emerald shiner, black crappie, orangespotted sunfish, bluegill, green sunfish, pumpkinseed, yellow perch, and largemouth bass (Greenfield and Rogner, 1984).

In 1991, fishes were collected using electrofishing gear by MWRDGC from the Calumet River at 130th Street and downstream at the O'Brien Lock & Dam (Figure 9). The station located near the O'Brien Lock & Dam is technically in Reach 10B, but because the data were combined for both stations, the results from both Calumet River fish sampling stations are presented here.

Approximately 1,150 individual fish, representing 26 species and 3 hybrids, were collected from the Calumet River station. By number, the most abundant fish were gizzard shad, bluntnose minnow, green sunfish, bluegill and largemouth bass. Although only 57 carp were collected, their total weight was more than half of the total sample weight (Table 50). The 2 sampling stations had maximum IBI scores of 32 and 34 (Class C stream, moderate aquatic resource).

Fish collections made by S. G. Dennison between 1988 through 1991, and maintained by INHS, included quillback, black buffalo, white perch, white bass, spottail shiner, stickleback sp., warmouth, pumpkinseed x bluegill, pumpkinseed x green sunfish, and pumpkinseed x orangespotted sunfish.

In addition to fish sampling, MWRDGC also sampled benthic macroinvertebrates from two stations in this reach in 1989, 1990, and 1991 (MWRDGC, 1990; Polls et al., 1991, 1992). The two sampling stations were located at 95th Street and at 130th Street, upstream from the O'Brien Lock & Dam (Figure 9).

Fifty-six benthic species were collected from the Calumet River during the 1989 survey. The most abundant species were naidid and tubificid worms and chironomid midges. The most numerically abundant species were the midge *(Procladius sp.),* the naidid worm *(Vejdovskyella intermedia)* and the tubificid worms *(L. hoffmeisteri* and *Q. multisetosus)* (Table 51).

Sixty-five species were identified from the 1990 survey. Tubificid worms comprised more than 60 percent of the total number of individuals collected. Common macroinvertebrates from this sampling period were the midge *(Procladius sp),* the naidid worm *(N. variabilis),* and the tubificid worm *(L. udekemainus)* (Table 52). In 1991, 44 species were collected. Tubificid and naidid worms again comprised the most abundant species groups. The most abundant species were the naidid *(V. intermedia)* and the midge *(Procladius sp.)* (Table 53).

Waterway Characterization

The physical appearance and character of Reach 10C is similar to those of the South Fork of the Chicago River and the upper portions of the CSSC. Physical features are homogenous throughout. Data were collected at Turning Basin Station 1 near East 95th Street in South Chicago. Water depth in Turning Basin Station 1 ranges from 25 to 30 feet. A single sediment sample collected in this reach was composed of approximately 80 percent silt and 20 percent sand. The banks along Reach 10C are lined with steel sheet pilings, backfilled and stabilized in places with large rocks. From the channel waterline, both banks have a slope of 90 degrees and are 10 feet in height from the waterline to the top of the bank (Table 3).

Land use is dominated by heavy industry, ore, mineral storage areas, and freighter terminals requiring river access. Riverside industrial development has precluded the growth of woody vegetation that might provide shading. The only vegetation along the channel consists of weedy grasses and herbs. The river banks are devoid of vegetation at the Acme Steel and Wisconsin Steel sites. The coal, slag, and mineral piles present harsh environmental conditions that prevent plant growth. Total plant cover never exceeds 40 percent in those areas with vegetation. Tree canopy and in-stream cover are conspicuously absent throughout Reach 10C.

Natural Areas and Other Natural Land Features

Although there are no dedicated Illinois Nature Preserves in Reach 10C, four INAI sites were identified in or near this reach (Table 4). The 130th Street Marsh is the only one of the four INAI sites actually located within the study corridor. This area is recognized for breeding populations of rare marsh nesting birds.

A second site consists of Lake Calumet and its associated marshlands, which, combined, total 3,145 acres. Despite having been significantly altered by industry and associated activities, this area receives extensive use by migratory waterfowl, shorebirds, and other marsh birds, and supports breeding populations of a variety of wetland-dependent marsh birds. One of these adjacent wetlands, popularly known as Big Marsh, has supported the largest breeding colony of black-crowned night herons Illinois.

Most of these wetlands are located in an area bounded by Lake Calumet on the west, Torrence Avenue on the east, 103rd Street on the north, and 127th street on the south. Lake Calumet and its associated marshlands are the most significant wildlife habitats in or near the entire study corridor. The Calumet Sedge Meadow near Lake Calumet at 96th Street and Wolf Lake, owned by IDNR, are INAI sites. Wolf Lake, like the preceding two areas, lies slightly beyond the study limits. Eggers Grove and Wolf Lake Overlook, two FPDCC holdings totaling 249 acres, are located along the northern segment of Wolf Lake. According to FPDCC documents, a population of Sassafras trees uncommon to Cook County are located within Eggers Grove. Eggers Grove and Wolf Lake Overlook are the sole FPDCC holdings within or adjacent to this subreach (Table 6).

Despite the significant natural areas and wildlife habitat within or adjacent to Reach 10C, relatively little land within or adjacent to the corridor is dedicated public natural open space. This is largely due to the extensive commercial and industrial use of the area.

For a list of recent records of federally or State-listed endangered and threatened species, see discussion under Reach 10A and Table 7.

CONCLUSIONS

Wetlands

The purpose of this portion of the study is to summarize existing National Wetlands Inventory information by reach and to update the NWI mapping. Because of extensive land development that occurred during the decade since the original NWI mapping was conducted, significant changes could have occurred in the distribution of wetlands in the corridor. Revised mapping would provide a more accurate baseline for future watershed planning.

In reviewing the wetlands data generated through this work, it is important to understand that NWI identifies and maps areas other than natural vegetated wetlands. In addition to wetlands, NWI maps deepwater habitats which are commonly referred to as lakes. Because of the operational definition of a wetland, shallow open water areas that lack vegetation, commonly known as ponds, are identified as wetlands. Such areas are identified and mapped whether they are natural or artificial. In a landscape as altered by human activity as the Chicago region, artificial waters and wetlands are expected to comprise a significant proportion of all aquatic and wetland habitats.

Of the 15 reaches and subreaches studied, Reaches 4, 5B, and 6 have no wetlands associated with them outside of the channel itself. These reaches are in densely developed portions of the City of Chicago. In 9 of the remaining 12 reaches, artificial open water bodies ranked first among wetland types in *total number* of wetlands, and in 7 of these reaches, artificial open water bodies ranked first among wetland types in *total acreage.*

When considering only "new" (previously unmapped) wetlands, artificial open water bodies comprised the most abundant wetland type in 6 of the 12 reaches. Most of these open water wetlands are urban stormwater detention basins that were constructed to meet local or regional stormwater management ordinances.

Because most new residential or commercial construction requires stormwater detention, the greatest abundance of such wetlands, especially those that have appeared since the original NWI mapping, can be expected to be located in areas that experience the most rapid development. In fact, 85 percent of the total "new" wetlands are located in Reaches 1, 2B, and 3, where open water wetlands comprise the most abundant "new" wetland type. These reaches traverse Lake County and portions of northern Cook County, where explosive development has occurred since the 1980's.

Although these areas collectively represent a significant area, they are of limited value as wildlife habitat. Most wetlands are small and isolated from other habitat by development. Water quality is typically poor, since the primary source of water is runoff from streets, parking lots, and other impervious surfaces.

Wetland losses were expected to be significant during the interval between the original NWI mapping and the inventory conducted for this study. Losses in all reaches were less than 1 percent, with the exception of Reach 10C, which experienced a 6-percent loss. Presumably, regulatory programs such as Section 404 of the Clean Water Act, State floodplain regulations, and local stormwater ordinances, as well as a better public understanding of the importance of wetlands, have helped to limit wetland losses.

Upon a cursory review, the most startling findings might be the overall net increases in wetland acreage that were reported for all reaches. These increases ranged from less than 1 percent (Reach 10C) to 56 percent (Reach 5A). Increases in Reaches 1, 2B, and 3 were all 23 percent. Smaller increases were seen in lower reaches, although they ranged from 1 to 8 percent. To a great extent, these increases reflected the number of excavated ponds constructed during the intervening period. These would likely have been identified using the methods employed by the original NWI, and therefore are directly comparable to the original NWI maps. However, as stated in the Study Methodology section, the results of this inventory are not directly comparable to the NWI effort because mapping procedures and materials differed significantly. The differences would be most pronounced in the identification of previously unmapped natural wetlands, especially those that are seasonally saturated or inundated for only brief periods.

This study used low-altitude, high-resolution aerial photographs, that were supported by extensive ground-truthing. Published data, such as soil surveys and notes on plant communities, were used to supplement the data.

Wetlands that are difficult to identify using NWI procedures (e.g., forested wetlands, temporarily inundated or saturated wetlands) were identified with greater certainty. For example, this study identified 11 previously unmapped forested wetlands in Reach 2B. It is unlikely that these truly represent "new" wetlands that appeared on the landscape, but rather are wetlands that were beyond the limits of resolution of NWI or were outside of the operational definition of wetlands used by NWI at the time of mapping.

Fishes and Benthic Macroinvertebrates

Fish communities in undisturbed habitats have characteristic structure and composition that change when the physical habitat or chemical/water quality is altered. Populations become grossly imbalanced in favor of habitat "generalists," such as green sunfish and fathead minnows, at the expense of habitat "specialists," such as darters that are intolerant of habitat degradation. Overall species richness decreases, as does the proportion of top carnivores. Physical simplification of the habitat occurring through stream channelization eliminates species-isolating mechanisms and promotes hybridization. These and other community characteristics have been developed into a series of metrics and incorporated into an Index of Biotic Integrity (IBI), which is an accepted standard for evaluating stream fish communities in the Midwest (Karr et al., 1986).

Biotic indices of benthic macroinvertebrates use the concept of the indicator species, which are species that have specific tolerances relative to a known set of physical or chemical conditions. Biotic indices assess the degree of pollution in an aquatic system, based on known tolerances or sensitivities of macroinvertebrate species to specific pollutants (Rosenberg and Resh, 1993). For example, in most regions, chironomid midges are reliable indicators of organic pollution. Similarly, the abundance of the tubificid worm *(Limnodrilus hoffmeisteri)* increases with organic pollution. Thus, the dominance of these taxa strongly suggests significant environmental disturbance, especially in the absence of taxa that are intolerant of environmental disturbance.

Over the past 20 years, periodic fish sampling has been conducted in most reaches of the Chicago Waterway System. In general, fish populations that are severely impacted by habitat degradation caused by physical habitat modification, sediment contamination, point and non-point discharges, high flows, combined sewer overflows, and other factors occur throughout most of the reaches. However, improvement in the fish community has occurred over the last 20 years. This improvement is a key trend because the fish communities in most reaches are still moderately to severely degraded.

Collections throughout most of the system were dominated by green sunfish, carp, and goldfish, species that are tolerant of high turbidity and low dissolved oxygen. Carnivorous fishes were sporadically present in low numbers, and are moderately pollution-tolerant species (e.g., black crappie; largemouth bass). Hybrids of carp and goldfish and of various sunfishes were also present in most surveys. Hybrids are also indicative of environmental stresses and the breakdown of species-isolating mechanisms. As a result of the long history of municipal and industrial pollutant discharges and from urban runoff, fish populations, as a whole, are limited to the more pollution-tolerant species.

Similarly, benthic invertebrate communities range from moderately tolerant to highly tolerant. The most depauperate invertebrate communities occur in the soft sediments of the deep draft reaches of the waterway system. Some evidence shows that the number of benthic invertebrate species has increased over the years and the percentage composition has changed. However, benthic invertebrate communities overall remain degraded.

Because the upper reaches of the Chicago Waterway System comprise the headwaters and have not been as intensively developed for urban use as have the middle and lower reaches, the three upper forks of the North Branch appear not to have been subject to the severity of habitat degradation as have the lower reaches. This is somewhat obscured by a less well-developed historic collection record and by the

fact that species diversity naturally tends to increase from headwaters to lower reaches.

A total of 14, 16, and 9 fish species were collected from Reaches 1, 2B, and 3, respectively, which compares favorably with collections made by MWRDGC in the early 1980's (Brigham et al., 1978). The collections, however, were all dominated by species considered pollution-tolerant, and were disproportionately represented by green sunfish and fathead minnows.

Hite and Bertrand (1989) classified the Middle Fork (Reach 2B) as a Grade D stream, or a limited aquatic resource. Mierzwa and Beltz (1994), however, calculated an IBI score of 31 for the same reach, based on a single collection. This equates to a Grade C classification, or a moderate aquatic resource. Water quality data cited in Brigham et al. (1978) showed elevated levels of ammonia nitrogen, silver, and cyanide in the upper reaches, suggesting chemical pollution as an important factor impacting fish populations. Still, with only 11 fish species known historically from these reaches, there is little evidence that species richness has declined over time. It is also not known how thoroughly these reaches were sampled prior to large-scale habitat alteration.

Collection of an Iowa darter, a State-listed endangered species, from the West Fork (Reach 1) is significant. Originally, the Iowa darter was common throughout the northern portion of Illinois, but was presumably decimated by increased turbidity and the drainage of natural bodies of standing water (Smith, 1979). As a group, darters are considered to be intolerant of habitat degradation, although some can withstand low oxygen concentrations. Others (e.g., Johnny darter) are widely distributed and are routinely found in rather degraded conditions.

Other noteworthy species collected include a young-of-the-year northern pike and one of the native madtoms *(Noturus* sp.) from the Middle Fork (Reach 2B). The northern pike is significant because it suggests reproduction is occurring by a relatively intolerant species. A single madtom was the only record for this genus in the Chicago Waterway System.

Fish community composition in this waterway is limited by structural habitat diversity, water quality, and sediment contamination. The extent that water quality or sediment contamination has on fish populations in the upper reaches is unknown. However, stream habitat structure in all three forks of the North Branch has been greatly simplified through stream channelization. The presence of these three fish species (Iowa darter, northern pike, and native madtoms) suggests that water quality, although poor, may not be limiting. It is possible that in-stream habitat enhancement and streamside wetland creation could be directed at these upper reaches in ways that could benefit remnant fish species diversity.

Benthic invertebrate populations are also more diverse in the upper reaches than in the lower reaches, probably due to the same influences affecting fish communities. MBI scores for Reaches 1, 2A, 2B, 3, 5A and 5B are all within the moderately pollution-tolerant range. The benthic invertebrate communities found in the upper reaches are significantly more diverse than downstream. These communities consist of beetles, true bugs, mayflies, caddisflies, dragonflies, sowbugs, snails, and clams. None of the benthic taxa collected are considered intolerant of pollution, but are considerably less tolerant than than the predominant species collected in the lower reaches.

Fish species diversity appears to decline in Reach 5A below the confluence of the three forks of the North Branch and upstream of the North Shore Channel. Repeated collection attempts by MWRDGC in 1976 in this reach produced no fish (cited in Brigham et al, 1978). Only three species were collected at two stations by MWRDGC in 1980 (Schmeelk et al., 1984), and six species were collected at one station in 1981 (Schmeelk, 1985). Sampling conducted through NAWQA in 1990 resulted in collecting only four species (Warren, 1991), and no fish were collected at two stations in 1993. The fish species represented in these surveys (carp, pumpkinseed, fathead minnow, green sunfish, white sucker, yellow bullhead, and largemouth bass) are considered moderately to highly tolerant of degraded habitat conditions.

Low fish species diversity in this reach seems somewhat anomalous because the stream channel retains far more natural habitat than the three forks which support a more diverse fish community. This occurrence is also counter to the trend for fish species diversity which increases with greater stream order and higher habitat complexity associated with the downstream versus upstream reaches. Either water quality may be limiting fish species diversity or the small sample sizes may be due to sampling bias.

Fish and invertebrate communities remain significantly degraded in the middle and lower reaches, although improvement has been documented in recent years largely due to improvements in municipal waste treatment.

One of the most dramatic improvements in water quality in the Chicago Waterway System during the last 20 years is in the fish species composition in the North Shore Channel (Reach 4). In 1976, MWRDGC collected 12 species from this reach, all of which were represented at the Sheridan Road Station nearest Lake Michigan.

Collections made at two stations located downstream on the North Shore Channel totaled three and two species, respectively (Brigham et al, 1978). The greater diversity of species at the Sheridan Road Station was due to the proximity to Lake Michigan, which is the upstream source of water for the channel. Diversity was greatly reduced downstream because of progressively poorer water quality.

In contrast, sampling conducted by MWRDGC at four North Shore Channel Stations in 1991 from upstream (nearest lake Michigan) to downstream, resulted in collecting 21, 15, 15, and 16 species, respectively, for a total of 25 species from the entire Reach (Dennison et al., 1992). This corresponds to a period of significant increases in dissolved oxygen and reductions in ammonia nitrogen and suspended solids downstream of the MWRDGC North Side Water Reclamation Plant (Polls et al., 1994).

Despite this increase in fish species richness, overall biotic integrity remains poor to fair. Calculated IBI values for the four sampling stations on the North Shore Channel ranged from 20 (very poor stream quality, a restricted use aquatic resource) to 34 (fair stream quality, a moderate aquatic resource), with an average IBI of 27 for all samplings at all stations (Dennison et al., 1992).

A similar trend is noted in the deep draft portion of the North Branch of the Chicago River (Reach 5B). Four fish species were collected at one station and no fish were collected at a second station (Brigham et al., 1978). Dennison, et al (1992) recorded 16 species at 2 stations in this same reach. IBI values, however, ranged from 18 (very poor stream quality, a restricted use aquatic resource) to 24 (poor stream quality, limited aquatic resource).

The southern reaches of the waterway system, including the South Branch, Chicago Sanitary and Ship Canal, and the Cal-Sag Channel, are all characterized by pollution-tolerant fish communities, reflecting a long history of habitat degradation caused by of channelization, dredging, pollutant discharges, contaminated urban runoff, and sediment contamination. The fish community tends to be highly imbalanced and dominated by relatively few habitat generalists that are tolerant of habitat degradation.

Existing conditions have been documented through two collections. In 1994, a fisheries investigation of the upper Illinois Waterway conducted for Commonwealth Edison by EA Engineering, Science, and Technology (1995) described the fish assemblage in the Lockport Pool (Reaches 8, 9A, and 9B) as very poor. The fish community was characterized by low fish abundance and was dominated by highly tolerant species.

Collections made by MWRDGC (Dennison et al., 1992) in the Chicago Sanitary and Ship Canal resulted in 19 species, but were overwhelmingly dominated by carp, goldfish, and bluntnose minnows. IBI values at the sampling stations in this reach ranged from 16 to 30 (very poor to poor stream quality). In the same reach, MWRDGC collected only four species of fish in 1977, reflecting considerable improvement in habitat quality (cited in Brigham et al., 1978) .

The Cal-Sag Channel is similar to the Chicago Sanitary and Ship Canal in the quality of its fish communities. Dennison, et al (1992), however, found a greater species richness and higher IBI values in the Calumet River, reflecting its connection and proximity to Lake Michigan and Lake Calumet. This phenomenon was also observed near the mouths of the Chicago River and the North Shore Channel.

In summary, fish communities throughout the Chicago Waterway System and in the lower reaches have become significantly more diverse during the last 20 years. However, they remain moderately to severely degraded by objective standards. The degraded condition of the fish communities is related both to physical habitat simplification that has occurred as a result of navigational dredging and to poor water quality caused by large inputs of urban runoff and residual contamination.

The benthic invertebrate community also reflects extremely degraded sediment quality. Surveys conducted throughout the middle and lower reaches were dominated by naidid and tubificid worms and by chironomid midges, which proliferate in silty, organically rich substrates. The long history of municipal and industrial discharges, bank and upland erosion throughout the watershed, and a low energy depositional environment have resulted in a buildup of organically rich silt deposits. These present a poor substrate for invertebrate colonization.

Maintenance dredging for navigation has removed most in-stream structures that would otherwise serve as attachments for benthic invertebrates. Commercial vessels create constant turbulence which physically displace benthic invertebrates and resuspend silt, causing chronic turbidity (Environmental Science and Engineering, 1995). All of these factors combine to create a hostile environment for all but the most tolerant invertebrates.

Waterways

Reaches 1, 2A, 2B, 3, and 5A have distinctive physical habitat and faunal characteristics. Although these stream segments have been extensively channelized, they retain a distinct headwater character, including shallows, limited riffle and pool sequences, and in-stream structure. By contrast, middle and lower reaches have been deepened for navigation and more closely resemble lotic habitat. These reaches have also been more severely degraded from municipal and industrial pollution which, although significantly abated in recent years, continues to pollute sediments.

Upper reaches are generally smaller and shallower and have at least some areas of firm substrate. Stream velocities, particularly under high-flow conditions, are much higher than the deep draft portions of the waterway which allow for some bottom scouring and bedload transport. This situation minimizes the accumulation of organically rich, contaminated bottom sediments. Sunlight penetrates to the stream bottom in many of the shallowest reaches, and there is often an abundance of course particulate organic material (e.g. sticks, leaves, and root masses) which serves as attachment sites for benthic invertebrates.

Upper reaches are also above most point-source discharges, and the watershed is less intensively developed. Less development results in a lower volume of contaminated urban discharges to the stream. A combination of better water quality and greater habitat diversity is likely responsible for the greater species diversity found in the upper reaches.

The remainder of the Chicago Waterway System from the mouth of the North Shore Channel in Wilmette south to the Lockport lock and eastward through the Cal-Sag Channel to Calumet Harbor has been repeatedly dredged and deepened for commercial navigation. This area has also served the Chicago metropolitan area's waste disposal needs since the 1800's. Thus, its basic character is radically different from upstream reaches, as reflected by different fauna.

Aquatic macrophytes are extremely limited in areal extent in the lower reaches, although occasional aquatic macrophyte beds can be found in channel border locations (Environmental Science and Engineering, Inc., 1994a). Prior to the 1980's, aquatic macrophytes were absent in the lower reaches of the waterway system (Irwin Polls, MWRDGC, pers. comm.). Macrophytes are important to aquatic systems for a variety of reasons. Several functions that aquatic macrophytes perform are nutrient retention and removal, stormwater detention/ flood flow alteration, sediment detention, fish and wildlife habitat, shoreline stabilization, and water quality improvement. These plant communities also provide habitat for aquatic invertebrates and fish, as well as food supply and nesting habitat for waterfowl and wading birds (Adamus et al., 1991).

Overall, water quality in the lower reaches is probably adequate to support aquatic macrophytes and a host of invertebrates dependent on them if physical habitat characteristics were not limiting. Turbidity, poor sediment quality, and excessive water depths have been identified as factors limiting plant growth in the pool above Lockport (Tazik, 1995). In these reaches, main channel borders provide the only available habitat, but even these areas are generally unsuitable because they typically are lined with seawalls or riprap, which create a high energy, scouring environment. The result has been a very limited distribution of macrophyte beds, consisting of common species that are relatively pollution-tolerant.

Water quality, as reflected in the recent diversification of fish communities, has improved markedly during the last 20 years (Polls et al., 1994). Further improvements in water quality will likely occur as the benefits of the recently constructed Sidestream Elevated Pool Aeration systems are realized. Other factors, such as watershed characteristics, sediment quality, and physical habitat limitations, will limit the extent of recovery and rehabilitation.

Nearly the entire Chicago Waterway System has been channelized, which has created uniform habitat conditions unsuitable for habitat specialists. This condition is most prevalent throughout the southern two-thirds of the project area, where the channel has been greatly enlarged and modified for commercial navigation and the banks have been supported with steel sheet piling or riprap. Structurally, this modification has created continuous, uniform pool habitat without riffle and pool sequences, raceways, undercut banks, debris piles, sand and gravel bars, or marshy backwaters. Species typically adapted to such habitats are lost from the system.

Upper reaches of the waterway are much narrower and shallower than the lower reaches. Some stretches either retain or are redeveloping instream and streamside habitat structure. The greatest opportunity to reconstruct stream habitat as a means of further diversifying aquatic communities is available in the upper reaches. Headwaters also hold the greatest potential for such activities. If habitat structure can be redeveloped, then there is further opportunity to improve aquatic communities through watershed management practices. The upper reaches provide the greatest opportunity for watershed management activities because they are less densely developed. These activities could include a combination of wetland restoration, stormwater detention pond retrofitting, streamside buffers, vegetated drainage swales and other practices.

Historically, water quality in the Chicago Waterway System has been poor due to municipal and industrial discharges. Since the enactment of the Clean Water Act, these pollution sources have been significantly abated, and the recent diversification in the fish populations is mostly attributable to lower levels of pollutants in point source discharges.

Additional improvements may be seen as the Tunnel and Reservoir Project becomes fully implemented. It is possible, however, that the most significant improvements reflected in overall stream biodiversity have already occurred. Efforts to further curtail municipal and industrial discharges may be met with diminishing returns due to the fixed characteristics of the watershed.

The Chicago Waterway System watershed is largely urbanized and is mainly characterized by impervious surfaces. Impervious surfaces collect pollutants deposited from various sources where they are quickly washed into receiving waters during rainfall. Several recent studies (discussed in Schueler, 1994) show that water quality cannot be maintained under a certain threshold of imperviousness, and that common indicators of stream health (e.g., benthic invertebrate diversity) show significant drops in urban streams, sometimes with as little as 10-15 percent surrounding imperviousness. At this threshold, intolerant or specialized invertebrates begin to be replaced by tolerant species such as chironomids and tubificid worms, which are the dominant benthic fauna in the Chicago Waterway System. Not only do impervious surfaces affect stream communities due to pollutant loads, higher peak flows occur, which destabilize and simplify channel structure. These events affect the structural component of habitat quality.

Elimination of future municipal and industrial waste discharges can be achieved through regulatory programs aimed at principal polluters. However, when pollutant sources are as diffuse as atmospheric deposition and automobile use, or consist of in-place pollutants associated with stable sediments whose removal is neither logistically nor economically practical, the remedy is not easy. Modifying watershed runoff characteristics in fully developed areas to reduce this pollutant source will require a sustained and coordinated watershed planning effort involving many local governments and planning bodies. A small-scale demonstration project in the Chicago area could demonstrate how such modifications could be achieved.